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The Stoneflies of Minnesota (Plecoptera)

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INTRODUCTION

THE INCREASING INTEREST in recent years in stream management based on thorough knowledge of the biotic as well as the physical and chemical factors concerned has focused attention on the need of further study of the aquatic insects involved. In Minnesota progress has been made in recent years in the study of three groups of aquatic insects, namely, Trichoptera by Denning *(33, 34)*, Ephemeroptera by Daggy *(30, 31)*, and the dipterous family, Simuliidae, by Nicholson and Mickel *(88)*.

The writers are endeavoring in this and a previous work *(50)* to add to the knowledge of another aquatic group, Plecoptera or stoneflies. Emphasis has been placed on associating undescribed nymphs with previously named adults and verifying associations previously made. Collections of stoneflies have been made by the writers in all the major streams of the state and in many of their tributaries. Collecting was done every month of the year; however, most of the field work was done in the spring and early summer, since most species found in Minnesota emerge at that time of the year.

Of the 207 species of stoneflies treated by Needham and Claassen in their monograph on the stoneflies of America north of Mexico *(82)*, 11 were recorded from Minnesota. The total number of species from Minnesota now stands at 51. Of these, the nymphs of 38 species have been previously described, four of them by one of the writers. In the present work five nymphs are described for the first time and associated with the appropriate species, bringing the total number of known nymphs in the state to 43. This leaves eight species of stoneflies known at present from Minnesota with undescribed nymphs, four of which are new species being described for the first time by the writers.

[1] From a thesis submitted by the senior author to the University of Minnesota in partial fulfillment of the requirements for the degree of Doctor of Philosophy. The writers wish to express their appreciation to Dr. Richard Daggy for his aid in collecting and rearing, to the late Dr. T. H. Frison for determinations and counsel, and to Maxine Harden for assistance in the drawings for this study.

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[4] Numbers in parentheses refer to Literature Cited, page 77.

Economic Importance

The main importance of stoneflies is as food for fish. Future study may show that they can be used more extensively as ecological indicators, but little progress has been made in that line as yet. At least one species has been shown to be injurious to fruit crops *(83)*. A study of the food of trout in Yellowstone Park by Muttkowski *(74)* revealed that stoneflies in that area made up about 90 per cent of the food of the cutthroat trout. However, studies in other areas show that stoneflies make up a much smaller proportion of trout food than that found by Muttkowski; results have varied from 0.9 per cent to 16 per cent *(51, 67, 70, 73, 93)*. The value of Plecoptera to fishermen as bait and as models for flies should not be overlooked *(63)*.

Biology of Nymphs

The embryonic development of a stonefly, *Pteronarcys proteus* Newman, is reported by Miller *(71, 72)* to require 5½ months, although 10 months elapse between the time of oviposition and the time of hatching. A New Zealand species, *Stenoperla prasina* (Newman) was found by Helson *(53)* to have an incubation period of about 94 days.

Most nymphs have fully developed compound eyes on hatching but some species have been reported to have a group of simple ocelli in the position of the compound eyes in the earliest instar or instars. Such a condition was reported for *Stenoperla prasina (53);* for *Eusthenia spectabilis* Westwood, an Australian species *(92);* and for *Taeniopteryx maura* (Pictet), a North American species *(38*, p. 402*)*.

In their nymphal development stoneflies pass through a large number of instars. *Nemoura vallicularia* Wu was reported to have 22 nymphal instars, completing its development in one year *(116)*. *Perla burmeisteriana* Claassen was observed to have 22 nymphal instars also *(102);* however, this latter species required 3½ to 4 years to complete its nymphal development. *Pteronarcys proteus* Newman was reported to have 12 instars in male nymphs and 13 instars in female nymphs *(55, 56)*. Most of the smaller species have been reported to require but one year for their life cycle. Some overwinter in the egg but some of them pass the winter as nymphs. The writers maintained eggs of *Isoperla bilineata* (Say) under laboratory conditions from June through the summer. Hatching was observed in October; however, the small nymphs failed to survive in the laboratory.

The nymphs of stoneflies vary in their feeding habits, some being herbivorous and some carnivorous. As a rule the members of the suborder Filipalpia, containing the families Pteronarcidae and Nemouridae, feed on plant matter and detritus. Members of the suborder Setipalpia, containing the families Perlidae, Perlodidae, and Chloroperlidae, are mixed in their feeding habits, with many of them herbivorous. The gut content of five nymphs of the species *Isoperla bilineata* (Say) was examined and found to consist mainly of small aquatic larvae, most of them belonging to the dipterous family Chironomidae. The same was found to be true for five *Isoperla slossonae* nymphs and for five *I. signata* nymphs.

Methods of Association, Rearing, and Collecting

The fact that many of the adult characteristics are found in the nymphs has been an aid in the association of nymphs with described adults. Rearing is, of course, the most reliable method of association. Another possibility is that of collecting nymphs, exuviae, and adults at the time of emergence and from a locality in which there is but one species emerging.

Many methods of rearing stoneflies have been described. One makes use of an aquarium or artificial pond with a continual inflow of tap water *(108)*. Wu *(116)* kept and reared his specimens in vials stoppered with bolting silk and placed in the bed of a small springfed stream. Frison *(39)* constructed small cages of wood and screen which were partially submerged in running water of the habitat from which the nymphs were taken.

The method of rearing used by the writers was that used by Denning and by Daggy. In this method a long series of air outlets is connected to a source of compressed air by means of rubber tubing with glass or metal T joints. From these outlets air is conducted to alundum bacteriological filters in the water of rearing jars.

Wide-mouthed quart jars were used as rearing jars. A piece of cheesecloth was held over the top of each jar by means of a rubber band, and the cloth was tucked snugly around the air hose of each jar to prevent the escape of the adults when they emerged. A reducing valve with a meter made possible the regulation of airflow to the rearing jars; a pressure of two or three pounds per square inch was maintained to these jars.

Many adults of the spring and summer species of Plecoptera of Minnesota have been collected by "sweeping" the vegetation along streams. Some have been taken at lights, and many have been obtained by rearing. The early spring species were most easily obtained from bridges over streams in which they are found or from trees nearby. The nymphs of many species could most easily be collected by wading through riffles and rapids and picking up small rocks and stones from the water. The mature nymphs were picked off with tweezers and put into a jar.

A metal frame sieve net with a short handle and with a lining of fine meshed screen was found convenient, especially in the deep and swift currents. In use the net was held against the bottom in a current while the collector moved stones and gravel about with his feet in front of the net. Thus many nymphs were dislodged and caught in the net. Some species were obtained by "sweeping" the vegetation in the water with an aquatic net. Others were best collected by gathering and picking over masses of leaves and twigs lodged in the stream. Still others were obtained by rolling over logs and tree trunks partially submerged in a stream.

Living specimens of the nymphs were taken from the streams to the laboratory in quart jars with screen covers, the jars being carried in a milk bottle carrier. It was necessary, especially on warm days, to stop every hour or so at some stream to replace the water in the jar with fresh water.

Preservation and Study

Both adults and nymphs in the University of Minnesota Collection are preserved in a modified Hood's solution. (Hood's solution is made up as follows: 95 per cent ethyl alcohol, eight parts; distilled water, five parts; glycerin, one part; glacial acetic acid, one part.) Mouthparts of nymphs were dissected out in 95 per cent alcohol and mounted directly from that alcohol into diaphane. Mounts made in this manner 10 years ago are still in good condition. Drawings of the mouthparts for this work were made with a camera lucida on a compound microscope. The drawings of the whole nymphs were made with the use of a micrometer eyepiece in a wide field binocular dissecting microscope.

In keys and descriptions of nymphs length is the distance from the most anterior point of the head to the tip of the abdomen exclusive of the antennae and cerci. Length in adults is the distance from the most anterior point of the head to the tip of the wings. Width of the head in both nymphs and adults is the width including the compound eyes. Color, unless stated otherwise, is of specimens preserved in Hood's solution.

The synonymy given for each species includes only the original description, the reference in Needham and Claassen *(82)*, and any subsequent references which include descriptive or biological material on the species or synonymies. If subsequent research has shown that a synonymy given in Needham and Claassen is in error, or if a species is not listed in that monograph, a complete synonymy is given. The type specimens of the new species described herein are in the University of Minnesota Collection on the St. Paul Campus.

In the Minnesota records of a species the counties are listed in general from south to north and from west to east. The initials PHH listed with the collection data refer to one of the writers, Harden, as collector.

SYSTEMATIC TREATISE

Key to Families and Subfamilies

Adapted from Ricker (87)

Adults

1. The tip of the glossa produced nearly as far forward as the tip of the paraglossa or farther (suborder **SETIPALPIA**) 2
   The tip of the glossa situated much behind that of the paraglossa (suborder Filipalpia) 7
2. Remains of branched gills present on the ventral side of abdominal segments 1 and 2 as well as on the thorax; anal area of forewing with two or more full rows of crossveins ..... **PTERONARCIDAE**
   Remains of branched gills absent from the abdomen; anal area of forewing without crossveins or with only one row of them 3
3. Cockroachlike; the head normally turned under, broader than long; only two ocelli; costal crossveins of the forewing numerous, at least 10 in number. (Not recorded in Minnesota.) ..... **PELTOPERLIDAE**

   Form typical; ocelli three; costal crossveins few ..... **NEMOURIDAE** 4
4. Second tarsal segment at least as long as the first; cerci with one to several segments ..... **TAENIOPTERYGINAE**
   Second tarsal segment much shorter than the first 5
5. Either with wings rolled around the body at rest, or with A_2 of the forewing simple and cerci usually four-to-many segmented 6
   Wings lying nearly flat when at rest, A_2 of forewing forked, and cerci consisting of only a single segment ..... **NEMOURINAE**
6. Wings rolled around the body; intercubital crossveins in forewing usually more than five; A_2 of forewing forked; cerci consisting of a single segment ..... **LEUCTRINAE**
   Wings lying flat; usually only one (rarely two) intercubital crossveins in the forewing; A_2 simple; cerci of at least four segments ..... **CAPNIINAE**
7. Remains of gills present at the lower angles of the thorax. Cubito-anal crossvein of forewing usually in the anal cell or distant from it by no more than its own length; supraanal lobe of male simple, very little modified ..... **PERLIDAE** 8
   Remains of gills absent from the thorax. Cubito-anal crossveins, if present, usually distant from the anal cell by more than its own length 10
8. Male with subanal lobes produced inward and upward, sharply pointed or hooked; middle of hind margin of the tenth tergite not cleft; a definitely raised knob or hammer usually present on the ninth sternite (absent in **Perlesta**). Dorsal prolongations of the hind margin of the tenth tergite usually absent; if present, they are developed from its lateral angles rather than from the sides of a median cleft ..... **ACRONEURIINAE**
   Subanal lobes not modified as above; hind margin of the tenth tergite deeply cleft at the middle, with dorsal prolongations developed from the sides of the cleft and adjacent regions of the hind margin; usually no hammer on the ninth sternite 9
9. With only two ocelli, set very close together ..... **NEOPERLINAE**
   With three ocelli, normally placed ..... **PERLINAE**
10. Pronotum nearly rectangular, the corners acute or narrowly rounded; fork of A_2 of the forewing included in the anal cell so that its two branches leave the cell separately ..... **PERLODIDAE** 11
    Pronotum ellipsoidal; A_2 of the forewing not forked, or forked beyond the anal cell; male supraanal process variously modified, never a simple lobe ..... **CHLOROPERLIDAE**
11. Male tenth tergite completely cleft; supraanal process broadly and irregularly U-shaped in side view, attached to the anterior dorsal end of the segment, surrounded by a fleshy cowl which is slit dorsally, and usually with two lateral stylets inserted on it ..... **ISOGENINAE**
    Male tenth tergite entire, or at most slightly notched; a definite lobe at the hind margin of the male eighth sternite ..... **ISOPERLINAE**

Nymphs

1. The tip of the glossa produced nearly as far forward as the tip of the paraglossa or farther 2
   The tip of the glossa situated much behind that of the paraglossa 7
2. Branched gills present on the ventral side of abdominal segments one and two as well as on the thorax ..... **PTERONARCIDAE**
   Branched gills absent from the abdomen 3
3. Cockroachlike; the head normally turned under, broader than long; ocelli two; thoracic sterna produced posteriorly into thin plates, each overlapping the segment behind it. (Not recorded in Minnesota) ..... **PELTOPERLIDAE**
   Form typical; ocelli three; thoracic sterna not produced ..... **NEMOURIDAE** 4
4. Second tarsal segment at least as long as the first ..... **TAENIOPTERYGINAE**
   Second tarsal segment much shorter than first 5
5. Hindwing pads strongly diverging from the axis of the body ..... **NEMOURINAE**
   Hindwing pads nearly parallel to the axis of the body 6
6. Lateral margins of abdominal segments somewhat rounded, segments widest at posterior margin and narrower towards base. Anal lobe or area of hindwing pad extending far beyond middle of wing pad. Anal gills never present ..... **CAPNIINAE**
   Lateral margins of abdominal segments almost straight; abdomen appearing cylindrical. Anal lobe or area of hindwing pad small, not reaching much beyond the middle of wing pad. Anal gills present in some species ..... **LEUCTRINAE**
7. Branched gills present at the lower angles of the thorax. Paraglossa little longer than broad, its tip very broadly rounded; galea with a transverse suture near its middle region ..... **PERLIDAE**
   Branched gills absent from the thorax. Paraglossa more elongate, its tip acute or narrowly rounded; galea without a suture near the middle 8
8. Medium to large size, the body pigmented in a distinct pattern; cerci usually at least as long as the abdomen; pads of the hindwings in nearly mature nymphs set at an angle so that their central axis diverges considerably from the axis of the body; gills absent, or simple gills present on submentum, thorax, or abdomen ..... **PERLODIDAE** 9
   Usually of small size (if moderately large, the abdomen very narrow and elongate); the body almost concolorous, without a distinct pattern; cerci not more than two-thirds as long as abdomen; pads of the hindwing nearly parallel to the axis of the body ..... **CHLOROPERLIDAE**
9. With a small membranous fingerlike gill located near each side of the outer basal angle of submentum ..... **ISOGENINAE**
   Without such gill on submentum ..... **ISOPERLINAE**

Biology, Taxonomy, and Distribution of Species, Including Keys to Genera and Species

KEY TO THE GENERA OF PTERONARCIDAE

There is but one genus of this family recorded for Minnesota.

KEY TO THE SPECIES OF PTERONARCYS NEWMAN, 1838

Adults

1. Ninth abdominal sternite prolonged backward, bifid; tenth abdominal tergite divided and produced backward into two lobes (males) 2
   Ninth abdominal sternite not prolonged backward; tenth abdominal tergite not divided into two lobes (females) 3
2. Tips bordering the notch in the ninth sternite straightish, not decurved ..... **dorsata**
   Tips bordering the notch in the ninth sternite decurved ventrad ..... **pictetii**
3. Posterior margin of the eighth sternite entire; sometimes two small projections extending caudad ..... **dorsata**
   Posterior margin of the eighth sternite with a small rectangular median incision ..... **pictetii**

Nymphs

1. Tenth tergite projecting caudad and dorsad into a point; posterior margin of ninth sternite almost straight (females) 2
   Projection of tenth tergite extending caudad, then curving ventrad with a peg on its caudal surface (males) 3
2. Females of the two species found in Minnesota separable only by size. Fully developed nymph over 40 millimeters in length ..... **dorsata**
   Fully developed nymph less than 39 millimeters in length ..... **pictetii**
3. Backward projection of ninth sternite subtriangular as in figure 8 of plate IX ..... **pictetii**
   Backward projection of ninth sternite with sides more nearly parallel, as shown in figure 7 of plate IX ..... **dorsata**

Pteronarcys dorsata (Say)

Plate IX, Fig. 7

1823 *Sialis dorsata* Say. West. Quart. Rptr. **2**:164.
1836 *Pteronarcys regalis* Newman. Ent. Mag. **5**:176.
1917 *Pteronarcys dorsata* Smith. Amer. Ent. Soc., Trans. **43**:446 (synonymy).
1923 *Pteronarcys dorsata* Needham and Claassen. Plecoptera of No. Amer. p. 35.
1931 *Pteronarcys dorsata* Claassen. Plecoptera nymphs of Amer. p. 31 (nymph?).

1942 *Pteronarcys dorsata* Frison. Ill. Nat. Hist. Survey Bul. 22:242 (synonymy).

Recorded distribution—type locality: Pittsburg, Pennsylvania. Other records: Maine, to District of Columbia, to Kansas, Minnesota, Alberta, Alaska to Labrador.

Minnesota records—Lake of the Woods County (Rainy River), Koochiching County (Big Falls), St. Louis County (Lester River, French River), Lake County (Stewart River, Gooseberry River), Cook County (Cascade River, Kimbal Creek, Devils Track River). Adults, April and May.

Claassen *(26)* figured and described the nymph of *P. dorsata*, while Frison *(39)* figured the nymph of *P. pictetii*. Later Frison *(41)* stated that after a study of a series of nymphs of both species he was unable to find workable characters which would separate the two. A study of reared material from Minnesota, however, reveals that the mature male nymphs of the two can easily be distinguished on the basis of the difference in the shape of the backward projection of the ninth abdominal sternite. In *P. pictetii* this projection is somewhat triangular, *i.e.*, the sides converge markedly caudad, while in *P. dorsata* this projection is more nearly rectangular, with the sides nearly parallel. The mature female nymphs of the two species can be consistently differentiated in Minnesota material by size.

P. dorsata has been collected from five northeastern counties of the state. The nymphs have been recorded from medium-sized streams and are usually found in riffles or on stony bottoms. The nymphs evidently feed from leaves and other vegetable matter that fall into the water. Several nymphs of this species have been maintained in rearing jars for many months on a diet of elm leaves. The leaves were not eaten completely but were skeletonized, leaving a network of veins.

It is interesting to note that although the ranges of *P. dorsata* and of *P. pictetii* coincide in the eastern part of the United States to a large extent, there is a definite separation of the two in Minnesota. *P. dorsata* has been found only in the northeastern part of the state while *P. pictetii* has been found in Hubbard County in the central part of the state and from there south and east to the southeast corner of the state.

Pteronarcys pictetii Hagen

Plate IX, Fig. 8

1873 *Pteronarcys pictetii* Hagen. Boston Soc. Nat. Hist., Proc. 15:286.
1925 *Pteronarcys nobilis* Needham and Claassen. Plecoptera of No. Amer. p. 26.
1935 *Pteronarcys nobilis* Frison. Ill. Nat. Hist. Survey Bul. 20:336 (nymph).
1942 *Pteronarcys pictetii* Frison. Ill. Nat. Hist. Survey Bul. 22:244 (synonymy, designation of lectotype).

Recorded distribution—type locality: Philadelphia, Pennsylvania. Other records: eastern Canada to Georgia, west to Kansas and Minnesota. There is a doubtful Los Angeles record.

Minnesota records—Houston County (Root River), Fillmore County (Root River), Olmsted County (Bear Creek), Hennepin County, Ramsey County, Anoka County (Coon Creek), Chisago County (stream at North Branch, St. Croix River), Morrison County (Mississippi River), Hubbard County (Straight River). Adults, May and June; one August record.

The nymphs of *P. pictetii* have been taken from some rather small streams as well as from medium and large ones. Some of the streams from which the nymphs have been taken have but little fall and have rather fine sand or silt bottoms. The nymphs are often found clinging to submerged trees and branches or trash anchored under water. They are able to withstand fairly high summer water temperatures. One collection was made from a partially submerged log in a backwash pool of a stream where the water of the pool felt hot to the hand. No thermometer was available to obtain the water temperature of the pool.

The differentiation of the nymphs of this species from those of *P. dorsata*, as well as a comparison of the distribution of the two within the state, is made under the discussion of *P. dorsata*.

FAMILY NEMOURIDAE

Key to the Genera of Taeniopteryginae

From Frison, 41, p. 248

Adults

1. Males with one-segmented anal cerci; ninth abdominal sternite reaching only to tip of abdomen and not abruptly recurved upwards about tip of abdomen; forewings always normal; females with subgenital plate produced scarcely or not at all; both sexes show coxal gill scars ..... **Taeniopteryx**

   Males with several-segmented anal cerci; ninth abdominal sternite abruptly curved up about tip of the abdomen; forewings sometimes brachypterous; females with a well-developed, protruding subgenital plate; both sexes without traces of coxal gill scars ..... **Brachyptera**

Nymphs

1. Coxal gills present; terminal abdominal structures suggestive of characters of adults ..... **Taeniopteryx**

   Coxal gills absent; terminal abdominal structures suggestive of characters of adults ..... **Brachyptera**

KEY TO THE SPECIES OF TAENIOPTERYX PICTET, 1841

Adults *From Frison, 39, pp. 340, 341*

1. Males with a globular appendage on ninth abdominal sternite (subgenital plate); females with portion of eighth abdominal sternite anterior to genital opening darkly sclerotized ..... **maura**

   Males without a globular appendage on abdominal sternite; females with portion of eighth abdominal sternite anterior to genital opening not darkly sclerotized; at most, anterior border of genital opening dark, contrasting with membranous area ..... **parvula**

Nymphs

1. Males and females with a conspicuous white mid-dorsal stripe extending from head to end of abdomen. Apex of male abdomen, side view, with supraanal lobe protruding considerably above apical segment; not so in female. Mature nymphal male with outline of globular appendage visible near middle of ninth sternite ..... **maura**

   Males and females without a conspicuous white mid-dorsal stripe extending from head to end of abdomen. Apex of male abdomen, side view, with supraanal lobe protruding considerably above apical segment; not so in female. Mature nymphal male without outline of appendage visible near middle of ninth sternite ..... **parvula**

Taeniopteryx maura (Pictet)

1841 *Nemoura maura* Pictet. Hist. Nat. des Insectes Neuropteres. p. 361.
1847 *Taeniopteryx nivalis* Fitch. Amer. Jour. Agr. Sci. 5:274.
1925 *Taeniopteryx maura* Needham and Claassen. Plecoptera of No. Amer. p. 239.
1925 *Taeniopteryx nivalis* Needham and Claassen. Plecoptera of No. Amer. p. 240.
1929 *Taeniopteryx nivalis* Frison. Ill. Nat. Hist. Survey Bul. 18:381 (nymph, biology).
1935 *Taeniopteryx nivalis* Frison. Ill. Nat. Hist. Survey Bul. 20:341.
1942 *Taeniopteryx maura* Frison. Ill. Nat. Hist. Survey Bul. 22:248 (synonymy).

Recorded distribution—type locality: Pennsylvania. Other records: Connecticut, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Labrador (?), Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New York, North Carolina, Nova Scotia, Ohio, Oklahoma, Oregon, Tennessee, Virginia, West Virginia, Wisconsin.

Minnesota records—Scott County (Credit River), Hennepin County (Nine Mile Creek, Mississippi River), Anoka County (Coon Creek), Pine County, Carlton County, St. Louis County (stream seven miles north of Cloquet), Lake County (Stewart River), Cook County (Arrowhead River). Adults, March through first week of May.

Taeniopteryx maura has been collected in streams varying from rather sluggish Nine Mile Creek in southern Hennepin County to the rapids below St. Anthony Falls of the Mississippi River. This species, as well as *T. parvula*, is found from eastern central Minnesota up to the northeastern corner of the state. The two species are often taken from the same stream; in fact they are found together more often than separate.

Frison *(39)* records that the females carrying egg masses crawled below the surface of the water where the water dissolved the matrix holding the eggs, allowing them to drop to the bottom.

The recorded range of this species extends from eastern United States and southeastern Canada westward to Oregon on the north and to Missouri on the south.

Taeniopteryx parvula Banks

1918 *Taeniopteryx parvula* Banks. Mus. Comp. Zool. Bul. 62:7.
1925 *Taeniopteryx parvula* Needham and Claassen. Plecoptera of No. Amer. p. 241.
1931 *Taeniopteryx parvula* Claassen. Plecoptera nymphs of Amer. p. 105 (nymph).
1935 *Taeniopteryx parvula* Frison. Ill. Nat. Hist. Survey Bul. 20:345 (nymph, biology).
1942 *Taeniopteryx parvula* Frison. Ill. Nat. Hist. Survey Bul. 22:249 (designation of lectotype; aedeagus figured).

Recorded distribution—type locality: Peach Grove Hill, Virginia. Other records: District of Columbia, Maine, Maryland, Massachusetts, Minnesota, New Jersey, Wisconsin.

Minnesota records—Scott County (Credit River), Hennepin County (Mississippi River), Ramsey County, Anoka County (Rum River, Coon Creek), Chisago County (stream at North Branch), Pine County (Kettle River, junction of St. Croix and Snake Rivers), Lake County (Stewart River), Cook County (Arrowhead River, Reservation River). Adults, March through first week of May.

The occurrence of this species in association with *T. maura* has been noted under the latter species. *T. parvula* has been collected from a greater number of streams in the state than has *T. maura*, although the distribution of these streams within the state is generally about the same. The seasonal occurrence of the two species within the state is also about the same. Adults of *T. maura* have been recorded from March 16 through May 4, while adults of *T. parvula* have been recorded from March 2 through May 4. Frison *(39)* states that in Illinois *T. parvula* occupies a later position in the seasonal succession of adults than does *T. maura*.

The finding of an adult male of *T. parvula* crawling on ice below the surface of the water near exuviae from which it had probably emerged will be mentioned under *Brachyptera glacialis*.

KEY TO THE SPECIES OF BRACHYPTERA NEWPORT, 1851

Adults

1. Eighth abdominal sternite produced as a subtriangular subgenital plate (females) 3

   Eighth abdominal sternite unmodified; ninth abdominal sternite much produced, broad and upturned at caudal end (males) 2

2. Ninth abdominal sternite very broadly rounded behind, its sides almost parallel; inward-pointing process from below each cercus ..... **glacialis**

   Ninth abdominal sternite moderately rounded behind, its sides converging markedly caudad; no inward-pointing process below each cercus ..... **fasciata**

Nymphs

1. Males and females with a conspicuous white mid-dorsal stripe extending from head to end of abdomen. Apex of male abdomen, side view, with supraanal lobe protruding considerably above apical segment; not so in female. Mature nymphal male with outline of globular appendage visible near middle of ninth sternite ..... **maura**

   Males and females without a conspicuous white mid-dorsal stripe extending from head to end of abdomen. Apex of male abdomen, side view, with supraanal lobe protruding considerably above apical segment; not so in female. Mature nymphal male without outline of appendage visible near middle of ninth sternite ..... **parvula**

Taeniopteryx maura (Pictet)

1841 *Nemoura maura* Pictet. Hist. Nat. des Insectes Neuropteres. p. 361.
1847 *Taeniopteryx nivalis* Fitch. Amer. Jour. Agr. Sci. 5:274.
1925 *Taeniopteryx maura* Needham and Claassen. Plecoptera of No. Amer. p. 239.
1925 *Taeniopteryx nivalis* Needham and Claassen. Plecoptera of No. Amer. p. 240.
1929 *Taeniopteryx nivalis* Frison. Ill. Nat. Hist. Survey Bul. 18:381 (nymph, biology).
1935 *Taeniopteryx nivalis* Frison. Ill. Nat. Hist. Survey Bul. 20:341.
1942 *Taeniopteryx maura* Frison. Ill. Nat. Hist. Survey Bul. 22:248 (synonymy).

Recorded distribution—type locality: Pennsylvania. Other records: Connecticut, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Labrador (?), Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New York, North Carolina, Nova Scotia, Ohio, Oklahoma, Oregon, Tennessee, Virginia, West Virginia, Wisconsin.

Minnesota records—Scott County (Credit River), Hennepin County (Nine Mile Creek, Mississippi River), Anoka County (Coon Creek), Pine County, Carlton County, St. Louis County (stream seven miles north of Cloquet), Lake County (Stewart River), Cook County (Arrowhead River). Adults, March through first week of May.

Taeniopteryx maura has been collected in streams varying from rather sluggish Nine Mile Creek in southern Hennepin County to the rapids below St. Anthony Falls of the Mississippi River. This species, as well as *T. parvula*, is found from eastern central Minnesota up to the northeastern corner of the state. The two species are often taken from the same stream; in fact they are found together more often than separate.

Frison *(39)* records that the females carrying egg masses crawled below the surface of the water where the water dissolved the matrix holding the eggs, allowing them to drop to the bottom.

The recorded range of this species extends from eastern United States and southeastern Canada westward to Oregon on the north and to Missouri on the south.

Taeniopteryx parvula Banks

1918 *Taeniopteryx parvula* Banks. Mus. Comp. Zool. Bul. 62:7.
1925 *Taeniopteryx parvula* Needham and Claassen. Plecoptera of No. Amer. p. 241.
1931 *Taeniopteryx parvula* Claassen. Plecoptera nymphs of Amer. p. 105 (nymph).
1935 *Taeniopteryx parvula* Frison. Ill. Nat. Hist. Survey Bul. 20:345 (nymph, biology).
1942 *Taeniopteryx parvula* Frison. Ill. Nat. Hist. Survey Bul. 22:249 (designation of lectotype; aedeagus figured).

Recorded distribution—type locality: Peach Grove Hill, Virginia. Other records: District of Columbia, Maine, Maryland, Massachusetts, Minnesota, New Jersey, Wisconsin.

Minnesota records—Scott County (Credit River), Hennepin County (Mississippi River), Ramsey County, Anoka County (Rum River, Coon Creek), Chisago County (stream at North Branch), Pine County (Kettle River, junction of St. Croix and Snake Rivers), Lake County (Stewart River), Cook County (Arrowhead River, Reservation River). Adults, March through first week of May.

The occurrence of this species in association with *T. maura* has been noted under the latter species. *T. parvula* has been collected from a greater number of streams in the state than has *T. maura*, although the distribution of these streams within the state is generally about the same. The seasonal occurrence of the two species within the state is also about the same. Adults of *T. maura* have been recorded from March 16 through May 4, while adults of *T. parvula* have been recorded from March 2 through May 4. Frison *(39)* states that in Illinois *T. parvula* occupies a later position in the seasonal succession of adults than does *T. maura*.

The finding of an adult male of *T. parvula* crawling on ice below the surface of the water near exuviae from which it had probably emerged will be mentioned under *Brachyptera glacialis*.

KEY TO THE SPECIES OF BRACHYPTERA NEWPORT, 1851

Adults

1. Eighth abdominal sternite produced as a subtriangular subgenital plate (females) 3

   Eighth abdominal sternite unmodified; ninth abdominal sternite much produced, broad and upturned at caudal end (males) 2

2. Ninth abdominal sternite very broadly rounded behind, its sides almost parallel; inward-pointing process from below each cercus ..... **glacialis**

   Ninth abdominal sternite moderately rounded behind, its sides converging markedly caudad; no inward-pointing process below each cercus ..... **fasciata**

3. Subtriangular subgenital plate with sides incurved; notch in seventh abdominal sternite subtriangular ..... **fasciata**
   Subtriangular subgenital plate with sides outcurved; notch in seventh abdominal sternite subrectangular ..... **glacialis**

Nymphs

1. Cerci as long or longer than body; head and prothorax dark above ..... **glacialis**
   Cerci less than two-thirds as long as body; head and prothorax mostly light above ..... **fasciata**

Brachyptera fasciata (Burmeister)

1839 *Semblis fasciata* Burmeister. Handbuch der Ent. **2**:875.
1925 *Taeniopteryx fasciata* Needham and Claassen. Plecoptera of No. Amer. p. 243.
1929 *Strophopteryx fasciata* Frison. Ill. Nat. Hist. Survey Bul. **18**:385 (nymph, biology).
1931 *Taeniopteryx fasciata* Claassen. Plecoptera nymphs of Amer. p. 106 (nymph).
1935 *Strophopteryx fasciata* Frison. Ill. Nat. Hist. Survey Bul. **20**:347 (nymph, biology).
1938 *Taeniopteryx fasciata* Ricker. Roy. Canad. Inst., Trans. **22**:132.
1942 *Brachyptera fasciata* Frison. Ill. Nat. Hist. Survey Bul. **22**:250 (variations noted).

Recorded distribution—type locality: Philadelphia, Pennsylvania. Other records: Connecticut, Illinois, Indiana, Kansas, Maine, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, New York, North Carolina, Ohio, Tennessee, Virginia, Washington, D. C., West Virginia.

Minnesota records—Hennepin County (Mississippi River), Ramsey County, Washington County (St. Croix River), Anoka County (Rice Creek, Coon Creek), Sherburne County (Elk River), Pine County (Kettle River, Snake River). Adults, March through the first week of May.

Brachyptera fasciata is one of the early spring species found in the eastern central part of the state. It is found often in association with *Taeniopteryx maura* and *Taeniopteryx parvula*. *Phasganophora capitata* has often been collected from the same streams as these three species, but at a different time of the year. *B. fasciata* has been collected from riffles and rapids of almost all sizes of streams from creeks to large rivers. Frison *(39)* recorded this species feeding in large numbers on elm blossoms along the Rock River in Illinois.

Brachyptera glacialis (Newport)

Plate IV; VI, Fig. 1; VII, Figs. 5-8

1848 *Nemoura glacialis* Newport. Linn. Soc. London, Proc. 1:389.
1852 *Nemoura glacialis* Newport. Linn. Soc. London, Trans. 20:451.
1861 *Taeniopteryx glacialis* Hagen. Syn. Neuroptera No. Amer. p. 36.

1928 *Taeniopteryx glacialis* Claassen. Ent. Soc. Amer., Ann. **21**:667.
1938 *Taeniopteryx alex* Hanson. Brooklyn Ent. Soc. Bul. **33**:79 (male, female, female nymph).
1938 *Taeniopteryx glacialis* Ricker. Roy. Canad. Inst., Trans. **22**:131 (designated and described lectotype and lectoallotype).
1942 *Taeniopteryx glacialis* Harden. Ent. Soc. Amer., Ann. **35**:321 (male nymph).
1942 *Brachyptera glacialis* Frison. Ill. Nat. Hist. Survey Bul. **22**:251 (synonymy).

Recorded distribution—type locality: Albany River, Ontario, Canada. Other records: Alberta, Connecticut, Minnesota, New York, Saskatchewan, Utah.

Minnesota records—Pine County (Kettle River, junction of Snake and St. Croix Rivers), St. Louis County, Lake County (Stewart River), Cook County (Arrowhead River).

This species has been collected from streams of medium size in the northeastern part of the state. Nymphs have been taken from rocky riffles in most instances. In every stream from which this species has been taken, *Taeniopteryx parvula* has been found also.

The recorded range of *B. glacialis* extends from northeastern United States across the northern part of the country and southern Canada to Utah in the United States and Alberta in Canada. Adults have been collected in Minnesota the last part of March and through most of April.

One of the writers described the male nymph of this species (Harden, *50*). The female and male nymph are figured in the present work. The writer was in error at that time in stating that the types of this species were from Nova Scotia; the type locality is St. Martins Falls, Albany River, Ontario, Canada.

A male of *B. glacialis* was collected under an interesting circumstance from the Snake River in Pine County. This adult male was taken from below the surface of the water, crawling on fixed ice near a firmly attached cast skin from a male of the species. This indicates that it may be possible that at times members of this species emerge beneath the surface of the water. A male of *Taeniopteryx parvula* was collected at about the same time under similar circumstances.

Key to the Genera of Nemourinae

There is but one genus in this subfamily recorded in Minnesota.

KEY TO THE SPECIES OF NEMOURA LATRIELLE, 1796

Adults

1. Supraanal process present; subgenital plate extending backward from eighth abdominal sternite; from its base comes a flaplike ventral lobe (males) 2
   No supraanal process present; no ventral lobe; genital opening on eighth abdominal sternite usually guarded by valves of some form (females) 5

2. Gill remnants in cervical region; supraanal process recurved, narrow, and elongate, bearing spines below; subanal lobes each divided longitudinally and bearing spines ..... **venosa**

   No gill remnants in cervical region; subanal lobes not divided longitudinally 3

3. Ventral lobe circular; cerci membranous, with a sclerotized process from tenth tergite above each cercus ..... **rotunda**

   Ventral lobe longer than wide; no sclerotized process above each cercus 4

4. Cerci modified, sclerotized, each with three spinelike projections; supraanal process largely membranous, wide ..... **trispinosa**

   Cerci unmodified, membranous; supraanal process sclerotized, linear ..... **completa**

5. Gill remnants in cervical region ..... **venosa**

   No gill remnants of any kind 6

6. Eighth abdominal sternite with posterior margin sclerotized, except for genital opening; anterior to each half of sclerotized posterior margin is a broad sclerotized band extending inward from each lateral margin of the sternite and then backward (see plate XII, fig. 5) ..... **rotunda**

   Eighth abdominal sternite not sclerotized as above 7

7. Eighth abdominal sternite unmodified; seventh broadly rounded behind ..... **trispinosa**

   Seventh abdominal sternite unmodified; eighth not produced but with a notch in the center of posterior margin ..... **completa**

Nymphs

1. Cervical gills present ..... **venosa**

   Cervical gills absent 2

2. Pronotum broadly rounded on sides, subcircular, much narrower than head ..... **rotunda**

   Pronotum subrectangular, about as wide as head 3

3. Dorsal aspect of femur and tibia of each leg with longitudinal stripe almost void of hairs and setae; length of mature nymph about seven mm. ..... **trispinosa**

   Dorsal aspect of femur and tibia of each leg with hairs and setae quite uniformly distributed; length of mature nymph about five mm. ..... **completa**

Nemoura completa Walker

Plate I, Fig. 2; Plate VIII, Figs. 1, 2

1852 *Nemoura completa* Walker. Cat. Neurop. Insects Brit. Mus. p. 191.
1923 *Nemoura glabra* Claassen. Canad. Ent. **55:**281 (male and female).
1925 *Nemoura glabra* Needham and Claassen. Plecoptera of No. Amer. p. 202.
1938 *Nemoura completa* Ricker. Roy. Canad. Inst., Trans. **22:**133 (synonymy).
1943 *Nemoura completa* Ricker. Stoneflies of S.W. Brit. Columbia. p. 68 (nymph).

Recorded distribution—type locality: Nova Scotia. Other records: British Columbia, Colorado, Maine, Utah, Washington.

Minnesota records—Scott County, Pine County (Crooked River, Bangs Brook), Carlton County (east branch, Nemadji River), Hubbard County (Straight River), St. Louis County (stream seven miles north of Cloquet). Adults, March 16 through May 22.

For many years this species went under the name of *Nemoura glabra* until Ricker *(96)* examined the type in the British Museum and designated the correct nomenclature for the species.

Ricker *(97)* gave an outline figure and a description of the nymph of *N. completa*. His description (*97*, p. 68) is as follows:

> "Length (extended), 5 mm. Cerci with 17 segments; antennae about 40.
> "Color (in alcohol) brown, rather mottled on head and thorax in these specimens, but this is probably the adult pattern beginning to show. Tenth tergite of male pointed in front and projecting behind; tenth sternite not chitinized in the mid line below. Ninth sternite pointed posteriorly and somewhat elongated anteriorly. Female ninth sternite slightly notched anteriorly. A median narrow light-colored line from the metanotum to the middle of the head, where it branches to go to the anterior border of either eye. No dorsal stripe on the abdomen. Mouth parts typical of the genus, galea as long as the lacinia.
> "Body not very hairy, as compared with some other species. A bordering ring of very short spines on the sides and front of the pronotum (these equal to about one third of the length of the shortest antennal segment), plus a single spine about 4 times as long as the others (but still shorter than the leg hairs) at each anterolateral angle. Femora and tibiae with hairs of varied size, the longest equal to the width of the basal antennal segment, i.e., much shorter than in most species of *Nemoura*. Abdomen with numerous short spines, especially in the mid line and on the hind margins of the segments, in which last situation there are also a few much longer spines. Bristles on the ends of the segments of the cerci very short, about one third of the width of basal segments, and equal to the width of the terminal ones."

Figures of a complete nymph and of its right mandible and right maxilla have been made to supplement Ricker's description and outline figure (plate I, fig. 2; plate VIII, figs. 1, 2).

Nemoura completa has been taken from or near medium-sized and small streams in east central and northeastern Minnesota. Ricker states *(97)* that in British Columbia it is a species of the larger rivers.

This species, like the other three species of *Nemoura* found in the state, has a range that extends from eastern United States and Canada across or almost across the continent from east to west. To the west *N. completa* has been found as far as Washington and British Columbia. The species that has been found most often in the same stream with *N. completa* is *Isoperla dicala*.

Nemoura rotunda Claassen

Plate I, Fig. 1; Plate VIII, Figs. 5, 6; Plate XII, Fig. 5

1923 *Nemoura rotunda* Claassen. Canad. Ent. **55:**280 (male and female).
1925 *Nemoura rotunda* Needham and Claassen. Plecoptera of No. Amer. p. 219.

Recorded distribution—type locality: Waldeboro, Maine. Other records: Manitoba, New Brunswick, Nova Scotia, Saskatchewan.

Minnesota records—Winona County (Mississippi River), Chisago County (St. Croix River), Pine County (Kettle River, Snake River), Carlton County (Little Otter River), Morrison County (Mississippi River), Mille Lacs County, St. Louis County (Stony Brook River), Beltrami County. Adults, April through June.

Female nymphs

Length 7.5 to 8.5 mm.; width of head 1.2 to 1.3 mm. General color yellowish-brown above with pronotum lighter than head; mesonotum and metanotum lighter than pronotum; abdomen about the same shade as pronotum; darker callosities and rugosities on head. Practically no pattern on pronotum. Small dark setae scattered over most of the surface.

Head wider than long. Ocelli dark brown; lateral ocelli ovate with long axis converging somewhat caudad. Ocelli form isosceles triangle with base somewhat longer than a side. Lateral ocelli closer to the eyes than to each other. A dark brown callosity behind each lateral ocellus, one at antero-medial margin of each compound eye and one behind and mesad of base of each antenna. A light yellow area around the junction of the coronal suture and the postfrontal sutures behind and between the lateral ocelli. Some obscure rugosities caudad to the postfrontal suture.

Pronotum much narrower than head, slightly wider than long. Small dark setae scattered over its surface. Practically no color pattern present. A narrow yellow line divides it into two lateral halves, the line continuing down the middle of the mesonotum and metanotum. Mesonotum and metanotum with fewer setae than pronotum. Wing pads narrow, diverging. Anal area of posterior wing pads slightly less than two-thirds as long as the inner margins of the posterior wing pads.

Each abdominal tergite with a row of small dark setae on its posterior margin and few setae over its surface. Tenth tergite broadly rounded behind, with a small membranous protrusion behind and below it.

Length of antennae about half the length of the body. Length of last antennal segment about equal to diameter of second antennal segment. Length of cerci about equal to that of antennae; length of last segment of cerci about equal to the diameter of the first antennal segment.

Legs yellow with a wide slightly darkened transverse band before the apex of the femora and a like band near the base of the tibia. First and second tarsal segments equal in length to the third segment; second tarsal segment half as long as the first. Small dark setae scattered over most of the area of the femora and tibiae. A row of long slender yellow hairs along the outer margin of each tibia.

Nymph generally yellow below. Mouth parts as figured, plate VIII, figs. 5, 6.

Male nymphs

Length 5.9 to 7.0 mm.; width of head 1.0 to 1.15 mm. General features same as those of female nymph; smaller in size; tenth abdominal tergite differs from that of the female.

Tenth tergite bifid caudad; emargination of tenth tergite covered with yellow membrane beneath which parts of the developing genitalia can be seen.

The interesting sclerotization pattern of the eighth sternite of the adult female was described and figured in the unpublished portion of a master's thesis by the senior author *(49)*. The figure is reproduced here, plate XII, fig. 5.

The known range of this species was extended much farther south than was formerly recorded, by the finding of a female *N. rotunda* by Mary E. Warters at John Latsch State Park in Winona County in the southern part of Minnesota and by the discovery of a female of this species along with a long series of *Nemoura venosa* taken in 1926 from Rockford, Illinois (now in the Illinois Natural History Survey Collection).

In Minnesota *N. rotunda* has been taken from or near large and medium rivers. Nymphs were taken in large numbers from the grass and leaves in the margin of the St. Croix River about a mile below Taylors Falls. Nymphs of this species were also observed through the clear water, crawling about on the rocky perpendicular sides of the gorge just below these falls.

Species found most often in the same streams as *N. rotunda* are *Brachyptera fasciata* and *Isoperla marlynia*.

Nemoura trispinosa Claassen

Plate VI, Fig. 4; Plate VII, Figs. 9-12

1923 *Nemoura trispinosa* Claassen. Canad. Ent. **55**:289 (male and female).

1925 *Nemoura trispinosa* Needham and Claassen. Plecoptera of No. Amer. p. 213.

1942 *Nemoura trispinosa* Harden. Ent. Soc. Amer., Ann. **35**:322 (nymph).

1942 *Nemoura trispinosa* Frison. Ill. Nat. Hist. Survey Bul. **22**:261 (male and female refigured).

Recorded distribution—type locality: Mud Creek, Tompkins County, New York. Other records: Illinois, Mackenzie, Manitoba, Minnesota, Nova Scotia, Quebec.

Minnesota records—Houston County (brook from bluff three miles north of Brownsville, spring outlet three miles northwest of New Albin, Iowa), Winona County (brook at base of Gwinn's Bluff), Goodhue County (small stream near Frontenac), Hennepin County (Minnehaha Creek, Isaac Walton Bass Pond Stream), St. Louis County (stream three miles north of Bass Lake). Adults, May through the first week of June.

Nemoura trispinosa has a rather scattered distribution across the continent from Nova Scotia to Mackenzie and south to northern Illinois. This is definitely a species of very small streams and spring outlets. Both localities in Houston County from which nymphs of this species were collected were spring outlets. One of these, located three miles northwest of New Albin, Iowa, was only six inches wide in places and not over 100 feet long before it reached the swampy flood plain of Winne-

bago Creek. No nymphs were found in the rivulet on this flood plain nor could any stonefly nymphs be found in Winnebago Creek in this area where that stream was badly silted. Thus it appears that in this instance the species was confined to the spring outlet where it bubbled a comparatively few yards down a hillside.

Approximately the same could be said of the habitat from which nymphs were collected three miles north of Brownsville, also in Houston County. Some of the other brooks from which nymphs were collected were somewhat larger, but none was so large that one could not easily step across it at most places along its course. Nymphs were found clinging both to the underside of small stones and to dead leaves in the streams.

An interesting reaction on the part of adults reared from the locality near Brownsville was noted. When approached, two adults were observed to crawl beneath the surface of the water on sticks placed upright in the rearing jars and to remain underwater a short period of time.

No other species of stonefly was found in the same streams with *N. trispinosa* in collections made by the writer in Minnesota. Frison records *Leuctra tenuis* from the same place as *N. trispinosa*, the Botanical Gardens at Elgin, Illinois.

Nemoura venosa Banks

1897 *Nemoura venosa* Banks. Amer. Ent. Soc., Trans. **24**:21.

1925 *Nemoura venosa* Needham and Claassen. Plecoptera of No. Amer. p. 209 (male and female).

1931 *Nemoura venosa* Claassen. Plecoptera nymphs of Amer. p. 95 (nymph).

1935 *Nemoura venosa* Frison. Ill. Nat. Hist. Survey Bul. **20**:349 (nymph).

1942 *Nemoura venosa* Frison. Ill. Nat. Hist. Survey Bul. **22**:261 (male and female refigured).

1944 *Nemoura venosa* Ricker. Canad. Ent. **76**:177 (variation noted).

Recorded distribution—type locality: Colden, New York. Other records: Illinois, Indiana, Mackenzie, Maine, Massachusetts, New Brunswick, North Carolina, Nova Scotia, Ohio, Pennsylvania, Virginia, West Virginia, Florida.

Minnesota records—Houston County (Upper Winnebago Creek), Carlton County (Little Otter Creek), Hubbard County (LaSalle Creek), Koochiching County, St. Louis County (McCarty Brook, Martin's Brook, French River), Cook County (Kadunce Creek, Cascade River, Durfee Creek). Adults, last week of July through first week of September.

Ricker (*98*, p. 177) says of specimens probably of this species from Cameron Bay, Great Bear Lake, Mackenzie, Canada:

> "As compared with specimens from southern Ontario and Indiana, they are small. The male genitalia also show differences; the supraanal process is shorter and broader, while the subanal lobes are much less developed, being scarcely curved forward, and having the armature of spines greatly reduced. The females have much shallower median and lateral notches in the subgenital plate than have Indiana females. However, similar, if less drastic differences are evident in comparing specimens from southern localities, so no taxonomic recognition of these points seems necessary."

The adult specimens of *Nemoura venosa* from Minnesota tend to resemble those from the northern part of its range with a few differences. The subanal lobes of the males are smaller and are each divided about equally into an outer and inner lobe instead of being unequally divided into a small outer and a large inner lobe. The valves of the female subgenital plate are sclerotized, being membranous in the females from the southern part of the range.

In addition, the nymphs from the northern part of Minnesota have much heavier and darker hairs and setae than those from farther south. The one nymph of this species from Houston County, near the southern border of the state, is of the southern type. A complete study of the whole series of *N. venosa*, both adults and nymphs, is desirable to determine whether Ricker's conclusion concerning the variation in this species is correct or whether two species or subspecies are involved.

N. venosa is one of the very few late summer and fall stoneflies found in Minnesota. Emergence of adults was recorded for July 29 through September 6.

Key to the Genera of Leuctrinae

There is but one genus recorded in this subfamily in Minnesota.

KEY TO THE SPECIES OF LEUCTRA STEPHENS, 1835

Adults

1. Raised sclerotized process on seventh or eighth abdominal tergites (males) 2
   No raised sclerotized process on seventh or eighth abdominal tergite (females) 4
2. Eighth abdominal tergite with raised sclerotized process ..... **decepta**
   Seventh abdominal tergite with raised sclerotized process 3
3. Sclerotized process of seventh abdominal tergite reaching across seventh tergite onto the eighth ..... **tenuis**
   Sclerotized process of seventh abdominal tergite not reaching more than halfway across the tergite ..... **hamula**
4. Membranous area of subgenital plate linear, narrow ..... **decepta**
   Membranous area of subgenital plate wide, almost circular ..... **tenuis**

Note: In this genus, only *decepta* females in good condition are available in the University of Minnesota collection. The *hamula* females are in very poor condition. No *tenuis* females are in the collection. The character used above in couplet 4 is from Frison (*41*, p. 259). Only the nymph of *L. decepta* is known in the genus in Minnesota.

Leuctra decepta Claassen

1923 *Leuctra decepta* Claassen. Canad. Ent. **55**:260 (male and female).

1925 *Leuctra decepta* Needham and Claassen. Plecoptera of No. Amer. p. 227.

1931 *Leuctra decepta* Claassen. Plecoptera nymphs of Amer. p. 99 (nymph).

1942 *Leuctra decepta* Frison. Ill. Nat. Hist. Survey Bul. **22:**257 (refigured male and female).

Recorded distribution—type locality: Ithaca, New York. Other records: Florida, Georgia, Illinois, Maine, Minnesota, New Brunswick, North Carolina, Nova Scotia, Ohio, Ontario, Tennessee, Virginia.

Minnesota records—St. Louis County (French River), Lake County (Gooseberry River, Encampment River), Cook County (Kadunce Creek, Cascade River, Temperance River, Durfee Creek). Adults, July and August.

In Minnesota *L. decepta* seems to be confined to streams running into Lake Superior along the north shore, since this species was collected from eight such streams ranging in size from creeks to small rivers.

This species, along with the two other species of the genus recorded from the state, has its farthest northwest record in Minnesota. Algonquin Park from which Frison *(41)* recorded this species in Ontario is in the eastern part of the province.

Nymphs of *L. decepta* were taken from an extremely fast rapids in the lower part of the French River in St. Louis County as well as from a sluggish part of Kadunce Creek above the fall line along Lake Superior. In this latter place the nymphs were found among leaves and trash held by branches which had fallen into the stream.

Leuctra hamula Claassen

1923 *Leuctra hamula* Claassen. Canad. Ent. **55:**261 (male and female).
1925 *Leuctra hamula* Needham and Claassen. Plecoptera of No. Amer. p. 229.

Recorded distribution—type locality: Old Forge, New York. Other records: Maine, New Brunswick, New Jersey, Nova Scotia.

Minnesota records—Cook County (Little Devils Track River, Kadunce Creek). Adults, August.

The above specimens were determined by Frison in 1938. Efforts in the late summer of 1948 by one of the writers to obtain other adults and nymphs from the streams recorded brought negative results.

Leuctra tenuis (Pictet)

1841 *Nemoura tenuis* Pictet. Hist. Nat. des Insectes Neuropteres. p. 375.
1925 *Leuctra tenuis* Needham and Claassen. Plecoptera of No. Amer. p. 232 (male and female).
1938 *Leuctra tenuis* Ricker. Roy. Canad. Inst., Trans. **22:**134 (saw types).
1942 *Leuctra tenuis* Frison. Ill. Nat. Hist. Survey Bul. **22:**258 (refigured male and female).

Recorded distribution—type locality: Philadelphia, Pennsylvania. Other records: Illinois, Maine, Michigan, Missouri, New Brunswick, New Jersey, New York, North Carolina, Nova Scotia, Ontario, Tennessee.

Minnesota record—Cook County. Kimbal Creek, July 22, 1948, PHH, one male.

Greer Spring in eastern Missouri is, along with the record from Minnesota listed above, the westernmost extension of the species. Frison *(op. cit.)* recorded the possession of nymphs of this species but did not describe or figure them. As stated by Claassen *(26,* p. 96) the nymphs of the various species of *Leuctra* are quite homogeneous in appearance. Close study will be necessary before differentiation of the various species can be made.

Key to the Genera of Capniinae

Modified from Frison, 39

Adults

1. Subcosta of forewing uniting with the costa much before the cord, a transverse line-up of crossveins and parts of longitudinal veins beyond the middle of the wing. Anal field or lobe of hindwing large, nearly as long as the front portion ..... **Allocapnia**
   Subcosta of forewing extending to or nearly to the cord. Anal field of hindwing not extending much beyond middle of wing ..... **Paracapnia** and **Capnia**

Nymphs

1. Wing pads present in most species; absent or rudimentary in at least one species. Anal field of wing pad--when wing pad present—extending almost the full length of pad ..... **Allocapnia**
   Wing pads always present, although sometimes reduced. Anal field of wing pad not extending much beyond the middle of pad ..... **Paracapnia**

(Note: The nymph of *Capnia vernalis,* the only member of the genus recorded for the state, is not known.)

KEY TO THE SPECIES OF PARACAPNIA AND CAPNIA

Adults

1. With a supraanal process recurved forward above ninth and tenth tergites (males) 2
   Without a supraanal process (females) 4
2. Supraanal process curving at base, more slender than that of the species below, projecting forward and tapering slightly toward apex; process 0.55 to 0.60 mm. long ..... **Paracapnia curvata**
   Supraanal process angulate at base, projecting forward 3
3. Supraanal process tapering toward its apex; subanal lobes rather blunt, fused with an underlying part to form a deeply trilobed plate ..... **Paracapnia opis**
   Supraanal process abruptly constricted two-thirds of its length forward, the distal one-third markedly more slender than the proximal two-thirds; subanal lobes acutely pointed, their inner margins heavily sclerotized and approximated so that they form a plate with a single acute tip ..... **Capnia vernalis**

4. Seventh and eighth abdominal sternites joined by a narrow sclerotized bridge; median one-third of the posterior margin of the eighth abdominal sternite darkly sclerotized; from this margin extending forward the sclerotized floor of the genital tract can be seen through the eighth sternite ..... **Capnia vernalis**
   Seventh and eighth abdominal sternites not joined by sclerotized bridge; no sclerotized floor of genital tract visible through eighth sternite 5
5. Head width more than 0.90 mm. ..... **Paracapnia opis**
   Head width less than 0.87 mm. ..... **Paracapnia curvata**

Nymphs

This key applies only to mature nymphs, those showing convoluted wings inside the wing pads.

1. An acute projection extending upward and backward from below caudal margin of tenth tergite (males) 2
   No acute projection from the tenth segment (females) 3
2. Head width less than 0.78 mm. ..... **Paracapnia curvata**
   Head width more than 0.81 mm. ..... **Paracapnia opis**
3. Head width less than 0.87 mm. ..... **Paracapnia curvata**
   Head width more than 0.90 mm. ..... **Paracapnia opis**

Nymphs of *Capnia vernalis* are not known.

GENUS CAPNIA PICTET, 1841

Capnia vernalis Newport

1843 *Capnia vernalis* Newport. Linn. Soc. London, Proc. **1**:388.
1851 *Capnia vernalis* Newport. Linn. Soc. London, Trans. **20**:451.
1938 *Capnia vernalis* Ricker. Roy. Canad. Inst., Trans. **22**:135 (designated and described lectotype and lectoallotype).

Recorded distribution—type locality: Albany River, Ontario, Canada. Other records: Alberta, Manitoba, Ohio (?).

Minnesota records—St. Louis County. Duluth, May 4, 1941, D. G. Denning, one male, one female.

Lake County. Stewart River, April 11, 1941, C. E. Mickel, one male.

The species now recognized as *Paracapnia opis* (Newman) has for many years gone under the name of *Capnia vernalis* (Newport). Ricker *(96)* revealed the true identity of the two species and figured the male and female genitalia of the latter species. Frison *(41)* accepted Ricker's use of the name *opis* but suggested that *vernalis* was but a variant of *opis* since he had found but one species in a long series studied from eastern North America including Ohio. (Ohio is mentioned in particular since Walker in 1947 lists *vernalis* from that state, probably using *vernalis* Needham and Claassen, not Newport.)

Ricker (*97*, p. 95) again shows *vernalis* to be a distinct species in his key to the *Capnia (s. l.)* of North America, listing it from northern Ontario, Manitoba, and Alberta. Except for the doubtful Ohio record, Minnesota represents the southernmost extension of the species recorded to date. This is the only species of which this can be said at present.

The sclerotized floor of the female genital tract is visible through the eighth sternite and is quite characteristic of the species. A series of females of *Paracapnia opis* and *P. curvata* were cleared in KOH solution; none of these showed this sclerotized genital tract either before or after treatment.

Judging by the streams near which the adults were collected in Minnesota, Lester River and Stewart River, this species is found in medium streams. The nymph is as yet unknown.

GENUS PARACAPNIA HANSON, 1946

Paracapnia curvata Hanson

Plate II, Fig. 1; Plate VIII, Figs. 3, 4

1946 *Paracapnia curvata* Hanson. Amer. Midland Nat. **35**:237 (male and female).

Recorded distribution—type locality: Arietta, Hamilton County, New York. Other records: Minnesota.

Minnesota records—Lake County (Stewart River, Knife River), Cook County (Temperance River, Devils Track River, Arrowhead River, Pigeon River). Adults, April.

P. curvata adults are found in fairly large numbers along some of the larger streams running into Lake Superior in Cook County. They are found more sparsely farther south along this north shore of the lake.

The one species of stoneflies with which *P. curvata* was found most often was *Allocapnia minima*. *P. curvata* was found with *Paracapnia opis* in or near but two streams, the Knife River and the Stewart River—both in Lake County.

Hanson, in his description of *P. curvata* gives the forewing length of the males as four to five mm. A series of about 40 males from Minnesota was measured, males from several different rivers being used, and it was found that among these the length of forewings varied from about two mm. to five mm. There was a noticeable grouping of lengths about the 2.5-2.9 mm. length and another grouping about the 4.0-4.4 mm. lengths. To be specific, the distribution is as follows:

Forewing length	*P. curvata*	*P. opis*
millimeters	number	number
1.5-1.9	1	1
2.0-2.4	4	3
2.5-2.9	12	2
3.0-3.4	3	2
3.5-3.9	1	1
4.0-4.4	12	1
4.5-4.9	6	6
5.0-5.4	2	2
Total	41	17

For comparison the measurements of the forewing lengths of 17 *P. opis* males are listed in the last column. In neither species did the stream from which the specimens came seem to influence wing length.

Male nymphs

Length about 7.0 mm.; width of head about 0.8 mm. General color brownish-yellow above with brown pattern. Antennae and cerci lighter toward extremities. Long coarse hairs over most of the body. Wing pad length variable.

Head much wider than long. Ocelli scarcely visible. Distance from one lateral ocellus to nearest compound eye more than three times distance between lateral ocelli. Base of ocellar triangle longer than side. Dark M connecting bases of antennae; this M interrupted in the middle by the median ocellus. Hairs on M interrupted in the middle by the median ocellus. Hairs on clypeus directed inward. Hairs present between compound eye and antenna on each side both above and below.

Pronotum as wide as head; wider posteriorly; corners rounded; anterior margin outcurved; posterior margin straight. An irregular row of long, upright, stiff hairs completely around margin. Disk of pronotum brown with anterior and lateral margins yellowish-brown.

Mesonotum and metanotum yellowish-brown. Axis of wing pads almost straight back. A patch of stiff hairs in front of base of anterior wing pads. A row of hairs about margin of each wing pad with a few scattered hairs on wing pad surface.

Lateral margin of each abdominal segment almost straight. A very diffuse dark pattern on abdominal tergites 1 through 4. Contrasting pattern on tergites 5 through 9 made up of a dark band on the anterior margin and a dark ovate spot on each side midway on the tergite. The anterior dark band is interrupted on the median line of each tergite; the ovate spot is obliquely placed with the median end farther forward. Tenth tergite cleft by a median piece. Developing supraanal process extending upward and backward from below this median piece. Long stiff hairs at posterior margin of each tergite; other somewhat shorter stiff hairs scattered over each tergite with some longer ones near the anterior margin. Hairs much fewer and shorter on first four tergites than on the remaining ones. Cerci about as long as abdomen. Antennae shorter than cerci. Legs brownish-yellow.

Femora and tibiae covered with stiff hairs above. Row of silky hairs on posterior margin of femora and tibiae. First tarsal segment one-third as long as third; second much shorter than first. Mouth parts as figured, plate VIII, figs. 3, 4.

Female nymphs

Length about 8.0 mm.; width of head about 0.9 mm. Same general form and color as male nymph. Wing pads longer. Abdomen lacks anterior dark band on tergites. No developing supraanal process present.

The above descriptions are from nymphs obtained from the Arrowhead River in Cook County, April 7, 1948.

Paracapnia opis (Newman)

1839 *Chloroperla opis* Newman. Mag. Nat. Hist. N. S. **3**:89.

1925 *Capnia vernalis* Needham and Claassen. Plecoptera of No. Amer. p. 256 (male and female).

1931 *Capnia vernalis* Claassen. Plecoptera nymphs of Amer. p. 109 (nymph).

1938 *Capnia opis* Ricker. Roy. Canad. Inst., Trans. **22**:134 (saw types, synonymy).

1942 *Capnia opis* Frison. Ill. Nat. Hist. Survey Bul. **22**:264 (distribution).

1946 *Paracapnia opis* Hanson. Amer. Midland Nat. **35**:236.

Recorded distribution—type locality: "Weston" or "Chuston," Newfoundland. Other records: Connecticut, Illinois, Maryland, Michigan, New York, North Carolina, Ohio, Ontario, Pennsylvania, Quebec, Tennessee, Virginia, West Virginia, Wisconsin.

Minnesota records—Pine County (Kettle River), Carlton County (Little Otter Creek), St. Louis County (stream seven miles north of Cloquet, French River), Lake County (Stewart River, Knife River), Cook County (Kimbal Creek). Adults, March 24 through April 22.

Although Hanson *(loc. cit.)* maintains that the true identity of *P. opis* is in doubt, there is no doubt in the writers' minds concerning it. Without knowledge of the true *Capnia vernalis*, one might find Ricker's *(96)* differentiation of the types of the two above species somewhat ambiguous. But with the finding of *P. vernalis* in recent years as a species distinct from *P. opis*, no further confusion should result.

The variation of the forewing of the males of *P. opis* has been noted under *P. curvata*. It can be noted from the chart that this length varies in *P. opis* from 1.4 to 5.2 mm. The adults of *P. opis* are somewhat larger than those of *P. curvata*.

Minnesota probably represents the present recorded western limit of this species. Frison *(loc. cit.)* lists a record from Glen Major, Ontario. No Glen Major could be located on Ontario maps or lists of towns and cities, but there is a Glen Meyer near Tillsonburg in Norfolk County in southeastern Ontario. If Frison's record refers to this place, then the Minnesota records represent a considerable westward extension of the known range of this species.

KEY TO THE SPECIES OF ALLOCAPNIA CLAASSEN, 1928

Adults

1. With a slender dark sclerotized supraanal process recurved above the ninth and tenth abdominal tergites; eighth sternite unmodified; usually brachypterous (males) 2
   Without a supraanal process; eighth abdominal sternite variously modified (females) 5
2. No wings ..... **vivipara**
   With at least short wings 3
3. Eighth abdominal tergite expanded caudad and dorsad and ending in a single tubercle; less than five mm. in length ..... **minima**
   Eighth abdominal tergite with two tubercles; length more than 5.5 mm. 4

4. Eighth abdominal tergite expanded caudad and dorsad; two tubercles on the posterior margin of this expansion ..... **granulata**
   Eighth abdominal tergite expanded dorsad only—in its posterior part; the two tubercles before the posterior margin of this expansion ..... **pygmaea**
5. Brachypterous; wings reaching less than half the length of abdomen ..... **vivipara**
   Macropterous; wings extending past end of abdomen 6
6. Length to tip of wings 5.0 to 5.5 mm.; a dark rectangular sclerotized area in the median area of the eighth abdominal sternite, this dark area slightly longer than wide ..... **minima**
   Length to tip of wings more than 6.0 mm. 7
7. Eighth abdominal sternite separate from the seventh; eighth modified as a subgenital plate on its posterior border; caudal angles of this plate acute and directed outward ..... **granulata**
   Eighth abdominal sternite fused with seventh 8
8. Eighth abdominal sternite as wide as seventh and smoothly fused with it ..... **vivipara**
   Eighth abdominal sternite narrower than seventh and inset from it ..... **pygmaea**

Nymphs

This key applies only to mature nymphs in which the convoluted, unexpanded wings can be seen within the wing pads.

1. With a protuberance extending upward and backward from the tenth tergite (males) 2
   With tenth tergite convex behind but not extended as a protuberance (females) 5
2. Mature nymphs, those over six mm. in length, with no wing pads ..... **vivipara**
   Mature nymphs, those over 4.5 mm. in length, with at least short wing pads 3
3. With circular single brown spot on dorsum of eighth abdominal tergite; length less than 5 mm. ..... **minima**
   With a two-lobed brown or yellow spot on dorsum of eighth abdominal tergite; length over 5.5 mm. 4
4. General color usually light brown with obscure darker markings; length of tenth tergite of abdomen, including developing supra-anal process, less than width of that segment; apex rounded ..... **granulata**
   General color usually yellow with contrasting brown markings; length of tenth tergite of abdomen, including the developing supraanal process, equal to or greater than width of tenth segment; apex triangular and somewhat pointed ..... **pygmaea**
5. Length of mature nymph less than six mm. ..... **minima**
   Length of mature nymph more than seven mm. 6
6. Wing pads short; forewing pads less than three times as long as wide ..... **vivipara**
   Wing pads normal; forewing pads at least four times as long as wide 7
7. Two dark spots in front of median ocellus; general color yellow, with contrasting dark pattern above ..... **pygmaea**
   No dark dots immediately in front of median ocellus; general color brown, with obscure color pattern above ..... **granulata**

Allocapnia granulata (Claassen)

Plate III, Fig. 1; Plate IX, Figs. 1, 2

1924 *Capnella granulata* Claassen. Canad. Ent. **56:**44.
1925 *Capnella granulata* Needham and Claassen. Plecoptera of No. Amer. p. 273.
1929 *Allocapnia granulata* Frison. Ill. Nat. Hist. Survey Bul. **18:**394 (nymph).
1931 *Allocapnia granulata* Claassen. Plecoptera nymphs of Amer. p. 114 (nymph).
1935 *Allocapnia granulata* Frison. Ill. Nat. Hist. Survey Bul. **20:**364.

Recorded distribution—type locality: Johnstown, New York. Other records: Washington, D.C., Illinois, Indiana, Maryland, Ohio.

Minnesota records—Scott County (Credit River), Lake County (Knife River), Lake of the Woods County. This Minnesota record from Lake of the Woods County is the farthest north that this species has been recorded to date.

Female nymphs

Length 7.5 to 9.0 mm.; width of head 0.9 to 1.0 mm.; antennae 4.0 to 4.4 mm. in length; cerci 2.8 to 3.7 mm. in length. General color light brown with obscure somewhat darker markings.

Head same width as pronotum; dorsal markings include a spot mesad of each antenna—one inside the anteromesal angle of each compound eye—and an intricate pattern between the compound eyes and behind the postfrontal suture.

Pronotum somewhat wider than long, with a curved submarginal groove along the anterior margin. Quite prominent hairs around the margin, those along the anterior and posterior margins being most noticeable. The obscure pattern on the pronotum is somewhat variable.

Length of anterior wing pads on outside margin about 1.4 mm.; width about 0.6 mm. Anal area so large that there is practically no indication of the division between the main part of wing pad and its anal area.

Abdomen almost uniformly brown above, with some obscure darker spots on the sides. Two dark dots on the tenth tergite. Legs yellow.

Mouth parts as figured, plate IX, figs. 1, 2.

Male nymphs

Length about 7.5 mm.; width of head about 1.0 mm. General appearance like that of the female, with the following exceptions:

Length of anterior wing pads on outside margin about 0.5 mm.; width about 0.28 mm.

Length of posterior wing pads on outside margin about 0.51 mm.; width about 0.3 mm.

Eighth tergite with two yellow spots near the median line; tenth tergite extended outward and upward to contain the developing supra-anal processes; this extension rounded on apex. Length of tenth tergite

including this extension 0.45 to 0.55 mm., its length being less than the width of the tenth segment.

Both Claassen *(26)* and Frison *(39)* take out *A. granulata* and *A. pygmaea* together in their keys to the nymphs of *Allocapnia* and state that the two are practically alike. In order to facilitate their differentiation a further description of the nymphs of the former species is given above. Descriptions and figures of the latter are cited under that species.

Nymphs of *A. granulata* were found in a rocky riffle of the Credit River, a small stream running into the Minnesota River from the south. Adults have been collected from the last day of January through April.

Allocapnia minima (Newport)

Plate III, Fig. 2; Plate IX, Figs. 3, 4

1848 *Perla minima* Newport. Linn. Soc. London, Proc. **1**:388.
1851 *Perla minima* Newport. Linn. Soc. London, Trans. **20**:450.
1924 *Capnella incisura* Claassen. Canad. Ent. **56**:45.
1925 *Capnella incisura* Needham and Claassen. Plecoptera of No. Amer. p. 275.
1938 *Allocapnia minima* Ricker. Roy. Canad. Inst., Trans. **22**:136.

Recorded distribution—type locality: St. Martins Falls, Albany River, Canada. Other records: Illinois (?), Newfoundland, New York, Nova Scotia, Maine, Ontario.

Minnesota records—Chisago County (stream at North Branch), Pine County (St. Croix River), St. Louis County (Sucker River, Lester River, stream seven miles north of Cloquet), Lake County (Stewart River, Knife River, west branch of Silver Creek), Cook County (Temperance River, Kimbal Creek, Arrowhead River, Reservation River, Pigeon River).

Female nymphs

Length 5.3 mm.; width of head 0.72 mm. General color pale yellowish-brown with a few brown markings. Legs and antennae also pale yellowish-brown. A faint brown speckling over dorsal aspects of head, pronotum, and median areas of mesonotum and metanotum.

Head wider than long. A transversely oval brown spot median to each antenna on dorsum of head; another more elongate oval spot median to each compound eye, the longer axis of this spot directed toward the antenna of the same side. Ocelli only faintly visible as somewhat lighter spots.

Pronotum wider than long, narrowed anteriorly; median half of anterior margin rounded; posterior margin straight; posterior angles rounded. Narrow yellow stripe on pronotum with darker line down its center and darker pattern on each side.

Anterior wing pads narrow; outside margin about 1.1 mm. in length; width about 0.3 mm. Posterior wing pads broad, outside margin about 0.9 mm. in length; width about 0.5 mm.; anal region almost as long as wing pad.

Abdomen generally brownish-yellow above, with two darker spots on both sides of each segment and two dark dots above these spots on the first seven segments; one dark spot on each side of the eighth and ninth segment. A row of fine yellow hairs on posterior margin of each tibia.

Mouthparts as figured, plate IX, figs. 3, 4.

Male nymphs

Length 4.8 mm.; width of head 0.60 mm.; length of antennae about 2 mm.; length of cerci also about 2 mm. Legs, dorsum of head, and pronotum same as in female nymph. Length of anterior wing pads on outside margin about 0.55 mm.; width about 0.2 mm. Length of posterior wing pads, outside, about 0.45 mm.; width about 0.22 mm.

Abdomen with brown pattern above as follows: a patch beginning on each side of a median light stripe on the anterior third of each of the first six segments. This patch extending laterad and ventrad to about the median lateral line and on this line extending caudad two-thirds the width of the segment. A diffuse spot in the angle of this patch on the second and third segments; two brown dots, one above the other, on the fourth segment; in succeeding segments these dots tend to become fused with the brown patch. Eighth segment with a brown patch on the side and a brown dot on the dorsal median line two-thirds of the way back on the segment. Supraanal process protruding upward and backward from the tenth segment.

This species is listed under the name *Allocapnia incisura*, in Claassen's *Plecoptera Nymphs of North America (26)* but no description or figure is given.

In Minnesota *A. minima* has been found in or along several of the streams on the north shore of Lake Superior, in the St. Croix River, and along Hay Creek in Chisago County. It has been collected from March 22 through May 4. A spider was observed eating an adult female on a bridge over the Arrowhead River.

Allocapnia pygmaea (Burmeister)

Plate XI, Fig. 2; Plate XII, Figs. 1, 2

1839 *Semblis pygmaea* Burmeister. Handbuch der Ent. **2**:874.
1925 *Capnella pygmaea* Needham and Claassen. Plecoptera of No. Amer. p. 277.
1931 *Allocapnia pygmaea* Claassen. Plecoptera nymphs of Amer. p. 112 (nymph).
1935 *Allocapnia torontonensis* Ricker. Canad. Ent. **67**:257.
1935 *Allocapnia pygmaea* Frison. Ill. Nat. Hist. Survey Bul. **20**:367 (in part).
1941 *Allocapnia torontonensis* Harden. Unpublished part of thesis, p. 25.
1942 *Allocapnia pygmaea* Frison. Ill. Nat. Hist. Survey Bul. **22**:265 (*A. torontonensis* synonymized).
1943 *Allocapnia pygmaea* Hanson. Brooklyn Ent. Soc. Bul. **38**:155.

Recorded distribution—type locality: Pennsylvania. Other records: Connecticut, Georgia, Illinois, Indiana, New Hampshire, New York, North Carolina, Maine, Maryland, Massachusetts, Michigan, Minnesota, Ohio, Ontario, Tennessee, Virginia, Washington, D.C., West Virginia, Wisconsin.

Minnesota records—Scott County (Credit River), Anoka County, St. Louis County (Sucker River, Lester River, stream seven miles north of Cloquet), Lake County (Stewart River, Knife River, west branch of Silver Creek), Cook County (Arrowhead River, Reservation River).

Of interest is the finding of an adult of this species, as well as an adult of *A. granulata*, under 12 inches of ice on January 30, 1940, by Dr. Charles Rief. In order to carry on an observation in a stream study that he was making, he had chopped a hole in the ice over some riffles in Credit River near Savage, Minnesota, and found these two adult stoneflies crawling out from beneath the ice. This observation indicated the possibility that these species may emerge beneath the ice over rapids, mate and lay eggs without coming out into the open.

The nymphs of *A. pygmaea* have been collected from rocky riffles. Adults have been found in the state from January 30 through April 18.

Allocapnia vivipara (Claassen)

1924 *Capnella vivipara* Claassen. Canad. Ent. **56**:46.
1925 *Capnella vivipara* Needham and Claassen. Plecoptera of No. Amer. p. 276.
1929 *Allocapnia vivipara* Frison. Ill. Nat. Hist. Survey Bul. **18**:392 (nymph, biology).
1931 *Allocapnia vivipara* Claassen. Plecoptera nymphs of Amer. p. 114 (nymph).
1942 *Allocapnia vivipara* Frison. Ill. Nat. Hist. Survey Bul. **22**:265 (synonymy).

Recorded distribution—type locality: Lake Forest, Illinois. Other records: New York, Missouri, Ohio, Indiana, Iowa, Kansas, Kentucky, Oklahoma, Pennsylvania, Tennessee, Virginia, and West Virginia.

Minnesota records—Rice County. Nerstrand Woods, April 29, 1949, C. E. Mickel, two females; same time and place, A. A. Soliman, two females.

The finding of *Allocapnia vivipara* in southern Minnesota by the junior author adds another interesting species of stoneflies to the state list. This collection in Minnesota probably represents the northernmost record of this species and certainly a northwestern extension of the known range. The previous most northern record of the species is Bluff Point, New York. Since there is a Bluff Point on Lake Champlain in northeastern New York and also a Bluff Point in southwest central New York not far west of Ithaca, one cannot be certain of the point of collection of *A. vivipara* in that state. The latter location is probably the place of collection.

Frison *(38)* recorded this species from small and medium streams in Illinois, with greatest abundance in the former size. The small stream from which it was collected in Minnesota is a south branch of Prairie Creek, between sections 9 and 10, R 19 W, T 110 N. This stream goes over a small falls caused by a limestone layer and below this runs over limestone rubble. At the time one of the writers visited it in the last part of May it was little more than a trickle between small pools. No other species of stonefly was found at the time of the collection of adults on April 29 nor at the time of the visit of one of the writers in the last part of May.

Claassen *(24)* maintained that this species is ovoviviparous, but Frison *(38)* disputed this claim after making several dissections of gravid females. Only eggs could be seen through the thin ventral body wall of the females collected in Minnesota.

The apterous condition of the males and brachypterous condition of the females is an exceptional condition among North American Plecoptera. Frison *(39)* states that macropterous females are found in the southern part of Illinois. Although the four females collected in Minnesota were brachypterous, it may be that macropterous females will be found in the state.

Since the above was written Kurt Fritsch of New Ulm, Minnesota, collected 184 specimens of this species on snow, February 27, 1952, and March 10, 1952. These specimens included 26 wingless males, 5 long-winged (macropterous) females, 41 brachypterous females, and 100 females intermediate between brachypterous and macropterous.

FAMILY PERLODIDAE

Key to the Genera of Isogeninae

There is but one genus recorded in this subfamily in Minnesota.

KEY TO THE SPECIES OF ISOGENOIDES KLAPALEK, 1912

Adapted from Hanson, 46

Adults

1. Supraanal process present; eighth abdominal sternite not produced backward (males) 2
   Eighth abdominal sternite produced backward as a subgenital plate; no supraanal process present (females) 3
2. Supraanal process with an apical hook posteriorly directed ..... **frontalis**
   Supraanal process without an apical hook ..... **varians**
3. Subgenital plate with a broad median emargination ..... **frontalis**
   Subgenital plate with a median nipplelike protrusion on apical margin ..... **varians**

Nymphs

1. Length of body about 15 mm.; general color pale yellowish, with few brown markings ..... **varians**
   Length of body up to 22 mm.; general color brownish-yellow, with pronotum and head darker ..... **frontalis**

Isogenoides frontalis (Newman)

1838 *Isogenus frontalis* Newman. Ent. Mag. **5**:178.
1925 *Isogenus frontalis* Needham and Claassen. Plecoptera of No. Amer. p. 69.
1938 *Isogenus frontalis* Ricker. Roy. Canad. Inst., Trans. **22**:144 (examined types).

1942 *Isogenus frontalis* Frison. Ill. Nat. Hist. Survey Bul. **22:**290 (nymph, male, female, synonymy).
1943 *Isogenoides frontalis* Hanson. Amer. Midland Nat. **29:**657 (synonymy).
1944 *Isogenoides frontalis* Ricker. Canad. Ent. **76:**181 (synonymy).

Recorded distribution—type locality: Trenton Falls, New York. Other records: Alberta, British Columbia, Manitoba, Michigan, Minnesota, Newfoundland, Oregon, Quebec, Wisconsin, Idaho, Alaska, Yukon, Mackenzie, Ontario, Labrador, Saskatchewan, New Jersey, Washington.

Minnesota records—Hennepin County. May 11, 1920, one male. Cook County. Feb. 12, 1941, PHH, one nymph. Two Island River, June 23, 1941, PHH, one male. Kimbal Creek, April 7, 1948, PHH, two nymphs; April 21, 1948, PHH, two nymphs.

Isogenoides frontalis is another species with a transcontinental distribution. It has been collected so seldom in Minnesota that little can be said of its habitat preference. The nymphs from Kimbal Creek were collected from a place with rubble bottom with rapid flow.

Since the above was written, a communication from W. E. Ricker states, "I should add that I am describing a new species of Stonefly of which I have one specimen from Minnesota. . . . The species in question is another species of *Isogenus* which had been confused with *frontalis*."

Isogenoides varians (Walsh)

1862 *Perla varians* Walsh. Acad. Sci. Phila., Proc. **14:**364 (male and female).
1925 *Perla varians* Needham and Claassen. Plecoptera of No. Amer. p. 83.
1935 *Hydroperla varians* Frison. Ill. Nat. Hist. Survey Bul. **20:**426 (male refigured, biology).
1937 *Hydroperla varians* Frison. Ill. Nat. Hist. Survey Bul. **21:**82 (female refigured, nymph).
1943 *Isogenoides varians* Hanson. Amer. Midland Nat. **29:**664.

Recorded distribution—type locality: Rock Island, Illinois. Other records: Indiana, Kansas, Michigan, Minnesota, Wisconsin.

Minnesota records—Ramsey County, St. Paul.

The only record of this midwestern species for Minnesota is that given by Needham and Claassen *(loc. cit.)*. This is one of the species of which Minnesota represents the northernmost record to date.

Key to the Genera of Isoperlinae

There is but one genus recorded in this subfamily in Minnesota.

KEY TO THE SPECIES OF ISOPERLA BANKS, 1906

Adults

1. Ninth ventral abdominal segment much produced posteriorly and recurved upward so that tenth sternite is mostly or entirely concealed. Eighth sternite slightly produced or with a small lobe in middle of posterior margin (males) 2

   Ninth ventral abdominal segment poorly or not at all produced; tenth segment always visible from below. Eighth sternite without a small lobe in middle of posterior margin; posterior margin either broadly rounded or strongly produced as a subgenital plate (females) 15

2. Ocelli connected with a black V or enclosing a more or less dark area 4

   Ocelli not connected with a black V nor enclosing a more or less dark area; dorsum of head yellow except for black areas immediately around ocelli 3

3. Lobe of eighth abdominal sternite deeply recessed, long and narrow ..... **dicala**

   Lobe of eighth abdominal sternite shallowly recessed and broad 12

4. Subanal lobes little modified, scarcely sclerotized, projecting caudad, little or not at all upcurved 11

   Subanal lobes modified, sclerotized, recurved upward and sometimes forward 5

5. Subanal lobes long, cylindrical, slender, sharp 8

   Subanal lobes short, flattened 6

6. Dorsum of head and thorax predominately yellow; longitudinal dark stripes on abdomen; lobe of eighth abdominal sternite as long as broad ..... **transmarina**

   Dorsum of head and thorax predominantly brownish; dorsum of abdomen uniformly brown or yellow; lobe on eighth abdominal sternite broader than long 7

7. Dorsum of abdomen uniformly brown; subanal lobes well developed and recurved upon tenth tergite; color pattern dark brown; lobe on eighth sternite very broad and low; a crossvein usually in forewing beyond the cord between radial sector and medii 1 and 2 ..... **slossonae**

   Dorsum of abdomen uniformly yellow; subanal lobes only partially sclerotized and recurved but little past margin of tenth tergite; lobe of eighth sternite almost as high as broad; two dark sclerotized subtriangular points on penis showing through ninth sternite ..... **signata**

8. Ocelli connected by a dark V, which is main color pattern of head; color mainly yellow above 10

   Ocelli more or less enclosed by a dark pattern which encloses a light ocellar spot; color mainly yellowish-brown or brown 9

9. Diameter of ocellar spot equal to less than half the distance between lateral ocelli; light spot in front of median ocellus subcircular ..... **lata**

   Diameter of ocellar spot equal to more than half the distance between lateral ocelli; light spot in front of median ocellus subrectangular with long axis crossways ..... **marlynia**

10. Over 11 mm. long; without dark patches or setae on ninth and tenth abdominal tergites ..... **montana**

    Less than 9 mm. long; two brown patches with setae on tenth ab-

dominal tergite and a two-lobed brown patch on ninth abdominal tergite ..... **longiseta**

11. Light area in dark V over ocelli touching black pigment of median ocellus 12
Light area in dark V over ocelli separated from median ocellus by a distance at least equal to diameter of ocellus 13

12. Dorsal median stripe present on abdomen; caudal projection of ninth sternite quadrate; subanal lobes usually visible from below ..... **richardsoni**
No dorsal median stripe on abdomen; caudal projection of ninth sternite rounded; subanal lobes seldom visible from below ..... **bilineata**

13. Lobe present on posterior margin of seventh abdominal sternite; this lobe much smaller than that on the eighth sternite ..... **maxana**
No lobe on seventh abdominal sternite 14

14. Abdomen brown above; much brown on mesonotum and metanotum ..... **orata**
Abdomen yellow above, often with faint darker stripes; mesonotum and metanotum mainly yellow ..... **truncata**

15. Ocelli connected by a black V or enclosing a more or less dark area 19
Ocelli not connected by a black V nor enclosing a more or less dark area; dorsum of head yellow except for dark areas around ocelli in some; a very faint line at times connecting lateral ocelli with median ocellus 16

16. Subgenital plate produced but little caudad; broadly rounded ..... **richardsoni**
Subgenital plate much produced caudad; subtriangular 17

17. Subgenital plate acutely emarginate at apex; head wider than 2.0 mm. ..... **emarginata**
Subgenital plate not emarginate at apex or very slightly so; head less than 1.8 mm. in width 18

18. Margins of subtriangular subgenital plate somewhat incurved before apex ..... **dicala**
Margins of subtriangular subgenital plate straight or somewhat outcurved before apex; apex sometimes slightly emarginate ..... **bilineata**

19. Species mainly yellow with lateral ocelli connected to median ocellus by a dark brown V 20
Species fuscous to dark brown with ocellar triangle enclosed in dark brown with central light spot; this light spot sometimes slightly open caudad 25

20. Margins of subgenital plate subparallel just before apex; apex truncate and turned downward away from body ..... **truncata**
Subgenital plate subtriangular, rounded, or emarginate behind; apex may or may not turn downward away from body 21

21. Width of subgenital plate about half the anterior width of eighth abdominal segment, evenly rounded behind and reaching about one-third across ninth sternite; apex darkly sclerotized ..... **longiseta**
Width of subgenital plate more than half that of eighth abdominal segment; not more sclerotized than rest of segment 22

22. Light area in ocellar triangle separated from anterior ocellus by a distance at least equal to diameter of ocellus; subgenital plate as wide as anterior margin of ninth abdominal segment; often emarginate behind; apex turned downward away from body ..... **orata**
Light area in ocellar triangle touching pigment of anterior ocellus; subgenital plate not turned downward away from body 23

23. Subgenital plate subtriangular ..... **bilineata**
Subgenital plate rounded behind 24

24. Subgenital plate produced caudad but little, broadly rounded ..... **richardsoni**
Subgenital plate produced caudad about halfway across tenth sternite ..... **montana**

25. Subgenital plate truncate; width of base less than half the width of eighth abdominal segment ..... **transmarina**
Subgenital plate broadly rounded; width of base more than half the width of eighth abdominal segment 26

26. Subgenital plate low and broad; scarcely produced behind; light spot in front of median ocellus transversely rectangular; abdomen predominately yellow below ..... **signata**
Subgenital plate considerably produced behind; light spot in front of median ocellus quadrate, crescent-shaped, or subcircular 27

27. Light spot in front of median ocellus quadrate; subgenital plate broadly emarginate; abdomen brown below; light spot in ocellar triangle usually nearly touching lateral ocelli; an additonal r-m crossvein beyond the cord ..... **slossonae**
Light spot in front of median ocellus crescent-shaped or subcircular; light spot in ocellar triangle usually less than half as wide as distance between lateral ocelli; subgenital plate may or may not be emarginate 28

28. Subgenital plate emarginate; abdomen predominately yellow below; light spot in front of median ocellus crescent-shaped or semicircular ..... **marlynia**
Subgenital plate evenly rounded behind; abdomen fuscous below; light spot in front of median ocellus subcircular ..... **lata**

Nymphs

1. Dorsal abdominal segments uniformly brown; occasionally a few light spots 2
Dorsal abdominal segments with alternating transverse or longitudinal light and dark stripes or bands 3

2. Irregular light central stripe of varying width on pronotum; margins of pronotum light; a narrow dark line on outer edge of wing pad beside the central broad dark band of the wing pad ..... **slossonae**
Uniformly brown above ..... dark phase of **marlynia**

3. Abdominal tergites with transverse stripes 4
Abdominal tergites with longitudinal stripes 5

4. Both anterior and posterior margins of abdominal tergites dark; middle portion light, although this middle portion sometimes interrupted ..... **marlynia**

Posterior half of abdominal tergites dark, anterior half light; sometimes extreme anterior margin is somewhat darkened ..... **signata**

5. Light area within ocellar triangle completely enclosed by darker area 6
Light area within ocellar triangle not completely enclosed by darker area 10

6. Dorsal pattern essentially light on a dark background; ocellar spot very small or lacking; dorsal abdominal stripes darker than abdomen, with borders lighter than abdomen; abdomen decidedly speckled above ..... **dicala**
Dorsal pattern essentially dark on light background; ocellar spot large, its diameter usually more than half the distance between the lateral ocelli; each abdominal tergite with at most six dark dots 7

7. Central dark stripe on dorsum of abdomen sometimes only partially complete on abdominal segments caudad of the fourth; lateral stripes continuous; large tooth of lacinia equal in length to the sclerite to which it is attached ..... **orata**
All three dark dorsal abdominal stripes continuous at least to the last tergite; large tooth of lacinia much shorter than the sclerite to which it is attached 8

8. Abdominal stripes usually indistinct; six dark dots on each abdominal tergite; stripes on wing pads wide 9
Abdominal stripes distinct; no dark dots or freckling on abdominal tergites; stripes on wing pads narrow and show venation darker than stripes ..... **transmarina**

9. The two lacinial teeth followed by a tuft of hairs ..... **richardsoni**
The two lacinial teeth followed by a row of hairs ..... **bilineata**

10. Dark transverse band across head through anterior ocellus without extensions back to lateral ocelli, although a much lighter brown extension may be present ..... **richardsoni**
Dark transverse band across head through anterior ocellus with extensions back to or through lateral ocelli 11

11. Two dark bands across the head, one on clypeus, enclosing between them a light M; apex of lacinia broad and heavily beset with hairs ..... **lata**
Only one dark band across head; apex of lacinia receding below apical teeth 12

12. Very little dark color on pronotum, mesonotum, or metanotum—the dark spots on these three areas forming two lines; the three dark stripes on abdomen uniform in width, narrow ..... **truncata**
As much dark area as light on pronotum; two lines of spots not present on pronotum, mesonotum, and metanotum 13

13. Two dark extensions from the dark band across head forward completely across clypeus; lateral stripes of abdomen only slightly wider than median stripe ..... **transmarina**
Dark extensions from dark band across head forward only partly across clypeus; median stripe of abdomen much narrower than lateral stripes (from Texas specimens) ..... **longiseta**

Nymphs undescribed: *I. montana, I. maxana, I. emarginata.*

Isoperla bilineata (Say)

1823 *Sialis bilineata* Say. West. Quart. Rptr. **2**:165.
1925 *Isoperla bilineata* Needham and Claassen. Plecoptera of No. Amer. p. 154.
1931 *Isoperla bilineata* Claassen. Plecoptera nymphs of Amer. p. 73 (nymph).
1935 *Isoperla bilineata* Frison. Ill. Nat. Hist. Survey Bul. **20**:437 (nymph, biology).
1942 *Isoperla bilineata* Frison. Ill. Nat. Hist. Survey Bul. **22**:322 (dark phase of nymph).

Recorded distribution—type locality: Ohio River near Cincinnati, Ohio. Other records: Newfoundland to Saskatchewan, and North Carolina to Colorado; a very common eastern species.

Minnesota records—this common species has been collected in many localities in the eastern part of the state from Houston and Fillmore Counties in the southeast corner up to Koochiching, St. Louis, Lake, and Cook Counties in the north central and northeast parts of the state. In the western part of the state it has been collected from the Red River in Wilkin County. The other rivers from which or along which it has been taken include the following: Mississippi, Minnesota, St. Croix, Blue Earth, Root, Rum, Elk, Kettle, Floodwood, and Rainy.

In the southern part of Minnesota this species has been collected from May 1 to June 19, with the peak of population being May 20 to June 5. In the northern part of the state it has been collected from May 27 through July 4, with one collection recorded in Cook County on August 21.

As stated by Frison *(39)* this species is found in medium and large rivers. Nymphs have been found clinging to submerged stones as well as to submerged plant stems and coarse detritus. *I. bilineata* has been reported from as far west as Saskatchewan and Colorado.

Isoperla dicala Frison

1942 *Isoperla dicala* Frison. Ill. Nat. Hist. Survey Bul. **22**:321 (nymph, male, female).

Recorded distribution—type locality: Free Soil, Great Sable River, Michigan. Other records: Indiana, Minnesota, Missouri, New Brunswick, Tennessee.

Minnesota records—Fillmore County (Root River), Houston County (Root River), Pine County (Crooked River, Bangs Brook, Snake River, Big Sand Creek), Hubbard County (Straight River, Fishhook River), Koochiching County (Rainy River), St. Louis County (stream seven miles north of Cloquet, Hellwig Creek, Vermilion River, Pike River), Cook County (Devils Track River, Little Devils Track Creek). Adults, May 16 through August 8.

It is interesting to find such a light-colored adult (practically all yellow) coming from a fairly dark nymph. This nymph in its natural

state has a greenish-brown hue. It loses the green shade when preserved in alcohol.

The nymphs are found in small to medium streams clinging to rocks, submerged vegetation, or submerged branches and trash. Some of the streams from which it was taken are rather sluggish.

Frison *(41)* noted that this species emerged during the daytime, a habit not usually found in the genus.

I. dicala is found in the eastern part of Minnesota from the Root River in the south to the Rainy River on the north. Minnesota represents the northwestern limit of the range of the species recorded to date. The other western extension recorded is Greer Springs in southeastern Missouri, and the most northern record outside of Minnesota is Penobsquis in southeastern New Brunswick.

Isoperla emarginata n. sp.

Plate X, Figs. 3, 4

Females

General body color pale yellow to yellowish-brown; brown markings on head and pronotum. Length to tip of wings 16 mm.; width of head 2 mm.; width of pronotum 1.7 mm. Cerci yellow, becoming yellowish-brown near extremity; antennae yellowish-brown at base, becoming darker toward extremity.

Head pale yellow, with a dark brown crescent-shaped spot on inside margin of each lateral ocellus, the lower point of each of these crescents extending outward beyond each ocellus; a light brown spot behind the median ocellus; a faint brown stripe from median ocellus forward onto the clypeus. Uncolored rugosities posterior to postfrontal suture.

Pronotum pale yellow, with pale brown stripe on each side of median yellow stripe; rugosities in these yellow stripes a darker brown; pronotum slightly narrowed caudad, much wider than long. Mesonotum and metanotum yellowish-brown forward, becoming darker brown caudad. Veins of wings yellowish-brown to yellow.

Abdomen yellowish-brown above. Eighth sternite produced behind into a broadly subtriangular subgenital plate sharply emarginate at the apex. Abdomen yellow below. Legs brownish-yellow.

Holotype: one female, Grand Marais, Minnesota, July 13, 1939. Gerhard Kretzschmar.

Males

Males unknown.

Isoperla lata Frison

Plate XI, Fig. 1; Plate XII, Figs. 3, 4, 6

1942 *Isoperla lata* Frison. Ill. Nat. Hist. Survey Bul. **22**:334 (nymph, male, female).

Recorded distribution—type locality: Boulder Junction, Wisconsin. Other records: Michigan, Nova Scotia, Tennessee, Quebec.

Minnesota records—Cook County. Devils Track River, April 12, 1941, PHH, three females reared, emerging May 6 to 8, 1941; April 28, 1940, one nymph.

It is interesting to note that the Minnesota locality records of *lata* are but a few miles west of a line running north from the type locality of the species across Lake Superior, previously the farthest west record. The Minnesota locality records are also about the same latitude as the Quebec record in Laurentides National Park, the farthest north record of the species heretofore.

Devils Track River, from which this species was collected, is a medium-sized stream, having a fairly rapid fall over rock and a rubble bottom for some distance above the point where this species was collected. Smith and Moyle *(107)* report this fall to be 130 feet per mile.

A description of the then unnamed nymph was included in the unpublished part of a thesis by one of the writers *(49)*.

Isoperla longiseta Banks

1906 *Isoperla longiseta* Banks. Canad. Ent. **38**:337 (female only).
1925 *Isoperla longiseta* Needham and Claassen. Plecoptera of No. Amer. p. 156 (male and female).
1942 *Isoperla longiseta* Frison. Ill. Nat. Hist. Survey Bul. **22**:318 (nymph).
1943 *Isoperla longiseta* Ricker. Stoneflies of S.W. Brit. Col. p. 124 (male and female).

Recorded distribution—type locality: Onaga, Kansas. Other records: Alberta, British Columbia, Colorado, Illinois, Iowa, Manitoba, Minnesota, Missouri, Montana, Saskatchewan, South Dakota, Texas, Wyoming.

Minnesota records—Ramsey County. St. Paul, at light, June 16, 1933, A. A. Granovsky, one female, recorded by Frison *(41,* p. 320).

In addition to the above records, there are the following in the University of Minnesota collection:

Wessington Springs, South Dakota, June 16, 1940, PHH, one female. Huron, South Dakota, June 4, 1948, PHH, one female. Pierre, South Dakota, July 31, 1940, at light, R. H. Daggy, one male. Fargo, North Dakota, May 11, 1939, D. G. Denning, one female.

Frison *(loc. cit.)* described the nymph from exuviae from Texas and also described a brachypterous race from that area. This is one of the few known brachypterous species of the genus, *Isoperla*.

Judging by the records from South Dakota, North Dakota, and Minnesota, it is quite probable that this species is found in medium to large prairie rivers that are rather sluggish, such as the Missouri River, the James River, and the Red River of the North.

On the other hand, the record at Wessington Springs, South Dakota, would indicate that this species may be able to survive in intermittent small streams. This town is at least 20 miles from the James River on the east and over 40 miles from the Missouri River on the west. Other possible sources of this stonefly were small intermittent creeks five to ten miles away. It is possible that the specimen drifted in or was blown in from the James River, or it might have been carried in by some vehicle.

I. longiseta is listed by Ricker *(100)* as the one species of stoneflies that is typical of the prairies; the records in North and South Dakota and in Minnesota certainly substantiate this claim.

Isoperla marlynia Needham and Claassen

1925 *Isoperla marlynia* Needham and Claassen. Plecoptera of No. Amer. p. 148.
1931 *Chloroperla clio* Claassen. Plecoptera nymphs of Amer. p. 69 (nymph).
1942 *Isoperla marlynia* Frison. Ill. Nat. Hist. Survey Bul. **22**:330 (synonymy).

Recorded distribution—type locality: Lakehurst, New Jersey. Other records: Illinois, Indiana, Manitoba, Michigan, New Brunswick, New Hampshire, Nova Scotia, Quebec, Virginia, Wisconsin.

Minnesota records—Chisago County (St. Croix River), Pine County (Kettle River, Snake River). Adults, May 3 through June 7.

The nymphs of this species vary considerably, ranging from those with a definite dorsal pattern to those that are illustrated by Frison (*41*, frontispiece). Such variation is found in the series of nymphs recorded above from the Kettle River.

The three rivers in the state from which *I. marlynia* has been collected have several different species of stoneflies, but they have the following species in common: *Hastaperla orpha, Nemoura rotunda,* and *Brachyptera glacialis.*

The recorded range of *I. marlynia* extends across northern United States to Minnesota and from southeastern Canada west into Manitoba.

Isoperla maxana n. sp.

Plate X, Figs. 1, 2

Males

General body color pale yellow with some light to dark brown markings. Length to tips of wings 10 mm.; width of head 1.3 mm.; width of pronotum 1.1 mm. Antennae dark brown; cerci light brown at base, becoming darker distally.

Head pale yellow, with a subrectangular transverse dark spot twice as long as broad just back of the median ocellus; anterior margin of this dark spot dividing the median ocellus; each posterior lateral corner of this spot connected with a lateral ocellus. Dark areas bordering compound eyes.

Pronotum pale yellow with two brown spots across the anterior marginal groove; caudad from each of these extends a faint brown stripe which practically disappears before reaching the posterior margin.

Abdomen with a distinct median stripe and two rather indistinct lateral stripes. Tenth tergite but little convex behind but with a distinct depression. Subanal lobes scarcely sclerotized, not recurved. Ninth sternite extending caudad and then dorsad; tenth sternite not visible from below; eighth sternite with a rather large lobe, with apex low and broad; seventh sternite also with a median lobe, about one-third the size of that on the eighth sternite. Legs yellow, becoming brownish at the extremities.

Holotype: one male, Hubbard County, Fishhook River, four miles south of Park Rapids, June 28, 1948, PHR.

Females

Females unknown.

Isoperla montana (Banks)

1898 *Chloroperla montana* Banks. Amer. Ent. Soc., Trans. **25**:199.
1925 *Isoperla montana* Needham and Claassen. Plecoptera of No. Amer. p. 155.
1942 *Isoperla montana* Frison. Ill. Nat. Hist. Survey Bul. **22**:331 (paratype male = *I. marlynia* Needham and Claassen).

Recorded distribution—type locality: Mt. Washington, New Hampshire. Other records: Connecticut, Maine, New York, Nova Scotia.

Minnesota record—Ramsey County. St. Anthony Park, June 20 (recorded by Needham and Claassen, *loc. cit.*).

This species has not been recorded from Minnesota in recent years.

Isoperla orata Frison

1942 *Isoperla orata* Frison. Ill. Nat. Hist. Survey Bul. **22**:323 (nymph, male, female).

Recorded distribution—type locality: Gatlinburg, LeConte Creek, Tennessee. Other records: New Brunswick, New Hampshire, New York, North Carolina, Nova Scotia, Pennsylvania, Tennessee, Vermont.

Minnesota records—Carlton County (Nemadji River), St. Louis County (stream seven miles north of Cloquet), Cook County (Little Devils Track Creek). Adults, June 1 through August 8.

Ricker states (*101*, p. 409) concerning this species, "Either the species *orata* is unusually variable, or a complex of several closely related forms is found in Canada from Ontario eastward. The maritime specimens differ from typical *orata* in having the black markings of the head more diffuse. The female subgenital plate is always definitely notched, whereas in typical *orata* it is only occasionally notched, and then very shallowly so. Decision on the taxonomic value of these differences must await a general review of the variation of *orata*-like specimens from a wide area."

These statements of variation apply to the Minnesota specimens. Ricker probably did not have nymphs from the localities recorded in Canada. Nymphs from Carlton County, Minnesota, deviate from the description given by Frison (*loc. cit.*) in having the middle abdominal dark line uninterrupted and by having less yellow in the central area of the pronotum. Those from St. Louis County are somewhat darker and have somewhat more diffuse dark markings. They all show the characteristic form of the maxillae and are with little doubt *orata*.

The nymphs were collected from rubble bottom of rather slowly flowing small streams in the northeast part of the state. Minnesota represents the westernmost extension of the recorded range of *I. orata*.

Isoperla richardsoni Frison

1935 *Isoperla richardsoni* Frison. Ill. Nat. Hist. Survey Bul. **20**:459 (male, female, nymph).

Recorded distribution—type locality: Sterling, Illinois. Other records: Connecticut.

Minnesota records—Houston County (Root River), Fillmore County (Root River), Winona County, Hennepin County (Mississippi River), Anoka County (Coon Creek, Rum River), Sherburne County (Elk River), Morrison County (Mississippi River), Crow Wing County, Pine County (Snake River, Big Sand Creek, Kettle River), Beltrami County (Blackduck River).

To date this species has been recorded only from the Rock River in Illinois and from Connecticut. Collections in Minnesota indicate that it is widely distributed in the state and that it is often though not always found in assocation with *I. bilineata*. Both species are found in medium and large streams.

Special note was made of the relative numbers of the two species in two instances. Ten nymphs were collected from a log in the edge of the Elk River along a road grade; six were *I. richardsoni* and four were *I. bilineata*. In another instance 36 exuviae were collected from a concrete railway abutment at the edge of the rapids of the Mississippi River below St. Anthony Falls; of these 13 were *I. richardsoni* and 26 were *I. bilineata*.

The type series of adults of *I. richardsoni* were collected in Illinois May 10 through May 16. Adults have been collected in Minnesota May 14 through July 9.

Frison stated in his original description of this species that the males of *I. bilineata* could not be separated satisfactorily in a key from the males of this species. Further study of reared specimens has shown that the two can usually be separated easily by the dorsal coloration of the abdomen and by the shape of the ninth abdominal sternite. (See key to the males of this genus.)

In most females collected in the state the subgenital plate is evenly rounded behind; in the two females from Brainerd collected July 9, 1948, the subgenital plate is definitely emarginate behind. There is a tendency in some specimens of the species for the dark V on the head to be partially closed behind; in some others the dark V is partially obsolete, leaving the dark color confined largely to the area of the ocelli.

Isoperla signata (Banks)

1902 *Perlinella signata* Banks. Canad. Ent. **34**:124.
1925 *Isoperla signata* Needham and Claassen. Plecoptera of No. Amer. p. 149.
1931 *Isoperla signata* Claassen. Plecoptera nymphs of Amer. p. 75 (nymph).

Recorded distribution—type locality: Michigan. Other records: Connecticut, New Brunswick, New York, Nova Scotia.

Minnesota records—Houston County (Winnebago Creek), Scott County (Credit River), Hennepin County (Nine Mile Creek), Anoka County (Coon Creek), Pine County (Big Sand Creek, Grindstone River, Kettle River, Bangs Brook), St. Louis County (French River, Sucker River, stream seven miles north of Cloquet), Lake County (Stewart River), Cook County (Temperance River, Devils Track River). Adults, May 8 through July 22.

The nymphs of this species are found in smaller rivers and creeks. They have been taken most often in riffles and in rapids. Minnesota is the farthest west point that *I. signata* has been recorded, Michigan previously being the farthest west record.

As in *Isoperla marlynia*, some *I. signata* nymphs do not show the transverse alternate dark and light stripes of the abdomen. In addition the yellow area of the pronotum is at times much reduced and the yellow ocellar spot is very small or lacking in contrast to these characteristics, as described by Claassen *(loc. cit.)* in his description of the nymph.

A character found in adult males and not previously mentioned by writers is the presence of two small dark sclerotized points on the ventral aspect of the penis. These points can be seen through the ninth sternite when the penis is withdrawn into the abdomen.

Isoperla slossonae (Banks)

Plate V, Fig. 1; Plate VII, Figs. 13-16

1911 *Perla slossonae* Banks. Amer. Ent. Soc., Trans. **37**:335 (female only).
1925 *Clioperla annecta* Needham and Claassen. Plecoptera of No. Amer. p. 140 (female).
1942 *Isoperla annecta* Harden. Ent. Soc. Amer., Ann. **35**:326 (nymph).
1942 *Isoperla slossonae* Frison. Ill. Nat. Hist. Survey Bul. **22**:329 (nymph, male, synonymy).

Recorded distribution—type locality: Franconia, New Hampshire. Other records: Maine, Michigan, Minnesota, New Brunswick, New York, Nova Scotia, Quebec, Wisconsin.

Minnesota records—Hennepin County (Nine Mile Creek), Anoka County (Coon Creek, Rum River), Chisago County, St. Louis County (stream seven miles north of Cloquet).

This species has been collected from large creeks and small rivers. As previously noted by one of the writers *(50)*, the nymphs of this species were collected from leaves and trash gathered against tree trunks, branches, and boards in the stream.

The dorsal color pattern of the nymph varies from a form with light spots on the abdomen, medium-width stripe on the pronotum, and a fairly large ocellar spot, to a form with a uniformly dark abdomen above, practically no medium stripe on the pronotum, and a very small ocellar spot.

Adults have been collected in Minnesota from April 5 through the first part of May. *I. slossonae* is one of the many species of stoneflies for which Minnesota is the farthest west record to date.

Isoperla transmarina (Newman)

Plate V, Fig. 2; Plate VII, Figs. 17-20

1838 *Chloroperla transmarina* Newman. Ent. Mag. **5**:499.
1839 *Chloroperla transmarina* Newman. Nat. Hist. Mag., N. S. **3**:87.
1908 *Isoperla ventralis* Banks. Psyche **15**:66.
1925 *Isoperla ventralis* Needham and Claassen. Plecoptera of No. Amer. p. 150.
1933 *Isoperla fumosa* Neave. Canad. Ent. **65**:235.
1938 *Isoperla transmarina* Ricker. Roy. Canad. Inst., Trans. **22**:146 (redescription of female holotype).
1942 *Isoperla transmarina* Harden. Ent. Soc. Amer., Ann. **35**:329 (nymph, synonymy).
1942 *Isoperla transmarina* Frison. Ill. Nat. Hist. Survey Bul. **22**:318 (nymph, synonymy).
1943 *Isoperla transmarina* Ricker. Roy. Canad. Inst., Trans. **26**:6 (synonymy).

Recorded distribution—type locality: Trenton Falls, New York. Other records: Manitoba, Michigan, Minnesota, New Brunswick, Newfoundland, New Jersey, Ontario, Quebec, Wisconsin.

Minnesota records—Houston County (Root River), Winona County, Olmsted County (Bear Creek), Anoka County (Rum River), Chisago County (stream at North Branch), Pine County, Carlton County (Little Otter Creek, Nemadji River, Silver Creek), Beltrami County (creek at Red Lake), St. Louis County (McCarty Brook, Pine River), Lake County (Kawishiwi River), Cook County (Kimbal Creek, Devils Track River). Adults, May 20 through June 13.

The nymphs of this species have been found mainly in small rivers and large creeks of somewhat sluggish nature. As has been previously noted *(50)*, the nymphs seem to prefer matted leaves and vegetation held by submerged wood and branches. The species of Plecoptera found most often with it is *Paragnetina media*.

There is a tendency in the younger nymphs of *I. transmarina* for the outer abdominal stripes to extend in toward the median stripe at the anterior border of each segment. This condition was found in some of the smaller nymphs from North Branch and from Olmsted County. This species ranges from south to north in the eastern part of the state. In Canada its range extends westward into Manitoba.

An emergence of one of this species was observed in the laboratory on May 15, 1942. A nymph had crawled out of the water onto the tubing of the air inlet of one of the rearing jars and had securely fastened itself by hooking all of its claws. The exuviae broke first along the midline of the prothorax and then along the midline of the mesothorax, the metathorax, and the posterior margin of the head above. The thorax of the emerging adult protruded first and then the head and wings were freed. Next the legs were pulled out of the exuviae, after which came the antennae.

At this stage the insect extended its legs and remained stationary for about a minute and a half while supporting its weight by its abdomen still enclosed in the exuviae. Then using its legs it pulled its abdomen and cerci free from the cast skin. Four minutes after the first break in the nymphal cuticula, the adult was free of it. About two minutes later its wings were completely expanded but were held rooflike above its abdomen. Five minutes later it folded its wings flat on its abdomen in the manner characteristic of stoneflies and started crawling away. It could not yet be incited to fly. About 11 minutes passed from the time the individual started to emerge to the time it started to crawl.

Isoperla truncata Frison

1937 *Isoperla truncata* Frison. Ill. Nat. Hist. Survey Bul. **21**:94 (nymph, male, female).

Recorded distribution—type locality: Namakagon River, Spooner, Wisconsin. Other records: Indiana, Michigan, New Brunswick, Nova Scotia.

Minnesota records—Houston County (Root River), Hennepin County (Mississippi River), Pine County (Snake River, Big Sand Creek, Grindstone River), Carlton County (Nemadji River), Hubbard County (Straight River), St. Louis County (stream five miles south of Ely), Lake County (stream 12 miles southeast of Ely).

The nymphs of this species have been collected from rapids and riffles. The size of the streams from which they have been taken varies from small brooks and medium streams to large rivers. Adults have been collected from May 16 through July 20 in Minnesota.

The nymphs can be readily distinguished by the three narrow distinct dark lines on the dorsum of the abdomen; these lines continue forward as two interrupted lines on the metanotum, mesonotum, and pronotum. Additional characters by which the nymphs can be distinguished include the single dark M band across the head, touching all three ocelli, and the tuft of hairs below the two lacinial teeth. Usually there is a row of hairs below the two lacinial teeth in other species.

The female may be distinguished by the well-developed subgenital plate extending as a caudal projection of the eighth abdominal sternite. This subgenital plate is truncate at the apex and turned away from the body at an angle when viewed from the side.

The male cannot be easily distinguished from some other males of the genus which have a rectangular dark spot adjacent to the median ocellus, with dark extensions back to the lateral ocelli.

This is another one of the species with a range extending from eastern United States and Canada to Minnesota, the recorded western limit. As noted under *Hastaperla orpha*, *I. truncata* was described with *H. orpha* from the same stream in Wisconsin but occurs with it only in the Mississippi River in Minnesota. The Plecoptera species most often found with *I. truncata* in Minnesota are *Paragnetina media* and *Isoperla dicala*.

KEY TO THE GENERA OF PERLIDAE

Adults *Adapted from Frison, 39, p. 373*

1. Ninth ventral abdominal segment much produced posteriorly and

recurved upward so that tenth ventral abdominal segment is mostly or entirely concealed. Some species with a disklike structure in middle of posterior portion of ninth ventral abdominal segment. Eighth ventral abdominal segment never notched in middle of posterior margin nor produced over ninth ventral abdominal segment (males) 2

Ninth ventral abdominal segment poorly or not at all produced posteriorly; tenth ventral abdominal segment always visible. Eighth ventral abdominal segment notched in middle of posterior margin, or with a subgenital plate partly projecting over ninth segment (females) 8

2. Median ocellus lacking or so poorly developed that only lateral ocelli are clearly visible, head therefore appearing to have but two ocelli 3

Median ocellus well developed, therefore head clearly with three ocelli 4

3. Lateral ocelli close together, much closer to one another than each is removed from compound eye. Forewing without crossveins in anal field and with many crossveins before subcosta. Ninth ventral abdominal segment without a disklike structure in middle of posterior portion ..... **Neoperla**

Lateral ocelli far apart, at least as far removed from one another as each is removed from compound eye. Forewing with crossveins in anal field and few if any crossveins before subcosta. Ninth ventral abdominal segment with a disklike structure in middle of posterior portion ..... **Atoperla**

4. Ninth ventral abdominal segment with a disklike structure in middle of posterior portion 7

Ninth ventral abdominal segment without a disklike structure in middle of posterior portion 5

5. Fifth dorsal abdominal segments enlarged and prolonged backwards. Tenth dorsal abdominal segment divided in middle and with a pair of genital hooks directed forward 6

Fifth dorsal abdominal segment similar to preceding segments. Tenth dorsal abdominal segment undivided and without genital hooks ..... **Perlesta**

6. Genital hooks on tenth dorsal abdominal segment short ..... **Paragnetina**

Genital hooks on tenth dorsal abdominal segment very long ..... **Phasganophora**

7. Forewings with few or no crossveins in costal cell and several crossveins between first and second anal veins. Compound eyes set forward on side of head about their diameter distant from hind margin of head. Prothorax with sides and a median longitudinal stripe of black or brown; area between yellow ..... **Perlinella**

Forewings with numerous crossveins in costal cell and usually no crossveins (rarely one) between anal veins of forewing. Compound eyes set back on side of head near hind margin. Prothorax essentially brown, with scattered interrupted lighter markings ..... **Acroneuria**

8. Median ocellus lacking or so poorly developed that only lateral ocelli are visible; head therefore appearing to have only two ocelli 9

Median ocellus well developed; therefore head clearly with three ocelli 10

9. Lateral ocelli close together, much closer to one another than each is removed from compound eye. Forewing without crossveins in anal field and with many crossveins in costal cell ..... **Neoperla**

Lateral ocelli far apart, at least as far removed from one another as each is removed from compound eye. Forewing with crossveins in anal field and with few if any crossveins in costal cell ..... **Atoperla**

10. Forewing with few or no crossveins in costal cell and several crossveins between first and second anal veins ..... **Perlinella**

Forewing with numerous crossveins in costal cell and usually no crossveins (rarely one) between first and second anal veins 11

11. Costal margin of forewing and base of Rs and M yellowish, contrasting with brownish veins 12

Costal margin of forewing dark and almost unicolorous with rest of wing 13

12. Eighth ventral abdominal segment with a well-developed subgenital plate ..... **Phasganophora**

Eighth ventral abdominal segment without a well-developed subgenital plate ..... **Perlesta**

13. Forewing with at least one crossvein, usually more, beyond the cord in apical portion of the wing in addition to those in subcostal cell. Eighth ventral abdominal segment in some species with well-developed subgenital plate; in others with subgenital plate not well developed ..... **Acroneuria**

Forewing usually with no crossvein (rarely one) beyond the cord in apical portion of wing in addition to those in subcostal cell. Eighth ventral abdominal segment without a well-developed subgenital plate ..... **Paragnetina**

Nymphs

1. Compound eyes situated far forward on side of head and considerably removed from posterior margin 2

Compound eyes situated well back on side of head and close to posterior margin 3

2. Anterior ocellus absent. Nymphs small, not exceeding 12 mm. when full grown. Almost uniform light brown ..... **Atoperla**

Anterior ocellus present in half-grown to full-grown nymphs but inconspicuous in small ones. Of medium size, up to 20 mm. or more when full grown. Dorsum of head, thorax, and abdomen with a discernible pattern of contrasting areas of light and dark brown ..... **Perlinella**

3. Anterior ocellus absent. Distinct transverse occipital ridge back of lateral ocelli ..... **Neoperla**

Anterior ocellus present. With or without distinct transverse occipital ridge 4

4. Dorsum of abdomen with conspicuous freckle-like spots on a uniform dark background. Transverse occipital ridge present. Anal gills present ..... **Perlesta**

Dorsum of abdomen without frecklelike spots. With or without transverse occipital ridge. With or without anal gills 5
5. Transverse occipital ridge present 6
Transverse occipital ridge absent ..... **Acroneuria**, in part
6. Anal gills present. Dorsum of abdomen with conspicuous alternating light and dark transverse areas or bands present ..... **Phasganophora**
Anal gills absent. Dorsum of abdomen without conspicuous alternating light and dark transverse areas or bands 7
7. Dorsum of head, thorax, and abdomen nearly uniform light brown. Lateral ocelli ahead of the transverse occipital ridge a distance about equal to the distance between them ..... **Acroneuria**, in part
Dorsum of head and thorax with some light areas distinct from brown background. Lateral ocelli ahead of the transverse occipital ridge a distance equal to or less than one-half the distance between them ..... **Paragnetina**

Subfamily Perlinae

GENUS PHASGANOPHORA KLAPALEK, 1906

1921 *Phasganophora* Klapalek. Soc. Ent. de Belg., Ann. **61**:66.
1922 *Neophasganophora* Lestage. Soc. Ent. de Belg. Bul. **4**:102 (*Phasganophora* incorrectly claimed to be preoccupied by *Phasgonophora* Westwood).
1925 *Neophasganophora* Needham and Claassen. Plecoptera of No. Amer. p. 286 (subgenus of *Perla*).
1935 *Neophasganophora* Frison. Ill. Nat. Hist. Survey Bul. **20**:407.

Phasganophora capitata (Pictet)

1841 *Perla capitata* Pictet. Hist. Nat. des Insectes Neuropteres. p. 214.
1925 *Perla capitata* Needham and Claassen. Plecoptera of No. Amer. p. 96.
1931 *Perla capitata* Claassen. Plecoptera nymphs of Amer. p. 47 (nymph).
1935 *Neophasganophora capitata* Frison. Ill. Nat. Hist. Survey Bul. **20**:409 (nymph, biology).

Recorded distribution—type locality: "United States." Other records: Connecticut, Florida, Indiana, Illinois, Kansas, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, New York, New Brunswick, North Carolina, Nova Scotia, Ohio, Ontario, Pennsylvania, Tennessee.

Minnesota records—Fillmore County (Root River), Wabasha County (Zumbra River), Ramsey County, Hennepin County (Mississippi River), Anoka County (Mississippi River), Sherburne County (Mississippi River), Morrison County (Mississippi River), Pine County (Kettle River, Snake River, Grindstone River), Crow Wing County (Mississippi River), Cass County, St. Louis County (Cloquet River), Cook County (Devils Track River, Arrowhead River, Kadunce Creek). Adults, May 30 through June 12.

In Minnesota this species has been collected from medium and large rivers throughout the eastern part of the state. Nymphs have been taken from coarse gravel to rocky bottoms as a rule, but one collection was made from dead leaves lodged behind submerged branches.

This is another of the many species of the state which reach in Minnesota the western limit of their recorded distribution across northern United States and Canada. The Ontario record noted above is from Guelph in the eastern part of the province. Farther south the recorded western limit is in Kansas.

Neither Banks (*15*, p. 117) nor Ricker was able to locate the types of this species in a tour of European museums. Banks (*loc. cit.*) maintained on very slim evidence that the present species going under this name is not Pictet's *capitata* but is another species. He accordingly used Walsh's name, *flavescens*, for it. In addition he erected a new genus, *Harrisiola*, with *flavescens* as genotype. He further recognized as species the several variants that have been accepted as synonyms by recent American authorities and he described several other variants as new species. We see no basis for discarding the present use of the name, *capitata*, at least until the type material can be located. And so we are following Needham and Claassen, Frison, and Ricker in their concept of the species in its wide sense.

GENUS PARAGNETINA KLAPALEK, 1907

Paragnetina media (Walker)

1852 *Perla media* Walker. Neuropt. Insects Brit. Mus. Cat. p. 145.
1861 *Perla tristis* Hagen. Syn. Neuroptera No. Amer. p. 22.
1925 *Perla media* Needham and Claassen. Plecoptera of No. Amer. p. 103.
1931 *Perla media* Claassen. Plecoptera nymphs of Amer. p. 48 (nymph).
1935 *Togoperla media* Frison. Ill. Nat. Hist. Survey Bul. **20**:412 (nymph, biology).
1947 *Paragnetina media* Ricker. Roy. Canad. Inst., Trans. **26**:407.

Recorded distribution—type locality: St. Martins Falls, Albany River, Ontario, Canada. Other records: Illinois, Maine, Manitoba, Minnesota, New Brunswick, New York, Quebec, Saskatchewan.

Minnesota records—Fillmore County (Root River), Olmsted County (Bear Creek), Scott County (Credit River), Hennepin County (Mississippi River), Anoka County (Mississippi River, Coon Creek, Rum River), Benton County (Little Rock River), Morrison County, Kanabec County (Snake River), Pine County (Snake River, Bangs Brook, Big Sand Creek, Kettle River), Carlton County (Nemadji River), Crow Wing County (Nokaysippi River), Hubbard County (Crow Wing River, Straight River), Clearwater County (Clearwater River), Polk County, St. Louis County (White Pine River, Lester River, French River, Sucker River, McCarty Brook, stream seven miles north of Cloquet, Artichoke River, Vermilion River, Whiteface River), Lake County (Stewart River, Gooseberry River, Kawishiwi River), Cook County (Two Island River, Devils Track River). Adults, May 15 through June 27.

Paragnetina media is surpassed only by *Perlesta placida* in the number of streams in Minnesota from which collections of the species have been made. *Acroneuria lycorias* comes next: unlike *P. media*, *A. lycorias*

is found in some of the western prairie streams. On the other hand these two species are similar in that both have been collected from streams of all sizes. In about half of the rivers in which one of these two species is found, the other one is found also. These rivers from which both species are taken range from the Root River in the southeastern part of the state through many of the central eastern streams and some of the streams of the north shore of Lake Superior to the Kawishiwi River in the northern part of the state. It would be an interesting study to determine the factors which control the coincidence of the two species in some rivers and their separate existence in others.

The recorded range of *P. media* extends beyond Minnesota to the west into Saskatchewan. The species is a member of the early summer fauna of the state.

Subfamily Neoperlinae

GENUS NEOPERLA NEEDHAM, 1905

Neoperla clymene (Newman)

1839 *Chloroperla clymene* Newman. Mag. Nat. Hist. N. S. 3:87.
1925 *Neoperla clymene* Needham and Claassen. Plecoptera of No. Amer. p. 134 (male and female).
1931 *Neoperla clymene* Claassen. Plecoptera nymphs of Amer. p. 67 (nymph).
1935 *Neoperla clymene* Frison. Ill. Nat. Hist. Survey Bul. **20:**381 (nymph, biology).
1938 *Neoperla clymene* Ricker. Roy. Canad. Inst., Trans. **22:**137 (saw type).

Recorded distribution—type locality: Georgia. Other records: Arizona, Connecticut, Florida, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, Nova Scotia, Ohio, Pennsylvania, Tennessee, Texas, Vermont.

Minnesota records—Hennepin County (Mississippi River), Anoka County (Mississippi River), Pine County (Snake River), Kanabec County. Adults, June 24 through July 25.

Neoperla clymene is evidently a species of the larger rivers. Nymphs were taken in or below rapids, where they were found clinging to rocks in the current. This species has been recorded only once from Canada, *i.e.*, from Nova Scotia. It has been collected from northern states of the United States, from Maine across to Minnesota, where the western limit of its range swings south and west through Kansas into Arizona.

The variation in coloration of the nymphs of *N. clymene* is illustrated by Frison *(loc. cit.)*. There is a light form and a dark form.

Subfamily Acroneuriinae

KEY TO THE SPECIES OF ACRONEURIA PICTET, 1841

Adapted from Frison, 39, p. 390

Adults

1. Ninth ventral abdominal segment greatly produced posteriorly and recurved upward so that tenth segment is mostly or entirely concealed, and with a raised disk in middle of posterior portion; eighth ventral segment similar to preceding segments and never produced over ninth; subanal lobes well developed and recurved over dorsal surface of tenth dorsal segment (males) 2

   Ninth ventral abdominal segment not greatly enlarged and not covering tenth segment, and without a raised disk; eighth ventral segment often with posterior margin produced over ninth segment or with a hump anterior to posterior margin; subanal lobes not well developed and not recurved over dorsal surface of tenth dorsal segment (females) 5

2. Subanal lobes fingerlike ..... **internata**

   Subanal lobes broad, flat, and somewhat triangular 3

3. Numerous short spinelike setae on ninth and tenth abdominal tergites 4

   No spinelike setae on ninth and tenth abdominal tergites ..... **ruralis**

4. Subanal lobes divergent upward; dorsum of head mostly black ..... **abnormis**

   Subanal lobes parallel upward; dorsum of head with little more than ocellar triangle dark ..... **lycorias**

5. Eighth abdominal sternite produced but little over ninth sternite ..... **abnormis**

   Eighth abdominal sternite moderately or greatly produced over ninth sternite 6

6. Raised disk or hump on posterior portion of eighth abdominal sternite before the posterior margin ..... **ruralis**

   No raised disk or hump on posterior portion of eighth abdominal sternite before the posterior margin 7

7. With two flaplike lobes attached to subgenital plate of eighth abdominal sternite ..... **internata**

   No flaplike lobes attached to subgenital plate, which is evenly curved; posterior margin of subgenital plate dark ..... **lycorias**

Nymphs

1. Abdomen with anal gills; tergites of abdomen with alternating light and dark transverse bands ..... **lycorias**

   Abdomen without anal gills; tergites of abdomen with or without alternating light and dark transverse bands 2

2. Head a unicolorous brown; occipital ridge present on posterior margin of head ..... **ruralis**

   Head with light spots or an irregular light M-shaped band contrasting with a dark background; no occipital ridge present 3

3. Dorsum of abdomen uniformly dark; head with light spots or sometimes a light continuous M in front of median ocellus ..... **abnormis**

   Alternating transverse light and dark bands on dorsum of abdomen 4

4. Head anterior to postfrontal suture with five light spots contrasting with dark background; light areas on dorsum of abdominal segments transverse, bandlike, and parallel with dark bands ..... **internata**

   Head anterior to median ocellus with a light transverse M band; light areas on abdominal tergites tending to divide dark bands along the midline into two detached lateral dark areas ..... **abnormis**

Acroneuria abnormis (Newman)

1838 *Perla abnormis* Newman. Ent. Mag. **5**:177.

1925 *Acroneuria abnormis* Needham and Claassen. Plecoptera of No. Amer. p. 178.

1931 *Acroneuria abnormis* Claassen. Plecoptera nymphs of Amer. p. 82 (nymph).

1935 *Acroneuria abnormis* Frison. Ill. Nat. Hist. Survey Bul. **20**:391 (nymph, biology).

1935 *Acroneuria sp. b.* Frison. *Ibid.*, p. 407 (nymph with dorsal abdominal pattern).

1938 *Acroneuria abnormis* Ricker. Roy. Canad. Inst., Trans. **22**:137 (examined type).

Recorded distribution—type locality: Trenton Falls, New York. Other records: Connecticut, Florida, Georgia, Illinois, Indiana, Maine, Manitoba, Maryland, New Brunswick, New Jersey, New York, North Carolina, Nova Scotia, Ohio, Ontario, Pennsylvania, Quebec, West Virginia.

Minnesota records—Houston County (Root River), Fillmore County (Root River), Wabasha County (Zumbra River), Le Sueur County (Minnesota River), Scott County (Minnesota River), Hennepin County (Mississippi River), Anoka County (Mississippi River), Pine County (Snake River), Kanabec County (Snake River), Crow Wing County (Mississippi River), Hubbard County (Crow Wing River), St. Louis County (McCarty Brook, Whiteface River, White Pine River, stream seven miles north of Cloquet), Cook County (Devils Track River, Temperance River). Adults, May 5 through July 9.

Acroneuria abnormis ranges from the southern border to the northern boundary in the eastern part of Minnesota. It is found in medium to large streams. Other species with which it is often found are *Acroneuria lycorias, Isoperla transmarina, I. richardsoni* and/or *I. bilineata.*

The nymph has been described as having a uniformly dark brown abdomen above. Rearings have shown that there is a light, patterned phase, as suggested by Frison *(39)* in describing a nymph from a cast skin of a then unknown determination. The dorsal aspect of this light, patterned phase is well illustrated by Frison, who has shown the light M pattern in front of the median ocellus and the broad, paired, semicircular, dark patches on the basal part of most of the abdominal tergites.

Acroneuria internata (Walker)

1852 *Perla internata* Walker. Neuropt. Insects Brit. Mus., Cat. p. 152.

1925 *Acroneuria internata* Needham and Claassen. Plecoptera of No. Amer. p. 184.

1935 *Acroneuria internata* Frison. Ill. Nat. Hist. Survey Bul. **20**:401 (nymph, biology).

1938 *Acroneuria internata* Ricker. Roy. Canad. Inst., Trans. **22**:139 (saw types).

Recorded distribution—type locality: "North America." State records: Colorado, Illinois, Indiana, Michigan, Missouri, West Virginia.

Minnesota records—Anoka County. Rum River, May 7, 1940, Irven B. Tarshis, five nymphs.

Kanabec County. Mora, June 24-30, 1934, C. R. Yeager, one male.

This is one of the *Acroneuria* species with a range extending farther west than Minnesota; it has been recorded from Colorado. In Minnesota it has been recorded from medium-sized, rather sluggish rivers in the central part of the state. It is one of the rarer Plecoptera species in the state. Frison noted that it was the least abundant of the Illinois species of *Acroneuria*, also.

Acroneuria lycorias (Newman)

1839 *Perla lycorias* Newman. Mag. Nat. Hist. N. S. **3**:35.

1925 *Acroneuria lycorias* Needham and Claassen. Plecoptera of No. Amer. p. 189.

1933 *Acroneuria perbranchiata* Neave. Canad. Ent. **65**:237 (male, female, and nymph).

1938 *Acroneuria lycorias* Ricker. Roy. Canad. Inst., Trans. **22**:139 (examined and designated lectotype).

1942 *Acroneuria lycorias* Frison. Ill. Nat. Hist. Survey Bul. **22**:283 (synonymy, nymph, male, and female).

Recorded distribution—type locality: "Canada." Other records: Connecticut, Florida, Maine, Manitoba, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New York, Ohio, Ontario, Pennsylvania, Quebec, Tennessee, West Virginia, Wisconsin.

Minnesota records—Fillmore County (Root River), Le Sueur County (Minnesota River), Yellow Medicine County (Florida Creek, Lac qui Parle River), Scott County (Credit River), Hennepin County (Mississippi River), Anoka County (Mississippi River, Rum River), Stearns County, Benton County (Little Rock River), Morrison County (Platte River), Crow Wing County (Nokaysippi River), Kanabec County (Snake River), Pine County (Big Sand Creek, Bangs Brook, Snake River, Kettle River), Carlton County (Nemadji River), Red Lake County (Red Lake River), St. Louis County (French River, Lester River, Sucker River, stream seven miles north of Cloquet, Whiteface River, St. Louis River, Cloquet River, Vermilion River, Lake Vermilion), Lake County (Stewart River, Gooseberry River, Encampment River), Cook County (Temperance River, Cascade River, Two Island River, Devils Track River).

In Minnesota *Acroneuria lycorias* has been collected from streams of various sizes ranging from Bangs Brook in Pine County, a stream one can step across in places, up to the largest river in the state, the Mississippi. Nymphs have most often been collected from rocks and rubble in riffles and rapids, but they have also been taken from places away from riffles or rapids.

This species is quite widespread in the state and is one of the few which have been collected in the western prairie counties of Minnesota.

Ricker *(100)* lists it as one of the prairie stoneflies, not maintaining, however, that it is limited to that area.

Frison *(41)* called attention to the fact that the nymph described by Claassen *(26)* as *A. lycorias* is really *A. carolinensis* (Banks), a species which lacks anal gills. The nymphs of *A. lycorias* as a rule show a definite banding on the abdomen, with the basal half yellowish and the posterior half darker. Some specimens collected in northern Minnesota lack this definite banding.

Adults have been collected in the state from the first week in May through the middle of July.

Acroneuria ruralis (Hagen)

1861 *Perla ruralis* Hagen. Syn. Neuroptera No. Amer. p. 18.
1925 *Acroneuria ruralis* Needham and Claassen. Plecoptera of No. Amer. p. 181.
1931 *Acroneuria ruralis* Claassen. Plecoptera nymphs of Amer. p. 89 (nymph).
1935 *Acroneuria ruralis* Frison. Ill. Nat. Hist. Survey Bul. **20**:403 (nymph, biology).

Recorded distribution—type locality: St. Louis, Missouri. Other records: Colorado, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Manitoba, Maryland, New York, Ohio, Pennsylvania, Tennessee, Wisconsin.

Minnesota records—Hennepin County. Minneapolis near University of Minnesota, June 2, 1948, PHH, one male. Minneapolis, Mississippi River, June 6, 1922, Arthur Hertig, one male. Minneapolis, June 8, 1942, J. W. Moore, one female.

Acroneuria ruralis has been taken near the Mississippi River in Hennepin County around the first week in July. Frison records it from medium as well as large rivers.

GENUS ATOPERLA BANKS, 1905

Atoperla ephyre (Newman)

1839 *Chloroperla ephyre* Newman. Mag. Nat. Hist. N. S. **3**:87.
1925 *Atoperla ephyre* Needham and Claassen. Plecoptera of No. Amer. p. 161.
1931 *Atoperla ephyre* Claassen. Plecoptera nymphs of Amer. p. 78 (nymph).
1935 *Atoperla ephyre* Frison. Ill. Nat. Hist. Survey Bul. **20**:377 (nymph, biology).
1938 *Atoperla ephyre* Ricker. Roy. Canad. Inst., Trans. **22**:136 (saw type).

Recorded distribution—type locality: Georgia. Other records: Arkansas, Florida, Kansas, Illinois, Indiana, Massachusetts, New York, North Carolina, Pennsylvania.

Minnesota records—Hennepin County (Mississippi River), Ramsey County, Anoka County (Mississippi River), Pine County (Kettle River). Adults, June 7 through 13.

Atoperla ephyre has been collected along some of the larger rivers in the eastern central part of the state. The Minnesota collections represent records found farthest north to date, and they are about as far west as the western limit of its range previously recorded near Hot Springs, Arkansas. Species found with *A. ephyre* in both Minnesota rivers from which it has been collected are *Acroneuria lycorias, Hastaperla orpha, Isoperla bilineata, Isoperla richardsoni, Isoperla transmarina, Nemoura rotunda, Phasganophora capitata, Brachyptera fasciata, Taeniopteryx parvula,* and *Paragnetina media.*

GENUS PERLESTA BANKS, 1906

Perlesta placida (Hagen)

1861 *Perla placida* Hagen. Syn. Neuroptera No. Amer. p. 28.
1925 *Perlesta placida* Needham and Claassen. Plecoptera of No. Amer. p. 158.
1931 *Perlesta placida* Claassen. Plecoptera nymphs of Amer. p. 77 (nymph).
1935 *Perlesta placida* Frison. Ill. Nat. Hist. Survey Bul. **20**:386 (nymph, biology).

Recorded distribution—type locality: Washington, D.C. Other records: Alabama, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Manitoba, Maryland, Massachusetts, Michigan, Minnesota, New Brunswick, New Jersey, New York, North Carolina, Nova Scotia, Ohio, Pennsylvania, Texas, Vermont, Virginia, West Virginia, Wisconsin.

Minnesota records—common over the state in midsummer; records from 41 counties, from Houston County in the southeast corner and Nobles County in the southwest corner to Kittson County in the northwest corner and Lake County near the northeast corner. Adults recorded from June 2 through August 31, with the highest adult population occurring in July.

Perlesta placida surpasses all other species of Plecoptera found in the state in the number of streams from which it has been collected and in the extent of range within the state. It is found in many of the prairie streams in the western part of the state, as well as in many of the streams over the rest of the state. Two other species, *Acroneuria lycorias* and *Isoperla bilineata,* have been collected from prairie streams in a few instances, but neither has been found in such a large number of this type of stream.

P. placida is a species that can survive in an intermittent stream. Nymphs of this species were collected from Buffalo Creek, which is near Glencoe in McLeod County, in the early summer of 1948. In late August of that year the stream was no longer flowing, being at that time a series of stagnant pools separated by muddy stream bottom. Again in the spring of 1949 collections of nymphs of the species were made from the same place in Buffalo Creek.

Recently Banks *(15)* reviewed the variants of *P. placida*, removing several which had been named as species from synonymy and describing another form from the Smoky Mountains as a new species. Most recent authorities in North America, *i.e.* Needham and Claassen *(82)*, Claassen *(26)*, Frison *(39)*, and Ricker, have recognized but one species of *Perlesta* which ranges over a large part of the United States. The writers are following this wide concept of the species.

GENUS PERLINELLA BANKS, 1900

Perlinella drymo (Newman)

1839 *Isogenus drymo* Newman. Mag. Nat. Hist. N.S. **3**:86.
1925 *Perlinella drymo* Needham and Claassen. Plecoptera of No. Amer. p. 164 (male and female).
1931 *Perlinella drymo* Claassen. Plecoptera nymphs of Amer. p. 79 (nymph).
1935 *Perlinella drymo* Frison. Ill. Nat. Hist. Survey Bul. **20**:380 (nymph, biology).
1938 *Perlinella drymo* Ricker. Roy. Canad. Inst., Trans. **22**:137 (saw types).

Recorded distribution—type locality: Georgia. Other records: Illinois, Indiana, Maine, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Tennessee.

Minnesota records—Winona County, Washington County (St. Croix River), Anoka County (Mississippi River), Pine County (Snake River, Big Sand Creek). Adults, May 8 through June 10.

Perlinella drymo has been found in small to large streams in the southeastern and central eastern parts of Minnesota. Claassen collected nymphs of this species from pools in streams and also from a small lake formed by an artificial dam in a creek.

This is another of the species with its recorded western limit in Minnesota. Although the species is poorly represented in collections in the state, it is found more abundantly in other parts of its range, as stated by Frison *(loc. cit.)*.

FAMILY CHLOROPERLIDAE

Key to the Genera of Chloroperlinae

Adapted from Frison, 41

Adults

1. Hindwing without a distinct folded anal area ..... **Hastaperla**
   Hindwing with a distinct folded anal area; third anal vein of forewing with basal portion fused with second anal vein so that second anal vein appears branched; anal lobe of hindwing small, extending about to middle point of wing ..... **Alloperla**

Nymphs

1. Length of body about seven mm.; segments in cerci about 15 ..... **Alloperla**
   Length of body about five mm.; segments in cerci about 10 ..... **Hastaperla**

KEY TO THE SPECIES OF ALLOPERLA BANKS, 1906

Adults

1. Supraanal process behind tenth abdominal tergite; caudal margin of eighth abdominal sternite straight (males) 2
   No supraanal process; caudal margin of eighth abdominal sternite produced backward as a subgenital plate (females) 3
2. Supraanal process recurved, slender, sclerotized, gradually tapering to a point ..... **imbecilla**
   Supraanal process largely membranous, subtriangular, with a brown, sclerotized, subrectangular band on its caudal surface ..... **sylvia**
3. Subgenital plate quadrate, less than one-tenth width of segment ..... **quadrata**
   Subgenital plate triangular 4
4. Basal width of subgenital plate about one-third width of segment ..... **imbecilla**
   Basal width of subgenital plate less than one-fifth width of segment ..... **sylvia**

In this genus the nymph of but one of the species found in Minnesota is known, *A. imbecilla*.

Alloperla imbecilla (Say)

Plate IX, Figs. 5, 6

1823 *Sialis imbecilla* Say. West. Quart. Rptr. **2**:165.
1925 *Alloperla imbecilla* Needham and Claassen. Plecoptera of No. Amer. p. 125.

Recorded distribution—type locality: Ohio River near Cincinnati, Ohio. Other records: Georgia, New York, Maine, North Carolina, Alaska (?), Connecticut, New Brunswick, Nova Scotia.

Minnesota records—St. Louis County (French River), Cook County (Cascade River, Temperance River, Kimbal Creek, Little Devils Track Creek, Devils Track River, Kadunce Creek). Adults, July 22 through August 8.

Freshly cast nymphal skins were found on the rocks of an upper rapids of the Temperance River where the adults of *A. imbecilla* were common and no other *Alloperla* was collected. A description has been made of the nymph of the species, based on these cast skins.

Nymphs

Length about seven mm.; length of antennae about 2.5 mm.; length of cerci about 2.5 mm.; segments in cerci about 15. No definite dorsal pattern. General color brownish-yellow, darker on legs, antennae, and cerci.

Hairs on body moderately long. General shape same as in other Alloperlids (41, p. 343). Mouthparts as illustrated, plate IX, figs. 5, 6.

The green color of the adults of this species of summer stonefly is quite sriking. As stated by Ricker (97, p. 29) this green color fades quickly in fluid and slowly in dry specimens. This is one of the few late summer species found in the state, others being *Nemoura venosa*, *Perlesta placida*, and species of *Leuctra*. *A. imbecilla* seems to be confined to small rivers and large creeks in the state. In Minnesota it has been recorded only from streams of the north shore of Lake Superior.

Alloperla sylvia n. sp.

Plate X, Figs. 7, 8, 9

Males

Length to tip of wings 7.5 to 9.2 mm.; width of head about one mm. General color yellowish-white with darker tibiae, tarsi, and antennae beyond the base; cerci light. Most of insect covered with fine short and long hairs.

Head completely yellowish-white above except for the dark brown compound eyes and black ocelli. Distance between lateral ocelli slightly more than twice the distance from a lateral ocellus to the adjacent compound eye. Lateral ocelli on a line setting off the posterior one-third of the compound eyes. Mandibles and laciniae of maxillae sclerotized.

Pronotum yellowish-gray with rugosities yellowish-white, narrower than head; anterior and posterior margins slightly outcurved; lateral margins broadly rounded. Marginal grooves along lateral margins obsolete.

Abdomen yellowish-white without a dark stripe. Ninth tergite slightly emarginate on its posterior margin; tenth tergite cleft. Supraanal process largely membranous, yellowish-white, subtriangular in caudal aspect; a groove dorso-ventrally in its anterior surface; a long, subrectangular, brown, sclerotized band on its caudal surface, ending dorsally in two sharp spines directed laterad. Ninth abdominal sternite somewhat produced, broadly quadrate. Wing venation same as in typical Alloperlids. Membrane of wings and veins without color, except stigmal area, which is somewhat white and opaque. Legs yellowish-white, with tarsi darker; a brownish longitudinal line along dorsal aspect of each femur. Cerci with about nine segments.

Females

Resembling male in general appearance; somewhat larger than male, varying from 9.5 to 10.2 mm. in length; width of head about 1.1 mm.

Tenth tergite not cleft; supraanal process lacking; ninth sternite not produced. Eighth abdominal sternite produced posteriorly as a subtriangular subgenital plate, with base about one-fifth the width of abdominal segment 8, and length about equal to basal width; subgenital plate somewhat keeled. Variation of this keeling alters the apparent width of the subgenital plate.

Holotype male and allotype female: Pine County, Big Sand Creek, May 27, 1949, PHH. Paratypes: same data as holotype, four males. Same place and date as holotype, collector Sophie Parfin, one male, two females. Same place as holotype, June 2, 1948, PHH, one male.

This species has a definite green color in nature; this color is quickly lost in the liquid preservative used.

The senior author takes pleasure in naming this species after his daughter, who accompanied him on both of the trips on which this species was taken.

Alloperla quadrata n. sp.

Plate X, Fig. 6

Females

Length to tip of wings about 10 mm.; width of head about 1.0 mm. General color yellowish-white with tarsi and antennae brownish-black beyond the bases. Cerci light. Most of insect covered with short fine hairs; these hairs longer on abdomen.

Head yellowish-white above except for dark brown compound eyes and black ocelli. Distance between lateral ocelli about twice the distance from a lateral ocellus to the adjacent compound eye. Lateral ocelli on a line setting off the posterior one-third of the compound eyes. Mandibles and laciniae of maxillae sclerotized.

Pronotum yellowish-white above, slightly narrower than head; anterior and posterior margins outcurved; angles broadly rounded. Marginal groove along lateral margins obsolete. Wing venation like that of typical members of the genus as recognized at present in North America.

Abdomen uniformly yellowish-white above. Eighth abdominal sternite produced behind as a narrow squarish subgenital plate with its width about one-tenth the width of abdominal segment 8 and its length slightly more than width. About eight segments in cerci.

Holotype female: Pine County, Minnesota, Kettle River east of Hinckley, June 1, 1948, PHH.

This species is quite close morphologically to *Alloperla sylvia*, from which it differs in the shape of the subgenital plate; in the lack of the longitudinal brown bands on the dorsal aspect of the femora, and in the relative width of the head.

Males

Males unknown.

KEY TO THE SPECIES OF HASTAPERLA RICKER, 1935

Adults

1. A recurved supraanal process present; ninth sternite not produced caudad (males) 2
   Ninth sternite produced caudad; no supraanal process present (females) 3
2. Dorsal dark stripe on abdomen; supraanal process quadrate ..... **orpha**
   No dorsal dark stripe on abdomen; supraanal process rounded ..... **brevis**
3. Dorsal dark stripe on abdomen; subgenital plate subtriangular, somewhat truncate ..... **orpha**
   No dorsal dark stripe on abdomen; subgenital plate rounded ..... **brevis**

Nymphs

1. Pronotum with four angles dark, leaving light diamond-shaped center ..... **orpha**
   Pronotum rather uniform in color ..... **brevis**

Hastaperla brevis (Banks)

1895 *Chloroperla brevis* Banks. Amer. Ent. Soc., Trans. **22**:314.
1925 *Chloroperla cydippe* Needham and Claassen. Plecoptera of No. Amer. p. 128.
1931 *Chloroperla cydippe* Claassen. Plecoptera nymphs of Amer. p. 63 (nymph).
1935 *Chloroperla cydippe* Frison. Ill. Nat. Hist. Survey Bul. **20**:431 (nymph, biology).
1938 *Hastaperla brevis* Ricker. Roy. Canad. Inst., Trans. **22**:144 (synonymy).
1942 *Hastaperla brevis* Frison. Ill. Nat. Hist. Survey Bul. **22**:340 (synonymy).

Recorded distribution—type locality: Sherbrooke, Canada. Other records: Arkansas, Illinois, Indiana, Kentucky, Maine, Manitoba, Maryland, Michigan, Minnesota, Missouri, New Brunswick, New Jersey, New York, North Carolina, Nova Scotia, Ohio, Oklahoma, Oregon, Ontario, Quebec, Tennessee, Virginia, Washington, Wisconsin.

Minnesota records—Hennepin County, Pine County (Bangs Brook, Big Sand Creek), Wadena County, Crow Wing County, Hubbard County (Straight River, Fishhook River), Clearwater County (Clearwater River), St. Louis County, Lake County, Cook County (Temperance River, Little Devils Track Creek, Kadunce Creek). Adults, May 29 through August 8.

Hastaperla brevis is found, often in large numbers, in small to medium streams in the central eastern to the northern part of the state. The other member of the genus, *H. orpha*, is found in medium to large streams over about the same area. In two instances the two species have been found together, or at least the adults have been collected from near the same streams. These streams are the Kettle River in Pine County and part of the upper Mississippi above St. Cloud. *H. brevis* has a transcontinental distribution; there are records of it from Washington and Oregon in the West to Nova Scotia and New York in the East.

Hastaperla orpha (Frison)

Plate II, Fig. 2; Plate VIII, Figs. 7, 8; Plate X, Fig. 5

1937 *Chloroperla orpha* Frison. Ill. Nat. Hist. Survey Bul. **21**:91 (male).
1942 *Hastaperla orpha* Frison. Ill. Nat. Hist. Survey Bul. **22**:338.

Recorded distribution—type locality: Spooner, Namakagon River, Wisconsin. Other record: New Brunswick.

Minnesota records—Hennepin County (Mississippi River), Anoka County (Mississippi River), Chisago County (St. Croix River), Stearns County, Crow Wing County, Pine County (Snake River, St. Croix River, Kettle River), St. Louis County. Adults, May 18 through July 7.

The male has been described by Frison; the type specimens were from the Namakagon River, near Spooner, Wisconsin. A series of females as well as males of this species were found at the type locality on May 27, 1949. A description of the female follows:

Females

Resembles the male as described and figured by Frison *(40)* in most features. These include the general color of pale yellowish-white, the dark margins of the pronotum, and the dorsal abdominal stripe on the first five or six abdominal segments.

The female lacks the supraanal process; its ninth sternite not produced caudad. Size 7.5 to 8.0 mm. in length to tip of wings. Eighth abdominal sternite produced over about half the ninth sternite as a subtriangular subgenital plate. Apex of subgenital plate somewhat truncate; sides of subgenital plate somewhat incurved (plate X, fig. 5).

Allotype female: Namakagon River, Spooner, Wisconsin, May 27, 1949, PHH. Same data as allotype, 19 females, 14 males.

Nymphs

Length 5.0 mm., width of head 0.7 mm. General color yellowish-white above with a somewhat diffuse black pattern. Antennae and legs yellowish-white. Cerci progressively darker toward apex. Moderately long silky hairs over body. Outer margins of wing pads broadly rounded.

Head slightly wider than long. Posterior margin of lateral ocelli almost touching a line joining posterior margin of compound eyes; each lateral ocellus one-half as far from compound eye as from the other lateral ocellus. Coronal suture short, about equal in length to longest diameter of lateral ocellus.

Dark areas include a subtriangular patch ahead of the median ocellus; the base of this triangle is at the front and equal in length to the width of the head at clypeus; another triangle behind each compound eye extending inward behind the lateral ocellus on the side almost to the midline. Several especially long slender hairs back of each compound eye, equal in length to the distance between the lateral ocelli; two somewhat shorter hairs anterior to each compound eye, one above midline and one below it. A long upright hair laterad from each lateral ocellus; another hair cephalad from each of these and laterad from median ocellus.

Front margin of pronotum about straight; rear margin outcurved; all corners broadly rounded, the rear angles more than the front ones. Marginal groove complete on all sides. Corners dark, leaving large diamond-shaped light area on the pronotum and almost filling it. Long hairs along rear margins and around all angles.

Outer margins of wing pads broadly outcurved; inner margins nearly parallel. Dark area along front margin of mesothorax and metathorax; a dark spot at base of inner margin of each wing pad. A row of hairs around outer margins of wing pads.

A somewhat diffuse black band along anterior margin of each abdominal tergite, this band about one-third width of tergite at the midline, widening to two-thirds the width on the sides. Scattered, moderately long

hairs over surface of abdomen, those along the posterior margin of each segment being longer. A row of short spines, directed caudad, along the posterior margin of each segment.

Cerci slightly over one-half length of abdomen; about 10 segments in cerci; antennae somewhat longer. First two tarsal segments very short. A row of long hairs on posterior margin of tibia. Mouthparts as figured, plate VIII, figs. 7, 8.

The above description is from a single nymph obtained from the rakings of the protective gratings above one of the St. Anthony Falls hydroelectric plants on the Mississippi River at Minneapolis, May 19, 1949. Since *Hastaperla orpha* is the only species of the genus recorded for Minneapolis after several seasons of collecting, the above nymph is described as *H. orpha* with a fair degree of certainty. The record of this species from New Brunswick by Ricker *(101)* indicates that this species will doubtless be found in other places in northeastern United States and southeastern Canada.

With the exception of St. Anthony Falls of the Mississippi River, the rivers in Minnesota and the Namakagon River in Wisconsin by which this species has been taken are streams with little fall and no riffles. It is interesting to note that *Isoperla transata*, which was described from the same river as *H. orpha*, has not been found with it in any of the Minnesota streams from which it has been recorded, with the exception of the Mississippi River.

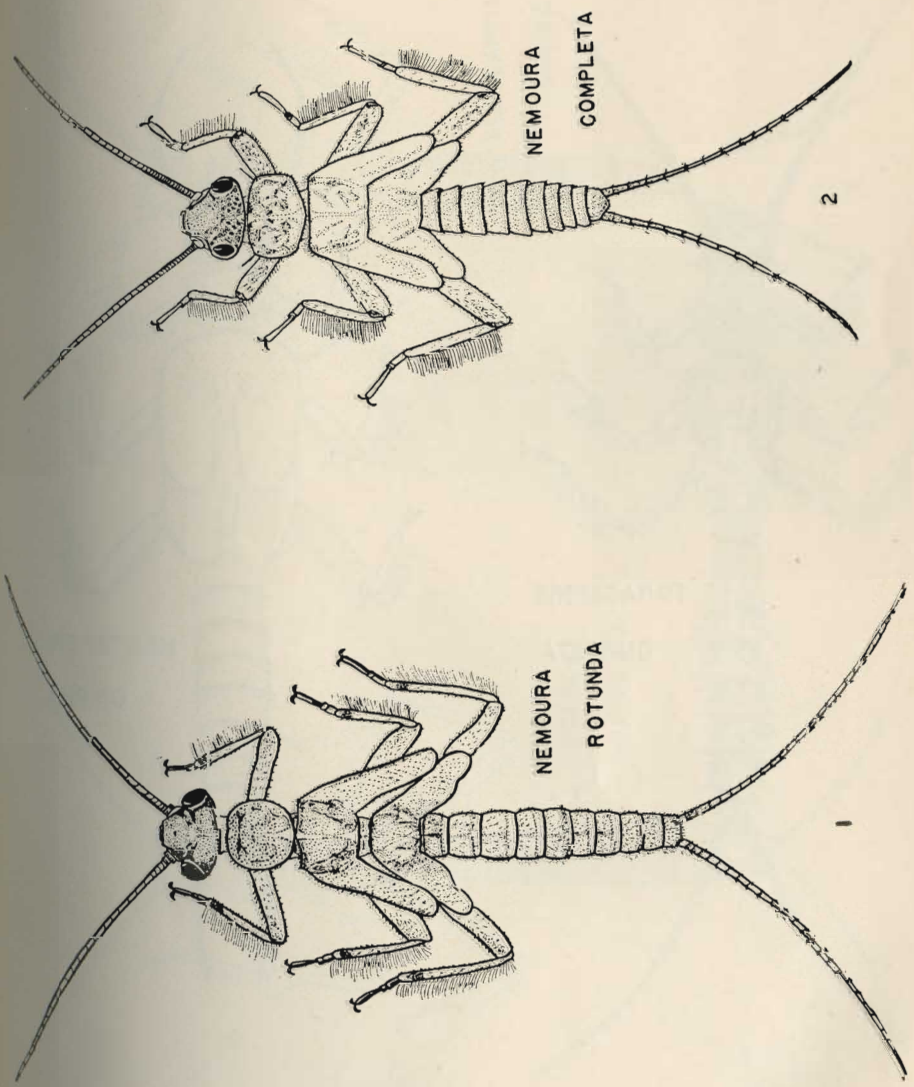


PLATE 1. Nymphs—1. Nemoura rotunda Claassen. 2. Nemoura completa Walker.

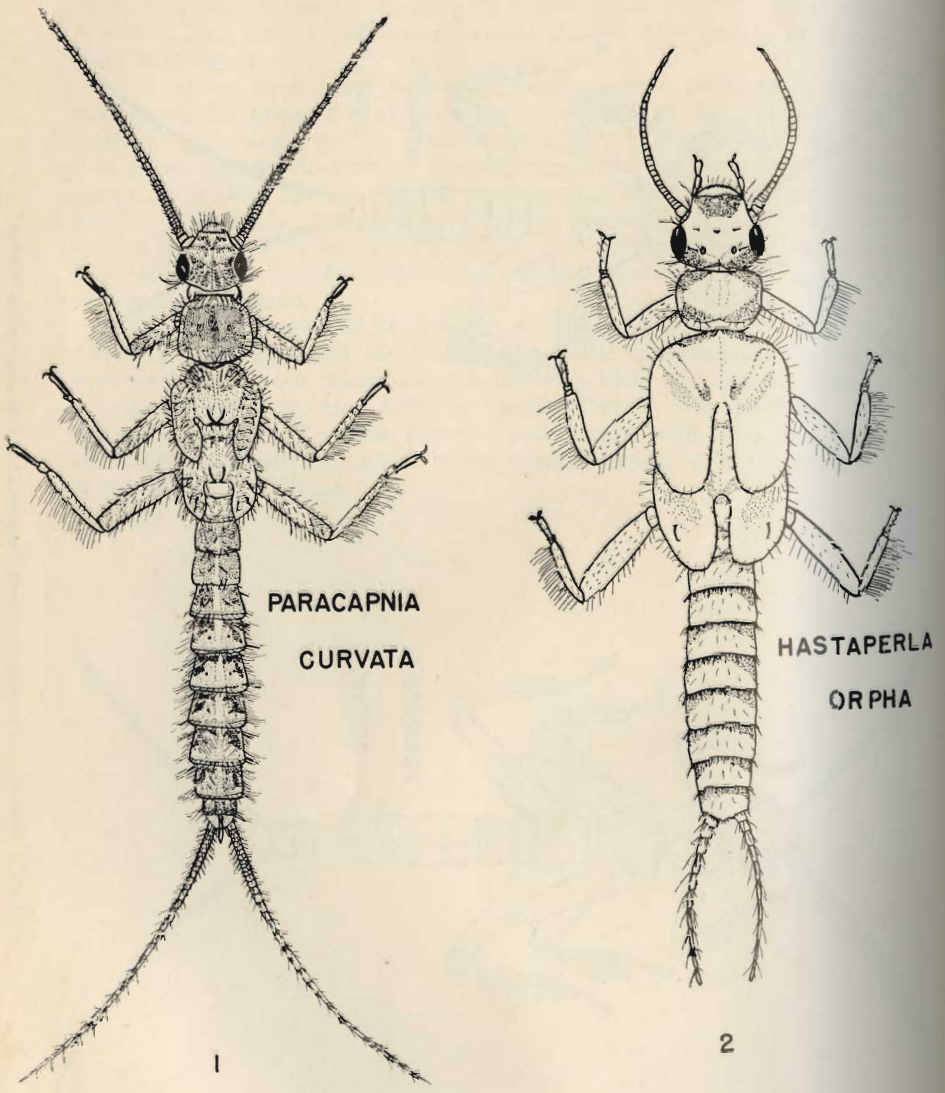


PLATE II. Nymphs—1. *Paracapnia curvata* Hanson. 2. *Hastaperla orpha* (Frison).

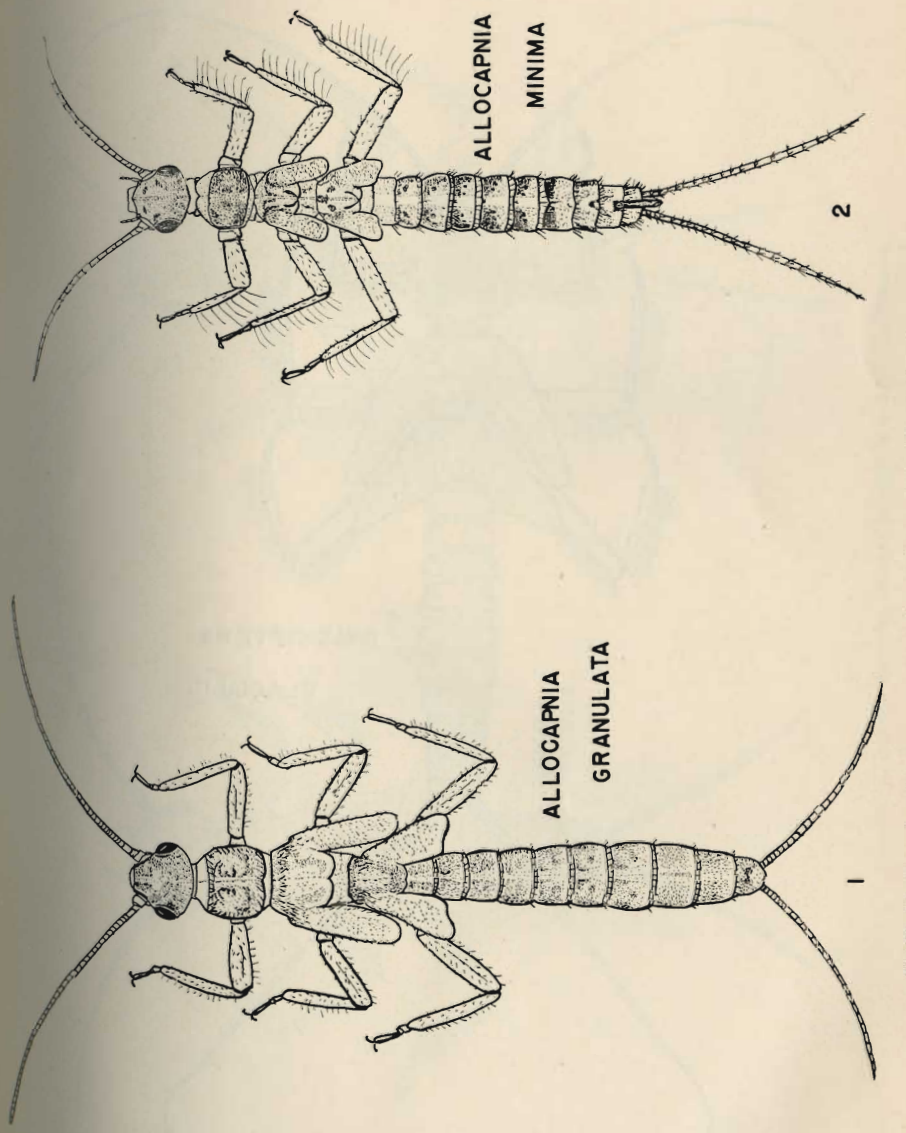


PLATE III. Nymphs—1. *Allocapnia granulata* (Claassen). 2. *Allocapnia minima* (Newport).

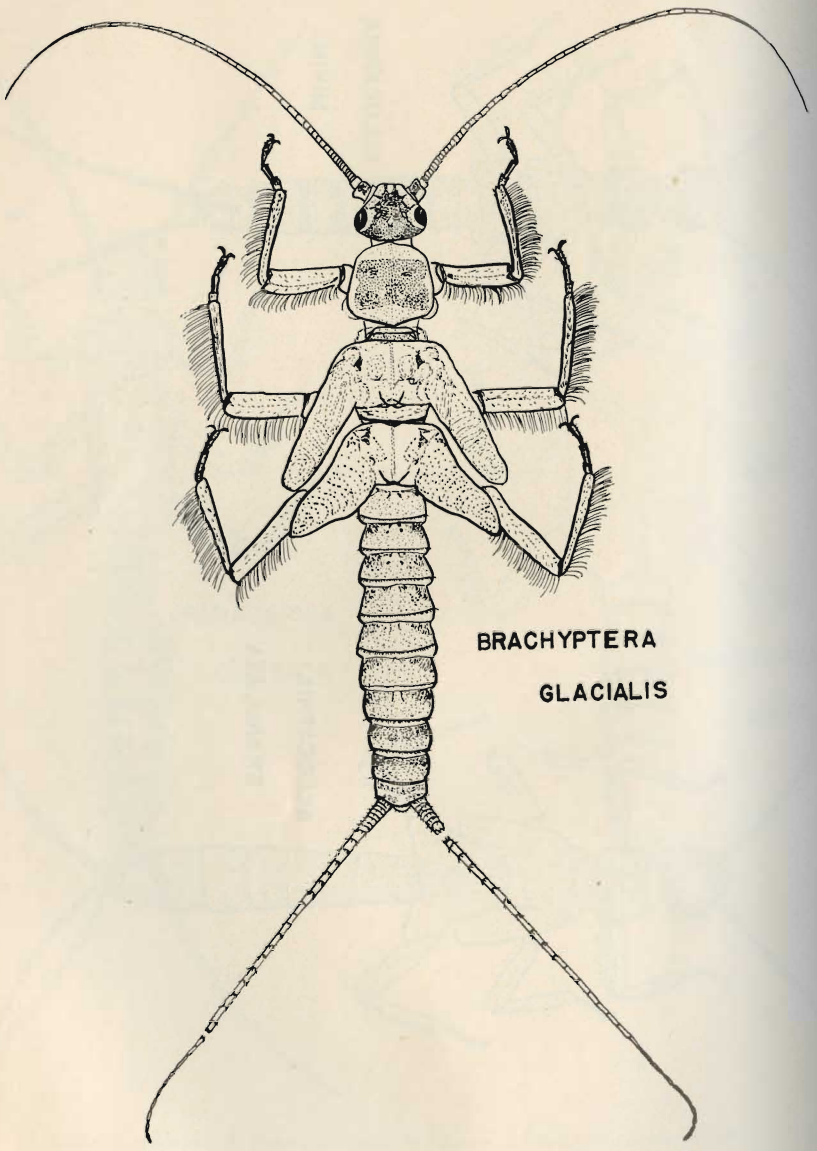


PLATE IV. Nymph—*Brachyptera glacialis* (Newport)—female.

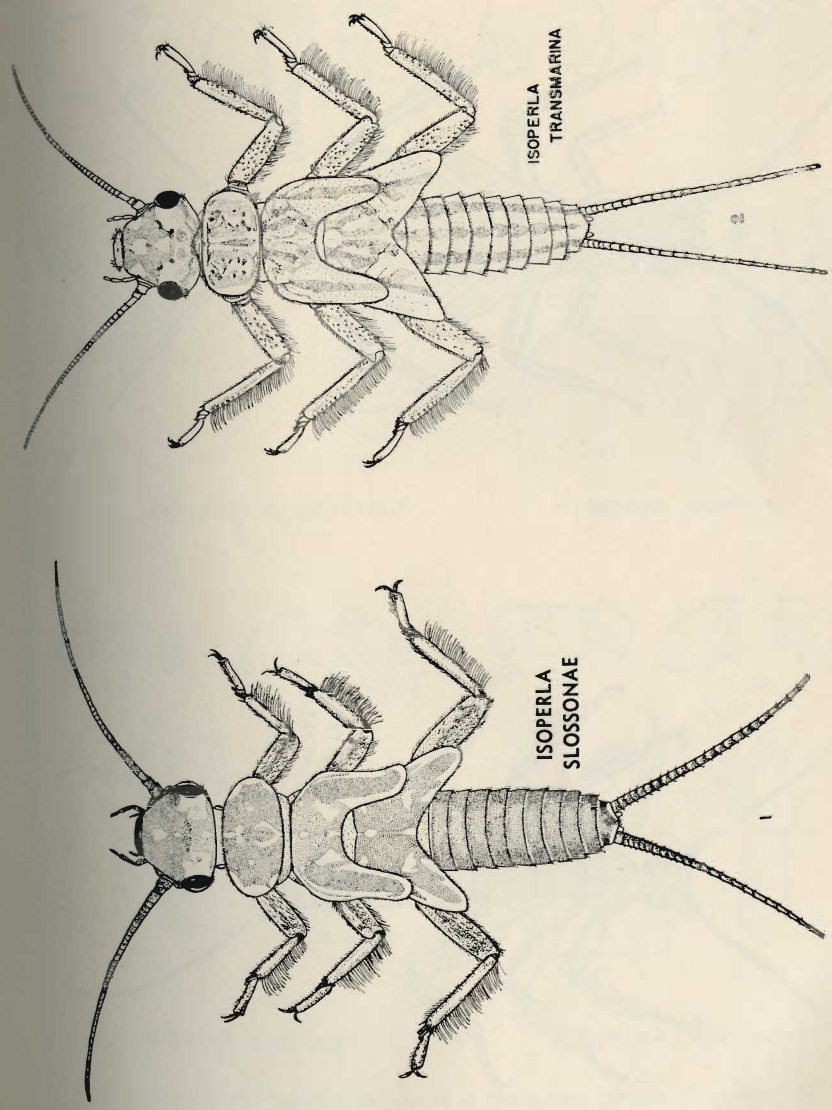
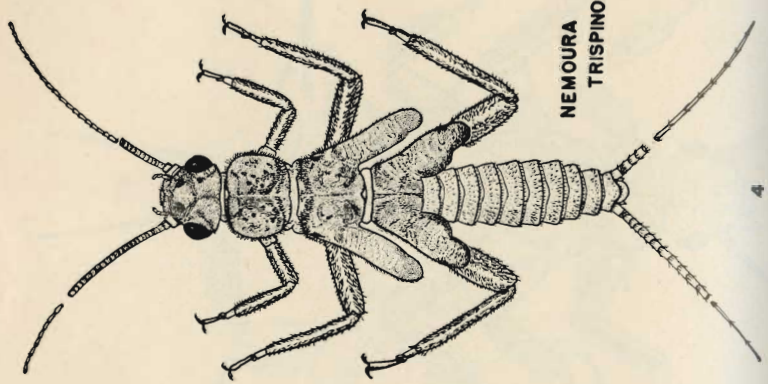


PLATE V. Nymphs—1. *Isoperla slossonae* (Banks). 2. *Isoperla transmarina* (Newman).



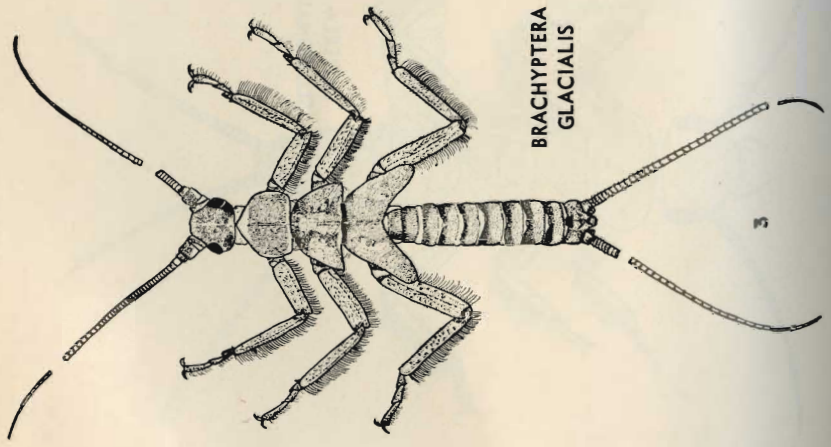
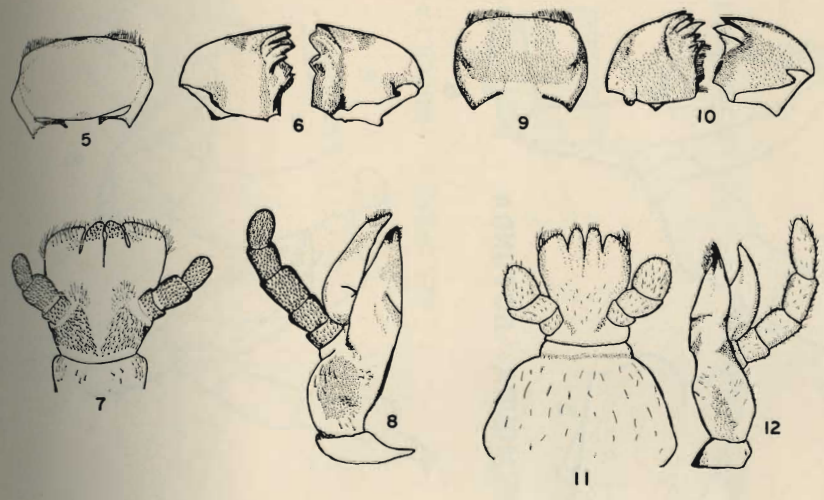


PLATE VI. Nymphs—3. *Brachyptera glacialis* (Newport). 4. *Nemoura trispinosa* Claassen.



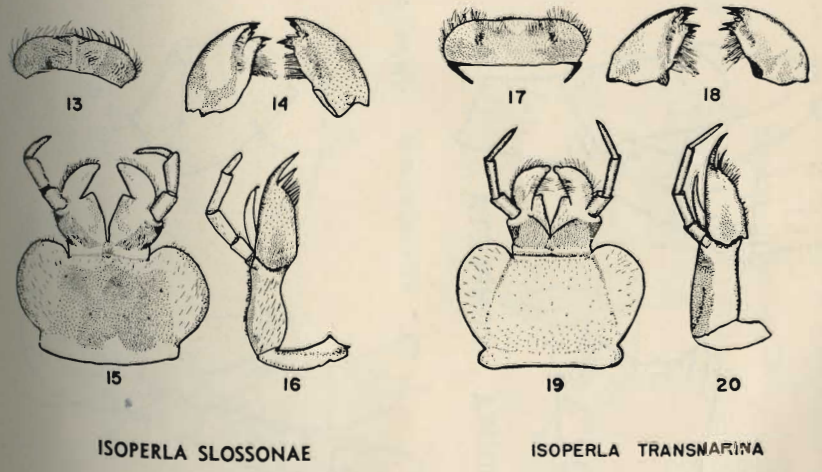
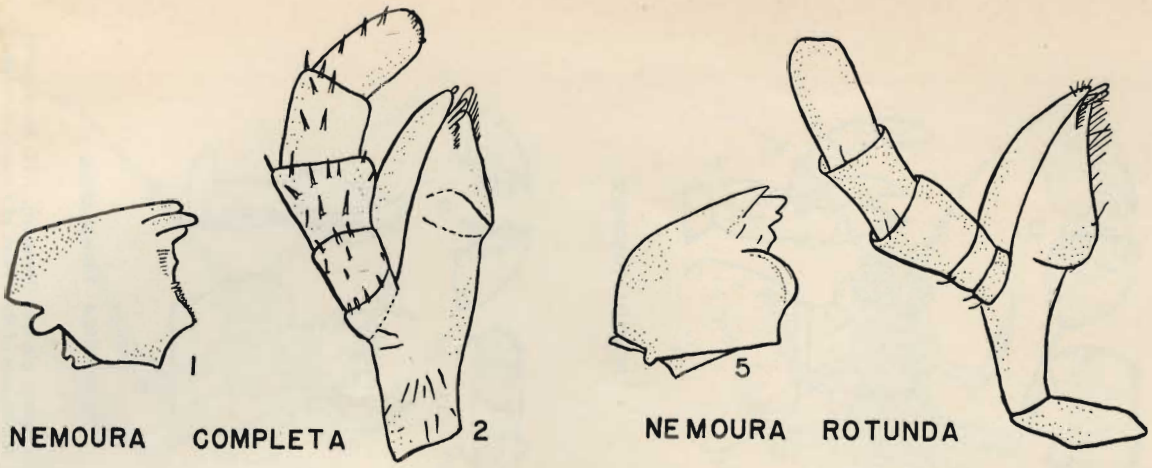


PLATE VII. Nymphs—5-8. Mouthparts of the nymph of *Brachyptera glacialis* (Newport). 9-12. Mouthparts of the nymph of *Nemoura trispinosa* Claassen. 13-16. Mouthparts of the nymph of *Isoperla slossonae* (Banks). 17-20. Mouthparts of the nymph of *Isoperla transmarina* (Newman).



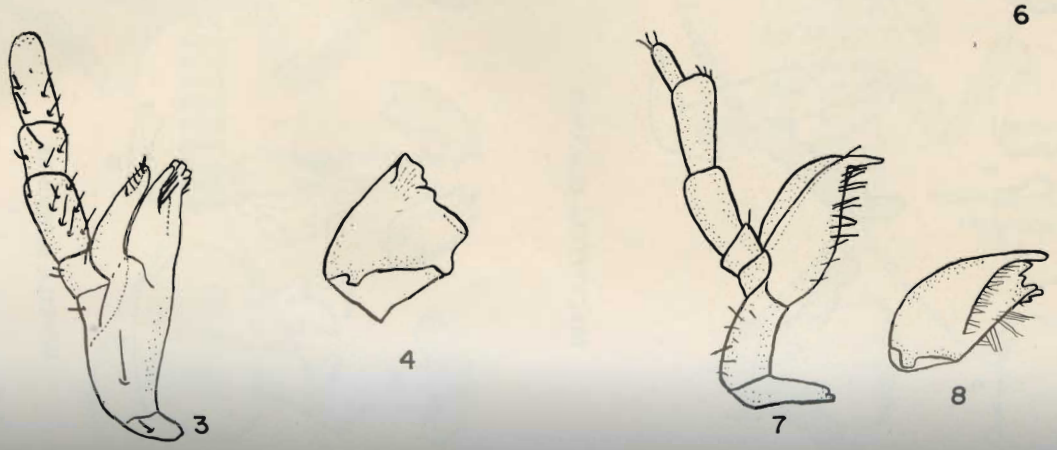
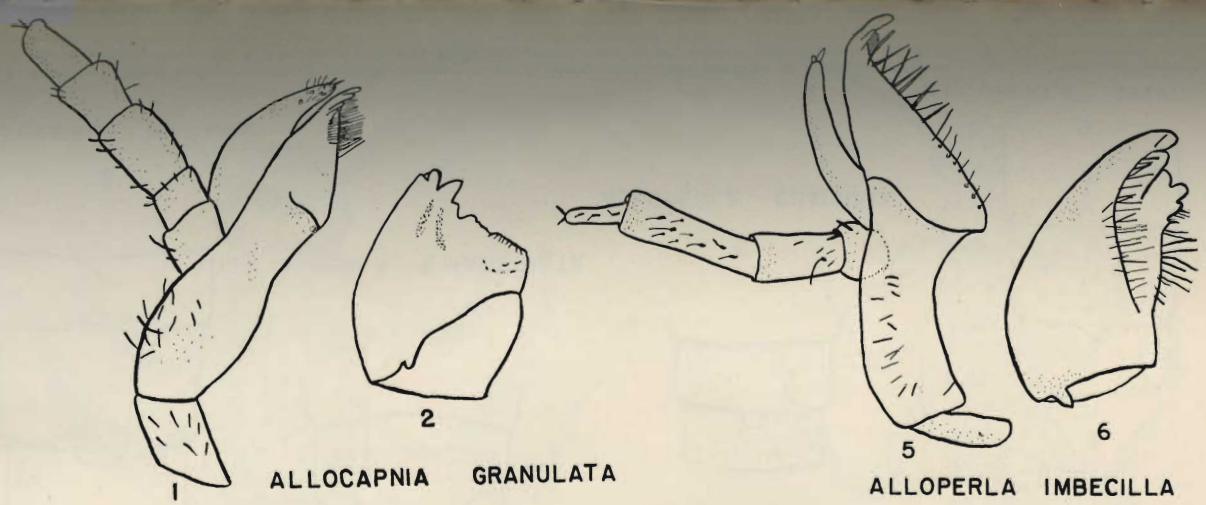


PLATE VIII. Nymphs—1. Right mandible of *Nemoura completa* Walker. 2. Right maxilla of *Nemoura completa* Walker. 3. Right maxilla of *Paracapnia*



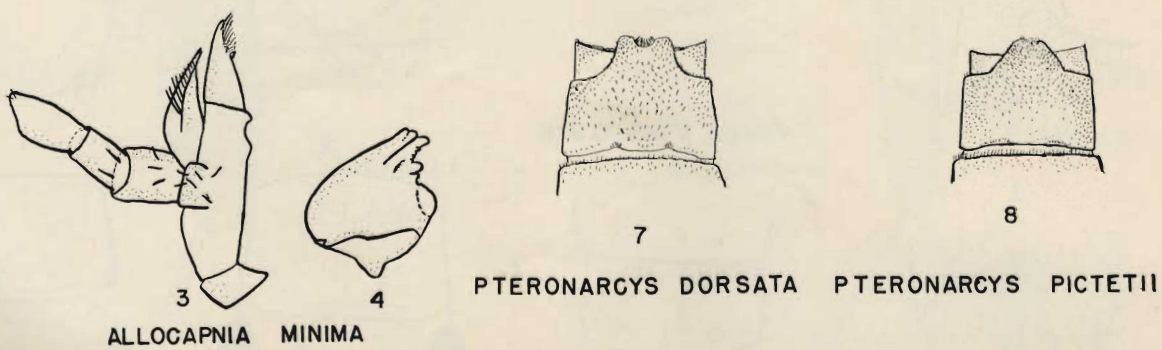


PLATE IX. Nymphs—1. Right maxilla of *Allocapnia granulata* (Claassen). 2. Right mandible of *Allocapnia granulata* (Claassen). 3. Right maxilla of *Allocapnia minima* (Newport). 4. Right mandible of *Allocapnia minima* (Newport). 5. Right maxilla of *Alloperla imbecilla* (Say). 6. Right mandible of *Alloperla imbecilla* (Say). 7. Ninth abdominal sternite of *Pteronarcys dorsata* (Say)—male nymph. 8. Ninth abdominal sternite of *Pteronarcys pictetii* (Hagen)—male nymph.

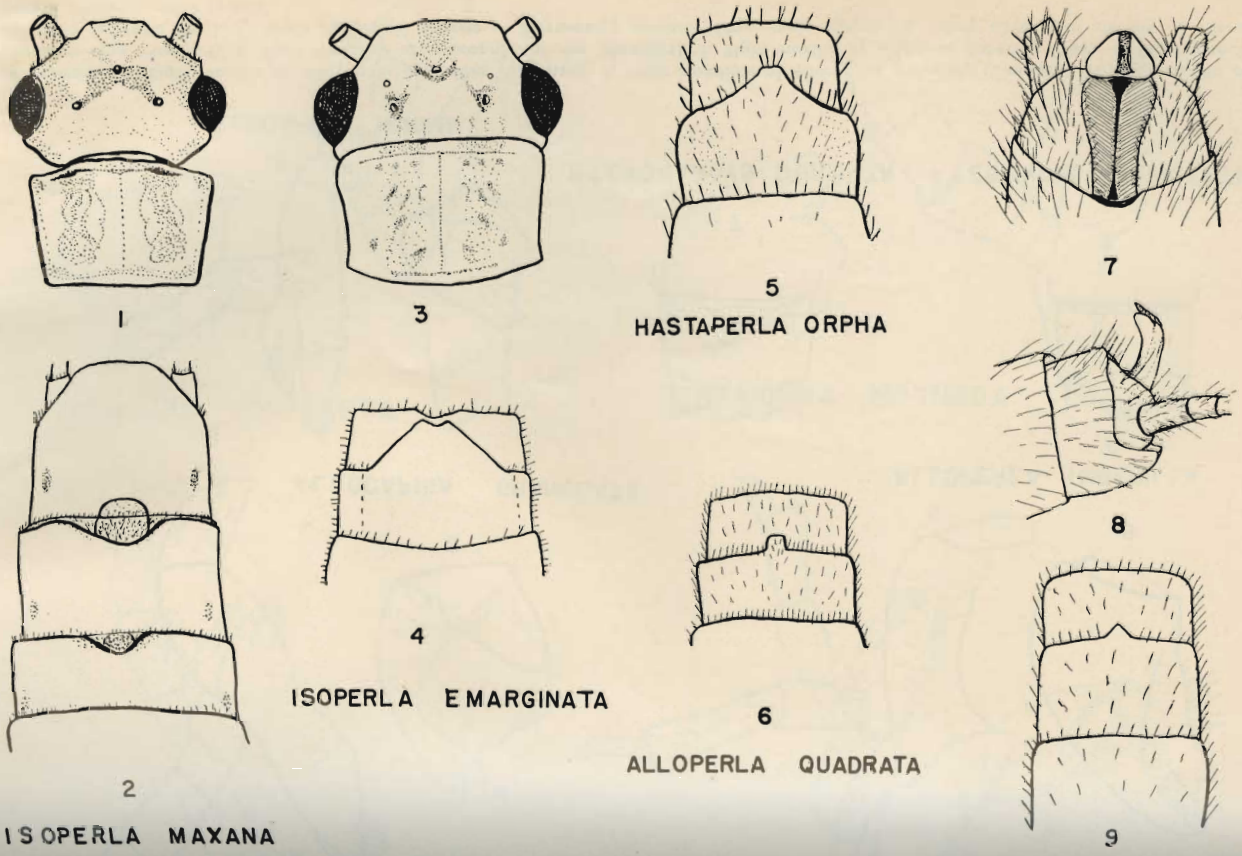


PLATE X. Adults—1. Head and pronotum of Isoperla maxana n. sp. 2. Male; abdominal sternites of *Isoperla maxana n. sp.* 3. Head and pronotum of Isoperla emarginata n. sp. 4. Female; eighth and ninth abdominal sternites of *Isoperla emarginata n. sp.* 5. Female; eighth and ninth abdominal sternites of Hastaperla orpha (Frison). 6. Female; eighth and ninth abdominal sternites of *Alloperla quadrata n. sp.* 7. Male; abdominal tergites and supranal process of Alloperla sylvia n. sp. 8. Male; lateral aspect of abdominal segments of *Alloperla sylvia n. sp.* 9. Female; eighth and ninth abdominal sternites of Alloperla sylvia n. sp.

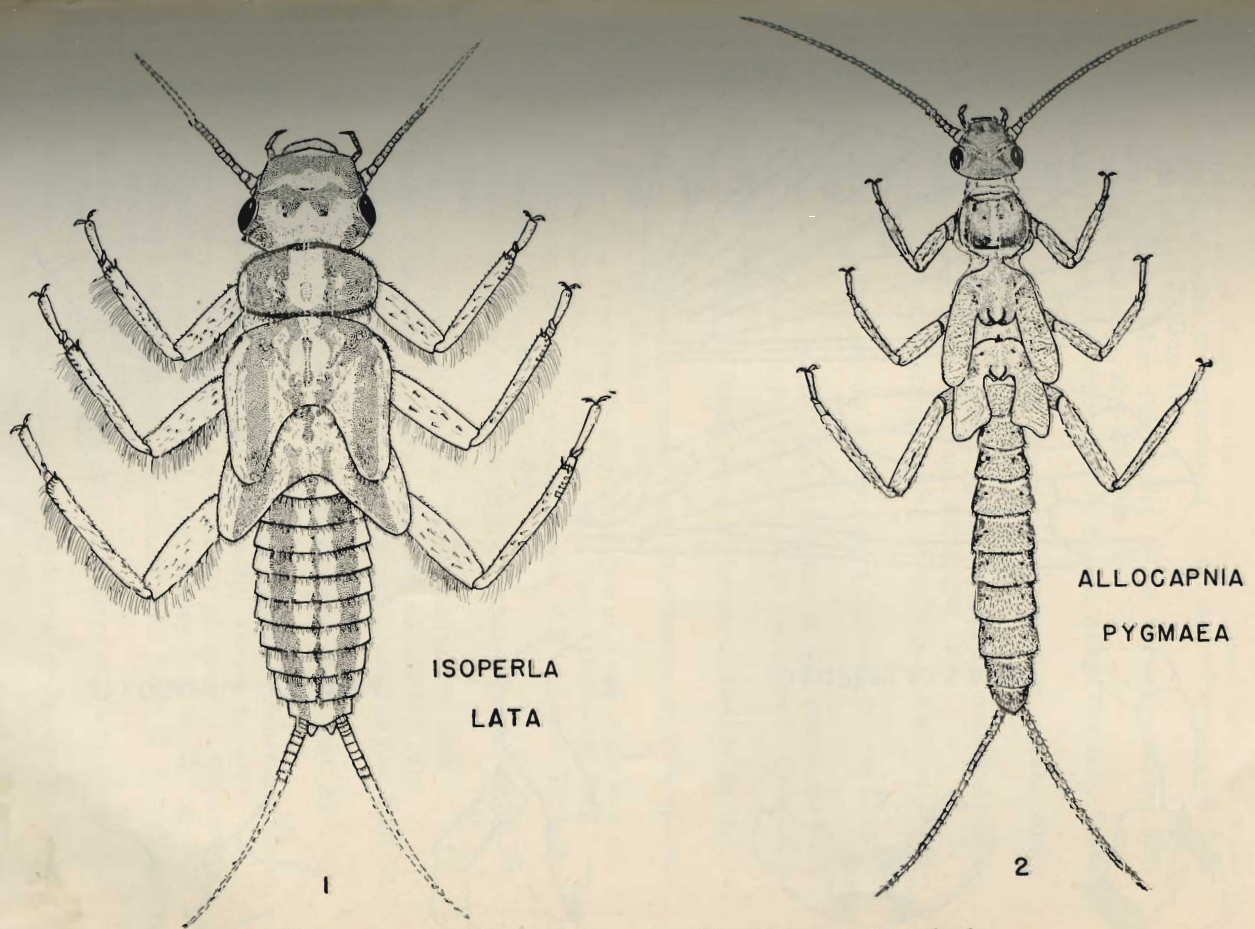


PLATE XI. Nymphs—1. *Isoperla lata* Frison. 2. *Allocapnia pygmaea* (Burmeister).

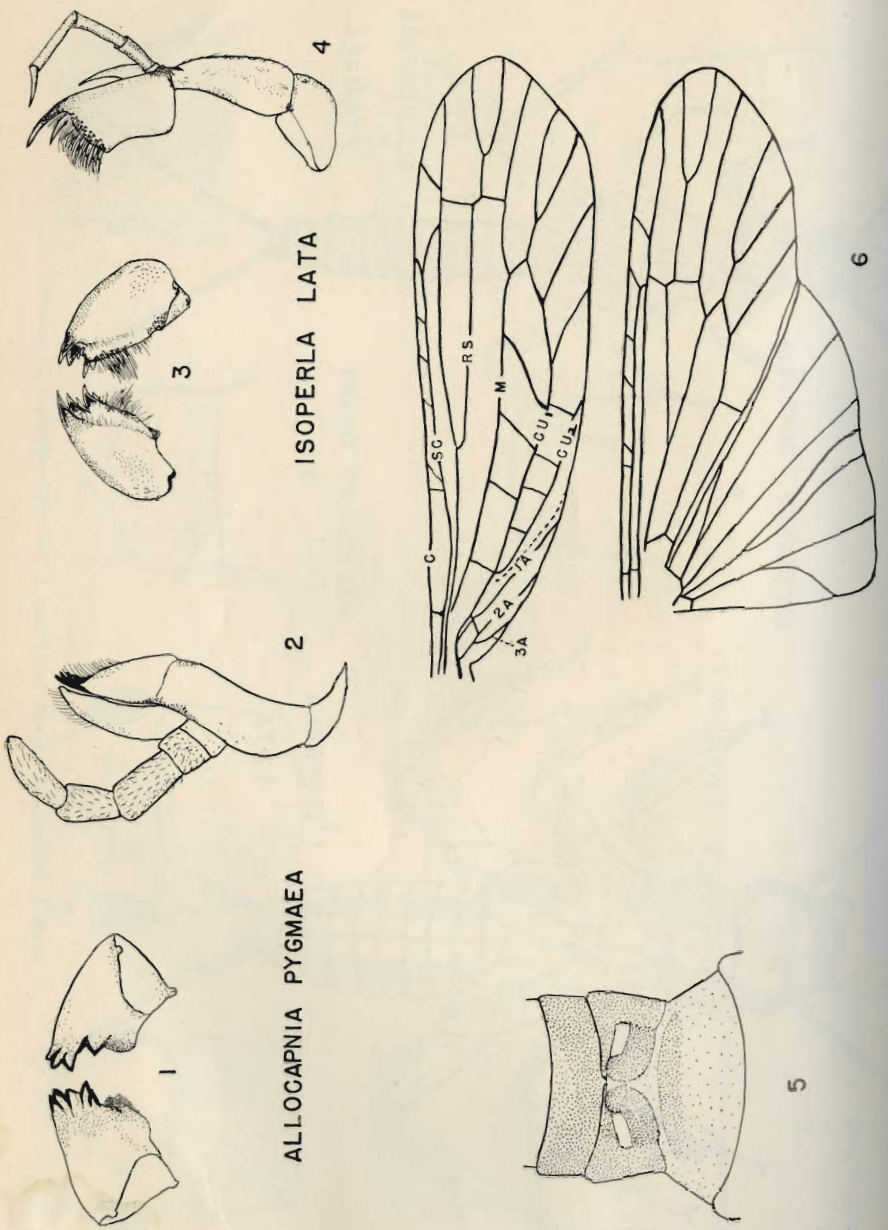


PLATE XII. Nymphs—1. Mandibles of Allocapnia pygmaea (Burmeister). 2. Right maxilla of Allocapnia pygmaea (Burmeister). 3. Mandibles of Isoperla lata Frison. 4. Left maxilla of Isoperla lata Frison. Adults—5. Female; eighth and ninth abdominal sternites of Nemoura rotunda Claassen. 6. Right wings of Isoperla dicala Frison to show venation.

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INDEX TO GENERA AND SPECIES

Names of genera are in CAPITALS: synonyms are in *italics*.