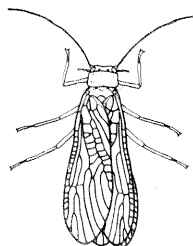


Guide to the Insects of Connecticut

PART VII. THE PLECOPTERA OR STONEFLIES OF CONNECTICUT

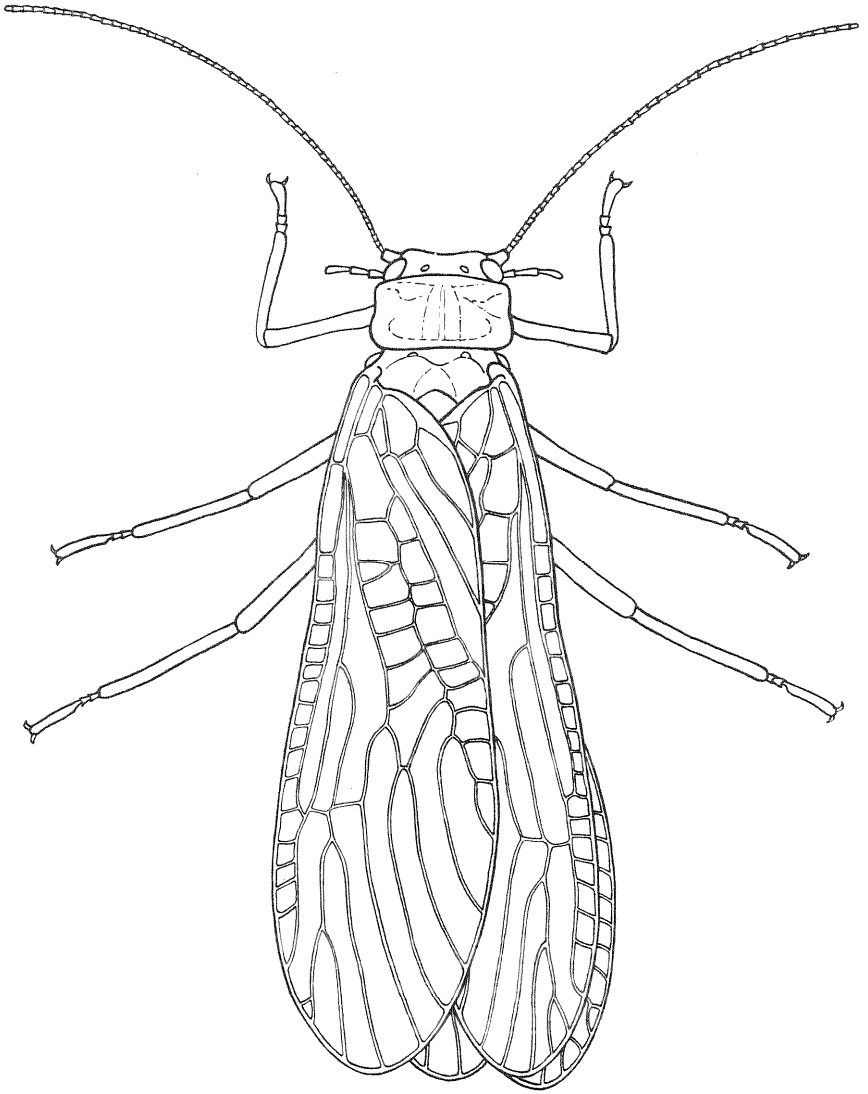
by STEPHEN W. HITCHCOCK



STATE GEOLOGICAL AND NATURAL HISTORY SURVEY
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DEPARTMENT OF ENVIRONMENTAL PROTECTION

1974
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Adult of *Peltoperla maria*.

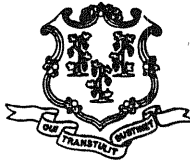
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PART VII. THE PLECOPTERA OR STONEFLIES
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by STEPHEN W. HITCHCOCK
Connecticut Department of Environmental Protection



BULLETIN NUMBER 107

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Stephen W. Hitchcock

The Connecticut Agricultural Experiment Station, New Haven
January 15, 1973

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The Plecoptera or Stoneflies of Connecticut

by

Stephen W. Hitchcock

INTRODUCTION

The Plecoptera are a small order of aquatic insects, with 465 described species in America north of Mexico, 74 of them recorded from Connecticut. Almost all species pass their larval life in streams in temperate climes. Some of the same species are also found in lakes in colder areas. Adults are terrestrial. Exceptions are found in the Southern Hemisphere, where a few stoneflies are terrestrial in the larval stage (Wisely, 1953; Illies, 1960a; 1964b; McLellan, 1967). In California one species of *Capnia* is aquatic as an adult (Jewett, 1963, 1965).

There is a great need for biological and behavioral studies of various species of stoneflies. Unfortunately, the immature stages of most stoneflies are not known. Rearing the larvae and developing means of identifying them, together with biological studies, should prove a productive field for the amateur and professional entomologist alike.

Most of the known biological information about the stoneflies is scattered in bits and pieces over many journals and years. I have attempted to summarize it in the body of the text.

General works on North American stoneflies include Needham and Claassen (1925), Claassen (1931), Frison (1935, 1942), Hanson, (1946, 1961), Ricker (1943, 1952, 1959a, b), Ricker and Ross (1968), Ross and Ricker (1971), Harden and Mickel, (1952), Jewett (1959b, 1960a), Nebeker and Gaufin (1965), Bauman and Gaufin (1970), Gaufin, Nebeker, and Sessions (1966), Gaufin, Ricker, Miner, Milam, and Hays (1972). For several genera, I have modified keys published by the above authors.

For other parts of the world, recent general works on Plecoptera, which include keys, are by Brinck (1949) for Sweden, Hynes (1958) for Great Britain, Illies (1955) for Germany, Despax (1951) for France, Aubert (1959) for Switzerland, Zhiltzova (1964) for Russia, Wu (1938) for China, Raušer (1968) for northeast Asia, Kawai (1967) for Japan, McLellan (1965, 1966) and Winterbourn (1965) for New Zealand, Illies (1960b, 1969), Kimmins (1951), Riek (1970), Burns (1957), Perkins (1958), and McLellan (1971) for Australia, Illies (1960b, 1961, 1963, 1964a) and Jewett (1959a, 1960b) for South America, and Jewett (1958) for Central America.

PHYLOGENY

The Plecoptera belong to the general orthopteroid group of insects, although this group has been variously subdivided. Of present orders, they are most closely related to the Embioptera (Crampton, 1932; Ford, 1923; Hudson, 1948; Nutting, 1951; Walker, 1922, and others).

The present-day order probably originated in Late Carboniferous time from insects close to the family Narkemidae in the extinct order Paraplecoptera (Sharov, 1960, 1966). That order contains those fossils originally included in the Protoperlaria. The Paraplecoptera differ from modern Plecoptera in having free MA and MP veins rather than a single M vein as do recent forms. Some of the Paraplecoptera had greatly expanded pronotal margins. Paraplecoptera adults all had 5 tarsal segments, whereas even the most primitive Plecoptera today have only 3. However, the larval forms of the Paraplecoptera had either 3 or 4 segmented tarsi (Carpenter, 1935). Abdominal gills are found on the larvae of both Paraplecoptera and the more primitive Plecoptera. The first true Plecoptera appear in the fossil record of the Lower Permian.

The phylogenetic relationships within the order have been the subject of several interesting studies. Illies (1965a, 1965b) summarized his earlier work and discussed his conclusions in some detail. He referred to previous works; of these particularly Tillyard (1921a) and Ricker (1950) should be consulted. Kawai (1967) gave an extended discussion of the phylogeny and biogeography of the stoneflies of the Northern Hemisphere. Raušer (1968) discussed the paleontological record and zoogeography. He suggested that the Plecoptera originated in the African subregion in or prior to Early Carboniferous time. Zwick (1969) has recently examined plecopteran phylogeny but, as I have seen only an abstract of his conclusions, it is difficult to form an opinion of his results. He has proposed several new taxa in the higher categories. Generally, the families with the most archaic characters are Australian or South American. If we consider only the North American families, there is fair agreement between various students. The Capniidae and Leuctridae are closely related and, together with the Nemouridae and Taeniopterygidae, make up the superfamily Taeniopterygoidea. The Perlidae, Perlodidae, and Chloroperlidae seem to make another natural grouping. The Pteronarcidae were an offshoot from the common stem of these last three families. The remaining northeastern family, Peltoperlidae, has been variously placed. Illies put it tentatively with some families found in the Southern Hemisphere. Raušer (1962) thought that it had a common origin with the nemourid (*sens. lat.*) groups. Ricker (1950) and Zwick (1969) believed that it should be closer to the basal stem from which the Perlidae-Perlodidae arose. Kawai (1967) came to a similar conclusion and showed that the Peltoperlidae are of Oriental origin.

LARVAL FEEDING

Several investigations have been made of the food of larval stoneflies. Generally the Setipalpia are carnivorous and the Filipalpia herbivorous but there are numerous exceptions. In the Nearctic families we find:

PTERONARCIDAE The first instar of *Pteronarcys proteus* takes no food but digests the remains of yolk in the midgut. The second instar feeds on algae (Miller, 1939). Older *P. dorsata* larvae have been reared on dead elm leaves which they skeletonize (Harden and Mickel, 1952) and *P. scotti* prefers alder leaves. When an energy budget was tabulated for the latter, the assimilation- and growth-efficiencies were found to be quite low (McDiffett, 1970). Muttkowski and Smith (1929) found the guts of 26 specimens of *P. californica* to contain 42 percent detritus, 4 percent animal matter, and 54 percent plant material. The latter was principally wood fibers and moss. Richardson and Gaufin (1971) found that 275 specimens of the same species contained 80 percent detritus, 9 percent plant material, and 11 percent animal matter. More than half the specimens contained animal matter. These investigators found *Pteronarcella badia* to be omnivorous but to eat less detritus and more plant and animal matter than does *Pteronarcys*. They observed *Pteronarcys californica* preying occasionally on other insects.

PELTOPERLIDAE Chapman and Demory (1963) stated that *Peltoperla brevis* feeds chiefly on algae. In stream cages, I found that *P. maria* skeletonized dead leaves of maple and beech but fed only sparingly on oak. The guts of captured specimens contained detrital material, probably the remains of the dead leaves and associated flora. Wallace, Woodall, and Sherberger (1970) found that *P. maria* (?) feeds on leaves of 15 species of trees, with elm, alder, and sourwood preferred.

TAENIOPTERYGIDAE Frison (1929) noted that the larvae of this family feed on decaying leaves and on 7 species of diatoms. Hynes (1941), Brinck (1949), and Richardson and Gaufin (1971) found the gut contents to be principally detritus, with appreciable amounts of the tissue of higher plants, together with diatoms, algae, and mineral matter—the latter undoubtedly picked up inadvertently. *Brachyptera* can graze on the surface of stones.

NEMOURIDAE, LEUCTRIDAE, CAPNIIDAE Wu (1923), Frison (1929), Hynes (1941), Brinck (1949), and Jones (1950) all agree that the larvae feed on dead leaves of higher plants. Early instars of nemourids apparently feed on detritus (Hynes, 1941).

PERLIDAE Samal (1923) stated that 1st instar *Perla burmeisteriana* probably do not feed and that 2nd instar eat algae. Chisholm (1962) found that 1st instar *Dinocras cephalotes* feed on diatoms. Later instars of Perlidae are carnivorous and apparently feed on any stream animals that they can catch and swallow. Although plant material is occasionally found in the gut, it probably comes from the gut content of the prey or is only a minor food source (Smith, 1913; Grau, 1926; Muttkowski and Smith, 1929; Hynes, 1941; Brinck, 1949; Jones, 1949; Mackereth, 1957; Chisholm, 1962; Sheldon, 1969; Richardson and Gaufin, 1971; Tarter and Krumholz, 1971).

PERLODIDAE Food habits are similar to those of the Perlidae. Whereas an occasional perlid specimen has only vegetable matter in the gut (Hynes, 1941), at least two of the small *Isoperla* species appear to be completely herbivorous (Frison, 1935). Jones (1950) found that the diet of *I. gram-*

matica shifted toward animal food as the larvae became larger. Grown larvae in this family are principally predacious but do take plant materials on occasion (Dunn, 1954; Richardson and Gaufin, 1971).

CHLOROPERLIDAE This family appears to be less restricted to a carnivorous diet than either of the last two. Frison (1935) said that *Hastaperla* is herbivorous but Hynes (1941) and Jones (1950) found *Chloroperla* to take either plant or animal material. Nicola (1968) found *Alloperla* scavenging on dead trout embryos. Chapman and Demory (1963) claimed that *Kathroperla perdita* feeds in equal parts on algae and detritus.

The food of larval Plecoptera is dependent on the size of the larva. Very young larvae feed on particles of detritus and other material small enough for them to handle. As the carnivorous forms become larger, they eat progressively larger and more active prey. They are apparently somewhat selective, either through choice or chance. Mackereth (1957) found that the gut content of *Perla bipunctata* was 5 percent *Rithrogena* in December, when the latter formed 25 percent of the stream fauna. However, in early spring *Baetis* made up 23 percent of the gut content but only 11 percent of the fauna. *Acroneuria californica* feeds mostly on Diptera when small, Ephemeroptera when of intermediate size, and Trichoptera when large. The choice of prey also depends on the season: Diptera are taken most often in summer, Trichoptera in winter, and Ephemeroptera at all seasons (Sheldon, 1969).

My own observations bear out those of Brinck (1949), who found that the larger predatory stoneflies recognize prey only on antennal contact. Unlike him, however, I have observed *Acroneuria* and *Paragnetina* actively searching for prey during the day. That such means is adequate is borne out by the work of Davis and Warren (1965), who found that *Acroneuria pacifica* individuals were able to crop the common food source more efficiently than do sculpins. The presence of these stoneflies reduced the food consumption and production of the fish.

The mouthparts of the predacious *Dinocras cephalotes* illustrate those of carnivorous forms. According to Chisholm (1962), the laciniae (fig. 4) of the maxillae catch the prey and adjust its position so that the mandibles can cut it transversely into slices. The labrum (fig. 1) is in synchrony with the mandibles so that when the latter open, the former is lifted. The hypopharynx moves upward to force the food into the cutting edge of the mandibles but as the mandibles close, it retracts, moving the food particles toward the oesophagus. Sclerotized hooks and spines in the crops of predacious forms keep the larger, harder parts of the prey from reaching the stomach. These undigestible portions are probably regurgitated (Hynes, 1941; Grau, 1926).

The phytophagous species gather material in with the laciniae, and perhaps with the labrum; this vegetative matter is then cut free and crushed with the mandibles. The mandibles are shorter and stouter than those of carnivorous species and bear a grinding surface. The food is presumably transported to the oesophagus by the action of the labium, hypopharynx, and perhaps the basal area of the mandibles (Brinck, 1949). Richardson and Gaufin (1971) suggested that *Pteronarcys* regurgitates the inedible sand grains that have been ingested with plant material.

ADULT FEEDING

For many years it was believed that adult stoneflies did not feed, an idea apparently based on the flabby condition of the mouthparts of the large perlids and pteronarcids.

Newcomer (1918) found, however, that adult *Brachyptera* feed on the buds and young fruit of various fruit trees, as well as on the leaves of several trees and on the catkins of willow. Subsequently Wu (1923) determined that *Nemoura vallicularia* feeds on the leaves of the touch-me-not. Frison (1929) discovered that all Illinois specimens of *Taeniopteryx* and *Allocapnia* feed on the blue-green alga *Protococcus vulgaris* and that *Brachyptera fasciata* feeds on the blossoms of elm trees. He (1935) further stated that *Leuctra* and *Nemoura* adults are also herbivores. Hynes (1942), studying *Nemoura cinerea* in England, found that adults given lichen and Protococcales lived 32 to 37 days, whereas unfed adults lived only 4 to 5 days. He also surmised that food is necessary to allow egg maturation. I have observed *Nemoura depressa* in the laboratory feeding on algal growth from twigs collected by the stream where they emerged. Dissection showed their guts filled with this material. Hynes (1941) starved representatives of 25 species of stoneflies for a few days and then provided them with water, lichens, and algae. All Taeniopterygidae, Capniidae, Leuctridae, and Nemouridae fed on this material and all species of both sexes drank water. Brinck (1949) observed in nature that certain nemourids, capniids, taeniopterygids, and leuctrids feed on lichens and green algae and a lesser number also feed on decaying leaves near the stream bank.

All of the above genera belong to the superfamily Taeniopterygoidea. The evidence for adult feeding in other groups is less secure. Miller (1939) obtained viable eggs from unfed *Pteronarcys proteus* that had been reared from late instar nymphs. They required water but apparently do not take, and obviously do not require, any food. I have provided adult *Peltoperla maria* with a variety of substances from their normal habitat but did not observe any feeding. However, they avidly drank a mixture of honey and water. Hynes (1941), in the tests mentioned above, found that adult Perlodidae and Perlidae drank water but would not eat lichens or algae. Brinck (1949) agreed that most Setipalpia do not feed but he did find food in the gut of an adult *Chloroperla burmeisteri*. Smith (1913) found that adult *Paragnetina immarginata* do not require food but their lives were shortened by several days if denied water. Her unfed specimens apparently produced viable eggs. Arnold (1966) observed *Acroneuria arenosa* adults drinking water. Claassen (1931) reported that adult *Alloperla pallidula* had been observed feeding on honeydew secreted by aphids on alder. Frison (1935) saw adults of *Isoperla nana* feeding on the pollen of dock (*Rumex*) and wild grape. He found their mandibles to be well sclerotized. He states that the mandibles of *I. decepta* also appear functional but those of other *Isoperla* do not.

Generally it appears that the smaller larval herbivores feed as adults but that the carnivores and large herbivores do not.

NATURAL ENEMIES

Adult stoneflies appear to be surprisingly free from predators. Spiders

catch some, and often as a first check on what is emerging from a stream the collector can examine nearby spider webs. Occasionally in the early spring, I have observed hunting spiders attacking winter stoneflies. I have also captured an immature *Ptyohyphantes phrygianus* (determination by J. Anderson) feeding on a male *Taeniopteryx burksi* on February 29.

There seem to be few records of other insects preying on adult stoneflies. Odonata capture mostly small Diptera (Pritchard, 1964) and apparently do not hesitate to attack any prey. However, of numerous publications of dragonfly prey records that I have examined, none mention the capture of adult stoneflies. Neither have I seen any record of empids, asilids, or other predacious insects attacking adult Plecoptera. There seems to be no reason why these predators should not include stoneflies in their diet and Plecoptera possibly are a very small component of their menu. Rohwer (1913) recorded a sawfly, *Tenthredo rurigena* feeding on adult *Alloperla signata* but this would not be a significant cause of mortality.

Even birds do not seem to eat stoneflies as much as might be expected. Although stoneflies were numerous near their nests, only one bank swallow out of 60 took any stoneflies (2 *Alloperla mediana*) and this was only about 1 percent of the food in the bird's stomach (Stoner, 1935). As stoneflies have but feeble powers of flight, swallows are not likely to take them on the wing.

Other reports of individual birds feeding on identified stoneflies are: a robin on *Perlesta placida* (Frison, 1935), a chickadee on *Allocapnia pygmaea* (Willey, 1936), a bluejay on "*Capnia vernalis*" (Hamilton, 1932)—probably *Paracapnia opis* or *P. angulata*, and a golden crowned kinglet and a chickadee probably feeding on *Allocapnia recta* (Hamilton, 1933).

Although adult stoneflies apparently are not the principal food of any bird, they are palatable to a wide variety of bird species. McAtee (1932) identified Plecoptera in the stomachs of 41 species of Nearctic birds but these insects only represented 0.0419 percent of all insects taken. Knappen (1934) found Plecoptera in 122 stomachs of 50 species of Nearctic birds. These were generally adult insects, although a few larvae were also found. Nighthawks were the most persistent feeders, with stoneflies found in 21 stomachs. The stomach and gullet of one had 41 and 42 adult stoneflies, respectively. Other birds that appear to feed extensively on stoneflies are the American Golden-eye, Swainson's Hawk, and the Western Grebe. As might be expected, the greatest number were ingested in late spring and early summer.

Frost (1924) found adult Plecoptera in the stomachs of frogs, and Minckley (1963) reported an adult *Paragnetina* in the stomach of a bat.

Larval forms suffer more from predators than do adults. Fish take a considerable number of stoneflies, as recorded in the voluminous fisheries literature. In New Zealand, according to Tillyard (1921b), introduced trout eliminated certain native stoneflies. However, most earlier workers indicated that fish eat insects in general relationship to availability of the prey. This is not necessarily related to the total numbers of the insects. Elliott (1967c) found that the species of stonefly larvae taken by fish show a seasonal as well as a diurnal change. Gerald (1966) noted that the long-

nose dace (*Rhinichthys cataractae*) feed proportionally more on small Plecoptera than on large. In some cases, more than the size of the insect is involved. Hartman (1958) found that active and long-legged stoneflies were taken less often (or rejected more often) as compared with Trichoptera, than would be expected merely from their size in relation to the mouth size of trout. Many fish have been recorded feeding on larval Plecoptera, and I have seen nothing to indicate that any fish does not. Maitland (1966) found 5 species of fish feeding on *Amphinemura sulcicollis* and others (for example, Lochman (1955)) have recorded various fish species preying on these insects.

Other vertebrates have been noted feeding on stoneflies. Two out of 25 water shrews (*Sorex palustris*) had fed on Plecoptera, which made up 2.8 percent by volume of the ingested material (Connor, 1966). Three out of 27 spotted turtles, (*Clemmys guttata*) contained stoneflies (Surface, 1908). Bakus (1959) reported a dipper, *Cinclus mexicanus*, putting its head into the water and picking Plecoptera off rocks in the stream. Salamanders have been found eating *Acronemura californica* (Anderson, Martin, and Pratt, 1966).

Larval stoneflies are also preyed upon by crayfish (Prins, 1968).

Larvae are also subject to predation by the larvae of other insects; in fact, they probably take a major share of the stonefly population.

The predacious caddisworms feed on stoneflies but, except on *Leuctra* (Jones, 1950), less so than on Ephemeroptera and Diptera (Muttkowski and Smith, 1929; Jones, 1949). Slack (1936) lists no Plecoptera in the diet of caddisworms but there were apparently few in the stream he studied. Thut (1969) found *Rhyacophila vaccua* feeding on *Nemoura* spp. but 4 other species of *Rhyacophila* feed very little or not at all on stoneflies. Generally the caddisworms do not seem to take a heavy toll, perhaps because the larval stoneflies are either too quick or too well concealed. The predacious stoneflies take many of their stonefly brethren and are one of the chief causes of mortality. Coleoptera apparently feed only lightly on Plecoptera (Muttkowski and Smith, 1929; Hynes, 1941; Brinck, 1949; Jones, 1950). However, Wu (1923) reported that hydrophilid beetle larvae are common predators of *Nemoura vallicularia*. I have seen only one record of aquatic Neuroptera preying on stoneflies (Helson, 1934) but we can assume that they do because they eat almost any insect.

Few parasites have been recorded; undoubtedly this reflects only the rarity of close examinations for parasites in stoneflies. Winkler (1956), Schoenemund (1924), and Kührtreiber (1934) have all found mermithid worms in stoneflies. Imamura (1950) discussed a parasitic mite found on 6 species of stoneflies in Japan. Léger and Gauthier (1932) described the endomycete *Orphella coronata* from the larva of a *Protonemura* and Helson (1934) discovered a gregarine parasite in *Stenoperla prasina*. Muttkowski and Smith (1929) found that 12 percent of larval *Acronemura pacifica* contained gregarines. Desportes (1963) included a figure of a gregarine found in *Perla* and *Isoperla*. She also gave additional references to gregarine infections. Weiser found 2 species of microsporidia on *Chloroperla* (Thomson, 1960). Cercariae of trematodes infect stoneflies but apparently do little harm (Hall, Weaver and Gomez-Miranda,

1969). Cercariae appear to be most common in the Perlidae, Perlodidae, and Pteronarcidae (Hall, 1960; Hall and Groves, 1963; Anderson, Martin, and Pratt, 1966).

Frison (1935) described what he called "anal gills" on *Leuctra claasseni* and later (1942) stated that *L. tenuis* and *L. ferruginea* had similar gills. I have observed such structures on a *Nemoura* larva and, because it does not seem likely that such delicate gills would grow sporadically in diverse genera, conclude that they are probably fungal growths on the living larva.

MATING AND OVIPOSITION

It was noted in the mid-1800s that some stoneflies beat the ends of their abdomens on the surfaces where they were resting. This drumming, observed many times subsequently, was assumed to be a mating signal. Rupperecht (1965, 1968, 1969) has recently studied it in some detail. Drumming has been found in *Acroneuria*, *Pteronarcys*, *Taeniopteryx*, *Capnia*, *Dimocras*, *Diura*, *Isoperla*, and *Perla*. The signal is specific to each species in frequency and duration. Drumming is not necessary before mating to release the sexual response; it serves only to bring the two sexes into close proximity. The males drum and unmated females respond. Depending on genus (and perhaps species?), the two sexes either actively search for each other or the females remain in place while the males seek them out. The signal is not given by the sound of the drumming but by the vibrations of the substrate and is perceived by the subgenual organs of the tibiae. Once a female is mated, she no longer responds to the drumming signal of a male.

The manner in which exact immediate recognition of the sexes is made is not known but it is probably tactile. Males often try to mate with unreceptive females and I have even observed a male *Allocafnia* apparently trying to mate with a female *Taeniopteryx*, which would imply a lack of fine discrimination. *Perlesta placida* apparently depends on visual recognition or chance encounters (Stewart, Atmar, and Solon, 1969). Other senses may be involved, however. Hynes (1941) observed a male *Capnia nigra* attempting to mate with a female *Leuctra nigra* that had been in contact with a female *C. nigra*. He therefore suggested the presence of a pheromone. Coleman and Hynes (1970) state that *Allocafnia pygmaea* males can recognize females at distances of 15 cm.

Mating is usually necessary to produce viable eggs. However, Degrange (1958) discovered that a small percentage of eggs from virgin females of at least 2 species would hatch. Because females would not oviposit, the eggs had to be obtained by dissection but it is possible that in nature there may be occasional young produced without fertilization.

In mating, the male mounts the back of the female, puts his abdomen to the side of the female and recurves the tip to bring his genitalia into position against hers on the ventral side of her abdomen. The male has a variety of projections, varying by species, with which to accomplish mating. Various genital hooks or protrusions are present on any of the distal abdominal segments, including, in some species, the epiproct and paraprocts (fig. 9). Either of two principal means of sperm transference occur in

Nearctic stoneflies. The first, in the Setipalpia and some Filipalpia, is a simple extrusion of the eversible copulatory organ, apparently made turgid by body fluid. The second, found in some Filipalpia, is the use of the epiproct as a sperm conveyor. *Notonemoura* males use the ventral process of the subgenital plate as a sperm conveyor (McLellan, 1968). Some Plecoptera have accessory glands and in at least one species, *Arcynopteryx compacta*, there is a spermatophore (Brinck, 1962). Brinck (1955) examined the reproductive system and mating of a number of stoneflies from different families in some detail and gave a valuable comparative study of the order. Berthélmey (1969) made additional comments on mating in *Leuctra*. The limited information available on individual North American species is given in the accounts that follow.

In at least some species, several matings can occur and several batches of eggs can be laid. This is probably a common occurrence, so that counts of single egg masses probably do not represent the full complement of eggs. Percival and Whitehead (1928) state that 5 *Perlodes microcephala* (= *mortoni*) laid 11 egg masses in 11 days, thus averaging 2.2 egg masses per female. Brinck (1949) found that *Dinocras cephalotes* extruded 3 successive masses of 600, 470, and 250 eggs. *Paragnetina immarginata* mates more than once, perhaps before each oviposition, and in *P. media* the egg mass is formed within 1 hour of copulation (Heiman and Knight, 1970). The number of egg masses varies between 2 and 4, the number of eggs decreasing with each successive mass (Smith, 1913). *Pteronarcys proteus* will mate between successive ovipositions but this is not necessary in order to deposit the full number of eggs. Again, successive egg masses decrease in size with time, for example, 386, 134, 88, 25, 45 eggs per mass (Miller, 1939). All of the above species are Setipalpia but Khoo (1968b) found that *Brachyptera risi* also laid up to 1,500 eggs in 4 batches with 8 to 11 days between successive batches. However, *Capnia bifrons* deposits only a single group of eggs, generally 300-400 but with a range of 110-713 (Khoo, 1964), and *Allocapnia pygmaea* also lays but a single batch (Coleman and Hynes, 1970).

To deposit the eggs, females either crawl to the edge of the water (and sometimes into the water), or run across the water, or fly across it, dipping the tip of the abdomen. The exact method apparently depends on species and circumstances.

When the egg mass is deposited in the water, the gelatinous coating surrounding each egg swells and the eggs separate and fall free. Upon reaching the substrate, each egg becomes glued to the surface. Setipalpians eggs are variable in shape and reticulation but generally possess a collar at one end (apparent exceptions are found in several *Alloperla*, according to Knight and his co-workers, 1965a, b). This collar bears a circular white structure, the basal plate, which, upon contact with the substrate, sticks the egg in place. The sticky material of the basal plate is elastic, allowing the eggs to return to position when displaced. In some Setipalpia, there are additional adhesive knobs on the gelatinous covering of the egg, or the eggs bear hooked filaments (*Perlesta placida*). Filipalpians eggs are round or oval, without a collar or anchor plate. These eggs are attached to the substrate by the gelatinous coating that swells and becomes sticky when wetted. In those few species whose embryos develop while the egg is still

in the female, there is no sticky material on the eggs but these larvae hatch as soon as the eggs are deposited in the water (Percival and Whitehead, 1928; Miller, 1939; Brinck, 1949; Berthélemy, 1964; Knight, Nebeker, and Gaufin, 1965a, b; Stewart, Atmar, and Solon, 1969).

INCUBATION OF EGGS AND LARVAL DEVELOPMENT

The period from oviposition to the hatching of the egg varies greatly, from a few minutes for the European *Capnia bifrons* to 10 months in *Pteronarcys proteus* and *Diura bicaudata*. *Dinocras cephalotes* spends up to a year in the egg stage (Ulfstrand, 1968). In the laboratory under cold temperatures, eggs of *Brachyptera risi* can have an incubation period of as long as 14 months (Khoo, 1968c). In nature, the range of most species is apparently from 3 weeks to a month, with some species needing up to 3 months (Frison, 1929; Percival and Whitehead, 1928; Helson, 1934; Hynes, 1941; Brinck, 1949; Komatsu, 1971).

Our knowledge of diapause (a period of arrested development) in the egg or larval stage comes in part from Miller (1939) but more particularly from the interesting work of Khoo (1964, 1968a, b, c). Not all stoneflies have diapause; studies show that at least 2 *Leuctra* species, 1 species of *Taeniopteryx*, and 1 *Nemoura* species do not.

Diapause in the *Pteronarcys proteus* egg is initiated by freezing temperatures in the fall and is broken by warmer temperatures in the spring. No photoperiodic phenomenon is involved, for if the eggs are kept warm, they develop normally and hatching occurs in December. In nature, egg diapause occurs from November to April. *Capnia bifrons* diapauses in the larval stage. It hatches from the egg immediately following oviposition in the spring, develops to the 4th or 5th instar and then, following higher temperatures and lengthening days, enters diapause. Diapause ends in the fall and larval growth resumes. Diapause is shortened by low temperatures. *Brachyptera risi* also diapauses over the summer but in the early stage, just after formation of the germ disc. In contrast to *C. bifrons*, diapause was lengthened by low temperatures. Different environmental conditions affecting the egg did not initiate nor break diapause, so probably diapause is initiated in the mother, as it is in some other insects. Diapause in *Diura bicaudata* is genetically determined in part. In two different populations, one laid diapause eggs and one did not. Diapause occurred in the egg stage just before the revolution of the embryo and lasted 4 to 4½ months over the summer, until broken by chilling in the fall. Nondiapause eggs had a 3-month incubation period and the insect a 1-year life cycle, whereas diapause eggs had a 9- to 11-month incubation period and the insect a 2-year life cycle.

Of the 4 stoneflies known to diapause that have been carefully studied, 3 diapause in the egg stage (although at different periods of embryonic life), 1 as a larva; 3 diapause in the summer, 1 over the winter; 2 have diapause initiated in the egg stage, 1 in the larval, and 1 apparently in the adult mother; 2 have diapause broken by cooler temperatures, 1 by warmer, and for 1 the temperature effect is unknown.

In Plecoptera, larval diapause is possibly of wider occurrence than realized. Various North American species emerge from the egg in the spring

but exhibit little or no growth until fall. Others, such as *Perlesta placida*, do not appear to have a synchronized emergence period and perhaps do not diapause. Harper and Hynes (1970) found diapausing larvae of several winter stoneflies in the genera *Taeniopteryx*, *Brachyptera*, *Allocapnia*, and *Capnia* but not in *Paracapnia*.

In the latter part of embryonic life, the hypodermis secretes an embryonic cuticle about the body. On the head, this cuticle is formed into a conical hollow egg-tooth. At hatching, the egg-tooth presses against a pre-existing rupture line, causing the shell to split. In the *Setipalpia* this rupture line separates a cap from the rest of the egg, whereas in the *Filipalpia* it is a longitudinal division. The embryonic cuticle and egg-tooth are usually left in the empty egg shell when the 1st instar larva emerges (Miller, 1939, 1940; Degrange, 1957).

The number of larval instars has been investigated in only a few species. *Capnia bifrons* has 14 to 15 in the male, 15 to 16 in the female (Khoo, 1968a); *Nemoura vallicularia* has 22 (Wu, 1923); *Amphinemura decemceta* has 24 (Komatsu, 1971); *Perla burmeisteriana* has 23 (Šámal, 1923); *Pteronarcys proteus* has 12 in the male and 13 in the female (Holdsworth, 1941b).

Larval development occurs at a variable rate, depending on species. Brinck (1949) has divided the stoneflies into various growth classes— a) rapid growth in late summer or early fall and again in late spring but little or no growth through the winter, b) greatest growth in fall and early winter, with adult emergence in late winter, c) steady growth throughout the year, somewhat retarded in the coldest part of the winter, d) even growth throughout the year, and e) most growth occurring in the warm weather of late spring and early summer.

There is a relationship between temperature and light that regulates larval growth. The influence of each depends somewhat on the species. Hirvenoja (1960) found that the uniform temperature of a spring in Finland apparently disrupts the normal growth pattern of *Nemoura picteti*, so that adults and larvae of all ages could be taken simultaneously. This is in contrast to *Nemoura cinerea* (Hirvenoja, 1960) and *Brachyptera risi*, *Leuctra hippopus*, and *Nemoura picteti* in Denmark (Thorup, 1963) whose growth rates were not correlated with temperature; they grew at seasonally regulated rates throughout the year, even though found in the uniform water temperature of a spring. Thorup suggested that this variable growth rate may reflect the degree of plant growth or the presence of detritus from decomposing leaves in the fall. It is also possible that there may be a direct effect of photoperiod on the insect itself. I have collected adults of *Nemoura depressa* in all months of the year at a single location in California.

In northern Sweden there is a cessation of larval growth in the winter but in a less rigorous climate, winter temperatures play a less decisive part in the growth pattern and speed of growth may vary from one year to another (Svensson, 1966).

ECOLOGY, BEHAVIOR, AND LOCAL DISTRIBUTION

The presence or absence of a stonefly in a stream can be the result of a

multitude of interacting factors. For example, cold water may slow metabolism but it also holds more oxygen. The movement of the water and the character of the stream substrate affect aeration, insect drift, collection of detritus, and plant composition. These, in turn, feed back to the patterns of water movement and available oxygen. For general reviews of these factors on stream organisms, one may consult Macan (1961, 1963) or Hynes (1970). Although much of the information on other aquatic insect orders is applicable to stoneflies, in the discussions below I will include only those studies that were concerned specifically with the Plecoptera.

In more temperate areas, winter does not seem to be a time of exceptional danger to stoneflies. Some damage to plecopteran populations comes from anchor ice, both physical damage to the insect itself and from damage lifting the benthic Plecoptera into the stream where fish can feed on them. Brown, Clothier, and Alvord (1953) found Plecoptera even in areas where anchor ice formed several times a season, and Benson (1955) found a few Plecoptera in floating anchor ice. As long as any free water remained on the bottom, the insects could survive. Farther north, winter temperatures are more crucial. Clifford (1969) determined that larval *Nemoura cinctipes* suffered very heavy mortality when a dry autumn allowed the reduced amount of water to be frozen down into the substrate. A severe winter considerably reduced the numbers of *Perlodes* and *Nemoura* in England but left other species little affected (Elliott, 1967b). Pattée (1959) discovered that the larvae of *Perla abdominalis* became acclimated to the lowering temperatures and that small specimens consumed even more oxygen in February than in September and October. Kamler (1965), working in Poland, found Plecoptera more abundant in the cooler streams, and that even in the warmer streams they were more likely to be found in the cooler parts.

Needham and Usinger (1956), in sampling the organisms, water velocity, and depth across a stream, found that *Alloperla* and *Isoperla* were collected in inverse ratio to the depth and speed of the water. The velocity ranged up to about 5 ft per sec but these stoneflies were most common at velocities of 1-2.5 ft per sec. The presence of *Isogenus* bore no relationship to water speed or depth.

However, the speed of the water measured at the surface does not necessarily reflect the velocity at the spot occupied by an insect, and close to the substrate there may be relatively little current. The insect responds to the stream velocity of its microhabitat. The European *Brachyptera risi* is found on the upper parts of stones in the current but in slack water will swim or hang from the water surface. Individuals do not necessarily face directly upstream but, rather, orient to the flow of the water over the substrate. As the current increases, they maintain position but press their bodies more closely to the surface (Madsen, 1969). Moreover, the velocity and pattern of the current also regulate the deposition of sediment and detritus. Egglisshaw (1964, 1969) studied the relationship between detritus and several stonefly species and found that, for species of *Nemoura*, *Leuctra*, *Isoperla*, *Chloroperla*, and *Perla*, an increase in detritus means an increase in the number of stoneflies. Presumably the insects were aggregating for food rather than as a direct response to the current. Too

much deposition of matter is, of course, detrimental and Plecoptera disappear, to be replaced by chironomids when inorganic sedimentation becomes too heavy (Cordone and Kelley, 1961).

Many stoneflies feed on allochthonous detritus, derived from plant material falling into the stream, rather than on living plant growth within the stream (Minshall, 1967). Consequently, the stream cover probably regulates the species of stonefly to be found in a stream, but this effect has never been closely examined. *Pteronarcys dorsata* was not found in a stream below a productive lake rich in nutrients but was common in the stream above the lake (Cushing, 1963), even though there was more food available in the former location. Likewise, *Acroneuria theodora* was found only in riffles above geyser basins in Yellowstone, not below, although other stoneflies were not affected by the ion concentration and higher temperature (Vincent, 1967). Whether these differences are due to the availability of certain food or whether the insects are directly affected by the quality of the water is not known. Larval *Pteronarcys californica* can regulate its internal salt balance from the surrounding water, even without access to food (Colby, 1970). However, stonefly populations can be related to general ecological conditions within streams (Marlier, 1954; Gaufin, 1959). Pollution studies have shown that some stoneflies are quite resistant to certain chemical changes in their environment, whereas such changes cause other Plecoptera to disappear quickly. *Chloroperla tripunctata* was common in a river with a heavy zinc concentration (Jones, 1958) and nemourids and capniids common in acidic waters (Maitland, 1966; Ochiai, 1962). Bell and Nebeker (1969) give the median lethal pH level for several species of stonefly in the laboratory, with the most hardy reaching a pH of about 3. Gaufin and Hern (1971) and Nebeker (1971c) give information on the tolerance of various stoneflies to heated water, with the most sensitive dying at 16°C. However, even at temperatures that permitted larval survival, there was an adverse effect on adult emergence.

The amount of available oxygen is related both to water temperature and current speed. *Brachyptera risi* is found on top of stones, where there is a high oxygen content in the water, whereas *Nemoura flexuosa* is found beneath the stones, where the oxygen content is low. Although oxygen is available within leaf packets, *B. risi* remains on the surface of the packet. This probably reflects the greater current speed at the surface. The water current brings fresh oxygenated water to the insect after the animal has exhausted the oxygen immediately adjacent to its body. *B. risi* dies sooner than *N. flexuosa* under conditions of declining oxygen unless the water is agitated (Madsen, 1968). There are day-night differences in oxygen consumption in some species, with oxygen uptake greater in the dark (Zoladek and Kapoor, 1971).

The variation in oxygen consumption between individual larval specimens is very great—various workers have reported results that vary by many hundredfold.

Olson and Rueger (1968) determined that, unlike other aquatic insects, larger specimens of the stoneflies *Pteronarcys pictetii* and *Paragnetina media* have higher oxygen-consumption rates than do smaller individuals

of these species. That is, large specimens consume more oxygen per mg of body weight than do small ones. By contrast, *Pteronarcys californica* and *Acroneuria pacifica* fit the usual pattern of greater oxygen consumption by smaller individuals (Knight and Gaufin, 1966b). This is an unsolved discrepancy. However, the relationship of size to oxygen consumption is possibly correlated with body surface rather than with weight (Istencic, 1963).

Pattée (1955), working with *Perla abdominalis*, found that the oxygen consumption of larvae shifted sharply with a change in temperature; greater consumption with a rise in temperature, less consumption with a decrease.

As the larvae became accustomed to the new temperature, the difference in oxygen consumption lessened; that is, a sudden rise in temperature caused a great increase in oxygen consumption that later was somewhat moderated.

In response to respiratory distress, stoneflies often make rapid up-and-down body movements by flexing the legs, so that they appear to be doing "pushups." Presumably this is to increase the amount of oxygen-bearing water in contact with the gills. As the water immediately adjacent to the larva becomes deficient in oxygen, this movement creates currents and also moves the position of the gills in the water.

Using the number of movements per minute as an indication of respiratory demand, one can compare the relationship between the concentration of dissolved oxygen, the velocity, and the temperature of the water. *Acroneuria pacifica* was observed to begin these "pushups" sooner and at a faster rate the higher the temperature and the lower the water velocity. These undulatory movements increased as the oxygen concentration dropped, until the insect could no longer increase the rate of movement to compensate for the oxygen lack in the water. There was then a sharply decreasing amount of movement until death occurred. Stonefly larvae with gills can apparently stand lower oxygen concentrations than can those without gills (Knight and Gaufin, 1963, 1966a). Kamler (1970) likewise found respiratory movements in *Perlodes intricata* greater with higher temperatures and lower oxygen.

Both *Acroneuria pacifica* and *Pteronarcys californica* can survive lower dissolved-oxygen concentrations better at lower temperatures, probably because of reduced metabolism, but *A. pacifica* is killed at water temperatures above 60°F, even when oxygen is abundant (Gaufin and Gaufin, 1961; Knight and Gaufin, 1964).

Possibly there are more subtle effects than oxygen starvation alone. At low levels of oxygen, *P. californica* is unable to regulate body-fluid volume and becomes distended. Even if removed to oxygen-rich water, it is apparently unable to rid itself of this excess fluid and dies, although, if the fluid is removed with a hypodermic syringe, normal life resumes (Knight and Gaufin, 1964).

For stoneflies, therefore, there is an intimate relationship between water velocity, oxygen content, and temperature. The papers of Knight and the Gaufins cited above should be consulted for the exact figures on these

parameters for the survival of the two stonefly species which they studied.

Several studies have correlated species or species groups of immature stoneflies with various types of streams. It appears from these studies that there are additional factors that help to regulate the kind and number of stoneflies in a stream. Ulfstrand (1967) studied the distribution of larval plecopterans within a stream, correlating the effects of stream depth, current, and substrate. *Diura nanseni* was found in areas of strong current and bare rock, whereas other stoneflies were found in areas of less current and more sediment and detritus. Ulfstrand concluded that distribution within the stream is related more closely to food than to any other factor; a conclusion with which Egglisshaw (1964, 1969) concurred.

Water temperature determines the emergence of adult stoneflies and altitudinal differences in adult-emergence time probably only reflect temperature differences (Sprules, 1947; Gledhill, 1960; A. W. Knapp in Scott, 1961; Nebeker, 1971b; Radford and Hartland-Rowe, 1971b). The emergence time of any one species becomes progressively later as the altitude increases and there is also a shift in species toward the more predacious forms (Knight and Gaufin, 1966c). It has not been determined whether the water must reach a certain critical temperature for adults to emerge or if emergence time is determined by a summation of accumulated heat (Radford and Hartland-Rowe, 1971a). There is possibly an interaction of photoperiod and temperature that determines maturation and size. Khoo (1964) found that photoperiod initiates adult development whereas cold temperatures restrict growth, causing the formation of adult characters within the larval skin. However, Nebeker and Gaufin (1967) stated that wing brachyptery is genetically determined, rather than a response to lengthening days and cool temperatures.

Emergence usually occurs at the time of day when humidity is highest (Brinck, 1949) or perhaps when water temperature is lowest and oxygen tension highest (Radford and Hartland-Rowe, 1971a), although I have observed *Paracapnia* emerging at midday. Closely related species are usually temporally isolated when emerging from the same stream. Although closely related species may emerge at the same time from two separate streams, if they are together in the same stream one species will usually emerge several days ahead of the other. Males emerge first (Sheldon and Jewett, 1967), although there may be exceptions in some stoneflies with extended emergence periods (Harper and Pilon, 1970).

The effects of light on stoneflies have been little examined. Light traps in Connecticut have caught some adult perlids, particularly *Perlesta placida*. Other stoneflies (principally *Leuctra*) were caught in a light trap only occasionally and singly. In Africa, where *Neoperla spio* adults emerge year round, a mercury-vapor light trap made peak catches of this stonefly from 30 to 90 minutes after sunset (Tjonneland, 1961). The larval European *Dinocras cephalotes* is photonegative (Scherer, 1962).

Larval stoneflies are commonly collected in insect drift in streams. The considerable information on this subject has been summarized by Elliott (1967a, b). Plecoptera are more active at night and are, therefore, most commonly found in the drift at night. This stonefly activity is correlated

with changes in light rather than with other factors (Elliott, 1967a; Chaston, 1969). Although stoneflies in drift have been described as re-attaching themselves to the substrate within a short time, there is one bit of evidence indicating that this is not always so. The trematode *Cephalouterina dicamptodoni* has as its first intermediate host a snail that is not found below 2,000-ft altitude. The second intermediate host is the stonefly *Acroneuria californica*. Cysts of *C. dicamptodoni* have been found in *A. californica* as far down the watershed as 200 ft above sea level (Anderson, Martin, and Pratt, 1966). As the stonefly could have obtained these cysts only at the higher elevations, at least some larval stoneflies are carried longer distances downstream than previously thought.

In addition to downstream drift, both adults and larvae can move upstream. Both sexes fly with the wind (Elliott, 1967a) and so, if the wind is right, presumably can go considerable distances and populate denuded areas upstream. Thomas (1966) reported that adult *Capnia atra* emerging from a stream moved preferentially toward a nearby forest. Once inside the bordering woods, they walked upstream. If no woods were visible as the stoneflies emerged, the insects tended to move upstream immediately. Adult *Allocapnia pygmaea* moved directly away at a right angle from the stream but were not seen to turn upstream (Coleman and Hynes, 1970).

Although the larvae of many arthropods have been recorded moving upstream, there is little information on Plecoptera. Hultin and his co-workers (1969) found larval *Nemoura flexuosa*, and Bishop and Hynes (1969) found larval *Allocapnia pygmaea* moving upstream in mid-winter.

ECONOMIC IMPORTANCE

Stoneflies are of little direct importance to man. In the Pacific Northwest, *Brachyptera pacifica* has been reported as a minor pest in orchards (Newcomer, 1918, 1950) and on ornamental plants (Schuh and Mote, 1948). The adults feed on the foliage, buds, and fruit, and are most injurious to apricots, peaches, and plums. Kawai (1967) stated that Japanese workers have found the closely related *Rhabdiopteryx nohirae* as an occasional pest on soft fruits in Japan. Tsukiji and Suzuki (1957) found larval nemourids causing damage by feeding on the underwater parts of the edible *Wasabia* plant.

Winter *Allocapnia* stoneflies, upon adult emergence, commonly crawl up any vertical surface. If large numbers emerge, they sometimes cause annoyance to nearby residents. In the spring of 1967, a school in Connecticut sought to control adult allocapnids that were crawling up the building and into the classrooms. In Pennsylvania, *Allocapnia recta* was reported crawling into a milkhouse and contaminating milk cans and other equipment (Anon., 1960).

Acroneuria pacifica is the alternate host to at least one internal fluke of birds (Macy and Bell, 1968). Hall and Groves (1963) found that 7 out of 9 species of cercariae in a species of river snail entered Plecoptera.

A. pacifica has also been observed attacking and killing eggs and small alevins of the steelhead or rainbow trout, *Salmo gairdneri* (Claire and

Phillips, 1968). Nicola (1968) however, found that larvae of *Alloperla sp.* are beneficial in one way; they scavenge dead salmon eggs, thereby preventing the spread of fungus to living eggs.

Indirectly, stoneflies are probably of greatest economic importance as a natural fish food and as biological indicators of unpolluted waters. Generally, fish feed on stoneflies in the proportion in which they are available, relative to other foods. A decrease in stonefly availability merely causes the fish to shift to other prey. Stoneflies are usually indicative of clean water and, in conjunction with other aquatic organisms, have been used as a measure of water purity. Hynes (1960) summarizes much of the work on this subject. Gaufin (1958) lists those stoneflies found in the zone of clean water and those in the zone of degradation. None was found in grossly polluted waters.

In addition to the above references, an interesting and more extended discussion on the practical importance of stoneflies is given by Winkler (1964).

EFFECTS OF INSECTICIDES AND POLLUTION

Like many other aquatic insects, stoneflies are quite sensitive to insecticides. These chemicals are usually applied to control forest defoliators and reach streams only incidentally. The effects on stoneflies of such spraying were summarized by Hitchcock (1965). More recent studies are by Ide (1967) and Sprague (1968). Laboratory studies defining more exact levels of stonefly mortality were made by Hitchcock (1965) and by Jensen and Gaufin (1964, 1966).

Resistance to insecticides varies by species and, unfortunately, most North American stoneflies cannot be identified in the immature stages. However, some stoneflies are quite resistant to certain chemicals (Jones, 1958) and possibly there are also considerable differences in resistance to insecticides. Certain species, such as larval *Peltoperla maria*, recover from insecticidal treatment but show a reduced adult emergence (Hitchcock, 1965). No resistance has yet been acquired by field populations following 7 successive years of spraying (Sprague, 1968).

Most of the larger streams in Connecticut have suffered from varying degrees of pollution. Some, such as the Naugatuck River, are devoid of stoneflies. Although pollution and land use undoubtedly affect the distribution and movement of stoneflies, this has never been examined in detail.

DISTRIBUTION IN CONNECTICUT

Because most Plecoptera are poor fliers and restricted to water courses, they are good subjects for zoogeographical studies. Several faunal movements of stoneflies in eastern North America have been postulated (Ricker, 1964; Ross, 1965; Ricker, Malouin, Harper, and Ross, 1968; Ross and Ricker, 1971). Most of these apply only indirectly to New England.

The present distribution of stoneflies in Connecticut is of recent origin, dating back to the last glaciation of 15,000 to 20,000 years ago. Consequently, our population is somewhat depauperate compared to those of the

Appalachians and Cumberlands to the south, which remained ice free. Preglacial stoneflies were forced southward by the advancing ice and only the more active species were able to return after its retreat.

To re-enter this area, stoneflies needed to find a suitable habitat and a means of access. Unfortunately, little is known of the absolute requirements of stoneflies, particularly for food. Probably the plant cover that contributes dead leaves to a stream determines in part what Plecoptera are found there. This aspect of stonefly distribution has yet to be examined.

According to Davis (1965, 1969), there probably was tundra vegetation in Connecticut 12,000 to 14,000 years ago. At 12,000 B.P. (years before the present) there was a gradual increase of woodland, with a sharp rise at 9,000 B.P. These woodlands consisted of white pine and other trees now typical of the forests of the northern Great Lakes region. At 8,000 B.P., with a warmer, drier climate, deciduous trees became more common. Subsequently, beech (6,500 B.P.), hickory (5,500 B.P.), and chestnut (2,000 B.P.) appeared.

A large number of stonefly species that are not found in Connecticut or other parts of New England have penetrated from unglaciated regions into the Great Lakes area, New York state, and the St. Lawrence River plain to the Maritimes (Hitchcock, 1968; Ricker, Malouin, Harper, and Ross, 1968; Ross and Ricker, 1971). A barrier running along the Hudson River-Lake Champlain line apparently denied them access to New England. The lower Hudson Valley was an estuary of the sea 12,000 B. P. and, as recently as 4,000 B. P. and perhaps even later, was saline enough to support oysters (Newman and his co-workers, 1969). This condition would be fatal to any stoneflies that tried to establish themselves there or that were carried downstream into this brackish water. To the north there were several post-glacial lakes that interrupted eastward movement. The present-day Hudson River drains only a narrow strip of land on its eastern boundary, providing only limited access to aquatic insects moving eastward. Its small eastern drainage basin and its general southward flow contrast sharply with those of its principal tributary, the Mohawk River to the west. That river aids east-west movement of stoneflies and its numerous tributaries help north-south movement. North of the Hudson River, Lake Champlain and the relatively high Adirondacks prevent eastward stonefly movement.

Within Connecticut there are 9 principal drainage basins, of which only 3 (Housatonic, Connecticut, Thames) extend over any considerable area (Flint, 1930). Because all these streams debouch into saline Long Island Sound, it would be difficult for a species to move from the mouth of one stream to the mouth of another along the coast, as may have occurred along the tributaries of the Mississippi River (Ross and Ricker, 1971). However, since the tributary headwaters of the various streams are in close proximity, there seems no reason why east-west movement should not take place there.

The topography of Connecticut is divided generally into Eastern and Western Uplands and a Central Lowland. Few stoneflies appear to be restricted to any one of these areas.

Allocaenia zola and *Capnia manitoba* are restricted to the Western Upland in small brooks in Hartland and Goshen, respectively. The former

species occurs on the Cumberland Plateau with outlying populations in previously glaciated areas in Connecticut and New Brunswick. This distribution is difficult to explain unless there are other undiscovered populations in limited areas of New England. *C. manitoba* is found in Canada from Manitoba eastward, with collections also from various parts of New England (Hanson and Hitchcock, 1961). As all its closest relatives are western and its distribution unique, it seems clear that it must be a recent immigrant from western Canada, with Connecticut representing its southernmost extension.

Brachyptera glacialis has been collected only in the Eastern Uplands. Enough collections have been made to show that it is not a collecting artifact. There is no apparent reason why this species should not also be present in western Connecticut.

Species that are found in both the Eastern and Western Uplands but not in the Central Lowlands or along the coast are: *Allocapnia minima*, *Brachyptera pacifica*, *Alloperla imbecilla* and *Neoperla clymene*. With the exception of the last named, these are either northern or mountainous species.

Presumably the first stonefly colonizers in Connecticut were those species that can survive near-tundra conditions and/or are now found only to the north of us. These would probably not include such northern species as *Claasenia sabulosa* or *Capnia vernalis*, which have western affinities, no immediate relatives to the south, and have probably only recently extended their range eastward. More likely candidates are *Arcynopteryx compacta* and *Diura nanseni*. These presumed Pilgrim Fathers of the Connecticut stoneflies are northern Holarctic species and were pushed southward ahead of the advancing glaciation, then retreated with the melting ice sheet, to be eventually trapped as isolated populations near or above timberline in the White Mountains of New Hampshire, probably at about the time of the Valderan glacial substage some 10,500 years ago. Because of long distributional gaps, it is extremely unlikely that they could have attained the peaks of the White Mountains from a northern population after the disappearance of the ice sheet from northern Canada. *Allocapnia minima* occurs over most of the previously glaciated area of North America. It perhaps survived the Wisconsin ice sheet in an unglaciated part of Newfoundland (Ross and Ricker, 1971; Ross, Rotramel, Martin, and McAlpine, 1967), then moved down the East Coast.

From 12,000 years ago, the gradual increase of woodland and the amelioration of climate allowed stoneflies that had survived glaciation south of the ice to move north again. The Great Lakes watershed alternately drained to the west and south or to the east, depending on the advance or retreat of lesser glacial ice sheets in the colder Middletown (13,000 B.P.), the warm Two Creek (11,500 B.P.), the colder Valdres (10,500 B.P.) stages, and the warm thermal maximum of the Mankata (5,000 B.P.). Depending on the glaciation to the north, western New York was drained either eastward through the Hudson or northward to the St. Lawrence (Flint, 1953, 1956, 1957). These changes in streamflow and drainage basins provided ample opportunity for stoneflies to move from the area of the present Ohio River drainage into the Great Lakes drainage. Although the St. Lawrence plain was covered by intrusions of the sea, when land emerged, the stoneflies

could easily follow the St. Lawrence downstream to the Maritimes, although this movement must be of relatively recent date.

Movement directly eastward past the Hudson River and its succession of glacial lakes was more difficult and only some species extended their range into southern New England. Presumably some of the less active species should also be found in the lower (northern) Lake Champlain Valley, an area that has never been searched thoroughly for stoneflies. There are some indications that as these species reached the Maritimes, their range extended southward along the coast. Perhaps, over a long period of time, they will reach southern New England, if their way is not blocked by grossly polluted streams.

From 8,000 to 2,000 years ago, the woodlands of Connecticut assumed approximately their present composition, with a decline of conifers and an increase in deciduous trees. There was probably a continuing trickle of new species from the Appalachian hardwood forests.

There thus appear to be four main elements of the stonefly population in Connecticut: 1) Species that could survive near-tundra conditions and were probably the first colonizers following glacial retreat. Those that were sufficiently adaptable remained as the climate warmed. Example: *Allocaonia minima*. 2) Midwestern species that are typical of the Great Lakes region and the St. Lawrence River plain. Several species have penetrated the Hudson River barrier. Example: *Leuctra ferruginea*. 3) Appalachian species that moved northward as deciduous trees increased in this area. Example: *Peltoperla maria*. 4) Species from western North America that moved across Canada following final retreat of the Wisconsin glaciation and then moved southward into New England. These are the most recent invaders of only a few thousand years ago. Example: *Capnia manitoba*.

COLLECTING

Immature stoneflies in the eastern United States usually live in running water and can be captured by stirring rocks with the feet or hands and letting the insects drift on to a screen held a few feet downstream. Moss and bunches of dead leaves should also be removed from the water and carefully examined for stoneflies in a water-filled white pan or taken back to the laboratory for examination. Seepage areas, small trickles, and intermittent streams should not be neglected when collecting. Cast skins may be found on bridges or rocks over streams.

Adults are usually collected by sweeping the vegetation near streams or by examining bridges, posts, and tree trunks near running water. Some adults may be found hiding under rocks on shore, although turning over rocks is a tedious and often unproductive way to collect. The winter forms (*Allocaonia*, *Taeniopteryx*, *Brachyptera*) can be collected in numbers where they have come out of the water and crawled up on bridges and high-way posts. Some species come readily to light traps (*Perlesta*, *Acroneturia*). Occasionally, good collecting may be had by netting adults as they fly over the stream. A Malaise trap over a stream will capture some specimens.

Whenever possible, late instar larvae should be reared in order to associate them with known adults. All instars may be preserved in 80 per-

cent alcohol. With large specimens, it is usual to change the liquid in a week or two, as the body contents of the insect will dilute the alcohol.

GLOSSARY OF DESCRIPTIVE TERMS

This Glossary is not exhaustive and the definitions are applicable **only** to stoneflies. Some of them may make purists cringe. Nevertheless, it is hoped that the glossary will make the keys and biological discussions intelligible to those who have not previously studied entomology.

A: anal vein.

aedeagus: the penis or intromittent organ.

anal cell: an area between two longitudinal anal veins that is delineated by crossveins.

anal vein: (A): longitudinal vein in the posterior area of the wing (fig. 6).

anterior: toward the forward part.

anterolateral: the front corner.

apical segment: the segment farthest from the base to which the series of segments is attached; the last segment.

apically: at the extremity.

apophyseal pit: the external pit (or pits) on the thorax that marks a cuticular ingrowth.

apterous: without wings.

basal lobe: a rounded lobe found on the 7th, 8th, or 9th sternite of some species.

basal processes: accessory sclerotic structures at the base of the epiproct.

basisternum (bs): the largest thoracic sternite (figs. 10, 12).

brachypterous: with short, abbreviated wings.

bs: basisternum.

C: costa.

carina: a ridge or low keel.

ce: cercus.

cell: wing area bounded on all sides by veins.

cephalad: toward the head.

cercus (pl. cerci) (ce): terminal paired appendages at the posterior extremity of the abdomen (fig. 9).

cervix (adj. cervical): the neck, the area between head and thorax.

clypeus: the most anterior part of the head, to which the labrum is attached.

cord: a transverse line in the wings, made of crossveins and bases of main veins, generally running from the apex of the subcosta to the cubitus.

costa (C): the anterior vein of the wing (fig. 6).

coxa: the basal segment that connects the leg to the body.

crossvein: a short vein connecting two longitudinal veins.

Cu: cubitus.

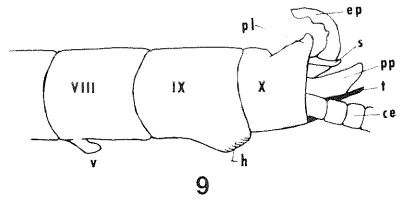
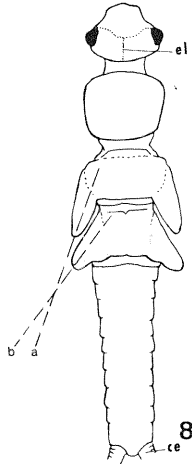
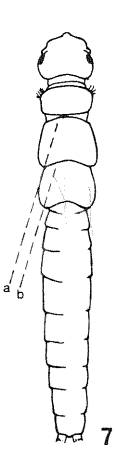
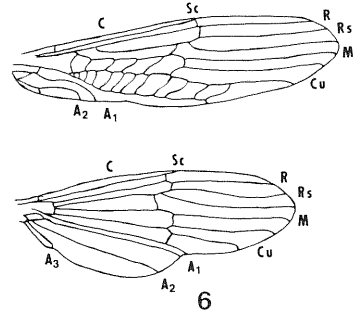
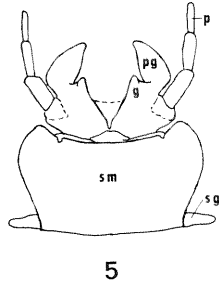
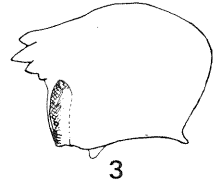
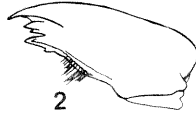
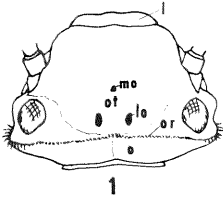
cu-a: a crossvein connecting the cubitus with the 1st anal vein.

cubitus (Cu): the longitudinal wing veins lying between the media and the anal veins (fig. 6).

cusp: a pointed process resembling a sharp tooth.

cuticle: the outermost layer of the integument.

detritus: very small pieces of organic matter derived from larger pieces by mechanical or bacterial action.



diapause: a state of arrested development, usually initiated by temperature or light.

distal: farthest from the center of the body.

ecdysial line: the Y-shaped line on the head, marking where the cuticle splits at time of molting.

egg-tooth: a projecting point on the head used by the embryonic insect to break the egg shell at hatching.

ep: epiproct.

epiproct (ep): a raised (generally), unpaired, sclerotic structure attached to the 10th tergite of the male and used in mating.

eversible: able to be turned inside out.

femur (pl.=femora): the large basal segment of the leg, connected to the thorax by the coxa.

fs: furcasternum.

furcal pit: apophyseal pit.

furcasternum (fs): a sclerotized thoracic plate posterior to the basisternum (figs. 10, 12).

FIGURES 1-9

A = anal vein

C = costa

ce = cercus

Cu = cubitus

el = ecdysial line

ep = epiproct

g = glossa

ga = galea

h = hammer

l = labrum

la = lacinia

lo = lateral ocellus

M = media

mo = median ocellus

o = occipital region

or = occipital ridge

ot = ocellar triangle

p = palpus

pg = paraglossa

pl = posterior lobe

pp = paraproct

R = radius

Rs = radial sector

s = stylet or basal process

Sc = subcosta

sg = submental gill

sm = submentum

t = titillator

v = vesicle or basal lobe

Fig. 1. Head of larval *Paragnetina media*.

Fig. 2. Mandible of larval *Isogenus subvarians*.

Fig. 3. Mandible of larval *Nemoura* sp.

Fig. 4. Maxilla of larval *Isogenus subvarians*.

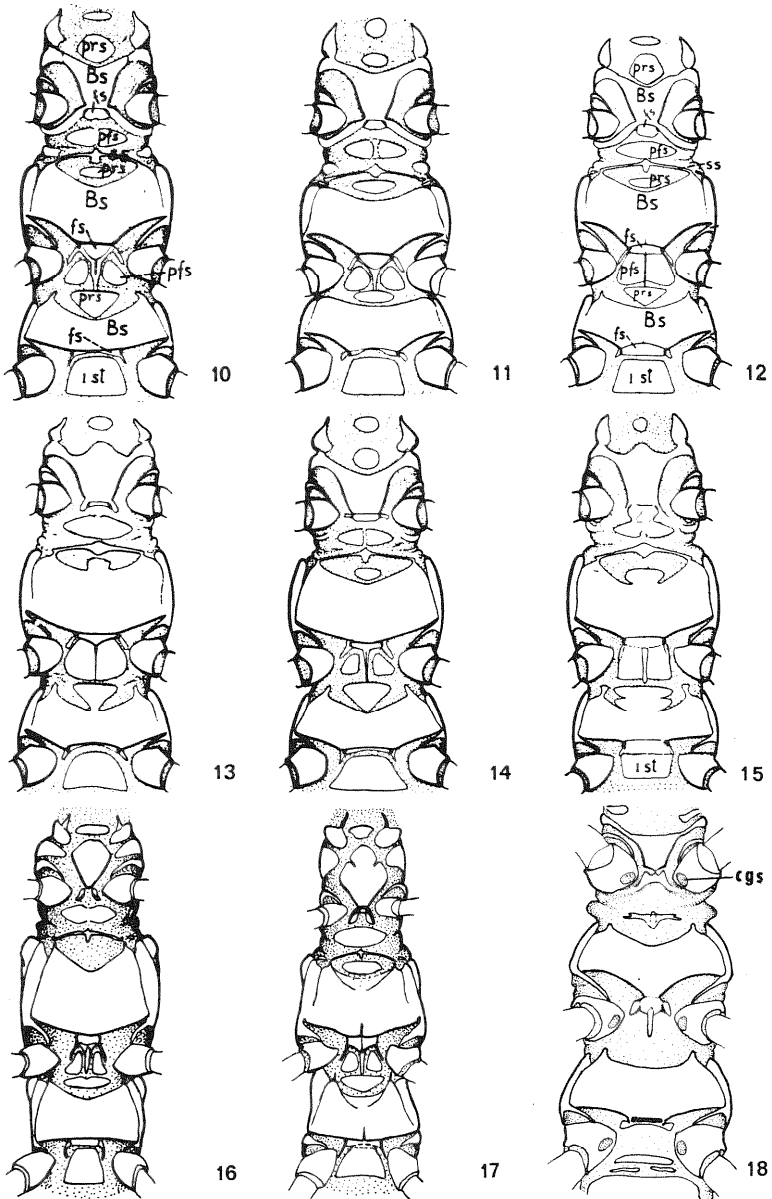
Fig. 5. Labium of larval *Isogenus subvarians*.

Fig. 6. Forewing and hindwing of *Paraleuctra sara*.

Fig. 7. Unknown larva from Gale River, New Hampshire. The eyes are at a distance from the posterior margin of the head greater than their own length. The forewing pad (a) is parallel to the hindwing pad (b).

Fig. 8. Larval *Nemoura* sp. The eyes are "normal"; that is, they are at a distance from the posterior margin of the head less than their own length. The forewing pad (a) is divergent from the hindwing pad (b).

Fig. 9. Adult male genitalia.



Bs = basisternum
cgs = coxal gill scar

THORACIC STERNAE OF ADULTS
fs = furcasternum
pfs = postfurcasternum
prs = presternum

ss = spinasternum
1st = first abdominal
sternite

Fig. 10. *Capnia*
Fig. 11. *Allocapnia*
Fig. 12. *Paracapnia*

Figures 10-15 are from Hanson (1946).

Fig. 13. *Nemocapnia*
Fig. 14. *Eucapnopsis*
Fig. 15. *Isocapnia*

Fig. 16. *Leuctra ferruginea*
Fig. 17. *Paraleuctra sara*
Fig. 18. *Taeniopteryx maura*

g: glossa.
ga: galea.
galea (ga): a process on the maxilla (fig. 4).
ganglia: dislike structures along the ventral nerve cord.
genital hook: a sclerotized process on the male terminalia used in mating; it can originate from the 10th tergite or from a paraproct.
gill: a fleshy protuberance, either single or branched, serving as a respiratory organ.
glossa (g): the paired inner lobes of the labium (fig. 5).
glabrous: without hairs.

h: hammer.
hammer (h): a raised tubercle on the posterior margin of the 9th sternite of *Acroneuria* (fig. 9).
hemitergal lobe: either segment of the cleft 10th tergite of the male.
Holarctic: pertaining to the northern hemisphere.
hypodermis: the cellular layer of the integument that secretes the cuticle.
hypopharynx: the "tongue."

imago: the adult insect.
incised: cut or narrowly notched.
instar: the form of the insect between each moult.
intercubital: crossveins running between the cubital veins.
intersegmental membrane: thin flexible tissue connecting the sclerites of the body segments.

l: labium.
la: lacinia.
labium: the lower "lip" (fig. 5).
labrum (1): the upper "lip" (fig. 1)
lacinia (la): the inner projecting process of the maxilla (fig. 4).
larva: an immature insect.
lateral: pertaining to the side.

M: media.
MA vein: anterior media.
macropterous: with normal-size wings.
mandibles: the 1st pair of jaws (figs. 2, 3).
maxilla: the 2nd pair of jaws (fig. 4).
media (M): longitudinal wing vein situated between the radial sector and cubitus (fig. 6).
median: middle.
mentum: a sclerite on the labium that bears the distal processes.
mesal: on the median plane of the body.
mesally: along the median plane of the body.
meso: a prefix pertaining to the 2nd thoracic segment; for example, the mesonotum is the dorsal surface of the 2nd thoracic segment.
meta: a prefix pertaining to the 3rd thoracic segment, for example, the metabasisternum is the basisternum of the 3rd thoracic segment.
MP vein: posterior media.

Nearctic: pertaining to North America and adjacent islands.
notum: dorsal surface.

occipital region: the posterior area of the head.

occipital ridge (or): a ridge or line of bristles running laterally across the head behind the eyes.

ocellar triangle: the area included within an imaginary line connecting all 3 ocelli (fig. 1).

ocellus: a simple eye located on the head between the compound eyes; stoneflies have either 2 or 3.

or: occipital ridge.

ovoviviparous: living young produced by the hatching of the egg within the mother's body.

p: palpus

palpus (p): an antennalike process on the maxilla and labium (fig. 4, 5).

paragenital plate: a paired sclerotized plate at the base of the epiproct.

paraglossa (pg): the paired outer lobes of the labium (fig. 5).

paraproct (pp): a pair of sclerotized lobes or plates located behind the 10th sternum (fig. 9); in some species they are curved forward as genital hooks or otherwise modified.

pfs: postfurcasternum.

pg: paraglossa.

pheromone: a chemical released by one insect that modifies the behavior of another.

phytophagous: feeds on plant material.

posterior: toward the rear.

posterior lobe: a produced hemitergal lobe.

postfucasternum (pfs): a sclerotized thoracic plate posterior to the furcasternum (figs. 10, 12).

pp: paraproct.

pro: a prefix pertaining to the 1st thoracic segment, for instance, a proleg is a leg on the 1st thoracic segment.

process: a projection or outgrowth.

proximal: closest to the center of the body.

prothoracic stripe: a longitudinal colored mark on the pronotum.

pterostigma: a thickened and/or darkened spot on costal margin of the wing.

R: radius.

r-m: a crossvein between the radius and media.

radial sector (Rs): a longitudinal wing vein branching from the radius (fig. 6).

radius (R): a longitudinal anterior wing vein (fig. 6).

reticulation: a network of fine lines.

Rs: radial sector.

rugose: wrinkled; roughened.

s: stylets.

Sc: subcosta.

sclerite: an area of the integument that is hardened and darkened.

sclerotized: hardened and darkened.

scutellum: the posterior dorsal sclerite of the meso- and metanotum.

seta: stiff "hair."

setose: covered with setae.

sinuate: wavy.

specilla: terminal processes in *Leuctra*. If figure 9 were a *Leuctra*, pp would

be the specillum and *t* the paraproct or titillator.

spermatophore: a capsule containing sperm.

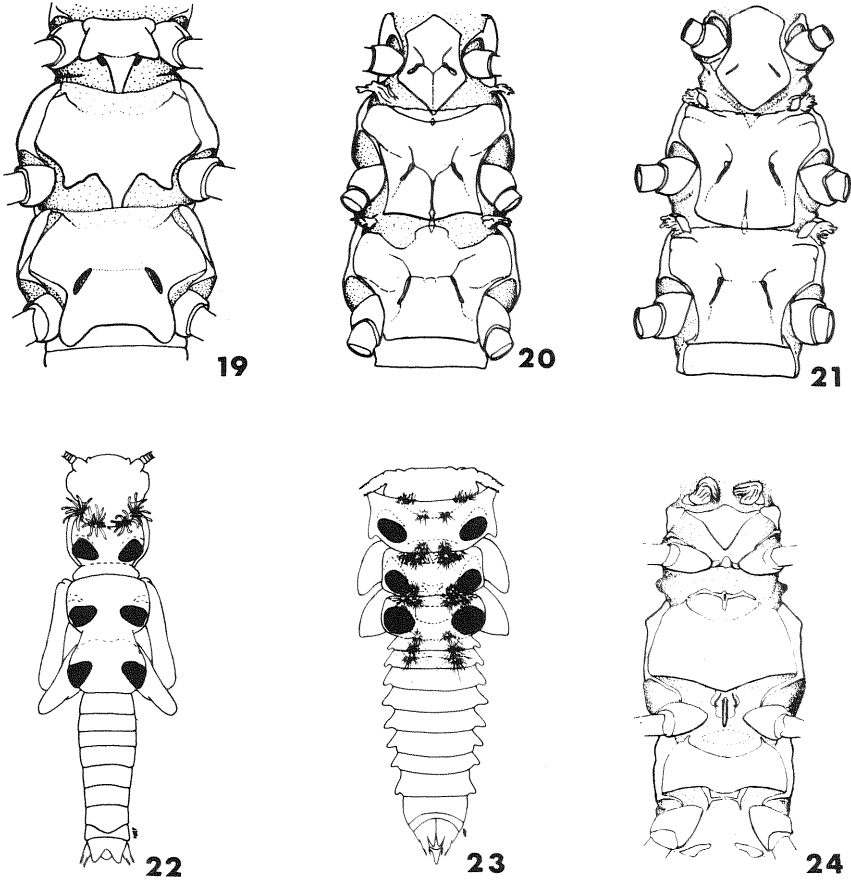
spinasternum (ss): an intersegmental sclerite of the thoracic sternum (figs. 10, 12.)

ss: spinasternum.

sternite: a sclerite on the sternum.

sternum: ventral surface.

stylets (s): accessory lateral processes at the base of the epiproct.



THORACIC STERNAE

Fig. 19. *Peltoperla maria*, adult female

Fig. 20. *Phasganophora capitata*, adult female

Fig. 21. *Acroneuria abnormis*, adult female

Fig. 22. *Nemoura* sp., larva

Fig. 23. *Pteronarcys* sp., larva

Fig. 24. *Nemoura nigritta*, adult

subanal lobes: paraprocts.

subcosta (Sc): longitudinal vein just behind the leading edge of the wing (fig. 6).

subgenital plate: produced part of the female 7th or 8th sternite, covering the genital opening.

subgenual organ: a receptor in the tibia for perceiving vibrations of the leg.

submentum (sm): the basal sclerite of the labium (fig. 5)

supra-anal apparatus: the epiproct and associated structures.

t: titillator.

tarsus (adj. tarsal; pl. tarsi): the distal part of the leg, consisting of 3 segments and bearing the claws (figs. 25, 26, 27).

teneral: a newly emerged adult, soft and light colored.

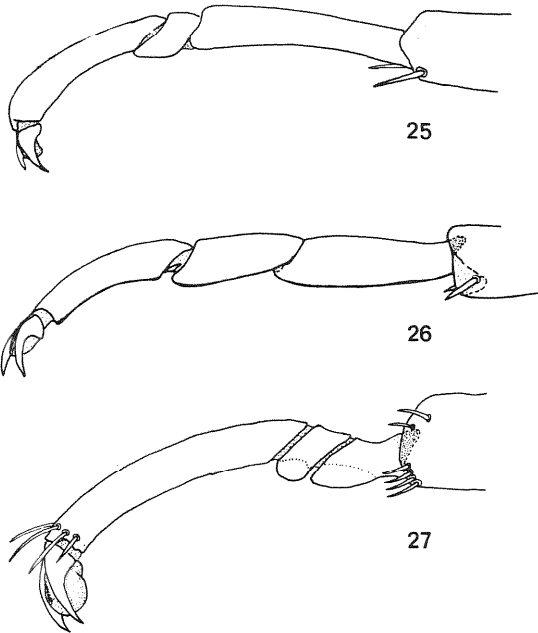
tergum: dorsal surface.

thorax (adj. thoracic): the middle section of the body, between the head and abdomen.

tibia: a segment of the leg connected proximally with the femur, distally with the tarsi.

titillator (t): a lateral pair of apical processes in *Leuctra* (fig. 9).

These probably represent the paraprocts (see discussion under Leuctridae).
tubercle: a small rounded projection.



ADULT TARSI

Fig. 25. *Nemoura nigritta*

Fig. 26. *Taeniopteryx maura*

Fig. 27. *Peltoperla maria*

v: vesicle.

vannal area: the wing region of the anal veins.

ventral lobe: a rounded projection or fleshy lobe on the posterior margin of a male abdominal sternite.

vesicle (v): a lobe on the anterior part of an abdominal sternite (fig. 9).

wing pad: in larvae, the projections on the meso- and meta thorax that contain the developing wings.

MORPHOLOGY

The following account, identifying the anatomical parts used in the keys and discussed in the descriptions that follow, complements the preceding Glossary. More detailed information is given in recent studies of the external morphology of Capniidae (Hanson, 1946), *Chloroperla*, *Isopteryx*, *Perla*, *Leuctra*, *Nemoura* (Grandi, 1948, 1950; Wittig, 1955) and *Pteronarcys* and *Utaperla* (Nelson and Hanson, 1969a,b). A comparative study of the thorax was made by Matsuda (1970), of the abdominal nervous system by Schmitt (1963) and Knox (1965), and of the blood by Arnold (1966). Summaries of the available information on genetics was given by Matthey and Aubert (1947) and White (1954); and on neurosecretions by Gabe (1966). Brinck (1955) gave comparative details of the genitalia of various species.

The eyes (figs. 1, 8) are generally near the posterior margin of the head (in the keys which follow this is termed "normal") but in some species the eyes are placed far forward (fig. 7). Most genera have 3 ocelli (fig. 1), 1 median and 2 lateral; a few have only the 2 lateral ones (fig. 10). An imaginary line connecting the 3 ocelli includes the "ocellar triangle." The ecdysial line is Y shaped, with the stem extending from the back of the head forward, forking just posterior to the lateral ocelli (fig. 8). On some species there is a distinct occipital ridge (fig. 1) across the back of the head. It may bear short bristles or long setae. The occipital region is the posterior part of the head.

The mouthparts used in classification are the labrum, mandibles, maxillae, and labium. In adults that do not feed, the mouthparts are weak and unsclerotized. The mandibles of the larvae may be sharply toothed (fig. 2) or have grinding surfaces (fig. 3), depending on the food habits of the insect. The appendages of the maxilla (fig. 4) are the 5-segmented palpus, the galea, and the lacinia. The latter may be variously shaped, with 1 or 2 sharp teeth and a row or tuft of bristles. The labium (fig. 5) bears a segmented labial palpus of 3 segments. The distal area of the labium bears 2 pairs of lobes, the outer paraglossae and the inner glossae. In the Filopalpia these are approximately equal length but in the Setipalpia the glossae are much reduced, in some genera appearing only as small projections on the inner side of the paraglossae. Proximally there is a small mentum and beyond it a relatively large submentum.

The prothorax bears a pair of legs. The pronotum is unornamented but some species have a median longitudinal prothoracic stripe (fig. 249c). The mesothorax bears a pair of legs and the forewings (fig. 10); the

metathorax another pair of legs and the hindwings. The mesonotum and metanotum can bear a U-shaped mark, a dark line outlining the scutellum (fig. 249d). There can also be a median longitudinal dark line within the "U mark." The largest thoracic sternal sclerite is the basisternum (fig. 10). This is preceded by the small presternum and followed by the furcasternum. The spinasternum is a small elongate sclerite. The furcal pits or apophyseal pits are on each side of the furcasternum. On some Plecoptera these individual sclerites are not readily apparent. In some species, a transverse ridge runs between the furcal pits, and another ridge runs posteriorly from each pit. These join and run together, forming a Y-shaped ridge.

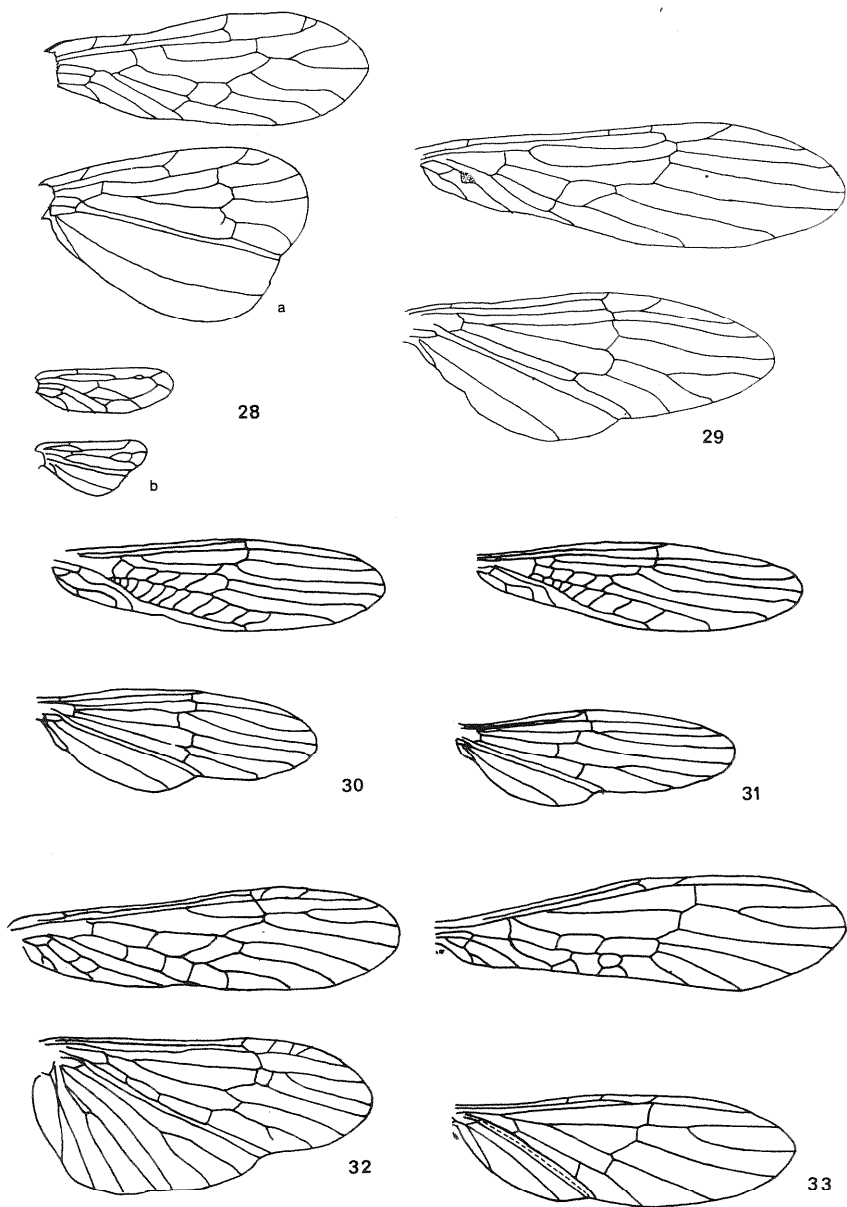
The femur and tibia of each leg bear various bristles and hairs that are of occasional value in taxonomy. The ratio of length of the various tarsal segments is important in some genera.

The wing venation of stoneflies is not unusual and the wings of Plecoptera (fig. 6) are often used to illustrate the basic pattern of insect venation. In order, the veins are subcosta (Sc), costa (C), radius (R), radial sector (Rs), media (M), cubitus (Cu), and anal (A). The various branchings and crossveins are quite variable and not always of value in describing new species, although the positions of crossveins cu-a and m-c are used to define some species. There are up to 3 anal veins in the forewing. The 2nd anal vein A_2 is forked in some species; this is sometimes interpreted as a fusion of A_2 and A_3 at their bases. There is generally only 1 crossvein in the anal area, so that most stoneflies have only 1 anal cell. Some have several anal crossveins and thus several anal cells. The venation is commonly distorted on brachypterous specimens. The wing pads of the larvae may be parallel, that is, the forewings and hindwings are essentially in line with each other (fig. 7), or they may be divergent, that is, the hindwing aligned at an angle to the forewing (fig. 8).

Larval gills are present on various parts of the body. Fingerlike submental gills (fig. 5) are at the posterior corner of the submentum. Cervical gills (fig. 22) are on the neck and are simple and fingerlike or tufted. Thoracic gills can be simple or bushy and much divided. These can appear in the pleural areas or from beneath the sterna. Coxal gills are simple telescopic gills that occur singly on the ventral surface of each coxa. Abdominal gills occur laterally on the basal abdominal segments or distally between the cerci (figs. 210, 230); the latter are known as subanal gills. Vestiges of all these larval gills, except for the coxal gills, are visible on the adult. The sites of these coxal gills appear only as round membranous scars on adult coxae.

Males are quickly separated from females by observing the hooks or projections of the genitalic apparatus, which are generally visible dorsally. The female dorsum is unornamented. Ventrally, some males have a lobe or knob on a posterior abdominal segment, whereas the female commonly has one abdominal sternite (usually the 8th) expanded.

The abdomen of many males bears various processes that aid them in mating and us in identification (fig. 9). The diversity in size and shape of these projections is great; they range from barely perceptible bumps to



WINGS

- Fig. 28. *Allocapnia pygmaea*: a, female; b, male
 Fig. 29. *Capnia maculata*
 Fig. 30. *Paraleuctra sara*
 Fig. 31. *Leuctra ferruginea*
 Fig. 32. *Perlinella drymo*
 Fig. 33. *Alloperla idei*

13. Adults apterous; without ocelli; vestiges of gills on intersegmental membrane between 9th and 10th abdominal segments; restricted to Japan and Korea SCOPURIDAE
 Without all of above characters 14
14. In lateral view, 2nd tarsal segment subequal to 1st in length 15
 In lateral view, 2nd tarsal segment shorter than 1st 16
15. In lateral view, 3rd tarsal segment subequal in length to, or shorter than, first 2 combined; 3 ocelli; few costal crossveins, generally 3 or less TAENIOPTERYGIDAE
 In lateral view, 3rd tarsal segment longer than first 2 combined; 2 ocelli; many costal crossveins; however, Japanese *Microperla* have 3 ocelli and some species have as few as 4 or 5 costal crossveins ..
 PELTOPERLIDAE
16. Adult cercus reduced to 1 segment 17
 Adult cercus with several to many segments 20
17. 5 or more anal veins in hindwing 19
 About 3 anal veins in hindwing 18
18. Wings flat at rest; only 1 or 2 intercubital crossveins in forewing; media of hindwing joined with Rs before arc .. CAPNIINAE (in part)
 Wings rolled around body at rest; generally more than 4 intercubital crossveins in forewing; media and Rs of hindwing not joined before meeting arc LEUCTRIDAE
19. Vein Cu₂ of forewing generally running approximately straight from origin to terminate at margin half way from base to tip of wing; media of hindwing forks after r-m crossvein; Northern Hemisphere except southeastern Asia NEMOURIDAE
 Vein Cu₂ of forewing turns just before margin and runs 'subparallel with margin for a distance equal to almost half the length of the vein; in most species, vein bent cephalad before terminating at wing margin at three-fifths the length of wing; media of hindwing forks at or before the r-m crossvein;¹ Southern Hemisphere
 CAPNIIDAE; NOTONEMOURINAE
20. Generally 3 (rarely 4) anal veins reaching margin of hindwing; only 1 or 2 intercubital crossveins in forewing; no crossveins beyond cord in forewing except where brachypterous; if apterous, found in Northern Hemisphere CAPNIIDAE; CAPNIINAE
 More than 4 veins reaching anal margin in hindwing; numerous intercubital crossveins in forewing; crossveins beyond cord in forewing; if apterous, found in Southern Hemisphere 21
21. Abdominal-sternite 1 present; many costal crossveins
 AUSTROPERLIDAE

¹*Megaleuctra* lacks all these characters. Its venation resembles that of the Leuctridae except that it has 6 anal veins in the hindwing.

Abdominal-sternite 1 absent (abdominal segment 1 visible only as a tergite); most genera have only 1 or 2 costal crossveins	22
.....	GRIPOPTERYGIDAE
22. Adults wingless	23
Adults winged	25
23. With ocelli	LEPTOPERLINAE
Without ocelli	24
24. Males with a small 11th tergite	ANTARCTOPERLINAE
Males without 11th tergite	PARAGRIPOPTERYGINAE
25. Large, with long cercus of more than 20 segments; forewing Rs with long fork, bearing 2 or more crossveins or fore branches of Rs fused with R	26
Small to medium, with short cercus of 20 segments or less; forewing Rs without or with only a very short fork that bears at most 1 crossvein	27
26. Rs obviously forked; pterostigma generally with crossveins	GRIPOPTERYGINAE
Rs forked, with fusing of Rs ₁ and R; pterostigma generally without crossveins	LEPTOPERLINAE
27. Cu ₁ in forewing invariably forked; cercus commonly short, with 7 to 20 segments	PARAGRIPOPTERYGINAE
Cu ₁ in forewing not forked; cercus generally very short, with 5 to 9 segments	ANTARCTOPERLINAE

KEY TO THE GENERA OF ADULT NORTH AMERICAN PLECOPTERA

1. Paraglossae and glossae subequal in length (fig. 74)	2
Paraglossae much longer than glossae (fig. 5)	21
2. Remnants of branched gills on abdominal-segments 1 and 2 (fig. 23); anal area of forewing with 2 or more rows of crossveins	3
.....	PTERONARCIDAE
No gill remnants on abdominal-segments 1 and 2 (fig. 22); anal area of forewing without crossveins or with only 1 row of them	4
3. Gill remnants present on abdominal-segment 3; western genus only ..	
.....	<i>Pteronarcella</i>
Gill remnants absent on abdominal-segment 3 (fig. 23)	
.....	<i>Pteronarcys</i>
4. 2 ocelli (frontispiece)	<i>Peltoptera</i>
3 ocelli (figs. 1, 170)	5
5. Tarsi in lateral view with 2nd segment much shorter than 1st (fig. 25)	7

- Tarsi in lateral view with 2nd segment at least as long as 1st (fig. 26) TAENIOPTERYGIDAE 6
6. Each coxa with small, round membranous area on ventral surface (fig. 18); male cercus with 1 segment (fig. 153) *Taeniopteryx*
Coxae without membranous areas on ventral surfaces; male cercus with at least 3 segments (fig. 168) *Brachyptera*
7. Cercus of more than 1 segment; A₂ of forewing unbranched (figs. 28, 29) CAPNIIDAE 9
Cercus of only 1 segment; A₂ of forewing branched (figs. 30, 31) ... 8
8. Wings flat when at rest; last segment of labial palpus in ventral view appears subcircular and larger than subterminal segment (fig. 139) NEMOURIDAE: *Nemoura*
Wings rolled around body at rest; last segment of labial palpus in ventral view longer than wide and equal in size to subterminal segment (fig. 74) LEUCTRIDAE 17
9. Wingless 10
Winged 12
10. Prothoracic spinasternum fused at lateral angle with mesothoracic basisternum (fig. 10) 11
Prothoracic spinasternum not fused at lateral angles with mesothoracic basisternum (eastern species only) (fig. 11) *Allocapnia*
11. Mesothoracic postfurcasternal plates transversely oval and isolated by membrane from other sclerotized regions (fig. 10) *Capnia*
Mesothoracic postfurcasternal plates large and united to spinasternum and furcasternum (western species only) (fig. 15) *Isocapnia*
12. Cu of hindwing unbranched; anal area of hindwing large — only slightly smaller than remainder of hindwing; Sc ending before cord; eastern genus only (fig. 28) *Allocapnia*
Cu₁ and Cu₂ present in hindwing, anal area of hindwing of normal size; Sc ending at the cord (fig. 29) 13
13. R₁ in forewing bent upward at origin, A₁ bent abruptly caudad at junction of cu-a and then curved out again (fig. 29) *Capnia*
R₁ and/or A₁ of forewing straight 14
14. Prothoracic and mesothoracic presterna broadly united with basisterna 15
Prothoracic and mesothoracic presterna separated from basisterna (figs. 12, 14) 16
15. In forewing no costal crossveins beyond Sc; A₁ only slightly bent beyond cu-a; male without lobe on 9th sternite (eastern species)
..... *Nemocapnia*
In forewing at least 1 costal crossvein beyond Sc, A₁ straight; male with lobe on 9th sternite (western species) *Isocapnia*
16. Mesothoracic postfurcasternal plates subtriangular and separated from

other sclerotized regions by membrane (fig. 14); forewing R ₁ straight; male 9th sternite with lobe (western species)	<i>Eucapnopsis</i>
Mesothoracic postfurcasternal plates large and united to spinasternum and furcasternum (fig. 12); forewing R ₁ slightly curved; male 9th sternite without lobe (eastern species)	<i>Paracapnia</i>
17. Anal area of hindwing with 6 veins	<i>Megaleuctra</i>
Anal area of hindwing with 3 veins	18
18. Veins Rs and M of forewing with common origin on R (western species)	<i>Perlomyia</i>
Vein Rs of forewing arising from R beyond origin of M	19
19. m-cu crossvein of hindwing joins Cu ₁ after it divides (fig. 30); prosternal presternum partially or completely separated from the basisternum (fig. 17); male cercus with sharp projections or pointed (figs. 91, 96)	20
m-cu crossvein of hindwing joins Cu ₁ before it divides (fig. 31); prosternal presternum joined to the basisternum without trace of division (fig. 16); male cercus normal, without point or projections (fig. 76)	<i>Leuctra</i>
20. Male 9th tergite deeply cleft (fig. 96); female without a median dorsal abdominal stripe and generally with a lobe on posterior margin of 7th sternite (fig. 97)	<i>Zealeuctra</i>
Male 9th tergite entire (fig. 91); female with median dorsal abdominal stripe (fig. 93), posterior margin of 7th sternite entire (fig. 92)	<i>Paraleuctra</i>
21. Remains of branched gills at the lower angles of the thorax (figs. 20, 21); cu-a of forewing in most specimens either in the anal cell or distant from it by no more than its own length; 2 or 3 ocelli ...	22
Remains of branched gills absent from the thorax; cu-a, if present, generally distant from the anal cell by more than its own length (fig. 304); 3 ocelli	36
22. Males: paraprocts sharply pointed or hooked, or sides of 10th tergite produced forward into "genital hooks"	23
Females (eastern species only): paraprocts and 10th tergite unmodified; 8th sternite either unmodified or, more commonly, produced into a subgenital plate	31
23. Raised knob or "hammer" on 9th sternite (fig. 9)	24
No "hammer" on 9th sternite; found east of Rockies	28
24. 2 ocelli	25
3 ocelli	26
25. Anal area of forewing with 2 or more crossveins, thus forming 1 or more cells in addition to the anal cell; A ₂ of hindwing not sinuate; east of Rockies (fig. 32)	<i>Perlinella</i>
Anal area of forewing with only 1 or 2 crossveins between A ₁ and	

- A_2 , thus having only 1 anal cell between these 2 veins; A_2 of hindwing sinuate; known only from Texas southward ... *Anacroneuria*
26. Anal area of forewing with 2 or more crossveins, thus forming 1 or more cells in addition to the anal cell (fig. 32); pronotum with dark median band; east of Rockies *Perlinella*
 Anal area of forewing with only 1 crossvein, thus having only 1 anal cell (fig. 238); without dark median band on pronotum 27
27. 10th tergite with hooks arising from the lateral angles; paraprocts normal *Claassenia*
 10th tergite unmodified; paraprocts formed into recurved hooks (fig. 218) *Acroneuria*
28. Hind margin of 10th tergite deeply cleft, with dorsal projections (genital hooks) extending forward from sides of cleft (figs. 191, 201) 29
 Hind margin of 10th tergite not cleft; no dorsal projections on 10th tergite but with pointed paraprocts (fig. 240) *Perlesta*
29. With 2 ocelli (fig. 204) *Neoperla*
 With 3 ocelli 30
30. Genital hooks extending to anterior border of 8th tergite (fig. 198) *Phasganophora*
 Genital hooks extending at most to posterior margin of 9th tergite (figs. 191, 194) *Paragnetina*
31. Anal area of forewing with 2 or more crossveins, thus forming 1 or more cells in addition to the anal cell (fig. 32) *Perlinella*
 Anal area of forewing with only 1 crossvein, thus having only 1 anal cell (fig. 238) 32
32. 2 ocelli (fig. 204) *Neoperla*
 3 ocelli 33
33. Distinct Y-shaped prosternal and mesosternal ridge pattern (not invariably clear on prosternum) (fig. 20) 34
 Sternal ridge patterns not in a distinct and dark Y shape (fig. 21) 35
34. Subgenital plate notched or excavated (figs. 192, 197) ... *Paragnetina*
 Subgenital plate rounded (fig. 200) *Phasganophora*
35. Size 9-14 mm (to tip of wings); costal margin of forewing and base of Rs and M yellowish and lighter in color than brownish veins; subgenital plate barely projecting and notched (fig. 242) ... *Perlesta*
 Larger than 14 mm; costal margin not yellowish and not lighter in color than remainder of wing; subgenital plate either produced or, if not produced, without a median notch (figs. 219, 223) *Acroneuria*
36. A_2 of forewing either not forked or forked beyond the anal cell; that is, 2 main anal veins, the 2nd of which is forked on some species

- (fig. 33) CHLOROPERLIDAE 37
- Fork of A_2 of forewing included in anal cell, so that its 2 branches leave the cell separately; that is, there are 3 main anal veins (fig. 304) PERLODIDAE 42
37. Anal veins of hindwing with 5-7 branches reaching margin of the wing; eyes generally small and set far forward (fig. 7); western family PARAPERLINAE 38
 Anal veins of hindwing with at most 4 branches; eyes normal CHLOROPERLINAE 40
38. Ocellar area dark; at least 3 crossveins in costal area beyond the subcosta; posterior margin of the male 7th sternite neither raised nor hairy *Paraperla*
 Ocellar area light; at least 3 crossveins in costal area beyond subcosta; posterior margin of the male 7th sternite raised and hairy 39
39. Eyes almost normal in position *Utaperla*
 Eyes small and set far forward *Kathoperla*
40. Anal area of hindwing apparently absent (fig. 254) *Hastaperla*
 Anal area of hindwing present 41
41. A_2 of forewing forked (fig. 33) *Alloperla*
 Without any branched anal veins in forewing (fig. 251) ... *Chloroperla*
42. Males: paraprocts modified into recurved hooks, or considerably produced backward, or genitalia complicated by various stylets and sclerotized areas 43
 Females (eastern species only): paraprocts unmodified; genitalia simple, 8th sternite generally produced into a genital plate 48
43. 10th tergite completely cleft; genitalia complicated by stylets or various sclerotized structures (figs. 309, 314) ISOGENINAE 44
 10th tergite entire or at most slightly notched; genitalia simple ... 45
44. Wings with 4 to many crossveins beyond the cord, generally arranged in an irregular network; 7th sternite without a lobe *Arcynopteryx*
 Wings with no more than 2 crossveins beyond the cord; 7th sternite generally with a lobe *Isogenus*
45. Paraprocts produced inward and backward, meeting along their inner faces (fig. 336); no lobe on 8th sternite PERLODINAE: *Diura*
 Paraprocts either formed into hooks or only slightly modified; generally with lobe on 8th sternite ISOPERLINAE 46
46. Paraprocts not formed into hooks (although the 10th tergite has hooks arising from lateral angles); 10th tergite notched on posterior margin; western genus *Calliperla*
 Paraprocts produced into recurved hooks or pointed; 10th tergite entire 47

47. Lobe on 7th sternite but not on 8th; western genus *Rickera*
 Lobe generally on 8th sternite but rarely on both 7th and 8th or on
 neither *Isoperla*
48. Numerous irregular crossveins between Rs and R; subgenital plate
 with 2 lobes broadly separated *Arcynopteryx (compacta)*
 Apical crossveins few or absent; subgenital plate variable 49
49. Submental gills present (fig. 5) *Isogenus*
 Submental gills absent 50
50. Median mesosternal ridge not dividing into a Y; medial ridge com-
 monly weak *Isogenus*
 Median mesosternal ridge dividing into a Y, each arm of which ex-
 tends toward, if not reaching, an apophyseal pit (fig. 305) 51
51. Dark brown with yellow median stripe on pronotum; hairs on margin
 of groove in femur of proleg not noticeably longer than other hairs
 on femur; subgenital plate produced halfway or more across 9th
 sternite; rare, found in New England only above timberline in
 the White Mountains and on the mountains of Gaspé *Diura*
 Without all of above characteristics 52
52. Light yellow to greenish; subgenital plate not invariably greatly pro-
 duced *Isoperla*
 Brown or dark yellow; subgenital plate produced halfway or more
 across 9th sternite; yellow medial stripe on pronotum
 *Isoperla* and *Isogenus (bilobatus, hastatus, decisus)*

KEY TO THE GENERA OF LARVAE KNOWN FROM
 NORTHEASTERN NORTH AMERICA

1. Glossae and paraglossae subequal in length (fig. 74) 2
 Paraglossae extend greatly beyond glossae (fig. 5) 13
2. Gill tufts on first 2 abdominal segments (fig. 23) *Pteronarcyx*
 No gill tufts on first 2 abdominal segments (fig. 22) 3
3. Thoracic terga and sterna produced into expanded plates that overlap
 the following segment; head partially concealed beneath prothorax
 (fig. 190) *Peltoperla*
 Thoracic terga and sterna not produced; head not concealed (fig. 8)
 4
4. A single retractile gill on each coxa *Taeniopteryx*
 No coxal gills 5
5. In lateral view, first 2 tarsal segments subequal (fig. 26); 9th ster-
 nite produced and much longer than 9th tergite *Brachyptera*
 In lateral view, 1st tarsal segment longer than 2nd (fig. 25); 9th
 sternite subequal to tergite 6
6. Extended hind legs exceed end of abdomen; hindwing pads divergent
 from axis of body (fig. 8); cervical gills present in some species
 (fig. 23) *Nemoura*

Extended hind legs not exceeding end of abdomen; hindwing pads subparallel to axis of body (fig. 7); no gills present	7
7. First 8 abdominal segments divided into tergum and sternum by a membranous fold	10
First 6 or less abdominal segments divided into tergum and sternum by a membranous fold	8
8. First 4 abdominal segments divided laterally; labial palpi extending well beyond paraglossae	<i>Leuctra</i>
First 6 abdominal segments divided laterally; labial palpi extending to approximate tip of paraglossae	9
9. Abdominal bristles sparse; subanal lobes separate	<i>Paraleuctra</i>
Abdominal bristles absent; subanal lobes partly fused	<i>Zealeuctra</i>
10. Body with numerous conspicuous bristles	<i>Paracapnia</i>
Body with few and inconspicuous bristles	11
11. Hindwing pad (if present) broad, as developing vannal area extends almost to wing tip	<i>Allocapnia</i>
Hindwing pad narrower, as developing vannal area extends only half-way to wing tip	12
12. Cerci with a fringe; several long bristles on each segment	<i>Nemocapnia</i>
Cerci without obvious fringe; bristles principally at joints of segments	<i>Capnia</i>
13. Tufts of filamentous gills on thorax	14
Thoracic gills absent	20
14. Eyes set far forward on head, distance from hind margin of eye to posterior corner of head greater than diameter of eye in most species (fig. 7)	<i>Perlinella</i>
Eyes set normally, distance from hind margin of eye to posterior corner of head less than diameter of eye (fig. 205)	15
15. 2 ocelli (fig. 204)	<i>Neoperla</i>
3 ocelli (figs. 205-210)	16
16. Spinules or long hairs set in a row across the back of the head; in some species, spinules are on a low occipital ridge (fig. 210) ..	17
No spinules in row across back of head except near hind margin of eye; no occipital ridge (fig. 205)	<i>Acroneuria</i>
17. Subanal gills present (fig. 210)	18
Subanal gills absent (figs. 207, 208)	19
18. Abdomen with numerous freckles	<i>Perlesta</i>
Abdomen without numerous freckles but brightly patterned (fig. 210)	<i>Phasganophora</i> ²

²*Acroneuria georgiana*, which can occur just south of New England, keys here but its abdomen is uniformly brown.

19. Transverse line of spinules on occiput somewhat wavy and broken at
midline (fig. 209); body uniformly light brown
..... *Acroneuria (ruralis)*
Transverse line of spinules on occiput not wavy and not broken at
midline (fig. 1); body either uniformly dark or patterned
..... *Paragnetina*
20. Hindwing pads at angle to axis of body (fig. 8); cerci as long as or
longer than abdomen; body commonly patterned; segments of
maxillary palpus evenly tapering in diameter from 1st to 5th (fig. 4)
..... 21
Hindwing pads subparallel to axis of body (fig. 7); cerci three
quarters the length of abdomen; body uniformly brown (fig. 259);
last segment of maxillary palpus abruptly thinner than previous
segments (fig. 258) 28
21. Arms of mesosternal Y ridge approach or meet anterior corners of
furcal pits; genus known in the Northeast only from the Adiron-
dacks, the White Mountains and the shores of Lake Superior
..... *Arcynopteryx (compacta)*
Arms of mesosternal Y ridge meet posterior corners of furcal pits
..... 22
22. Single fingerlike gill at each basal corner of submentum (fig. 5)
..... *Isogenus*
Submental gills absent 23
23. Abdominal tergites with dark longitudinal markings or dark dots
(fig. 299) *Isoperla*
Abdominal tergites with transverse markings, or unicolorous, or white
spotted (figs. 287, 308) 24
24. Only 1 tooth on lacinia *Isogenus (bilobatus)*
2 teeth on lacinia (fig. 4) 25
25. Lacinia with sharp angle just below smaller tooth 26
Lacinia without sharp angle below smaller tooth, rounded or, more
commonly, tapering from tooth to base 27
26. Abdominal tergites dark, with transverse row of 6 or 8 white dots
on each segment; submental gills present but inconspicuous
..... *Isogenus (hastatus)*
Abdominal tergites dark, with 2 dorso-lateral spots and a few small
lateral spots; genus found at high elevations in the White Moun-
tains and the Gaspé *Diura*
27. Abdominal tergites banded laterally, with anterior margins of ter-
gites dark *Isogenus*
Abdominal tergites banded laterally, with anterior margins of tergites
light, or tergites uniformly brown, or tergites dark, with white spots
or light longitudinal line *Isoperla*

28. Inner margin of hindwing pads sinuate or notched (fig. 259); body of mature larva larger than 7 mm *Alloperla*
 Inner margin of hindwing pads straight; body of mature larva 7 mm or less *Hastaperla*, *Chloroperla*

FAMILIES, GENERA, AND SPECIES OF NORTHEASTERN PLECOPTERA, WITH SPECIES ILLUSTRATIONS AND KEYS

Descriptions of each family and genus represented in the northeastern United States are given below. For each genus a key to the species found in the Northeast is included. In these keys, the numeral preceding a species name gives its order among the species described under that generic heading.

Immediately under each species heading are recorded the references to the type description and any synonymy. For categories higher than generic, Illies' (1966) fine catalog is followed; for the genera, however, with a few exceptions, the concepts of Ricker, Jewett, and Gaufin have been followed. In the genera *Nemoura*, *Leuctra*, *Arcynopteryx*, *Alloperla*, and *Isogenus*, Illies has raised Ricker's subgenera to generic rank. In most cases, I have retained the older, more familiar generic names but have included the subgeneric names because future work will possibly make greater use of them.

Length, given just before the species description, is measured from the anterior portion of the head to the top of the folded wing. In each case, the smaller size is that of the male and the larger that of the female. Where published descriptions include larger or smaller specimens than I have seen, I have given this greater range. Brachypterous specimens are measured to the end of the abdomen.

A description of each species follows; almost invariably with one or more figures illustrating the species. The type locality, location of the type specimen, and range of each species are also included.

Connecticut records are given by town, in most cases with the name(s) of the collector(s). Collections within a town are separated by commas and set off from those in other towns by semicolons. The present locations of the specimens are given in parentheses: (AMNH)=The American Museum of Natural History, New York City; (CAES)=The Connecticut Agricultural Experiment Station, New Haven; (UC)=University of Connecticut, Storrs; (YU)=Yale University, New Haven. Where several collections from the same town are in one institution, that location is given at the end of the records for that town. Specimens collected by Stephen W. Hitchcock, and in his collection, are indicated by (SWH).

FAMILY CAPNIIDAE

These small dark stoneflies are divided into 2 subfamilies—the Capniinae, which are found in North America, Eurasia, and northern Africa, and the Notemourinae, which occur in southern Africa, southern South America, and Australia, with a single genus (*Megaleuctra*) in North America.

Wing venation is reduced, with very few crossveins, and the abdominal ganglia are reduced in some species, varying from 6 to 8. Adult Capniidae possess long cerci, with numerous segments. The males have a well developed epiproct but the paraprocts are simple in most species. Harper and Hynes (1971b) have given a key to the known larvae of the Northeastern species.

GENUS *Capnia* PICTET

Capnia Pictet, 1841, Perlides: 318.

Arsapnia Banks, 1897, Trans. Am. Entomol. Soc. 24: 22.

Capnura Banks, 1900, Trans. Am. Entomol. Soc. 26: 245.

This genus is most easily distinguished by having R_1 of the forewing bent upward at its point of origin and A_1 of the forewing bent abruptly caudad at its junction with cu-a and then curved outward. The thoracic presterna are free on each segment, the spinasterna are fused to the basisterna, and the mesothoracic postfurcasternal plates are free. Hanson (1946) defined the genus in detail.

Capnia are essentially western, with only a few species reaching eastern North America. Three eastern species, *C. sugluka*, *C. nearctica*, and *C. labradora*, are north of the range of this bulletin but the latter is included in the key because more intensive collecting may extend its range southward.

Type of genus: *Perla nigra* Pictet.

KEY TO NORTHEASTERN SPECIES

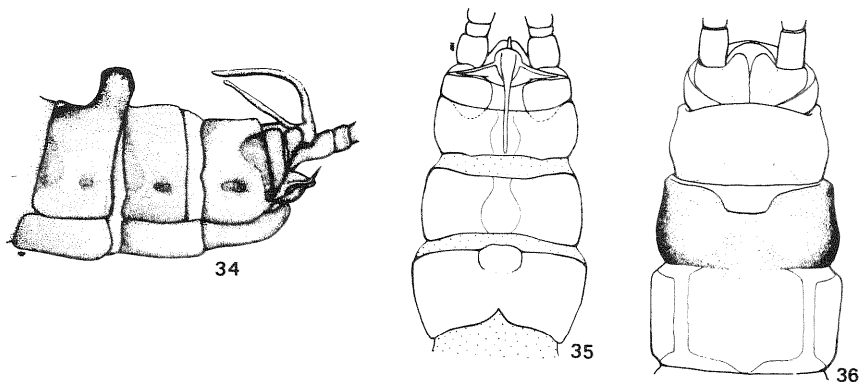
1. Males: epiproct recurved over 10th tergite 2
Females: without epiproct 4
2. Epiproct bipartite, divided into dorsal and ventral part 3
Epiproct unipartite 2, *vernalis*
3. Upper arm of epiproct notched apically *labradora*
Upper arm of epiproct tapering to a point apically 1, *manitoba*
4. Subgenital plate not produced past hind margin of 8th sternite, smoothly rounded or recessed 5
Subgenital plate somewhat produced; notched at apex *labradora*
5. Subgenital plate terminating in a sclerotized tip; subgenital tract visible through 8th sternite 2, *vernalis*
Apex of subgenital plate not more darkly sclerotized than remainder of plate; subgenital tract not visible 1, *manitoba*

1. *Capnia manitoba* Claassen (figs. 34-36)

Capnia manitoba Claassen, 1924, Can. Entomol. 56: 54.

Length: 5-9.5 mm.

Description: The male has a rounded, granulate, dorsal process on the 7th



Capnia manitoba: posterior abdominal segments

Fig. 34. Male, lateral view.

Fig. 35. Male, dorsal view.

Fig. 36. Female, ventral view.

tergite near the posterior margin. The epiproct is divided into an upper and lower arm, both arms being roundly pointed at the tip. The female has the subgenital plate recessed from the hind margin of the 8th sternite, forming a broad quadrate area. Adult genitalia and wings were figured by Needham and Claassen (1925) adults and larva by Harper and Hynes (1971b).

This species seems to be of widespread but sporadic occurrence in the northeastern United States. It flies more readily than other early-spring capniids (Hanson and Hitchcock, 1961) and does not commonly crawl up on the fence posts and bridge railings which are the usual collecting spots for other capniids.

Type locality: Awene, Manitoba. Type in Canadian National Collection, Ottawa.

Range: From Manitoba east across Canada, probably to the Maritimes and then south into New England. This is a northern species that was able, unlike most *Capnia*, to spread eastward following the last glaciation.

Connecticut records: Goshen, April 1, 1959 (SWH).

2. *Capnia vernalis* Newport (fig. 37)

Capnia vernalis Newport, 1849, (1848), Proc. Linn. Soc. London. 1: 388.

Length: 4.5-6.5 mm.

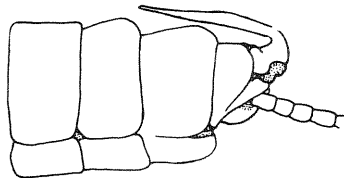


Fig. 37. *Capnia vernalis* male, lateral view of posterior abdominal segments (from Harper and Hynes, 1971d).

Description: The unipartite epiproct of the male distinguishes this from all other *Capnia*. The wing venation and thoracic sternites easily separate it from similar species of *Paracapnia*. The medial part of the posterior margin of the female 8th sternite is a darkly sclerotized lip and, extending anteriorly from this, the sclerotized floor of the genital tract can be seen through the body wall. Ricker (1938) illustrated the type specimens: Harper and Hynes (1971b) the wings, adult genitalia, and larva.

This species was confused for some years with *Paracapnia opis* but is a more northern species.

Type locality: St. Martin's Falls, Albany River, Hudson's Bay, Ontario. Type in the British Museum.

Range: Across Canada from Alberta to Labrador; apparently comes into the United States only in Minnesota.

GENUS *Allocapnia* CLAASSEN

Capnella Claassen, 1924, Can. Entomol. 56: 43 (preoccupied).

Allocapnia Claassen, 1928, Ann. Entomol. Soc. Am. 21: 667.

Allocapnia are small, dark, commonly brachypterous stoneflies that would escape general notice altogether except for their habit of emerging in mid-winter in large numbers and crawling over the snow. Consequently, some North American species were described earlier than all except the largest pteronarcids and perlids and also earned comment from naturalists such as Thoreau.³

In recent years, H. H. Ross and W. E. Ricker and their co-workers have published a series of papers describing new species and discussing the distribution and evolution of members of this genus. There appears to be some hybridizing between species (Hanson, 1960), and the genus as a whole seems to be in a period of unusually great evolutionary change.

The monumental study of Ross and Ricker (1971) is basic to any examination of the *Allocapnia*. They have keyed, figured, and mapped the distribution of every species in the genus and discussed the phylogeny and movements of populations. *Allocapnia* appears to be just one of a series of species groups, most of which have been lumped under *Capnia*. According to these authors, the Japanese *Takagripopteryx* which has sometimes been considered to be congeneric and senior to *Allocapnia* (see Kawai, 1967) is presumably just one of the forementioned species groups.

Allocapnia can be distinguished by the well developed anal area of its hindwing, and by having the prothoracic spinasternum free of the mesothoracic basisternum. As with other Capniidae, Hanson's (1946) study should be consulted for morphological and taxonomic details.

Many species seem to overlap in some characters. As H. H. Ross and

³Wade (1927) lists seven citations by Thoreau to stoneflies; however, a careful perusal of Thoreau's journals reveals considerably more, especially in those entries made in late winter, when *Allocapnia* are active.

his fellow workers have demonstrated, geographic isolation during glaciation has resulted in a multiplicity of closely related species. In single collections, occasional specimens have protuberances that do not fit the general description of the apparent species. It is probable, due to this plasticity of structure, that exact definition of some species may have to await breeding studies. Most species have to be cleared and expanded before they can be adequately studied; this is particularly true of the females.

Type of genus: *Capnella granulata* Claassen.

KEY TO MALES OF NORTHEASTERN AND CENTRAL UNITED STATES

1. 7th and 8th abdominal tergites with dorsal projections or strongly humped (figs. 46, 51, 63, 64) 2
 8th abdominal tergite with dorsal projections; 7th segment not raised 14
2. 8th segment with 2 processes, one anterior to the other (figs. 39, 64) 3
 8th segment with single process, although this can be lobed (figs. 43, 44) 4
3. 7th tergite with bilobed process⁴ (fig. 64) 24, *zola*
 7th tergite with unilobed process and with tip directed posteriorly (fig. 39) 2, *curiosa*
4. Process of 8th tergite trilobed 5
 Process of 8th tergite bilobed 9
5. Process of 8th tergite with median tooth smaller than lateral teeth (figs. 51, 53) 6
 Process of 8th tergite with median tooth as large as lateral teeth (fig. 44) 7
6. Process of 7th tergite tridentate, raised, and on posterior half of tergite (fig. 53) 14, *ohioensis*
 Process of 7th tergite blunt or, if barely tridentate, is on anterior half of tergite, barely raised, and with median tooth tallest⁵ (fig. 51) 13, *nivicola*
7. Process on 7th tergite raised on posterior half of tergite; somewhat tridentate (fig. 44) 7, *indianae*
 Process on 7th tergite a low ridge in middle of tergite, commonly blunt 8
8. In lateral view, posterior corner of 8th tergal process angled; in dorsal view, lower arm of epiproct scarcely wider than upper (fig. 59) 19, *smithi*

⁴Some specimens of *illinoensis* key here but the process on the 7th tergite is at the posterior margin of the tergite, not on the anterior half, as in *zola*.

⁵If process of 7th tergite is on anterior half of tergite and is very low and shallowly notched, see *aurora*.

- In lateral view, posterior corner of 8th tergal process rounded; in dorsal view, lower arm of epiproct considerably wider than upper (fig. 51) 13, *nivicola*
9. Process of 7th tergite unilobed or humped (figs. 40, 46, 63) 10
 Process of 7th tergite bilobed or notched (figs. 38, 43, 54) 12
 10. 7th tergite rounded into prominent hump; process of 8th tergite with shelf posterior to rugose lobe; distal part of upper arm of epiproct subequal in length to basal part (fig. 63) 23, *zekia*
 7th tergite with definite lobe; hind margin of 8th tergite dropping away from lobe so that no shelf is seen in lateral view; distal part of upper arm of epiproct much shorter than basal part (figs. 40, 46) 11
 11. Process of 7th tergite closer to hind margin of segment; lobes of process of 8th tergite so widely separated that they appear distinctly apart (fig. 40) 3, *forbesi*
 Process of 7th tergite closer to front margin of segment; lobes of process of 8th tergite separated by a notch (fig. 46) 9, *maria*
 12. Process of 8th tergite projecting posteriorly (fig. 43) ... 6, *illinoensis*
 Process of 8th tergite projecting anteriorly or vertically (figs. 38, 54) 13
 13. Process of 7th tergite prominent and narrowly notched (fig. 54)
 15, *pechumani*
 Process of 7th tergite a low transverse ridge, shallowly bilobed (fig. 38) 1, *aurora*
 14. 8th tergite with large posterior process and smaller anterior process (fig. 60) 20, *virginiana*
 8th tergite with a single process or, if it has 2 sets of processes, anterior process is larger than posterior one (figs. 41, 49, 57) ... 15
 15. Principal process of 8th tergite not bilobed 16
 Principal process of 8th tergite bilobed or slightly incised (if the latter, the tip of dorsal arm of epiproct is sharply upturned) 19
 16. Process of 8th tergite broad, subrectangular, or truncate in lateral view (figs. 49, 57) 17
 Process of 8th tergite pointed or subtriangular in lateral view (figs. 48, 61) 18
 17. Process of 8th tergite with apex arcuate and wider than base in posterior view (fig. 49) 11, *mohri*
 Process of 8th tergite with apex not arcuate and with base shouldered and wider than apex in posterior view (fig. 57) 17, *recta*
 18. Process of 8th tergite narrow, black, transverse, and anterior to hind margin of tergite (fig. 61); only rudiments of wings ... 21, *vivi para*
 Process of 8th tergite rounded and continuous with hind margin of tergite (fig. 48); wings short but present 19, *minima*

- 19. A pair of smaller setose lobes beneath or posterior to principal process of 8th tergite; process of 8th tergite U shaped in posterior view (figs. 41, 42) 20
 A single bilobed process on 8th tergite; process of 8th tergite rounded or slightly inclined in posterior view 21
- 20. Rugose process of 8th tergite shield shaped in dorsal view (fig. 41) ... 4, *frisoni*
 Rugose process of 8th tergite not shield shaped in dorsal view (fig. 42) 5, *granulata*
- 21. Broad, deep notch separating lobes of process of 8th tergite (figs. 38, 50) 23
 Shallow notch separating lobes of process of 8th tergite (figs. 42, 62) 22
- 22. Upper arm of epiproct with sharply upturned tip (fig. 45) 8, *loshada*
 Upper arm of epiproct rounded at distal end (fig. 62) 22, *wrayi*
- 23. Notch separating lobes of process of 8th tergite wider than width of a lobe (figs. 38, 58) 24
 Notch separating lobes of process of 8th tergite equal to or less than width of a lobe (figs. 50, 55) 25
- 24. Basal part of upper arm of epiproct one and one half as long as the short apical segments (fig. 58) 18, *rickeri*
 Basal part of upper arm of epiproct subequal in length to the apical segment (fig. 38) 1, *aurora*
- 25. Process of 8th tergite slanting posteriorly; apical segment of lower arm of epiproct notched (fig. 50) 12, *mystica*
 Process of 8th tergite extending vertically; apical segment of lower arm of epiproct generally not notched (fig. 55) 16, *pygmaea*

1. *Allocaonia aurora* Ricker (fig. 38)

Allocaonia aurora Ricker, 1952, Ind. Univ. Publ. Sci. Ser. 18: 159.

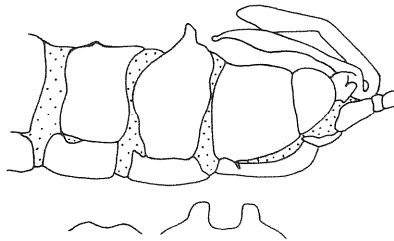


Fig. 38. *Allocaonia aurora* male, lateral view of posterior abdominal segments, including posterior views of the raised areas on the tergites (after Ricker, 1952).

Length: 4.5-7 mm.

Description: The male 7th tergite bears a small ridge near its anterior margin. This ridge can be shallowly lobed or even completely absent. There is a large bilobed process on the 8th tergite. These 2 lobes are separated by a deep, wide notch that, in some individuals, has a median tooth. The 7th and 8th sternites are fused in the female. The truncate subgenital plate is intermediate in size between those of *nivicola* and *pygmaea*. Adults were figured by Ricker (1952), as well as by Ross and Ricker (1971).

Type locality: Woodrow, North Carolina. Type at Illinois Natural History Survey.

Range: A southern species, extending from Maryland to Alabama. Ross and Ricker (1971) published a distribution map of this species.

2. *Allocapnia curiosa* Frison (fig. 39)

Allocapnia curiosa Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 268.

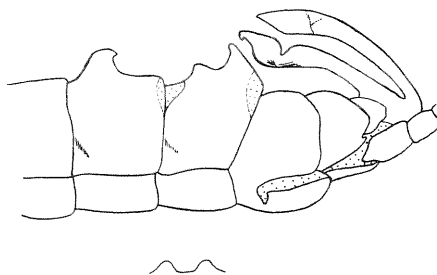


Fig. 39. *Allocapnia curiosa* male, lateral view of posterior abdominal segments, including posterior view of raised area on the tergites (after Frison, 1942).

Length: About 6 mm.

Description: The aptly named species is quite distinctive in that the 7th sternite is swollen and the posterior margin extends lobelike over part of the 8th. Illustrations of adults were given by Frison (1942) and Ross and Ricker (1971).

Type locality: Kanetown, West Virginia. Type at Illinois Natural History Survey.

Range: New York to eastern Tennessee; distribution maps were published by Frison (1942).

3. *Allocapnia forbesi* Frison (fig. 40)

Allocapnia forbesi Frison, 1929, Ill. Nat. Hist. Surv. Bull. 18: 397.

Length: 6-8 mm to end of body.

Description: Both the 7th and 8th tergites of the male bear tubercles (as does the 6th on occasional specimens). On the 8th this process is bilobed, without a posterior shelf. On the 7th it is single lobed near the posterior margin. The female has abdominal tergites 8, 9, and 10 darkly sclerotized, with the membranous dorsal

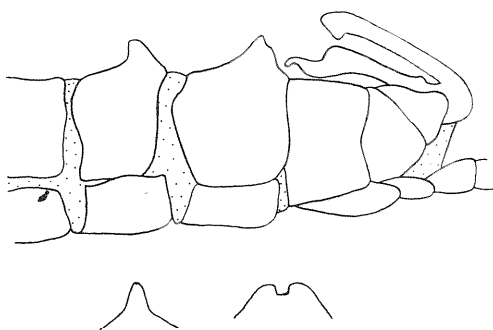


Fig. 40. *Allocapnia forbesi* male, lateral view of posterior abdominal segments, including posterior views of the raised areas on the tergites (after Frison, 1935).

stripe going only through the 7th tergite. The 7th and 8th sternites are not fused. Illustrations of the adult are given by Ross and Ricker (1971).

Frison (1929) found specimens most abundant in late fall. The adults were feeding on algae from stones and posts. They can be found in streams that dry up in summer (Ross and Ricker, 1971).

Type locality: Herod, Illinois. Type at Illinois Natural History Survey.

Range: The Midwest from southern Illinois to West Virginia. Ross and Ricker (1971) published a distribution map of this species.

4. *Allocapnia frisoni* Ross and Ricker (fig. 41)

Allocapnia frisoni Ross and Ricker, 1964, Trans. Ill. State Acad. Sci. 57: 90.

Length: 5-6 mm.

Description: The male 7th tergite has neither lobes nor processes. The 8th tergite has a raised process near the hind margin. The tergite gradually rises from the anterior margin to the process. Behind the main process are 2 small setose lobes. *A. frisoni* is thus closely related to *granulata* but can be distinguished from that species by the main process of its 8th tergite, which is shield shaped in dorsal view. The females are distinguished with difficulty from those of *granulata*. Further figures have been published by Ross and Ricker (1964, 1971).

Type locality: Evansville, West Virginia. Type at Illinois Natural History Survey.

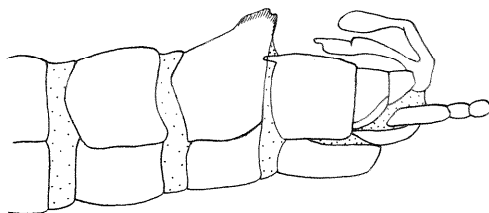


Fig. 41. *Allocapnia frisoni* male, lateral view of posterior abdominal segments (after Ross and Ricker, 1964).

Range: New York, Pennsylvania, Ohio, West Virginia, Kentucky, and Tennessee. Ross and Ricker (1971) published a distribution map of this species.

5. *Allocapnia granulata* (Claassen) (fig. 42)

Capnella granulata Claassen, 1924, Can. Entomol. 56: 44.

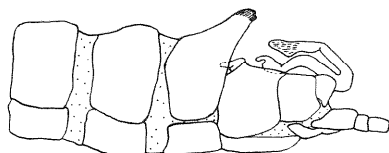


Fig. 42. *Allocapnia granulata* male, lateral view of posterior abdominal segments (from Ross and Ricker, 1971).

Length: 5-7 mm.

Description: The male of this species is characterized by a raised V-shaped process (when viewed from behind) on the 8th segment and 2 small haired lobes below the larger process. The larger rugose process is not shield-shaped in dorsal view. The female 8th sternite bears a shiny wedge-shaped area medially. There are several species closely related to *granulata* but the only one of these in the Northeast is *frisoni*.

The larvae feed on decaying leaves and at least 3 species of diatoms, whereas the adults feed on the alga *Protococcus vulgaris* (Frison, 1929). Frison observed females resting and gradually producing numerous eggs in a matrix that was carried beneath the abdomen. However, the abdomen was curled forward so that the eggs appeared to be carried dorsally. The females apparently either fly or crawl to the water and release the eggs, which separate out from the mass and drop to the stream bottom. *A. granulata* has a wider tolerance of various streams than do most *Allocapnia* species and can be found in the larger, slower streams. In a laboratory test, 50 percent of the population withstood a temperature of 23°C for 96 hours. However, this species apparently has a larval diapause in summer (Harper and Hynes, 1970).

Ross and Yamamoto (1967) and Ross and Ricker (1971) discussed the morphological variations in the male and gave a phylogenetic analysis of the various populations and their movements following the Pleistocene glaciations. Adults were figured by Frison (1929, 1935), Ross and Yamamoto (1967), and Ross and Ricker (1971), larvae by Frison (1929), Harden and Mickel (1952), and Harper and Hynes (1971b).

Type locality: Johnstown, New York. Type at Cornell University.

Range: Southern Quebec and New York to North Carolina and west to Minnesota and Oklahoma. Ross and Ricker (1971) published a distribution map.

6. *Allocapnia illinoensis* Frison (fig. 43)

Allocapnia illinoensis Frison, 1935, Ill. Nat. Hist. Surv. Bull. 20: 365.

Length: 6-8 mm.

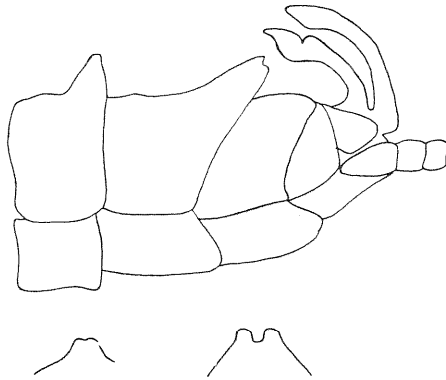


Fig. 43. *Allocapnia illinoensis* male, lateral view of posterior abdominal segments, including posterior views of the raised areas on the tergites (after Frison, 1935).

Description: The male has raised bilobed processes on the posterior margins of both the 7th and 8th tergites. Some specimens from New York have raised area on the anterior half of tergite 8. The posterior margin of the 8th sternite in the female is a bit sunken, with a subtriangular projection. A somewhat membranous area almost divides the sternite into 2 longitudinal parts. Further figures of the adult are by Ross and Ricker (1970) and of the adult and larva by Harper and Hynes (1971b).

Type locality: Dolson, Illinois. Type at Illinois Natural History Survey.

Range: Found at widely separated points in Ohio, Illinois, Minnesota, New York, Maine, southern Quebec and Ontario. Ross and his associates (1967) presented a distribution map and suggested that, following the Wisconsin glaciation, *illinoensis* dispersed from the Cumberland Plateau to the northeast and then westward across southern Canada to Wisconsin and Minnesota.

7. *Allocapnia indianae* Ricker (fig. 44)

Allocapnia indianae Ricker, 1952, Ind. Univ. Publ. Sci. Ser. 18: 162.

Length: 4.5-8 mm.

Description: This species has a process on both the 7th and 8th tergites and is closely related to *nivicola*. It has a trilobed process on the 8th tergite. The process on the 7th tergite is either blunt or with a suggestion of a trilobed condition. The female 7th and 8th sternites are fused on the midline but the posterior margin of the subgenital plate is broader than in *nivicola*. The female 8th sternite can be sclerotized or membranous mesally.

Type locality: Medora, Indiana. Type at Illinois Natural History Survey.

Range: Found in scattered regions in Indiana, Kentucky, Ohio, and New York. Ross and Freytag (1967) mapped the distribution of this species and suggested that the Wisconsin glaciation separated it from the closely related *ohioensis* and that each evolved into a separate species. Upon the retreat of the ice sheet, the ranges of these species became sympatric. The more southern records are limited to streams

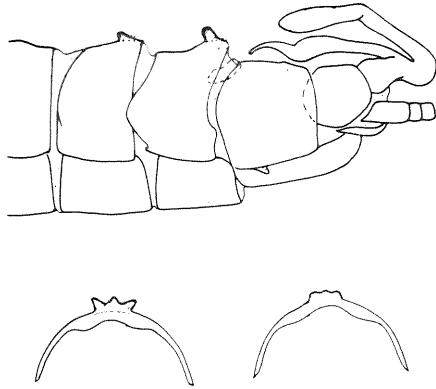


Fig. 44. *Allocapnia indianae* male, lateral view and cross sections of posterior abdominal segments (from Ross and Ricker, 1971).

of spring or cave origin, which are usually warmer in winter and cooler in summer than other streams.

8. *Allocapnia loshada* Ricker (fig. 45)

Allocapnia loshada Ricker, 1952, Ind. Univ. Publ. Sci. Ser. 18: 163.

Length: 4.5-6 mm.

Description: The male has no tubercle on the 7th tergite, a slightly bilobed projection on the 8th tergite, and a flat shelf behind this process. The projection is small, erect, with a flat notch separating the 2 lobes. The upper arm of the epiproct is upturned at the tip, distinguishing it from the closely related *recta*, which is found in the same area. The posterior margin of the female 8th sternite is slightly produced centrally. Further figures are by Ross and Ricker (1971).

Type locality: Jaeger, West Virginia. Type at Illinois Natural History Survey.

Range: Has been collected from West Virginia, Tennessee and Virginia. Ross and Ricker (1971) published a distribution map of this species.

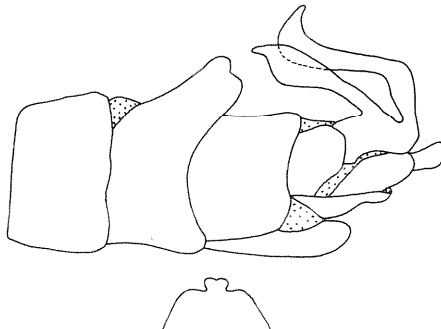
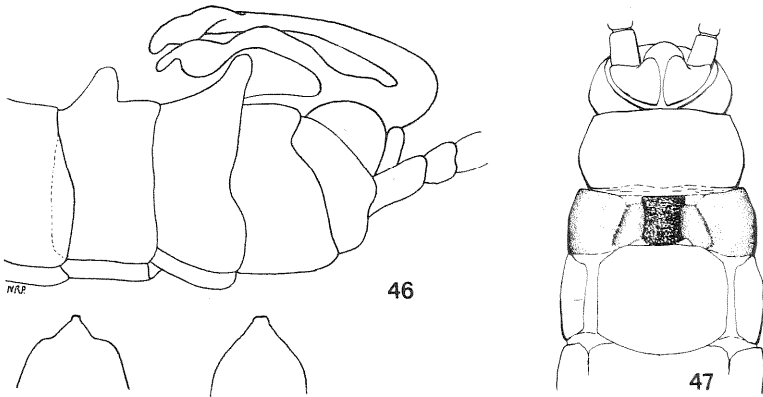


Fig. 45. *Allocapnia loshada* male, lateral view of posterior abdominal segments, including posterior view of raised area on the tergites (after Ricker, 1952).

9. *Allocapnia maria* Hanson (figs. 46, 47)

Allocapnia maria Hanson, 1942, Bull. Brooklyn. Entomol. Soc. 37: 81.



Allocapnia maria: posterior abdominal segments

Fig. 46. Male, lateral view, including posterior view of the raised areas on the tergites.

Fig. 47. Female, ventral view.

Length: 3-6 mm.

Description: The male has a single lobed process on the 7th tergite and a shallowly bilobed one on the 8th tergite. The female 7th and 8th sternites are fused. The 8th sternite is depressed medially, with a shiny, glabrous subrectangular area. The females are not easily distinguished from *minima*.

This species, with *minima*, is the smallest Northeastern stonefly. Hanson (1960) has demonstrated hybridizing between these two species and shows that, as the number of *maria* individuals increases in a given collection, so does the amount of *maria*-like characters in the *minima* population. Ross and Ricker (1971) found this species also hybridizing with *pechumani* in New Brunswick and Nova Scotia.

Further figures are by Hanson (1942a) Ricker (1952), and Ross and Ricker (1971).

Type locality: East Amherst, Massachusetts. Type in Hanson Collection, University of Massachusetts.

Range: Quebec and Nova Scotia to West Virginia. Ross and Ricker (1971) published a distribution map of this species.

Connecticut records: Bethlehem, Mar. 13, 1965 (SWH); Botsford, Mar. 9, 1962 (SWH); Hartland, Mar. 3, 1965, Mar. 14, 1962, Mar. 25, 1965 (SWH); Newtown, Mar. 9, 1962 (SWH); Plymouth, Mar. 12, 1965 (SWH).

10. *Allocapnia minima* (Newport) (fig. 48)

Perla minima Newport, 1849 (1848), Proc. Linn. Soc. London 1 : 388.

Capnella incisura Claassen, 1924, Can. Entomol. 56 : 45.

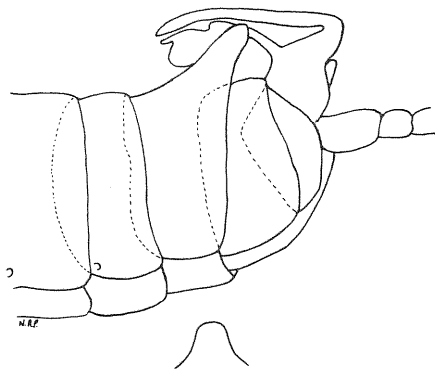


Fig. 48. *Allocapnia minima* male, lateral view of posterior abdominal segments, including posterior view of raised area on the tergite.

Length: 3.3-5.5 mm.

Description: The male of *minima* has a single posteriorly angled process on the 8th tergite. There is no process on the 7th tergite. The female is very similar to *maria*. In some individuals the median shiny plate of the 8th sternite is somewhat thinner in relation to length than normal for the species; however, there is considerable overlap in this characteristic.

Hanson (1960) found evidence that hybrids between *minima* and *maria* occur. Ross and his associates (1967) state that this is apparently of local occurrence, where small brooks with *maria* meet larger streams with *minima* and that there is probably a natural selection against the hybrids, so that morphological evidence of this crossing is not widespread within the populations. *A. minima* is the only *Allocapnia* found in Newfoundland that is also found northward to the tundra. It is found on this continent only on previously glaciated areas. Ross and Ricker (1971) suggest that it survived the Wisconsin glaciation in Newfoundland or that it is a result of a hybrid cross between two new animals following glaciation. The former seems more likely, particularly in view of the fact that Ross and Ricker were unable to place *minima* with certainty with any other species group. Following glaciation, Connecticut had a tundralike flora and at that time *minima* may have become widespread down the East Coast to the south, later to follow the retreat of the glaciation northward. Perhaps competition from other forms of *Allocapnia* just south of the glaciated region, as well as restrictions caused by its adaptation to a more northern climate, kept *minima* from expanding its range farther south.

Further figures are by Ross and Ricker (1971); larval forms were figured by Harden and Mickel (1952) and Harper and Hynes (1971b).

Type locality: St. Martin's Falls, Albany River, Canada. Type in the British Museum.

Range: Newfoundland and New England west to Ontario and Minnesota.

Connecticut records: Chaplin, Mar. 19, 1964 (SWH); Colebrook, Mar. 14, 1962 (SWH); Gurleyville, Mar. 17, 1959 (SWH); Hartland, Mar. 14, 1962 (SWH); Mansfield, Feb. 18, 1965, A. Squires, Mar. 1954, J. Slater, Mar. 8, 1963, R. Hevey, Mar. 20, 1955, I. Miller (UC).

11. *Allocapnia mohri* Ross and Ricker (fig. 49)

Allocapnia mohri Ross and Ricker, 1964, Trans. Ill. State Acad. Sci. 57: 91.

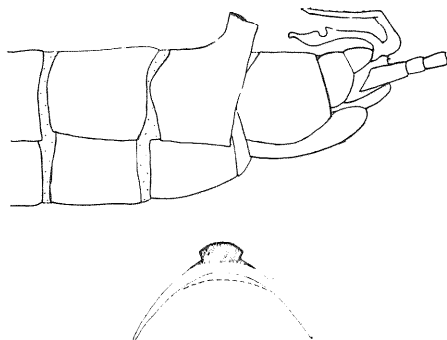


Fig. 49. *Allocapnia mohri* male, lateral view and cross section of posterior abdominal segments (from Ross and Ricker, 1971).

Length: 4.5 mm. to about 6 mm.

Description: The male is close to *recta*. On the posterior part of the 8th tergite is a process which in posterior view is wide and arcuate at the apex and does not rest on a shouldered base. The female 8th sternite is relatively undistinguished and not separable from *recta*. Further figures of the adult were given by Ross and Ricker (1964, 1971).

Type locality: Near Summit, Oklahoma. Type at Illinois Natural History Survey.

Range: Has been found only in Oklahoma. Its distribution was mapped by Ross (1965) and Ross and Ricker (1971).

12. *Allocapnia mystica* Frison (fig. 50)

Allocapnia mystica Frison, 1929, Ill. Nat. Hist. Surv. Bull. 18: 399.

Length: 6-8 mm to end of body.

Description: The male has a single bilobed projection near the posterior margin of the 8th tergite. The notch between the lobes is narrow but fairly deep. The 8th tergite is considerably produced, with a sloping anterior face. The 7th and 8th sternites of the female are not fused. Adults were figured by Frison (1929, 1935), as well as by Ross and Ricker (1971).

Frison (1929) states that this is an early winter species, mating pairs being found as early as November. The females, who cannot fly, crawl to the water to deposit

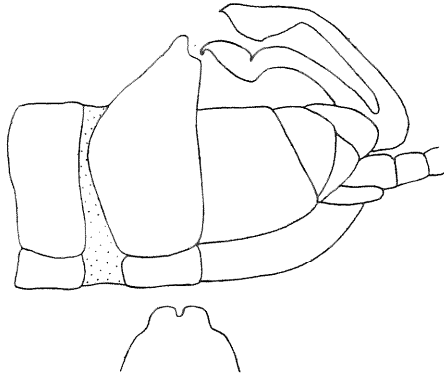


Fig. 50. *Allocapnia mystica* male, lateral view of posterior abdominal segments, including posterior view of raised area on the tergites (after Frison, 1935).

their eggs, each carrying about 600 eggs. Adult females feed on algae, chiefly from tree trunks. The larvae eat decaying leaves, diatoms, and a few protozoans, the latter presumably gathered in fortuitously. Frison kept adults alive for 2 weeks in his laboratory.

Type locality: Oakwood, Illinois. Type at Illinois Natural History Survey.

Range: Illinois to Arkansas and east to Ohio and Georgia. Its distribution has been mapped by Ross and Ricker (1971).

13. *Allocapnia nivicola* (Fitch) (figs. 51, 52)

Perla nivicola Fitch, 1847, Am. Quart J. Agric. and Sci. 5: 278 (reprinted by J. A. Lintner, 1885, Rept. N. Y. State Entomol. 2: 239)

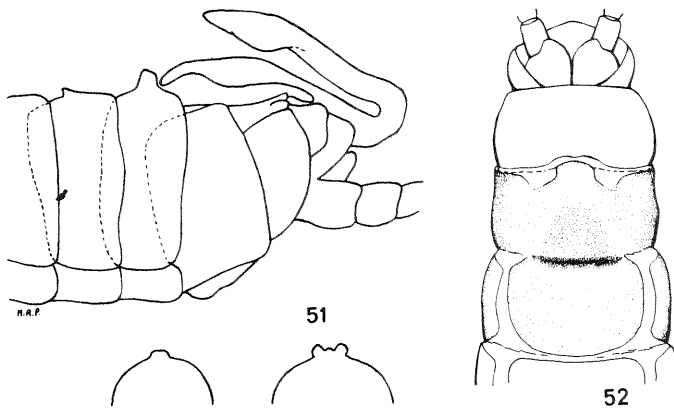
Length: 5-7 mm.

Description: The male has processes on both the 7th and 8th tergites, that on the 8th trilobed and that on the 7th blunt and only slightly raised. There is considerable variation in the relative size of the center lobe of the 8th tergal process and in the presence or absence of extra lobes on the 7th tergal process. The female 7th and 8th sternites are fused and the posterior median part is about one quarter the width of the hind margin. The female cannot be readily distinguished from its near relatives but most of these do not occur in New England. (This is scant comfort to more westerly or southern entomologists.) Further illustrations of the adult are by Hanson (1942a) and Ross and Ricker (1971) and of adult and larva by Harper and Hynes (1971b).

Type locality: New York State. Lectotype in Museum of Comparative Zoology, Harvard University.

Range: Quebec and the Maritimes to North Carolina and west to Wisconsin and Alabama.

Connecticut records: Bethlehem, Mar. 13, 1965 (SWH); Coventry, Mar. 6, 1965, R. Johnson and K. Welch; East Lyme, Mar. 2, 1964 (SWH); Eastford, Apr. 5, 1968 (SWH); Haddam, Apr. 3, 1969 (SWH); Hartland, Mar. 3, 1965, Mar. 14, 1962,



Allocapnia nivicola: posterior abdominal segments

Fig. 51. Male, lateral view, including posterior views of the raised areas on the tergites.

Fig. 52. Female, ventral view.

Mar. 21, 1966, Mar. 25, 1965 (SWH); Killingworth, Apr. 7, 1969 (SWH); Lyme, Mar. 2, 1964 (SWH); Mt. Carmel, Feb. 27, 1959 (SWH); Newtown, Mar. 9, 1962 (SWH); Norfolk, Mar. 14, 1962 (SWH); Plainfield, Mar. 19, 1964 (SWH); Redding, Mar. 24, 1964 (SWH); Storrs, Feb. 15, 1956, J. Slater (UC); Winchester, Mar. 14, 1962 (SWH).

14. *Allocapnia ohioensis* Ross and Ricker (fig. 53)

Allocapnia ohioensis Ross and Ricker, 1964, Trans. Ill. State Acad. Sci. 57: 92.

Length: 5-8 mm.

Description: *A. ohioensis* is very closely related to *indianae* but the middle point of

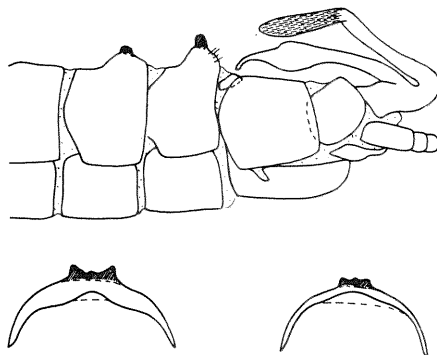


Fig. 53. *Allocapnia ohioensis* male, lateral view and cross sections of posterior abdominal segments (from Ross and Ricker, 1971).

the trilobed process on the 8th tergite is smaller than the lateral points. The process on the 7th tergite appears somewhat trilobed. Furthermore, the lower member of the epiproct in dorsal view tapers almost evenly, forming a subtriangular apex. In *nivicola* the lower member is long and tongue-like. The margin of the female of *ohioensis* forms a short, wide, infolding flange. Further illustrations are by Ross and Ricker (1971).

Ross and Freytag (1967) gave a distribution map of this species and stated that, during the Wisconsin glaciation, it probably became isolated from the population that ultimately became *indianae*. The two species are now sympatric.

Type locality: Coolville, Ohio. Type at Illinois Natural History Survey.

Range: Kentucky and Ohio into New York.

15. *Allocapnia pechumani* Ross and Ricker (fig. 54)

Allocapnia pechumani Ross and Ricker, 1964, Trans. Ill. State Acad. Sci. 57: 88.

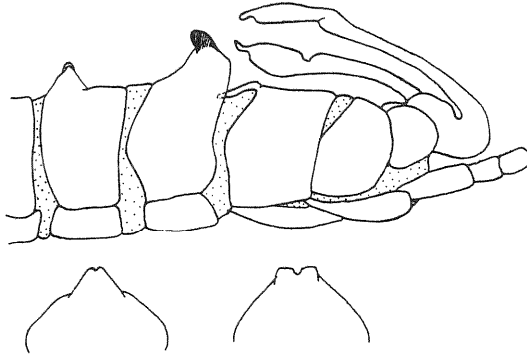


Fig. 54. *Allocapnia pechumani* male, lateral view of posterior abdominal segments, including posterior views of the raised areas on the tergites (after Ross and Ricker, 1964).

Length: 5-6 mm.

Description: *A. pechumani* belongs to the group of species whose males have tergal processes on segments 7 and 8. The process on the 7th tergite is on the anterior half of the segment with the apex cleft. The process of the 8th is high, with 2 distinct lobes. The female is similar to *maria*. Figures of the adult are given by Ross and Ricker (1971). They found *pechumani* hybridizing with *maria* where the two species overlap on the northern edge of their ranges. Harper and Hynes (1971b) figured the adult and larva.

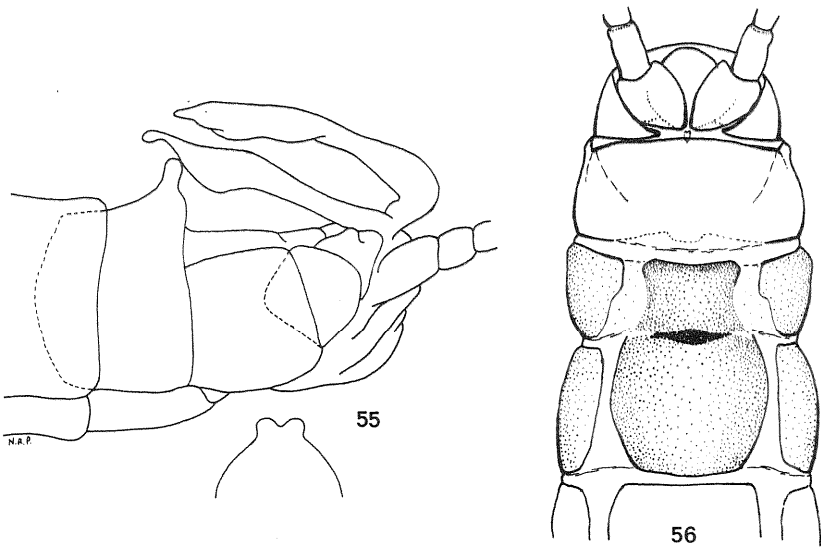
Type locality: Starkville, New York. Type at Illinois Natural History Survey.

Range: Found in New York, Quebec, and the Maritimes. A distribution map of this species was published by Ross and Ricker (1971).

16. *Allocapnia pygmaea* (Burmeister) (figs. 28, 55, 56)

Semblis pygmaea Burmeister, 1839, Handbuch der Entomol. 2: 874.

Allocapnia torontonensis Ricker, 1935, Can. Entomol. 67: 257.



Allocapnia pygmaea

Fig. 55. Male, lateral view of posterior abdominal segments, including posterior view of raised area on the tergite.

Fig. 56. Female, ventral view of posterior abdominal segments.

Length: 5-8 mm.

Description: In the male, only the 8th abdominal tergite bears a process—a bilobed structure near the posterior margin. The female 7th and 8th sternites are fused along a dark line. The subgenital plate is broad and truncate, and separated from the remainder of the segment by membranous areas. Further figures of the adult are by Hanson (1943b) and Ross and Ricker (1971). The larva is illustrated by Claassen (1931), Harden and Mickel (1952), and Harper and Hynes (1971b).

Hanson (1942a) observed mating in this species and found that the upper arm of the epiproct was inserted into the female, the sperm flowing through a duct on the under side of this part. The lower arm was inserted under the posterior part of the male's own 8th segment, forcing the bilobed tergal process to press against a protuberance on the female's 7th sternite. Harden and Mickel (1952) suggested that mating and oviposition may sometimes take place beneath the ice over frozen streams. Coleman and Hynes (1970) found that males can detect females within a radius of 15 cm and also noted that, after emergence, adults moved away at right angles to the stream. One individual was followed for 75 m. In the laboratory adults fed on algae and lichen and oviposited 4 to 5 weeks after emergence. A female produces one batch of eggs and dies a few days thereafter. Eggs start to hatch after 21 days at 10°C. Bishop and Hynes (1969) found larvae of this species moving upstream in some numbers in winter and Harper and Hynes (1970) recorded a diapause stage during the summer. Willey (1936, 1937) discussed variations in wing venation and noted that adults are preyed on by chickadees.

Type locality: Pennsylvania. Type in Zoological Museum, Halle, Germany.

Range: Quebec south to Virginia and, in the mountains, almost to Alabama; west to Minnesota and Missouri but not through the tier of states from Iowa to Ohio.

Ross (1965) and Ross and his associates (1967) surmised that, following the last glacial retreat, this insect spread northward from the Appalachians to the St. Lawrence River plain and the Great Lakes and from thence to Minnesota and Wisconsin. A relict population in the Missouri Ozarks apparently did not spread northward. An alternative explanation (Ross and Ricker, 1971) is that the Missouri population was pushed southward by an earlier glaciation from Minnesota and Wisconsin. The present Wisconsin population is an extension of the Appalachian population, once again spreading westward and northward.

Connecticut records: Bethlehem, April 14, 1967 (SWH); Botsford, Mar. 12, 1965 (SWH); Colebrook, Mar. 3, 1965, Mar. 14, 1962 (SWH); Coventry, Mar. 6, 1965, R. Johnson and K. Welch; East Lyme, Mar. 2, 1964 (SWH); Eastford, Mar. 28, 1963 (SWH); Easton, Jan. 5, Feb. 11, 1965, Mar. 5, 1966, Mar. 29, 1965 (SWH); Gurleyville, Mar. 17, 1959 (SWH); Hartland, Mar. 14, 1962, Mar. 21, 1966, Mar. 25, 1965 (SWH); Huntington, Mar. 9, 1962 (SWH); Killingworth, Feb. 28, 1959 (SWH); Madison, Feb. 28, 1959 (SWH); Mansfield, Feb. 28, 1965, A. Squires, Mar. 1954, J. Slater, Mar. 8, 1963, R. Hevey, Mar. 20, 1955, I. Miller (UC); Marlborough, Mar. 2, 1964 (SWH); Newtown, Mar. 9, 1962 (SWH); Oakdale, Mar. 2, 1964 (SWH); Robertsville, Mar. 3, 1965 (SWH); Storrs, Feb. 15, 1956, J. Slater, April 4, 8, 1957, J. Scheiber (UC); Washington Depot, Feb. 26, 1964 (SWH); Winchester, Mar. 14, 1962 (SWH).

17. *Allocapnia recta* (Claassen) (fig. 57)

Capnella recta Claassen, 1924, Can. Entomol. 56: 44.

Length: 5-6 mm.

Description: This is a common eastern species, the male distinguished by a large single process on the 8th tergite only, which is broad in lateral view and, in some individuals, with suggestions of lobes. The female 7th and 8th sternites are not fused

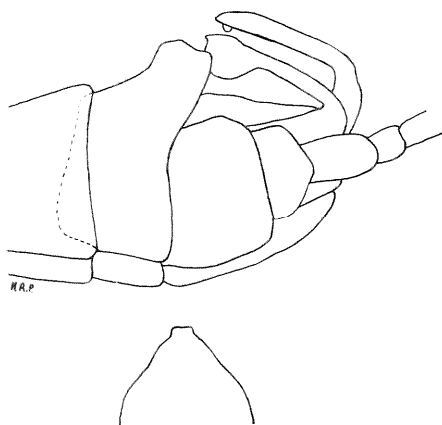


Fig. 57. *Allocapnia recta* male, lateral view of posterior abdominal segments, including posterior view of the raised area on the tergite.

and the subgenital plate is not well differentiated from the remainder of the segment. In posterior view, the projection on the 8th tergite is shouldered. Illustrations of the adult were given by Needham and Claassen (1925), Frison (1929), and Ross and Ricker (1971); of the larva by Harper and Hynes (1971b).

This is the earliest appearing Connecticut stonefly and is found in both permanent and temporary streams.

Frison (1929) found adults active when the air temperature was 20°F. He also observed that adults fed on blue-green algae and that larvae fed on diatoms and decaying leaves. Females did not fly but crawled into the water to deposit their eggs. Hamilton (1933) found chickadees and kinglets feeding on *recta*. An anonymous report (1960) describes the nuisance caused by great numbers of *recta* individuals crawling into dairy equipment inside buildings. Ross (1965) and Ross and Ricker (1971) published distribution maps.

Type locality: Ithaca, New York. Type at Cornell University.

Range: Quebec and New England south to North Carolina and west to Mississippi and Illinois.

Connecticut records: East Morris, April 1, 1959 (SWH); Easton, Jan. 4, Apr. 5, 1966 (SWH); Hamden, Jan. 9, 1945, R. Morrill (YU); Killingworth, Feb. 28, 1959 (SWH); Mt. Carmel, Dec. 6, 1968, Feb. 27, 1959 (SWH); Plainfield, Mar. 19, 1964 (SWH); Storrs, Dec. 28, 1958, M. Sweet, Feb. 25, 1956, Apr. 14, 1957, J. Slater, (UC).

18. *Allocapnia rickeri* Frison (fig. 58)

Allocapnia rickeri Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 269.

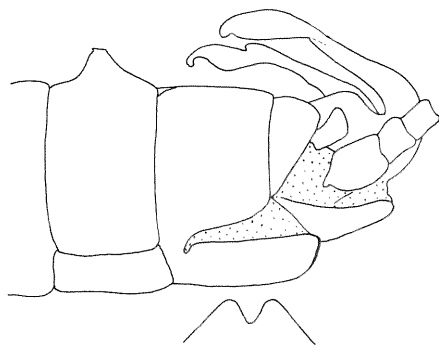


Fig. 58. *Allocapnia rickeri* male, lateral view of posterior abdominal segments, including posterior view of the raised area on the tergite (after Frison, 1942).

Length: 4.5-5.5 mm.

Description: The male has a bilobed process on the 8th abdominal tergum, with a broad notch separating the lobes. The female has the 7th and 8th sternites fused and is not readily separable from relatives with the same characteristic. Further figures of

adults were published by Frison (1942) and Ross and Ricker (1971). The larva was illustrated by Harper and Hynes (1971b).

Type locality : Golconda, Illinois. Type at Illinois Natural History Survey.

Range: Southern Ontario and New York to northern Georgia and west to Minnesota and Oklahoma. The species is most widely distributed south of the glaciated area, with scattered records to the north. Ross (1965) and Ross and Ricker (1971), who published distribution maps of this species, found that it had penetrated only slightly into the glaciated areas, except along the Mississippi River into Wisconsin and along other streams into New York and southern Ontario.

19. *Allocapnia smithi* Ross and Ricker (fig. 59)

Allocapnia smithi Ross and Ricker, 1971, Ill. Biol. Monog. 45: 48

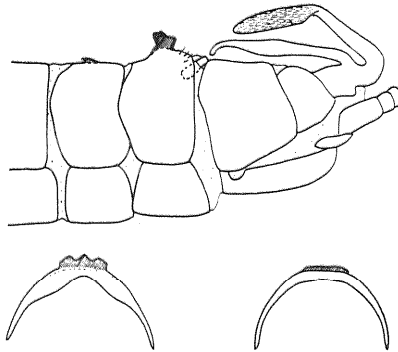


Fig. 59. *Allocapnia smithi* male, lateral view of posterior abdominal segments, and cross sections of abdominal segments (after Ross and Ricker, 1971).

Length: About 6 mm.

Description: The male of this species is very close to *nivicola*, with a dorsal process on both the 7th and 8th tergites. That on tergite 7 is a flat ridge, scarcely raised; that on tergite 8 is trilobed. In lateral view, the corners of the 8th tergal process are angled (rather than rounded, as in *nivicola*), with the top surface appearing flattened rather than rounded. The female is said to be similar to *aurora*. Figures of the adult and a distribution map are with the original description.

Type locality : South Hill, Kentucky. Type at Illinois Natural History Survey.

Range: Has been collected in Alabama, Kentucky, Ohio, and Illinois.

20. *Allocapnia virginiana* Frison (fig. 60)

Allocapnia virginiana Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 269.

Length: About 6 mm.

Description: The male has 2 processes on the 8th tergite, a smaller single-

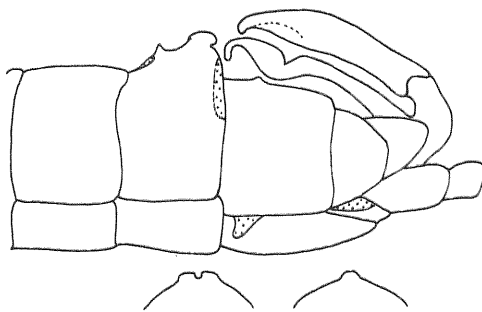


Fig. 60. *Allocapnia virginiana* male, lateral view of posterior abdominal segments, including posterior view of the raised areas on the tergites (after Frison, 1942).

lobed anterior one and a larger, slightly cleft posterior one that is broad and long in dorsal view. There is no tubercle on the 7th tergite. The female subgenital plate of the 8th sternite is broad and rounded and connected to the 7th by a narrow strap. Other illustrations of the adult are by Frison (1942) and Ross and Ricker (1971).

Type locality: Shelby, Virginia. Type at Illinois Natural History Survey.

Range: Apparently collected, as yet, only in Virginia.

21. *Allocapnia vivipara* (Claassen) (fig. 61)

Capnella vivipara Claassen, 1924, Can. Entomol. 56: 46.

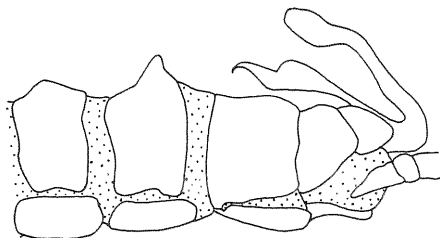


Fig. 61. *Allocapnia vivipara* male, lateral view of posterior abdominal segments (after Frison, 1935).

Length: 4.5-8 mm.

Description: The male process on the 8th tergite is single and pointed, and rises before the posterior edge of the tergite. The male lacks wings and the female ranges from brachyptery to macroptery. The larvae eat decaying leaves and at least 3 species of diatoms. The adults feed on *Protococcus vulgaris*. Males emerge first and then mate with the females very soon after their emergence. Unlike many *Allocapnia*, the female, when carrying eggs, does not curl her abdomen so that the eggs appear uppermost. She crawls into the water to deposit the eggs, varying from 211 to 412. Eggs

hatch in about 19 days but the larvae do not grow appreciably until fall. The adults are active when the air temperature is as low as 20° F. Females can live 3 weeks or more (Frison, 1929). Ross and Ricker (1971) state that this species is often found in streams bearing considerable organic matter, including those with barnyard pollution.

Claassen (1924) claimed that females of this species are ovoviparous, a statement challenged by Frison (1929), who had excellent evidence against it. Claassen (1931) reiterated his claim but Harden and Mickel, writing in 1952, supported Frison. It is possible, of course, that sibling species may be involved.

Further figures of the adult are by Ross and Ricker (1971), Harper and Hynes (1971b), and Frison (1935). The last two works also figure the larva.

Type locality: Lake Forest, Illinois. Type at Cornell University.

Range: Quebec south to Virginia (omitting the New England states) and west to Minnesota and Oklahoma.

22. *Allocapnia wrayi* Ross (fig. 62)

Allocapnia wrayi Ross, 1964, Entomol. News 75: 170.

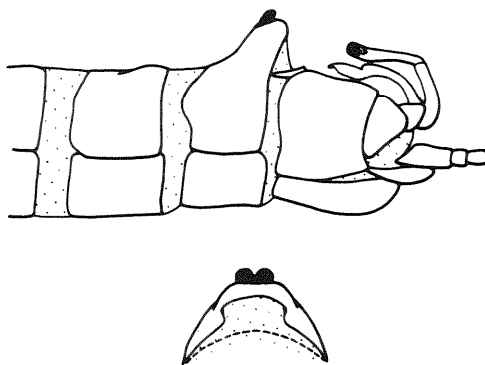


Fig. 62. *Allocapnia wrayi* male, lateral view and cross section of posterior abdominal segment (from Ross and Ricker, 1971).

Length: 5-6.5 mm.

Description: The male of this species appears intermediate between *mystica* and *zekia*. Like those two species, it has a high process on the 8th tergite, ending with a bilobed structure. Unlike *mystica*, the apical segment of the upper arm of its epiproct is as long as the basal segment. Unlike *zekia*, it lacks a large hump on the 7th tergite. The female is indistinguishable from *mystica*. Figures of the adult were given by Ross and Ricker (1971).

Type locality: Richmond, Virginia. Type at Illinois Natural History Survey.

Range: Has been collected from the District of Columbia to Georgia. Ross and Ricker (1971) published a distribution map of this species.

23. *Allocapnia zekia* Ross (fig. 63)

Allocapnia zekia Ross, 1964, Entomol. News 75: 171.

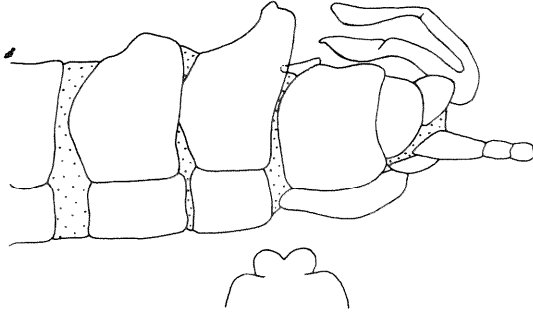


Fig. 63. *Allocapnia zekia* male, lateral view of posterior abdominal segments, including posterior view of the raised areas on the tergite (after Ross, 1964).

Length: 5-6.5 mm.

Description: This species is known only from the male. The 7th tergite lacks a distinct process but the posterior two thirds of the tergite forms a round, prominent hump. The 8th tergite bears a bilobed process similar to that of *mystica*. However, unlike the latter, the apical segment of the upper arm of the epiproct is longer than the basal segment. Ross and Ricker (1971) figured the adult and stated that it may be only a variant of *wrayi*.

Type locality: La Plata, Maryland. Type at Illinois Natural History Survey.

Range: Has been found only in Maryland.

24. *Allocapnia zola* Ricker (fig. 64)

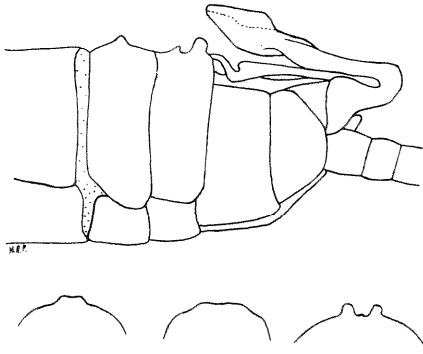


Fig. 64. *Allocapnia zola* male, lateral view of posterior abdominal segments, including posterior view of the raised areas on the tergites.

Allocapnia sola Ricker, 1952, Ind. Univ. Publ. Sci. Ser. 18: 166.

Length: 5.5-6.5 mm.

Description: The male has tergal lobes on abdominal segments 7 and 8. The 8th tergite bears 2 processes, the posterior one in the middle of the segment, the anterior one near the margin. The 7th tergite bears a bilobed process in the middle and a suggestion of another at the anterior edge. The female has the 7th and 8th sternites fused and the 8th produced partway over the 9th. Further figures are by Ricker (1952) and Ross and Ricker (1971).

This is apparently the only *Allocapnia* that has penetrated east of the Hudson River valley yet has not become widely distributed in New England. In Connecticut it has been found only in a very small, clear stream in the northwestern part of the state.

Type locality: Ash Cave, Ohio. Type at Illinois Natural History Survey.

Range: Eastern Tennessee to western New York, with outlying collections from Connecticut and New Brunswick. Ricker (1952) and Ross and Ricker (1971) published a distribution map of this species.

Connecticut records: Hartland, Mar. 21, 1966, Mar 25, 1965 (SWH).

GENUS *Paracapnia* HANSON

Paracapnia Hanson, 1946, Am Midl. Nat. 35: 225, 236

This genus has but 2 species, both found in eastern North America. Superficially it resembles the other Capniidae but, as described by Hanson (1946), it can be distinguished from other genera of that family because the mesothoracic postfurcasternal plate is united with the furcasternum and the spinasternum; the mesofurcasternum and metafurcasternum are transverse and almost rectangular; R_1 of the forewing is bent caudally beyond its base; the apical portion of Cu_1 of the hindwing is generally missing.

Type of genus: *Chloroperla opis* Newman

KEYS TO NORTHEASTERN SPECIES

MALES

1. Epiproct in lateral view strongly angulate at base (fig. 65) 1, *angulata*
Epiproct in lateral view smoothly curved at base (fig. 67) ... 2, *opis*

LARVAE

(from Harper and Hynes, 1971d)

1. Middle and distal segments of cerci each with a long intermediate bristle at ventral base of segment; bristles on inner surface of the tibiae short, half as long as width of the tibia 1, *angulata*
Cercal segments without intermediate bristles; bristles on the inner surface of the tibiae long, as long as width of the tibia 2, *opis*

1. *Paracapnia angulata* Hanson (fig. 65)

Paracapnia angulata Hanson, 1961, Bull. Brooklyn. Entomol. Soc. 56: 29.

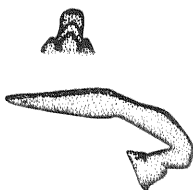


Fig. 65. *Paracapnia angulata* epiproct, with ventral view of posterior margin of epiproct (modified from Hanson, 1961).

Length: 4.0-8.5 mm.

Description: This species is very closely related to *P. opis* and is differentiated only on the basis of the shape of the male epiproct. In dorsal view the epiproct of *angulata* is thicker, whereas that of *opsis* is evenly tapered. The *angulata* epiproct is broadened once in dorsal view and then tapered to the tip but that of *opsis* is enlarged at two different places. The females are indistinguishable. *P. angulata* is sympatric with *P. opis* over much of its range. Figures of adult and larva were published by Harper and Hynes (1971b); of the adult by Hanson (1961).

According to Harper and Hynes (1970), this insect, unlike other winter stoneflies, does not have a larval diapause during the summer.

Type locality: Pelham, Massachusetts. Holotype in Hanson Collection, University of Massachusetts.

Range: Until all previously identified species have been rechecked, no geographic range can be given.

Connecticut records: Haddam, Apr. 3, 7, 1969 (SWH); Mansfield, Mar. 20, 1955, I. Miller (UC); Monroe, Mar. 27, 1938, G. Plumb (CAES); Staffordville, Mar. 23, 1964 (SWH); West Goshen, Apr. 14, 1967 (SWH).

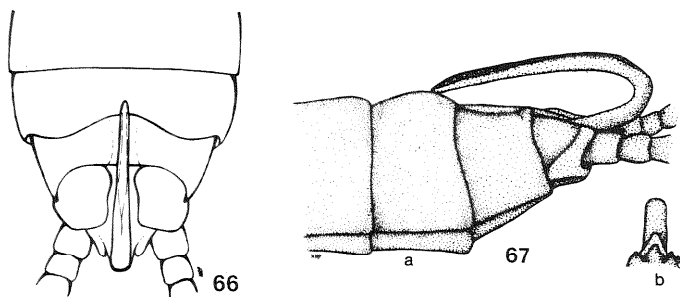
2. *Paracapnia opis* (Newman) (figs. 66, 67)

Chloroperla opis Newman, 1839, Ann. Mag. Nat. Hist. 3: 89.

Paracapnia curvata Hanson, 1946, Am. Midl. Nat. 35: 237.

Length: 4.5-6.5 mm.

Description: This species has had a peculiar history in the taxonomic literature. Originally described in 1839, it remained unrecognized for many years. Needham and Claassen (1925), in their monograph on North American species, passed over the name and redescribed the species under the name *Capnia vernalis* Newport. Ricker (1938), after examining the type specimens, determined that Needham and Claassen's *vernalis* = Newman's *opsis*, and that the true *vernalis* Newport was an entirely different species. Hanson (1946) then described a new species, *curvata*, as distinguished from *opsis* as used by Frison (1942). Finally, Hanson (1961), on re-examining the



Paracapnia opis male

Fig. 66. Dorsal view of posterior abdominal segments.

Fig. 67. a, Lateral view of posterior abdominal segments; b, ventral view of posterior margin of epiproct.

types of *opis* Newman, decided that *curvata* = *opis* and that what had been called *opis* in this country was therefore without a name. Subsequently, he renamed *opis auctores* as *angulata* Hanson.

P. opis can be distinguished only in the male, by means of the posterior extension and basal curve of the epiproct. It follows *Allocapnia* phenologically, emerging in March and April. Harden and Mickel (1952) and Harper and Hynes (1971b) published figures of the larva.

In Quebec, the small larvae of this species were first found during the last part of June. Growth was slow until the fall, when the size increased rapidly until February. There was little further growth until emergence as adults in April. Probably the females are long lived, as ovipositing females were present from the last of April to early June (Harper and Magnin, 1969).

Type locality: Chuston (?) Newfoundland. Type in University Museum, Oxford, England.

Range: As this species was not clearly differentiated from *angulata* until 1961, no definite geographic range can yet be given.

Connecticut records: Brooklyn, Mar. 19, 1964 (SWH); Eastford, Mar. 28, 1963 (SWH); East Willington, Apr. 28, 1963 (SWH); Gurleyville, Mar. 17, 1959 (SWH); Harwinton, Apr. 1, 1959 (SWH); Mansfield, Mar. 25, 1963 (SWH); Melrose, May 21, 1957, Grant (UC); Montville, Mar. 2, 1964 (SWH); Storrs, Apr. 4, 1959 (UC); Warrenville, Mar. 28, 1963 (SWH); Woodstock, Mar. 28, 1963 (SWH).

GENUS *Nemocapnia* BANKS

As with other Capniidae, the present generic differentiation is the result of Hanson's (1946) studies. *Nemocapnia* is distinguished by the following characteristics: its presternum is united to the basisternum on each thoracic sternite, its mesothoracic postfurcasternum is large and united to the spinasternum and furcasternum, vein A_1 of the forewing is slightly bent just beyond the origin, and there is no costal crossvein beyond Sc in the

forewing.

There is only 1 North American species.

Type of genus: *Nemocapnia carolina* Banks.

1. *Nemocapnia carolina* Banks (figs. 13, 68)

Nemocapnia carolina Banks, 1938, Psyche J. Entomol. 45: 74.

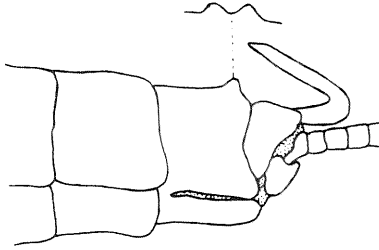


Fig. 68. *Nemocapnia carolina* male, lateral view of posterior abdominal segments, with posterior view of projection on 9th tergite (from Harper and Hynes, 1971).

Length: About 7 mm.

Description: As this is the only species found in North America, the generic characters serve to identify it. The male has a unipartite epiproct and lacks a ventral lobe on the 9th sternite. The female subgenital plate is slightly rounded but set before the hind margin of the sternite. The adults emerge in early spring. Figures of adults and larvae have been published by Frison (1942) and Harper and Hynes (1971b).

Type locality: Morgantown, North Carolina. Type in Museum of Comparative Zoology, Harvard University.

Range: Quebec to North Carolina and west to Illinois and Arkansas; apparently does not occur in New England.

FAMILY LEUCTRIDAE

These small stoneflies occur in North America, Eurasia, and northern Africa. The wings are rolled around the body at rest, cu-m and intercubital crossveins of forewing are present, in most genera the media of the hindwing is simple and the cubitus forked. There are no gills. The adult cerci are single segmented and simple in most genera. The male epiproct is generally inconspicuous. Ricker and Ross (1969) have made a comparative study of the genitalic parts of the various leuctrid genera. They state that the leuctrids are peculiar in having a long median process or subanal probe between the paraprocts. In the genera under consideration here, *Paraleuctra* demonstrates this most clearly, with the median process bending posteriorly and then recurving (fig. 90b). The paraprocts have been reduced

in this genus to suspensory bars on each side of the median process. In *Leuctra*, the median process has divided into 2 broadened specilla (the "sub-anal lobes" of Needham and Claassen, 1925) and the paraprocts have become narrow and elongate (the "titillators" of Needham and Claassen, 1925). In figure 9, *pp* would represent the specillum and *t* the paraproct (=titillator) for this genus. In *Zealeuctra*, the paraprocts and median processes are fused together for much of their length.

The Leuctridae has been divided into various groups, some of which have generic status, some only subgeneric. The considerable differences in morphology necessitate a greater division than has usually been accorded. I have here followed Ricker and Ross (1969) for the Northeastern species, considering *Paraleuctra* and *Zealeuctra* to be separate genera, although a possible alternative is to consider *Zealeuctra* a subgenus of *Paraleuctra*. The phylogeny of the generic groups within this family has been discussed by Raušer (1962), Berthélemy (1969) and Ricker and Ross (1969). Hitchcock (1969) keyed the males of Northeastern *Leuctra s.s.*

GENUS *Leuctra* STEPHENS

Leuctra Stephens, 1835, *Illust. Br. Entomol.* 6: 144.

These are small, brownish, inconspicuous stoneflies that may, at times, be exceedingly numerous. Generally they seem to favor the smaller, slower streams and are among the few adult stoneflies that are found from spring until autumn. The adults are characterized by glossae subequal in size to the paraglossae; no slanting crossvein beyond the costa, cerci of 1 segment, wings rolled around the body when at rest, and Rs and M of forewing originating at different points on the radius. It is separated from the closely related *Paraleuctra* and *Zealeuctra* by having the m-cu crossvein of the hindwing proximal to the dichotomy of Cu₁. In most species the prothoracic basisternum has no line of division from the presternum but is separate from the furcasternum (fig. 16). The male cerci are unmodified.

Specific differentiation is usually based on the shape and number of processes of the male 7th and 8th tergites. These differences are not always clear cut and there may be some additional synonymy involved when collections are made from the intervening areas between type localities.

Proposed type of genus: *Phryganea fusca* L. This species has been proposed as the type of the genus (*Bull. Zool. Nomen.* 22[2]: 108-109) but by March 1973 the International Commission had taken no action on the matter.

KEYS TO NORTHEASTERN SPECIES

MALES⁶

1. Processes on both tergites 7 and 8 or on neither (figs. 70-72, 75) ... 2
- Process on either tergite 7 or 8 but not on both 4

⁶Male of *baddecka* not known.

2. No process on either tergite 7 or 8; or a single, rounded barely raised process on each segment (figs. 71, 72) 3, *ferruginea*
Processes on both tergites 7 and 8; that on 8 either bi- or trilobed (figs. 70, 76) 3
3. Process bilobed on both tergites 7 and 8 (fig. 70) 2, *duplicata*
Process trilobed on tergite 8; single, rounded, and barely raised on 7 (figs. 75, 76) 4, *laura*
4. Process on tergite 7 only (figs. 82, 84) 5
Process on tergite 8 only (figs. 81, 88) 9
5. Process on tergite 7 distinctly trilobed (figs. 86, 89a) 6
Process on tergite 7 not trilobed (figs. 83, 85, 89b) 7
6. No spines on apices of specilla; paraprocts slightly curved or straight 11, *variabilis*
Specilla finely spinulate apically; paraprocts well curved . . . 9, *triloba*
7. Process of tergite 7 reaching anterior margin of tergite 8 (figs. 85, 89) 8
Process of tergite 7 not reaching more than halfway across tergite 7 (figs. 83a, b) 7, *tenella*
8. Sclerotized process long, extending out over tergite 8; vesicle longer than wide (fig. 84) 8, *tenuis*
Sclerotized process not extending over tergite 8; vesicle as wide as long (fig. 89) 11, *variabilis*
9. Tergite 8 with a single process (figs. 87, 88) 10
Tergite 8 with 2 processes or a single bifurcate or trifurcate one (figs. 79, 81) 11
10. Process truncate (fig. 88) 10, *truncata*
Process rounded and barely raised (fig. 72) 3, *ferruginea*
11. Tergite 8 with trifurcate process (if it is questionably trifurcate, with lateral lobes rounded, go to Couplet 12) (fig. 76) 4, *laura*
Tergite 8 with 2 processes or single bifurcate one 12
12. Process on tergite 8 with 2 slender processes widely separate and several times as long as wide (fig. 81); specilla without trough 6, *sibleyi*
Process of tergite 8 with 2 lobes close together; trough in specilla (fig. 79) 5, *maria*

LARVAE⁷

(from Harper and Hynes, 1971a)

1. Whorls of bristles on cercal segments bushy 6, *sibleyi*
Whorls with fewer bristles 2

⁷Larvae of *laura*, *triloba*, and *variabilis* not known.

2. In side view, all abdominal tergites covered with short, stout bristles 4
 Only the last 3 or 4 abdominal tergites with short, stout bristles ... 3
3. Anterolateral angles of mesonotum with many short, stout bristles 7, *tenella*
 Few very short, stout bristles on anterolateral angles of mesonotum;
 late-summer species 10, *truncata*
4. As seen in profile, some abdominal sternites, at least the 9th, bear
 short, stout bristles 5
 No stout bristles on abdominal tergites; however, a few long bristles
 on posterior margins of last segments 3, *ferruginea*
5. Short, stout bristles on nearly all sternites, at least on sternites 4-9
 6
 Short, stout bristles numerous only on sternite 9, although there may
 be a few on preceding sternites 8, *tenuis*
6. Pronotum with many short bristles on margin; no long bristle on an-
 terior angle; a few short, stout bristles at base of anterior margin
 of fore wing-pad 2, *duplicata*
 Pronotum with at least 1 long bristle on anterior angle; no short,
 stout bristles at base of anterior margin of fore wing-pad
 5, *maria*

1. *Leuctra baddecka* Ricker (fig. 69)

Leuctra baddecka Ricker, 1965, J. Fish. Res. Bd. Can. 22: 493.

Length: 8.5-10 mm.

Description: This species, known only from the female, bears an abdominal sclerotized stripe similar to that of the *Paraleuctra* but otherwise would seem to belong to the *Leuctra*. The subgenital plate is broadly produced, with a medial notch and is emarginate on each side of the notch. Ricker (1965) illustrated the female.

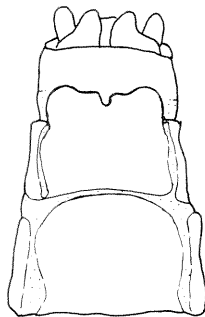


Fig. 69. *Leuctra baddecka* female, ventral view of posterior abdominal segments (after Ricker, 1952).

Type locality: Baddeck Forks, Nova Scotia. Type in Canadian National Collection, Ottawa.

Range: Found only at the type locality.

2. *Leuctra (Leuctra) duplicata* Claassen (fig. 70)

Leuctra duplicata Claassen, 1923, Can. Entomol. 55: 260.

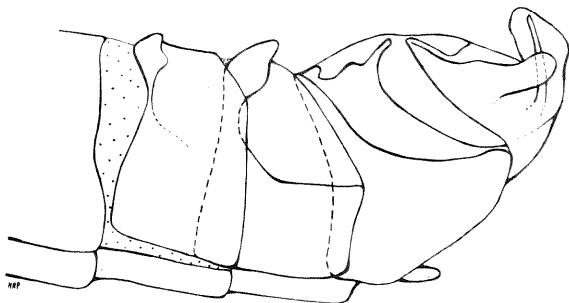


Fig. 70. *Leuctra duplicata* male, lateral view of posterior abdominal segments.

Length: 6-9 mm.

Description: This species is easily distinguished from other eastern *Leuctra* because *duplicata* is the only species whose males have bilobed raised processes on both tergites 7 and 8. The female is also distinctive because of a raised tubercle just anterior to the genital opening. Further figures of the adult genitalia were given by Needham and Claassen (1925), of the larva by Harper and Hynes (1971a).

In Connecticut, I have found it in muddy, slow-moving streams in swamps, as well as in clear little brooks in wooded areas.

Type locality: Labrador Lake, New York. Type at Cornell University.

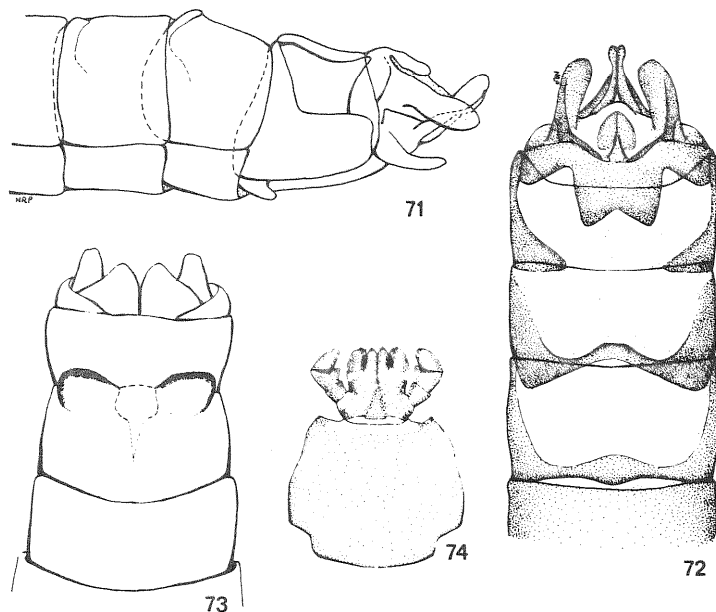
Range: Quebec and Ontario south to New York and southern New England.

Connecticut records: Bethany, May 19, 1959 (SWH); Beacon Falls, May 17, 1961 (SWH); Branford, May 10, 1951, J. Kring; Canaan, June 19, 1968 (SWH); East Hartland, May 14, 1966 (SWH); Granby, June 7, 1962 (SWH); Griswold, June 14, 1967 (SWH); Guilford, June 28, 1967 (SWH); Killingworth, May 21-28, 1965, D. Leonard; Lyme, May 17, 1965 (SWH); Madison, June 18, 1965 (SWH); Newtown, May 21, 1962 (SWH); North Plain, May 20, 1933, S. Ball (YU); Plymouth, May 19, 1961 (SWH); Salem, May 29, 1967 (SWH); Stafford, June 9, 1966 (SWH); Sterling, June 1, 1960 (SWH); Storrs, May 11, 1954, W. Davis (UC), June 8-18, 1954, J. Slater (UC); Thomaston, May 5-26, 1961 (SWH); Union, June 9, 1966 (SWH); Voluntown, June 14, 1967 (SWH); Wolcott, May 14, 1969 (SWH); Woodbridge, May 12, 1949, May 27, 1950, C. Remington (YU); Woodstock, June 9, 1966 (SWH).

3. *Leuctra (Leuctra) ferruginea* (Walker) (figs. 16, 31, 71-74)

Nemoura ferruginea Walker, 1852, Cat. neur. Br. Mus. 183.

Leuctra decepta Claassen, 1923, Can. Entomol. 55: 260.



Leuctra ferruginea

Fig. 71. Male, lateral view of posterior abdominal segments.

Fig. 72. Male, dorsal view of posterior abdominal segments.

Fig. 73. Female, ventral view of posterior abdominal segments.

Fig. 74. Adult labium.

Length: 6-8.5 mm.

Description: The synonym aptly describes this species, as the male is variable in appearance. Generally it has a small process on the anterior margin of the 8th abdominal tergite but in some individuals it appears to be missing. In occasional specimens, the 7th tergite also has a dark sclerotization that resembles a process but is not raised. The female subgenital plate is produced into 2 rounded lobes, separated by a membranous area extending anteriorly onto the 8th sternite. Figures of the adult (under *decepta*) were given by Needham and Claassen (1925), Ricker (1938), and Frison (1942); and of the larva by Claassen (1931) and Harper and Hynes (1971a).

Frison (1942) stated that the larvae show the delicate anal gills that he figured in 1935 for *claasseni* but, as discussed under that species, it is possible that these are fungal growths rather than gills. *L. ferruginea* has been taken from late April to fall; it is sometimes attracted to lights.

Type locality: Nova Scotia. Type in the British Museum.

Range: Unusually broad: from Quebec and the Maritimes south to Florida and west to Minnesota and Illinois.

Connecticut records: Bethany, June 5, 1961 (SWH); June 26, 1969, V. Nelson; Canaan, June 19, 1968, Aug. 31, 1962 (SWH); Chester, June 18, 1965 (SWH); Eastford, June 9, 1966 (SWH); Easton, May 27, 1968, Sept. 1-9, 1964 (SWH); Glastonbury, Apr. 22, 1959 (SWH); Granby, June 7, 1962 (SWH); Hamden, Oct. 26, 1951, S. Ball (YU); Harwinton, June 4, 1965 (SWH); Killingworth, June 18, 1965 (SWH); Lebanon, June 12, 1959 (SWH); Madison, June 18, 1965 (SWH); Naugatuck, June 3, 1969 (SWH); North Guilford, August 17, 1960 (SWH); North Haven, at light, June 24, 1953, C. Remington (YU); North Madison, June 18, 1965 (SWH); North Plain, Apr. 20, 1935, S. Ball (YU); Portland, May 23, 1963 (SWH); Sterling, June 11, 1959 (SWH); Storrs, at light, Sept. 24, 1959, M. Sweet (UC); Voluntown, June 14, 1967 (SWH); Washington, at light, Sept. 24, 1961, S. Hessel (YU).

4. *Leuctra (Leuctra) laura* Hitchcock (figs. 75-77)

Leuctra laura Hitchcock, 1969, Entomol. News 80: 313.

Length: about 8.5 mm.

Description: The male has a trifurcate process on the 8th abdominal tergite. The 2 lateral points are raised, whereas the center one is not. The 7th tergite bears a single rounded, sclerotized area that is barely raised above the surface of the segment. The female is unknown, although Hitchcock (1969) illustrated the possible female of this species, a specimen swept from the shore of a rapid, rocky stream.

Type locality: Cutler's Brook, Tuckerman's Ravine, Mt. Washington, New Hampshire. Type in United States National Museum.

Range: Has been found only in the type locality.

5. *Leuctra (Leuctra) maria* Hanson (figs. 78, 79)

Leuctra maria Hanson, 1941, Am. Midl. Nat. 26: 174.

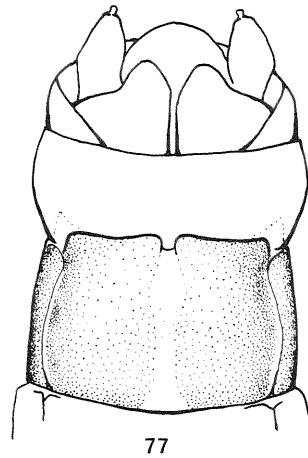
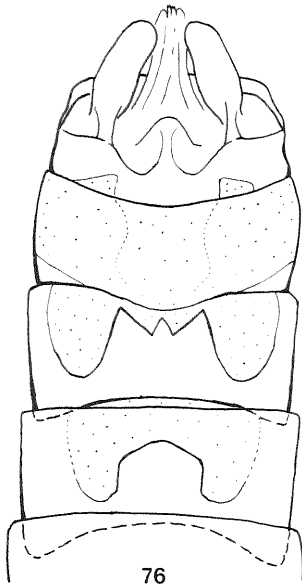
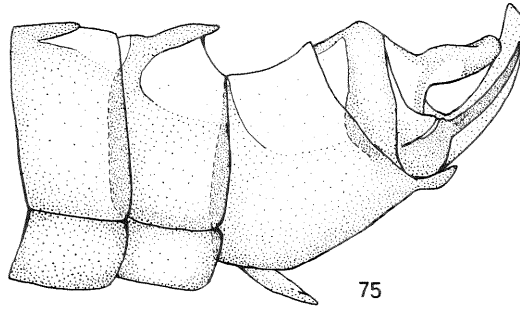
Length: 6-9 mm.

Description: Males of this species are distinctive in having the specilla grooved into a trough. This occurs in no other North American *Leuctra*. The 8th tergite has a short, bilobed process. The female is less distinctive but has a median hump on the 8th sternite and a bilobed subgenital plate (Ricker, 1952) somewhat like that of *L. duplicata* but with more widely separated lobes. Hanson (1941) and Ricker (1952) have figured the adult and Harper and Hynes (1971a) the larva.

This species has been rarely collected, so it may be of interest to add records from Jefferson, New Hampshire, June 21, 1965 (A. H. Mason and W. J. Morse, University of New Hampshire collection), and Londonderry, Vermont, June 21, 1965 (SWH).

Type locality: Barrington, New Hampshire. Type in Hanson collection, University of Massachusetts.

Range: Has been recorded from northern New England, Quebec, and Ontario.



Leuctra laura

Fig. 75. Male, lateral view of posterior abdominal segments.

Fig. 76. Male, dorsal view of posterior abdominal segments.

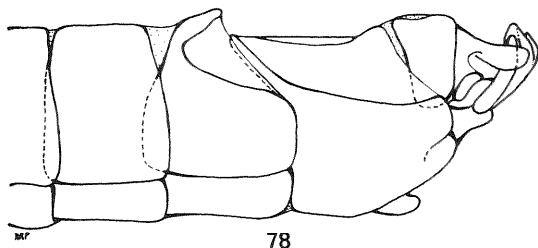
Fig. 77. Probable female of this species, ventral view of posterior abdominal segments.

6. *Leuctra (Leuctra) sibleyi* Claassen (figs. 80, 81)

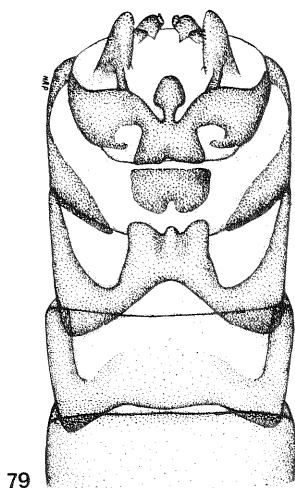
Leuctra sibleyi Claassen, 1923, Can. Entomol. 55: 262

Length: 8-11 mm.

Description: The male 8th tergite bears 2 elongate, broadly separate processes. There seems to be some variation in the length of the lobes. In a few individuals, the sclerotized area between the lobes is expanded posteriorly, thus giving the lobes



78



79

Leuctra maria male: posterior abdominal segments

Fig. 78. Lateral view.

Fig. 79. Dorsal view.

a shorter appearance and, in some cases, suggesting a small median lobe between them. The female subgenital plate is somewhat produced into 2 lobes with a notch between. In some individuals, a lighter membranous area extends slightly anterior of the notch. This is one of the larger and lighter colored *Leuctra*. Further figures are by Ricker (1965) and Harper and Hynes (1971a). The adult emergence pattern was graphed by Harper and Pilon (1970).

Type locality: Moore's Brook, Ithaca, New York. Type at Cornell University.

Range: The Maritimes to southern New England and west to Ontario and New York.

Connecticut records: Barkhamsted, May 20, 1960 (SWH); Bethany, May 31, 1962 (SWH); Canton, May 20, 1960 (SWH); Cheshire, May 21, 1959 (SWH); North Granby, June 1, 1967 (SWH); Woodbridge, June 2, 1950, C. Remington (YU).

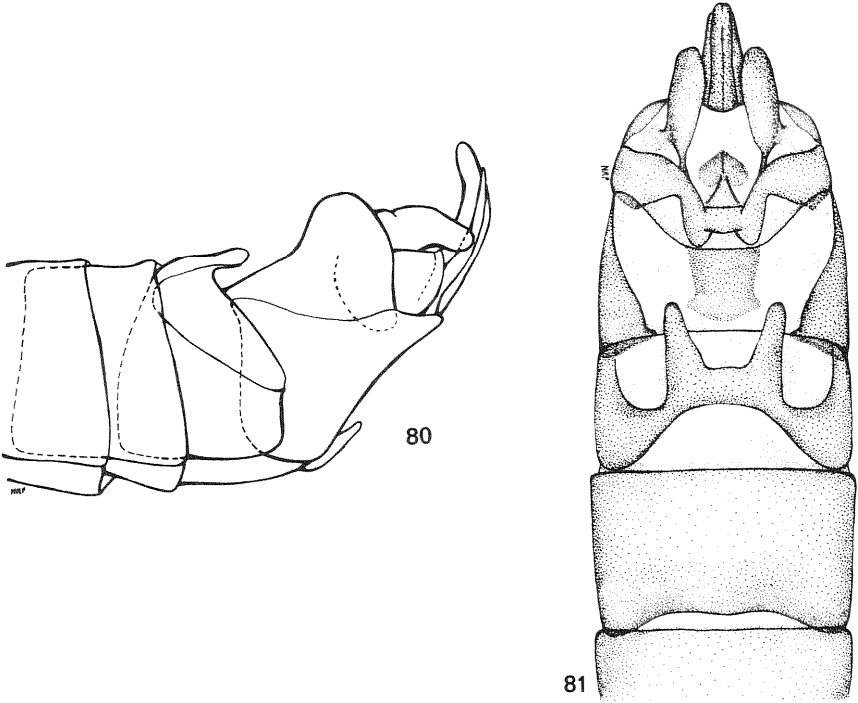
7. *Leuctra (Leuctra) tenella* Provancher (figs. 82, 83)

Leuctra tenella Provancher, 1876, Nat. Can. 8: 218.

Leuctra hamula Claassen, 1923, Can. Entomol. 55: 261.

Length: 6.5-9 mm.

Description: The male bears a bluntly pointed process on the 7th tergite. This process is variable in dorsal view, in some individuals approaching the suggestion of a trilobed condition and in some the sides are impressed. The female subgenital plate is produced into 2 lobes with a narrow notch between them. The adult was illustrated by Needham and Claassen (1925) under the name *hamula* and the larva by Harper



Leuctra sibleyi male: posterior abdominal segments

Fig. 80. Lateral view.

Fig. 81 Dorsal view.

and Hynes (1971a). Harper and Pilon (1970) graphed the adult emergence pattern and found that, unlike most stoneflies, the females can emerge earlier than the males at the start of the emergence period.

Type locality: Near Quebec City, Quebec. Type in Provancher Collection, Quebec Provincial Museum, Quebec City.

Range: Labrador south to New Jersey and West to Minnesota.

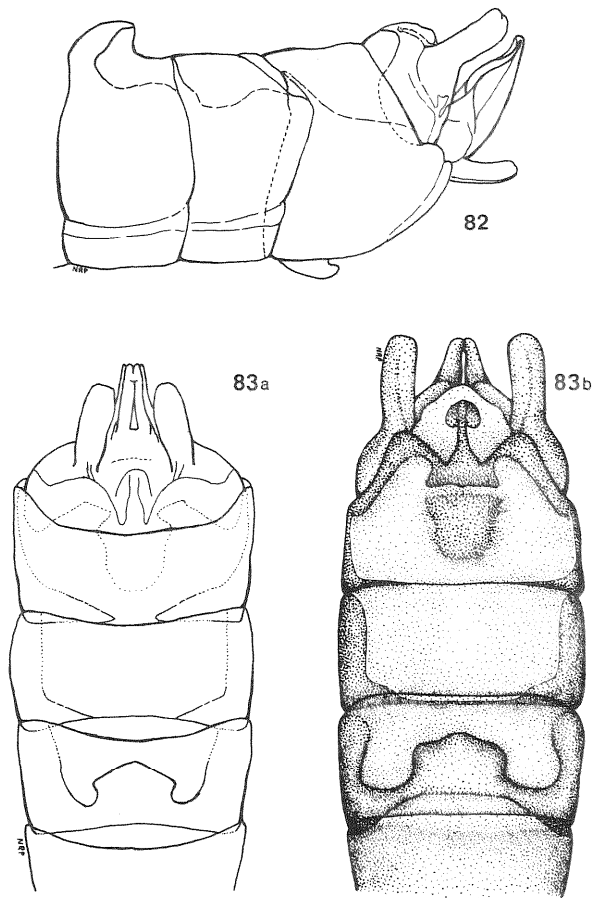
Connecticut records: Bethany, June 26, 1969, V. Nelson; Beacon Falls, May 17, 1961 (SWH); Granby, June 2, 1965 (SWH); Newtown, May 21, 1962 (SWH); Shelton, June 19, 1962 (SWH); Sterling, June 14, 1967 (SWH); Voluntown, June 14, 1967 (SWH).

8. *Leuctra (Leuctra) tenuis* (Pictet) (figs. 84, 85)

Nemoura tenuis Pictet, 1841, Perlides: 375.

Length: 6.5-8 mm.

Description: The male 7th abdominal tergite bears an elongate truncate process that projects part way onto the 8th tergite. The female subgenital plate is slightly

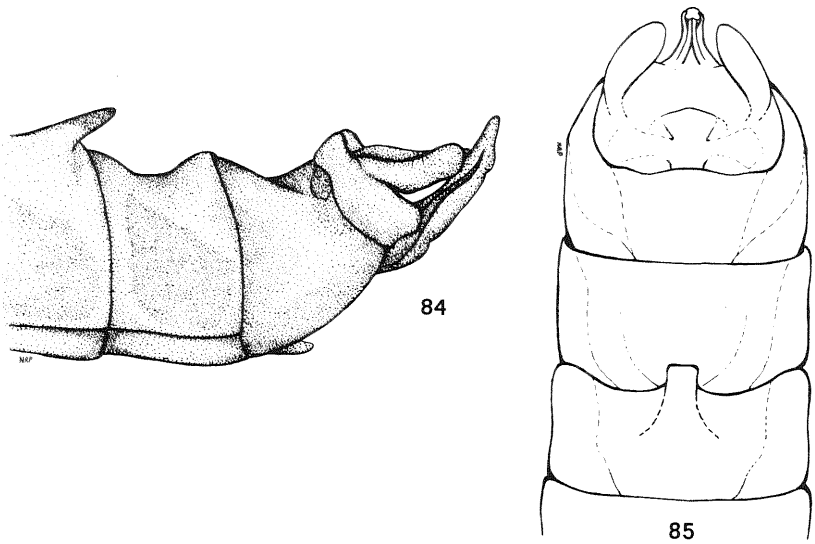


Leuctra tenella male, posterior abdominal segments
 Fig. 82. Lateral view.
 Fig. 83. Dorsal views; a and b show variations in the dorsal lobe.

produced into 2 lobes separated by a notch and a membranous area. Frison (1942) and Needham and Claassen (1925) figured the adult genitalia. However, the female figure in the latter work appears to be *ferruginea* rather than *tenella*. Harper and Hynes (1971a) figured the larva. Harper and Pilon (1970) graphed the adult emergence pattern.

Frison (1942) stated that this species, like *claasseni* and *ferruginea*, has delicate anal gills but as mentioned above, I believe these to be fungal growths rather than gills. This is one of the few species of stonefly that appears as an adult in late summer and fall.

Although Slosson (1895) captured a specimen of *tenella* at the summit of Mt.



Leuctra tenuis male, posterior abdominal segments

Fig. 84. Lateral view.

Fig. 85. Dorsal view.

Washington, the small amount of water available there probably does not provide a breeding area. I have found *L. tenella* on the lower forested slopes of Mt. Washington and it would seem likely that *tenuis* would be found in the same places. Although Needham (1901) did not observe that this species flies, most *Leuctra* do fly readily and I have captured them half a mile from the nearest stream. The strong winds on Mt. Washington could easily carry specimens to the summit, where Mrs. Slosson made her collections (Hitchcock, 1969).

Type locality: Philadelphia, Pennsylvania. Type in the Berlin Museum.

Range: The Maritimes south to New Jersey and west to Minnesota and Missouri.

Connecticut records: Easton, July 8-21, 1965, Aug. 4, Sept. 9, 1964 (SWH); Stafford, Aug. 7, 1968 (SWH); Sterling, Aug. 19, 1959 (SWH); Voluntown, June 14, 1967 (SWH); Washington, at light, Sept. 19, 1961, S. Hessel (YU); Waterford, Aug. 5, 1960 (SWH).

9. *Leuctra (Leuctra) triloba* Claassen (fig. 86)

Leuctra triloba Claassen, 1923, Can. Entomol. 55: 263.

Leuctra crosbyi Claassen, 1937, J. Kans. Entomol. Soc. 10: 45.

Length: 6.5-8 mm.

Description: The male bears a trilobed process on the 7th abdominal tergite that, in many individuals, extends over the anterior part of the 8th. The female subgenital plate is produced into 2 lobes, separated by a narrow membranous notch. This is another late summer and fall species. It was illustrated by Needham and Claassen (1925).

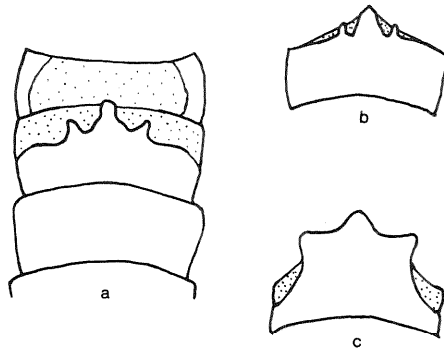


Fig. 86. *Leuctra triloba* male, dorsal view of posterior abdominal segments; a, b, and c show variations in the dorsal lobe.

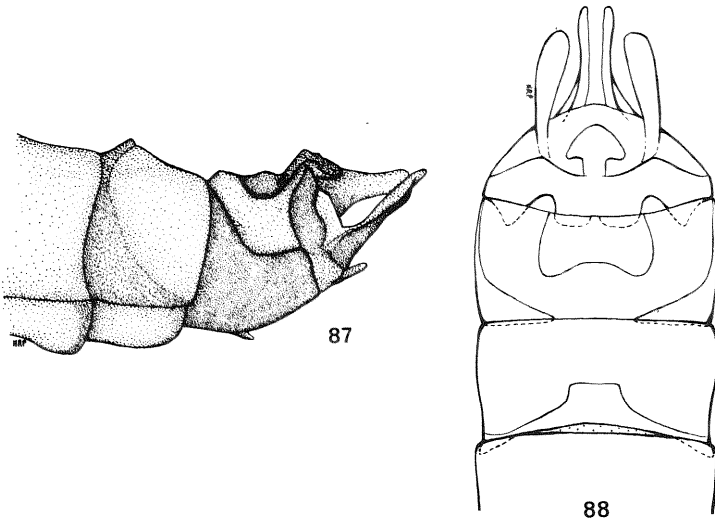
Type locality: McLean, New York. Type at Cornell University.

Range: This uncommon species apparently ranges from Quebec south to Florida.

10. *Leuctra (Leuctra) truncata* Claassen (figs. 87, 88)

Leuctra truncata Claassen, 1923, Can. Entomol. 55: 263.

Length: 6.5-9 mm.



Leuctra truncata male, posterior abdominal segments

Fig. 87. Lateral view.

Fig. 88. Dorsal view.

The male 8th abdominal tergite bears a single truncate process that reaches only part way across it. The female subgenital plate is somewhat produced, with a notch between the lobes. It was illustrated by Needham and Claassen (1925). Harper and Hynes (1971a) illustrated the larva. The adult emergence pattern was graphed by Harper and Pilon (1970).

This species appears to be very close to some variations of *ferruginea* and may be conspecific with it. However, in most *truncata* individuals the process of the 8th segment is raised and more obvious than in *ferruginea*.

Type locality: Old Forge, New York. Type at Cornell University.

Range: Quebec to southern New England and west to New York.

Connecticut records: Bethany, Apr. 14, 1960 (SWH); Granby, June 7, 1962 (SWH); Killingworth, June 18, 1965 (SWH); Stafford, June 9, 1966 (SWH).

11. *Leuctra (Leuctra) variabilis* Hanson (fig. 89)

Leuctra variabilis Hanson, 1941, Bull. Brooklyn, Entomol. Soc. 36: 62.

Length: 7-9 mm.

Description: The male 7th abdominal tergite bears a process that is truncate in most individuals but rounded or slightly trilobed in a few. The female subgenital plate is somewhat produced into 2 lobes that slightly converge apically and have a narrow, shallow notch between them. Hanson (1941) figured the adult genitalia,

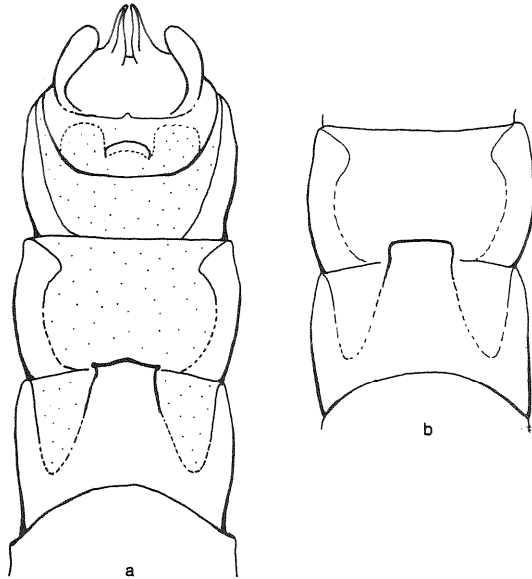


Fig. 89. *Leuctra variabilis* male, dorsal views of posterior abdominal segments; a and b show variations in the dorsal lobe (b is drawn from the paratype).

wings, prothoracic sternum, and larval labium.

This species has been captured above timberline at the outlet to Lakes of the Clouds on Mt. Washington, as well as farther south in Massachusetts. It is an autumn species, having been collected from late August to late November.

Type locality: Sunderland, Massachusetts. Type in Hanson Collection, University of Massachusetts.

Range: Has been collected in New Hampshire, Vermont, Massachusetts, and Virginia.

GENUS *Paraleuctra* HANSON

Paraleuctra Hanson, 1941, Bull. Brooklyn Entomol. Soc. 36: 57

This genus is closely related to *Leuctra* and is separated from other genera in the Plecoptera by means of the characters listed under that genus. It differs from *Leuctra*, however, in having the m-cu crossvein reach Cu_1 after it has divided and, in most species, by having the prothoracic basisternum partially or completely separated from the presternum and united to the furcasternum (fig. 17). The male cerci are heavily sclerotized and modified, with various projections. The dorsum of the female has a longitudinal sclerotized stripe bordered on each side by a membranous longitudinal stripe (fig. 93).

Type of genus: *Leuctra occidentalis* Banks.

1. *Paraleuctra sara* (Claassen) (figs. 6, 17, 30, 90-93)

Leuctra sara Claassen, 1937, J. Kans. Entomol. Soc. 10: 44.

Length: 7-10.5 mm.

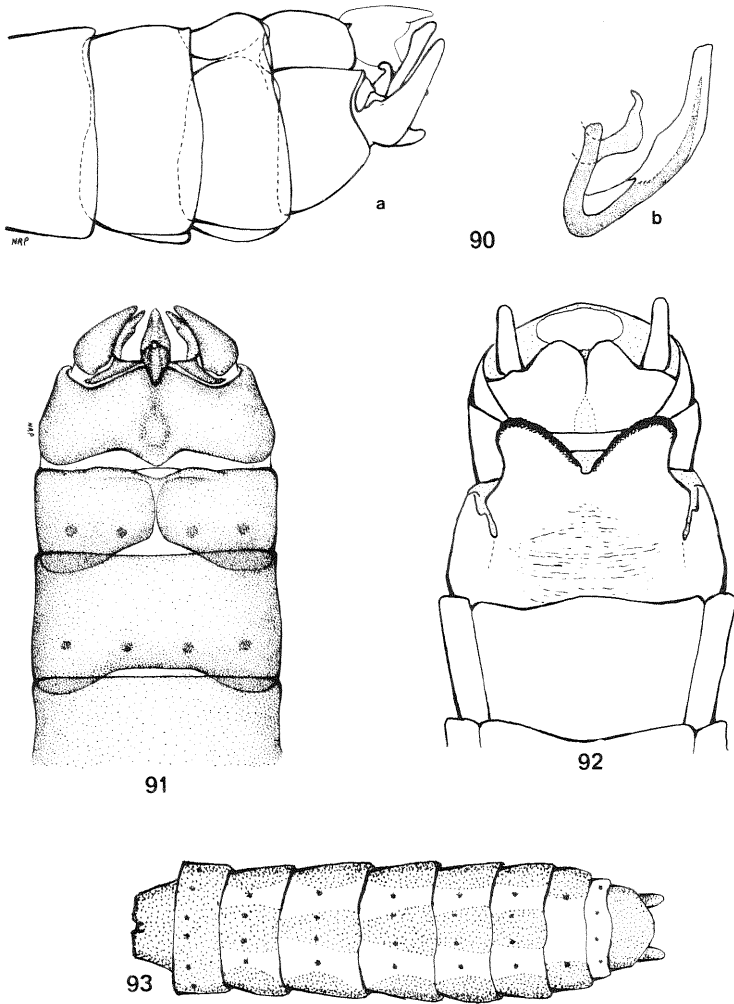
Description: The male is distinctive among eastern species of Leutridae in having a strongly sclerotized, 2-pronged cercus. Each prong bears a smaller process half-way down its length, although the process on the lower prong is on the inner edge of the cercus and somewhat difficult to see. The epiproct is recurved, the specilla project anteriorly beneath the cerci before recurving from behind the 9th sternite into a long, fused process that reaches over the epiproct. The female subgenital plate is produced into 2 lobes with a broad notch between. Claassen (1937) and Hanson (1962) illustrated the adult. Hanson (1941) figured the adult prosternum and wings and the larval labium and terminalis; Harper and Hynes (1971a) various larval parts.

There was some question as to whether the eastern *sara* has a transcontinental distribution until Hanson's (1962) paper clearly differentiated the eastern and western species.

Type locality: Ringwood Lloyd Preserve near Ithaca, New York. Type at Cornell University.

Range: Quebec and New England south to Virginia and west to Ontario and New York.

Connecticut records: East Hampton, Mar. 26, 1965, C. Remington (YU).



Paraleuctra sara

Fig. 90. Male: a, lateral view of posterior abdominal segments; b, lateral view of epiproct (to the left) and median process (to the right).

Fig. 91. Male, dorsal view of posterior abdominal segments.

Fig. 92. Female, ventral view of posterior abdominal segments.

Fig. 93. Female abdomen, dorsal view.

GENUS *Zealeuctra* RICKER

Zealeuctra Ricker, 1952, Ind. Univ. Pub. Sci. Ser. 18: 173.

This genus is separated from the closely related *Paraleuctra* by the

broad depression on the 9th tergite of the male (figs. 98, 100) and by the shape of the paraprocts (fig. 94). The female lacks dorsal sclerotization on the abdomen and (except in *Z. warreni*) bears a median lobe on the 7th sternite.

Type of genus: *Leuctra claasseni* Frison.

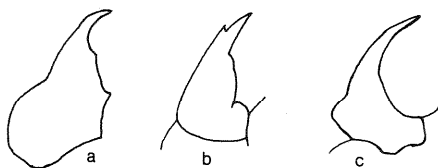


Fig. 94. *Zealeuctra* male epiprocts: a, *claasseni*; b, *fraxina*; c, *narfi* (after Ricker and Ross, 1969).

KEY TO NORTHEASTERN SPECIES
(from Ricker and Ross, 1969)

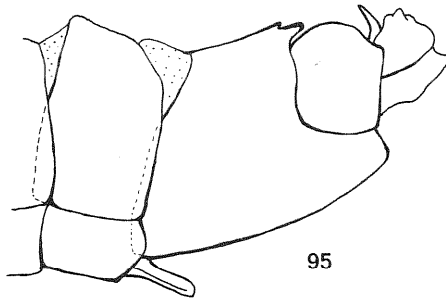
1. Male epiproct terminating in simple tapered cusp (figs. 94a,c); female 7th sternite with hind margin straight (except for median lobe)—an area of reduced sclerotization can mask the straightness (fig. 97) 2
- Male epiproct with secondary cusp near tip of main cusp (fig. 94b); female 7th sternite with hind margin notched to contain median lobe (fig. 99) 2, *fraxina*
2. Mesal margin of male central depression of 9th tergite minutely and irregularly serrate anterior to subterminal spine (fig. 96); base of epiproct rounded and as long as wide (fig. 94a); female median lobe of 7th sternite thick, white, and as broad as long in most specimens; posterior marginal hairs of 7th sternite numerous and long 1, *claasseni*
- Mesal margin of male central depression of 9th tergite smooth except for rounded terminal and subterminal projections (fig. 100); base of epiproct half as long as wide (fig. 94c); female median lobe of 7th sternite brown, about twice as broad as long; posterior marginal hairs few and short 3, *narfi*

1. *Zealeuctra claasseni* (Frison) (figs. 94a, 95-97)

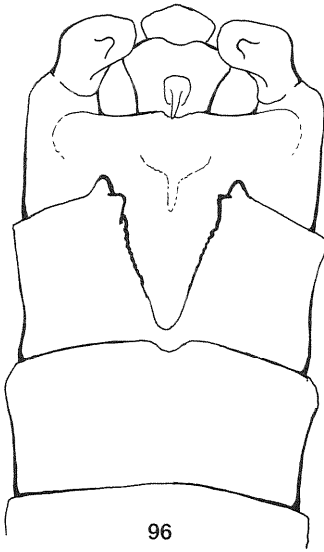
Leuctra claassenia Frison, 1929, Ill. Nat. Hist. Sur. Bull. 18: 404.

Length: 8-10 mm.

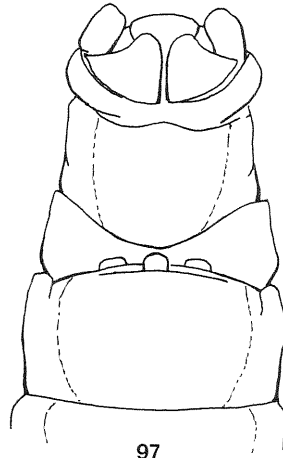
Description: The male 9th tergite has a longitudinally depressed area open to the rear; this cleft is bordered by sclerotized teethlike projections, terminating in a conspicuous projection on each side. The male epiproct has a single sharp tooth on a broadly rounded base. Each cercus has a rounded hump on the upper side. The



95



96



97

Zealeuctra claasseni, posterior abdominal segments

Fig. 95. Male, lateral view.

Fig. 96. Male, dorsal view.

Fig. 97. Female, ventral view.

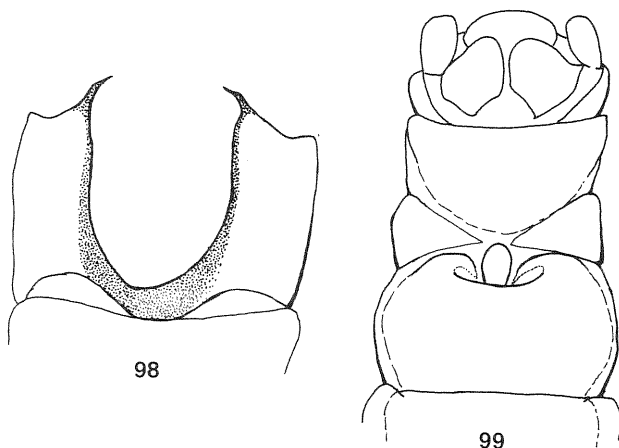
paraprocts are broad. The female subgenital plate is not produced but there is a median lobe on the posterior membrane of the 7th sternite. Illustrations of adults were given by Frison (1942) and Ricker and Ross (1969).

Z. claasseni emerges early in the spring (Frison, 1935) and can be found even in streams that dry up in midsummer (Ricker, 1952). Frison (1929) examined the gut of one larva and found it to contain decaying vegetation. The larvae have been figured with delicate anal gills (Frison, 1935) but, as similar structures have been observed in larvae of other genera, I believe them to be a fungal growth rather than gills.

Type locality : Bushy Fork, Herod, Illinois. Type at Illinois Natural History Survey.
Range : West Virginia to Missouri and Oklahoma.

2. *Zealeuctra fraxina* Ricker and Ross (figs. 94b, 98, 99)

Zealeuctra fraxina Ricker and Ross, 1969, Can. J. Zool. 47 : 1117.



Zealeuctra fraxina (after Ricker and Ross, 1969)
Fig. 98. Male 9th tergite.
Fig. 99. Female, ventral view of posterior abdominal segments

Length : 8-10 mm.

Description : This species is the only Northeastern *Zealeuctra* that has a secondary tooth behind the pointed apex of the male epiproct. The sclerotized margins of the male tergal depression terminate in a sharp point and a smaller subterminal projection. The female 7th sternite is strongly notched. The female median lobe is rounded and white. Adults were illustrated by Ricker and Ross (1969).

Type locality : Herod, Illinois. Type at Illinois Natural History Survey.

Range : West Virginia to Tennessee and southern Illinois.

3. *Zealeuctra narfi* Ross and Ricker (figs. 94c, 100)

Zealeuctra narfi Ricker and Ross, 1969, Can. J. Zool. 47 : 1118.

Length : 6-7.5 mm.

Description : The male epiproct of *narfi* has a single tooth on a base that is wider than long. The sclerotized margins of the 9th tergal depression terminate in a rounded point and rounded subterminal tooth. The female median lobe is brown and

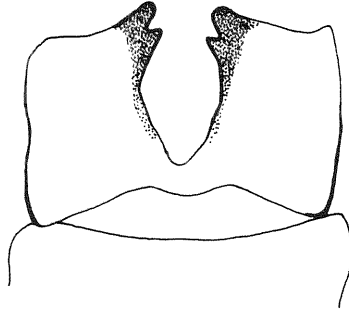


Fig. 100. *Zealeuctra narfi*, male 9th tergite (after Ricker and Ross, 1969)

wider than long. Additional figures of the adult are shown by Ricker and Ross (1969).

Type locality: Otter Creek, Sauk County, Wisconsin. Type at Illinois Natural History Survey.

Range: Arkansas to Wisconsin.

FAMILY NEMOURIDAE

These are small, inconspicuously colored stoneflies found in North America, Eurasia, and northern Africa. Gills are either absent or in the cervical region. The shortening and reduction of the abdominal ganglia are greatest in this family with only 5 or 6 ganglia visible upon dissection. The male epiproct and paraprocts are well developed and function in mating. A ventral vesicle is present in most genera and the adult cercus has only 1 segment.

GENUS *Nemoura* LATREILLE

Nemoura Latreille, 1796, Précis car. gen. ins.: 101.

This is a very large genus which European workers have broken into a considerable number of smaller genera. I am here following the more conservative pattern of North American workers and consider that all species belong to a single genus. Ricker (1952) has monographed the North American species, and in the following keys and discussions I have generally followed his concepts.

The adults, with a few exceptions, have a slanting crossvein between the costa and vein R_1 in the forewing (fig. 140), and have the terminal segment of the labial palp subcircular in ventral view. The wings are well developed in most species and lie flat over the back when at rest. The media of the hindwing is forked but the cubitus is not. Some species have cervical gills and can thus be identified immediately as to genus. Some larvae are difficult to identify; the first attempt to key Northeastern species was by Harper and Hynes (1971d).

Type of genus: *Perla cinerea* Retzius (Opinion 653, ICZN, 1963).

KEYS TO NORTHEASTERN SPECIES

MALES

(modified from Ricker, 1952)

1. Remnants of gills present under neck (fig. 24) ... (*Amphinemura*) 2
No gills 6
2. Outer (upper) division of paraprocts (subanal lobes) long, recurved, spinulose; inner (lower) division about half as long, unarmed (fig. 145) 17, *wui*
Outer division of paraprocts no longer than the inner, which is spinulose (fig. 141) 3
3. Paraprocts short, not recurved onto 10th tergite, inner members armed with only 4-6 spines (fig. 111) 5, *linda*
Paraprocts long, recurved over at least part of 10th tergite, inner members armed with at least 8 spines (figs. 46, 141) 4
4. Tip of outer member of paraprocts expanded and bearing a group of large spines separately from inner member (fig. 141) .. 15, *varshava*
Tip of outer member slender, bound to inner member, with few short spines or no spines (fig. 115) 5
5. Inner member of paraproct much produced rearward at bend, where it is thin and compressed; its tip unsclerotized and not recurved (fig. 109) 4, *delosa*
Inner member not compressed at the bend; its tip recurved at least on inner side (fig. 115) 7, *nigritta*
6. Vesicle present on 9th sternite 7
No vesicle on 9th sternite 8, (*Paranemoura*) *perfecta*
7. A₁ and A₂ of forewing united a little before their outer ends (fig. 140) (*Soyedina*) 8
A₁ and A₂ of forewing separate at tip 9
8. Anterior margin of paraproct straight near narrow truncate tip; no suggestion of a process; tergite 7 elevated posteriorly (fig. 137) 14, *vallicularia*
Anterior margin of paraproct concave near tip, commonly but not invariably with distinct anterodorsal projection; tergite 7 not elevated (fig. 143) 16, *washingtoni*
9. Cercus elongated and heavily sclerotized on at least outer surface, tip sharp or with processes (fig. 101, 131, 134) 10
Cercus weakly sclerotized, tip blunt or rounded (figs. 105, 128) ... 14
10. Cercus little elongated, membranous on inner surface, with terminal spines; all abdominal segments completely sclerotized and of approximately equal width (figs. 130, 131)
..... 12, (*Nemoura*) *trispinosa*
Cercus long and slender, completely sclerotized, pointed at tip; 9th and 10th abdominal segments more heavily sclerotized and much

- wider than proximal segments 11
11. Cerci definitely bent in side view; vesicle of 9th sternite attached at front margin of sternite (figs. 107, 120) 12
 Cerci almost straight in side view; vesicle of 9th sternite attached behind front margin (figs. 102, 133) 13
 12. Cerci with subterminal notch on the inside (fig. 107) ... 3, *complexa*
 Cerci without subterminal notch (fig. 120) 9, *prolongata*
 13. Tip of subgenital plate rather broad, with sharply pointed paraprocts (fig. 134) 13, *truncata*
 Tip of subgenital plate slender, divided medially by rather deep notch; spur on paraprocts 1, *albidipennis*
 14. Sides of 10th tergite produced into erect, incurved, spiny processes (fig. 125); wings with alternate clear and pigmented bands 10, (*Shipsa*) *rotunda*
 Sides of 10th tergite not as above; wings banded or uniformly colored 15
 15. Epiproct slender, completely recurved along 10th and 9th tergites, with slender process on each side at base (figs. 104, 127) (*Prostoia*) 16
 Epiproct short, thick, complex in structure, only slightly bent forward, with no basal processes (fig. 113) ... 6, (*Podmosta*) *macdunnoughi*
 16. Basal processes of epiproct twisted, divergent, and more than half as long as epiproct (figs. 127, 128) 11, *similis*
 Basal processes of epiproct short (less than one sixth as long as epiproct), appressed and easily overlooked (figs. 104, 105) 2, *completa*

FEMALES

(modified from Ricker, 1952)

1. Gills present under neck or head (fig. 24) 2
 Gills absent 7
2. Gills are simple filaments; 7th sternite produced completely over a very weak 8th sternite 18, (*Zapada*) *Nemoura* sp.
 Gills branched; 7th sternite moderately or little produced, not covering all of 8th; 8th sternite bears distinct terminal or subterminal notch (*Amphinemura*) 3
3. Tip of subgenital plate (8th sternite) not exceeding level of sides of 8th segment 4
 Tip of subgenital plate considerably exceeding the 8th segment (fig. 146) 17, *wui*
4. Border of subgenital plate with median notch and small but definite V- or U-shaped lateral notch on either side (fig. 110) ... 4, *delosa*
 Border of plate merely sinuate laterally or, less commonly, with broad

- V-shaped notch (figs. 112, 117, 142) 5
5. Northern and northwestern species, ranging southward to Michigan
..... 5, *linda*
Range elsewhere 6
6. Range in Middle West: Indiana, Illinois
..... 15, *varshava* or, rarely, 7, *nigritta*
Range from eastern Ohio to eastern Tennessee and from Quebec to
Florida 7, *nigritta*
7. A₁ and A₂ united near margin of forewing (fig. 140); a large species;
7th sternite produced over the full length of 8th (figs. 138, 144) ..
..... (*Soyedina*) 14, *vallicularia*, 16, *washingtoni*
A₁ and A₂ not united in forewing 8
8. Wings mostly dark, with clear or relatively clear band across middle
of outer field 9
Wings entirely clear, or with some or all veins margined with brown,
or with marginal or central dark spot at level of the cord 13
9. Terminal costal crossvein running between Sc and C, proximad of the
cord 8, (*Paranemoura*) *perfecta*
Terminal costal crossvein running between R₁ and C, beyond cord
(fig. 140) 10
10. Sternite 7 sclerotized and produced over full length of 8, its hind margin
straight to broadly rounded (fig. 132)
..... 12, (*Nemoura s.s.*) *trispinosa*
Sternite 7 produced only slightly or not at all over 8 (narrowly
rounded margin of subgenital plate of 8th sternite in *Shipsa* can be
mistaken for 7th sternite) (figs. 106, 126, 129) 11
11. Sternite 8 with subgenital plate terminating anterior to well developed
hind margin and bearing contrasting dark and light bands (fig. 126)
..... 10, (*Shipsa*) *rotunda*
Sternite 8 with terminal subgenital plate not separated from hind
margin of sternite and uniformly colored (figs. 106, 129)
..... (*Prostoia*) 12
12. Sternite 8 distinctly produced laterally and with large notch medially
(fig. 129) 11, *similis*
Sternite 8 little or not at all produced; median notch small or absent
(fig. 106) 2, *completa*
13. Sternite 8 very weak and unsclerotized medially; sternite 7 produced
over full length of 8 and not laterally excavated (fig. 132)
..... 12, (*Nemoura s. s.*) *trispinosa*
Sternite 8 sclerotized medially, at least near posterior margin; sternite
7 produced only slightly or not at all (except in *Ostrocerca prolon-*
gata, where it is excavated laterally) 14
14. Sternite 8 with narrow median sclerotized band, contrasting sharply

- with unsclerotized field on either side (fig. 114) 6, (*Podmosta*) *macdunnoughi*
- Sternite 8 without median stripe, uniformly sclerotized in most individuals (*Ostrocerca*) 15
- 15. 7th sternite lacking sclerotization, its hind margin not produced; margin of 8th sternite somewhat produced and broadly and almost rectangularly excavated (fig. 135) 13, *truncata*
- 7th sternite somewhat sclerotized along its hind margin, at least near the middle (inconspicuous in *albidipennis*); 8th sternite not as above 16
- 16. 7th sternite produced over most of 8th, its hind margin broadly rounded (fig. 123) 9, *prolongata*
- 7th sternite less produced (generally little produced), terminating in distinct nipple (best seen in side view) 17
- 17. Nipple of 7th sternite parallel sided, prominent; hind margin of 8th sternite straight, with little extra sclerotization at midline (fig. 108) 3, ? *complexa*
- Nipple of 7th sternite blunt-conical, weak, very easily overlooked in ventral view; hind margin of 8th very broadly notched or excavated, without extra sclerotization near middle (fig. 103) 1, *albidipennis*

LARVAE

(modified from Harper and Hynes, 1971d)

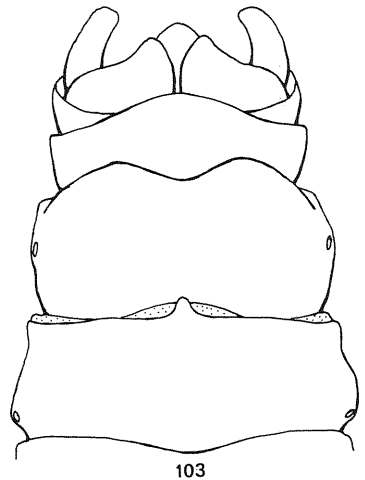
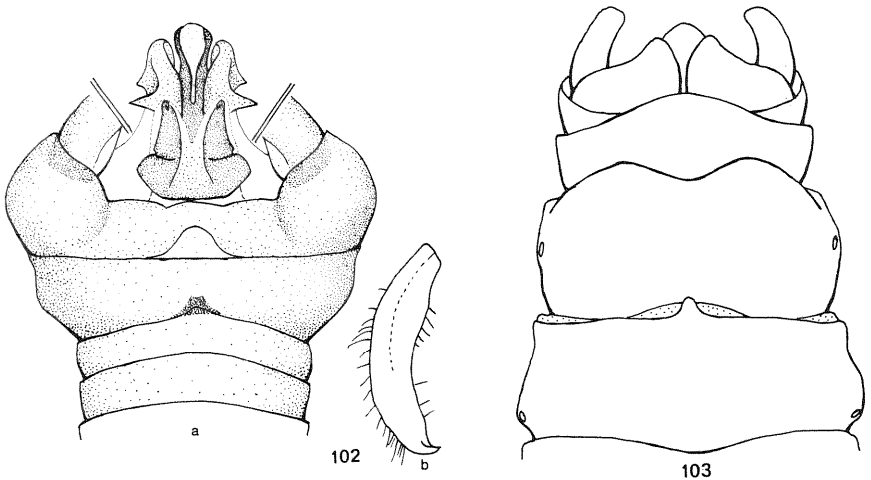
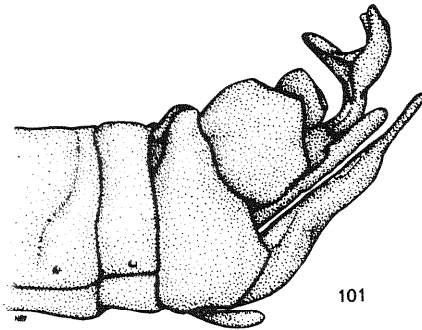
- 1. 4 prosternal gills 2
- Without gills 6
- 2. Prosternal gills simple (unbranched); femora with distinct transverse line of bristles 18, *N. (Zapada)* sp.
- Prosternal gills branched *Amphinemura* 3
- 3. All gill tufts containing about equal number of filaments; marginal bristles of pronotum long and pointed 4
- Lateral gill tufts containing about half as many filaments as median tufts; marginal bristles of pronotum short and round tipped 17, *wui*
- 4. Bristles of apical whorls of middle cercal segments about half as long as corresponding segment 7, *nigrilla*
- Bristles at least three quarters length of the segment 5
- 5. Spring species, mature larvae found from April to early July; larger bristles on femora and tibiae are same color as leg or only slightly darker 4, *delosa*
- Autumn species, mature larvae found from late July to October; larger bristles on femora and tibiae definitely darker than remainder of leg 5, *linda*
- 6. Pronotum with well defined lateral fringe 7

- Pronotum without definite fringe; in some species bristles on lateral margins of pronotum are longer than dorsal bristles but never set in distinct line 8
7. Legs short, hind femora in side view about 3 times as long as broad; pronotum with shallow notch laterally; 2 longer setae in pronotal fringe, 1 on anterior angle, the other near posterior angle *14, vallicularia*
- Legs longer, hind femora about 4 or 5 times as long as broad in side view; pronotum without notch; pronotal fringe without longer setae *12, trispinosa*
8. Femora bearing continuous fringe of long silky hairs 9
- Femora without fringe; in some species, there may be a few interspersed long hairs 11
9. Both dorsal and ventral bristles of cercal whorls longer than lateral bristles; legs not banded; marginal bristles on abdominal terga longer on distal segments than on proximal segments (*Prostoia*) 10
- Only ventral bristles longer than other bristles; legs banded; marginal bristles on abdominal terga about same length on all segments ... *10, rotunda*
10. Longest marginal bristles on apical abdominal terga about three-quarters as long as corresponding tergum; intermediate hairs on cercal segments well developed; white spots on head, covering both sides of Y ecdysial line *2, completa*
- Longest marginal bristles on apical abdominal terga about one third as long as corresponding tergum; intermediate hairs on cercal segments poorly developed or not developed; white spots on head restricted to area posterior to Y ecdysial line *11, similis*
11. Thorax and abdomen with distinct mid-dorsal stripe; intermediate hairs well developed throughout cercus, their length greater than diameter of corresponding segment *8, perfecta*
- No distinct mid-dorsal stripe; intermediate hairs inconspicuous and short or present only on distal segments 12
12. Dorsal and ventral bristles of cercal whorls longer than lateral bristles on distal joints; intermediate hairs on cerci long, especially the ventral hairs on the distal segments; developing genital organs in mature male larva not producing large apical protuberance *6, macdunnoughi*
- Ventral bristles of cercal whorls of apical segments longer than other bristles; intermediate hairs inconspicuous throughout; developing genital organs in mature male larva producing large apical protuberance (*Ostrocerca*) 13
13. Longest marginal bristles on abdominal terga about one sixth or one fifth as long as mid-dorsal length of corresponding tergum; abdominal bristles light; cerci not banded; protuberance of genitalia in mature male larva longer than broad in dorsal view

..... 13, *truncata*
 Longest marginal bristles on abdominal terga about one third as long
 as corresponding tergum; abdominal bristles dark; cerci lightly
 banded; protuberance of genitalia in mature male larva about as long
 as broad 1, *albidipennis*

1. *Nemoura (Ostrocerca) albidipennis* Walker (figs. 101-103)

Nemoura albidipennis Walker, 1852, Cat. neur. Br. Mus. 191.
Nemoura serrata Claassen, 1923, Can. Entomol. 55: 289.



Nemoura albidipennis, posterior abdominal segments

Fig. 101. Male, lateral view.

Fig. 102. Male: a, dorsal view; b, cercus.

Fig. 103. Female, ventral view

Length: 6-7 mm.

Description: The males are most easily distinguished by the large furcate epiproct and the sharp hooks on the paraprocts. The female 7th sternite has a small nipple on the posterior margin and the 8th sternite is produced and emarginate. Ricker (1965) and Needham and Claassen (1925) figured the adult, the latter authors under the name *serrata*; Harper and Hynes (1971d) illustrated the larva.

Type locality: Nova Scotia. Type in the British Museum.

Range: Nova Scotia to Connecticut and west to New York and Ontario.

Connecticut Records: Naugatuck State Forest, Beacon Falls, May 17, 1961 (SWH).

2. *Nemoura (Prostoia) completa* Walker (figs. 104-106)

Nemoura completa Walker, 1852, Cat. neur. Br. Mus. 191.

Nemoura glabra Claassen, 1923, Can. Entomol. 55: 281.

Length: 6-9.5 mm.

Description: The male paraprocts on this species are unmodified and the recurved epiproct has a short process on each side at the base. These processes are difficult to see in some individuals but there are very few North American *Nemoura* with simple, triangular paraprocts and a relatively smooth, unornamented epiproct. The 8th sternite of the female is only slightly produced but has a slight notch and darker sclerotization at the center of the hind margin. The 7th and 8th sternites are fused at their midline with a glabrous, somewhat shiny area extending from midway on the 7th to the notch of the 8th. *N. completa* is closely related to the western *N. besametsa*; Ricker (1964) gave a distribution map showing the geographic relationship between these 2 species. Harden and Mickel (1952) and Harper and Hynes (1971d) figured the larva, Needham and Claassen (1925) and Ricker (1952) the adult.

Type locality: Nova Scotia. Type in the British Museum.

Range: The Maritimes south to North Carolina and west to Minnesota and Arkansas.

Connecticut records: Bethlehem, Apr. 14, 1967 (SWH); Easton, May 12, 1966 (SWH) Killingworth, Apr. 1-5, 1965 (SWH); Madison, Apr. 3, 1969 (SWH); Mansfield, Apr. 7, 1967 (UC); Storrs, Apr. 4, 1957 (UC).

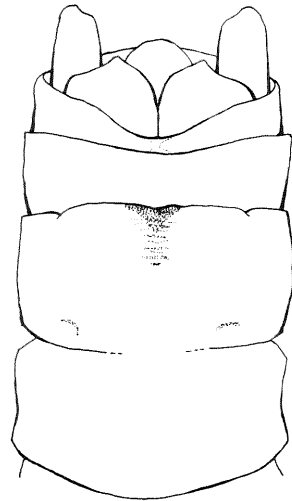
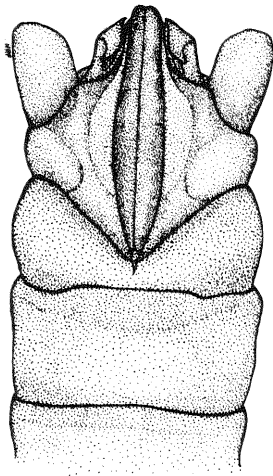
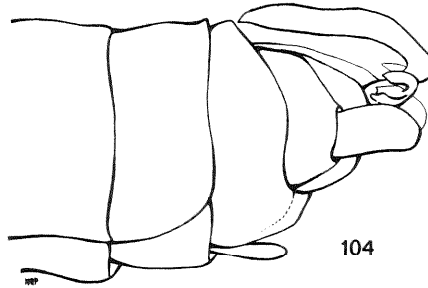
3. *Nemoura (Ostrocerca) complexa* Claassen (figs. 107, 108)

Nemoura complexa Claassen, 1937, J. Kans. Entomol. Soc. 10: 43.

Length: 6-7.5 mm.

Description: This aptly named species has a complicated genitalic structure in the male that can be seen in the accompanying figures more easily than described. The 9th and 10th abdominal segments are wider and more heavily sclerotized than the preceding segments. The paraprocts are broadened distally. The subgenital plate (9th sternite) is elongated, with a notch at the end. It is probably most easily distinguished from closely related species by the subterminal tooth on the curved cercus. Figures of the male are shown by Claassen (1937).

A female has never been unquestionably associated with the male of this species.



Nemoura completa, posterior abdominal segments

Fig. 104. Male, lateral view.

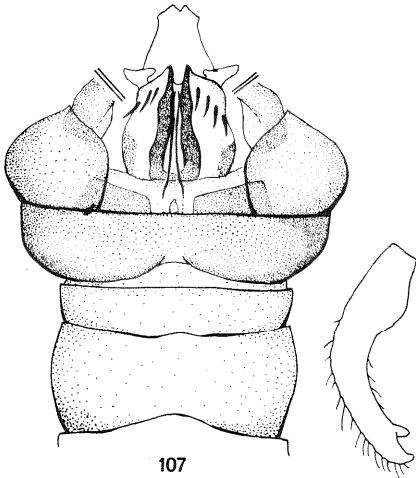
Fig. 105. Male, dorsal view.

Fig. 106. Female, ventral view of posterior abdominal segments.

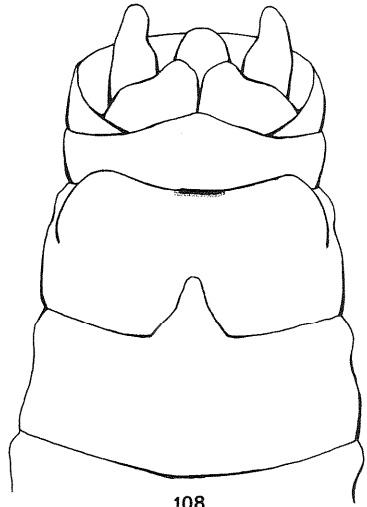
However, scattered collections of an unknown female over the Northeast probably represent this species (Ricker, 1952, 1965). This female has a central protrusion on the posterior margin of the 7th sternite and a broadly but slightly produced margin on the 8th sternite.

Type locality: Artists Brook, Essex County, New York. Type in Cornell University collection. It has been collected in New England, Quebec, Ontario, and New York.

Connecticut records: Voluntown, adult male and female, June 14, 1967 (SWH); East Hartland, June 14, 1966 (SWH).



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Nemoura complexa, posterior abdominal segments

Fig. 107. Male, dorsal view, also showing cercus.

Fig. 108. Female, ventral view of posterior abdominal segments.

4. *Nemoura (Amphinemura) delosa* Ricker (figs. 109, 110)

Nemoura delosa Ricker, 1952, Ind. Univ. Publ., Sci. Ser. 18: 18.

Length: 8-9.5 mm.

Description: This species is closely related to *nigritta*. The shape of the paraprocts in the male is different, however; the inner member is not recurved at the tip. The female resembles *nigritta* except that some individuals have an additional notch at each side of the subgenital plate. The female and male were illustrated by Ricker (1952), the larva by Harper and Hynes (1971d).

The larva feeds on algae and detritus (Minshall, 1967) and frequents the warmer small streams (Ricker, 1952).

Type locality: McCormick's Creek, Spencer, Indiana. Type at Illinois Natural History Survey.

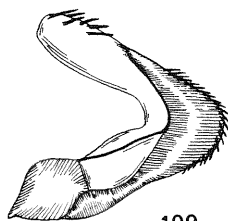
Range: Western Quebec south to Georgia and west to Oklahoma, Missouri, and Illinois.

5. *Nemoura (Amphinemura) linda* Ricker (figs. 111, 112)

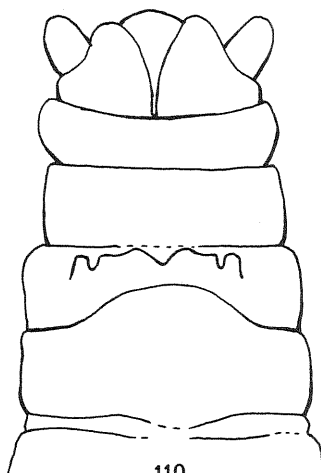
Nemoura linda Ricker, 1952, Ind. Univ. Publ. Sci. Ser. 18: 22.

Length: 5.5-10.5 mm.

Description: Closely related to other *nigrittalike* species, *linda* is distinguished in the male by smaller paraprocts, not recurved forward and by having both parts of its epiproct divided and armed with spines. The female is similar to *nigritta* and *varshava*.



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Nemoura delosa male (after Ricker, 1952)

Fig. 109. Male, paraproct.

Fig. 110. Female, ventral view of posterior abdominal segments.

Ricker (1952) illustrated the male and female genitalia; Harper and Hynes (1971d) the larva.

Type locality: Hunt Creek, Montmorency County, Michigan. Type at Illinois Natural History Survey.

Range: This is the northern member of this complex and extends across Canada from British Columbia to Labrador. Its range extends southward to Michigan.

6. *Nemoura (Podmosta) macdunnoughi* Ricker (figs. 113, 114)

Nemoura macdunnoughi Ricker, 1947, Trans. Roy. Can. Inst. 26: 403.

Length: About 6 mm.

Description: This species of small Plecoptera is closer to various western species than to any other eastern one. The male paraprocts are simple. The epiproct is recurved and complicated in shape, with the middle member sharply bent. The female 8th sternite is only slightly produced but heavily sclerotized on the midline. Ricker (1947, 1952), figured the adult, Harper and Hynes (1971d) the larva.

Type locality: Baddeck, Cape Breton Island, Nova Scotia. Type in the Canadian National Collection, Ottawa.

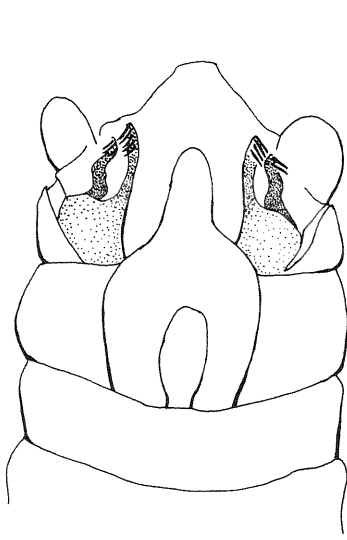
Range: Canada, from Newfoundland to western Quebec.

7. *Nemoura (Amphinemura) nigritta* Provancher (figs. 24, 25, 115-117)

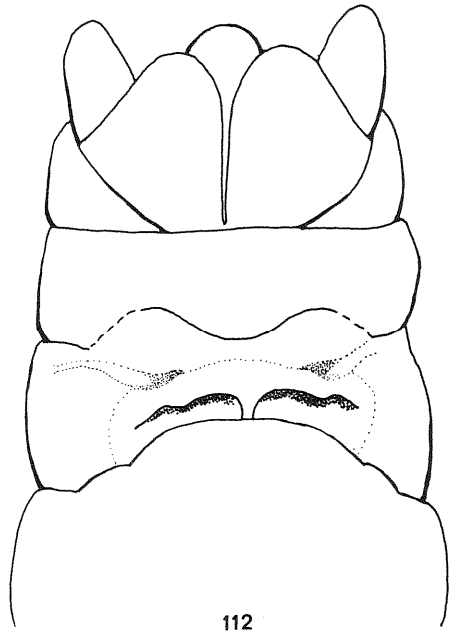
Nemoura nigritta Provancher, 1876, Nat. Can. 8: 217.

Nemoura venosa Banks, 1897, Trans. Am. Entomol. Soc. 24: 21.

Nemoura stylata Banks, 1920, Bull. Mus. Comp. Zool. 64: 324.

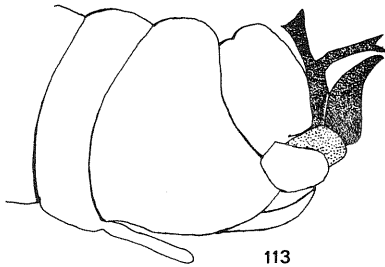


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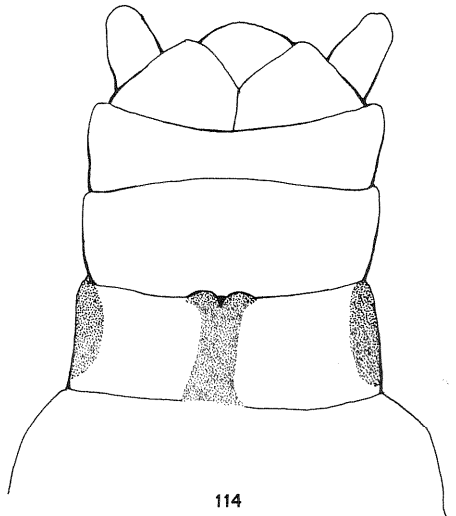


112

Nemoura linda, ventral views of posterior abdominal segments (after Ricker, 1952)
 Fig. 111 Male. Fig. 112. Female.

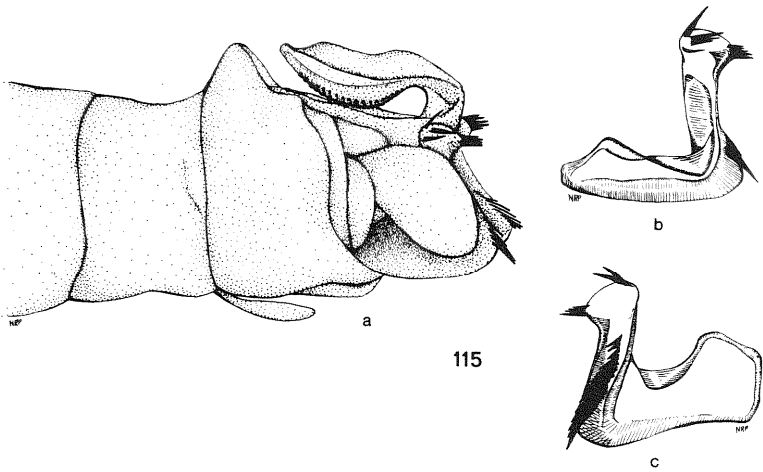


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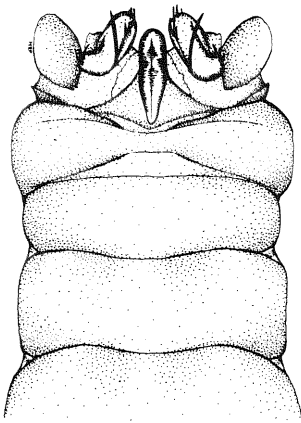


114

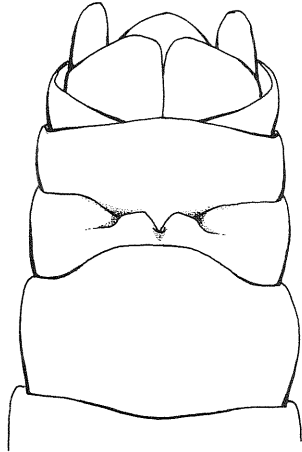
Nemoura macdunnoughi, posterior abdominal segments
 Fig. 113. Male, lateral view (after Ricker, 1952).
 Fig. 114. Female, ventral view (after Ricker, 1947).



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117

Nemoura nigritta

Fig. 115. Male: a, lateral view of posterior abdominal segments; b, lateral view of paraproct; c, medial view of paraproct.

Fig. 116. Male, dorsal view of posterior abdominal segments.

Fig. 117. Female, ventral view of posterior abdominal segments.

Length: 6.5-8 mm.

Description: This is probably the commonest *Nemoura* in the Connecticut area and is closely related to a number of other species (*delosa*, *linda*, *mockfordi*, *varshava*) found in neighboring states. The wings are dusky and there are remnants of the larval cervical gills. The male's distinctive divided paraprocts easily separate it from closely related species. Ricker (1952) illustrated the variations in this character. The female

7th sternite is produced in a broad rounded lobe that partly covers the 8th sternite, which is notched, with 2 projections on each side. Claassen (1931) illustrated the larva under the species name *venosa*. Harper and Hynes (1971d) also figured the larva. This is a very common species in Connecticut from early May to mid-June and has been taken in blacklight traps at night.

Type locality: Near Quebec City, Quebec. Type at Quebec Provincial Museum, Quebec City.

Range: This is the eastern member of the complex; it ranges from the Maritimes southward to Florida and westward to southern Illinois and south-central Quebec.

Connecticut records: Bethany, May 5, 1961, May 31, 1962, June 3-8, 1959, June 8, 1962, June 26, 1961 (SWH); Burlington, June 4, 1965 (SWH); Canaan, June 1, 1961 (SWH); Cheshire, May 21-23, 1959 (SWH); Chester, June 18, 1965 (SWH); Cornwall, May 20, 1960, June 4, 1964 (SWH); East Hartford, May 5, 1967 (SWH); East Hartland, June 1-6, 1967, June 14, 1966 (SWH); Eastford, June 9, 1966 (SWH); Easton, May 14-27, 1968, May 26, 1964 (SWH); Ellsworth, June 7, 1967 (SWH); Franklin, May 29-June 5, 1967 (SWH); Granby, May 25, 1962 (SWH); Griswold, June 14, 1967 (SWH); Hamden, May 20, 1959 (SWH); Hartland, June 14, 1966 (SWH); Harwinton, June 4, 1965 (SWH); Killingworth, June 18, 1965 (SWH); Lebanon, May 22, 1965, June 6, 1960 (SWH); Madison, June 18, 1965 (SWH); Milton, June 4, 1964 (SWH); Monroe, May 27, 1968 (SWH); Mt. Carmel, in UV light trap, May 20-24, 1960, J. B. Kring; Naugatuck, June 3, 1969 (SWH); Newtown, May 25, 1962 (SWH); Norwich, June 1, 1960 (SWH); Plainfield, June 14, 1967 (SWH); Portland, June 14, 1963 (SWH); Salem, May 29, June 15, 1967 (SWH); Shelton, June 19, 1962 (SWH); Somers, June 9, 1966 (SWH); Stafford, June 9, 1966 (SWH); Sterling, June 14, 1967 (SWH); Thomaston, May 5, 1961 (SWH); Union, June 9, 1966 (SWH); Voluntown, May 23-25, 1966, June 14, 1967 (SWH); West Cornwall, June 4, 1964, June 7, 1967 (SWH); Woodstock, June 9, 1966 (SWH).

8. *Nemoura (Paranemoura) perfecta* Walker (figs. 118, 119)

Nemoura perfecta Walker, 1852, Cat. neur. Br. Mus. 191.

Nemoura punctipennis Claassen, 1923, Can. Entomol. 55: 291.

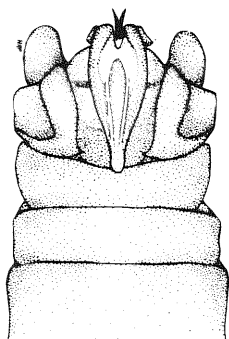
Length: 6.5-7.5 mm.

Description: This small species is the only *Nemoura* of eastern North America that does not bear a vesicle (ventral lobe) on the 9th sternite of the male. The paraprocts are unmodified and the forewing does not bear the usual slanting crossvein between R and C. In *perfecta* this slanting crossvein runs between the costa and subcosta. The 7th sternite of the female is produced over the 8th sternite, which bears a Y-shaped sclerotized area. The adult genitalia and wings were illustrated by Needham and Claassen under the species name *punctipennis*, the larva by Harper and Hynes (1971d). I have taken specimens from streams that dry up during the summer as well as from permanent streams.

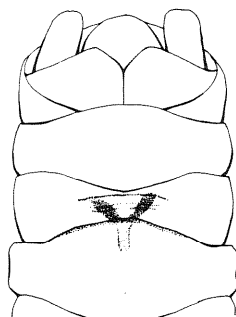
Type locality: Nova Scotia. Type in British Museum.

Range: The Maritimes west to New York and Ontario and south to North Carolina.

Connecticut records: Clinton, Apr. 7, 1969 (SWH); East Willington, Apr. 5, 1968 (SWH); Easton, Apr. 5, 1966 (SWH); Killingworth, Apr. 1-5, 1965 (SWH);



118



119

Nemoura perfecta, posterior abdominal segments

Fig. 118. Male, dorsal view.

Fig. 119. Female, ventral view.

Mansfield, Apr. 2, 1964, N. Duquette (UC); Old Lyme, Apr. 29, 1961, J. Fitzgerald (UC); Redding, Apr. 8, 1963 (SWH); Redding Ridge, Mar. 30, 1964, C. Remington (YU); Staffordville, Apr. 23, 1964 (SWH); Storrs, Apr. 8, 1958, C. Charter (UC); Voluntown, Apr. 23, 1966 (SWH); Wolcott, May 13, 1959 (SWH).

9. *Nemoura (Ostrocerca) prolongata* Claassen (figs. 120-123)

Nemoura prolongata Claassen, 1923, Can. Entomol. 55: 289.

Length: 7.5-9.5 mm.

Description: As with other members of the subgenus *Ostrocerca*, *N. prolongata* males have complicated genitalic structures. The species can best be distinguished by its long, narrow subgenital plate and curved cerci. The female 7th sternite is rounded and produced over the 8th. Adult genitalia were figured by Needham and Claassen (1925). The female illustrated by these authors may be a misidentification. Male *prolongata* in the collection of the U. S. National Museum are associated with several females much like *albidipennis*.

Type locality: Bretton Woods, New Hampshire. Type at Cornell University.

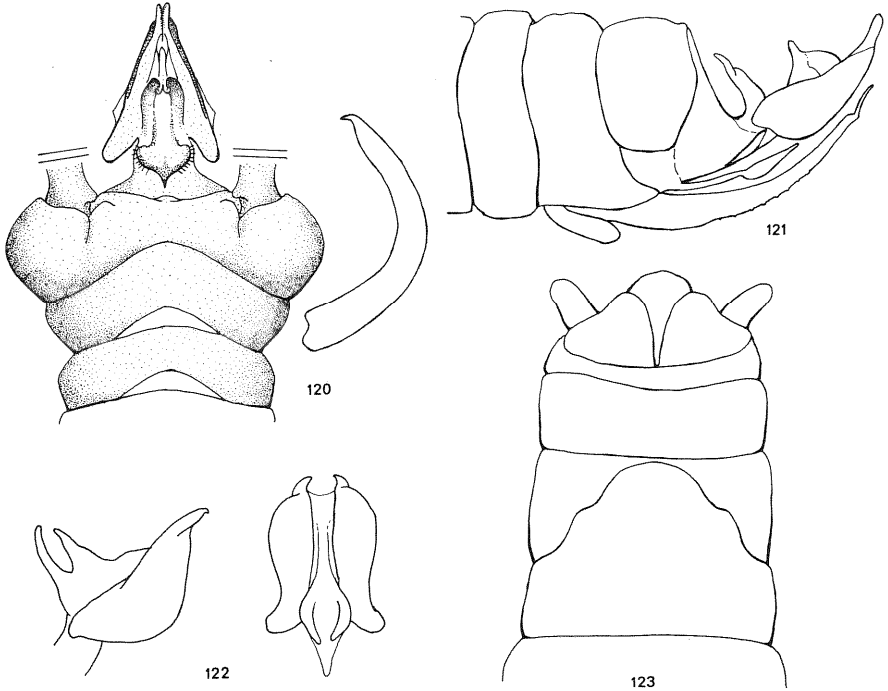
Range: Northern New England and the Maritime Provinces.

10. *Nemoura (Shipsa) rotunda* Claassen (figs. 124-126)

Nemoura rotunda Claassen, 1923, Can. Entomol. 55: 290.

Length: 7-11 mm.

Description: The male of this species is characterized by a 10th tergite produced into a pair of curved spiny lobes. The female 7th sternite is slightly produced. The 8th sternite bears a subgenital plate that reaches to the anterior margin of the 9th sternite. This plate originates near the base of segment 8, but is free only on the distal half. Harden and Mickel (1952) and Harper and Hynes (1971d) illustrated the larva; Needham and Claassen (1925) the adults.



Nemoura prolongata

Fig. 120. Male, dorsal view of posterior abdominal segments, showing cercus.

Fig. 121. Male, lateral view of posterior abdominal segments.

Fig. 122. Epiproct, lateral and dorsal views, showing variation.

Fig. 123. Female, ventral view of posterior abdominal segments (after Needham and Claassen, 1925, but see text).

Type locality: Waldoboro, Maine. Type at Cornell University.

Range: Canada, from Alaska to the Maritimes, and south as far as Minnesota, Michigan, and, in east, to Maryland.

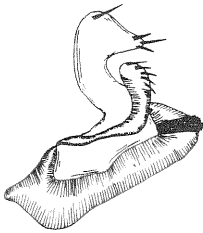
11. *Nemoura (Prostoia) similis* (Hagan) (figs. 127-129)

Taeniopteryx similis Hagen, 1861, Syn. Neurop. No. Amer.: 34.

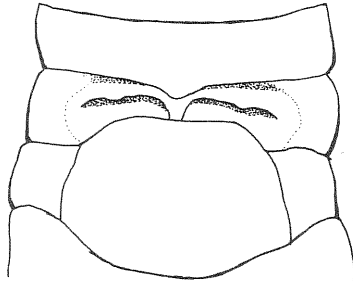
Nemoura divergens Claassen, 1923, Can. Entomol. 55: 282.

Length: 6.5-8.5 mm.

Description: The simple paraprocts and the processes at the base of the epiproct relate this species to *completa*. However, the processes in *similis* are long and slender and more easily visible. The female 8th sternite is more produced than that of *completa* and has a deeper median notch. The 7th and 8th sternites are fused along the midline and only the midline of the 7th and following sternites is strongly sclerotized. Needham and Claassen (1925) figured the adult genitalia under the name *divergens*. The larva was illustrated by Harper and Hynes (1971d).



141



142

Nemoura varshava (after Ricker, 1952)

Fig. 141. Male paraproct.

Fig. 142. Female, ventral view, showing subgenital plate.

Ricker (1952).

Type locality: Near Warsaw, Indiana. Type at Illinois Natural History Survey.

Range: Found in cool spring streams in Illinois, Indiana, and Kentucky.

16. *Nemoura (Soyedina) washingtoni* Claassen (figs. 143, 144)

Nemoura washingtoni Claassen, 1923, Can. Entomol. 55: 287.

Length: 8.3-11 mm.

Description: This species has veins A_1 and A_2 of the forewing fused just before the wing margin; it lacks any projections or humps on the abdominal tergites of the male. The females are not easily distinguishable from *N. wui*. Adults were figured by Needham and Claassen (1925).

Type locality: Mt. Washington, New Hampshire. Holotype at Cornell University.

Range: This subspecies has been collected only in New England; *N. washingtoni carolinensis* is recorded from the mountains of North Carolina and Tennessee.

Connecticut records: Mt. Carmel, May 5, 1961 (SWH); Woodbridge, Apr. 22-23, 1962, C. Remington (YU).

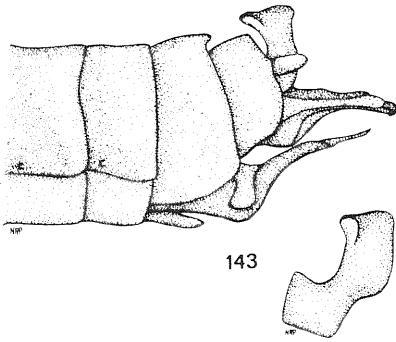
17. *Nemoura (Amphinemura) wui* Claassen (figs. 145, 146)

Nemoura sinuata Wu 1923, Bull. Lloyd Lib. Entomol. 23: 6-11, 59, 61 (name preoccupied).

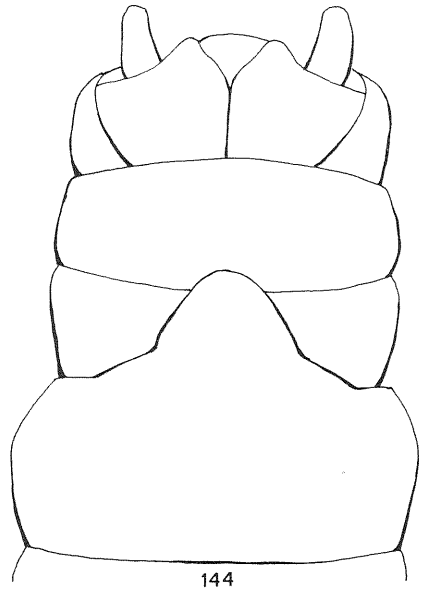
Nemoura wui Claassen, 1936, Ann. Entomol. Soc. Am. 29: 623.

Length: 7.5-10 mm.

N. wui has remnants of the larval cervical gills. Related to *N. nigritta*, it is paler and less robust than that species. The male is characterized by divided paraprocts, their upper parts long and spinulose. The female subgenital plate extends farther posteriorly than in *nigritta*. Illustrations of adults and larvae are by Needham and Claassen (1925) and Claassen (1931), under the species name *sinuata*. Further figures

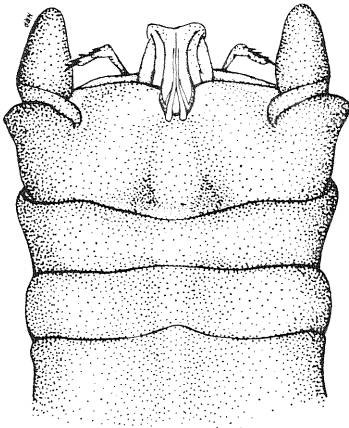


143

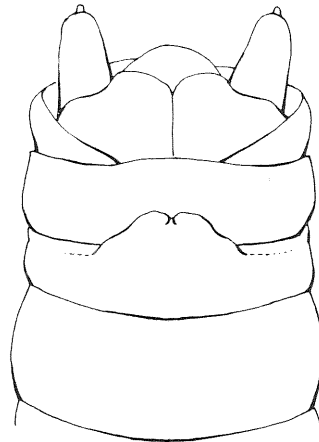


144

Nemoura washingtoni, posterior abdominal segments
 Fig. 143. Male, lateral view, also showing epiproct.
 Fig. 144. Female, ventral view.



145



146

Nemoura wui, posterior abdominal segments
 Fig. 145. Male, dorsal view.
 Fig. 146. Female, ventral view.

of the larva were given by Harper and Hynes (1971d). The adult emergence pattern was graphed by Harper and Pilon (1970).

Type locality: Ithaca, New York. Holotype at Cornell University.

Range: The Maritimes south to Georgia (in the mountains) and west to Quebec and New York.

Connecticut records: Chester, June 18, 1965 (SWH); Eastford, June 9, 1966 (SWH); Hartland, June 14, 1966 (SWH); Mt. Carmel, July 2, 1962, July 2, 1965 (SWH); North Haven, at light, June 24, 1953, C. Remington (YU); Thomaston, June 26, 1961 (SWH); Voluntown, May 23-25, 1966 (SWH); West Cornwall, June 4, 1964 (SWH).

18. *Nemoura (Zapada)* sp.

Females or larvae of this western subgenus have been found in Quebec and New Hampshire (Ricker, 1952; Ricker and his associates, 1968). Possibly this is the western *N. haysi*; however, a male must be collected before an exact identification can be given. Harper and Hynes (1971d) illustrated the larva.

FAMILY TAENIOPTERYGIDAE

This family of medium-size stoneflies is found in North America, Eurasia, and northern Africa. The tarsal joints are subequal in length and the glossae and paraglossae are also subequal. The male epiproct is prominent and the paraprocts are generally greatly modified, although concealed in many species. There are cu-m and intercubital crossveins. The overall form of the members of this family are similar but there are a number of differences between species. Single, untufted thoracic gills are present in some genera. Cerci are single or consist of several segments. Cu₁ of the forewing has several branches or only a few. There can be a vesicle on the male 9th sternite.

GENUS *Taeniopteryx* PICTET

Taeniopteryx Pictet, 1841, Perlides: 345.

Adults of this genus are distinguished by glossae and paraglossae subequal in length, tarsal segments subequal, and a membranous circular area on each coxa. These membranous areas are the scars of the larval coxal gills. A small pore on this membranous area, which was interpreted by Adams (1958) as being a coxal gland, more likely represents the remnant of the ligament or muscle that serves to retract the larval coxal gill. The male paraprocts are concealed and the 9th sternite must be peeled back to examine them. Usually there are 2 membranous lobes behind the subgenital plate of the female but in some species these are withdrawn and are not visible. The larvae are distinct from all other larval stoneflies in having a 3-segmented, telescopic gill on each coxa. The larvae cannot yet be separated to species but the *maura-burksi-nivalis* larvae have a white mid-dorsal stripe extending from the head to the end of the abdomen that other members of the genus apparently lack.

The *Taeniopteryx* emerge in late winter and early spring and, because of their size and their habit of crawling on bridges, are often collected. Ricker and Ross (1968) have recently revised the genus and described several new species.

Type of genus: *Phryganea nebulosa* L. (Opinion 652, ICZN, 1963)

KEYS TO NORTHEASTERN SPECIES

MALES

(modified from Ricker and Ross, 1968)

1. Distal part of paraprocts (subanal lobes) hooked at tip (figs. 161, 163) 2
 Distal part of paraprocts rounded or bluntly pointed (figs. 149, 156) 3
2. Vesicle present 8, *ugola*
 Vesicle absent 7, *parvula*
3. Paraprocts straight and bluntly pointed (fig. 148); vesicle present in most individuals 4
 Paraprocts narrowed distally but with broad base (fig. 156); vesicle absent 6
4. Hind femur with spur half as long as wide (fig. 147a) 4, *maura*
 Hind femur without spur or with only a slight thickening equal to less than half the width of spur (fig. 147b) 5

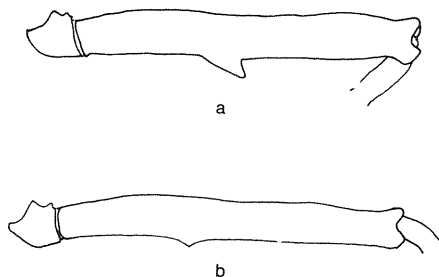


Fig. 147. Hind femur of adult; a, *Taeniopteryx maura* and b, *T. burksi*.

5. Hairs at hind margin of 9th sternite pointing downward and forward; generally much shorter than anterior hairs on sternite 6, *nivalis*
 Hairs at hind margin of 9th sternite pointing mainly backward, much longer than anterior hairs on sternite 1, *burksi*
6. Distal part of paraprocts broad and flat, with apex broadly rounded or subtruncate (fig. 149); cerci modified 7
 Distal part of paraprocts narrow (fig. 156); cerci globular 5, *metequi*

7. Cerci (dorsal view) longer than breadth of their bases, appearing twisted (fig. 151); posteroventral surface of 9th sternite a low flattened cone, not membranous, although, in some individuals, lighter colored than remainder of sternite 3, *lonicera*
Cerci no longer than their bases, chunky (fig. 149); posteroventral surface of 9th sternite elevated, pale, membranous, and bearing long, light-colored, twisty hairs 2, *lita*

FEMALES

(modified from Ricker and Ross, 1968)

1. Notch of subgenital plate deep, margined by a broadly U-shaped band of heavy sclerotization (fig. 152) 2, *lita* and 3, *lonicera*
Notch of subgenital plate margined merely by normal sclerotization or by narrow, V-shaped, dark marginal band (figs. 155, 157) ... 2
2. Middle part of 8th sternite little sclerotized, light colored, contrasting strongly with central plate and narrow, dark margin of notch (fig. 159) 7, *parvula*
Middle part of 8th sternite normally sclerotized, except, in some species, for light anterior spot near the midline 3
3. Sides of notch, if produced inward and forward, meet at obtuse angle (fig. 155) 1, *burksi* and 4, *maura*
Produced sides of notch meet at acute angle; generally with strongly sclerotized "shoulders" near hind margin of sternite (fig. 157)
..... 6, *nivalis* and 5, *metequi*

LARVAE

(modified from Harper and Hynes, 1971c)

1. With yellow mid-dorsal stripe 2
Without mid-dorsal stripe 5
2. Stripe not extending onto head capsule; occipital region of head uniformly dark 6, *nivalis*
Stripe extending onto head capsule, although partially obscured in some individuals by dark mottling on occiput; at least a light spot between lateral ocelli 3
3. Stripe very wide on occiput; all bristles on abdominal tergites long and curled 5, *metequi*
Stripe narrower; bristles on posterior margin of abdominal tergites short and blunt; others long and curled 4
4. Inner margin of hind femur of mature male with broad tooth containing developing femoral spur of the adult 4, *maura*
Inner margin of hind femur without tooth 1, *burksi*
5. Dorsum uniformly dark; pronotum totally dark; bristles on abdominal tergites long and curled 7, *parvula*
Dorsum with light dots on posterior margins of abdominal tergites in many individuals; lateral margins of pronotum yellow; bristles on abdominal tergites short and blunt 6, *nivalis*

1. *Taeniopteryx burksi* Ricker and Ross (figs. 147b, 148)

Taeniopteryx burksi Ricker and Ross, 1968, J. Fish. Res. Bd. Can. 25: 1425.

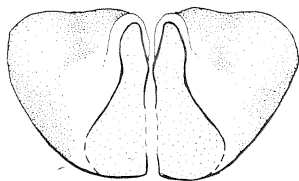


Fig. 148. *Taeniopteryx burksi*, male paraprocts.

Length: 9-15 mm.

Description: This insect is very closely related to *maura* and the females are indistinguishable. The males can be separated from those of the latter species because most *burksi* individuals lack a spur on the hind femora. However, on some there is a low swelling or projection there. Although the vesicle is much longer than that of *nivalis*, it is missing on a very few individuals. The pointed paraprocts separate *maura*, *nivalis*, and *burksi* from all other *Taeniopteryx* species. Those adult and larval specimens illustrated by Frison (1929, 1935) as *nivalis* belong here, according to Ricker and Ross (1968). The larva was figured by Harper and Hynes (1971c); the female genitalia by Ricker and Ross (1968).

Larvae feed on decaying leaves and diatoms of which Frison (1929) listed some 13 species. The adults feed on the blue-green alga *Protococcus* that grows on trees, stones, and other surfaces near the water. The female oviposits directly in the water, by alighting and releasing her eggs on the surface. Frison counted 1,407 eggs in one mass. The eggs hatch soon after deposition and the young diapause in the substrate until the fall, when growth resumes (Harper and Hynes, 1970). Adults are the victims of various predators, including the spider *Pityohyphantes phrygianus*, which I captured feeding on a male *burksi*. In Quebec, this species was observed to mate very shortly after emergence. A single female bore 1,280 eggs. Larval growth was rapid from early fall to February. From then until emergence in April there was little or no size change (Harper and Magnin, 1969).

Type locality: Urbana, Illinois. Type at Illinois Natural History Survey.

Range: The Maritimes south to Alabama and west to Ontario and Oklahoma.

Connecticut records: Bethlehem, Mar. 13, 1965 (SWH); Botsford, Mar. 9, 1962 (SWH); Brooklyn, Mar. 19, 1964 (SWH); Chaplin, Mar. 19, 1964 (SWH); East Granby, Mar. 14, 1962 (SWH); East Plymouth, Mar. 21, 1960 (SWH); Haddam, Apr. 3, 1969 (SWH); Litchfield, Mar. 16, 1964 (SWH); Lyme, Mar. 2, 1964 (SWH); Madison, Feb. 28, 1959 (SWH); Mansfield, Feb. 27, 1956, Michelson (UC), Mar. 1954, Slater (UC); Marlborough, Mar. 24, 1963 (SWH); Milton, Mar. 16, 1964 (SWH); Oxford, Mar. 21, 1960 (SWH); Redding, Mar. 24, 1964 (SWH); Simsbury, Mar. 14, 1962 (SWH); Southbury, Mar. 9, 1962, Mar. 21, 1960 (SWH); Storrs, Feb. 15, 1956, Slater (UC), Mar. 20, 1954, Kessner (UC); Stratford, Mar. 28, 1960, Jablonsky; West Granby, Mar. 3, 1965 (SWH); Woodstock, Mar. 28, 1963 (SWH).

2. *Taeniopteryx lita* Frison (fig. 149)

Taeniopteryx lita Frison, 1942, Ill. Nat Hist. Surv. Bull. 22: 249.

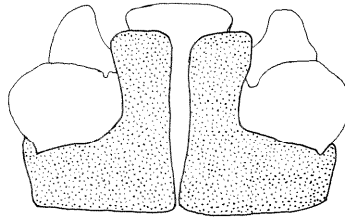


Fig. 149. *Taeniopteryx lita*, male paraprocts (after Frison, 1942)

Length: About 10 mm.

Description: This species is very close to *lonicera* and females of the two species cannot be separated. The male lacks a vesicle and its paraprocts are broadened and lobate distally. Its cerci are shorter and thicker than in *lonicera* and, unlike that species, the male *lita* has the distal part of the 9th sternite swollen, light in color, and bearing long hairs. Additional illustrations of the adult genitalia and wings were published by Frison (1942).

Type locality: Elizabethtown, Illinois. Type at Illinois Natural History Survey.

Range: Indiana and North Carolina to Alabama and west to Arkansas and Illinois.

3. *Taeniopteryx lonicera* Ricker and Ross (figs. 150-152)

Taeniopteryx lonicera Ricker and Ross, 1968, J. Fish. Res. Bd. Can. 25: 1427.

Length: 9-12 mm.

Description: The differences between *lonicera* and *lita* are not great. The male cercus of *lonicera* is deeply excavated on the inner surface, giving the cercus the appearance of being more slender and twisted than in *lita*. The 9th sternite is produced into a low cone near the distal margin and does not bear long extra hairs. The females cannot be separated but *lonicera* is more southern than *lita* and reaches the boundary of our area only in Maryland. Illustrations are with the original description.

Type locality: Laurel Fork, south of Blountsville, Alabama. Type at Illinois Natural History Survey.

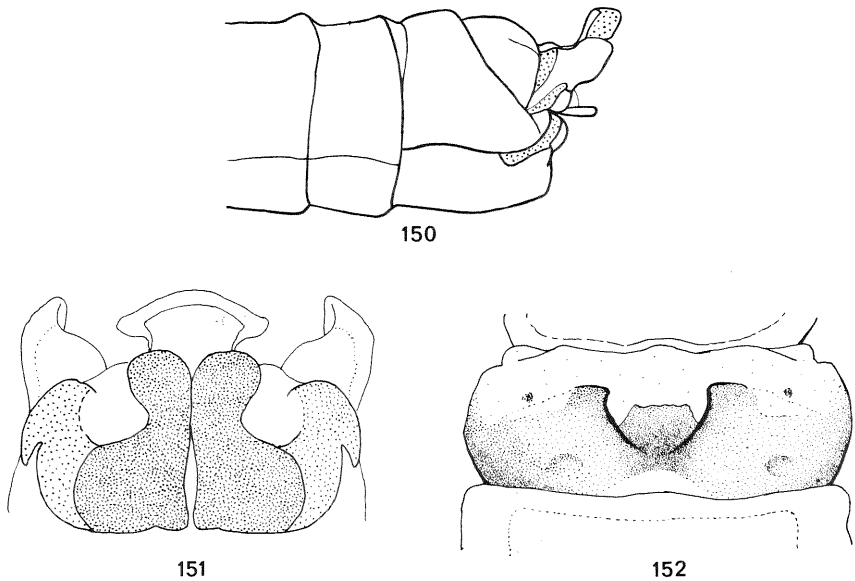
Range: Maryland south to Georgia and west to Tennessee and Mississippi.

4. *Taeniopteryx maura* (Pictet) (figs. 18, 26, 147a, 153-155)

Nemoura maura Pictet, 1841, Perlides: 361.

Length: 8-14 mm.

Description: This species is distinguished from the closely related *burksi* only by the strong projections on the hind femora of the male. It is one of those species with a vesicle on the 9th sternite and straight, pointed paraprocts. The females can-



Taeniopteryx lonicera

Fig. 150. Male, lateral view of posterior abdominal segments.

Fig. 151. Male, paraprocts.

Fig. 152. Female, ventral view of subgenital plate.

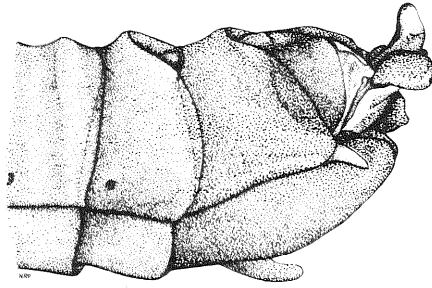
not be separated from those of *burksi*. The taxonomic concept of this species was enlarged by Frison (1942) to include *nivalis* but the specimens included were later divided among *nivalis*, *burksi*, and *maura* by Ricker and Ross (1968). Needham and Claassen (1925) illustrated the adult male genitalia and wings, Harper and Hynes (1971a) the larva.

Gaufin (1958) found *T. maura* the most tolerant of all stoneflies to organic enrichment in polluted streams. Frison (1929) had earlier noted that the closely related *nivalis* (= *burksi*) was more often found in areas of decaying vegetation than other stoneflies. Nebeker and Lemke (1968) and Bell and Nebeker (1969) further discovered that 50 percent of a larval test group could withstand a water temperature of 21°C or a pH of 3.25.

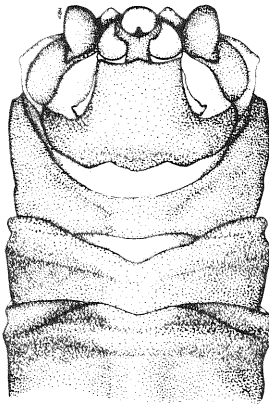
Type locality: Pennsylvania. Type missing.

Range: The Maritimes south to Georgia and west to Indiana and Arkansas.

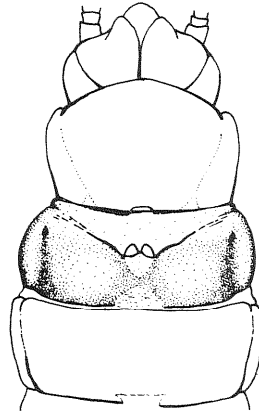
Connecticut records: Bethlehem, Mar. 13, 1965 (SWH); Botsford, Mar. 9, 1962, Mar. 12, 1965 (SWH); Colebrook, Mar. 3, 1965, Mar. 14, 1962 (SWH); East Plymouth, Mar. 21, 1960 (SWH); Granby, Mar. 3, 1965 (SWH); Hartland, Mar. 14, 1962 (SWH); Harwinton, Mar. 13, 1965, Mar. 21, 1960 (SWH); Kent, Feb. 26, 1964 (SWH); Marlborough, Mar. 24, 1963 (SWH); Middlebury, Mar. 1, 1961, Apr. 1, 1959 (SWH); Middletown, Mar. 21, 1959 (SWH); Monroe, Mar. 9, 1961 (SWH); Mt. Carmel, Feb. 20, 1961, Feb. 27, 1958, Feb. 27, 1959 (SWH); Naugatuck,



153



154



155

Taeniopteryx maura, posterior abdominal segments

Fig. 153. Male, lateral view.

Fig. 154. Male, dorsal view.

Fig. 155. Female, ventral view.

Mar. 1, 1961 (SWH); Newtown, Mar. 9, 1962 (SWH); Oxford, Mar. 21, 1960 (SWH); Plymouth, Mar 12, 1965 (SWH); Southbury, Mar. 9, 1962, Mar. 21, 1960 (SWH); Storrs, Feb. 15, 1956, Slater (UC); West Cornwall, Mar. 21, 1960 (SWH); Winchester, Mar. 14, 1962 (SWH); Winsted, Mar. 14, 1962 (SWH); Woodbury, Feb. 27, 1964, Mar. 13, 1965 (SWH).

5. *Taeniopteryx metequi* Ricker and Ross (fig. 156)

Taeniopteryx metequi Ricker and Ross, 1968, J. Fish. Res. Bd. Can. 25: 1431.

Length: 5.5-11.5 mm.

Description: The paraprocts of male *metequi* are shown in Fig. 156. The inner angle is subacute and the hind margin bears a club-shaped process. There is no vesicle. The female is indistinguishable from *nivalis*, although many individuals appear to

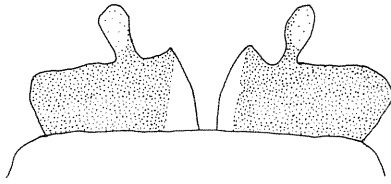


Fig. 156. *Taeniopteryx metequi*, male paraprocts (after Ricker and Ross, 1968).

carry the sclerotized lateral extensions of the V notch of the 8th sternite somewhat forward, rather than slightly posteriorly as does *nivalis*. Figures of the adult are with the original description; Harper and Hynes (1971c) figured the larva.

Type locality: Hayes Creek, Glendale, Illinois. Type at Illinois Natural History Survey.

Range: Ontario south to Alabama and west to Illinois and Oklahoma.

6. *Taeniopteryx nivalis* (Fitch) (fig. 157)

Nemoura nivalis Fitch, 1847, Am. Quart. Jour. Agric. and Sci. 5: 279 (reprinted by J. A. Lintner, 1885, Report N. Y. State Entomol. 2: 240)

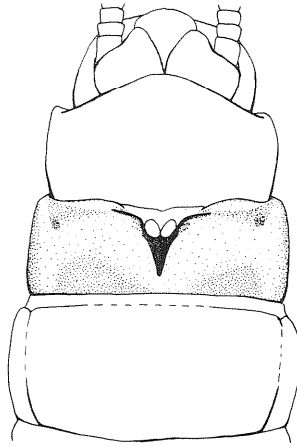


Fig. 157. *Taeniopteryx nivalis* female, ventral view of posterior abdominal segments.

Length: 11-17 mm.

Description: This species was put into the synonymy of *T. maura* by Frison (1942) but was subsequently separated again by Ricker and Ross (1968). The male bears a vesicle that is not as long as in other *Taeniopteryx* species and has no spurs or projections on the hind femur. The hairs on the hind margin of the 9th sternite (unlike those of *maura* and *burksi*) are not noticeably longer than the more anterior

hairs. The female has a strongly sclerotized, V-shaped notch on the 8th sternite and is very similar to *metequi*. The *nivalis* illustrated by Frison (1929, 1935) are actually *burksi*, according to Ricker and Ross (1968). Needham and Claassen (1925) illustrated the female; Harper and Hynes (1971c) and Claassen (1931) the larva.

Harper and Hynes (1970) determined that the eggs hatch soon after deposition but the larvae enter a diapause stage during the summer. Rapid larval growth occurs from October through the winter months (Coleman and Hynes, 1970).

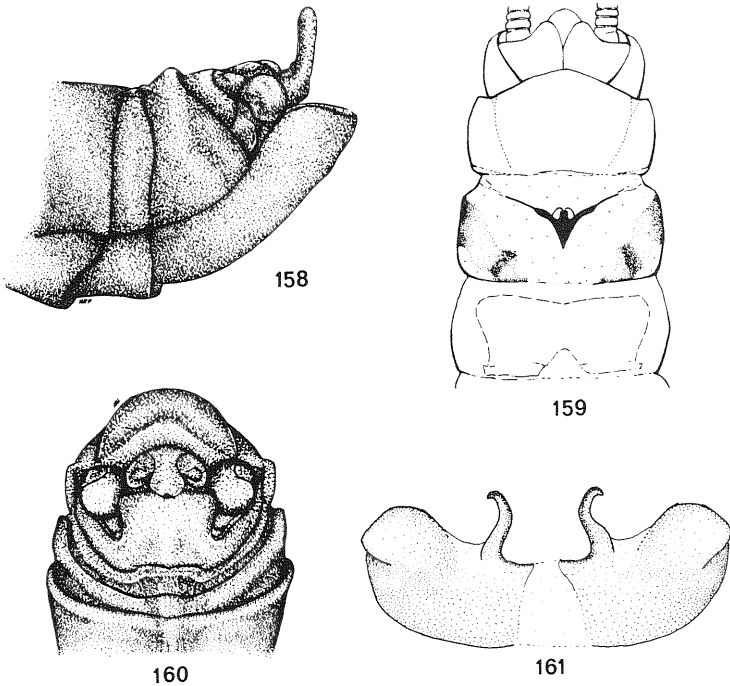
Type locality: New York state. Type missing.

Range: The Maritimes south to Pennsylvania and west to Minnesota and Illinois. It also occurs in the area bounded by northern California, Oregon, and Idaho.

Connecticut records: Clinton, Apr. 7, 1969 (SWH); Hamden, Feb. 24, 1961 (SWH); Mt. Carmel, Feb. 20, 1960, Feb. 27, 1958, 1959, Mar. 7, 21, 1960 (SWH).

7. *Taeniopteryx parvula* Banks (figs. 158-161)

Taeniopteryx parvula Banks, 1918, Bull. Mus. Comp. Zool. 62: 7.



Taeniopteryx parvula

Fig. 158. Male, lateral view of posterior abdominal segments.

Fig. 159. Female, ventral view of posterior abdominal segments.

Fig. 160. Male, dorsal view of posterior abdominal segments.

Fig. 161. Male, paraprocts.

Length: 9-14 mm.

Description: *T. parvula* is distinctive in both sexes. The male lacks a vesicle and has pointed, hooked paraprocts. The female 8th sternite is only very lightly sclerotized, in contrast to the dark color of the V notch. Further figures of this species were given by Frison (1935, 1942). Frison stated that the adults feed on blue-green algae. Harden and Mickel (1952) observed a male crawling on ice beneath the surface of the water near a cast larval skin from which it had probably emerged. Although widespread, *parvula* is never as common in Connecticut as other *Taeniopteryx*.

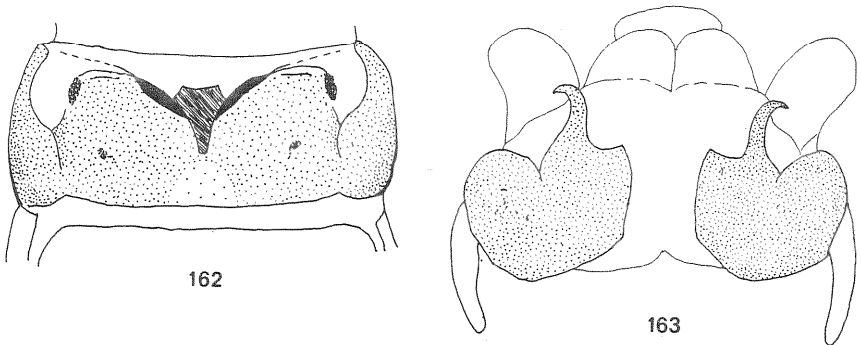
Type locality: Peach Grove Hill, Virginia. Type in Museum of Comparative Zoology, Harvard University.

Range: Hudson's Bay and the Maritimes south to Georgia and west to Manitoba and Arkansas.

Connecticut records: Chaplin, Mar. 19, 1964 (SWH); Colebrook, Mar. 3, 1965 (SWH); Madison, Feb. 27, 1959 (SWH); Mansfield, Feb. 27, 1956, Michelson (UC), Mar. 1954, Slater (UC); Storrs, Feb. 15, 1956, Slater (UC), Mar. 20, 1954, Kessner (UC).

8. *Taeniopteryx ugola* Ricker and Ross (figs. 162, 163)

Taeniopteryx ugola Ricker and Ross, 1968, J. Fish. Res. Bd. Can. 25: 1437.



Taeniopteryx ugola (after Ricker and Ross, 1968)
Fig. 162. Female, ventral view, showing subgenital plate.
Fig. 163. Male, paraprocts.

Length: 8-11.5 mm.

Description: The curved, hooked paraprocts of the male very closely resemble those of *parvula*. However, unlike *parvula*, *ugola* bears a vesicle on the 9th sternite. The female appears intermediate between *burksi-maura* and *nivalis-metequi*. There is a larger sclerotized area on the "shoulders" of the V-shaped notch of the 8th sternite than in these other species. Further illustrations were given by Ricker and Ross (1968).

Type locality: Fellowsville, West Virginia. Type at Illinois Natural History Survey.

Range: Has apparently been collected only in Tennessee and West Virginia.

GENUS *Brachyptera* NEWPORT

Brachyptera Newport, 1849 (1848), Proc. Linn. Soc. London 1: 389.

These insects are members of the spring and early-summer fauna. Adults feed on the buds and young foliage of trees and shrubs and occasionally have caused slight damage to fruit orchards in the Pacific Northwest. According to Newcomer (1918) the favored native plants of adult *pallida* and *nigripennis* are (in order) thimbleberry, alder, willow, wild rose, serviceberry, and maple.

Brachyptera are recognized by the fact that the glossae are approximately the same length as the paraglossae, the 3 tarsal segments are of subequal length, there are no gills in the larvae and no gill-remnant scars on the adult coxae. Both larvae and adults are brown or black, without colorful patterns.

Type of genus: *Nemoura trifasciata* Pictet.

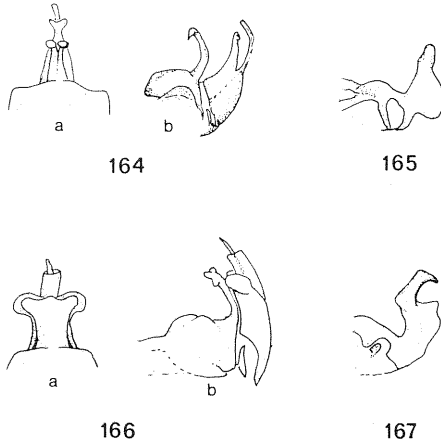


Fig. 164. *Brachyptera contorta*, 10th tergite and epiproct: a, dorsal view; b, lateral view.

Fig. 165. *B. fasciata*, epiproct.

Fig. 166. *B. glacialis*, 10th tergite and epiproct: a, dorsal view; b, lateral view.

Fig. 167. *B. pacifica*, epiproct.

KEYS TO NORTHEASTERN SPECIES

MALES

- 1. Vesicle on 9th abdominal sternite (fig. 183) 2
- No vesicle on 9th abdominal sternite (fig. 171) 3

2. 10th tergite with 2 long, pointed projections proximally; 9th sternite ending in sickle- or club-shaped structure (figs. 183, 184) 5, *rossi*
 10th tergite without projections proximally; 9th sternite smoothly rounded distally (fig. 164) 1, *contorta*
3. 10th tergite with 2 projections near anterior margin, extending backward (in some individuals hidden under posterior margin of 9th tergite) (fig. 180) 4, *pacifica*
 10th tergite without projections near anterior margin 4
4. Forewing normal, generally with 2 lobes on posterior margin of the 9th tergite (fig. 172) 2, *fasciata*
 Forewing less than half as long as hindwing; no lobes on 9th tergite (fig. 176) 3, *glacialis*

FEMALES⁸

1. Subgenital plate narrowed posteriorly, sides somewhat concave basally (fig. 173) 2, *fasciata*
 Subgenital plate rounded or evenly tapered (fig. 177) 2
2. Pronotum and posterior part of head light, with darker rugosities (fig. 182) 4, *pacifica*
 Pronotum and head dark but many specimens have light spots (figs. 170, 178) 3
3. Subgenital plate evenly tapered and reaching beyond subanal lobes (fig. 177); size, 15 mm or more; head pattern varying from that given in figure 178 to completely dark 3, *glacialis*
 Subgenital plate rounded (fig. 169); less than 15 mm long; head completely dark or with a light line between the posterior ocelli (fig. 170) 1, *contorta*

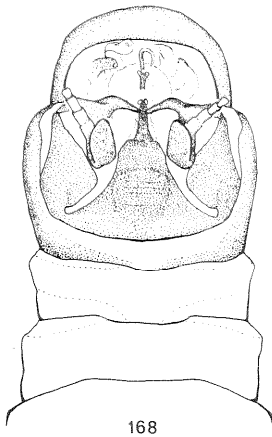
LARVAE

(from Harper and Hynes, 1971c)

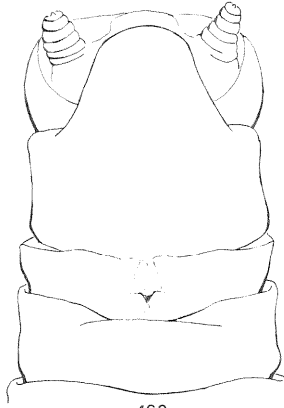
1. Dorsum yellow, with a distinct darker pattern 2, *fasciata*
 Dorsum uniformly brown, in some individuals with indistinct lighter areas 2
2. All cercal segments with a terminal whorl of very short bristles 4, *pacifica*
 Proximal cercal segments, with the whorl containing long dorsal bristles 3, *glacialis*
1. *Brachyptera (Oemopteryx) contorta* (Needham and Claassen) (figs. 164, 168-170)

Taeniopteryx contorta, Needham and Claassen, 1925, Monog. Plec. Am. No. Mex.: 242.

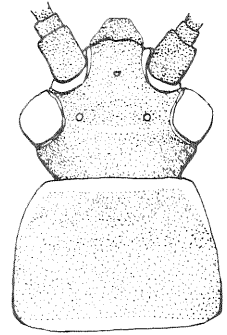
⁸Female of *rossi* not known.



168



169



170

Brachyptera contorta

Fig. 168. Male, ventral view of posterior abdominal segments.

Fig. 169. Female, ventral view of posterior abdominal segments.

Fig. 170. Female, dorsal view of head and pronotum.

Length: 10-11.5 mm.

Description: The males of this species and of *rossi* are the only Northeastern *Brachyptera* males with a lobe on the 9th sternite. However, unlike *rossi*, *contorta* does not have 2 pointed projections on the 10th tergite.

As with other *Brachyptera*, the parts of the male genitalia are difficult to homologize without detailed study. The subanal lobes are asymmetrical and both are divided into 2 parts. A flat plate (more heavily sclerotized on the right side) bears a small hairy lobe at its base. Connected to the right-hand plate is a membranous corkscrew-like structure. Connected to the left-hand plate is a slightly sclerotized hook. The presumed end of the aedeagus protrudes and is recurved, sclerotized, and whiplike. The 10th tergite narrows posteriorly and then curves upward into 2 small lobes. Another heavily sclerotized plate (the presumed epiproct) is behind and below the 10th tergite, with its posterior margin also curved upward into a prong. A membranous lobe envelops the bases of the epiproct as well as the base of the "whip." Touching the posterior corners of the 10th tergite, 2 additional plates end in pointed hooks that almost touch at the midline. Each cercus has a basal lobe.

The female has a broad, rounded, subgenital plate. The genital opening is bordered by 2 lightly sclerotized lobes but does not have strong sclerotization anterior to the opening.

Both sexes are very dark but many individuals have a light-colored line running between the 2 rear ocelli.

Type locality: Jaffrey, New Hampshire. Type at Cornell University.

Range: Apparently of sporadic but widespread distribution; it has been recorded from New Hampshire, Connecticut, and Virginia.

Connecticut records: Haddam, Apr. 3, 7, 1969 (SWH); Storrs, Feb. 15, 1956, J. Slater (UC).

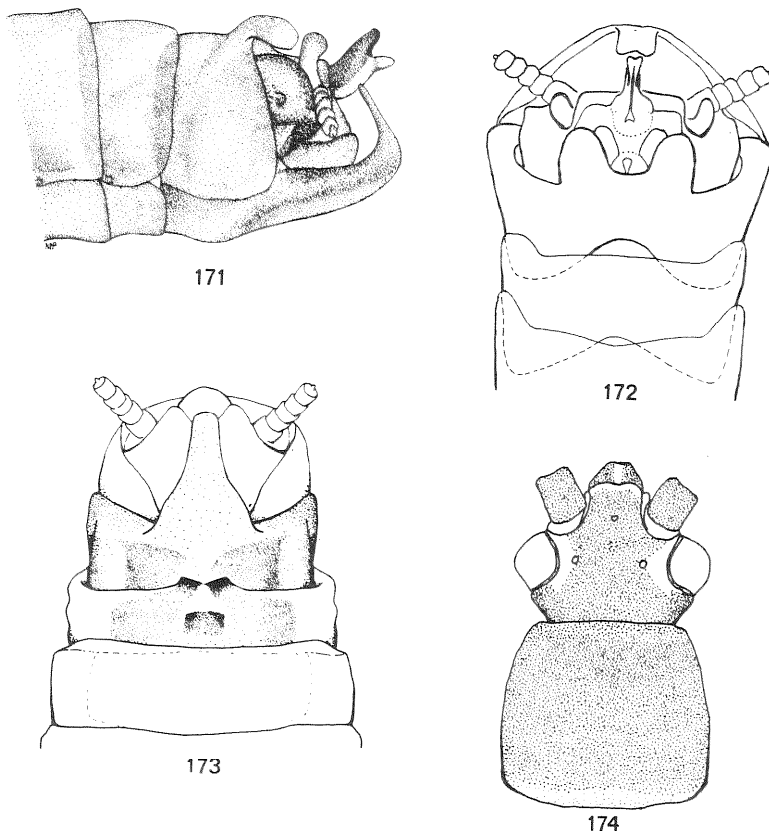
2. *Brachyptera (Strophopteryx) fasciata* (Burmeister) (figs. 165, 171-174)

Semblis fasciata Burmeister, 1839, Handb. Entomol. 2: 875.

Taeniopteryx frigida Hagen, 1861, Syn. Neur. No. Am.: 35.

Length: 10-15 mm.

Description: This is a widespread, numerous, and easily recognized species. Most males have 2 conspicuous lobes on the posterior margin of the 9th tergite and the 9th sternite is abruptly narrowed and recurved distally, ending in a bluntly bifurcate tip. The epiproct, connected to the 10th tergite by 3 sclerotized bands, varies some-



Brachyptera fasciata

Fig. 171. Male, lateral view of posterior abdominal segments.

Fig. 172. Male, dorsal view of posterior abdominal segments.

Fig. 173. Female, ventral view of posterior abdominal segments.

Fig. 174. Female, dorsal view of head and pronotum.

what in shape but is a sclerotized projection, with an unsclerotized protrusion of variable size on the rear surface. It is possible that this unsclerotized area is inflatable. The female subgenital plate ends in a narrow tongue-like protrusion, with the margins subparallel before the tip. The adult head and pronotum are dark brown, except for a light area between each lateral ocellus and the eye. This color pattern seems more consistent than those of other species of *Brachyptera*. Adults and larvae have been illustrated by Needham and Claassen (1925), Frison (1929, 1942, 1935), and Harper and Hynes (1971c).

B. fasciata is found over quite a range of stream size but apparently not in small leaf-choked brooklets. Frison (1929) observed the adults feeding on blossoms in the upper branches of elms. He found that larval stomachs contained fragments of decaying leaves and 7 species of diatoms. The female mated soon after emergence. The egg mass was held under the abdomen and released as the female briefly alighted on the water. Harper and Hynes (1970) found that the eggs hatched immediately but the 3rd-instar larva diapaused over the summer.

Type locality: Pennsylvania. The type specimen was probably in Berlin before World War II (Ricker, 1938).

Range: Quebec south to North Carolina and west to Minnesota and Kansas.

Connecticut records: Bethlehem, Apr. 14, 1967 (SWH); Bristol, Apr. 1, 1959 (SWH); Brooklyn, Mar. 19, 1964 (SWH); Chester, Apr. 1, 1965 (SWH); Clinton, Apr. 7, 1969 (SWH); East Willington, Apr. 5, 1968 (SWH); Eastford, Apr. 5, 1968 (SWH); Easton, Apr. 5, 1964 (SWH); Gurleyville, Mar. 17, 1959 (SWH); Hamden, Apr. 25, 1940, S. Ball (YU); Harwinton, Mar. 21, 1960 (SWH); Hotchkissville, Mar. 16, 1964 (SWH); Huntsville, Apr. 3, 1959 (SWH); Killingworth, Apr. 1, 5, 1964 (SWH); Madison, Apr. 3, 1969 (SWH); Mansfield, Mar. 25, 1963 (SWH), Apr. 15, 1964, L. Schauer (UC); Marion, Apr. 1, 1959 (SWH); Milton, Mar. 16, 1964 (SWH); Mt. Carmel, Mar. 21, 1960 (SWH); New Canaan, Apr. 13, 1960 (SWH); North Guilford, Mar. 21, 1959 (SWH); Oxford, Mar. 21, 1960 (SWH); Plymouth, Mar. 21, 1960 (SWH); Redding and Redding Ridge, Mar. 24, 1962, 1964, Apr. 1, 3, 8, 1963, Apr. 13, 1960 (SWH); Sharon, Mar. 16, 1964 (SWH); Southbury, Mar. 21, 1960 (SWH); Stafford, Apr. 23, 1964 (SWH); Storrs, Apr. 24, 1964, D. DeLoy (UC); Wallingford, Apr. 19, 1959, J. Kring; West Goshen, Apr. 1, 1959 (SWH); Wilton, Apr. 13, 1960 (SWH); Winchester, Apr. 14, 1967 (SWH); Woodbridge, Apr. 6, 1959, A. DeCaprio (SWH), Apr. 23, 1961, C. Remington (YU); Woodstock, Mar. 28, 1963, Apr. 23, 1964 (SWH).

3. *Brachyptera (Oemopteryx) glacialis* (Newport) (figs. 166, 175-178)

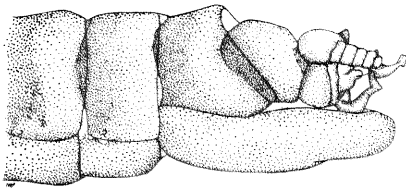
Nemoura (Brachyptera) glacialis Newport, 1849 (1848) Proc. Linn. Soc. London 1: 389.

Perla chicutimiensis Provancher, 1878, Petite Faune Can., Névr: 75.

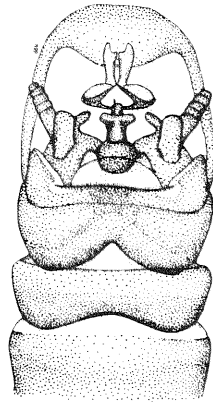
Taeniopteryx alex Hanson, 1938, Bull. Brooklyn. Entomol. Soc. 33: 79.

Length: 9-26 mm.

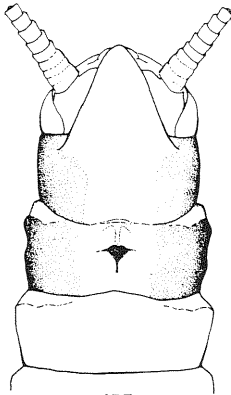
Description: This is the only Eastern species of *Brachyptera* in which the males have brachypterous forewings. As usual in this genus, the male genitalia are complicated. The 10th tergite narrows posteriorly and then is curved upward, ending in a trifurcate tip. Another plate behind and below, the presumed epiproct, curves



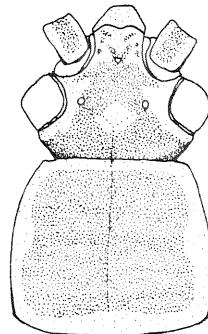
175



176



177



178

Brachyptera glacialis

- Fig. 175. Male, lateral view of posterior abdominal segments.
Fig. 176. Male, dorsal view of posterior abdominal segments.
Fig. 177. Female, ventral view of posterior abdominal segments.
Fig. 178. Female, dorsal view of head and pronotum.

upward to end in a broadly bilobed structure just behind the 10th tergite. Behind this is the whiplike tip of the presumed aedeagus. The cerci bear lobes at their base and are associated with the 2 inwardly projecting plates that extend from the postero-lateral corners of the 10th tergite. These structures are notably similar to those of *contorta* but the subanal lobes are more symmetrical in *glacialis* and different in shape.

The female subgenital plate is quite long, extending beyond the subanal lobes. The genital opening is just before the hind margin of the 8th sternite and in most specimens there is a darker, sclerotized, triangular area anterior to it. The color pattern of the head and pronotum ranges from that given in fig. 178 to almost completely dark.

Connecticut specimens are much smaller than those recorded by Hanson (1938). His males were 17 mm and his females 26 mm to the apex of the wings. Mine are about 11 mm and 16 mm, respectively. Species of *glacialis* previously recorded from western North America have been separated as distinct species by Ricker (1965). Harden and Mickel (1952) had some evidence that this species can emerge under water. Females possibly feed high up in trees (as do those of *fasciata*), as suggested by the fact that males are notably preponderant in collections of adults. The larva was figured by Hardin (1942), Harden and Mickel (1952), and Harper and Hynes (1971c); the adult by Hanson (1938) and Ricker (1938).

Connecticut records: Atwoodville, Mar. 19, 1964 (SWH); Chaplin, Mar. 19, 1964 (SWH); Gurleyville, Mar. 17, 1959 (SWH); Mansfield, Mar. 12, 1954, J. Slater (UC), Mar. 20, 1955, Miller (UC), Mar. 25, 1963 (SWH); Mansfield Center, Mar. 1954, J. Slater (UC); Storrs, Feb. 15, 1956, J. Slater (UC); Woodstock, Mar. 28, 1963 (SWH).

4. *Brachyptera (Taenionema) pacifica* (Banks) (figs. 167, 179-182)

Taeniopteryx pacifica Banks, 1900, Trans. Am. Entomol. Soc. 26: 244.

Taenionema analis Banks, 1905, Psyche J. Entomol. 12: 57.

Length: 12-15 mm.

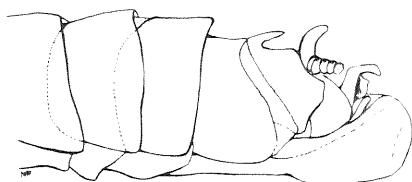
Description: The male is most easily recognized by the 2 projections on the hind margin of the 10th tergite although these are concealed in some individuals by the posterior margin of the 9th tergite. The male epiproct is simple and curved. The female subgenital plate is broadly rounded. In alcohol, the prothorax is light brown with darker rugosities but in life this difference is not so clear cut. Adult genitalia and wings were shown by Needham and Claassen (1925); larva by Harper and Hynes (1971c); egg by Knight and his co-workers (1965b).

This is one of the few stoneflies found on both Coasts and was the first to be implicated in causing economic damage. Newcomer (1918), investigating complaints of damage to foliage and flowers of budding fruit trees, found adults of this insect responsible. They are bothersome to apricots, peaches, and plums but not to cherry or apple. In uncultivated areas they feed on the young leaves of wild rose, wild cherry, alder, and American elm. They also feed on the leaves and catkins of willows. Schuh and Mote (1948) reported them as minor pests, skeletonizing the leaves of raspberries and plums in Oregon.

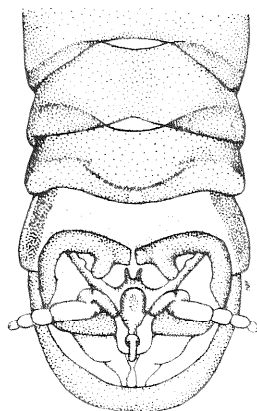
Type locality: Pullman, Washington. Type in museum of Comparative Zoology, Harvard University.

Range: In the West from British Columbia to California and east to Alberta and Colorado; the East Coast from Labrador to Virginia.

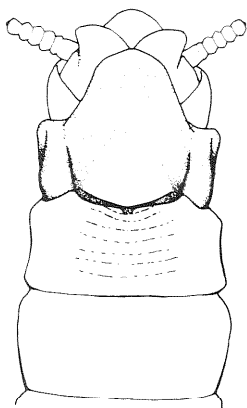
Connecticut records: Barkhamsted, May 20, 1960 (SWH); Bethlehem, Apr. 14, 1967 (SWH); Canton, May 20, 1960 (SWH); East Hampton, Apr. 17, 22, 1963 (SWH); Easton, May 4, 5, 1964 (SWH); Granby, Apr. 13, 16, 19, 1964 (SWH); Hartland, Apr. 13, 15, 1964 (SWH); Kent, May 3, 1966 (SWH); Redding, Mar. 24, 1963, Mar. 24, 1964, May 7, 1965 (SWH); Redding Ridge, Apr. 2, 5, 1964, Apr. 8, 1963 (SWH); Storrs, Apr. 4, 1957 (UC); Woodbridge, Apr. 23, 1961, C. Remington (YU); Woodstock, Apr. 23, 1964 (SWH).



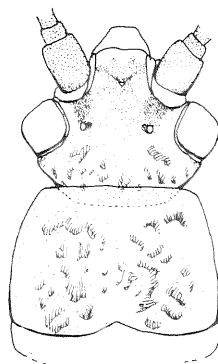
179



180



181



182

Brachyptera pacifica

Fig. 179. Male, lateral view of posterior abdominal segments.

Fig. 180. Male, dorsal view of posterior abdominal segments.

Fig. 181. Female, ventral view of posterior abdominal segments.

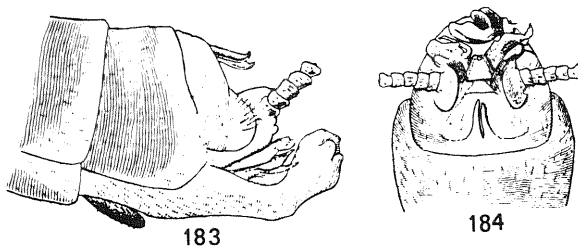
Fig. 182. Female, dorsal view of head and pronotum (in alcohol).

5. *Brachyptera (Taenionema) rossi* Frison (figs. 183, 184)

Brachyptera rossi Frison, 1942, III. Nat. Hist. Surv. Bull. 22: 254.

Length: 13 mm.

Description: This is an exceedingly rare species, known only from the holotype. It may be recognized in the male by the 2 narrow posterior projections on the 10th tergite and the irregular lobing of the 9th sternite. It shares with *contorta* the distinction of being the only eastern *Brachyptera* with a vesicle (subanal lobe) on the



Brachyptera rossi male, posterior abdominal segments (from Frison, 1942)
 Fig. 183. Lateral view. Fig. 184. Dorsal view.

9th sternite. The female is unknown. Figures of adult genitalia and wings are with the original description.

Type locality: Near Woodstock, New Hampshire. Type at Illinois Natural History Survey

Range: Unknown but may extend into Quebec (Ricker, Malouin, Harper, and Ross, 1968).

FAMILY PELTOPERLIDAE

This is a family of uncertain affinities that is found in North America and southeastern Asia. The larvae are cockroachlike, with a single large tergal and sternal plate on each thoracic segment. Gills are fleshy and fingerlike. There are 8 abdominal ganglia. The adult cerci are many segmented and in some genera have the basal segments modified. The male epiproct is generally sclerotized but the paraprocts are often inconspicuous. A vesicle is present on the male 9th sternite.

GENUS *Peltoperla* NEEDHAM

Peltoperla Needham, 1905, Proc. Biol. Soc. Wash. 18: 107.

This is a somewhat aberrant genus that does not appear to be closely related to any other stonefly. Most adults have 2 ocelli and many costal cross-veins. The thoracic sternae consist of large single plates, with the metasternal apophyseal pits large and placed centrally on the sternite. The head is generally somewhat withdrawn beneath the pronotum; the glossae are subequal in length to the glossae; and the 3rd tarsal segment is longer than the first 2 combined.

The larva is cockroachlike; brown, flattened, with overlapping thoracic shields on both dorsum and sternum. Lestage (1927) has illustrated the various parts of the immature form.

There are only 2 species found in northeastern United States. However, immediately to the south, in the Appalachians, there are several other species. Other species occur in the Far West. Ricker (1952) gives a key to the females of the subgenus *Peltoperla*, including the following 2 species.

Type of genus : *Peltoperla arcuata* Needham.

KEY TO ADULTS OF NORTHEASTERN SPECIES

1. Vesicle (basal lobe) at base of 9th sternite (fig. 187), males 2
9th sternite unmodified, females 3
 2. Cerci abruptly curved a short distance from base (fig. 186)
. 1, *arcuata*
Cerci normal and extended posteriorly without abrupt curve (fig. 188)
. 2, *maria*
 3. 8th sternite slightly produced and emarginate (fig. 189) 2, *maria*
8th sternite rounded and produced over half of 9th sternite
. 1, *arcuata*
1. *Peltoperla arcuata* Needham (figs. 185, 186)

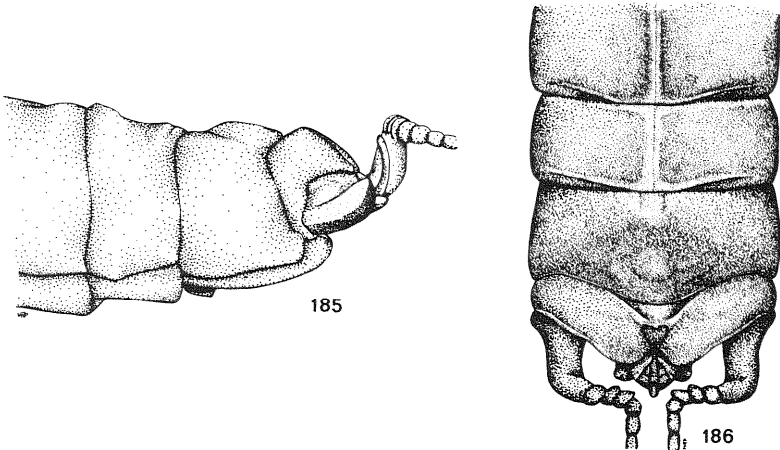
Peltoperla arcuata Needham, 1905, Proc. Biol. Soc. Wash. 18: 108.

Length: 14-18 mm.

Description: Males of this species differ from all other *Peltoperla* by having the cerci sharply curved toward each other a short distance from the base. The female 8th sternite is rounded and considerably produced over the 9th. However, occasional *maria* females also have rounded subgenital plates and are difficult to separate to species in the absence of the male.

Type locality: Ithaca, New York. Type at Cornell University.

Range: Southern Quebec south to Virginia and west to Pennsylvania and New York. Apparently it occurs sparingly, if at all, in New England.



Peltoperla arcuata male, posterior abdominal segments
Fig. 185. Lateral view. Fig. 186. Dorsal view.

2. *Peltoperla maria* Needham and Smith (frontispiece; figs. 19, 27, 187-190)

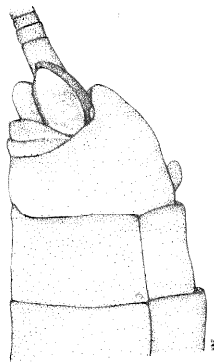
Peltoperla maria Needham and Smith, 1916, Can. Entomol. 48: 82.

Peltoperla cornelia Needham and Smith, 1916, Can. Entomol. 48: 84.

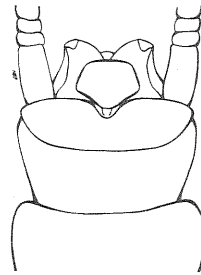
Peltoperla dorothea Needham and Smith, 1916, Can. Entomol. 48: 84.

Length: 12-18 mm.

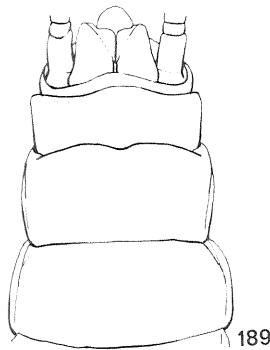
Description: The male of this species is easily separated from *arcuata* because it does not have the sharply curved cerci of the latter. When compared to males from more southern species, there do not appear to be any consistent distinguishing characters. The female has the 8th sternite produced, with a slight notch on the midline. However, the posterior margin varies from a distinct, broad notch, to a mere sinuosity, to a rounded subgenital plate. The female illustrated appears to be the most common form. The larvae cannot be distinguished from those of *arcuata*.



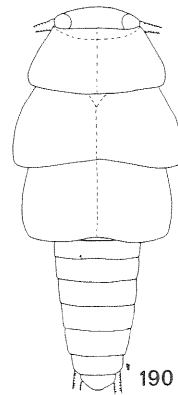
187



188



189



190

Peltoperla maria, posterior abdominal segments

Fig. 187. Male, lateral view (near cercus removed).

Fig. 188. Male, dorsal view.

Fig. 189. Female, ventral view.

Fig. 190. Larva, dorsal view.

The larvae feed on detritus and decaying leaves in streams. They hatch shortly after the eggs are deposited but grow little until late fall. In the laboratory adults feed avidly on a mixture of honey and water, suggesting that in the field they feed on sap or plant exudations. *P. maria* is a common species in smaller streams where dead leaves collect. Wallace, Woodall, and Sherberger (1970) found that the larvae skeletonized the fallen leaves of elm, alder, sourwood, and dogwood, preferably. Rhododendron, white pine, white oak, and chestnut oak were least preferred. Feeding by *Peltoperla* reduced the organic load of intact leaves within the stream but increased the dissolved organic content, as tannic acid was leached from *Peltoperla* feces. Although Wallace and his co-workers apparently lacked adult stoneflies and thus did not have certain specific identification, this feeding pattern undoubtedly is generally valid for most, if not all, eastern *Peltoperla*.

Hall and Groves (1963) found that, out of several tested, only 1 trematode cercaria would infect *Peltoperla*. Although they did not indicate the species, it was, most likely, *maria*.

Type locality: Pelham, Massachusetts. Type at Cornell University.

Range: Northern Georgia to Vermont but apparently not west of the Appalachians.

Connecticut records: Ansonia, A. Robelmann (UC); Barkhamsted, June 7, 12, 1967 (SWH); Burlington, G. Smith and J. Lewis (UC); Cheshire, D. Bennett (UC); Coventry, D. Peckham (UC); Ellsworth, June 7, 1967 (SWH); Hartland, June 2, 1965 (SWH); Kent, June 12, 1967 (SWH); Mt. Carmel, June 6, 18, 1968 (SWH); larvae from Norwich, S. White (UC); Salisbury, C. Dater (UC); Simsbury, F. Pocius (UC); Staffordville (SWH); Storrs, many student collectors (UC); Vernon, C. Data, J. Ernst, E. Dennis, H. Masurier, D. Peckham (UC); Willington, O. Taylor and J. Ernst (UC); Windsor, P. Leuthold (UC); Yantic, Lotring (UC).

FAMILY PERLIDAE

This family is characterized by thoracic gills that are finely branched tufts, appearing on all 3 thoracic segments. The paraglossae are broadly rounded. The male epiproct is reduced and inconspicuous; the adult cerci are long; there are 6 abdominal ganglia. There are 2 subfamilies. The Perlinae, occurring in Africa, Eurasia, and eastern North America, have the male 10th tergite cleft and the genital hooks as outgrowths from this tergite. The Acroneuriinae, occurring in eastern Asia and North and South America, have the male 10th tergite complete, with the genital hooks modified from the paraprocts. Additionally there is commonly an enlarged knob on the 9th sternite, the "hammer."

GENUS *Paragnetina* Klapálek

Paragnetina Klapálek, 1907, Rozpravy České Akad. 16(31): 17.

Banksiella Klapálek, 1921, Ann. Soc. Entomol. Belg. 61: 147 (preoccupied)

Banksiana Claassen, 1936, Ann. Ent. Soc. Am. 29: 622.

Paragnetina is in the subfamily Perlinae of the family Perlidae and is characterized by remnants of tufted thoracic gills, 3 ocelli, no anal gills, a prosternum and mesosternum with a Y-shaped medial ridge, the 10th tergite cleft dorsally in the male, with genital hooks arising from the side

of this cleft and extending anteriorly to the hind margin of the 9th tergite. The larvae, in addition to tufted thoracic gills, have a row of spinules on the occipital ridge.

Ricker (1949) reviewed and keyed all North American species.

Type of genus: *Perla tinctipennis* McLachlan

KEYS TO NORTHEASTERN SPECIES

MALES

1. 5th abdominal tergite produced posteriorly 2
 5th abdominal tergite not produced (fig. 193) 2, *kansensis*
2. Process of 5th tergite very shallowly notched or almost smooth;
 genital hooks rounded apically (figs. 195, 196) 3, *media*
 Process of 5th tergite narrowly and distinctly notched, genital hooks
 with apical point or spine (fig. 191) 1, *immarginata*

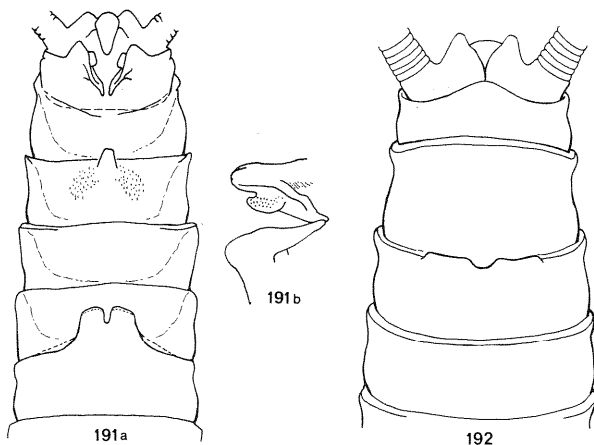
FEMALES

1. Subgenital plate narrowly notched, with produced lip on each side of
 notch (figs. 194, 197) 2
 Subgenital plate excavated medially, with no produced lip at each
 side (fig. 192) 1, *immarginata*
2. Subgenital plate triangularly produced part way over 9th sternite;
 yellow median stripe on pronotum (fig. 194) 2, *kansensis*
 Subgenital plate scarcely produced past hind margin of 8th sternite;
 dark median stripe on pronotum (fig. 197) 3, *media*

LARVAE

1. Larvae highly patterned with distinct transverse bands on most or all
 abdominal tergites 1, *immarginata*
 Abdominal tergites uniformly brown or with a few light spots or in-
 distinct streaks on distal segments or (rarely) with faint median
 line 2
 2. Anterior and posterior margins of dorsum of head light and distinctly
 contrasting with dark areas; a few light spots on apical abdominal
 segments 2, *kansensis*
 Anterior and posterior margins of dorsum of head not distinctly con-
 trasting with brown background, margins of light areas not clearly
 defined; abdominal tergites uniformly brown, except rarely a faint,
 light, median line or faint transverse streaks on distal segments
 3, *media*
1. *Paragnetina immarginata* (Say) (figs. 191, 192)

Sialis immarginata Say, 1823, Godman's Western Quarterly Reporter 2: 164.
Perla lurida Hagen, 1861, Syn. Neur. No. Am.: 21.
Acroneuria fumosa Ricker, 1935, Can. Entomol. 67: 262.



Paragnetina immarginata

Fig. 191. a, Male, dorsal view of posterior abdominal segments; b, genital hooks, three-quarters view.

Fig. 192. Female, ventral view of posterior abdominal segments.

Length: 24-39 mm.

Description: The male has a produced 5th tergite with a narrow notch. The female, unlike other *Paragnetina*, has the subgenital plate shallowly excavated and little produced. The larva is very colorful and might be confused with *P. capitata*, except that *immarginata* lacks anal gills. There is some variation in larval color and hairiness. There is, in many individuals, a row of thick, light, fluffy hairs on the midline and occipital ridge of the larva but this tends to disappear in older specimens and the amount undoubtedly depends on the age and past history of the individual. Additional figures of the larva are shown by Claassen (1931); the adult head pattern, wings, genitalia, and eggs were figured by Needham and Claassen (1925); and mandibles, egg, and adult genitalia by Smith (1913).

Smith (1913) noted 3 sizes of larvae, which suggested a 3-year life cycle. She found the larvae to be predacious, feeding on stoneflies, mayflies, and dipterans, but that they did not feed 8 or 10 days before transforming to adults. Her adults did not take solid food but would drink water. They mated soon after emergence, the male using the genital hooks of the 10th segment and the dorsal protrusion of the 5th in copulation. Mating recurred after egg deposition; up to 4 ovipositions took place. For all 4 egg masses, 1,600 eggs was considered about maximum. As with other stoneflies, the egg mass broke apart in contact with the water and the individual eggs became glued to the stream bottom. Length of adult life was 13 days for unmated insects and about 7 days (female) and 10 days (male) for adults kept together.

In late autumn Smith found that some 45 percent of *immarginata* larvae were carrying a phoretic chironomid like that noted below under *media* (Steffan, 1967). Nakahara (1919) discussed synopsis; he found that this insect has 10 chromosomes. Adult emergence takes place over an extended period and is sometimes delayed by cold weather (Harper and Pilon, 1970).

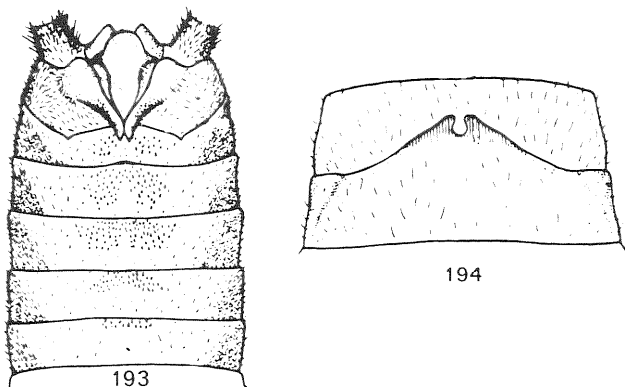
Type locality: Ohio River. Neotype (from Ithaca, New York) at Cornell University.

Range: James Bay and the Maritimes south to Georgia.

Connecticut records: Cornwall, Sept. 17, 1925, L. Woodruff (AMNH); Litchfield, Sept. 16, 1901, L. Woodruff (AMNH); Norfolk, June 26, 1965 (SWH); Washington, at light, Sept. 14, 1961, S. Hessel (YU); Sept 23, 1956, C. Remington (YU); larvae in UC collection are from Ashford, Bethany, Chaplin, Gurleyville, Hampton, Mansfield, Melrose, New Hartford, Storrs, Tolland, Vernon, Willington.

2. *Paragnetina kansensis* (Banks) (figs. 193, 194)

Perla kansensis Banks, 1905, Psyche J. Entomol. 12: 56.



Paragnetina kansensis, posterior abdominal segments (from Frison, 1937)

Fig. 193. Male, dorsal view.

Fig. 194. Female, ventral view.

Length: 18-22 mm.

Description: The male of this species lacks a produced 5th tergite. The female subgenital plate is produced halfway over the 9th sternite, with a narrow notch apically. The larva is darker than *immarginata* but more distinctly marked than *media*. Figures of the male and female were published by Needham and Claassen (1925) and Frison (1937) and of the larvae by Frison (1935) under the name *Togoperla sp. a.*

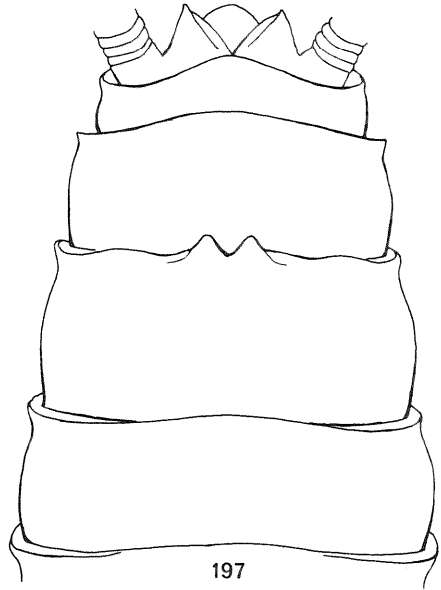
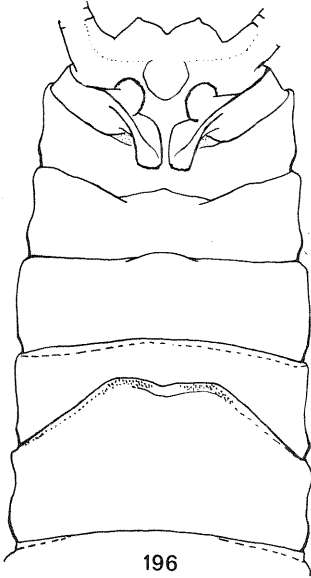
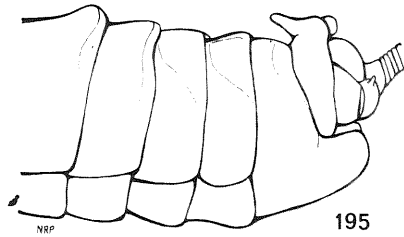
Type locality: Douglass County, Kansas. Type presumably in Museum of Comparative Zoology, Harvard University.

Range: Kansas, Illinois, and Indiana.

3. *Paragnetina media* (Walker) (figs. 1, 195-197)

Perla media Walker, 1852, Cat. Neur. Br. Mus.: 145.

Acroneuria salvelini Ricker, 1935, Can. Entomol. 67: 261.



Paragnetina media, posterior abdominal segments.

Fig. 195. Male, lateral view (near cercus removed).

Fig. 196. Male, dorsal view.

Fig. 197. Female, ventral view.

Length: 18-32 mm.

Description: The male has the produced 5th tergite only broadly excavated. The female subgenital plate is barely produced and narrowly cut. The larvae are dull in color. An occasional individual has whitish marks on the abdomen but they are not clearly defined. Many specimens have long hairs that collect detrital matter and flocculent material, giving them a dirty appearance. Others seem to lack these hairs—they probably have been worn off. One observed *media* larva lacked the row of spinules on the occipital ridge. The eggs and adult of this insect were illustrated by Needham and Claassen (1925), the larva by Claassen (1931), and both adults and larvae by Frison (1935).

This species is found in a wide variety of streams and even in lakes and ponds

(Claassen, 1931). Olson and Rueger (1968) stated that, in contrast to other aquatic orders, larger larval specimens of *P. media* have a higher rate of oxygen consumption than do smaller ones, although the rate is much less than that of some ephemeroids, being about 186.9 cu mm/hr/g live weight. Oxygen consumption is greater in the dark (Zoladek and Kapoor, 1971).

Steffan (1965) found a species of chironomid larva living phoretically on larval *P. media*. The fly larvae lived in gelatinous cases attached to the stonefly and fed on detritus caught on the long hairs of the host. The percentage of *media* carrying the chironomids increased from spring to fall.

Tarter and Krumholz (1971) and Heiman and Knight (1970) summarized much of the known biology of this species and gave the results of their own studies. They found the larva to be carnivorous, feeding principally upon Ephemeroptera (mainly *Baetis vagans*), Trichoptera (mainly *Hydropsyche* and *Cheumatopsyche*), and Diptera (mainly Chironomidae), as well as a few Plecoptera, Coleoptera, and Amphipoda. In March and April the number of diatoms in the gut increased. Almost half of the 477 stomachs examined were empty, particularly in midwinter and early summer. Adults did not feed. Larvae are preyed on by various fishes and crayfish and required 2 years to reach maturity. There was a 1:1 sex ratio and, based on dissected larvae, females produce from 394 to 1,296 eggs (mean 802). Egg masses formed within 1 hour of mating and had a 30-day incubation period at room temperature. The life cycle was 2 years in Kentucky and adult emergence took place between May 6 and August 12. In Canada, the emergence period (in contrast to that of *P. immarginata*) is quite brief (5-25 days), although the exact time shifts from year to year, depending on the temperature (Harper and Pilon, 1970). This insect is of average susceptibility to DDT in streams. For small *P. media* the 14-hr LD₅₀ is 0.33 ppm and for large ones, 0.66 ppm (Hitchcock, 1965). Of all stoneflies tested by Nebeker and Lemke (1968), *P. media* were the most tolerant of warm water: 50 percent survived at 30.5°C for 96 hrs.

Type locality: St. Martin's Falls, Albany River, Ontario, Canada. Type in the British Museum; abdomen of the type specimen is missing and the abdomen of another species has been glued in its place (Ricker, 1938).

Range: The Maritimes south (in the Appalachians) to North Carolina and west to Saskatchewan and Missouri. Ricker (1964) gave a distribution map of this species. In addition to the Connecticut records listed below, there are many larvae from Storrs and Mansfield in the UC collection.

Connecticut records: Hamden, June 29, 1960 (SWH); Kent, June 16-July 26, 1967 (SWH); Mt. Carmel, May 25, 1960, May 23, 1966, June 9, 1959, June 9-12, 1967 (SWH); Redding, May 31, 1962 (SWH); West Cornwall, June 4, 1964, June 19, 1960 (SWH); larvae from Chaplin, Easton, Guilford, Hamden, Hampton, Mt. Carmel, New Haven, Redding, Shelton, Tolland, Weston, Willington (UC and SWH).

GENUS *Phasganophora* Klapálek

Phasganophora Klapálek, 1921, Ann. Soc. Entomol. Belg. 61: 66.
Neophasganophora Lestage, 1922, Bull. Soc. Entomol. Belg. 4: 102.
Harrisiola Banks, 1948, Psyche J. Entomol. 55: 117.

As presently constituted, this genus contains only one North American

species. Adults have remnants of thoracic and anal gills and a Y-shaped-ridge pattern on both prosternum and mesosternum. The male sexual characteristics are distinctive and described under the species. The larvae are colorful and common. They are identified by a row of spines on the occipital ridge and by the presence of anal gills.

Type of genus: *Perla capitata* Pictet.

1. *Phasganophora capitata* (Pictet) (figs. 20, 198-200, 210)

Perla capitata Pictet, 1841, Perlides: 214.

Perla tristis Hagen, 1861, Syn. Neur. No. Am.: 22.

Perla annulipes Hagen, 1861, Syn. Neur. No. Am.: 22.

Perla flavescens Walsh, 1862, Proc. Acad. Nat. Sci. Philadelphia 13: 363.

Perla hieroglyphica Provancher, 1876, Nat. Can. 8: 211.

Perla marginipes Provancher, 1876, Nat. Can. 8: 212.

Perla americana Banks, 1900, Trans. Am. Entomol. Soc. 26: 243.

Perla illustris Banks, 1908, Trans. Am. Entomol. Soc. 34: 256.

Perla innota Banks, 1918, Bull. Mus. Comp. Zool. 62: 6.

Harrisiola nigriscens Banks, 1948, Psyche J. Entomol. 55: 119.

Harrisiola klapaleki Banks, 1948, Psyche J. Entomol. 55: 121.

Harrisiola modesta Banks, 1948, Psyche J. Entomol. 55: 121.

In addition to the above, *Harrisiola abbreviata* Banks, 1948, (Psyche J. Entomol. 55: 122) is probably also a synonym.

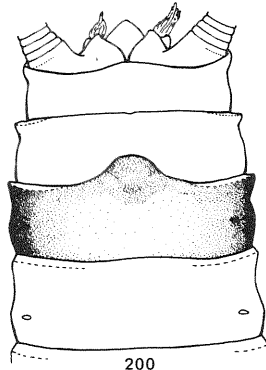
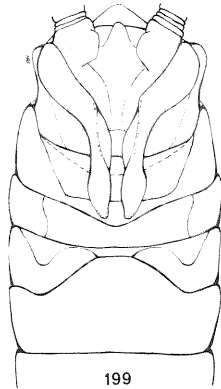
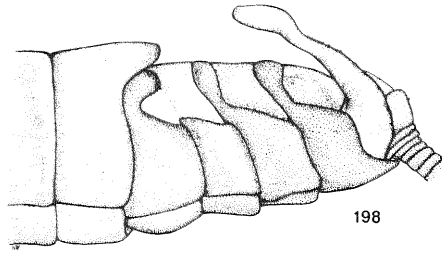
Length: 14-24 mm.

Description: This is a large and widely distributed species. Males are distinguished by the abdominal tergites: tergite 5 is produced over 6, which is somewhat bilobed; 7 is unsclerotized medially, whereas 8 is unsclerotized on the posterior margin, and 10 is produced forward into 2 long genital hooks that reach the hind margin of segment 7.

The females have a rounded subgenital plate on the hind margin of the 8th sternite. The remains of the anal gills do not show as clearly in all specimens as in the female figured here.

The larvae are quite colorful and the color pattern varies considerably. Generally, specimens from this area appear closest to that figured in Claassen's (1931) frontispiece but others are darker and a few have the darker areas expanded until the abdomen is almost all black. In any case, the only other larva with which it could be confused is *Claassenia* and the latter does not appear east of the Rockies or south of Hudson's Bay. The larval pattern is also somewhat similar to *Acroneuria xanthenes* but *xanthenes* lacks the occipital ridge. Figures of the adult are found in works by Needham and Claassen (1925) and Frison (1935); an analysis of variation in wing venation was given by Needham and Claassen (1925). Claassen (1931) figured the larva and Frison (1935) the larva and egg.

Frison (1935) stated that the adult is diurnal; he observed females with eggs flying over rapids, presumably to oviposit. He surmised that the larval stage lasted 2 or 3 years and determined that the larvae are carnivorous. Larvae of 2 different sizes have been collected together in Connecticut, so undoubtedly the life cycle is at least 2 years. Larval oxygen consumption is greater in the dark than in the light (Zoladek and Kapoor, 1971).



Phasganophora capitata, posterior abdominal segments

Fig. 198. Male, lateral view.

Fig. 199. Male, dorsal view.

Fig. 200. Female, ventral view.

In the East this insect apparently occurs in smaller streams than it does farther west, where it is restricted to medium and large-size rivers, according to Harden and Mickel (1952).

Type locality: United States. Type missing.

Range: The Maritimes south to Florida and west to Minnesota and Kansas. Castle (1939) reported collecting a larva in Montana but it apparently was a misidentification (R. Baumann, unpublished correspondence).

Connecticut records: Cornwall, June 4, 1964 (SWH); Easton, June 22, 1965 (SWH); Ellsworth, July 12, 1967 (SWH); Kent Falls, June 17, 1953, C. Remington (YU); Litchfield, May 17, 1924, May 30, 1913, L. Woodruff (AMNH); Mt. Carmel, July 13, 1960 (SWH); Old Lyme, June 1, 1960 (SWH); larvae from Canaan, Cheshire, East Hartford, Granby, Hartland, Litchfield, Mansfield, Milton, Mt. Carmel, Nepaug, Salisbury, Sharon, Vernon (UC and SWH).

GENUS *Neoperla* NEEDHAM

Pseudoperla Banks, 1892, Trans. Am. Entomol. Soc. 19: 342 (preoccupied).

Neoperla Needham, 1905, Proc. Biol. Soc. Wash. 18: 108.

Ochthopetina Enderlein, 1909, Stettin Ent. Zeit. 70: 324.

Javanita Klapálek, 1909, Wiener Ent. Zeit. 28: 224.

Tropidogynoplax Enderlein, 1910, Stettin Ent. Zeit. 71: 141.

Formosina Klapálek, 1913, Suppl. Ent. 2: 117 (preoccupied).

Formosita Klapálek, 1914, Suppl. Ent. 3: 118.

Oodeia Klapálek, 1921, Ann. Soc. Ent. Belg. 61: 321.

Neoperlops Banks, 1939, Bull. Mus. Comp. Zool. 85: 444.

Sinoperla Wu, 1948, Bull. Peking Nat. Hist. 17: 78.

Neoperla is characterized by tufted thoracic gills, only 2 ocelli and, in the male, by a divided 10th tergite, with no "hammer" on the 9th sternite. Two species are presently recognized in North America. *N. hubbsi* Ricker was described from Kansas.

Type of genus: *Neoperla clymene*

1. *Neoperla clymene* (Newman) (figs. 201-204)

Chloroperla clymene Newman, 1839, Mag. Nat. Hist. 3: 87.

Perla occipitalis Pictet, 1841, Perlides: 254.

Length: 10-18 mm.

Description: There is only 1 species of this genus found in northeastern North America. Only one other genus of the family Perlidae (*Perlinella*) has 2 ocelli and *Neoperla* can be distinguished from that species by its lack of cells in the forewing between veins A_1 and A_2 .

The male has a sclerotized projection at the hind margin of the 7th tergite, a humped medial area on the 8th, and 1 medial and 2 lateral humped areas on the 9th. These areas all bear small, rounded denticles. The 10th tergite is divided dorsally and bears a long, posteriorly directed process just before the midline on each side.

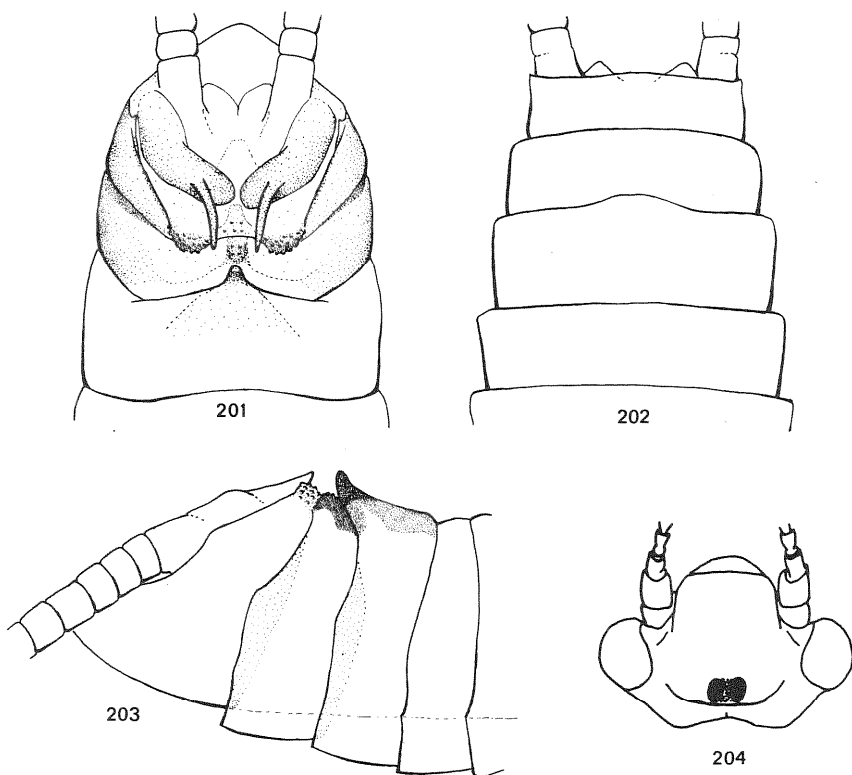
The female 8th sternite (subgenital plate) of most specimens has little to distinguish it from the other sternites. In the specimen figured, it is slightly expanded and an occasional specimen has the sternite slightly retuse along the hind margin. Hynes (1952) pictured 2 subgenital plates that are somewhat bilobed but generally there is no distinct subgenital plate.

Needham and Claassen (1925) figured the egg and gave an analysis of the variation in wing venation. Knight and his co-workers (1965b) pictured the egg in greater detail. Frison (1935) stated that the larva is carnivorous, feeding mainly on chironomids.

Type locality: Georgia. Type in the British Museum.

Range: Entire eastern part of North America from Nova Scotia to Florida, west to Minnesota and Texas, and extending to Arizona.

Connecticut records: North Branford, June 15, 1919, M. Zappe (CAES); Storrs,



Neoperla clymene

- Fig. 201. Male, dorsal view of posterior abdominal segments.
 Fig. 202. Female, ventral view of posterior abdominal segments.
 Fig. 203. Male, lateral view of posterior abdominal segments.
 Fig. 204. Adult head.

Aug. 15, 1955, J. Slater (UC); larvae from Canaan, Litchfield, Mansfield, Stafford, Storrs, Tolland and Willington (UC).

GENUS *Acroneuria* PICTET

Acroneuria Pictet, 1841, Perlides: 144.
Nosatura Navás. 1918, Mem. R. Acad. Cien. Artes Barcelona 14: 6.

The *Acroneuria* are large stoneflies that are predacious in the larval stage. Often collected as larvae, they are much less commonly captured as adults. Adult paraglossae are larger than the glossae and there are remnants of the larval tufted thoracic gills. The males have an undivided 10th tergite, a produced "hammer" on the 9th sternite, and the paraprocts are recurved into "genital hooks." Unlike most stoneflies, the species are more

easily separated in the adult female and larval stages than in the male adult. The life cycle probably takes more than 1 year for most species. The larvae are carnivorous.

Knox (1965) discussed the abdominal nervous system and musculature of this genus.

Type of genus: *Perla arenosa* Pictet

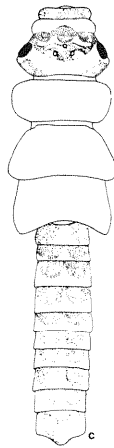
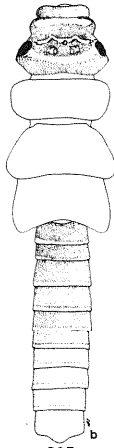
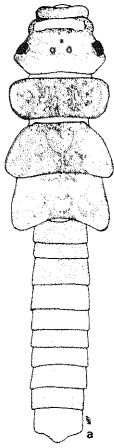
KEYS TO NORTHEASTERN SPECIES
MALES

1. A₂ of hindwing with many branches (about 12) 2, *arenosa*
A₂ of hindwing with fewer branches (generally 6 or less) 2
2. Remnants of subanal gills (generally concealed near base of paraprocts (fig. 236) 7
No remnants of subanal gills 3
3. Paraprocts cylindrical, fingerlike (figs. 220, 225) 4
Paraprocts flattened, somewhat triangular (figs. 215, 228) 5
4. Paraprocts with distinct notch on inner margin at tip (fig. 220)
. 3, *arida*
Paraprocts without notch (fig. 225) 7, *internata*
5. Abdominal tergites 9 and 10 without patches of short spines (fig. 234) 11, *ruralis*
Abdominal tergites 9 and 10 with patches of short spines 6
6. Ocellar triangle completely dark, margins of head behind ecdysial line light 4, *carolinensis*
Ocellar triangle partially light in most specimens; if all dark, margins of head behind ecdysial line have triangular brown streak from eye to apex of head 1, *abnormis*
7. "Hammer" of 9th sternite triangular, pointed posteriorly, and with transverse grooves on ventral surface *georgiana*
"Hammer" of 9th sternite subcircular and smooth 8
8. Paraproct with obvious brush of hairs on hind basal margin; patches of spines on tergite 10 only (fig. 236) 12, *xanthenes*
Paraproct without obvious brush of hairs; patches of spines on tergites 9 and 10 (fig. 232) 9
9. Light band extending across head between eyes, making ocellar triangle light; area anterior and posterior to this band dark . . . 10, *perplexa*
Ocellar triangle dark; posterior margin of head light, with lighter M-shaped mark anterior to median ocellus (obscure in some individuals) 5, *evoluta*, 6, *filicis*, 8, *lycorias*, 9, *mela*

FEMALES

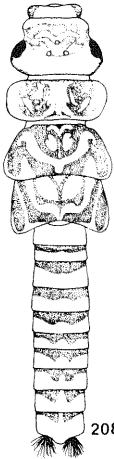
1. A₂ of hindwing with many branches (about 12) 2, *arenosa*

- A₂ of hindwing with fewer branches (generally 6 or less) 2
2. Remnants of subanal gills (fig. 230) 3
 No remnants of subanal gills 9
3. Posterior margin of subgenital plate has large rectangular notch (fig. 237) 12, *xanthenes*
 Posterior margin of subgenital plate emarginate, rounded, or narrowly notched 4
4. Subgenital plate extending over full length of 9th segment and deeply notched *georgiana*
 Subgenital plate not extending over full length of 9th segment; not deeply notched although it may be emarginate 5
5. Subgenital plate compressed at sides so that it appears to have a "waist" (fig. 223) 5, *evoluta*
 Subgenital plate tapering or evenly rounded from base to apex 6
6. Length of subgenital plate subequal to or greater than width, extending two thirds across 9th segment; posterior margin emarginate (fig. 231) 9, *mela*
 Length of subgenital plate less than width, extending one third across 9th segment; posterior margin emarginate or not (fig. 233) 7
7. Ocellar triangle light 10, *perplexa*
 Ocellar triangle dark 8
8. Posterior margin of subgenital plate rounded (fig. 224) 6, *filicis*
 Posterior margin of subgenital plate flattened or emarginate (fig. 229) 8, *lycorias*
9. Posterior corners of subgenital plate with flaplike protrusions (fig. 226) 7, *internata*
 Posterior corners of subgenital plate smoothly rounded 10
10. With small protuberance on 8th segment anterior to subgenital plate (fig. 235) 11, *ruralis*
 Without any protuberances on 8th segment anterior to subgenital plate (figs. 221, 222) 11
11. Subgenital plate constricted at base (fig. 221) 3, *arida*
 Subgenital plate widest at base (figs. 217, 222) 12
12. Subgenital plate emarginate on posterior margin (fig. 222); ocellar triangle completely dark; margins of head behind ecdysial line light 4, *carolinensis*
 Subgenital plate rounded on posterior margin (fig. 217); ocellar triangle generally at least partially light; margins of head behind ecdysial line commonly with triangular brown streak from eye to apex of head 1, *abnormis*



205

206

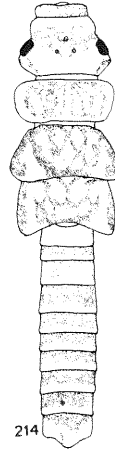
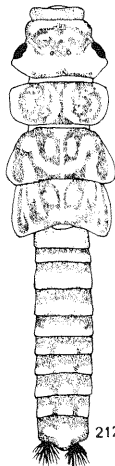


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LARVAE⁹

1. With subanal gills (figs. 210, 211) 6
 Without subanal gills (fig. 205) 2
2. Head unicolored, brown, with wavy line of occipital spinules continuous across head (fig. 209) *11, ruralis*
 Head variously marked with spots or lines; no spinules in center of occiput (fig. 205) 3
3. Abdomen uniformly dark (fig. 205a) *1, abnormis*
 Abdomen variously patterned in lateral light and dark bands or spots. (figs. 205b,c, 206, 207) 4
4. Posterior margin of abdominal tergites margined by dark markings (fig. 206) *4, carolinensis*
 Posterior margin of abdominal tergites margined by light markings (fig. 105b,c) 5
5. Light M-shaped band anterior to median ocellus; light areas on abdominal tergites varying from almost all dark to light, except for 2 detached lateral dark areas (fig. 205b,c) *1, abnormis*
 3 light spots anterior to median ocellus; light areas on abdominal tergites bandlike and parallel, with dark bands (fig. 214) *7, internata*
6. Head with wavy transverse occipital ridge; thoraces and abdomen uniformly yellowish brown *georgiana*
 Head without transverse occipital ridge, thoraces and, in some individuals, abdomen patterned 7
7. Large, light-colored patch extending from median ocellus to clypeus (fig. 211) *12, xanthenes*
 Median ocellus separated from clypeus by dark area (figs. 207, 212) 8
8. An irregular, light, M-shaped band on head anterior to median ocellus; abdomen generally banded (fig. 208) 9
 No light, M-shaped band but 3 lighter spots anterior to median ocellus; abdomen uniformly dark (fig. 207) *9, mela*
9. Posterior margin of abdominal tergites margined with dark markings (fig. 206) *8, lycorias*
 Posterior margin of abdominal tergites margined with light markings 10
10. Dark abdominal bands of approximately equal width across tergite; in some specimens lighter coloring invades posterior margin of dark ocellar triangle (fig. 213) *5, evoluta*
 Dark abdominal bands expanded posteriorly near median line; ocellar triangle completely dark (fig. 208) 11

⁹Larvae of *arenosa* and *arida* not known.

11. Dark abdominal bands decrease in width laterally, median expansions of dark bands not reaching posterior margin of tergites (fig. 208) 10, *perplexa*
 Dark abdominal bands not decreasing in width laterally, median expansions of dark bands commonly reaching to posterior margins of tergites, thus causing light posterior margin to be broken into 3 spots (fig. 212) 6, *filicis*

1. *Acroneuria abnormis* (Newman) (figs. 21, 205, 215-217)

Perla abnormis Newman, 1838, Entomol. Mag. 5: 177.
Acroneuria eidmanni Sámal, 1933, Zool. Anz. 102: 96.

Length: 25-42 mm.

Description: This is a common and widespread eastern species. Its larva is the most variable in appearance of all Eastern *Acroneuria*. There are no anal gills. In the adult, the female subgenital plate is broadly rounded by only slightly produced. The male paraprocts are broad and there are spinules on the 9th and 10th tergites. The abdominal color pattern of the larvae varies from all dark, to banded, to 2 dark spots per tergite. The difference between larval *abnormis* and *internata*, as given in the key, may not always be clear but generally those *abnormis* with a head pattern resembling *internata* have a uniformly dark abdomen. Very young larvae are unicolorous light brown but have neither anal gills nor occipital line.

The larvae are carnivorous and probably require more than a year to reach maturity. After a drought I have captured small larvae when the streams once more start to flow. Steffan (1967) described a phoretic relationship in which a chironomid lived in a gelatinous case on *A. abnormis* and fed on the detritus which collected on the long hairs of its host. The percentage of *abnormis* carrying these chironomids increased from spring to fall, reaching 96 percent in October. Steffan also observed *abnormis* active at water temperatures of -0.5°C .

Figures of the egg and larva, as well as additional figures of the adult, are by Needham and Claassen (1925), Claassen (1931), and Frison (1935). Harper and Pilon (1970) graphed the adult emergence of this species. They found a 1:1 ratio in their traps, although more females were captured on shore.

LARVAE

Fig. 205. *Acroneuria abnormis*, showing variation in dorsal coloration. Thoracic pattern on b and c is similar to that on a. (c is after Frison, 1935).

Fig. 206. *Acroneuria carolinensis*.

Fig. 207. *Acroneuria mela* (after Frison, 1935).

Fig. 208. *Acroneuria perplexa* (after Frison, 1937).

Fig. 209. *Acroneuria ruralis* (after Frison, 1935).

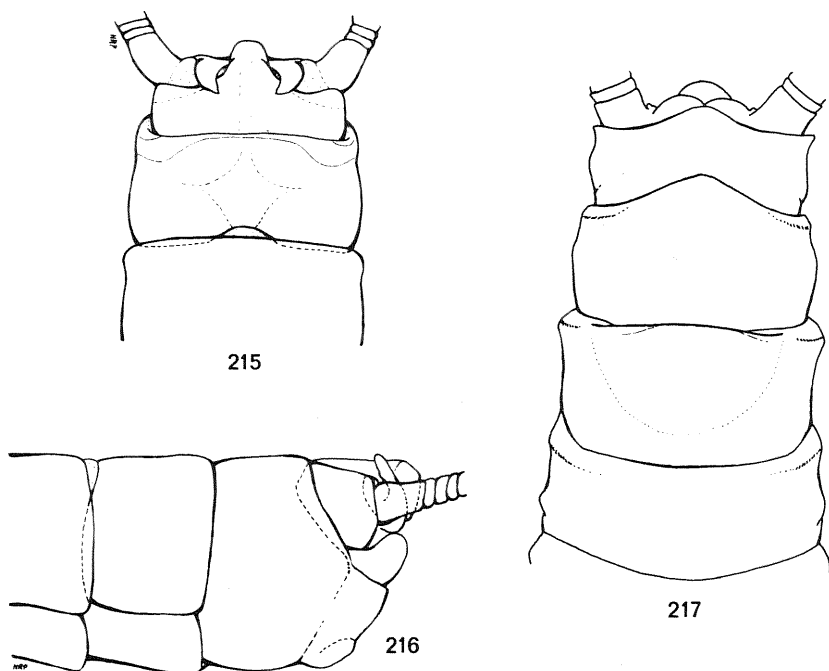
Fig. 210. *Phasganophora capitata*.

Fig. 211. *Acroneuria xanthenes*.

Fig. 212. *Acroneuria filicis* (after Frison, 1942).

Fig. 213. *Acroneuria evoluta* (after Frison, 1935).

Fig. 214. *Acroneuria internata* (after Frison, 1935).



Acroneuria abnormis, posterior abdominal segments

Fig. 215. Male, dorsal view.

Fig. 216. Male, lateral view.

Fig. 217. Female, ventral view.

Type locality: Trenton Falls, New York. Type in the British Museum.

Range: Northern Quebec and the Maritimes south to Florida and west to Manitoba and Illinois. Reports of this species in Idaho, Montana, and Colorado by Hagen (1818) and Banks (1894) are probably in error.

Connecticut records: East Haddam, May 27, 1968 (SWH); Easton, May 10, 1968, June 22, 1965, June 30, 1967 (SWH); Kent, June 30, 1967 (SWH); July 1, 1953, C. Remington (YU); Mt. Carmel, May 26-June 20, 1967, May 31-June 14, 1966, June 5, 1968, June 29, 1960 (SWH); North Granby, June 10, 1968, July 4, 1967 (SWH); Salem, July 6, 1967 (SWH); Storrs, June 18, 1954, J. Slater (UC).

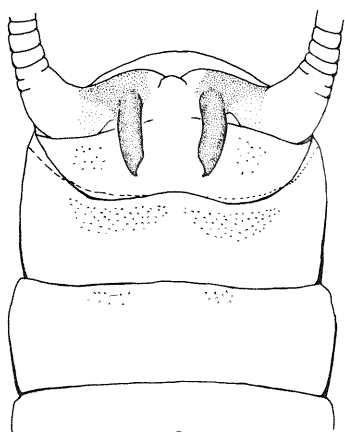
2. *Acroneuria arenosa* (Pictet) (figs. 218, 219)

Perla arenosa Pictet, 1841, Perlides: 178.

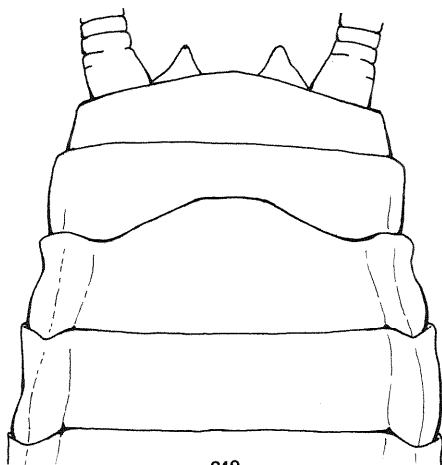
Perla pennsylvanica Rambur, 1842, Hist. nat. ins. Neur.: 456.

Perla trijuncta Walker, 1852, Cat. neur. Br. Mus.: 153.

Length: 25-37 mm.



218



219

Acroneuria arenosa, posterior abdominal segments

Fig. 218. Male, dorsal view.

Fig. 219. Female, ventral view.

Description: The adults of both sexes are easily identifiable by the many-branched 2nd anal vein of the hindwing, a characteristic apparently peculiar to this species. The genital hooks of the male are large. The 9th and 10th tergites bear many short, stout spines and the 8th a few scattered ones. The female subgenital plate is broad and produced.

Claassen (1931) described a larva that was identified as this species on the basis of the venation of the wing pads. However, he did not figure the specimen and it is now so faded in the preservative that neither color pattern nor venation can be seen. Needham and Claassen (1925) illustrated the egg and adult.

The adults of this species are nocturnal and can live for about 5 days if water is provided (Arnold, 1964). When disturbed, they occasionally release drops of blood from the coxal joints. Arnold (1964) illustrated the course of blood circulation in the wings and (1966) discussed and figured the haemocytes.

Type locality: Philadelphia, Pennsylvania. Type in Zoologisches Museum der Universität, Berlin.

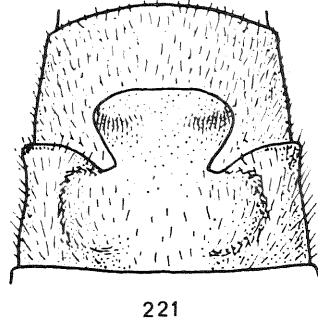
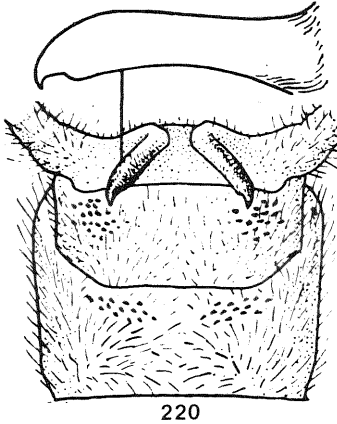
Range: Up the East Coast from Florida to Maine and Ontario.

Connecticut records: Branford, July 5, 1921, P. Garman, July 14, 1938, N. Turner (CAES); Mt. Carmel, July 13, 1960 (SWH); New Haven, at light, July 10, 1953, C. Remington (YU); North Haven, June, 1960, G. Papolizio; Windsor, July 22, 1938, D. Lacroix (CAES).

3. *Acroneuria arida* (Hagen) (figs. 220, 221)

Perla arida Hagen, 1861, Syn. Neur. No. Am.: 18.

Perla valida Banks, 1906, Trans. Am. Entomol. Soc. 32: 4.



Acroneuria arida (from Frison, 1942)

Fig. 220. Male, dorsal view of posterior abdominal segments with enlarged view of cercus (from Frison, 1942). -

Fig. 221. Female, ventral view of subgenital plate.

Length: 23-28 mm.

Description: The adults have no anal-gill remnants. The male genital hooks have a notch just before the tip. The 9th and 10th tergites bear a few short, stout spines. The female subgenital plate is constricted basally, so that the narrowest width is at the base. The larva is not known. Frison (1942) figured the adult.

Type locality: Philadelphia, Pennsylvania. Type in the Museum of Comparative Zoology, Harvard University.

Range: Georgia north to Pennsylvania.

4. *Acroneuria carolinensis* (Banks) (figs. 206, 222)

Perla carolinensis Banks, 1905, Bull. Am. Mus. Nat. Hist. 21: 215.

Acroneuria cuestae Ricker, 1935, Can. Entomol. 67: 260.

Length: About 28-34 mm.

Description: The larva has anal gills and the adults bear the remnants of these gills. The ocellar triangle of the adult is dark but the head is light behind the ecdysial line. The female subgenital plate is emarginate.

Hall and his co-workers (1969) infected larvae with cercariae shed by snails. The host response of the stonefly was slight. The entry lesion healed over and encapsulated some parasites. Except for some fat-body depletion, there was no apparent harm to the host. Frison (1942) and Claassen (1931) figured the larva, the latter under the species name *lycorias*.

Type locality: Black Mountain, North Carolina. Type in Museum of Comparative Zoology, Harvard University.

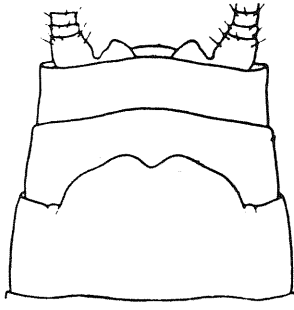


Fig. 222. *Acroneuria carolinensis* female, ventral view of subgenital plate (after Needham and Claassen, 1925).

Range: Quebec to Tennessee and Virginia.

Connecticut records: Larvae from Barkhamsted (UC), East Canaan (UC), Litchfield (UC).

5. *Acroneuria evoluta* Klapálek (figs. 213, 223)

Acroneuria evoluta Klapálek, 1909, Bull. Int. Acad. Sci. Bohem.: 12.

Acroneuria prolonga Claassen, 1937, J. Kans. Entomol. Soc. 10: 42.

Length: 22-37 mm.

Description: This species has anal gills. The female is best distinguished by the elongate subgenital plate. The lateral margins of the plate are compressed, so that its

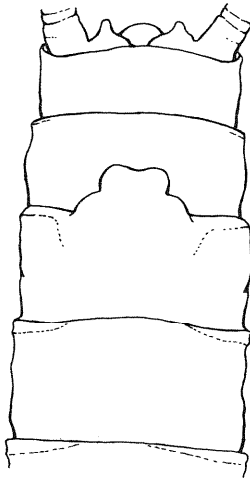


Fig. 223. *Acroneuria evoluta* female, ventral view of posterior abdominal segments.

narrowest part is in the middle third. Frison (1935) illustrated female subgenital plates that are rounded apically, rather than emarginate as pictured in Figure 223. The male cannot at present be clearly differentiated from its close relatives.

The adults are nocturnal and mating takes place at night (Frison, 1935). The specimens illustrated by him as *arida* are *evoluta*. Clark (1934) described and illustrated the external morphology of the adult but neglected to note the remnants of larval gills.

Type locality: New Orleans, Louisiana. Type in Naturhistorisches Museum, Vienna.

Range: Ohio and Illinois south to Kansas and Louisiana. Claassen's *prolonga*, which was declared a synonym of *evoluta* (Frison, 1942), was collected in Montana. Despite considerable further collecting in that state (Gaufin, 1964), it has apparently not been recaptured. Because of its known range in the Midwest, the collection data on *prolonga* probably is in error or another species is involved.

6. *Acroneuria filicis* Frison (figs. 212, 224)

Acroneuria filicis Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 275.

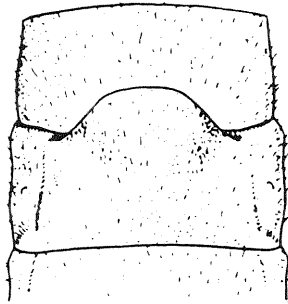


Fig. 224. *Acroneuria filicis* female, ventral view of subgenital plate (after Frison, 1942).

Length: 27-31 mm.

Description: The adult bears anal-gill remnants, a dark ocellar triangle, and a somewhat produced and rounded subgenital plate. The male paraprocts are pointed and somewhat curved but offer little to separate this male from its near relatives.

Type locality: Pineville, Kentucky. Type at Illinois Natural History Survey.

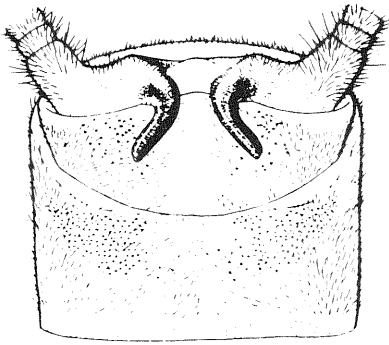
Range: Kentucky, Ohio, and Tennessee.

7. *Acroneuria internata* (Walker) (figs. 214, 225, 226)

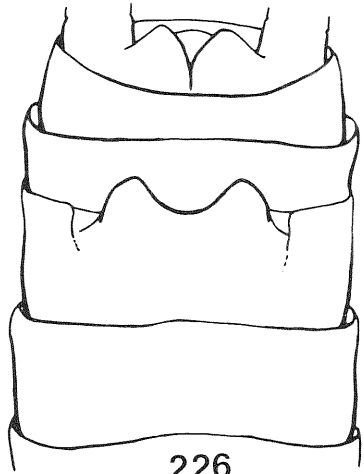
Perla internata Walker, 1852, Cat. neur. Br. Mus.: 152.

Length: 28-35 mm.

Description: The larva has no anal gills, so the adults show no gill remnants.



225



226

Acroneuria internata

Fig. 225. Male, dorsal view of posterior abdominal segments (from Frison, 1935).
 Fig. 226. Female, ventral view of posterior abdominal segments.

The female subgenital plate is unique in being produced and having a lobe at each distal corner. The male paraprocts are cylindrical (rather than flattened) and not strongly hooked. The adult was illustrated by Needham and Claassen (1925) and Frison (1935), the larva by Frison (1935).

Type locality: North America. Type in the British Museum.

Range: Midwestern states in Ohio and West Virginia west to Missouri and Minnesota, with an extension to Colorado.

8. *Acroneuria lycorias* (Newman) (figs. 227-230)

Perla lycorias Newman, 1839, Ann. Mag. Nat. Hist. 3: 25.

Perla navalis Provancher, 1876, Nat. Can. 8: 212.

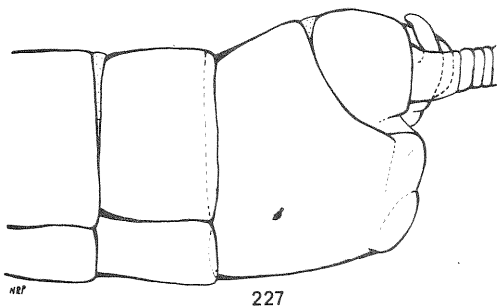
Perla riparia Provancher, 1876, Nat. Can. 8: 213.

Perla excavata Banks, 1908, Trans. Am. Entomol. Soc. 34: 256.

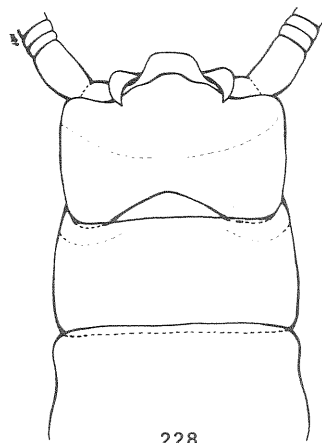
Acroneuria perbranchiata Neave, 1933, Can. Entomol. 65: 237.

Length: 18-35 mm.

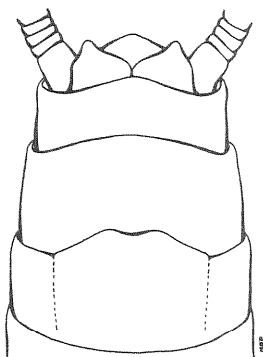
Description: This species has anal-gill remnants and a dark ocellar triangle. The female subgenital plate is produced but flattened or emarginate apically. If the anal-gill remnants are not observed, it might be confused with a female *abnormis*; however, *lycorias* has the dark ocellar patch more clearly defined than does that species. The males are not easily separated from near relatives. However, most individuals have paraprocts (genital hooks) which are much shorter than those of other species and are directed more anteriorly, without a definite terminal hook. They abrupt-



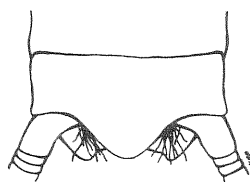
227



228



229



230

Acroneuria lycorias

Fig. 227. Male, lateral view of posterior abdominal segments.

Fig. 228. Male, dorsal view of posterior abdominal segments.

Fig. 229. Female, ventral view of posterior abdominal segments.

Fig. 230. Female, dorsal view, showing remnants of larval anal gills.

ly narrow before the sharply pointed end. The larva described under this name by Claassen (1931) is actually *carolinensis*. Occasional larval specimens have the abdomen mostly dark, with only a light streak across the tergite. Needham and Claassen (1925) studied the variations in veinal branching in this species.

A. lycorias larvae appear resistant to higher temperatures, a temperature of 30°C for 96 hours being necessary to kill 50 percent (Nebeker and Lemke, 1968). Likewise 50 percent were able to survive water acidity of pH 3.32 (Bell and Nebeker, 1969).

Type locality: Trenton Falls, New York. Type in the University Museum, Oxford, England.

Range: Northern Quebec to Florida and west to Saskatchewan and Tennessee—a widely distributed species.

Connecticut records: Barkhamsted, May 22, 1930, W. Manchester (CAES); East

Haddam, May 16, 1968 (SWH); Easton, May 26, 1964, May 27-29, 1968; June 2, 1967 (SWH); Hamden, May 25-29, 1960, May 31, June 2, 1966 (SWH), June 7, 1947, B. McFarland (CAES); Mt. Carmel, May 15, 1968 (SWH); Pomfret, May 3, 1968 (SWH); Stafford, June 9, 1966 (SWH); Stonington, May 30, 1962 (SWH); Storrs, June 21, 1964, J. Slater (SWH); Torrington, June 16, 1937, P. Wallace (CAES); larvae from Eastford, Hamden, Mansfield, and Storrs (UC).

9. *Acroneuria mela* Frison (figs. 207, 231)

Acroneuria mela Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 274.

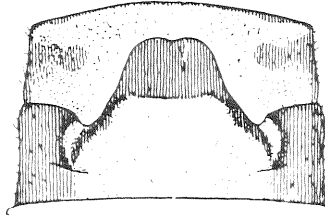


Fig. 231. *Acroneuria mela* female, ventral view of subgenital plate (after Frison, 1937).

Length: About 27 mm.

Description: The adult has remnants of anal gills. The female subgenital plate extends more than halfway across the 9th sternite and tapers to a broad apex that is emarginate distally. The male paraprocts are curved and the 9th and 10th tergites bear patches of small spines. The male is not easily distinguished from its near relatives. The larva is described as *Acroneuria sp. a* by Frison (1935).

Type locality: Petersburg, Indiana. Type at Illinois Natural History Survey.

Range: Ohio to Georgia and west to Illinois and Oklahoma.

10. *Acroneuria perplexa* Frison (figs. 208, 232, 233)

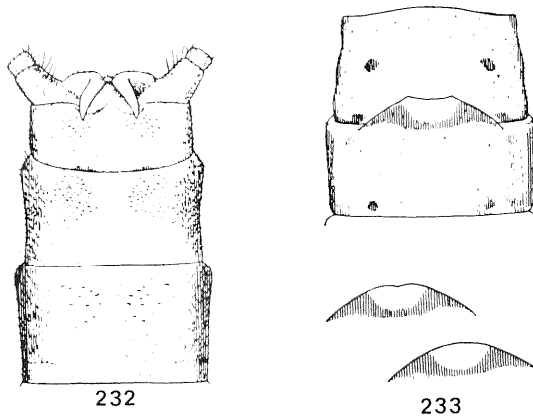
Acroneuria perplexa Frison, 1937, Ill. Nat. Hist. Surv. Bull. 21: 79.

Length: About 27 mm.

Description: This is another species whose adults bear remnants of anal gills. The female subgenital plate is somewhat produced and either rounded or slightly emarginate. The male, as usual with this genus, has the paraprocts recurved and sharply pointed. The 9th and 10th tergites bear patches of small spines. The most distinctive character is an area of lighter coloring that extends from eye to eye across the ocellar triangle. Further illustrations are with the type description.

Type locality: Petersburg, Indiana. Type at Illinois Natural History Survey.

Range: At least the area circumscribed by the District of Columbia, eastern Pennsylvania, Ohio, and Illinois.



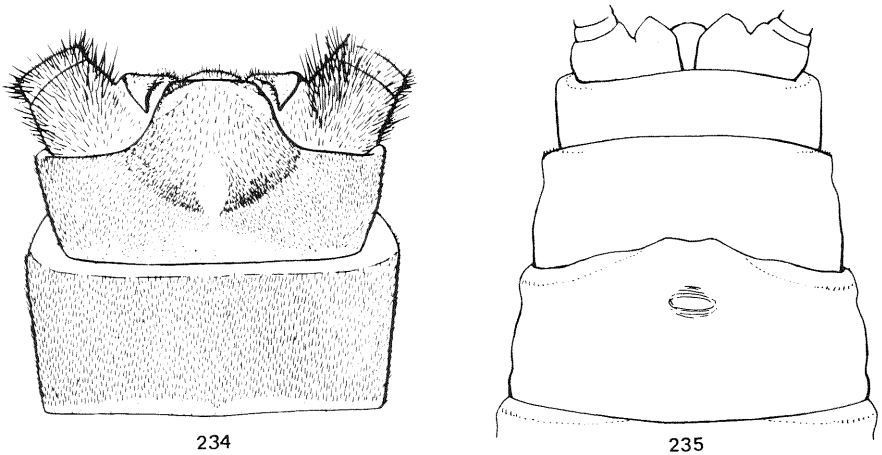
Acroneuria perplexa (from Frison, 1937)

Fig. 232. Male, dorsal view of posterior abdominal segments.
 Fig. 233. Female, ventral view, showing variation in the subgenital plate.

11. *Acroneuria ruralis* (Hagen) (figs. 209, 234, 235)

Perla ruralis Hagen, 1861, Syn. Neur. No. Am.: 18.
Perla rupinsulensis Walsh, 1862, Proc. Acad. Nat. Sci. Philadelphia 13: 363.
Perla attenuata Banks, 1905, Psyche J. Entomol. 12: 55.

Length: 28-33 mm.



Acroneuria ruralis, posterior abdominal segments

Fig. 234. Male, dorsal view (after Frison, 1935).
 Fig. 235. Female, ventral view.

Description: In all stages this species is somewhat different from other *Acroneuria* and was placed by Ricker (1954) in the subgenus *Attaneuria*, which Illies (1966) raised to generic rank; however here it is retained in *Acroneuria*.

There are no anal-gill remnants. The male paraprocts are short, triangular, and flattened. The "hammer" on the 9th sternite is oval and there are no spines on either the 9th or 10th tergite. The female subgenital plate is produced partly over the 9th sternite and is emarginate apically. There is a transverse protuberance in the middle of the plate. The larva is a uniform brown, with a wavy row of spinules on the occipital ridge. The egg, as figured by Needham and Claassen (1925) differs from most other *Acroneuria* in lacking a cap but does bear a produced equatorial ridge.

The larva is predacious, feeding on chironomids and caddis larvae. The larval stage probably lasts 2 or 3 years. The adults are nocturnal (Frison, 1935).

Further figures are by Needham and Claassen (1925), Claassen (1931), and Frison (1935).

Type locality: St. Louis, Missouri. Location of type specimen unknown.

Range: The published range is from New York to Florida and west to Minnesota and Kansas. There is one record from Colorado. Ricker and his co-workers (1968) thought that the synonymy of Provancher's *quebecensis* with *ruralis* was in error and that *ruralis* does not appear in Quebec.

12. *Acroneuria xanthenes* (Newman) (figs. 211, 236-238)

Perla xanthenes Newman, 1838, Entomol. Mag. 5: 178.

Acroneuria brevicauda Klapálek, 1909, Bull. Int. Acad. Sci. Fr. Jos. I 14: 245.

Length: 22-34 mm.

Description: The adults bear remnants of anal gills. The female is easily identified by the large rectangular notch in the subgenital plate. The male has a small but distinct oval "hammer" on the rear margin of the 9th sternite and a brush of hairs on the hind basal margin of the paraprocts. Needham and Claassen (1925) correctly stated that there are peglike spines on the 10th tergite only, although their figures indicate otherwise. The larva is distinctive in having a large light area anterior to the median ocellus. Needham and Claassen illustrated the egg and adult, Frison (1942) the larva.

Type locality: Georgia. Lectotype in the British Museum.

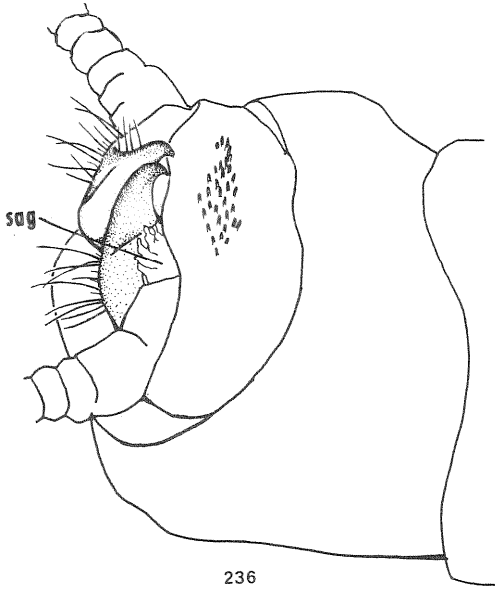
Range: Connecticut south to Florida and west to Ohio and Georgia. Banks (1894) reports a specimen from Kansas but this may be a misidentification.

Connecticut records: Bethany, June 8, 1962 (SWH); Mt. Carmel, UV light trap, June 18, 1962, A. DeCaprio; Salem, June 15-30, 1967 (SWH); larvae from Bethany, Ellington, Portland, Salem (UC, SWH). In addition, there are many larvae from Mansfield and Storrs in the student collections at UC.

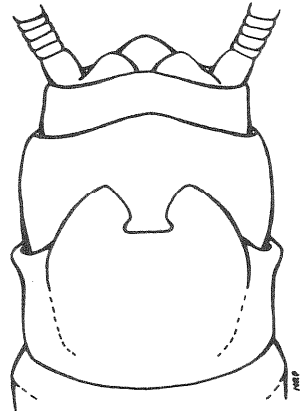
GENUS *Perlesta* BANKS

Perlesta Banks, Can. Entomol. 38: 222.

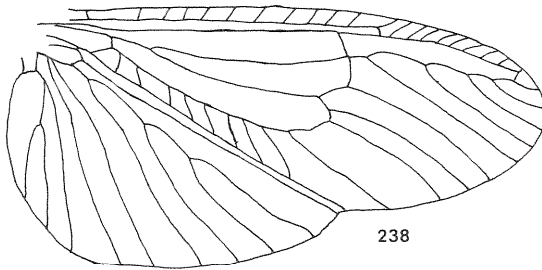
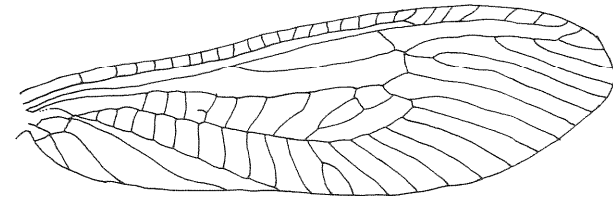
Adult members of this genus, like the other Perlidae, show the remnants



236



237



238

Acroneuria xanthenes

Fig. 236. Male, three-quarters view; *sag*=subanal gill.

Fig. 237. Female, ventral view of posterior abdominal segments.

Fig. 238. Wings.

of the larval gills but, in this genus, the gills are small and inconspicuous in most species. The adult males are separated from other genera of the family by lacking a raised "hammer" on the 9th sternite and by the uncleft 10th tergite. Both sexes are distinguished by 3 ocelli, no anal crossveins except those forming the anal cell, and the yellowish-white costal margin of the forewing. There are 2 species presently described from North America, although *P. frisoni* Banks from the Great Smoky Mountains may be merely a color variant of the common *P. placida*.

Type of genus: *Perla placida* Hagen

1. *Perlesta placida* (Hagen) (figs. 239-242)

Perla placida Hagen, 1861, Syn. Neur. No. Am.: 28.

Perla decipiens Walsh, 1862, Proc. Acad. Nat. Sci. Philadelphia 13: 364.

Perla brunneipennis Walsh, 1862, Proc. Acad. Nat. Sci. Philadelphia 13: 367.

Chloroperla virginica Banks, 1898, Trans. Am. Entomol. Soc. 25: 199.

Perlinella cinctipes Banks, 1905, Psyche J. Entomol. 12: 56.

Isoperla texana Banks, 1914, Proc. Acad. Nat. Sci. Philadelphia 66: 611.

Perlesta costalis Klapálek, 1921, Ann. Soc. Entomol. Belg. 61: 150.

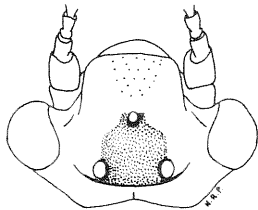
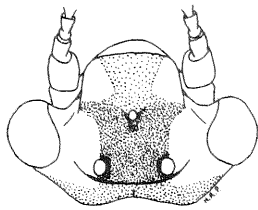
Length: 8.5-14 mm.

Description: The larva, with its many gills and speckled appearance, is quite distinctive. Adult males have the typical perlid hooks and may be identified by the characters described for the genus. In many individuals, the genital hooks slant posteriorly and have a slight projection just before the tips. The female has a slightly produced subgenital plate that is notched at the midline. The hind margin of the subgenital plate is semitransparent in many specimens and difficult to distinguish unless the segments are separated. The head pattern is distinctive but variable (fig. 239). Superficially, *placida* can be confused with some *Isoperla* but the time of emergence, the light coloring in the costal region of the wing, the remnants of gills, and a long single ventral hair on each cercal segment help separate it. Other figures of the larva are by Claassen (1931); Knight, Nebeker, and Gaufin (1965b), Stewart, Atmer, and Solon (1969) figured the egg, and Frison (1935, 1942) the egg, larva, and adult.

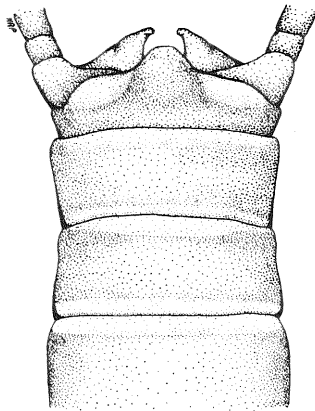
Stewart and his co-workers (1969) gave a detailed description of the reproductive system, mating, and egg of this species. Mating occurred the first day after adult emergence, probably in high vegetation or trees near the stream. Sexual recognition seemed to depend on chance encounters or visual recognition. Males lived 4 to 6 days, females 7 to 8 days and both mated several times during this period. Females mated in the first 6 days of life. The male copulatory hooks connect with the female subgenital lobes, locking the two individuals together. The male aedeagus is then everted from beneath the posterior part of the 9th sternite and is inserted into the genital opening of the female.

P. placida has a wide tolerance for different sorts of streams, including intermittent ones (Harden and Mickel, 1952). It is also one of the few stoneflies that emerge in midsummer and late summer. The larvae are carnivorous, feeding particularly on chironomids (Frison, 1935). Frison also saw robins preying on adult *P. placida*. Stewart and his co-workers (1970) found algae being carried on adults, providing a means of dispersal for these plants.

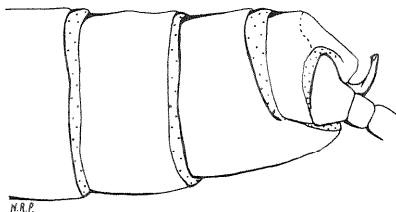
The adults come readily to lights and all the Mt. Carmel collections listed below



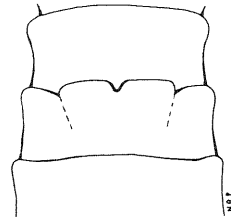
239



240



241



242

Perlesta placida

Fig. 239. Adult head patterns, showing variation.

Fig. 240. Male, dorsal view of posterior abdominal segments.

Fig. 241. Male, lateral view of posterior abdominal segments.

Fig. 242. Female, ventral view, showing subgenital plate.

were captured by this means.

Type locality: Washington, D.C. Type in Museum of Comparative Zoology, Harvard University.

Range: Widely distributed from Nova Scotia to Florida and west to Manitoba, Wyoming, and Texas.

Connecticut records: Bethany, Aug. 3, 1969, P. Edwards (UC); Easton, June 30-Aug. 13, 1965 (SWH); Mansfield, Aug. 7, 1968 (SWH); Mt. Carmel, June 21-Aug. 22, 1960, June 28-Aug. 1, 1961; North Franklin, June 11, 1959 (SWH); North Haven, July 10, 1953, July 6, 1954, C. Remington (YU); Pachaug, June 14, 1967 (SWH); Plainfield, June 23-30, 1967 (SWH); Poquonock, June 27, 1905, H. Viereck (CAES); Redding, Aug. 13, 1960 (SWH); Storrs, July 30, 1954, Aug. 7, 1968, J. Slater (UC); Voluntown, July 20, 1960 (SWH); Wallingford, June 27, 1960 (SWH); Waterford, Aug. 5, 1960 (SWH); larvae from Barkhamsted, Burlington, Chester, Granby, Easton, Lakeville, New Hartford, Suffield (UC, SWH).

GENUS *Perlinella* BANKS

Perlinella Banks, 1900, Trans. Am. Entomol. Soc. 26: 242.

Atoperla Banks, 1905, Psyche. J. Entomol. 12: 56.

This genus has more than one crossvein between A_1 and A_2 in the forewing. The male has sharply pointed and recurved paraprocts and bears a "hammer" on the 9th sternite. Zwick (1971) recently revised the genus.

Type of genus: *Isogenus drymo* Newman

KEY TO ADULTS OF NORTHEASTERN SPECIES

1. 3 ocelli; pronotum with broad yellow or reddish band on each side of median dark band 1, *drymo*
- 2 ocelli; pronotum concolorous 2
2. Clypeus yellow; male penial sclerites with fine serrations but without sclerotized hook (fig. 248) 3, *fumipennis*
- Clypeus darker; male penial sclerites finely serrated and with sclerotized hook (fig. 246) 2, *ephyre*

1. *Perlinella drymo* (Newman) (figs. 32, 243-245)

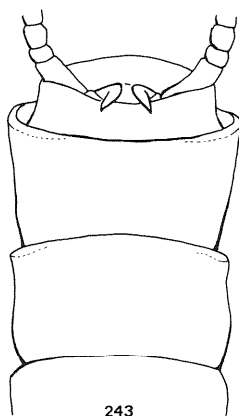
Isogenus drymo Newman, 1839, Mag. Nat. Hist. 3: 86.

Perla elongata Walsh, 1862, Proc. Acad. Nat. Sci. Philadelphia 13: 336.

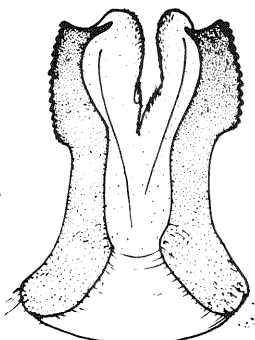
Perla trivittata Banks, 1895, Trans. Am. Entomol. Soc. 22: 313.

Length: 10-19 mm.

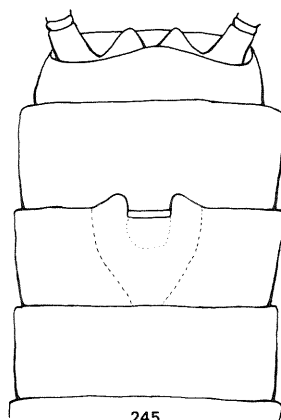
Description: The male paraprocts are relatively small but well sclerotized. The



243



244



245

Perlinella drymo

Fig. 243. Male, dorsal view of posterior abdominal segments.

Fig. 244. Penial sclerites (from Zwick, 1971).

Fig. 245. Female, ventral view of posterior abdominal segments.

10th segment is distinctly narrower than the 9th. The head pattern is distinctive, with a dark ocellar triangle, a light M line, and a dark triangular spot in front of the M line. The ocellar spot has dark arms reaching toward the margin of the head before the eyes. Further figures of the adult are by Needham and Claassen (1925), Frison (1935); of the larva by Claassen (1931) and Frison (1935).

Type locality: Georgia. Type in the British Museum.

Range: This widely distributed but uncommon insect ranges from Nova Scotia to Florida and west to Tennessee, Illinois and Minnesota. Frison (1935) suggested that further collecting will include other states of the Mississippi basin within its range.

Connecticut records: New Canaan, June 5, 1954, M. Statham (AMNH); Storrs, May 5, 1954, J. Slater (UC).

2. *Perlinella ephyre* (Newman) (figs. 246, 247)

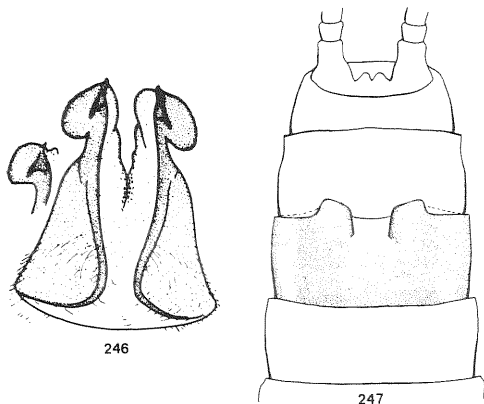
Chloroperla ephyre Newman, 1839, Mag. Nat. Hist. 3: 87.

Perla producta Walsh, 1862, Proc. Acad. Nat. Sci. Philadelphia 13: 365.

Atoperla consors Banks, 1948, Psyche J. Entomol. 55: 128.

Length: 9-16 mm.

Description: The male penial sclerites have a distinct hook at the inner distal angle. The female subgenital plate has a broad, light-colored notch medially. Not all specimens have more than 1 anal crossvein. In a collection from Ludlowville, New York, 2 out of 16 females lacked the extra anal cell. This species, although widely distributed, does not seem to be common. The adults are nocturnal and come to lights at night. The larva is presumably carnivorous and is found in larger streams with fast currents and gravelly or rocky bottoms (Frison, 1935; Harden and Mickel, 1952). Figures of the adult are given by Needham and Claassen (1925), Frison (1935), and Zwick (1971), larval figures by Claassen (1931) and Frison (1935).



Perlinella ephyre

Fig. 246. Penial sclerites (from Zwick, 1971).

Fig. 247. Female, ventral view of posterior abdominal segments.

Type locality: Georgia. Type in the British Museum.

Range: Widespread over eastern North America from New Hampshire to Florida and west to Arkansas and Minnesota.

3. *Perlinella fumipennis* (Walsh) (fig. 248)

Perla fumipennis Walsh, 1863 (1862), Proc. Acad. Nat. Sci. Philadelphia 13: 366.

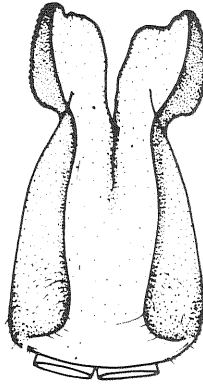


Fig. 248. *Perlinella fumipennis*, penial sclerites (from Zwick, 1971).

Length: 9-12 mm.

Description: This species has recently been removed from synonymy by Zwick (1971). It is best distinguished by the shape of the male penial sclerites, which are finely serrated but without hooks or sharp points. The head is yellowish with a black patch over the 2 ocelli. Further figures are by Zwick (1971).

Type locality: Rock Island, Illinois. Type missing.

Range: If Zwick (1971) is correct, and his specimens from Florida are the same as Walsh's *fumipennis*, this insect is widely distributed over the eastern United States.

FAMILY CHLOROPERLIDAE

This family of small- to medium-size stoneflies is found in North America, eastern Asia, Europe and western Asia. The wing venation is reduced, with a small anal area in the hindwing; the glossae are much shorter than the paraglossae; there are 7 abdominal ganglia; the adult cerci are long. The male epiproct is well developed but the paraprocts are unmodified. There are no lobes on any male sternites. The male 10th tergite is cleft.

GENUS *Chloroperla* NEWMAN

Chloroperla Newman, 1836, Entomol. Mag. 3: 500.

This genus is distinguished from *Hastaperla* by having the anal area of

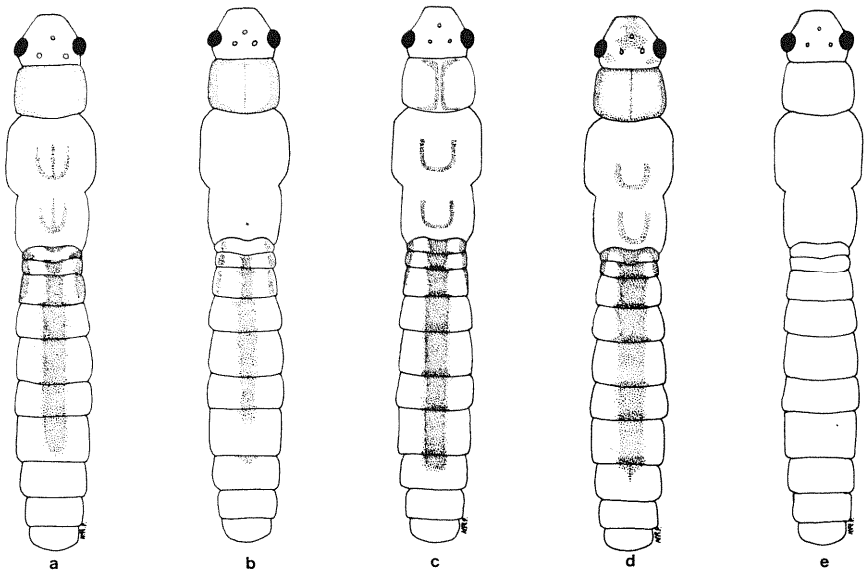


Fig. 249. ADULTS OF CHLOROPERLIDAE
 a. *Chloroperla terna*
 b. *Hastaperla orpha* (after Frison, 1937)
 c. *Alloperla mediana*
 d. *Alloperla naica*
 e. *Alloperla neglecta*

the forewing separated by a fold from the remainder of the wing. It differs from *Alloperla* in not having vein A_2 of the forewing branched, although there can be a small stub on A_2 that probably represents the remnants of this vein.

Zwick (1967) analyzed the European members of this genus, basing his study on the male genitalia. It is uncertain where our Northeastern *C. terna* fits into his scheme; *C. terna* was separated to the subgenus *Rasvena* by Ricker (1952) on the basis of a single anal vein in the hindwing. However, Zwick includes the European *C. breviata* (= *kimminsi*) in the nominate subgenus *Chloroperla s.s.* on the basis of the male aedeagus, even though, according to Despax (1951), there is only 1 anal vein in the hindwing. This leaves the status of *C. terna* uncertain and it possibly is closer to *Alloperla* than to *Chloroperla*. The genera *Alloperla* and *Chloroperla* seem very close in North America and the species now separated into these 2 genera may eventually be found to be congeneric. Alternatively, new separations based on genitalia or other characters may divide the species into new groupings.

There are only 2 species of *Chloroperla*, as now accepted, in North America. Only 1 of these is found in our area. *C. ovibovis* Ricker, from northern Canada, can be recognized because it has 3 anal veins in the hindwing.

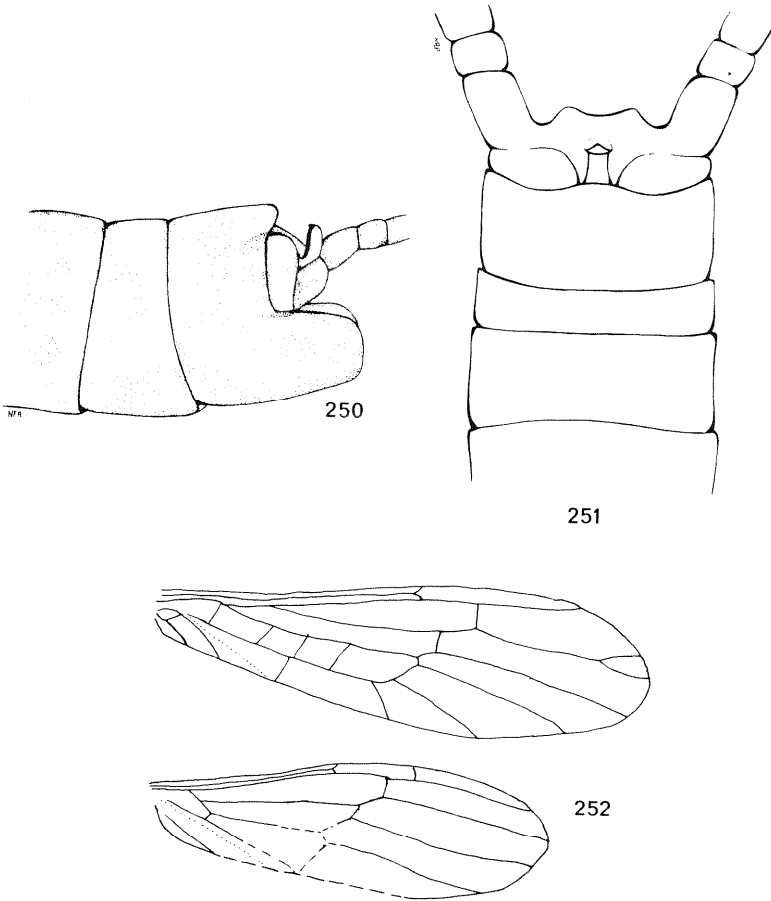
Type of genus : *Phryganea tripunctata* Scopoli

1. *Chloroperla terna* Frison (figs. 249a, 250-252)

Chloroperla terna Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22 : 339.

Length : 6-6.8 mm.

Description: This is the only species of this genus found in northeastern North America. It can be distinguished from closely related species by its folded anal lobe, the single anal vein in the hindwing, and (in most individuals) an unbranched vein A_2 in the forewing. It can be separated from eastern (but not western) *Alloperla* by



Chloroperla terna

Fig. 250. Male, lateral view of posterior abdominal segments.

Fig. 251. Male, dorsal view of posterior abdominal segments.

Fig. 252. Wings.

having U-shaped marks and a longitudinal line on the meso- and metathorax.

Type locality: Waits River, West Topsham, Vermont. Type at Illinois Natural History Survey.

Range: New Hampshire west to Wisconsin and south to Tennessee.

GENUS *Hastaperla* RICKER

Hastaperla Ricker, 1935, Can. Entomol. 67: 200.

This genus is distinguished from other Chloroperlidae genera by the lack of a fold separating the anal area from the remainder of the rear wing. There are 3 species, 2 of them found in our area.

Type of genus: *Hastaperla calcarea* Ricker (= *brevis* Banks)

KEYS TO NORTHEASTERN SPECIES

ADULTS

1. Abdomen with dorsal stripe (fig. 249b); male epiproct quadrate in dorsal view; female subgenital plate subtriangular and somewhat flattened apically 2, *orpha*
No dorsal abdominal stripe; epiproct rounded or pointed apically in dorsal view (fig. 254); female subgenital plate broadly rounded ...
..... 1, *brevis*

LARVAE

1. Pronotum with 4 corners dark, making a light diamond-shaped center
..... 2, *orpha*
Pronotum mostly uniform in color 1, *brevis*

1. *Hastaperla brevis* (Banks) (figs. 253-255)

Chloroperla brevis Banks, 1895, Trans. Am. Entomol. Soc. 22: 314.

Isopteryx oculata Klapálek, 1923, Ann. Soc. Belg. 63: 29.

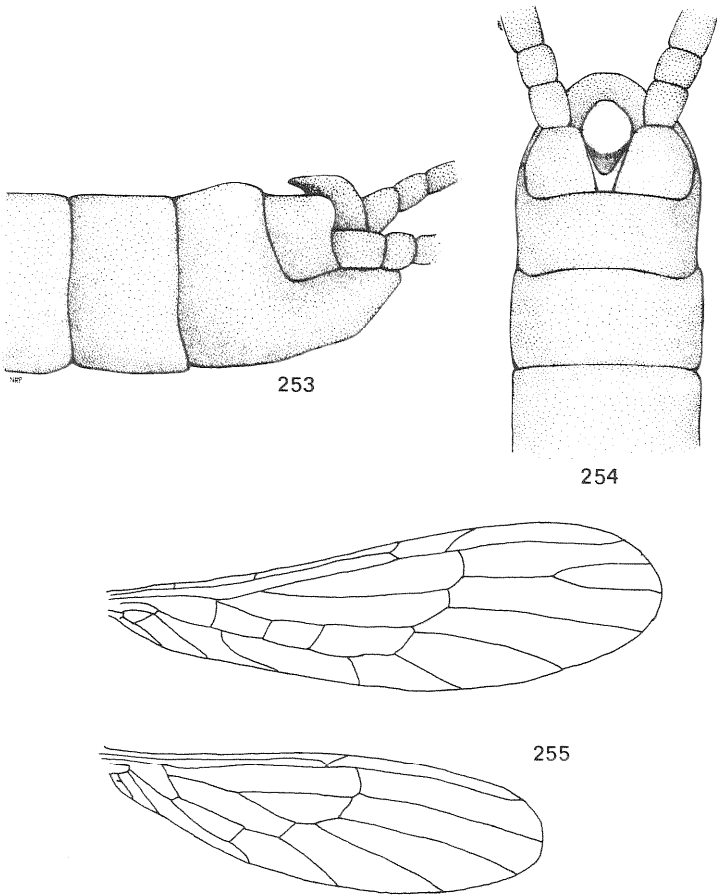
Hastaperla calcarea Ricker, 1935, Can. Entomol. 67: 200.

Length: 6.5-9 mm.

Description: Green in life, this species fades to yellow when preserved. It is distinguished from *Hastaperla orpha* by lacking a dorsal abdominal stripe and having the male epiproct and female subgenital plate both rounded. *Brevis* larvae are herbivorous and found among dead leaves. Adults have been figured by Needham and Claassen (1925), Ricker (1935), Frison (1935, 1942), and Gaufin, Nebeker, and Sessions (1966), the larvae by Frison (1935).

Harper and Magnin (1969) first found the young larvae in October. Growth was regular until January, when it slowed. In May, somewhat before adult emergence, larval growth increased rapidly.

Type locality: Sherbrooke, Quebec, Canada. Type in Museum of Comparative Zoology, Harvard University.



Hastaperla brevis

Fig. 253. Male, lateral view of posterior abdominal segments.
 Fig. 254. Male, dorsal view of posterior abdominal segments.
 Fig. 255. Wings.

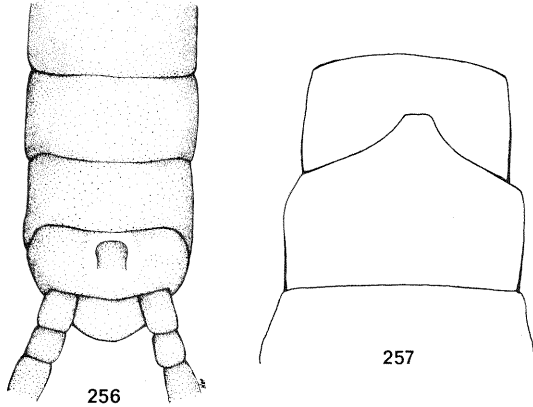
Range: Nova Scotia south to Georgia and west to Oklahoma and Manitoba.

Connecticut records: Barkhamsted, May 20, 1960 (SWH); Portland, May 22, 1963 (SWH); Seymour, May 20, 1949, C. Remington (YU); Sterling, June 11, 1959, June 14, 1967 (SWH).

2. *Hastaperla orpha* (Frison) (figs. 249b, 256, 257)

Chloroperla orpha Frison, 1937, Ill. Nat. Hist. Surv. Bull. 21: 91.

Length: 7-8 mm.



Hastaperla orpha

Fig. 256. Male, dorsal view of posterior abdominal segments (after Frison, 1937).
 Fig. 257. Female, ventral view, showing subgenital plate (after Harden and Mickel, 1952).

This species, green in life, is distinguished from *brevis* by having a dorsal abdominal stripe and dark lateral margins on the pronotum. The male epiproct in dorsal view and the female genital plate in ventral view are both somewhat quadrate. The adult was figured by Frison (1937), and also by Harden and Mickel (1952), who found that *orpha* inhabits larger streams than does *brevis*.

Type locality: Namakagon River, Spooner, Wisconsin. Type at Illinois Natural History Survey.

Range: This species is known only from Minnesota, Wisconsin, and New Brunswick.

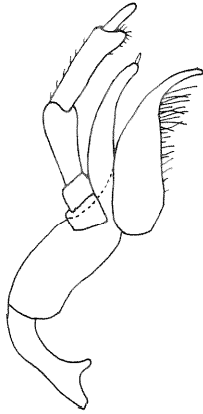
GENUS *Alloperla* BANKS

Alloperla Banks, 1906, Entomol. News 17: 175.

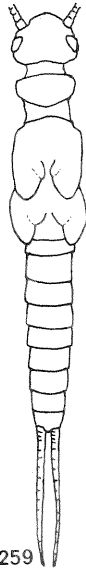
This genus is characterized by paraglossae larger than glossae, no gills, a folded anal lobe on the hindwing, and vein A_2 of the forewing branched. The genitalia of the males offer several diagnostic characters for specific determinations, although, as usual with stoneflies, female characteristics do not. Some species resemble *Chloroperla* but are at present separated on the basis of wing venation. Ricker (1943, 1952) has divided this group into several subgenera which Illies (1966) has raised to generic rank. I consider all these species to fall within the one genus *Alloperla*, and recently (1968) have reviewed and keyed the Northeastern species and given new collection records for several New England states.

The adults are yellow or green and emerge in late spring and early summer, when they may be swept from foliage over the streams. The larvae are presumably predacious.

Type of genus: *Sialis imbecilla* Say



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259

Alloperla sp.

Fig. 258. Larva, showing maxilla.

Fig. 259. Larva.

KEYS TO NORTHEASTERN SPECIES

MALES¹⁰

1. With dorsal abdominal stripe (fig. 249c) 2
 Without dorsal abdominal stripe (fig. 249e) 7
2. Inward-pointing process at base of each cercus (fig. 273)
 9, *marginata*
 No process at base of cercus 3
3. Epipect bifurcate at tip (fig. 279) 12, *nanina*
 Epipect not furcate 4
4. Epipect in lateral view with circular base and upturned process at tip
 (fig. 274); prothorax with obscure center stripe, not margined with
 black line (fig. 249c) 5
 Epipect not as above (figs. 269, 277); prothorax margined with black
 line (fig. 249d) 6
5. Proximal end of epipect in dorsal view has 4 lobes 14, *onkos*
 Epipect in dorsal view smoothly margined or notched (fig. 276)
 10, *mediana*

¹⁰Male of *quadrata* not known.

6. Epiproct long, slender, upturned (fig. 268) 7, *lateralis*
 Epiproct flattened, broad in dorsal view, almost pestle shaped (fig. 278) 11, *naica*
7. Epiproct recurved, slender, sclerotized, gradually tapering to a point (figs. 266, 267) 6, *imbecilla*
 Without above characters; epiproct variously shaped from oval to reniform, commonly lifted by an inflated body (figs. 262, 263) ... 8
8. Epiproct with 2 rounded, triangular projections extending ventrally near distal end (fig. 265) 5, *idei*
 Epiproct variously formed but not as above 9
9. Sclerotized part of epiproct slender, with parallel sides, truncate distally, with 2 sharp laterally directed projections (fig. 271) 8, *leonarda*
 Epiproct rounded or elongate oval and without 2 laterally directed projections distally 10
10. Sclerotized part of epiproct much broader than long, reniform (fig. 284) 16, *voinae*
 Sclerotized part of epiproct at least as long as broad (figs. 263, 285) 11
11. Epiproct in dorsal view more than twice as long as wide and with terminal tuft of hairs (fig. 260) 1, *banksi*
 Epiproct not more than twice as long as wide or, if twice as long, without terminal tuft of hairs 12
12. 9th tergite notched posteriorly; epiproct somewhat pear shaped in lateral view (fig. 285) 17, *vostoki*
 9th tergite not notched; epiproct not pear shaped (figs. 261, 264, 280) 13
13. Epiproct subtriangular in dorsal view (fig. 263) 3, *chloris*
 Epiproct oval or subrectangular in dorsal view (fig. 281) 14
14. Epiproct, except for glabrous circular area at distal end, covered with fine appressed hairs, giving silky sheen (fig. 262) 2, *caudata*
 Epiproct without silken sheen 15
15. In lateral view, epiproct evenly narrowed to tip, somewhat resembling the head of a duck (fig. 264) 4, *concolor*
 In lateral view, epiproct subparallel on margins, tip rounded, resembling a "hot dog" in shape (fig. 280) 13, *neglecta*

FEMALES¹¹

1. With dorsal abdominal stripe (fig. 249c) 2
 Without dorsal abdominal stripe (fig. 249e) 6

¹¹Female of *idei* not known.

2. Pronotum with dark lateral margins (fig. 249d) 5
 Pronotum without dark lateral margins but with obscure pronotal center stripe (fig. 249c) 3
3. Subgenital plate with 3 lobes 14, *onkos*
 Subgenital plate single lobed or bilobed 4
4. Subgenital plate rounded, flattened, or bilobed; basal width of subgenital-plate protrusion three quarters width of segment 10, *mediana*
 Subgenital plate V shaped; basal width of subgenital-plate protrusion only slightly more than half width of segment 12, *nanina*
5. Subgenital plate with narrow tongue-like protrusion 7, *lateralis*
 Subgenital plate broadly rounded 6
6. Brown coloring extending from posterior ocelli to clypeus (fig. 249d) 11, *naica*
 No coloring in ocellar triangle or anterior to it (fig. 249c) 9, *marginata*
7. Subgenital plate scarcely projecting beyond hind margin of 8th segment, very similar to hind margins of other segments ... 3, *chloris*
 Subgenital plate projecting well beyond posterior margin of 8th segment or with narrow median projection extending beyond margin 8
8. Subgenital plate with small quadrate projections, less than one tenth width of segment (fig. 282) 15, *quadrata*
 Subgenital plate without small quadrate projection 9
9. Subgenital plate with narrow tongue-like protrusion 10
 Subgenital plate rounded, without narrow tongue-like protrusion ... 11
10. Basal width of subgenital protrusion about one third width of segment and extending posteriorly halfway across following segment 6, *imbecilla*
 Basal width of subgenital protrusion less than one fifth width of segment and extending posteriorly one third distance across following segment 8, *leonarda*
11. Subgenital plate long, reaching posterior margin of 9th sternite 17, *vostoki*
 Subgenital plate shorter, not reaching posterior margin of 9th sternite 1, *banski*, 2, *caudata*, 4, *concolor*, 13, *neglecta*, 16 *voinae*

1. *Alloperla banksi* Frison (fig. 260)

Alloperla banksi Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 343.

Length: About 9 mm.

Description: This species, green in life, has no dorsal abdominal stripe. In dorsal view the epiproct is longer than wide and is distinguished from that of close

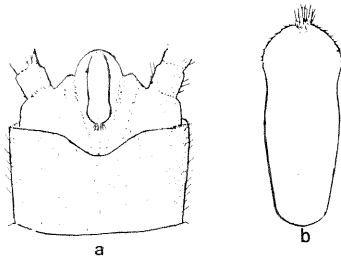


Fig. 260. *Alloperla banksi*: a, male, dorsal view of posterior abdominal segments; b, dorsal view of epiproct (from Frison, 1942).

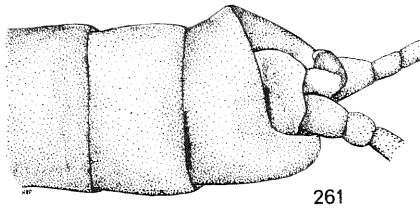
relatives by a tuft of hairs at its end.

Type locality: Flat Creek, New York. Type at Illinois Natural History Survey.

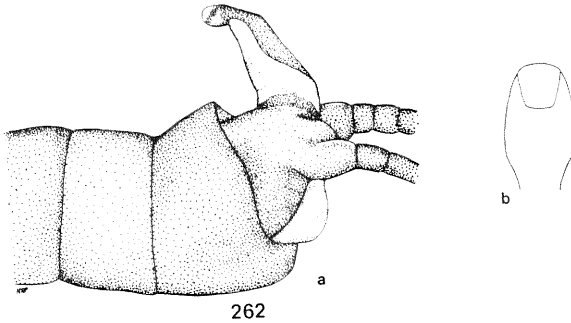
Range: Nova Scotia to Michigan and south to Illinois and New York. It is apparently one of several *Alloperla* found throughout the St. Lawrence River plain but not farther south in New England.

2. *Alloperla caudata* Frison (figs. 261, 262)

Alloperla caudata Frison, 1934, Can. Entomol. 66: 27.



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262

Alloperla caudata male

Fig. 261. Lateral view of posterior abdominal segments.

Fig. 262. a, Lateral view, with epiproct extended; b, dorsal view of distal end of epiproct.

Length: About 9 to 10.5 mm.

Description: This species has no dorsal abdominal stripe. The male epiproct has a brown, silky sheen caused by fine appressed hairs. There is a glabrous circular area at the distal end of the epiproct. Further illustrations of both adults and larvae are by Frison (1934, 1942).

Type locality: Adair County, Oklahoma. Type at Illinois Natural History Survey.

Range: Oklahoma north to Illinois and east to New England and Nova Scotia.

Connecticut record: Union, June 9, 1966 (SWH).

3. *Alloperla chloris* Frison (fig. 263)

Alloperla chloris Frison, 1934, Can. Entomol. 66: 27.

Chloroperla milnei Ricker, 1935, Can. Entomol. 67: 198.

Length: 7.5-9 mm.

Description: This species, green in life, can be recognized by its lack of a dark dorsal line on the abdomen and by its triangular epiproct. Further figures are by Frison (1934).

Type locality: Caroline, New York. Type at Illinois Natural History Survey.

Range: Found in New York, Quebec, and western New England.

Connecticut records: Easton, June 15, July 14, 1965 (SWH); Kent, July 1, 1953, July 9, 1954, C. Remington (YU); Salisbury, June 29, 1960 (SWH); West Cornwall, June 29, 1960 (SWH).

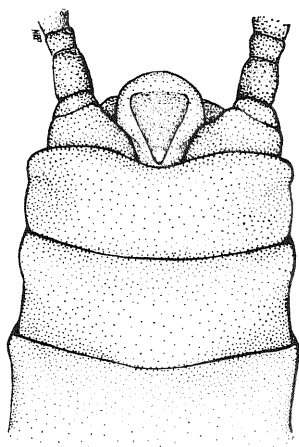


Fig. 263. *Alloperla chloris* male, dorsal view of posterior abdominal segments.

4. *Alloperla concolor* Ricker (fig. 264)

Alloperla concolor Ricker, 1935, Can. Entomol. 67: 256.

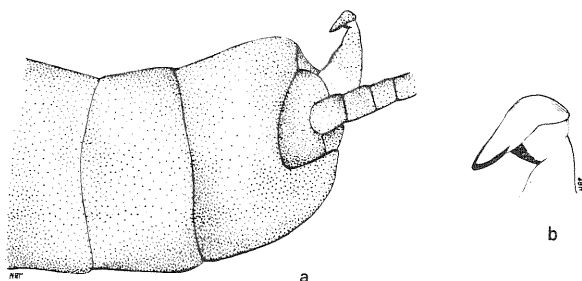


Fig. 264. *Alloperla concolor* male; a, lateral view of posterior abdominal segments; b, lateral view of distal end of epiproct.

Length: 12-14 mm.

Description: This species was, for some time, synonymized with *A. neglecta* but can be separated by the shape of the epiproct and the sclerotization on the anterior half of the 10th tergite. The epiproct is somewhat "duck shaped" in lateral view and lifted higher on the supra-anal body than in *neglecta*. The anterior sclerotization on the 10th tergite is emarginated, forming a wide V that does not reach the anterior margin of the segment. It is green in life but fades to whitish yellow in alcohol. Additional figures of the adult are by Ricker (1925) and Hitchcock (1968). Harper and Pilon (1970) graphed adult emergence and found a 1:1 sex ratio.

Type locality: Horning's Mills, Ontario. Type in Royal Ontario Museum, Ottawa.

Range: Quebec and Newfoundland south to Pennsylvania.

Connecticut records: Barkhamsted, May 20, 1960, June 1, 1967 (SWH); Ellsworth, June 7, 1967 (SWH); Hartland, June 14, 1966 (SWH); Sterling, June 11, 1959.

5. *Alloperla ideii* (Ricker) (figs. 33, 265)

Chloroperla ideii Ricker, 1935, Can. Entomol. 67: 198.

Length: About 7 mm.

Description: *A. ideii* is a green species without a dorsal stripe. It can be recognized in the male by the epiproct, which is produced ventrally as a pair of triangular

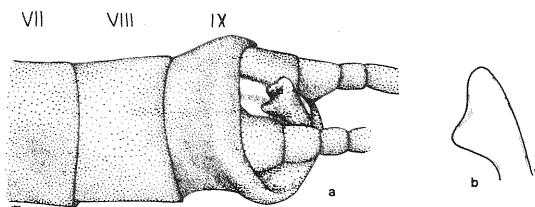


Fig. 265. *Alloperla ideii* male: lateral view of 7th, 8th, and 9th segments; b, lateral view of distal end of epiproct.

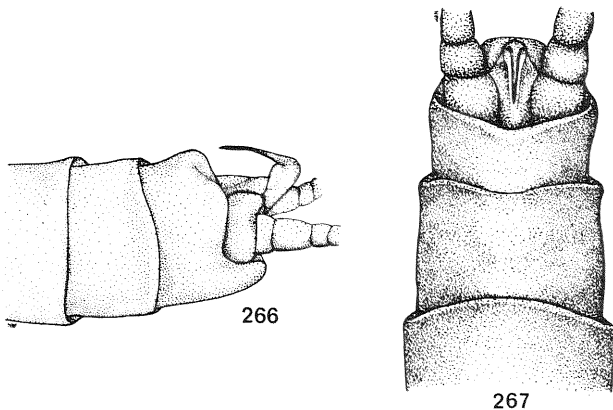
projections. Further information on the type specimen was given by Hitchcock (1968). The female is undescribed. Further illustrations of the male are by Ricker (1935) and Hitchcock (1968).

Type locality: South Bolton, Quebec. Type in Royal Ontario Museum, Ottawa.

Range: Has been found only in Quebec.

6. *Alloperla imbecilla* (Say) (figs. 266, 267)

Sialis imbecilla Say, 1823, Godman's Western Quarterly Reporter 2: 165.



Alloperla imbecilla male, posterior abdominal segments
Fig. 266. Lateral view. Fig. 267. Dorsal view.

Length: 8-10 mm.

Description: This is another green species without a dorsal stripe but is distinguished by having an epiproct which is recurved and tapers to a point. The female subgenital plate is narrow and extends partway across the following sternite. Unlike most stoneflies, this species has more females than males captured and graphed from adult-emergence traps (Harper and Pilon, 1970). Further figures of the adults are by Needham and Claassen (1925) and the mouthparts of the larva were figured by Hardin and Mickel (1952).

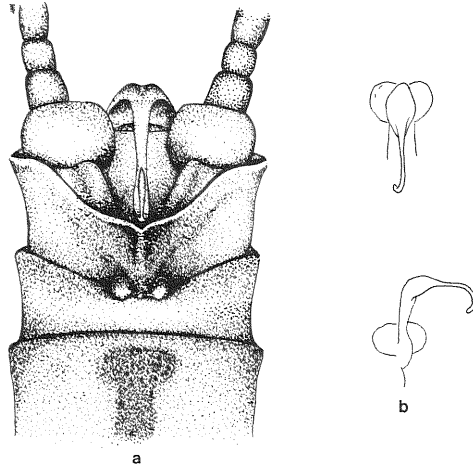
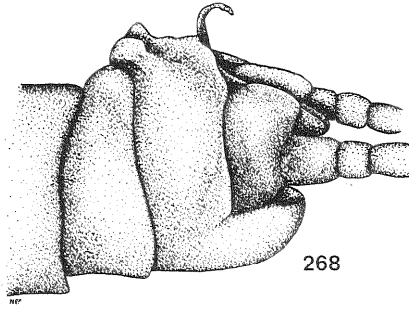
Type locality: Cincinnati, Ohio. Type specimen missing.

Range: Labrador and the Maritimes south to Georgia and west to Minnesota.

Connecticut records: Kent, July 1, 1953, C. Remington (YU); Lebanon, June 6, 1960, June 12, 1959 (SWH); Storrs, June 18, 1954, J. Slater (UC); Union, June 9, 1966 (SWH).

7. *Alloperla lateralis* Banks (figs. 268, 269)

Alloperla lateralis Banks, 1911, Trans. Am. Entomol. Soc. 37: 337.



Alloperla lateralis male

Fig. 268. Lateral view of posterior abdominal segments.

Fig. 269. a, Dorsal view of posterior abdominal segments; b, angled view of the epiproct, showing sclerotized projections at its base.

Length: 9-13 mm.

Description: *A. lateralis* is the only Eastern *Alloperla* with an abdominal dorsal stripe and a slender, tapering, recurved epiproct. On the anterior margin of the 9th tergite are 2 lobes. Near the base of the epiproct there can be projections of various types, from a slight bump to small sclerotized wings. The epiproct is somewhat broadened in some individuals, reinforcing the suggestion that *lateralis* is closely related to *mediana*. The female subgenital plate is narrow and tonguelike. Additional figures of the adult are by Needham and Claassen (1925).

Type locality: Black Mountain, North Carolina. Type in Museum of Comparative Zoology, Harvard University.

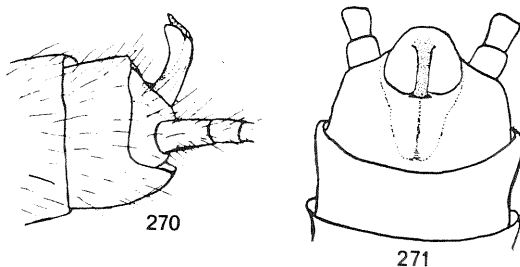
Range: Maine to Georgia in the Atlantic tier of states.

Connecticut records: Bethany, June 8, 1962 (SWH); Cheshire, May 21, 23, 1959 (SWH); East Hartland, June 1, 1967 (SWH); Mt. Carmel, May 15, 1962, May 20, 1960 (UV light trap), May 23, June 3, 1959, June 4, 1964, June 6, 1967, June 18, 1968 (SWH); Union, June 9, 1966 (SWH).

8. *Alloperla leonarda* Ricker (figs. 270, 271)

Alloperla leonarda Ricker, 1952, Ind. Univ. Publ. Sci. Ser. 18: 176.

Alloperla sylvia Harden and Mickel, 1952, Univ. Minn. Agric. Exp. Sta. Tech. Bull. 201: 60.



Alloperla leonarda male, posterior abdominal segments (from Harden and Mickel, 1952).

Fig. 270. Lateral view. Fig. 271. Dorsal view.

Length: 7.5-10 mm.

Description: *A. leonarda* is separated from other species of green *Alloperla* by the male epiproct, which is subrectangular, with a sharp projection at each distal corner. The female subgenital plate is quite narrow and projects only a short distance over the following sternite. Figures of the adult are found in the two references in the heading above.

Type locality: North Branch of the Otter River, Houghton County, Michigan. Type at Illinois Natural History Survey.

Range: Has been found in Michigan and Minnesota.

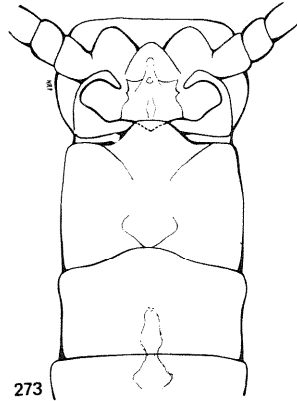
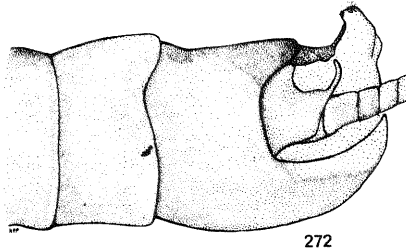
9. *Alloperla marginata* (Banks) (figs. 272, 273)

Chloroperla marginata Banks, 1897, Trans. Am. Entomol. Soc. 24: 21.

Length: 8-10 mm.

Description: This species is easily distinguished by the inward-pointing process at the base of each cercus, a characteristic shared by the Western *A. pallidula* but by no other Eastern species. Additional figures of the adult are by Needham and Claassen (1925). Adult emergence was graphed and sex ratio determined as 1:1 by Harper and Pilon (1970).

Type locality: Colden, New York. Type in Museum of Comparative Zoology, Harvard University.



Alloperla marginata male, posterior abdominal segments
 Fig. 272. Lateral view. Fig. 273. Dorsal view.

Range: This species is principally Eastern, found from Labrador south to New York and, according to Gaufin (1964), west to Wisconsin.

10. *Alloperla mediana* Banks (figs. 249c, 274-276)

Alloperla mediana Banks, 1911, Trans. Am. Entomol. Soc. 37: 336.

Length: 9-20 mm.

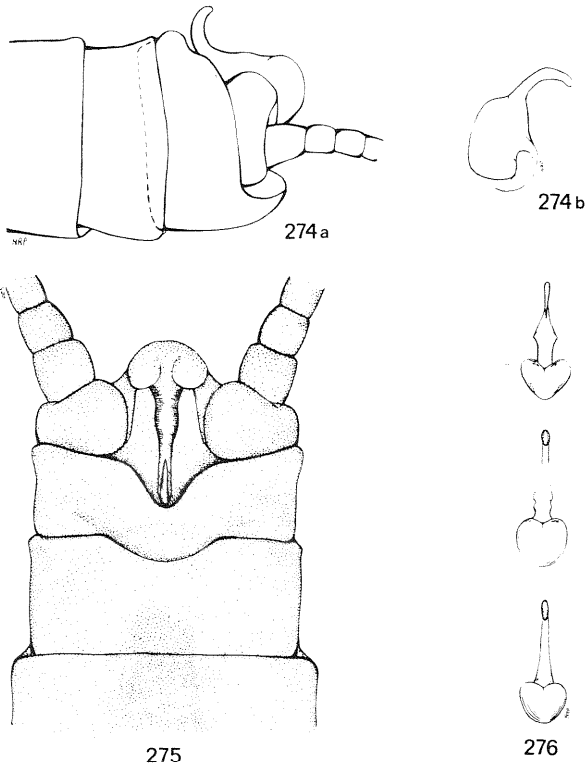
Description: *A. mediana* is quite a variable species but can be distinguished from all other Eastern species except *onkos* by its yellow color, dorsal abdominal stripe, median dark stripe on the pronotum, and the recurved epiprocts that, in lateral view, are flattened at the base. The 9th segment can have a dorsal lobe which varies considerably in size between specimens. In dorsal view, the male epiproct is either smooth or notched. The female subgenital plate is smoothly rounded, or somewhat truncate, or bilobed. Ricker (1964) gave a distribution map of *A. mediana* and *A. onkos* but probably most of his records apply to *mediana* alone. Hitchcock (1968) discussed and illustrated variation within this species. It is quite possible that *A. onkos* represents only the extreme of a variable population and is therefore a synonym of *mediana*. Additional illustrations are by Needham and Claassen (1925).

Stoner (1935) recorded bank swallows feeding on this species.

Type locality: Black Mountain, North Carolina. Type in Museum of Comparative Zoology, Harvard University.

Range: Down the East Coast from Labrador and the Maritimes to North Carolina and west to Ohio and Ontario.

Connecticut records: Barkhamsted, May 20, 1960, June 1, 1967 (SWH); Bethany, May 5, 1961 (SWH); Burlington, May 23, 1967 (SWH); Canaan, June 1, 1961 (SWH); Canton, May 20, 1960 (SWH); East Hartford, May 5, 1967 (SWH); East Hartland, June 5, 1967 (SWH); Ellsworth, June 7, 1967 (SWH); Hamden, May 20, 1959 (SWH); Lebanon, June 12, 1959 (SWH); North Granby, June 1, 1967 (SWH); North Guilford, May 27, 1967 (SWH); Portland, May 22, 1963



Alloperla mediana male

Fig. 274. a, Lateral view of posterior abdominal segments; b, epiproct, lateral view.

Fig. 275. Dorsal view of posterior abdominal segments.

Fig. 276. Variation in epiproct, dorsal view.

(SWH); Salem, May 29, 1967 (SWH); Union, June 9, 1966 (SWH); West Cornwall, June 7, 1967 (SWH).

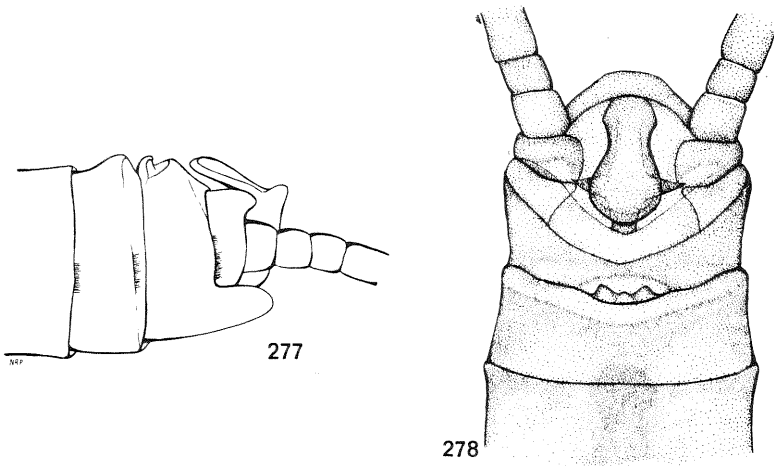
11. *Alloperla naica* (Provancher) (figs. 249d, 277, 278)

Perla naica Provancher, 1876, Nat. Can. 8: 214.

Alloperla novascotiana Needham and Claassen, 1925, Monog. Plec. Am. No. Mex. 2: 113.

Length: 8-10 mm.

Description: This species, with a dorsal abdominal line, is distinguished in the male by the large, flattened epiproct and by an emarginate lobe on the anterior margin of the 9th segment. The head pattern differs from other eastern *Alloperla* in being dark over, and anterior to, the ocellar triangle. Frison (1942) has illustrated the female and Needham and Claassen (1925) the male. Both of these illustrations are under the species name *novascotiana*.



Alloperla naica male, posterior abdominal segments
 Fig. 277. Lateral view. Fig. 278. Dorsal view.

At Pinkham Notch in New Hampshire, I have observed hundreds of females flying downstream, with only a scattering of males on the wing.

Type locality: Near Quebec, Quebec. Type in Quebec Provincial Museum, Quebec City.

Range: Labrador to eastern Pennsylvania and New York. Ricker (1964) presented a map showing the distribution of this species.

12. *Alloperla nanina* Banks (fig. 279)

Alloperla nanina Banks, 1911, Trans. Am. Entomol. Soc. 37: 336.

Alloperla lodgei Frison, 1935, Trans. Am. Entomol. Soc. 61: 340.

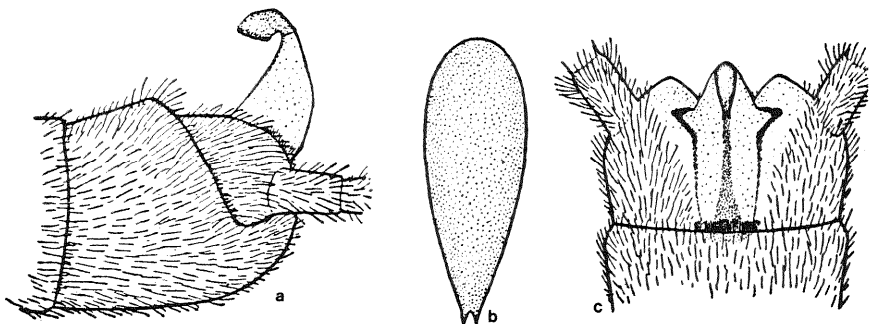


Fig. 279. *Alloperla nanina* male: a, lateral view of posterior abdominal segments; b, epiproct, dorsal view; c, dorsal view of posterior abdominal segments (from Frison, 1935).

Length: 9-10 mm.

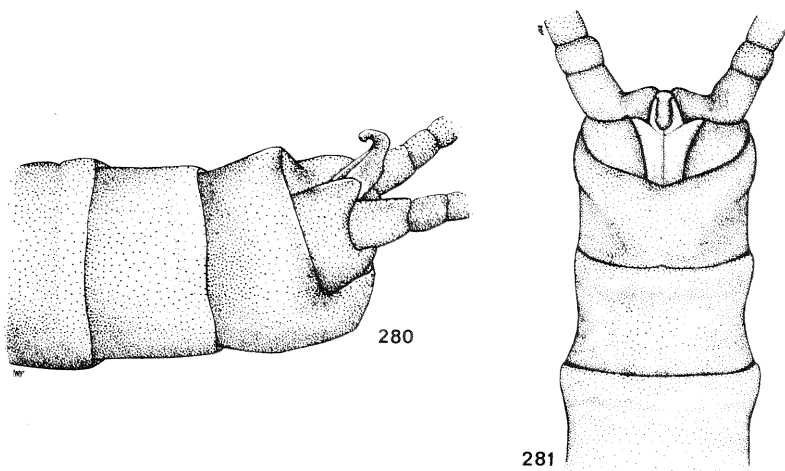
Description: This species has a dorsal abdominal stripe and is separated from other species by a bifurcate tip on the elongated epiproct. It was illustrated by Frison (1935) under the name *lodgei*.

Type locality: Black Mountain, North Carolina. Type in Museum of Comparative Zoology, Harvard University.

Range: According to Gaufin (1964), found from New York to Georgia and westward to Tennessee.

13. *Alloperla neglecta* Frison (figs, 249e, 280, 281)

Alloperla neglecta Frison, 1935, Trans. Am. Entomol. Soc. 61: 336.



Alloperla neglecta male, posterior abdominal segments
Fig. 280. Lateral view. Fig. 281. Dorsal view.

Length: 11-12 mm.

Description: This species has no dorsal abdominal stripe and the epiproct is a recurved, rounded tab, appearing oval as viewed from above. Frison (1935, 1942) and Hitchcock (1968) figured the adults.

Type locality: New Found Gap, North Carolina. Type at Illinois Natural History Survey.

Range: The southern Appalachians in Tennessee and North Carolina, possibly extending slightly northward.

14. *Alloperla onkos* Ricker

Alloperla onkos Ricker, 1935, Can. Entomol. 67: 256.

Length: 10-12 mm.

Description: This species was first described from Ontario but later its range was shown to extend farther south and it was distinguished from *mediana* on the basis of the shape of the male and female genitalia (Ricker 1952, 1964). However, there is much variation in these characters and *onkos* possibly represents only the extreme of a quite variable *mediana* population (Hitchcock, 1968). The original description stated that the male epiproct is four lobed basally and the female subgenital plate trilobed. Until further study is made, *onkos* should include only those insects with the above characters and consequently has been found only at the type locality. Harper and Pilon (1970) described this species as having more females than males and graphed adult emergence.

Type locality: Horning's Mills, Ontario. Type in the Royal Ontario Museum of Zoology.

Range: Part of Ontario.

15. *Alloperla quadrata* Harden and Mickel (fig. 282)

Alloperla quadrata Harden and Mickel, 1952, Univ. Minn. Agric. Exp. Sta. Tech. Bull. 201: 61.

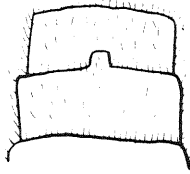


Fig. 282. *Alloperla quadrata* female, ventral view of subgenital plate (from Hardin and Mickel, 1952).

Length: 10 mm.

Description: *A. quadrata* is known only from the female. The subgenital plate is a narrow, squarish projection of the posterior margin of the 8th sternite. It was illustrated by Harden and Mickel (1952).

Type locality: Hinckley, Minnesota. Type at University of Minnesota.

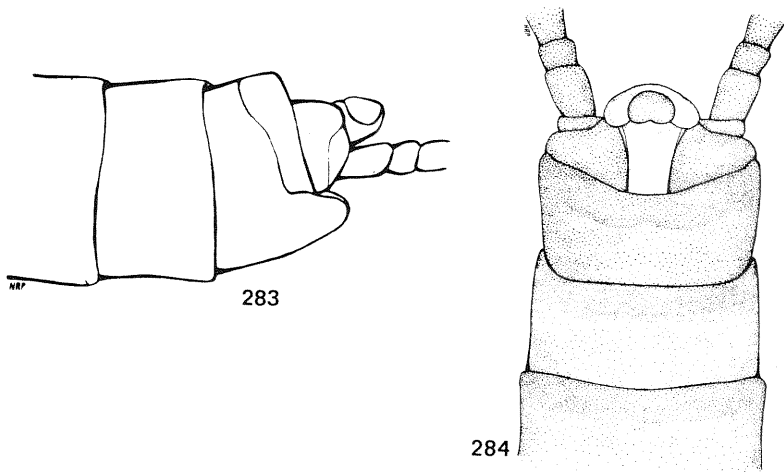
Range: Has been found only in Minnesota.

16. *Alloperla voinae* Ricker (figs. 283, 284)

Alloperla voinae Ricker, 1947, Trans. Roy. Can. Inst. 26: 412.

Length: 8-10 mm.

Description: As surmised by Ricker (1947), this species, like other *Alloperla* s.s., is green in life. The sclerotized part of the epiproct is reniform in dorsal view and does not closely resemble any other Eastern *Alloperla*. The adult male was illustrated by Ricker (1947). I have collected a female with male *voinae* and presume it to be that species. The subgenital plate appears similar to that of *concolor* but the latter is larger and is clothed with fewer bristles than is *voinae*.



Alloperla voinae male, posterior abdominal segments
 Fig. 283. Lateral view. Fig. 284. Dorsal view.

Type locality: Baddeck, Nova Scotia. Type in Canadian National Collection, Ottawa.

Range: Has been found from Nova Scotia up the St. Lawrence River plain in Quebec and Vermont and westward to New York state.

17. *Alloperla vostoki* Ricker (fig. 285)

Alloperla vostoki Ricker, 1947, Trans. Roy. Can. Inst. 26: 413.

Length: 9-10 mm.

Description: The epiproct of *A. vostoki* is brown, densely hairy, subcircular in dorsal view and somewhat pear shaped in lateral view. The posterior margin of the 9th dorsal tergite has a conspicuous notch. Both sexes were illustrated by Ricker (1947).

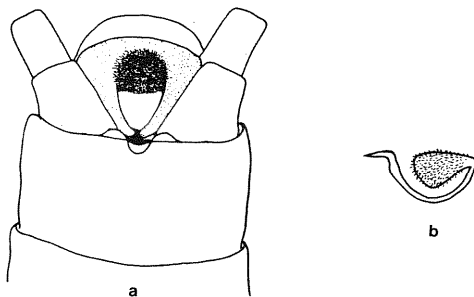


Fig. 285. *Alloperla vostoki* male: a, dorsal view of posterior abdominal segments; b, lateral view of epiproct (from Ricker, 1947).

Type locality: Harborcreek, Pennsylvania. Type at Illinois Natural History Survey.

Range: This species is another *Alloperla* whose range extends from Nova Scotia through the St. Lawrence River plain into western New York and Pennsylvania.

FAMILY PERLODIDAE

This is a family of Plecoptera of varied size and structure that is found in North America, Eurasia, and northern Africa. There are few features that characterize the family as a whole. The glossae are greatly reduced; gills, if present, are single and tufted; the paraglossae are pointed, rather than rounded like those of Perlidae. The number of crossveins and the size of the anal area of the wing vary by genus. The male 10th tergite is cleft and the epiproct well developed in the Isogeninae but not in Isoperlinae or Perlodinae. The paraprocts are poorly developed in Isogeninae but modified, in many genera, into recurved hooks in the Isoperlinae or projecting upward or backward in the Perlodinae. There can be 1 or more lobes on the distal male sternites.

GENUS *Isoperla* BANKS

Isoperla Banks, 1906, Entomol. News 17: 175.

Suzukia Okamoto, 1912, Trans. Sapporo Nat. Hist. Soc. 4: 109.

Megahelus Klapálek, 1923, Ann. Soc. Entomol. Belg. 63: 24.

Clioferla Needham and Claassen, 1925, Monog. Plec. Am. No. Mex.: 137.

Perliphanes Banks, 1947, Psyche J. Entomol. 54: 278.

Occiperla Banks, 1947, Psyche J. Entomol. 54: 280.

Nanoperla Banks, 1947, Psyche J. Entomol. 54: 283.

Walshiola Banks, 1947, Psyche J. Entomol. 54: 283.

Perliola Banks, 1947, Psyche J. Entomol. 54: 284.

The male of the genus is distinguished from other perlodids by its uncleft 10th tergite, lack of gills and epiproct, and variously modified paraprocts. There is a lobe on the hind margin of the 8th sternite of the male but not on the 7th, except in *maxana*, which has lobes on both, and the western *ebria*, which is without lobes. The females cannot be definitely distinguished from the genus *Isogenus* but most species do not have the subgenital plate produced as greatly as does *Isogenus*. Most larvae have longitudinal stripes on the abdomen.

The genus is sorely in need of revision and there is probably considerable synonymy in the following list of species. The keys, drawn largely from Frison (1942) and Harden (Harden and Mickel, 1952), are not definitive; also, variation in color patterns makes them inoperative for some specimens. However, these keys appear to be the best possible under present circumstances. Although there appear to be several new species in Connecticut, I have refrained from describing them until more is known of the variation within the genus—until aedeagal characters are determined.

An occasional *Perlesta placida* specimen may key out here, as the gill remnants are obscure on many adult specimens. These individuals may be

checked by observing the head pattern and by noting the lighter coloring on the costal area of the forewing, as well as the cercal and femoral setation.

The food habits are diverse; the adults of some species feed and those of others do not. Probably most of the larvae are carnivorous. Some larvae are host to cercariae.

Type of genus: *Sialis bilineata* Say.

KEYS TO NORTHEASTERN SPECIES

MALES¹²

1. Ocelli connected with black V or enclosing more or less dark area 4
 Ocelli not connected with black V nor enclosing more or less dark area; dorsum of head mostly yellow except for black areas immediately around ocelli 2
2. Vesicle of 8th abdominal sternite longer than broad 3
 Vesicle of 8th abdominal sternite broader than long 18
3. Vesicle of 8th abdominal sternite deeply recessed, long and narrow 7, *dicala*
 Vesicle of 8th abdominal sternite merely a small knob in middle of posterior margin 6, *decepta*
4. Paraprocts little modified, scarcely sclerotized, projecting caudad, up-curved little or not at all 14
 Paraprocts modified, sclerotized, recurved upward and, in some specimens, forward 5
5. Paraprocts long, cylindrical, slender, sharp 10
 Paraprocts short, flattened 6
6. Longitudinal dark stripes on abdomen 7
 Abdomen uniformly brown or yellow 8
7. Light spot in ocellar triangle broadly open caudally, forming a U or a broad V; dark markings on the head form a rough X 19, *namata*
 Light spot in ocellar triangle tapered behind, narrowly opening caudally; dark markings on head not forming an X ... 26, *transmarina*
8. Dorsum of head, thorax, and abdomen predominantly yellow, ocellar triangle completely dark 12, *holochlora*
 Brownish or yellowish; ocellar triangle has light spot in center in most individuals 9
9. Dorsum of abdomen uniformly brown; paraprocts well developed and recurved upon 10th tergite; color pattern dark brown; lobe on 8th

¹²Males of *emarginata* and *conspicua* not known.

- sternite very broad and low; most specimens have crossvein in forewing beyond cord between radial sector and M_1 and M_2 25, *slossonae*
- Dorsum of abdomen uniformly yellow; paraprocts only partially sclerotized and recurved but little past margin of 10th tergite; lobe of 8th sternite almost as high as broad; 2 dark, sclerotized subtriangular points on penis showing through 9th sternite 23, *signata*
10. Length to apex of wing tips less than 7 mm; predominantly dark brown, except for prothoracic stripe and (in most specimens) light ocellar spot 20, *nana*
 Length to apex of wing tips greater than 7 mm; most specimens yellowish or brown; all with prothoracic stripe and light ocellar spot 11
11. Ocelli connected by dark V, which is main color pattern of head; mainly yellow above 13
 Ocelli more or less enclosed by dark pattern which encloses light ocellar spot; mainly yellowish brown or brown 12
12. Diameter of ocellar spot less than half the distance between lateral ocelli; subcircular light spot in front of median ocellus 13, *lata*
 Diameter of ocellar spot more than half the distance between lateral ocelli; subrectangular light spot, with long axis crosswise, in front of median ocellus 15, *marlynia*
13. Over 11 mm long; without dark patches or setae on 9th and 10th abdominal tergites 18, *montana*
 Less than 9 mm long; 2 brown patches with setae on 10th abdominal tergite and 2-lobed brown patch on 9th abdominal tergite 14, *longiseta*
14. Ocellar triangle completely dark 15
 Ocellar triangle with light spot in center; light spot open or not open to rear 17
15. Terminal ridge on margin of 10th tergite; length to apex of wings more than 15 mm 3, *clio*
 No terminal ridge on margin of 10th tergite; length to apex of wings less than 15 mm 16
16. Dark color of ocellar triangle extends unbroken to labrum, with extensions toward antennal bases and toward back of head 24, *similis*
 Dark color of ocellar triangle roughly rectangular in shape, its front square at median ocellus and the rear bowed between the lateral ocelli 12, *holochlora*
17. Light area in dark V over ocelli touches black pigment of median ocellus 18
 Light area in dark V over ocelli separated from median ocellus by a distance at least equal to diameter of ocellus 19

18. Dorsal median stripe on abdomen; caudal projection of 9th sternite quadrate 22, *richardsoni*
 No dorsal median stripe on abdomen; caudal projection of 9th sternite rounded 1, *bilineata*, 2, *burksi*, 11, *gibbsae*
19. Lobe present on posterior margin of 7th abdominal sternite; this lobe much smaller than that on 8th sternite 16, *maxana*
 No lobe on 7th abdominal sternite 20
20. Terminal ridge on hind margin of 10th tergite; length to apex of wings greater than 15 mm 3, *clio*
 No terminal ridge on hind margin of 10th tergite; length to apex of wings less than 15 mm 21
21. Abdomen brown above, much brown coloration on mesonotum and metanotum 5, *cotta*, 9, *francesca*, 21, *orata*
 Abdomen yellow above, with faint darker stripes in many specimens; mesonotum and metanotum mainly yellow ... 10, *frisoni*, 17, *mohri*

FEMALES¹³

1. Ocelli connected by black V or enclosing a more or less dark area 5
 Ocelli not connected by black V nor enclosing a more or less dark area; dorsum of head yellow, except for dark areas around ocelli in some specimens; very faint line connects lateral ocelli with median ocellus in some specimens 2
2. Subgenital plate very slightly produced caudad; broadly rounded
 6, *decepta*, 22, *richardsoni*
 Subgenital plate much produced caudad; subtriangular 3
3. Subgenital plate acutely emarginate at apex; head wider than 2.0 mm 8, *emarginata*
 Subgenital plate not emarginate at apex or very slightly so; head less than 1.8 mm wide 4
4. Margins of subtriangular subgenital plate somewhat incurved before apex 7, *dicala*
 Margins of subtriangular subgenital plate straight or somewhat incurved before apex; apex slightly emarginate in some specimens 1, *bilineata*
5. Species mainly yellow, with lateral ocelli connected to median ocellus by a dark-brown V 6
 Most species fuscous to brown, ocellar triangle all dark or with only a central light spot; this spot sometimes slightly open caudad ... 14
6. Margins of subgenital plate subparallel just before apex; apex truncate and turned downward away from body 10, *frisoni*
 Subgenital plate subtriangular, rounded, or emarginate behind; apex

¹³Female of *maxana* not known.

- may or may not turn downward away from body 7
7. Subgenital plate about half as wide as anterior width of 8th abdominal segment, evenly rounded behind and reaching about one third across 9th sternite; apex darkly sclerotized 14, *longiseta*
 Width of subgenital plate more than half that of 8th abdominal segment; not sclerotized more than remainder of segment 8
 8. Apex of subgenital plate turned downward away from body 12
 Apex of subgenital plate not turned downward away from body ... 9
 9. Light area in ocellar triangle touching pigment of anterior ocellus 10
 Light area in ocellar triangle separated from anterior ocellus by a distance at least equal to diameter of ocellus 19, *namata*
 10. Subgenital plate subtriangular 1, *bilineata*
 Subgenital plate rounded behind 11
 11. Subgenital plate little produced, broadly rounded 22, *richardsoni*
 Subgenital plate produced about halfway or more across 10th sternite 11, *gibbsae*, 18 *montana*
 12. Head anterior to median ocellus dark (except for M line) 13
 Head anterior to median ocellus light 9, *francesca*, 21, *orata*
 13. Range, Illinois and Indiana 2, *burksi*
 Range, Michigan, Ontario, and Quebec 5, *cotta*
 14. Subgenital plate triangular, reaching almost to posterior margin of 9th segment 12, *holochlora*
 Subgenital plate rounded, truncate, or notched, reaching halfway or less across 9th segment 15
 15. Subgenital plate truncate; width of base less than half width of 8th abdominal segment 26, *transmarina*
 Subgenital plate broadly rounded or notched; width of base more than half width of 8th abdominal segment 16
 16. Ocellar triangle completely dark; area immediately anterior to median ocellus dark 24, *similis*
 Ocellar triangle has light spot in center or light intrusion from rear of head extending between lateral ocelli; if all dark has a light spot in front of median ocellus 17
 17. Length to tip of wings less than 8 mm; abdomen uniformly dark on all sides 20, *nana*
 Length to tip of wings greater than 8 mm; abdomen variously marked with yellow or orange; if dark dorsally is predominantly yellow ventrally 18
 18. Ocellar triangle dark, without light spot in center of triangle ... 3, *clio*
 Ocellar triangle with light spot in center 19

19. Subgenital plate deeply notched 4, *conspicua*
 Subgenital plate rounded or emarginate 20
20. Dorsum of abdomen with 8 longitudinal rows of minute black spots;
 on the 2 middle rows and the lateral rows of spots, the spots are
 paired 17, *mohri*
 Dorsum of abdomen variously marked but not as above 21
21. Subgenital plate low, broad and scarcely produced behind; light spot
 in front of median ocellus transversely rectangular; abdomen pre-
 dominantly yellow below 23, *signata*
 Subgenital plate considerably produced behind; light spot in front of
 median ocellus quadrate, crescent shaped, or subcircular 22
22. Light spot in front of median ocellus quadrate; subgenital plate broad-
 ly emarginate; abdomen brown below; in most specimens, light spot
 in ocellar triangle nearly touching lateral ocelli, an additional r-m
 crossvein beyond the cord 25, *slossonae*
 Light spot in front of median ocellus crescent shaped or subcircular;
 in most specimens, light spot in ocellar triangle less than half as
 wide as the distance between lateral ocelli; subgenital plate may or
 may not be emarginate 23
23. Subgenital plate emarginate; abdomen predominantly yellow below;
 light spot in front of median ocellus crescent shaped or semicircular
 15, *marlynia*
 Subgenital plate evenly rounded behind; abdomen fuscous below;
 light spot in front of median ocellus subcircular 13, *lata*

LARVAE¹⁴

1. Maxilla with 1 or 2 prominent teeth on lacinia; pattern of abdomen
 variable 2
 Maxilla without a prominent tooth on lacinia; abdominal tergites
 speckled 6, *decepta*
2. Lacinia with single tooth 3
 Lacinia with 2 teeth (fig. 4) 4
3. Abdominal tergites speckled; lacinial tooth a continuation of outer
 margin of lacinia, outer margin essentially glabrous; mandibles with
 several cusps 20, *nana*
 Abdominal tergites each with about 6 dark dots; lacinial tooth inset
 from outer margin of lacinia, outer margin with setae; mandibles
 each with 2 prominent cusps divided at tips 17, *mohri*
4. Both lacinial teeth long, largest subequal in length to the sclerite that
 bears it; a tuft of hairs on margin below 2nd tooth 5
 Lacinial teeth shorter, equal to half or three quarters the length of

¹⁴Larvae of *conspicua*, *emarginata*, and *maxana* not known; larval *montana* said to have pattern of *richardsoni*.

- sclerite that bears them; either a tuft or (more generally) a row of hairs on margin 7
5. Lateral dark lines on dorsum of abdomen 2, *burksi*
 Longitudinal dark lines on dorsum of abdomen 6
6. Dark markings on head posterior to ecdysial line
 5, *cotta*
 Head light behind ecdysial line, except for faint markings on ecdysial line and on hind margin of head; occipital region essentially light 9, *francesca*, 21, *orata*
7. Dorsal abdominal segments uniformly brown; an occasional specimen has a few light spots 8
 Dorsal abdominal segments with alternating transverse or longitudinal light-and-dark stripes or bands 10
8. Transverse stripe connecting lateral ocelli with eyes; large, pale spot extending from lateral ocelli forward past anterior ocellus . . . 3, *clio*
 No transverse stripe between ocelli and eyes; ocellar triangle partly dark and dark areas connected laterally to side of head 9
9. 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
 25, *slossonae*
 Uniformly brown above dark phase of 15, *marlynia*
10. Pale median longitudinal stripe on brown abdomen; ocellar triangle completely dark 24, *similis*
 Abdomen with more than 1 stripe (transverse or longitudinal); a light spot in ocellar triangle of most specimens 11
11. Abdominal tergites with transverse stripes 12
 Abdominal tergites with longitudinal stripes 13
12. Both anterior and posterior margins of abdominal tergites dark; middle portion light, although this middle portion is interrupted in some specimens; 10th tergite with dark markings . . . 15, *marlynia*
 Posterior half of abdominal tergites dark, anterior half light; extreme anterior margin somewhat darkened in some specimens; 10th tergite light 23, *signata*
13. Light area within ocellar triangle completely enclosed by darker area 14
 Light area within ocellar triangle not completely enclosed by darker area 17
14. In most specimens, dorsal pattern light on a dark background; ocellar spot very small or lacking; abdomen decidedly speckled above
 7, *dicala*
 Dorsal pattern essentially dark on light background; ocellar spot large, in most specimens its diameter is more than half the distance between the lateral ocelli; each abdominal tergite with 6 to 8 dark

- dots 15
15. Abdominal stripes generally indistinct; 6 to 8 dark dots on each abdominal tergite; wide stripes on wing pads 16
 Abdominal stripes distinct; no dark dots or freckling on abdominal tergites; stripes on wing pads narrow and show venation darker than stripes *11, gibbsae, 26, transmarina*
16. The 2 lacinial teeth followed by tuft of hairs *22, richardsoni*
 The 2 lacinial teeth followed by row of hairs *1, bilineata*
17. Dark transverse band across head through anterior ocellus without extensions back to lateral ocelli, although a much lighter brown extension can be present 18
 Dark transverse band across head through anterior ocellus, with extensions back to or through lateral ocelli 19
18. 2 lacinial teeth followed by a tuft of hairs *22, richardsoni*
 2 lacinial teeth followed by a row of hairs *19, namata*
19. 2 dark bands across the head, 1 on clypeus, enclosing between them a light M; apex of lacinia broad and heavily beset with hairs
 *13, lata*
 1 dark band across head; apex of lacinia receding below apical teeth 20
20. Very little dark color on pronotum, mesonotum, or metanotum—dark spots on these 3 areas form 2 lines; 3 dark stripes on abdomen, uniform in width, narrow *10, frisoni*
 As much dark area as light on pronotum; 2 lines of spots not present on pronotum, mesonotum, or metanotum 21
21. Lateral stripes of abdomen distinctly wider than median stripe ... 22
 Lateral stripes of abdomen subequal or only slightly wider than median stripe *26, transmarina*
22. Sides of head, from labrum to eyes, dark; dark line from each lateral ocellus forward to front edge of clypeus *12, holochlora*
 Area on side of head, from labrum to eyes, mostly light; lateral ocelli not connected to front edge of clypeus by dark areas
 *14, longiseta*

1. *Isoperla bilineata* (Say) (fig. 286)

Sialis bilineata Say, 1823, Godman's Western Quarterly Reporter 2: 165.

Length: 10-14 mm.

Description: This widely distributed species is somewhat variable in appearance but most specimens have the ocelli connected with a dark V-shaped mark. The abdomen lacks dark markings. The female subgenital plate is triangular and long. The male paraprocts are somewhat recurved. The lobe of the 8th male sternite is broad and rounded. Larvae are longitudinally striped on the abdomen and have a light spot in the ocellar triangle.

Needham and Claassen (1925) and Frison (1935) figured the adults, genitalia, wings,

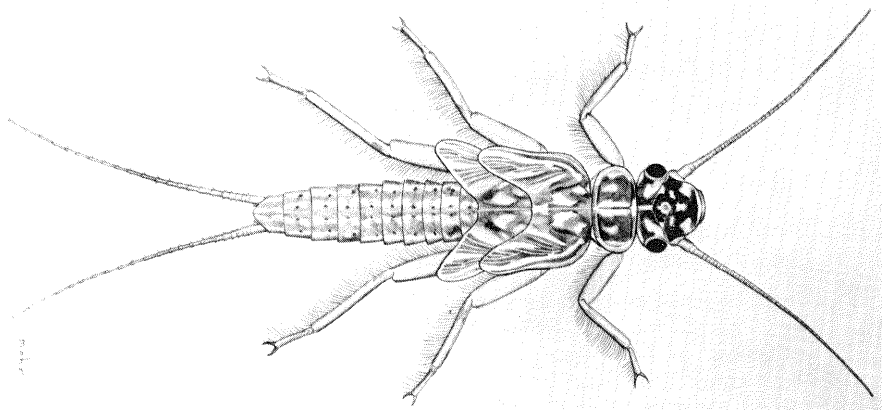


Fig. 286. *Isoperla bilineata* larva (from Frison, 1942).

and eggs; Frison (1935) and Claassen (1931) the larva. Needham and Claassen (1925) gave an analysis of the variation in wing venation in this species.

The adults are principally nocturnal. The larvae grow most rapidly from January to April and probably are herbivores (Frison, 1935). Harden found that the gut contents of larvae were principally Chironomidae. He also noted that eggs oviposited in June and kept in the laboratory did not hatch until October (Harden and Mickel, 1952).

The egg figured by Frison (1935) is quite different from that drawn by Needham and Claassen (1925).

Type locality: Near Cincinnati, Ohio. Type specimen missing.

Range: Quebec south to North Carolina and west to Manitoba and Colorado.

Connecticut records: Franklin, May 31, 1969 (SWH); Lebanon, June 6, 1960 (SWH); Mt. Carmel, UV light trap, July 11, 1961, A. DeCaprio; Storrs, June 11-18, 1954, J. Slater (UC); larvae from Easton (SWH); Glastonbury, J. Krause (UC); Melrose, D. Grant (UC); Vernon, E. Dennis (UC).

2. *Isoperla burksi* Frison (fig. 287)

Isoperla burksi Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 332.

Length: About 11 mm.

Description: The male has little to distinguish it from *bilineata*. In the female, the subgenital plate is produced over the 9th sternite and indented at the tip. In lateral view, the tip of the plate turns down. The larva has lateral stripes on the abdomen but can be separated by the head pattern and shape of the maxilla from the few other Eastern species that also have lateral stripes. Frison (1942) figured the adult genitalia and head pattern, as well as larval body pattern and mouthparts.

Type locality: Eddyville, Illinois. Type at Illinois Natural History Survey.

Range: Has been found in Illinois, Indiana, and Ohio.

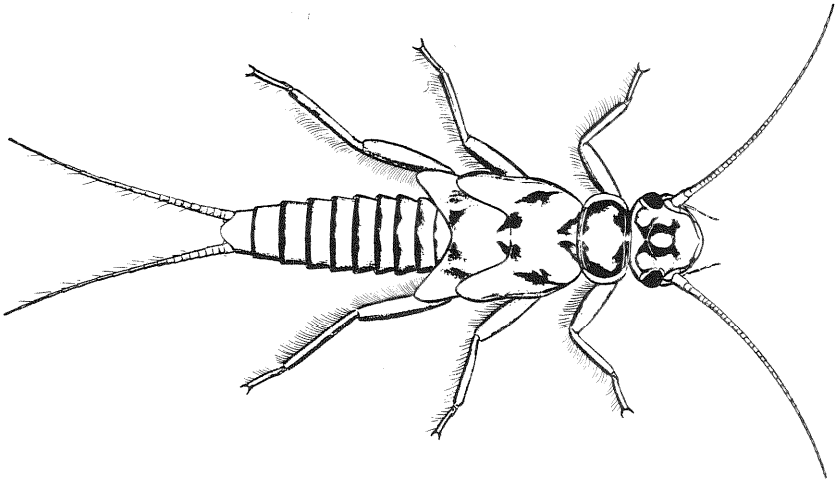


Fig. 287. *Isoperla burksi* larva (from Frison, 1942).

3. *Isoperla clio* (Newman) (fig. 288)

Isogenus clio Newman, 1839, Mag. Nat. Hist. 3: 86.

Isoperla confusa Frison, 1935, Ill. Nat. Hist. Surv. Bull. 20: 441.

Length: 16-20 mm.

Description: This is one of the larger *Isoperla* and the only Eastern species which has a ridge along the posterior margin of the male 10th tergite. Frison (1935) illustrated the adult genitalia, larva, and larval mouthparts under the species name *confusa*. Needham and Claassen (1925) pictured the adult genitalia and wings.

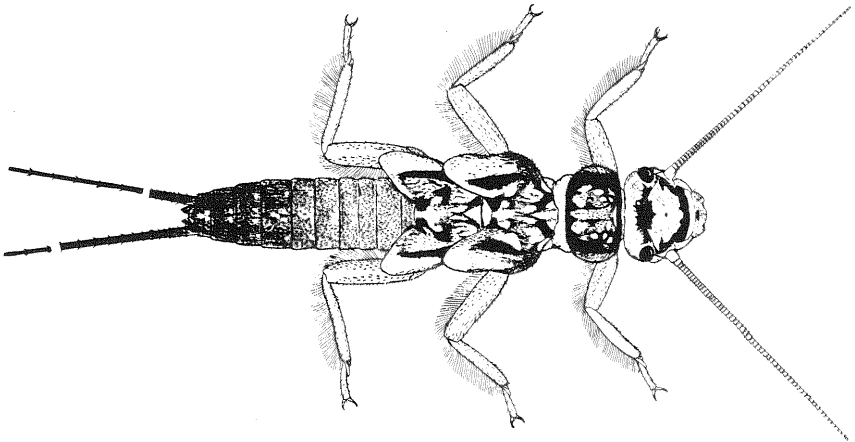


Fig. 288. *Isoperla clio* larva (from Frison, 1935).

Frison (1935), Minshall and Minshall (1966), and Minshall (1967) stated that the larval diet of this species is primarily animal material and that the larvae are usually found in packets of dead leaves. Minshall and Minshall (1966) noted that *I. clio* ate chironomids, mayfly larvae, *Asellus*, and *Phagocata* but it did not feed on *Gammarus*. They observed oviposition in late afternoon. The female glides from a height of about 2 m down to the surface of the stream, her abdomen touches the water several times as the eggs are deposited, and then she flies upward. The eggs apparently hatch in August and September. The greatest larval growth occurs in January and April, with the adults emerging in late spring and early summer.

Type locality: Georgia. Type in the British Museum.

Range: Connecticut to Florida and west to Illinois and Arkansas.

Connecticut records: Larvae from Mansfield, R. Frehm, L. Okta, N. Duquette (UC); Storrs, T. Burr (UC).

4. *Isoperla conspicua* Frison

Isoperla conspicua Frison, 1935, Ill. Nat. Hist. Surv. Bull. 20: 445.

Length: 12 mm.

Description: Apparently this species is known only from the holotype female. However, it is the only Eastern *Isoperla* with a deep notch in the subgenital plate. The genitalia of the female type was figured by Frison (1935).

Type locality: Rock Island, Illinois. Type at Illinois Natural History Survey.

Range: Unknown.

5. *Isoperla cotta* Ricker

Isoperla cotta Ricker, 1952, Ind. Univ. Publ. Sci. Ser. 18: 144.

Length: 11.5-13 mm.

Description: This species is very close to *orata* and *burksi* and is possibly conspecific with them. The male and female genitalia and the structure of the larval maxilla are almost identical in all three species. However, the range of *cotta* is north of *burksi's* range and *cotta* is somewhat lighter in color than *orata*. The color pattern and genitalia of the adult were pictured by Ricker (1952).

Type locality: Terra Cotta, Ontario. Type at Illinois Natural History Survey.

Range: Michigan, Ontario, Quebec, and New England.

6. *Isoperla decepta* Frison (fig. 289)

Isoperla decepta Frison, 1935, Ill. Nat. Hist. Surv. Bull. 20: 447.

Length: 10-14 mm.

Description. The adult is mostly yellow with some brownish areas. The lobe on the 8th sternite of the male is long but protrudes little beyond the hind margin of the sternite. The female has a rounded subgenital plate. The larva has a darker head than *richardsoni*, which species it most resembles. Frison (1935) illustrated the adult

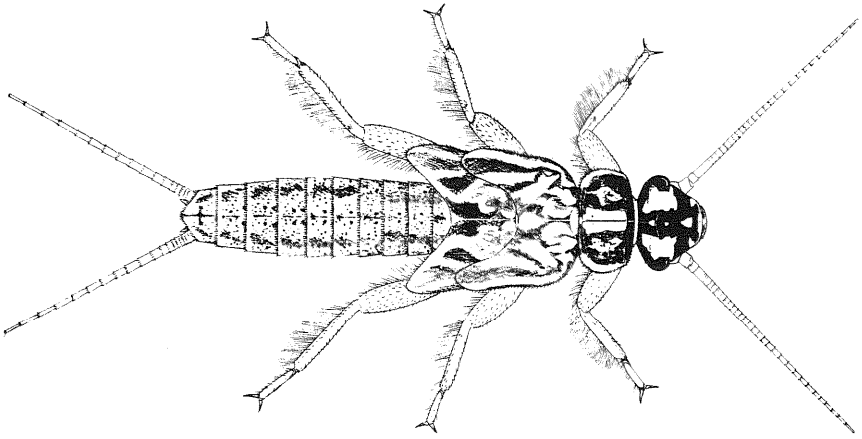


Fig. 289. *Isoperla decepta* larva (from Frison, 1935).

genitalia, the larva, and the larval mouthparts.

Frison (1935) captured a larva as it was swallowing chironomid larva, showing that it is at least partly predacious. The same author (p. 297) states that adults of this species also feed. The adults are diurnal.

Type locality: New Columbia, Illinois. Type at Illinois Natural History Survey.

Range: Has been collected in Illinois, Indiana, and Ohio.

7. *Isoperla dicala* Frison (fig. 290)

Isoperla dicala Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 321.

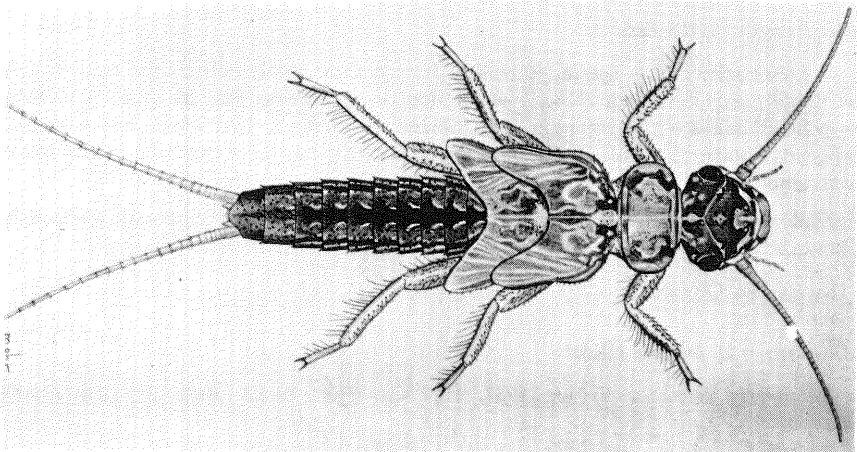


Fig. 290. *Isoperla dicala* larva (from Frison, 1942).

Length: 11-14 mm.

Description: This insect is one of the few *Isoperla* with a pale head lacking dark markings. The lobe of the male 8th sternite is narrow and recessed and the female subgenital plate is triangular, with a suggestion of a nipple at the tip. The larvae are dark, with longitudinal abdominal stripes. Frison (1942) pictured the adult, larva, and larval mouthparts.

Type locality: Free Soil, Michigan. Type at Illinois Natural History Survey.

Range: The Maritimes south to Connecticut and Tennessee and west to Minnesota and Missouri.

Connecticut records: Easton, May 27, 1968 (SWH); Mt. Carmel, June 1, 1966, June 12, 1967 (SWH), UV light trap, June 13, 28, 1961, July 8, 1960, A. DeCaprio.

8. *Isoperla emarginata* Harden and Mickel

Isoperla emarginata Harden and Mickel, 1952, Univ. Minn. Agric. Exp. Tech. Bull. 201: 40.

Length: 16 mm.

Description: This is another species with a pale head. There is a crescent-shaped brown marking over each lateral ocellus. The female subgenital plate is triangularly produced, with an emarginated tip. Only the female holotype is known and was illustrated by Harden and Mickel (1952).

Type locality: Grand Marais, Minnesota. Type at University of Minnesota at St. Paul.

Range: Unknown.

9. *Isoperla francesca* Harper

Isoperla francesca Harper, 1971, Can. J. Zool. 49: 688.

Length: 12-13 mm.

Description: This species is closely related to *orata*. However, the male vesicle on the 8th sternite of *francesca* is wider than long, whereas that on *orata* is as long as wide. There are also differences in the penial armature. The female has a bilobed subgenital plate. Illustrations of the both sexes and the larva are with the original description.

Type locality: St. Hippolyte, Quebec. Type in Canadian National Collection, Ottawa.

Range: In Quebec.

10. *Isoperla frisoni* Illies

Isoperla truncata Frison, 1937, Ill. Nat. Hist. Surv. Bull. 21: 94. (name preoccupied)

Isoperla frisoni Illies, 1966, Kat. rez. Plec., Das Tierreich 82: 402.

Length: 11-14 mm.

Description: The adult insect has the ocelli connected by a dark V-shaped marking. The female subgenital plate is truncate and turned downward in lateral view. The male paraprocts are neither hooked nor upturned. The larva has 3 distinct longitudinal stripes on the abdomen and 2 broken longitudinal stripes on the thoraces. Frison (1937) illustrated color patterns of both larvae and adults, the adult genitalia, and the larval mouthparts under the name *truncata*. Harper and Magnin (1969) found that this species emerges in June during the day on stones at the water's edge. Oviposition occurs within 15 minutes after sundown, when the females drop to the stream surface to deposit their eggs. The first larvae are found in October and growth is steady throughout the winter. In late spring, just before emergence, growth is accelerated. Harper and Pilon (1970) graphed adult emergence and found the pattern to be similar each year, although it could be shifted as much as several weeks, depending on temperature.

Type locality: Spooner, Wisconsin. Type at Illinois Natural History Survey.

Range: The Maritimes west to Indiana and Wisconsin.

Connecticut records: Bethany, Apr. 14, 1960 (SWH); Killingworth, June 18, 1965 (SWH); Stafford, June 9, 1966 (SWH).

11. *Isoperla gibbsae* Harper

Isoperla gibbsae Harper, 1971, Can. J. Zool. 49: 685.

Length: 11-14 mm.

Description: This species is apparently related to the *bilineata* group. For specific identification, the male penial sac must be examined, but the dark V-shaped mark between the ocelli and the lack of pigment anterior to the front ocellus also separates it from other species. The female subgenital plate is large and rounded. Harper (1971) figured the adult and larva.

Type locality: Rigaud, Quebec. Type in Lyman Museum, Montreal.

Range: Quebec, New York, and New England.

Connecticut record: Easton, May 15, 1968 (SWH).

12. *Isoperla holochlora* (Klapálek) (figs. 291, 292)

Chloroperla holochlora Klapálek, 1923, Ann. Soc. Entomol. Belg. 63: 28.

Length: 11-14 mm.

This insect has U-shaped markings on mesothorax and metathorax, is mostly yellow, has dark hairs on thoraces, and bears stiff bristles on the margin of the 8th sternite. The dark marking of the ocellar triangle is truncate in front, where it is even with the front ocellus and bowed backward between the hind ocelli. The female subgenital plate is triangular, covering most of the 9th sternite. The male paraprocts are rounded and, in some specimens, project slightly forward. The larva has longitudinal abdominal stripes and a dark head bearing a light spot in the ocellar triangle. Frison (1942) figured the adult, larva, and larval mouthparts. Ricker (1938) pictured the genitalia of the type specimens.

Type locality: Georgia. Type at Musée Royal d'Histoire Naturelle, Brussels.

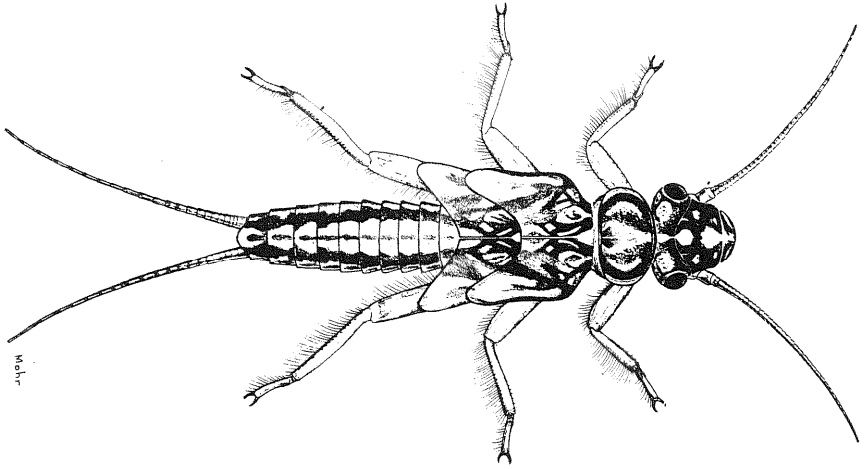


Fig. 291. *Isoperla holochlora* larva (after Frison, 1942).

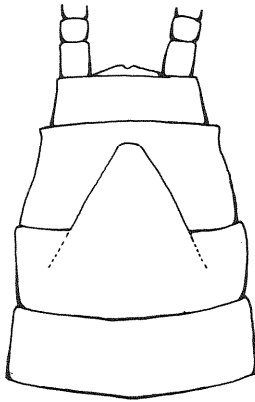


Fig. 292. *Isoperla holochlora* female, ventral view of posterior abdominal segments.

Range: Quebec south to Georgia and west to Tennessee.

Connecticut records: Ellsworth, June 7, 1967 (SWH); Kent, July 1, 1953, July 9, 1954, C. Remington (YU); Stratford, June 9, 1966 (SWH).

13. *Isoperla lata* Frison (fig. 293)

Isoperla lata Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 334.

Length: About 13 mm.

Description: This species is predominantly darkish, with a light spot in the ocellar triangle. The male has prominent recurved paraprocts; the female a rounded, slightly produced subgenital plate. The larva has longitudinal stripes on the abdomen,

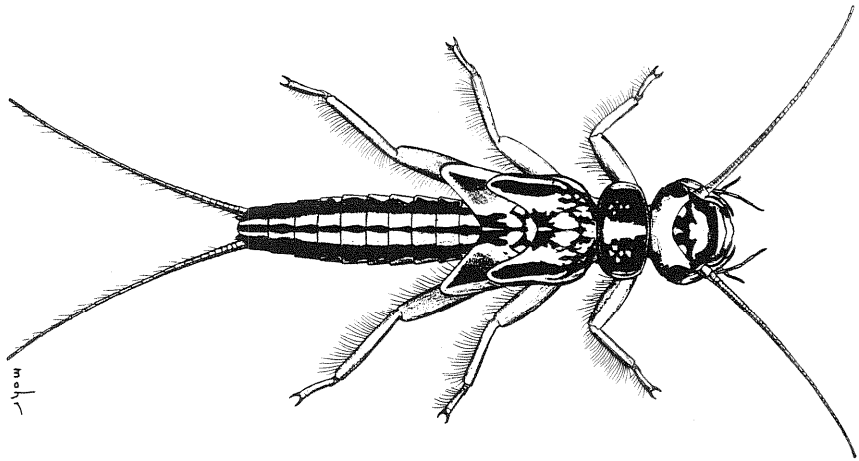


Fig. 293. *Isoperla lata* larva (from Frison, 1942).

a dark band across the head on the clypeus, and another band even with the ocelli. The larval lacinia is quite broad and does not recede after the 2nd tooth as in most *Isoperla*. Further figures of adults and larvae are by Frison (1942) and Harden and Mickel (1952).

Harper and Magnin (1969) found this species to emerge as adults at a height of about 2 m up the trunks of trees near the water. Larvae apparently hatch soon after oviposition. Harper and Magnin found larval growth to be regular until February or March with little increase from then until emergence in May.

Type locality: Boulder Junction, Wisconsin. Type at Illinois Natural History Survey.

Range: The Maritimes to Tennessee and west to Minnesota.

14. *Isoperla longiseta* Banks (fig. 294)

Isoperla longiseta Banks, 1906, Can. Entomol. 38: 337.

Length: 10-13 mm.

Description: This is a species of the prairies and apparently lives in large, sluggish streams. Adults are generally yellowish; males have sharp, recurved genital hooks. The female subgenital plate is abruptly produced. Apparently the far-southern form is brachypterous. Larva and adult are shown by Needham and Claassen (1925), Frison (1942), Ricker (1943), and Gaufin, Nebeker, and Sessions (1966), and the egg by Knight, Nebeker, and Gaufin (1965b).

Type locality: Onaga, Kansas. Type in Museum of Comparative Zoology, Harvard University.

Range: Mississippi River west to Utah and north to the Yukon. The one isolated eastern record, from Aylmer, Quebec, may be in error.

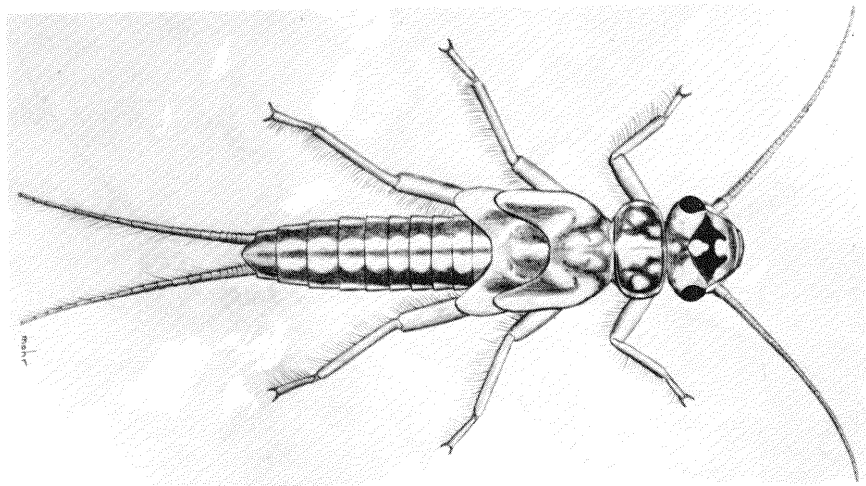


Fig. 294. *Isoperla longiseta* larva (from Frison, 1942).

15. *Isoperla marlynia* Needham and Claassen (figs. 295-297)

Isoperla marlynia Needham and Claassen, 1925, Monog. Plec. Am. No. Mex.: 148.

Length: 12-13 mm.

Description: The adult has a light spot in the ocellar triangle and a lateral light spot anterior to the front ocellus. The male genital hooks are slender, recurved, and comparatively long. The female subgenital plate is produced and with a shallow emargination. The larvae vary from light to dark. The galea is broad, about as broad as the lacinial tooth is long. Further figures of the adult are by Needham and Claassen (1925) and (under the name *clio*) by Frison (1942). The larva and larval mouthparts were figured by Frison (1942) and (under the name *clio*) by Claassen (1931) and Frison (1935).

Type locality: Lakehurst, New Jersey. Type at Cornell University.

Range: The Maritimes south to Virginia and west to Illinois and Manitoba.

16. *Isoperla maxana* Harden and Mickel

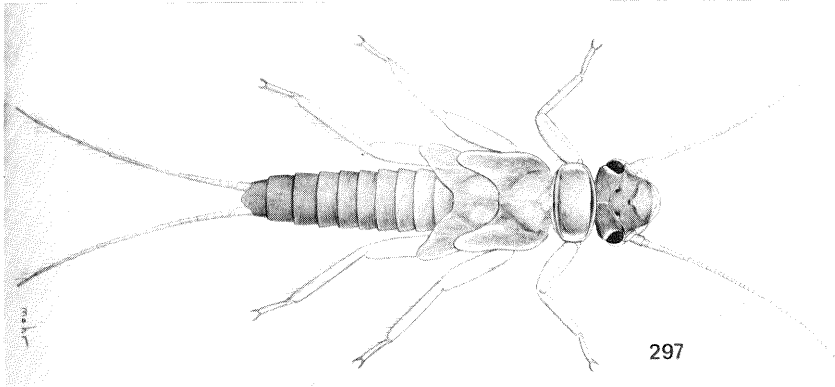
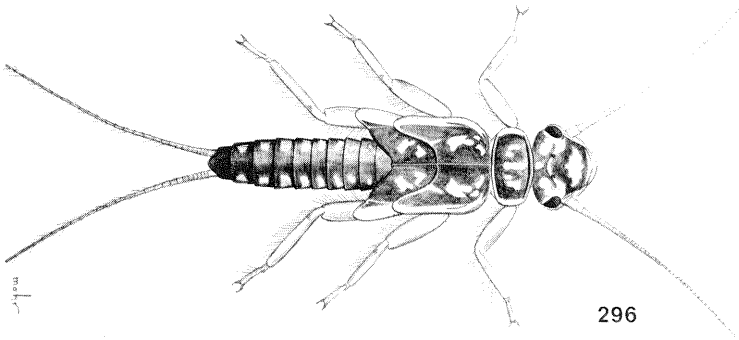
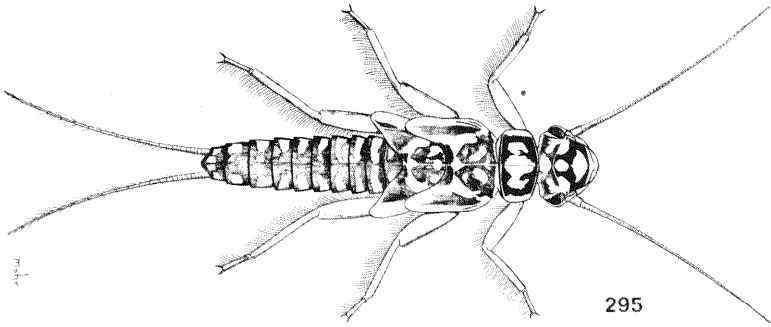
Isoperla maxana Harden and Mickel, 1952, Univ. Minn. Agric. Exp. Sta. Tech. Bull. 201: 42.

Length: 10 mm.

Description: This species is known only in the male. The genital hooks are not recurved. It is easily distinguished by the lobe on both the 7th and 8th sternites. Harden and Mickel (1952) figured the male adult.

Type locality: Four miles south of Park Rapids, Minnesota. Type at University of Minnesota, St. Paul.

Range: Not known, as only one specimen has ever been captured.



Figs. 295, 296, 297. *Isoperla marlynia* larva (from Frison, 1942).

17. *Isoperla mohri* Frison (fig. 298)

Isoperla mohri Frison, 1935, Ill. Nat. Hist. Surv. Bull. 20: 455.

Length: 11-12 mm.

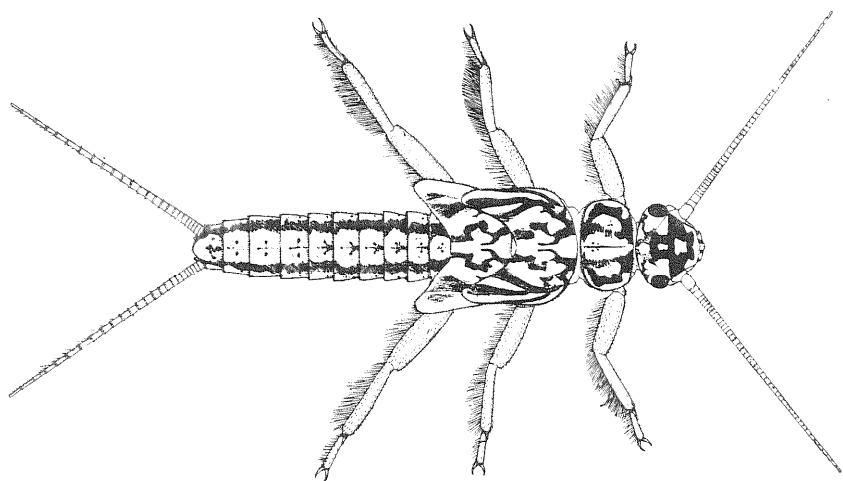


Fig. 298. *Isoperla mohri* larva (from Frison, 1935).

Description: In life, the adult is black and orangish yellow but is dull yellow and brown in preservative. The male genital hooks are not heavily sclerotized or upturned. The female subgenital plate is somewhat produced and rounded and generally slightly emarginate. The larva has only 1 maxillary tooth and on the mandibles the teeth are more widely separated than those of other *Isoperla* larvae. Figures of the genitalia, larval pattern, and larval mouthparts were presented by Frison (1935).

Type locality: Watson, Illinois. Type at Illinois Natural History Survey.

Range: Has been collected only in Illinois and Missouri.

18. *Isoperla montana* (Banks)

Chloroperla montana Banks, Trans. Am. Entomol. Soc. 25: 199.

Length: 11.5-14.5 mm.

Description: This is one of several species that have a dark V-shaped mark connecting the ocelli. Males from Quebec show a broad arrowhead-shaped aedeagal sclerite through the 9th sternite (Ricker and his co-workers, 1968). The genital hooks are sharp and recurved. The female subgenital plate is produced and rounded. The larval pattern is apparently almost identical with that of *richardsoni*, (Ricker, Malouin, Harper, and Ross, 1968). This species exemplifies the difficulties in presently identifying *Isoperla*. Banks' paratypes were said to be *marlynia* Needham and Claassen by Frison (1942) but Ricker and his associates (1968) stated they are *lata* Frison. Furthermore, they said that specimens have been confused with *bilincata* and noted that the latter apparently does not have as sharply recurved genital hooks as does *montana*. The adult color pattern and genitalia were figured by Needham and Claassen (1925).

Type locality: Mt. Washington, New Hampshire. Type in Museum of Comparative Zoology, Harvard University.

Range: This is probably an Eastern species, ranging from the Maritimes west to New York and Quebec. Needham and Claassen's (1925) record from Minnesota may be a misidentification.

Connecticut record: Killingworth, June 29, 1960, Ross and Ross (W. E. Ricker's collection).

19. *Isoperla namata* Frison (fig. 299)

Isoperla namata Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 327.

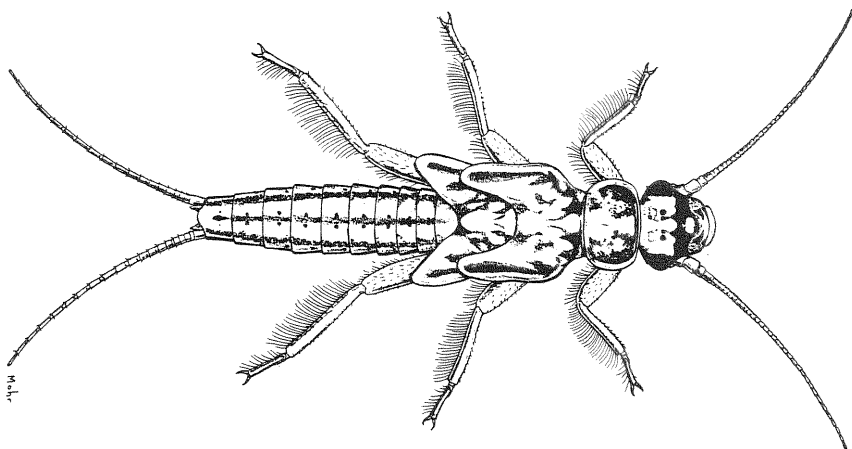


Fig. 299. *Isoperla namata* larva (from Frison, 1942).

Length: About 11 mm.

Description: The V-shaped marking between the ocelli of the adult is continued forward to form an "X." The male hooks are slightly recurved forward, the male ventral lobe broad and conspicuous. The female subgenital plate is produced and rounded. The larva is yellowish, with longitudinal markings on the abdomen and other markings as pictured in figure 299. Frison (1942) illustrated genitalia, larval mouthparts, and adult and larval color patterns.

Type locality: Silva, Missouri. Type at Illinois National History Survey.

Range: Has been collected in Indiana and Missouri.

20. *Isoperla nana* (Walsh) (fig. 300)

Chloroperla nana Walsh, 1862, Proc. Acad. Nat. Sci. Philadelphia 13: 367.

Chloroperla minuta Banks, 1900, Trans. Am. Entomol. Soc. 26: 244.

Length: 5.5-7 mm.

Description: This small-sized species is dark, with the male genital hooks fairly long and recurved forward. The female subgenital plate is broad and rounded. The

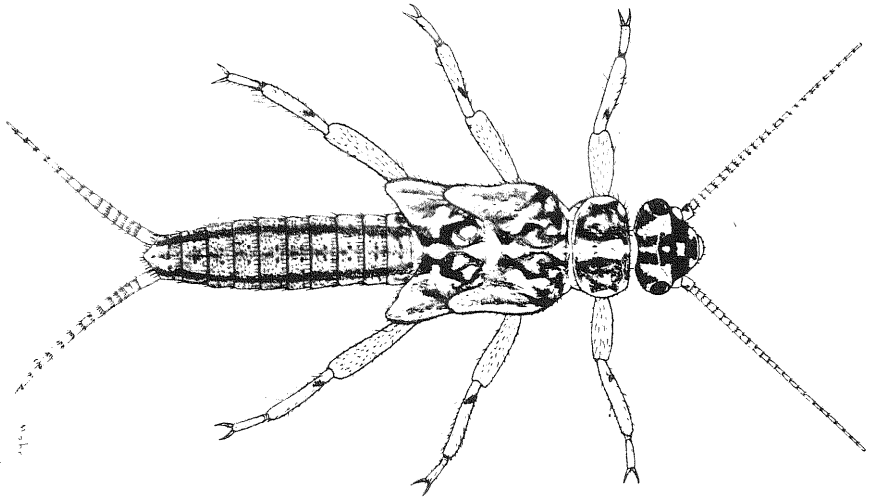


Fig. 300. *Isoperla nana* larva (from Frison, 1935).

larva is dark, with a speckled abdomen. Apparently there is only 1 tooth on the maxilla. Under the name *minuta* adults and larvae were illustrated by Needham and Claassen (1925) and Frison (1935).

The larvae are found in slow-moving streams with abundant vegetation. The adults were observed feeding on the pollen of dock (*Rumex*) and wild grape (*Vitis*). The larvae are probably herbivorous (Frison, 1935).

Type locality: Rock Island, Illinois. Type missing.

Range: Illinois through Ohio and north to Ontario and western Quebec.

21. *Isoperla orata* Frison (fig. 301)

Isoperla orata Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 323.

Length: 10-13.5 mm.

Description: This species belongs to the *burksi-cotta* group of *Isoperla* and may be conspecific with them. The male genital hooks are but weakly developed and are not recurved over the 10th tergite. The female subgenital plate is produced, emarginate at the tip, and turned downward away from the body distally. The larval maxilla is distinctive in these 3 species—it has 2 large cusps on the lacinia and a tuft of hairs below them. Frison (1942) pictured adult color pattern and genitalia, as well as the larval color pattern and mouthparts. Harper and Pilon (1970) graphed adult emergence.

Type locality: Gatlinburg, Tennessee. Type at Illinois Natural History Survey.

Range: The Maritimes south to North Carolina and west to Minnesota and Tennessee.

Connecticut records: Bethany, June 7, 26, 1969, V. Nelson; Canton, May 20,

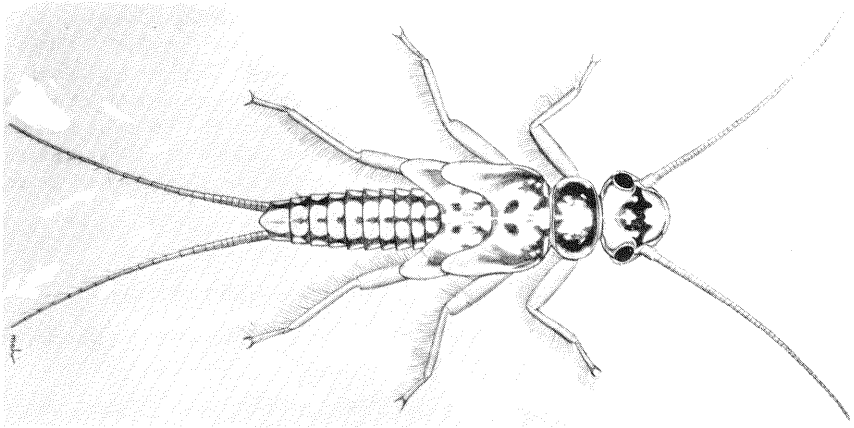


Fig. 301. *Isoperla orata* larva (from Frison, 1942).

1960 (SWH); Franklin, June 5-7, 1967 (SWH); Haddam, June 23, 1967 (SWH); Kent, June 9, 1967 (SWH), June 17, 1953, C. Remington (YU); Mt. Carmel, June 1, 1966 (SWH), June 4, 1962, UV light trap, A. DeCaprio; Plainfield, June 14, 23, 1967 (SWH); Redding, May 18, 1964 (SWH); Salem, June 7, 1967 (SWH); Sterling, June 11, 1959 (SWH).

22. *Isoperla richardsoni* Frison (fig. 302)

Isoperla richardsoni Frison, 1935, Ill. Nat. Hist. Surv. Bull. 20: 459.

Length: 10-13.5 mm.

Description: *I. richardsoni* has a yellow head dorsally or a dark V-shaped

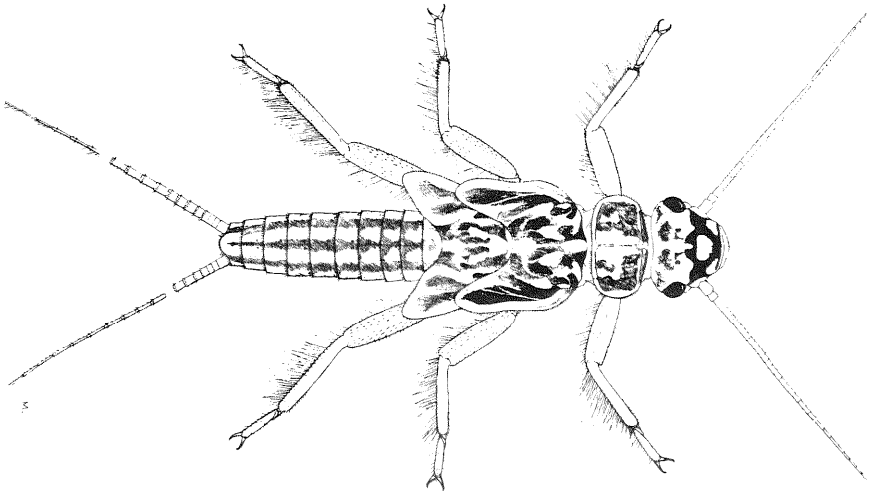


Fig. 302. *Isoperla richardsoni* larva (from Frison, 1935).

marking connecting the ocelli. The genital hooks are not strongly sclerotized or recurved. The female subgenital plate is somewhat produced and rounded. The typical larva has a tuft of hairs on the lacinia below the 2nd tooth. This species belongs to the *bilineata* group and is not easily separated from similar specimens in other species of that group. The lacinial characters seem to be distinctive in the larva and were so figured by Frison (1935) and keyed by Harden and Mickel (1952) but Eastern specimens do not seem to conform. Only further studies can show whether several species are confounded under one name.

The larva is carnivorous and feeds on chironomids (Frison, 1935).

Type locality: Sterling, Illinois. Type at Illinois Natural History Survey.

Range: The presumed range of this species is from Connecticut to Illinois and Minnesota.

Connecticut records: Burlington, June 23, 1967 (SWH); East Haddam, July 1, 1959; Kent, June 12, 1967 (SWH); Storrs, June 12, 1954, J. Slater (UC).

23. *Isoperla signata* (Banks)

Perlinella signata Banks, 1902, Can. Entomol. 34: 124.

Pictetia bimaculata Banks, 1948, Psyche J. Entomol. 55: 122.

Length: 13-16 mm.

Description: The male has recurved, bluntly pointed genital hooks. In some specimens, 2 subtriangular sclerites of the aedeagus show through the 9th sternite. The female subgenital plate is slightly produced and rounded. Some larvae have transverse banding on the abdominal tergites. Needham and Claassen (1925) illustrated the genitalia and Claassen (1931) the larva.

Harden and Mickel (1952) dissected several larvae and found that they had fed principally on chironomids.

Type locality: Michigan. Type in Museum of Comparative Zoology, Harvard University.

Range: The recorded range is from the Maritimes to southern New England and west to Minnesota.

Connecticut records: Storrs, April 27, 1954, Keller (UC), May 1959, at light, Schaefer (UC).

24. *Isoperla similis* (Hagen) (figs. 303-305)

Perla similis Hagen, 1861, Syn. Neur. No. Am.: 26.

Length: 12-15 mm.

Description: The adult ocellar triangle is completely dark. The males can be separated from the few other eastern *Isoperla* with this characteristic by the abdomen which is dark, except for the last 2 tergites, which are yellow. This characteristic is not obvious except on well hardened specimens. The hooks are lightly sclerotized and pointed but not recurved over the 10th tergite. The female subgenital plate is rounded, broad, and barely protrusive onto the anterior margin of the 9th sternite.

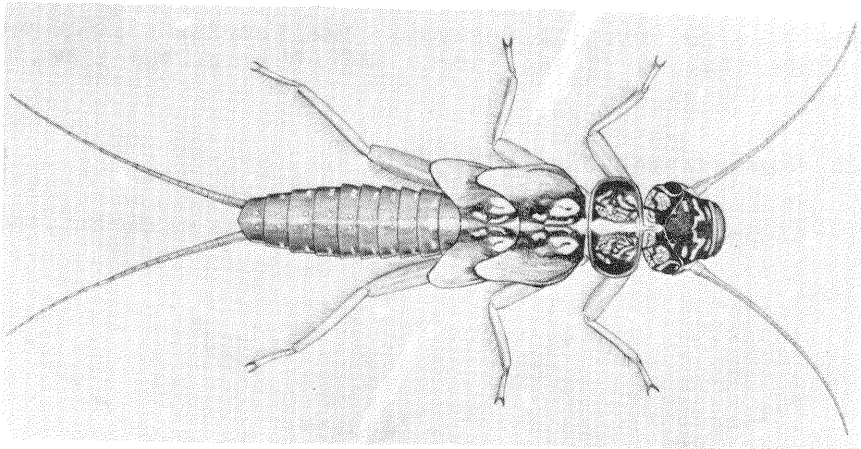
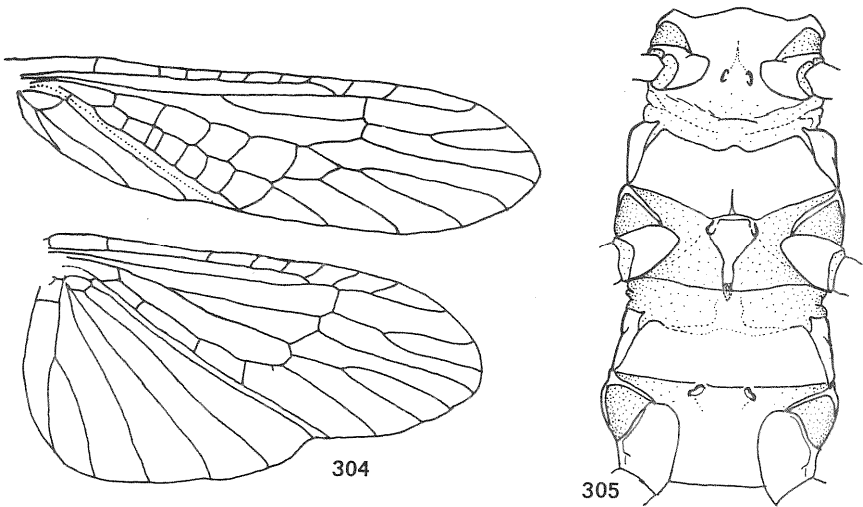


Fig. 303. *Isoperla similis* larva (from Frison, 1942).



305

Isoperla similis
Fig. 304. Wings
Fig. 305. Thorax

The color patterns of adults and larvae, the genitalia, and the larval mouthparts were pictured by Frison (1942).

Type locality: Pennsylvania. Type in Museum of Comparative Zoology, Harvard University.

Range: New Hampshire south to North Carolina and west to Tennessee.

Connecticut records: Ashford, May 7, 1964, D. Metzger (UC); Barkhamsted, June 1, 1967 (SWH); Bethany, May 5, 1959 (SWH); Hamden, May 5, 1959 (SWH);

Kent, May 3, 1966 (SWH); Mt. Carmel, May 5, 1961; Staffordsville, April 23, 1964 (SWH); Storrs, May 19, 1964, D. Debart (UC); Willimantic, May 3, 1964, J. Spencer (UC).

25. *Isoperla slossonae* (Banks) (fig. 306)

Perla slossonae Banks, 1911, Trans. Am. Entomol. Soc. 37: 335.

Chloperla annexa Needham and Claassen, 1925, Monog. Plec. Am. No. Mex.: 140.

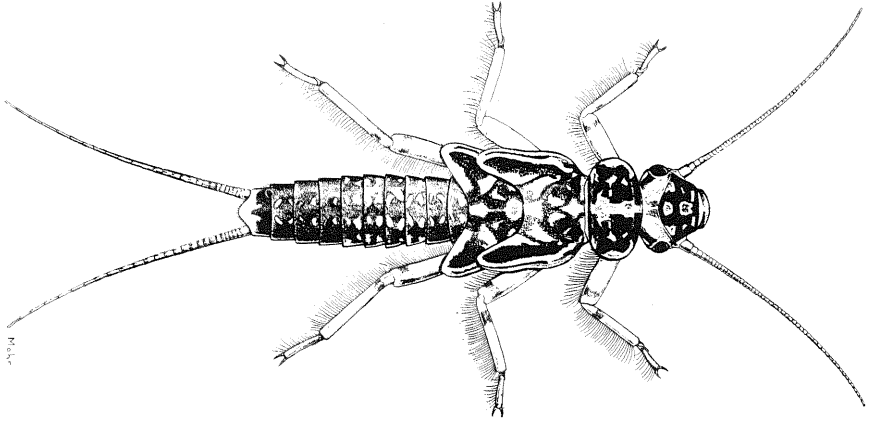


Fig. 306. *Isoperla slossonae* larva (from Frison, 1942).

Length: 12-16 mm.

Description: This is another species with a light spot in the ocellar triangle of the adult. The lobe on the male 8th sternite is broad and the genital hooks are re-curved and sturdy. The female subgenital plate is broad, rounded, and extends part-way over the 9th sternite. Larvae and their mouthparts were illustrated by Harden and Mickel (1952) and by Frison (1942), who also figured adult genitalia; Needham and Claassen (1925) figured the wing venation (under the name *annecta*).

The type series must have consisted of more than one species. The female subgenital plate illustrated by Banks (1911) is quite different from the description of the remaining specimen given by Frison (1942) and Needham and Claassen (1925).

The larvae feed principally upon chironomid larvae (Harden and Mickel, 1952).

Type locality: Franconia, New Hampshire. Type in Museum of Comparative Zoology, Harvard University.

Range: The Maritimes and northern New England west to Minnesota.

26. *Isoperla transmarina* (Newman) (fig. 307)

Chloroperla transmarina Newman, 1838, Entomol. Mag. 5: 499.

Isoperla ventralis Banks, 1908, Psyche J. Entomol. 15: 66.

Isoperla fumosa Neave, 1933, Can. Entomol. 65: 235.

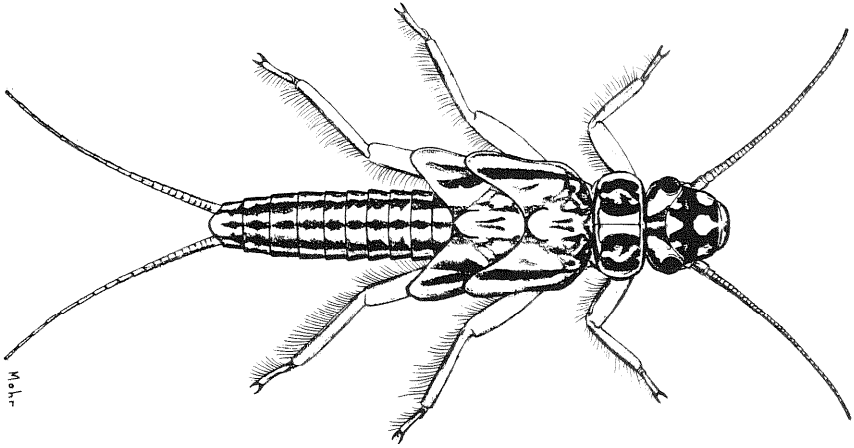


Fig. 307. *Isoperla transmarina* larva (from Frison, 1942).

Length: 10-14 mm.

Description: The adult has a light spot on the ocellar triangle that can be narrowly open to the rear. The male hooks are pointed and recurved. The female subgenital plate is produced and truncate. The larva has a large spot over the ocellar triangle but, except for color pattern, has little to distinguish it from other *Isoperla* larvae. The larval pattern and mouthparts were illustrated by Harden and Mickel (1952) and Frison (1942); the adult genitalia by Needham and Claassen (1925) (under the species-name *ventralis*). Figures of the type specimen were given by Ricker (1938).

The preferred habitat of the larvae is matted leaves and vegetation caught by submerged objects (Harden, 1942). An emerging adult takes about 4 minutes to emerge from the larval skin but a total of 11 minutes elapses before the wings are dry and may be folded, allowing the imago to crawl away (Harden and Mickel, 1952).

Type locality: Trenton Falls, New York. The label on the type specimen gives the type locality as "North America" (Ricker, 1938; Kimmins, 1970) but from Newman's original description and the journal of the collector, Doubleday (Entomol. Mag. 5: 37), it is clear that the specific locality is Trenton Falls, New York. Type in the British Museum.

Range: The Maritimes and Labrador south to New Jersey and west to Minnesota, Manitoba, and British Columbia.

Connecticut records: Several larvae from Storrs (UC).

GENUS *Isogenus* NEWMAN

Isogenus Newman, 1833, Entomol. Mag. 1: 415.

Nephelion Pictet, 1841, Perlides: 144.

There have been several other proposed genera that are here considered subgenera of *Isogenus*. Ricker (1952) has monographed the species of

North America and subgenera of the world. Illies (1966) considered these subgenera to be genera but I am using the name in the sense of those North American workers who have followed Ricker's usage.

Isogenus differs from most other perlodids in having a cleft male 10th tergite. It is closely related to *Arcynopteryx* but as only one uncommon species of the latter occurs in the area under consideration here, it can be separated on the venational characters in the key and (in most species) by the lobes of the male 7th sternite. The females are not easily distinguished from *Isoperla* and, in order to find the species, it may be necessary to key down isolated females in both generic keys.

Characters separating species are found in the presence or absence of submental gills and in the male genitalia—the presence or absence of lateral stylets, the shape of the posterior lobes of the 10th tergite, the shape and position of projections on the epiproct, and the presence of lobes on sternites 6 to 8.

Type of genus: *Isogenus nubecula* Newman.

KEYS TO NORTHEASTERN SPECIES
(modified from Ricker, 1952)

ADULTS

1. Median mesosternal ridge present, running from fork of Y to transverse ridge; submental gills long 2
 Median mesosternal ridge absent from fork of Y to transverse ridge 7
2. Epiproct ending in long, slender lash (fig. 332); female subgenital plate moderately produced, with shallow, broadly V-shaped median notch; northern species *12, olivaceus*
 Epiproct short, generally hooked; subgenital plates varied but have deep, rounded notch in northern species 3
3. Epiproct with pair of short, acute lobes posteriorly 4
 Epiproct without lobes posteriorly 5
4. Tip of epiproct sclerotized and excavated (saddlelike) (fig. 334) *14, varians*
 Epiproct produced into slender, blunt tip (fig. 328) *10, krumholzi*
5. Posterior lobes (terminal sclerotized corners of 10th tergite) directed inward and then somewhat forward (fig. 322): female subgenital plate only slightly produced, with deep, U-shaped, rounded notch *6, frontalis*
 Posterior lobes directed inward and backward (fig. 317); female subgenital plate considerably produced and lacking rounded notch 6
6. Yellow area on rear of head continued forward into ocellar triangle; female subgenital plate generally entire; found from Quebec to North Carolina *8, hansonii*
 Yellow area on rear of head not extending beyond occipital suture;

- female subgenital plate generally with shallow, broadly V-shaped notch; found from Iowa to Michigan and Quebec 4, *doratus*
7. No lobe on male 7th sternite; submental gills at least twice as long as wide' 8
Well defined lobe on male 7th sternite (fig. 313); submental gills mere stubs or absent 9
8. Epiproct terminating in large hook bent completely ventrad (fig. 313); female subgenital plate produced only one-fourth the lateral length of its sternite 2, *crobyli*
Epiproct bluntly pointed, not hooked (fig. 324); subgenital plate produced about half the lateral length of its sternite . . . 7, *fugitans*
9. Lateral stylets absent from the male supra-anal apparatus 10
Lateral stylets present 12
10. Basal support of supra-anal process situated at anterior edge of the 10th tergite 11
Basal support of supra-anal process situated at least halfway back on 10th segment, much behind anterior margin; tergite before support quite membranous (fig. 309) 1, *bilobatus*
11. Posterior end of paragenital plates with dorsal carina, subacute at tip; anal area of hindwing without dark mark; found in Michigan and Indiana (fig. 330) 11, *nalatus*
Tip of paragenital plates without carina, rounded; anal area of hindwing with large dark spot (except in teneral specimens); found from Quebec to Georgia 13, *subvarians*
12. Lateral stylets greatly exceeding tiny tip of epiproct, which is commonly difficult to see 5, *duplicatus*
Lateral stylets no longer than well developed tip of epiproct 13
13. Submental gills absent; lateral stylets slender, acute (fig. 314)
. 3, *decisus*
Submental gills short but distinct; lateral stylets hooked at tip (fig. 326) 9, *hastatus*

LARVAE¹⁵

1. Maxilla terminating in single spine and lacking spinules or hairs on mesal margin (fig. 308) 1, *bilobatus*
Maxilla with shorter spine mesad of main one and commonly with additional spinules or hairs 2
2. Portion of submental gill projecting beyond submentum is at least twice as long as its greatest width 3
Portion of submental gill projecting beyond submentum less than twice as long as their greatest width, generally about as long as wide, or entirely absent 11

¹⁵Larva of *krumholzi* not known.

3. Mesosternum with median ridge joining fork of the Y to transverse ridge 7
 Mesosternum without median ridge anterior to fork of Y; transverse ridge absent or very indistinct 4
 4. Sides of ventral cusps of mandibles margined by minute denticles; labrum greatly produced medially 5
 Ventral cusps of mandibles without denticles; labrum normal, only slightly produced 6
 5. Transverse black band on head narrow and not including ocellar triangle (fig. 329) 11, *nalatus*
 Transverse black band on head broad and including ocellar triangle, except for small central spot 13, *subvarians*
 6. Anterior half of each abdominal tergite dark, posterior half light 2, *crobyi*
 Anterior half of each abdominal tergite light, except for row of 6-8 small dots 7, *fugitans*
 7. Conspicuous denticles along margins of ventral cusp of both mandibles 8
 Margin of ventral cusp of left mandible with only minute, scarcely distinguishable denticles or denticles entirely absent 9
 8. Denticles large; body conspicuously patterned; Appalachian species 8, *hansoni*
 Denticles small; except for X-shaped mark on head, body is nearly uniformly colored (fig. 316) 4, *doratus*
 9. Abdominal tergites banded, anterior half light, posterior half dark; forepart of head predominantly light, posterior part dark (fig. 331) 12, *olivaceus*
 Abdomen uniformly colored, head not as above 10
 10. Body light colored; pronotum with submarginal band, which is broad laterally 14, *varians*
 Body dark colored; pronotum uniformly dark (fig. 321) 6, *frontalis*
 11. Submental gills absent or at least not projecting beyond borders of submentum 3, *decisus*
 Submental gills projecting beyond border of submentum for a distance about equal to their greatest width 12
 12. Median mesosternal ridge forked anteriorly; transverse ridge on mesosternum 9, *hastatus*
 Median mesosternal ridge not forked; no transverse ridge on mesosternum 5, *duplicatus*
1. *Isogenus (Remenus) bilobatus* (Needham and Claassen) (figs. 308-311)
Perla bilobata Needham and Claassen, 1925, Monog. Plec. Am. No. Mex.: 95.

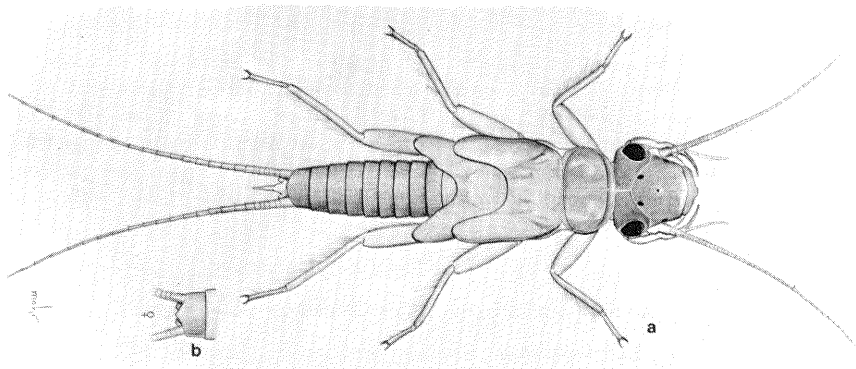
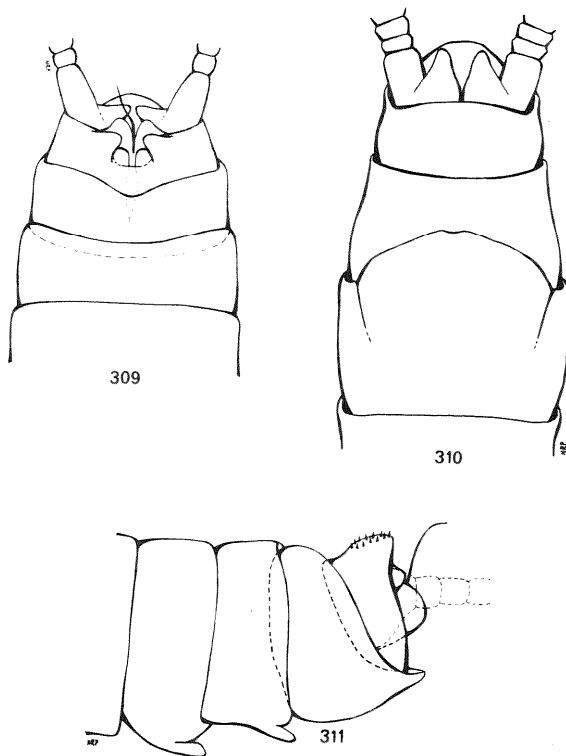


Fig. 308. *Isogenus bilobatus*: a, larva; b, posterior abdominal segment of female larva (from Frison, 1942).



Isogenus bilobatus, posterior abdominal segments

Fig. 309. Male, dorsal view.

Fig. 310. Female, ventral view.

Fig. 311. Male, lateral view.

Length: 10-14 mm.

Description: The adult male is the only *Isogenus* that bears both a whiplike extension of the epiproct (partially withdrawn in some specimens) and also a distinct lobe on both the 7th and 8th sternites. Also, the lateral stylets are missing. The larva lacks gills and is without a strong color pattern; its distinctive and unique feature among Eastern *Isogenus* is the single large tooth on the lacinia. Needham and Claassen (1925) illustrated the adult wing venation and genitalia; Claassen (1931) and Frison (1942) the larval mouthparts.

Type locality: Old Forge, New York. Type at Cornell University.

Range: New York and southern New England to Tennessee and Georgia.

Connecticut records: Bethany, larva (SWH); Killingworth, June 18, 1965 (SWH); Madison, June 18, 1965 (SWH); Phoenixville, larva, H. Hidu (UC); Storrs, June 18, 1954, J. Slater (UC).

2. *Isogenus (Hydroperla) crosbyi* (Needham and Claassen) (figs. 312, 313)

Perla crosbyi Needham and Claassen, 1925, Plec. Am. No. Mex.: 79.

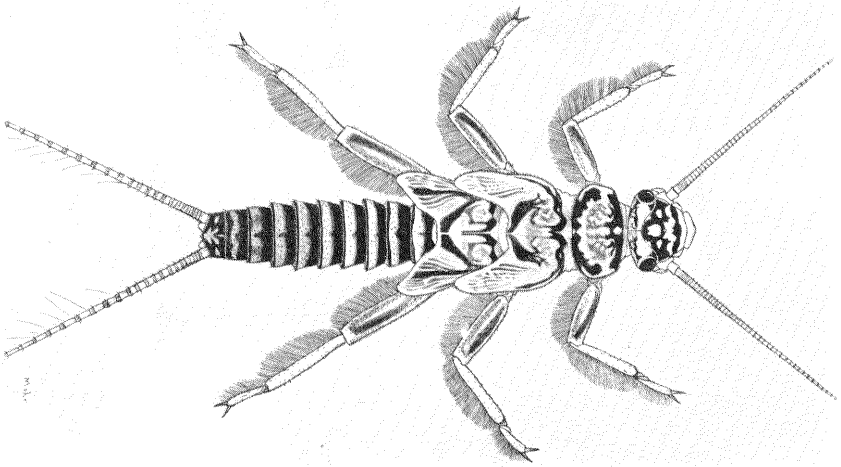


Fig. 312. *Isogenus crosbyi* larva (from Frison, 1935).

Length: 21-23 mm.

Description: The male does not have clearly recognizable ventral lobes on either the 7th or 8th sternites. The posterior lobes of the 10th tergite on each side of the cleft are produced into erect, recurved, thumblike projections. The male epiproct ends in a decurved process. The female subgenital plate is somewhat produced. Submental gills are present. Needham and Claassen (1925) figured the adult wing venation and genitalia, as did Frison (1935), who also figured the larval color pattern and mouthparts.

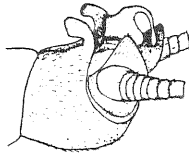


Fig. 313. *Isogenus crosbyi* male, lateral view of posterior abdominal segments (from Needham and Claassen, 1925).

The adult is diurnal. The larvae are predacious on chironomids and can be found in clumps of dead leaves in slowly moving streams. There is a 1-year life cycle and the larvae grow most rapidly in February and March (Frison, 1935).

Type locality: Missouri. Type at Cornell University.

Range: A Midwestern species, found in Indiana, Illinois, and south to Arkansas and Oklahoma.

3. *Isogenus (Cultus) decisus* (Walker) (figs. 314, 315)

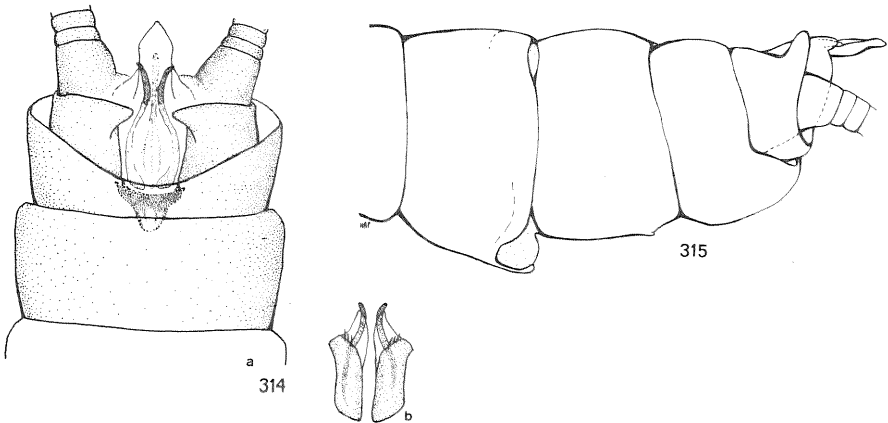
Perla decisus Walker, 1852, Cat. neur. Br. Mus.: 170.

Perla verticalis Banks, 1920, Bull. Mus. Comp. Zool. 64: 318.

Isoperla isolata Banks, 1920, Bull. Mus. Comp. Zool. 64: 322.

Length: 12-16 mm.

Description: The male 7th sternite bears a broad lobe and, in some specimens, the 8th sternite has a suggestion of a small lobe. There is a distinct, inward-pointing posterior lobe at the cleft of the 10th tergite. The halves of the split 10th tergite are joined anteriorly by a strongly sclerotized subtriangular area. The paragenital plates



Isogenus decisus male

Fig. 314. a, Dorsal view of posterior abdominal segments; b, paragenital plates and lateral stylets.

Fig. 315. Lateral view of posterior abdominal segments.

are somewhat quadrate, with a membranous extension reaching posteriorly. The lateral stylets are slender. The female subgenital plate is strongly produced, broad, and triangular. There are no submental gills. Adults were illustrated by Ricker (1938, 1944) and (under the species name *verticalis*) by Needham and Claassen (1925). Claassen (1931) illustrated the larvae under the species name *verticalis*.

I. decisus probably hatches in late summer or early fall but has its period of greatest larval growth from January to June. It is predacious, feeding principally on baetid mayflies and chironomids. There is one generation a year (Minshall and Minshall, 1966).

Type locality: St. Martin's Falls, Albany River, Ontario. Type in the British Museum.

Range: An Eastern species, ranging from northern Quebec and Ontario to New York, Kentucky, and southern New England and south in the mountains to Georgia.

Connecticut record: North Granby, May 23-June 5, 1968 (SWH).

4. *Isogenus (Isogenoides) doratus* (Frison) (figs. 316, 317)

Hydroperla dorata Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 295 (the accompanying figures are of *I. hansonii*, not *I. doratus*).

Length: 17-20 mm.

Description: There is a ventral lobe on the male 7th sternite and, in some individuals, a suggestion of lobes on other sternites. The lobe at the posterior corners of the cleft 10th tergite are broadly rounded, with a few long spinelike setae. The epiproct is mostly membranous, except for sclerotized supporting rods; paragenital plates are convex; lateral stylets are present; there are long submental gills. A longitudinal ridge joins the fork of the mesosternal Y ridge with the mesosternal transverse ridge. The female subgenital plate is broad, somewhat flattened, and produced halfway over the following sternite. The adult genitalia were pictured by Hanson (1953) and Ricker (1952); the larva by Frison (1942).

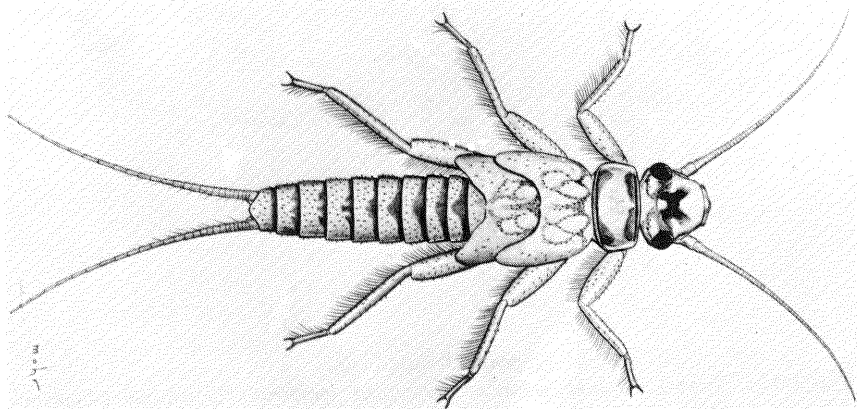


Fig. 316. *Isogenus doratus* larva (from Frison, 1942).

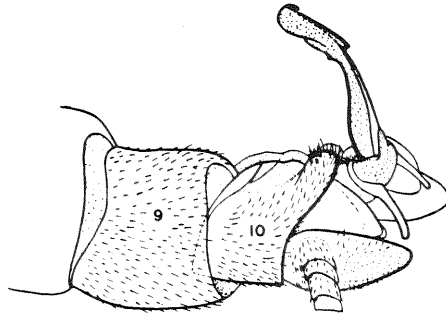


Fig. 317. *Isogenus doratus* male, lateral view of posterior abdominal segments (from Hanson, 1953).

Type locality: Pere Marquette River, Baldwin, Michigan. Type at Illinois Natural History Survey.

Range: Has been collected in three widely divergent places in Michigan, Iowa, and eastern Quebec.

5. *Isogenus (Diploperla) duplicatus* (Banks) (figs. 318-320)

Perla duplicata Banks, 1920, Bull. Mus. Comp. Zool. 64: 316.

Length: 13-17 mm.

Description: *I. duplicatus* has lobes on sternites 7 and 8. The male epiproct is slender and light colored, lying between the more obvious lateral stylets. The female subgenital plate is greatly produced, covering all or most of the following sternite.

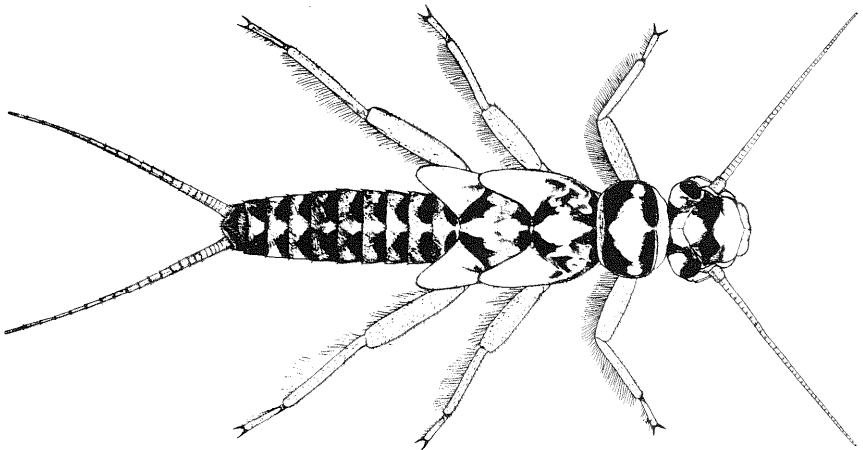
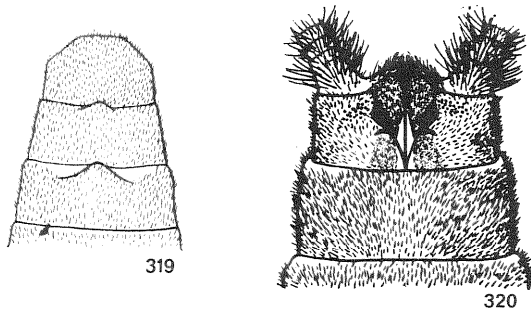


Fig. 318. *Isogenus duplicatus* larva (from Frison, 1935).



Isogenus duplicatus male posterior abdominal segments (from Frison, 1935)
 Fig. 319. Ventral view. Fig. 320. Dorsal view.

The male of this species might be confused with *bilobatus* because of its 2 sternal lobes, however, *duplicatus* bears lateral stylets and lacks any whiplike extension of the epiproct. Adult genitalia and larval mouthparts were figured by Needham and Claassen (1925) and Frison (1935).

Type locality: Newington, Virginia. Type at Museum of Comparative Zoology, Harvard University.

Range: Ohio and Indiana south to Georgia.

Connecticut record: Storrs, June 18, 1954, J. Slater (UC).

6. *Isogenus (Isogenoides) frontalis* (Newman) (figs. 321, 322)

Perla frontalis Newman, 1838, Entomol. Mag. 5: 178.

Isogenus colubrinus Hagen, 1874, Bull. Geol. Surv. Terr.: 576.

Perla titusi Banks, 1918, Bull. Mus. Comp. Zool. 62: 6.

Perla incesta Banks, 1920, Bull. Mus. Comp. Zool. 64: 318.

Isogenoides hudsonicus Hanson, 1943, Am. Midl. Nat. 29: 662.

Length: 12-25 mm.

Description: There is some question as to whether *hudsonicus* and *colubrinus* should be included in the above synonymy (Ricker, 1952; Hanson, 1949) but, since neither is found in Connecticut or elsewhere in New England, this causes no confusion.

There are long submental gills and a ridge connecting the fork of the mesosternal Y ridge with the mesosternal transverse ridge. The male epiproct has a heavy hook at the apex. The lobes at the posterior corner of the cleft of the 10th tergite are somewhat narrowed and directed forward. The female subgenital plate is only slightly produced, transverse, and has a strong notch. The adult genitalia, head pattern, and wings were figured by Needham and Claassen (1925), Frison (1942), and Hanson (1943a); the larva and larval mouthparts by Claassen (1931) under the species name *colubrinus* and by Frison (1942); the egg by Needham and Claassen (1925) and by Knight and his associates, (1965b).

Ricker (1964) gave a distribution map. Nebeker and Lemke (1968) and Bell and Nebeker (1969) gave temperature- and pH-tolerances of the larvae.

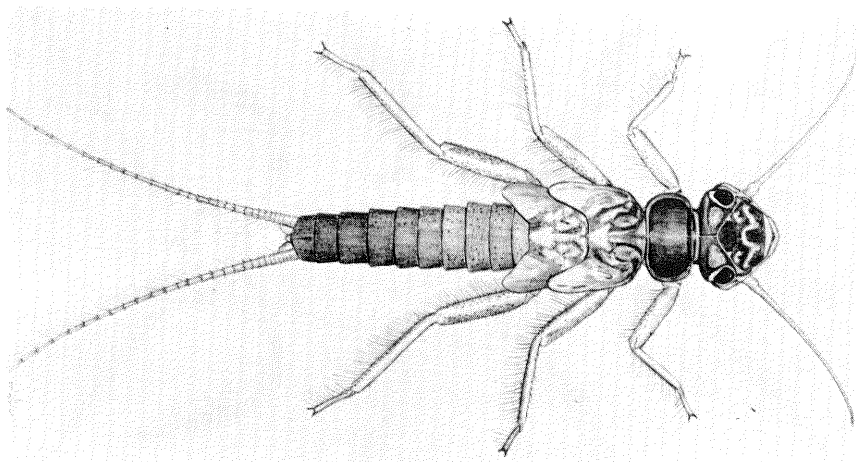


Fig. 321. *Isogenus frontalis* larva (from Frison, 1942)

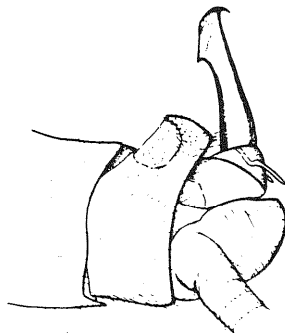


Fig. 322. *Isogenus frontalis* male, lateral view of posterior abdominal segments (from Hanson, 1943a).

Type locality: Trenton Falls, New York. Type in the British Museum.

Range: Including *colubrinus* and *hudsonicus*, this is a transcontinental species ranging across Canada, with southern extensions from New York to Minnesota; present in the Rockies to Utah and Colorado, and from the Pacific Northwest into California.

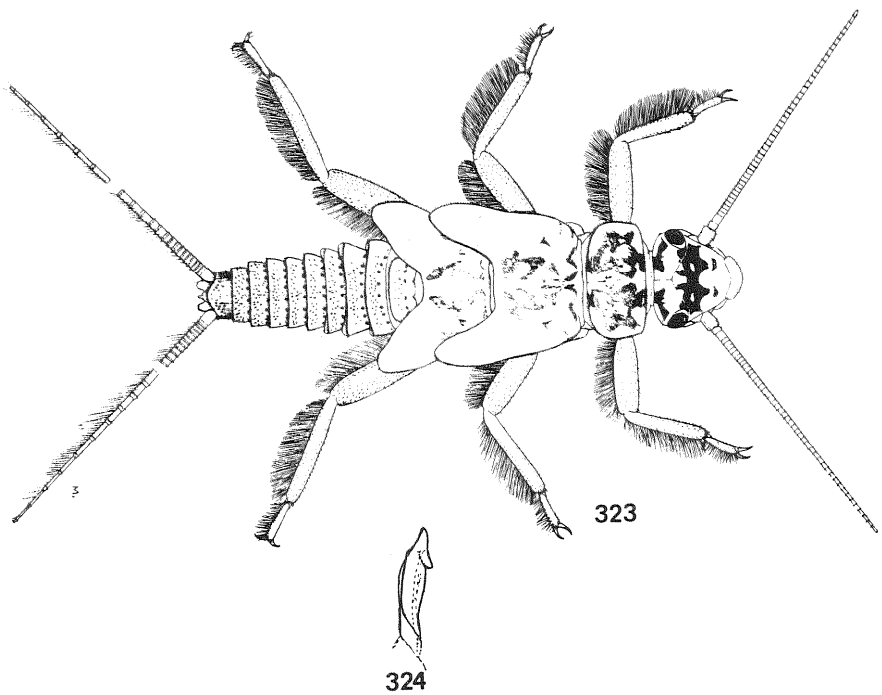
7. *Isogenus (Hydroperla) fugitans* (Needham and Claassen) (figs 323, 324)

Perla fugitans Needham and Claassen, 1925, Monog. Plec. Am. No. Mex.: 85.

Hydroperla harti Frison, 1935, Ill. Nat. Hist. Surv. Bull. 20: 423.

Length: 15-21 mm.

Description: The posterior lobes of the 10th tergite on either side of the cleft



Isogenus fugitans

Fig. 323. Larva (from Frison, 1942).

Fig. 324. Lateral view of epiproct (from Frison, 1935).

are produced into a backward-projecting elongate lobe that bears peglike setae on its inner margin. The epiproct is erect and pointed at the tip, with a hooklike process on its anterior face. The female subgenital plate is produced halfway over the 9th sternite and is either notched or smooth. Submental gills are present. The male genitalia and wing venation were pictured by Needham and Claassen (1925), and (under the name *harti*) the egg, larva, larval mouthparts, larval coloration and adult genitalia by Frison (1935).

The adult is diurnal and mates during the day (Frison, 1935).

Type locality: Austin, Texas. The type is apparently missing. The vial at Cornell University which contained the holotype is now empty and, according to a note in the vial, has been so since at least 1941.

Range: Indiana and Illinois south to Arkansas and Texas.

8. *Isogenus (Isogenoides) hansonii* Ricker (fig. 325)

Isogenus hansonii Ricker, 1952, Ind. Univ. Publ. Sci. Ser. 18: 111.

Length: 16-24 mm.

Description: As with other *Isogenoides*, *hansonii* has submental gills and a ridge

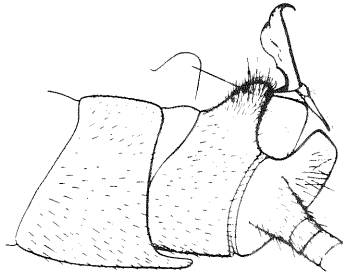


Fig. 325. *Isogenus hansonii* male, lateral view of posterior abdominal segments (from Hanson, 1943a).

connecting the fork of the mesosternal Y ridge with the transverse mesosternal ridge. The posterior lobes at the edge of the cleft of the 10th tergite are rounded and directed backward. The male epiproct bears a strong hook at the apex. The female subgenital plate is broad, produced, and rounded. The most distinguishing mark on this species of *Isogenoides* is the triangular yellow spot in the ocellar triangle. This spot is connected posteriorly to the broad yellow patch in the occipital region. The adult genitalia and color pattern were figured by Frison (1942) and Hanson (1943a) under the name *dorata*; the larval pattern and mouthparts by Ricker (1952).

Type locality: Broadhead Creek, Analomink, Pennsylvania. Type at Illinois Natural History Survey.

Range: The Maritimes and Quebec south to North Carolina and west to West Virginia and eastern New York.

Connecticut records: Melrose, larvae, O. Grant (UC); Willington, larvae, J. Ernst (UC); Storrs and Mansfield, many larvae from numerous student collectors (UC).

9. *Isogenus (Malirekus) hastatus* Banks (figs. 326, 327)

Isogenus hastatus Banks, 1920, Bull. Mus. Comp. Zool. 64: 314.

Length: 20-25 mm. (females).

Description: The male has a lobe on the 7th sternite and its broadened lateral stylets, hooked at the end, are the most distinctive feature. The female has a large, produced subgenital plate that is somewhat emarginate distally.

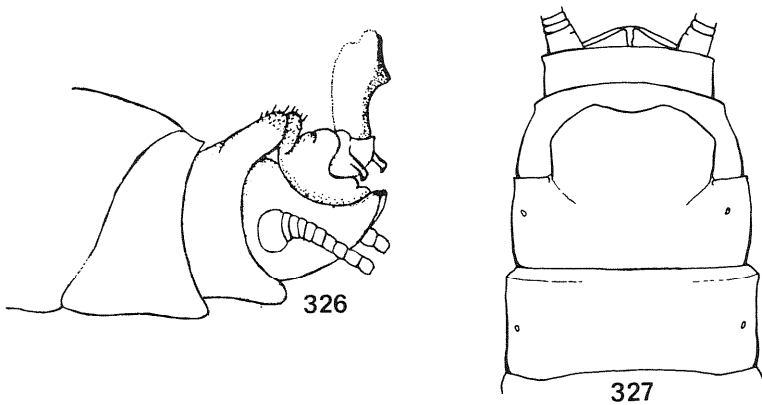
Hall, Weaver, and Gomez-Miranda (1969) exposed a larva, tentatively identified as *hastatus*, to the parasite *Cercaria stenodorya*. The host encapsulated some of the parasites with no apparent injury except for some fat-body depletion.

Type locality: Andrews, North Carolina. Type presumably in Museum of Comparative Zoology, Harvard University.

Range: Quebec to Georgia.

10. *Isogenus (Isogenoides) krumholzi* Ricker (fig. 328)

Isogenus krumholzi Ricker, 1952, Ind. Univ. Publ. Sci. Ser. 18: 112.



Isogenus hastatus

Fig. 326. Male, lateral view of posterior abdominal segments (from Needham and Claassen, 1925).

Fig. 327. Female, ventral view of posterior abdominal segments.

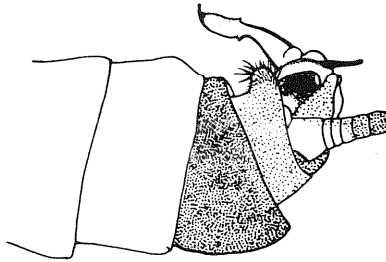


Fig. 328. *Isogenus krumholzi* male, lateral view of posterior abdominal segments (from Ricker, 1952).

Length: About 19 mm.

Description: The species has a median ridge connecting the mesothoracic Y ridge with the transverse mesosternal ridge and submental gills. The male has a lobe on the 7th sternite. The posterior lobes of the 10th tergite are rounded and bear long spinules. The epiproct, like that of most *Isogenoides*, is mostly membranous, with a hook at the apex. There are 2 small projections on the posterior face of the pointed epiproct. The female is unknown. The male was pictured by Ricker (1952).

The male might be confused with *varians* but the termination of the epiproct—pointed for *krumholzi* and grooved for *varians*—separates them.

Type locality: Pine River, Lake County, Michigan. Type at Illinois Natural History Survey.

Range: Has been collected in Michigan and Minnesota.

11. *Isogenus (Helopicus) nalatus* (Frison) (figs. 329, 330)

Hydroperla nalata Frison, 1942, Ill. Nat. Hist. Surv. Bull. 22: 293.

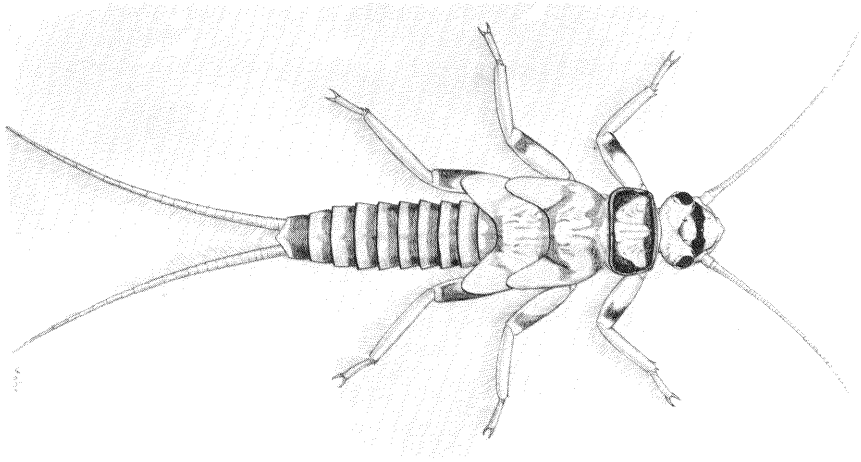


Fig. 329. *Isogenus nalatus* larva (from Frison, 1942).

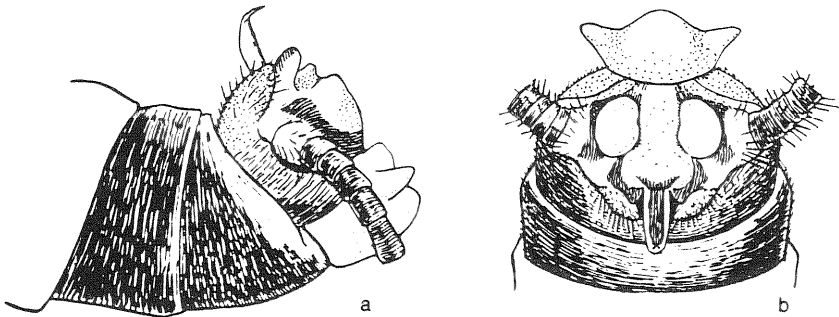


Fig. 330. *Isogenus nalatus* male posterior abdominal segments: a, lateral view; b, dorsal view (from Frison, 1942).

Length: About 17 mm.

Description: The lobes on the male 7th and 8th sternites represent color rather than a structural shape and so are not clear in all specimens. There are no lateral stylets. The epiproct is pointed and recurved. The female is unknown. The adult genitalia and wings, and the color pattern and the larva and the larval mouthparts were illustrated by Frison (1942).

Type locality: Huron River, Washtenaw County, Michigan. Type at Illinois Natural History Survey.

Range: Has been collected in Michigan and Indiana.

12. *Isogenus (Isogenoides) olivaceus* (Walker) (figs. 331, 332)

Perla olivacea Walker, 1852, Cat. neur. Br. Mus.: 144.

Perla sulcata Provancher, 1876, Nat. Can. 8: 213.

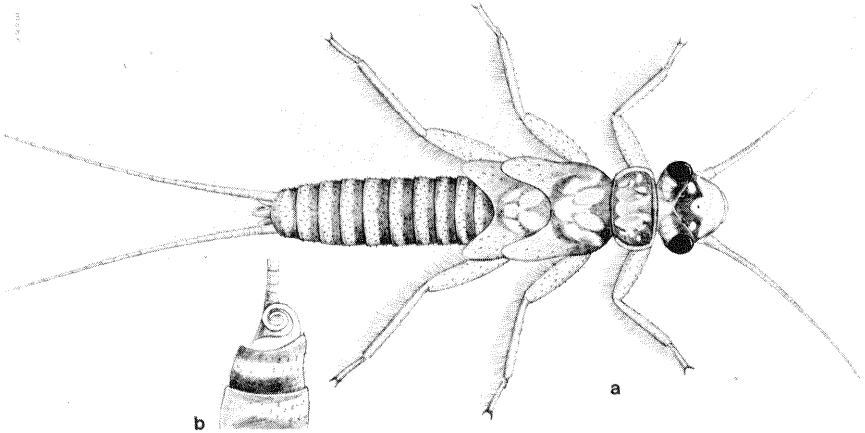


Fig. 331. *Isogenus olivaceus*: a, larva; b, lateral view of posterior abdominal segments of larva (from Frison, 1942).

Length: 14-20 mm.

Description: This species has the typical *Isogenoides* median ridge connecting the Y ridge with the mesosternal transverse ridge; it also has submental gills and a lobe on the male 7th sternite. The epiproct is distinguished from those of all other species by bearing a long "whip" at the base. *I. bilobatus* bears a terminal "whip" on the epiproct but has lobes on both the 7th and 8th sternites and also lacks the median mesosternal ridge. The female subgenital plate is broadly produced and notched in some specimens. The adult genitalia were figured by Ricker (1938), Hanson (1943a), and by Frison (1942), who also figured the larva and larval mouthparts.

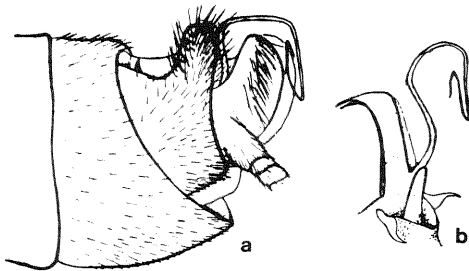


Fig. 332. *Isogenus olivaceus* male: a, lateral view of posterior abdominal segments; b, epiproct (from Hanson, 1943a).

Type locality: St. Martin's Falls, Albany River, Ontario. Type in the British Museum.

Range: A northern species, ranging from Ontario and Quebec to Wisconsin and Michigan.

13. *Isogenus (Helopicus) subvarians* (Banks) (figs. 2, 4, 5, 333)

Perla subvarians Banks, 1920, Bull. Mus. Comp. Zool. 64: 317.

Perla tincta Needham and Claassen, 1925, Monog. Plec. Am. No. Mex.: 89 (preocc.)

Perla tinctata Claassen, 1936, Ann. Entomol. Soc. Amer. 29: 622.

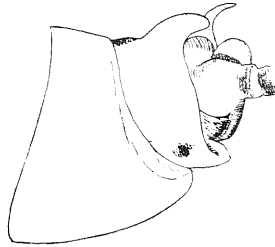


Fig. 333. *Isogenus subvarians* male, lateral view of posterior abdominal segments (from Frison, 1942).

Length: 10-18 mm.

Description: This species lacks lateral stylets in the male. The epiproct is recurved and pointed. The female subgenital plate is broadly produced and rounded. There is an area of darker coloration on the anal area of the hindwing. The male genitalia and adult head pattern were figured by Frison (1942), the female and larva by Ricker (1952).

Type locality: Great Falls, Virginia. Type in Museum of Comparative Zoology, Harvard University.

Range: Down the eastern side of the continent from Ontario and Quebec to Georgia.

Connecticut records: Melrose, larva, O. Grant (UC); Storrs and Mansfield, many larvae from numerous student collectors (UC).

14. *Isogenus (Isogenoides) varians* (Walsh) (fig. 334)

Perla varians Walsh, 1862, Proc. Acad. Nat. Sci. Philadelphia. 13: 364.

Length: 15-21 mm.

Description: There is a median ridge from the mesosternal Y ridge to the mesosternal transverse ridge, also submental gills, and a lobe on the male 7th sternite. The male posterior lobes of the 10th tergite are somewhat pointed and bear a few spinules on the inner face. The upright epiproct is partly membranous, with a pair of small spines on the posterior surface. The apex of the epiproct is sclerotized

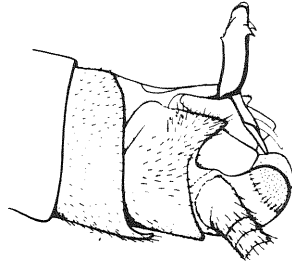


Fig. 334. *Isogenus varians* male, lateral view of posterior abdominal segments (from Hanson, 1943a).

and grooved. The female subgenital plate is produced and rounded. The adult head pattern and genitalia and the larva were pictured by Frison (1935, 1937), the adult genitalia by Hanson (1943a).

Type locality: Rock Island, Illinois. Type in Museum of Comparative Zoology, Harvard University.

Range: Because of the uncertainty of some past identifications, the exact range cannot be given. Ricker (1952) lists Michigan, Indiana, Illinois, Tennessee, and South Carolina.

GENUS *Arcynopteryx* Klapálek

Arcynopteryx Klapálek, 1904, Bull. Česká Akad. Cis. Fr. Jos. 9(2): 12.

This genus was monographed by Ricker (1952) and several subgenera were proposed. These have been raised to generic rank by Illies (1966). The differences between *Arcynopteryx* and *Isogenus* do not appear to be mutually exclusive in all species. However, American species of *Arcynopteryx* can be distinguished by their irregular network of crossveins between veins R and Rs. Other differences are less consistent, and Ricker (1952) should be consulted for subgenera and species found in other parts of North America.

Type of genus: *Dictyoptyeryx compacta* McLachlan

1. *Arcynopteryx compacta* (McLachlan) (fig. 335)

Dictyoptyeryx compacta McLachlan, 1872, Ann. Entomol. Soc. Belgique 15: 53.

Arcynopteryx dovrensis Morton, 1901, Entomol. Mon. Mag., 37: 146.

Dictyoptyeryx transsylvanica Klapálek, 1903, Bull. Česká Akad. Cis.

Fr. Jos. I, Internat., 7: 9.

Arcynopteryx carpathica Klapálek, 1906, Bull. Česká Akad. Cis. Fr. Jos. I, Internat., 11: 155.

Arcynopteryx americana Klapálek, 1912, Collect. Zool. Selys Longchamps, 4: 22.

Arcynopteryx minor Klapálek, 1912, Collect. Zool. Selys Longchamps, 4: 22.

Perlodes slossonae Banks, 1914, Proc. Acad. Nat. Sci. Philadelphia, 66: 608.

Perlodes arnaisi Navás, 1914, Bol. Soc. Aragonesa Cien. Nat., 13: 29.

Arcynopteryx lineata Smith, 1917, Trans. Am. Entomol. Soc. 43: 476.

- Arcynopteryx ignota* Smith, 1917, Trans. Am. Entomol. Soc. 43: 479.
Arcynopteryx inornata Smith, 1917, Trans. Am. Entomol. Soc. 43: 480.
Arcynopteryx pyrenaica Despax, 1927, Bull. Soc. Hist. Nat. Toulouse, 56: 491.
Arcynopteryx ringdahli Bengtsson, 1933, Lunds Univ. Arsskr., 29: 18.
Arcynopteryx brachifer Bengtsson, 1933, Lunds Univ. Arsskr., 29: 21.
Perlodes margarita Alexander, 1936, Bull. Brooklyn Entomol. Soc. 31: 24.

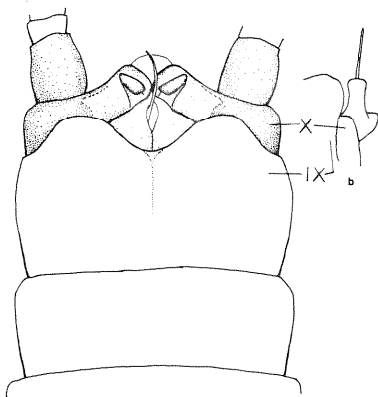


Fig. 335. *Arcynopteryx compacta* male: a, dorsal view of posterior abdominal segments; b, lateral view of epiproct and extremities of 9th and 10th tergites.

Length: 11-20 mm to end of body.

Description: This insect has an unusually complicated synonymy and has been described as a new species by numerous workers both in this country and abroad. This is the only *Arcynopteryx* found in New England and has been collected from high elevations in the White Mountains, from the shore of Lake Superior, and from northern New York. Additional figures of the adult were drawn by Hanson (1942b) under *A. minor*. Brinck (1949) figured the larval mouthparts and tarsi. The same author (1956) pictured the external and internal reproductive organs of the adults and describes mating.

Brinck (1949) has presented some biological data on *A. compacta* in Sweden. There, as elsewhere, this insect is found in high mountain lakes or northern streams. Larval growth occurs mainly in the fall and again in late spring. Adults emerge in midsummer during early morning or at night when the humidity is high. The short-winged males surround the newly emerging females in order to mate. The egg mass is carried on the abdomen of the female. As she crawls along the shore or runs across the water, the eggs fall off as they are wetted. The eggs subsequently become attached to the substrate within the water by adhesive knobs on a basal plate. The larvae feed principally on chironomid and mayfly larvae.

Type locality: Siberia.

Range: *A. compacta* is Holarctic in the higher latitudes but is found in isolated more southerly spots on high mountain ranges into the Pyrenees in Europe and the

White Mountains, Adirondacks, and Rockies in North America. Ricker (1964) provided a North American distribution map of the species.

GENUS *Diura* BILLBERG

Diura Billberg, 1820, Enum, Ins. Mus. Billberg: 96.

Dictyoptyerygella Klapálek, 1904, Bull. Česká Akad. Čis. Fr. Jos. I Trida 2:13: 5.

Diura is the only American representative of the Perlodinae. It is characterized by its uncleft male 10th tergite and by the paraprocts, which extend backward and meet on the mesal margin.

There are 3 North American species of which 2 are northern Holarctic (*nanseni* and *bicaudata*) and the other (*knowltoni*) is found in western United States and Canada.

Type of genus: *Phryganea bicaudata* Linné.

1. *Diura nanseni washingtoniana* Kempny (fig. 336)

Isogenus nanseni Kempny, 1900, Ver. Zool. Bot. Ges. Wien. 50: 90.

Dictyoptyerygella majuscula Klapálek, 1912, Coll. Zoo. Selys Longchamps 4(1): 45.

Dictyoptyerygella subfissa Bengtsson, 1933, Lunds Univ. Arsskr. (2) 29: 11.

Dictyoptyerygella washingtoniana Hanson, 1940, Proc. Entomol. Soc. Wash. 42: 147.

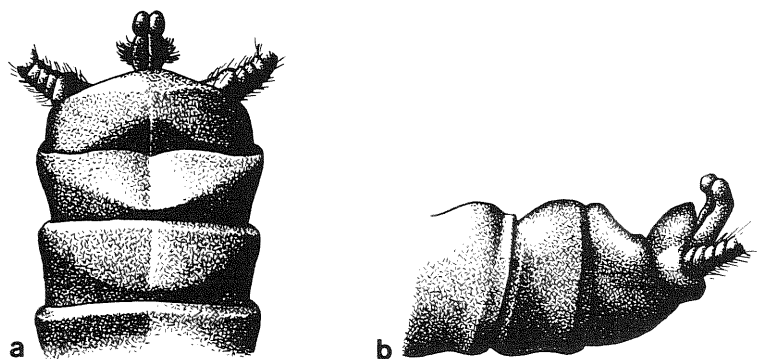


Fig. 336. *Diura nanseni washingtoniana* male, terminal abdominal segments: a, dorsal view; b, lateral view.

Length: 14-18 mm.

Description: This is the only *Diura* found in New England and can be recognized by the generic description. Brinck (1954) states that *nanseni* s.s. differs from *nanseni washingtoniana* in the shape of the male paraprocts and aedeagus and in the width of the female subgenital plate.

Further figures of the adults are by Hanson (1940) under the name *washingtoniana* and of the larva and egg by Brinck (1949).

Brinck (1949) stated that the incubation period of the eggs is 14-21 days. He found the larva to be predacious, principally on mayfly larvae. Svenson (1966) and Ulfstrand (1968) found a high rate of larval growth in autumn and spring but a cessation through the winter months. Ulfstrand (1967) correlated the distribution of larvae within a stream with current speed and the presence of rocks in the substrate. This species occurs in both lakes and rivers. In New England it is found running among the rocks near the Lake of the Clouds above timberline at 5,000-ft altitude. This isolated population is similar to other relict Arctic insects found in the same area.

Type locality: Norway, north of 66° latitude.

Range: Northern Europe and Asia as well as the Western Hemisphere. In North America it has been found only near Mt. Washington in New Hampshire and on the Gaspé Peninsula in Canada.

FAMILY PTERONARCIDAE

These are large, primitive stoneflies that are found in eastern Asia and in North America. Unlike other Setipalpia, the glossae and paraglossae are subequal in length. There are 8 abdominal ganglia. The larvae have tufted gills on the thorax and the basal abdominal segments. The adult cerci are many segmented and there are numerous crossveins in both wings. The male 10th tergite is cleft, both epiproct and paraprocts are conspicuous, and there is no vesicle on the 9th sternite.

GENUS *Pteronarcys* NEWMAN

Pteronarcys Newman, 1838, Entomol. Mag. 5: 175.

Kollaria Pictet, 1841, Perlides: 121.

These are among the largest of the stoneflies and, because of their conspicuous size, among the first described from North America. The family is found only in North America and eastern Asia. Members of this family retain several primitive features, such as numerous crossveins, abdominal gills, and slight coalescence of the abdominal ganglia.

The Northeastern species fall into 2 distinct groups. One, with upright epiproct, cupped paraprocts, unnotched 9th sternite with no peglike setae at the tip, with divided hemitergal lobes on the male 10th tergite, produced subgenital plates in the females, paired lateral projections on the larval abdomen, has been named subgenus *Allonarcys* by Ricker (1952). The other, with massive epiprocts, fleshy and rounded paraprocts, produced and notched 9th sternites bearing numerous peglike setae near the tip and produced rearward projecting hemitergal lobes on the 10th tergite, with unproduced subgenital plates in the females and whose larvae lack lateral projections, remains in *Pteronarcys s.s.*

Nelson and Hanson (1971) have recently studied in detail the anatomy and phylogeny of this genus. They believe that the subgeneric groupings (elevated to genera by Illies, 1966) do not accurately reflect the relationships within the family. They proposed 6 species groups without subgeneric standing.

Type of genus: *Pteronarcys dorsata* Say

KEYS TO NORTHEASTERN SPECIES

MALES¹⁶

1. Epiproct elongate and upright, simple in shape, rounded at apex; 9th sternite entire or only slightly emarginate (fig. 337) 2
Epiproct large, flattened, complex in shape (fig. 342); 9th sternite notched (fig. 342) 3
2. 9th tergite with emarginate median process on anterior margin; median hemitergal lobe broad and rounded (fig. 344) 5, *proteus*
9th tergite without dorsal process; median hemitergal lobe bluntly pointed (fig. 337) 1, *biloba*
3. Apex of 9th sternite straight in lateral view 3, *dorsata*
Apex of 9th sternite decurved ventrad in lateral view 4, *pictetii*

FEMALES

1. Subgenital plate conspicuously produced beyond margin for a distance equal to about half or more the length of the sternite 2
Subgenital plate not produced or with only 2 inconspicuous projections (figs. 341, 343) 4
2. Subgenital plate deeply notched, the notch reaching almost to or past margin of 8th sternite (fig. 338) 3
Subgenital plate only slightly notched (notch inconspicuous in some individuals) and ending well before margin of 8th sternite (fig. 339) 2, *comstocki*
3. Lobes of subgenital plate approximately equal in width throughout length; base of subgenital plate occupies about one-quarter the width of posterior margin of 8th sternite (fig. 345) 5, *proteus*
Lobes of subgenital plate roughly triangular; base of subgenital plate occupies about half the width of posterior margin of 8th sternite (fig. 338) 1, *biloba*
4. Posterior margin of 8th sternite entire or with 2 small projections (fig. 341) 3, *dorsata*
Posterior margin of 8th sternite with small rectangular emargination (fig. 343) 4, *pictetii*

1. *Pteronarcys biloba* Newman (figs. 337, 338)

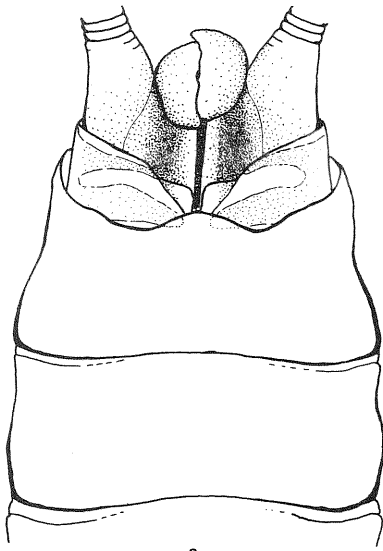
Pteronarcys biloba Newman, 1838, Entomol. Mag. 5: 176.

Pteronarcys bicarinatus Provancher, 1876, Nat. Can. 8: 190.

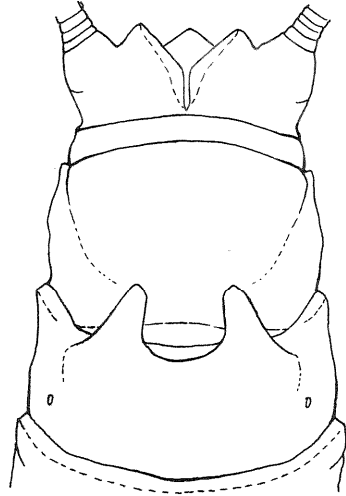
Length: 34-46 mm.

Description: *P. biloba* is easily recognized by the characteristics given in the key. It is widespread in New England but more often captured as a larva than as an adult. Commonly the epiproct is concealed within the large cupped paraprocts

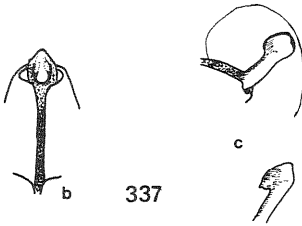
¹⁶Male of *comstocki* not known.



a



338



337

Pteronarcys biloba

Fig. 337. Male: a, dorsal view of posterior abdominal segments; b, dorsal view of epiproct and c, lateral view of epiproct, showing variations.

Fig. 338, Female, ventral view of posterior abdominal segments.

(fig. 337). These are easily parted to reveal the simple, straight epiproct arising between the paragenital plates. The epiproct has minute projections or rugosities near its end, which apparently vary somewhat between specimens. Figure 337 shows the epiprocts of 2 specimens in a single series.

The female subgenital plate is large and deeply notched. Both lobes of the plate are triangular, with a broad medial division between them.

Nelson and Hanson (1969b) made a detailed study of the external morphology. Claassen (1931) figured the larval mouthparts. Nelson and Hanson (1971) figured the male and female genitalia.

A similar species, *P. scotti* Ricker, is southern in range and may extend into New England. The median hemitergal lobes of the 10th tergite of *biloba* are bluntly pointed but in *scotti* they are sharply angled and bear a pair of transversely elongate membranous mounds.

Type locality : Trenton Falls, N.Y. Type in the British Museum.

Range: Quebec south to New York and New England and from there through the mountains south to Georgia. It apparently is not found west of New York State.

Connecticut records: Granby, June 5, 1967 (SWH); Hamden, June 8, 1942, H. Johnson (CAES); Litchfield, June 6, 1924, L. B. Woodruff (AMNH); Norfolk, June 1917, E. Stoddard (CAES); Washington, at light, June 1961, S. Hessel (YU). Larvae from Cornwall, Litchfield, Mansfield, Simsbury, Storrs, Vernon, Willington (UC).

2. *Pteronarcys comstocki* Smith (fig. 339)

Pteronarcys comstocki Smith, 1917, Trans. Am. Entomol. Soc. 43: 454.

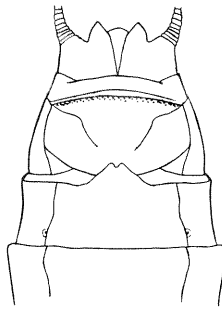


Fig. 339. *Pteronarcys comstocki* female, ventral view of posterior abdominal segments (from Nelson and Hanson, 1971).

Length: About 52 mm.

Description: This species is known only from the female. The female subgenital plate projects well beyond the 8th sternite but is not deeply notched as in other *Allonarcys*. The notch is quite inconspicuous in most specimens. There is a distinctive larva (Frison, 1942) found widely over the Northeast that is probably this species but the proper confirmation has never been made. Nelson and Hanson (1971) figured the female genitalia.

Type locality: Wilmurt, New York. Type at Cornell University.

Range: Northern New England or the Maritimes south to Virginia.

3. *Pteronarcys dorsata* (Say) (figs. 340, 341)

Sialis dorsata Say, 1823, Godman's Western Quarterly Reporter 2: 164.

Pteronarcys regalis Newman, 1838, Entomol. Mag. 5: 176.

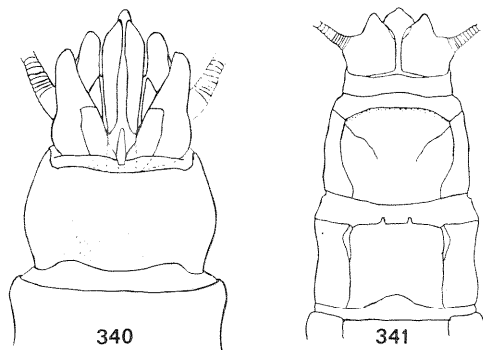
Kollaria insignis Pictet, 1841, Perlides: 123.

Pteronarcys nobilis Hagen, 1861, Syn. Neur. No. Am.: 15.

Pteronarcys frigida Gerstaecker, 1873, Festschr. Ges. Naturf. Freunde: 65.

Pteronarcys rectus Provancher, 1876, Nat. Can. 8: 189.

Pteronarcys flavicornis Provancher, 1876, Nat. Can. 8: 191.



Pteronarcys dorsata, posterior abdominal segments (from Nelson and Hanson, 1971)
 Fig. 340. Male, dorsal view. Fig. 341. Female, ventral view.

Pteronarcys labradoriensis Sámal, 1933, Zool. Anz. 102: 95.

Pteronarcys shelfordi Frison, 1934, Can. Entomol. 66: 25.

Length: 40-60 mm.

Description: This species is very close to *P. pictetii* in both the male and female. The end of the male 9th sternite is straight near its tip in lateral view and the female subgenital plate is either straight or has 2 small projections. The egg of *dorsata* was figured by Knight and his associates (1965b) and by Needham and Claassen (1925), who also discussed the variation in wing venation. Hoke (1924) figured the head and mouthparts and Claassen (1931) a larva that may be this species. Nelson and Hanson (1971) figured both male and female genitalia.

Harden and Mickel (1952) reared the larvae on elm leaves—the leaves were not eaten completely but skeletonized. Olson and Rueger (1968) found that, unlike most aquatic insects, large specimens of this animal have a higher rate of oxygen consumption in relation to body weight than do small ones. Cushing (1963) collected larvae in the rapids above a productive lake but not in the stream below it. Presumably organic additions from the lake changed the character of the stream.

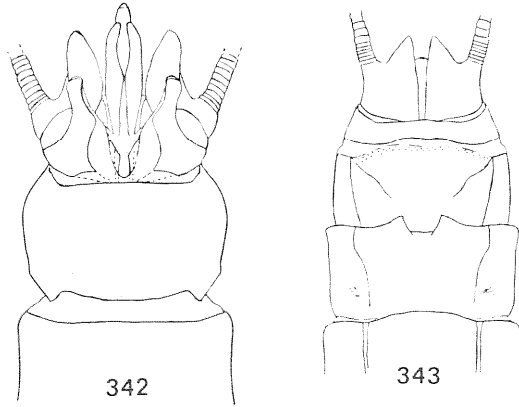
Half the larvae tested can stand a water temperature of 29.5°C or a pH of 4.25 for 96 hours (Nebeker and Lemke, 1968; Bell and Nebeker, 1969). When larvae were held in the laboratory at temperatures from 1°C to 35°C in 5° increments, most feeding took place at 20°C with none at 1° and 35°. Adult emergence took place only from larvae held at 10° to 20°C, with adults averaging a life span of 36 days when reared at 10° and only 17.5 days at 20°. Egg production averaged 475 eggs at 15° but only one of the females reared at 20° oviposited, and then only 175 eggs. Larvae held at 30°C died within 2 weeks, whereas those at 5°C survived but did not feed or develop for the 9 months of the test (Nebeker, 1971a).

Type locality: Pittsburgh, Pennsylvania. Type missing.

Range: A transcontinental distribution from Labrador to Alaska and south in the Rockies to Wyoming. Farther east it is found around the Great Lakes and south to Georgia. Ricker (1964) published a distribution map.

4. *Pteronarcys pictetii* Hagen (figs. 342, 343)

Pteronarcys pictetii Hagen, 1873, Proc. Boston Soc. Nat. Hist. 15: 286.



Pteronarcys pictetii, posterior abdominal segments (from Nelson and Hanson, 1971)
Fig. 342. Male, dorsal view. Fig. 343. Female, ventral view.

Length 31-48 mm.

Description: *P. pictetii* is distinguished from *dorsata* by the tip of the 9th sternite which, in lateral view, is turned downward near the tip. The female has a small quadrate notch on the posterior margin of the 8th sternite. Frison (1935) illustrated eggs, larva, and adult genitalia under the name "*nobilis*." Nelson and Hanson (1971) figured the male and female genitalia.

Olson and Rueger (1968) found the mean oxygen consumption of a larva at 20°C was 99.6 cu/mm/hr/g live weight.

Type locality: Philadelphia, Pennsylvania. Type (female) in Museum of Comparative Zoology, Harvard University.

Range: The Midwest from Manitoba to Kansas east to Georgia and Pennsylvania.

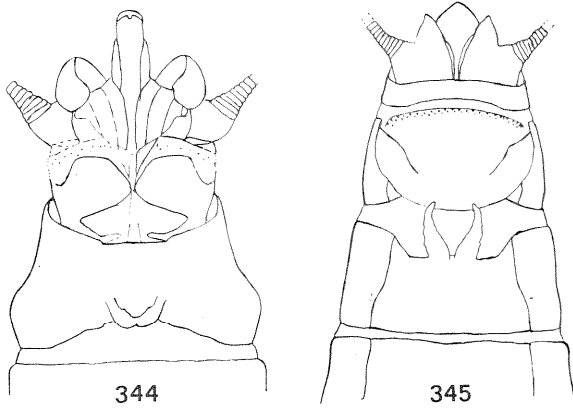
5. *Pteronarcys proteus* Newman (figs. 344, 345)

Pteronarcys proteus Newman, 1838, Entomol. Mag. 5: 177.

Pteronarcys spinosa Banks, 1906, Proc. Entomol. Soc. Wash. 8: 8.

Length: 33-40 mm.

Description: The male is distinguished by the conspicuous median process on the anterior part of the 9th tergite, as well as by the broad shape of the median hemitergal lobes. The median lobe is the sclerotized area of the split 10th tergite bearing peglike setae. The female has a subgenital plate of 2 long, curved lobes. The larva was figured by Claassen (1931), the wings by Needham and Claassen (1925), and the adult terminalia and reproductive organs by Nelson and Hanson (1969b, 1971).



Pteronarcys proteus, posterior abdominal segments (from Nelson and Hanson, 1971)
 Fig. 344. Male, dorsal view. Fig. 345. Female, ventral view.

Miller (1939, 1940) and Holdsworth (1941a,b) have given information on the life history of this species and the following is taken from their accounts. Adults can mate several times during a maximum life span of 20 days for the male and 25 days for the female. However, only one mating is necessary, as the sperms stored in the spermatheca remain active up to the death of the female. Mating takes place at any time of day and the insects can remain coupled for many hours (up to 24). Mating usually occurs shortly after the female emerges and eggs are laid 3 to 7 days after emergence and 1 to 4 days after mating. The adults do not feed but do drink water. Mating is necessary for egg deposition. Eggs are extruded between 2 PM and 5 PM and, less commonly, up to 9 PM. Each egg mass contains about 150 eggs (range from a few dozen to 450) but decreases in successive batches to the minimum. The female produces about 5 separate masses (range 2-9) over a period of 6-18 days. The total number of eggs per female is about 500 to 600, with a maximum of 1,000. In the water, the gelatinous coating expands and the rim of the anchor base glues the egg to the substrate. The embryo is fully developed by late fall but does not emerge until the following spring. The eggs can freeze without harm. Diapause is initiated at lower temperatures but is not obligatory. A cephalic egg-tooth enables the young *proteus* to escape the egg. The 1st larval instar subsists on the yolk remaining in the midgut, is inactive, and has no air in the tracheal system. The 2nd instar is active and feeds on algae. Larval development takes 2 years so, counting 1 year in the egg stage, the life cycle takes 3 years to complete. The female has 13 larval instars and the male 12.

Miller (1939, 1940) studied embryogenesis and Holdsworth (1940, 1942) discussed wing development in this species. Nelson and Hanson (1969) made a detailed examination of the external morphology and Schmitt (1963) described the abdominal nervous system of the larva.

Type locality: Trenton Falls, New York. Type in the British Museum.

Range: Quebec south to Virginia and west into New York.

CHECKLIST OF NEARCTIC STONEFLIES

The following list gives the 465 valid species of stoneflies in North America north of Mexico as of January 1972. A few older species whose identities are uncertain are not included. The geographical listings generally follow those by Berner (1959) of the Ephemeroptera (Bull. Fla. State Mus. 4[1]: 1-58). In the western states, these divisions are not always accurate, as some species from northern Utah and Colorado are of Northwestern rather than Southwestern affinities and some from Texas are Southwestern rather than Central. However, State lines are a convenient fiction for delimiting areas. "Northern California" is roughly the Coast Range to San Francisco and the Sierra Nevada to Yosemite.

Abbreviations are as follows:

A=Northern (Hudson's Bay through Alaska)

NE=Northeast (Maine south to the Potomac River and West Virginia and west through Pennsylvania and New York).

SE=Southeast (Virginia and Tennessee south through Louisiana).

C=Central (Ohio and Kentucky west through North Dakota and south through Arkansas and Texas).

SW=Southwest (Colorado and New Mexico west through Nevada and southern California).

NW=Northwest (Montana and Wyoming west through Washington and northern California).

CE=Eastern Canada (Newfoundland through eastern Ontario).

CC=Central Canada (western Ontario through Saskatchewan).

CW=Western Canada (Alberta and British Columbia).

Species that have been captured in Connecticut are marked with an asterisk. Any species listed as Northeastern might reasonably be expected to be eventually found in this state.

Peltoperlidae

Peltoperla Needham 1905

ada Needham & Smith 1916:
SE

anna Needham & Smith 1916:
SE

arcuata Needham 1905: SE,
NE, CE

brevis Banks 1907: NW, CW

campanula Jewett 1954: NW

cora Needham & Smith 1916:
SW, NW

fenderi Jewett 1955: NW

laurie Ricker 1952: SE

**maria* Needham & Smith 1916:
SE, NE, CE

mariana Ricker 1943: NW,
CW

quadrispinula Jewett 1954:
NW

thyra Needham & Smith 1916:
SW, NW

zipha Frison 1942: SE

Taeniopterygidae

Taeniopteryx Pictet 1841

- **burksi* Ricker & Ross 1968: SE, NE, C, CE
- lita* Frison 1942: SE, C
- lonicera* Ricker & Ross 1968: SE, NE
- **maura* Pictet 1841: SE, NE, C, NW, CE
- metequi* Ricker & Ross 1968: SE, NE, C
- **nivalis* Fitch 1847: NE, C, SW, NW, CE
- **parvula* Banks 1918: SE, NE, C, CE
- ugola* Ricker & Ross 1968: SE, NE

Brachyptera Newport 1849

- californica* Needham & Claassen 1925: SW, NW
- **contorta* Needham & Claassen 1925: NE
- cucullata* Frison 1934: C
- **fasciata* Burmeister 1839: SE, NE, C, CE
- fosketti* Ricker 1965: CC
- **glacialis* Newport 1848: NE, C, SW, CE, CC
- grinnelli* Banks 1918: SW
- limata* Frison 1942: SE
- nigripennis* Banks 1918: SW, NW, CW
- occidentalis* Banks 1900: SW, NW, CW, A
- oregonensis* Needham & Claassen 1925: NW
- **pacifica* Banks 1900: NE, SW, NW, CE, CW
- pallida* Banks 1902: SW, NW, CW
- raynori* Claassen 1937: NW
- rossi* Frison 1942: NE, CE
- vanduzeei* Claassen 1937: NW
- zelona* Ricker 1965: SW

Leuctridae

Leuctra Stephens 1835

- alexanderi* Hanson 1941: SE
- augusta* Banks 1907: NW, CW, A
- baddecka* Ricker 1965: NE
- biloba* Claassen 1923: SE

- carolinensis* Claassen 1923: SE, NE
- divisa* Hitchcock 1958: NW
- **duplicata* Claassen 1923: NE, CE
- **ferruginea* Walker 1852: SE, NE, C, CE
- grandis* Banks 1906: SE
- infuscata* Claassen 1923: NW, CW
- laura* Hitchcock 1970: NE
- **maria* Hanson 1941: NE, CE
- mitchellensis* Hanson 1941: SE
- moha* Ricker 1952: SE
- monticola* Hanson 1941: SE
- nephophila* Hanson 1941: SE
- **sibleyi* Claassen 1923: SE, NE, C, CE
- **tenella* Provancher 1878: NE, C, CE
- **tenuis* Pictet 1841: SE, NE, C, CE
- triloba* Claassen 1923: SE, NE, CE
- **truncata* Claassen 1923: NE, CE
- variabilis* Hanson 1941: NE
- Paraleuctra* Hanson 1941
- dusha* Ricker 1965: CW
- forcipata* Frison 1937: NW, A
- jewetti* Nebeker & Gaufin 1966: SW, NW
- occidentalis* Banks 1907: CW
- occidentalis auct.* (see Hanson 1962): SW, NW, CW
- purcellana* Neave 1934: NW, CW
- rickeri* Nebeker & Gaufin 1966: SW, NW
- **sara* Claassen 1937: NE, CE
- Zealeuctra* Ricker 1952
- arnoldi* Ricker 1969: C
- claasseni* Frison 1929: C
- fraxina* Ricker 1969: SE, C
- hitei* Ricker 1969: C
- narfi* Ricker 1969: C
- wachita* Ricker 1969: C
- warreni* Ricker 1969: C
- Perlomyia* Banks 1906
- collaris* Banks 1906: SW, NW, CW

- utahensis* Needham & Claassen
1925: SW, NW, CW
- Capniidae
- Allocapnia* Claassen 1928
- aurora* Ricker 1952: SE, NE
- brooksi* Ross 1964: SE
- cunninghami* Ross & Ricker
1964: SE
- curiosa* Frison 1942: NE, C
- forbesi* Frison 1929: C
- frisoni* Ross & Ricker 1964:
NE, C
- fumosa* Ross 1964: SE
- granulata* Claassen 1924: SE,
NE, C, CE
- illinoensis* Frison 1935: NE, C,
CE
- indianae* Ricker 1952: NE, C
- jeanae* Ross 1964: C
- loshada* Ricker 1952: NE
- malverna* Ross 1964: SE, C
- **maria* Hanson 1942: NE, CE
- **minima* Newport 1849: NE, C,
CE
- mohri* Ross and Ricker 1964:
C
- mystica* Frison 1929: SE, NE,
C
- **nivicola* Fitch 1847: SE, NE,
C, CE
- ohioensis* Ross & Ricker 1964:
C, NE
- ozarkana* Ross 1964: C
- pechumani* Ross & Ricker 1964:
NE, CE
- peltoides* Ross & Ricker 1964:
C
- perplexa* Ross & Ricker 1970:
SE
- polemistis* Ross & Ricker 1970:
SE
- **pygmaea* Burmeister 1839: SE,
NE, C, CE, CC
- **recta* Claassen 1924: SE, NE,
C, CE
- rickeri* Frison 1942: SE, NE,
C, CE
- sandersoni* Ricker 1952: C
- smithi* Ross & Ricker 1970:
SE, C
- stannardi* Ross 1964: SE
- tennessa* Ross & Ricker 1964:
SE
- unzickeri* Ross & Yamamoto
1966: SE
- virginiana* Frison 1942: SE
- vivipara* Claassen 1924: SE,
NE, C, CE
- warreni* Ross & Yamamoto
1966: C
- wrayi* Ross 1964: SE
- zekia* Ross 1964: SE, NE
- **zola* Ricker 1952: SE, NE, C,
CE
- Capnia* Pictet 1841
- arizonensis* Baumann & Gaufin
1969: SW
- autumna* Baumann & Gaufin
1970: NW, CW, A
- bakeri* Banks 1918: SW
- barbata* Frison 1944: SW
- barberi* Claassen 1924: NW
- bergi* Ricker 1965: A
- californica* Claassen 1924: SW
- cheama* Ricker 1965: A
- coloradensis* Claassen 1937:
SW, NW
- columbiana* Claassen 1924:
SW, NW, CW, A
- confusa* Claassen 1936: SW,
NW, CW, A
- cygna* Jewett 1954: NW
- decepta* Banks 1897: SW
- disala* Jewett 1962: NW
- distincta* Frison 1937: NW
- elevata* Frison 1942: NW
- elongata* Claassen 1924: SW,
NW, CW
- ensicala* Jewett 1962: NW
- erecta* Jewett 1955: NW
- excavata* Claassen 1924: NW,
CW
- fibula* Claassen 1924: SW
- frisoni* Baumann & Gaufin
1970: SW
- glabra* Claassen 1924: SW,
NW
- gracilaria* Claassen 1924: SW,
NW, CW
- gregsoni* Ricker 1965: CW
- imbera* Nebeker & Gaufin 1965:
NW

- jewetti* Frison 1942: NW
labradora Ricker 1954: CE, A
lacustra Jewett 1965: NW
lapwae Baumann & Gaufin
 1970: NW
lemoniana Nebeker & Gaufin
 1965: SW, NW
licina Jewett 1954: NW
limata Frison 1944: SW, NW
lineata Hanson 1943: SW, NW
logana Nebeker & Gaufin 1965:
 SW
maculata Jewett 1954: NW
**manitoba* Claassen 1924: NE,
 CE, CC, CW, A
melia Frison 1942: NW, CW
milami Nebeker & Gaufin 1967:
 NW
nana Claassen 1924: SW, NW,
 CW
nearctica Banks 1918: A
nedia Nebeker & Gaufin 1966:
 NW
oenone Neave 1929: NW, CW
ogotoruka Jewett 1963: CW, A
oregona Frison 1942: NW
oswegaptera Jewett 1965: NW
petila Jewett 1954: NW
pileata Jewett 1966: NW, CW
poda Nebeker & Gaufin 1965:
 SW, NW
porrecta Jewett 1954: NW
projecta Frison 1937: SW,
 NW, CW, A
promota Frison 1937: NW
quadrituberosa Hitchcock 1958:
 NW
rogozera Ricker 1965: CW
sasquatchi Ricker 1965: NW,
 CW
scobina Jewett 1966: NW
sextuberculata Jewett 1954:
 NW
sierra Nebeker & Gaufin 1965:
 NW
spenceri Ricker 1965: NW,
 CW
spinulosa Claassen 1937: SW
sugluka Ricker 1965: A
tahoensis Nebeker & Gaufin
 1965: NW
teresa Claassen 1924: SW
trava Nebeker & Gaufin 1965:
 NW
tumida Claassen 1924: NW
uintahi Gaufin 1965: SW, NW
unpqua Frison 1942: NW
utahensis Gaufin & Jewett
 1962: SW
venosa Banks 1900: NW
vernalis Newport 1848: C, CE,
 CC, CW
wanica Frison 1944: SW, NW
wernerii Baumann & Gaufin
 1970: SW
willametta Jewett 1955: NW
yoloensis Baumann & Gaufin
 1970: NW
zukeli Hanson 1943: NW
Eucapnopsis Okamoto 1922
brevicauda Claassen 1924: SW,
 NW, CW, A
Isocapnia Banks 1938
abbreviata Frison 1942: NW,
 CW
agassizi Ricker 1943: NW,
 CW
crinita Needham & Claassen
 1925: SW, NW
fraseri Ricker 1959: CW
grandis Banks 1907: SW, NW,
 CW, A
hyalita Ricker 1959: NW
integra Hanson 1943: CW
missouri Ricker 1959: SW,
 NW
mogila Ricker 1959: NW
spenceri Ricker 1943: NW,
 CW
vedderensis Ricker 1943: SW,
 NW, CW
Nemocapnia Banks 1938
carolina Banks 1938: SE, C
Paracapnia Hanson 1946
**angulata* Hanson 1961: SE,
 NE, C, CE
**opis* Newman 1839: NE, C,
 CE
Megaleuctra Neave 1934
complicata Claassen 1937: NW
kincaidi Frison 1942: NW
spectabilis Neave 1934 (possi-

- bly syn. with *stigmata*): CC
stigmata Banks 1900: CC
williamsae Hanson 1941: SE
- Nemouridae
Nemoura Latreille 1796
 **albidipennis* Walker 1852: NE, CE
apache Baumann & Gaufin 1972: SW
arctica Esben-Peterson 1910: A
banksi Baumann & Gaufin 1972: SW
besametsa Claassen 1923: SW, NW, CW
bifurcata Claassen 1923: NW
biloba Claassen 1923: SW
californica Claassen 1923: SW, NW, CW
cataractae Neave 1933: NW, CW
chila Ricker 1952: SE
cinctipes Banks 1897: C, SW, NW, CW, A
coloradensis Banks 1897: SW, NW
columbiana Claassen 1923: SW, NW, CW, A
completa Walker 1852: SE, NE, C, NW, CE
complexa Claassen 1937: NE, CE
cordillera Baumann & Gaufin 1971: NW
cornuta Claassen 1923: NW, CW
decepta Frison 1942: SW, NW, CW
delicatula Claassen 1923: SW, NW, CW
delosa Ricker 1952: SE, C, CE
depressa Banks 1898: SW, NW
dimicki Frison 1936: NW, CW
flexura Claassen 1923: SW, NW
foersteri Ricker 1943: NW, CW
frigida Claassen 1923: SW, NW, CW, A
glacier Baumann & Gaufin 1971: NW
- haysi* Ricker 1952: SW, NW, CW, A
linda Ricker 1952: C, SW, CE, CC, CW, A
macdunnoughi Ricker 1947: CE
marionae Hitchcock 1958: NW
mockfordi Ricker 1952: SE
mogollonica Baumann & Gaufin 1972: SW
nevadensis Claassen 1923: SW, NW, CW
 **nigritta* Provancher 1876: SE, NE, C, CE
normani Ricker 1952: A
obscura Frison 1936: NW
oregonensis Claassen 1923: SW, NW, CW, A
 **perfecta* Walker 1852: SE, NE, CE
perplexa Frison 1936: NW
potteri Baumann & Gaufin 1971: NW
producta Claassen 1923: NW, CW
prolongata Claassen 1923: NE, CE
rickeri Jewett 1971: A
rotunda Claassen 1923: NE, C, CE, CC, A
 **similis* Hagen 1861: NE, C, CE
spiniloba Jewett 1954: NW
tina Ricker 1952: NW
trispinosa Claassen 1923: NE, CE
 **truncata* Claassen 1923: NE, C, CE
tumana Ricker 1952: NW
 **vallicularia* Wu 1923: NE, C, CE
varshava Ricker 1952: C
venusta Banks 1911: SW, NW
wahkeena Jewett 1954: NW
 **washingtoni* Claassen 1923: SE, NE
weberi Ricker 1952: A
wenatchee Ricker 1965: NW
 **wui* Claassen 1923: SE, NE, CE
- Pteronarcidae
Pteronarcys Newman 1838

- *biloba* Newman 1838: SE, NE, CE
californica Newport 1849: SW, NW, CW
comstocki Smith 1917: NE, CE
dorsata Say 1823: SE, NE, C, NW, CE, CC, CW, A
**pictetii* Hagen 1873: SE, NE, C, CE
princeps Banks 1907: SW, NW, CW
proteus Newman 1838: NE, CE
scotti Ricker 1952: SE
Pteronarcella Banks 1900
badia Hagen 1873: SW, NW, A
regularis Hagen 1873: SW, NW, CW
- Perlidae**
Neoperla Needham 1905
**clymene* Newman 1839: SE, NE, C, SW, CE
hubbsi Ricker 1952: C
Paragnetina Klapálek 1907
fattigi Ricker 1949: SE
fumosa Banks 1902: SE
immarginata Say 1823: SE, NE, CE
kansensis Banks 1905: C
media Walker 1852: SE, NE, C, CE, CC, A
Phasganophora Klapálek 1921
**capitata* Pictet 1841: SE, NE, C, CE
Acroneuria Pictet 1841
**abnormis* Newman 1838: SE, NE, C, CE, CC
**arenosa* Pictet 1841: SE, NE, CE
arida Hagen 1861: SE
californica Banks 1905: SW, NW, CW
**carolinensis* Banks 1905: SE, NE, CE
depressa Needham & Claassen 1922: NW
evoluta Klapálek 1909: C, NW
flicis Frison 1942: SE, C
georgiana Banks 1914: SE
internata Walker 1852: NE, C, SW
**lycorias* Newman 1839: SE, NE, C, CE, CC
mela Frison 1942: C
pacifica Banks 1900: SW, NW, CW
perplexa Frison 1937: NE, C
ruralis Hagen 1861: SE, NE, C, SW, CC
theodora Needham & Claassen 1922: SW, NW
**xanthenes* Newman 1838: SE, NE, C
Claassenia Wu 1934
sabulosa Banks 1900: SW, NW, CC, CW, A
Perlesta Banks 1906
frisoni Banks 1948: SE
**placida* Hagen 1861: SE, NE, C, NW, CE, CC
Perlinella Banks 1900
**drymo* Newman 1839: SE, NE, C
**ephyre* Newman 1839: SE, NE, C
**fumipennis* Walsh 1862: SE, C
- Perlodidae**
Arcynopteryx Klapálek 1904
aurea Smith 1917: NW
barbara Needham 1933: NW
bradleyi Smith 1917: NW, CW
compacta MacLachlan 1872: NE, SW, NW, CE, CC, CW, A
curvata Hanson 1942: NW, CW
irregularis Banks 1900: SW, NW, CW
parallela Frison 1936: SW, NW, CW
picticeps Hanson 1942: NW, CW
signata Hagen 1874: SW, NW, CW
subtruncata Hanson 1942: NW, CW
tibialis Banks 1914: NW, CW
watertoni Ricker 1952: NW, CW

- yosemite* Needham & Claassen
 1925: NW
Calliperla Banks 1947
luctuosa Banks 1906: NW
Diura Billberg 1820
bicaudata Linne 1758: A
knowltoni Frison 1937: SW,
 NW, CW
nanseni Kempny 1900: NE,
 CE
Isogenus Newman 1833
aestivalis Needham & Claassen
 1925: SW, NW, CW
alameda Needham & Claassen
 1925: SW
arinus Frison 1942: SE
 **bilobatus* Needham & Claassen
 1925: SE, NE
bulbosus Frison 1942: SE
crosbyi Needham & Claassen
 1925: C
 **decisus* Walker 1852: SE, NE,
 C, CE, CC
doratus Frison 1942: C, CE
 **duplicatus* Banks 1920: SE, C
elongatus Hagen 1874: SW,
 NW, CW
erratus Claassen 1925: NW
expansus Banks 1920: SW,
 NW
frontalis frontalis Newman
 1838: NE, C, CE, A
frontalis colubrinus Hagen
 1874: SW, NW, CC, CW, A
fugitans Needham & Claassen
 1925: C
 **hansoni* Ricker 1952: SE, NE,
 CE
hastatus Banks 1920: SE, NE,
 CE
innubilis Needham & Claassen
 1925: SE
krumholzi Ricker 1952: C
misnomus Claassen 1936: NW
modestus Banks 1908: SW,
 NW, CW
nalatus Frison 1942: C
nonus Needham & Claassen
 1925: NW, CW
olivaceus Walker 1852: C, CE,
 CC
pilatus Frison 1942: NW, CW
 **subvarians* Banks 1920: SE,
 NE, CE
tostonus Ricker 1952: NW,
 CW
varians Walsh 1863: SE, C
venustus Jewett 1965: NW
yakimae Hoppe 1938: SW,
 NW, CW
zionensis Hanson 1949: SW, A
Isoperla Banks 1906
acula Jewett 1962: SW
adunca Jewett 1962: NW
bellona Banks 1911: SE
 **bilineata* Say 1823: SE, NE, C,
 SW, CE, CC
burksi Frison 1942: C
citronella Newport 1849: CC,
 A
 **clio* Newman 1839: SE, NE, C
conspicua Frison 1935: C
cotta Ricker 1952: C, CE
decepta Frison 1935: C
decolorata Walker 1852: CC, A
denningi Jewett 1955: SW
 **dicala* Frison 1942: SE, NE,
 C, CE
ebria Hagen 1874: SW, NW,
 CW
emarginata Harden & Mickel
 1952: C
extensa Claassen 1937: C
 **francesca* Harper 1971: CE
 **frisoni* Illies 1966: C, CE
fulva Claassen 1937: SW, NW,
 CW
fusca Needham & Claassen
 1925: NW, CW
 **gibbsae* Harper 1971: NE, CE
gravitans Needham & Claassen:
 NW
 **holochloro* Klapálek 1923: SE,
 NE, CE
irregularis Klapálek 1923: C
lata Frison 1942: SE, C, CE
longiseta Banks 1906: C, SW,
 NW, CW, A
marlynia Needham & Claassen
 1925: SE, NE, C, CE
marmorata Needham & Claas-
 sen 1925: SW, NW

maxana Harden & Mickel
 1952: C
mohri Frison 1935: C
**montana* Banks 1898: NE, C,
 CE
mormona Banks 1920: SW,
 NW, CW
namata Frison 1942: C
nana Walsh 1862: C, CE
**orata* Frison 1942: SE, NE, C,
 CE
patricia Frison 1942: C, SW,
 NW, CW
petersoni Needham & Christen-
 son 1927: SW, NW, CW
phalerata Needham 1917: SW,
 NW
pinta Frison 1937: SW, NW,
 CW
quinquepunctata Banks 1902:
 SW
rainiera Jewett 1954: NW
**richardsoni* Frison 1935: NE,
 C
**signata* Banks 1902: NE, C,
 CE
**similis* Hagen 1861: SE, NE
**slossonae* Banks 1911: NE, C,
 CE
sobria Hagen 1874: SW
sordida Banks 1906: SW, NW
**transmarina* Newman 1838:
 NE, C, CE, CC
trictura Hoppe 1938: NW,
 CW
Rickera Jewett 1954
sorpta Needham & Claassen
 1924: NW

Chloroperlidae

Alloperla Banks 1906
albertensis Needham & Claas-
 sen 1925: NW, CW
autumna Hoppe 1938: NW,
 CW
banksi Frison 1942: NE, C,
 CE
borealis Banks 1895: SW, NW,
 CW, A
californica Jewett 1965: NW
**caudata* Frison 1934: NE, C,
 CE

chandleri Jewett 1954: SW
**chloris* Frison 1934: NE, CE
coloradensis Banks 1898: SW,
 NW, CW
**concolor* Ricker 1935: NE, CE
continua Banks 1911: SW
cydippe Newman 1839: SE
delicata Frison 1935: SW,
 NW, CW
diversa Frison 1935: SW, NW,
 CW, A
exquisita Frison 1935: NW,
 CW
fidelis Banks 1920: SW, NW,
 CW, A
forcipata Neave 1929: NW,
 CW, A
fraterna Frison 1935: NW,
 CW, A
idei Ricker 1935: CE
**imbecilla* Say 1823: SE, NE,
 C, CE
lamba Needham & Claassen
 1925: SW, NW
**lateralis* Banks 1911: SE, NE,
 CE
leonarda Ricker 1952: C, CE
lineosa Banks 1918: SW, NW
marginata Banks 1897: NE, C,
 CE
**mediana* Banks 1911: SE, NE,
 C, CE
medveda Ricker 1952: SW,
 NW, CW, A
naica Provancher 1876: NE,
 CE
nanina Banks 1911: SE
neglecta Frison 1935: SE
occidens Frison 1937: NW,
 CW
onkos Ricker 1935: CE
oregonensis Frison 1935: NW,
 CW
pacifica Banks 1895: SW, NW,
 CW, A
pallidula Banks 1904: SW,
 NW, CW, A
pastina Jewett 1962: NW
pilosa Needham & Claassen
 1925: SW
pintada Ricker 1952: C, SW,
 NW

quadrata Harden & Mickel
 1952: C
revelstoka Jewett 1955: NW,
 CW
serrata Needham & Claassen
 1925: NW, CW, A
severa Hagen 1861: SW, NW,
 A
signata Banks 1895: SW, NW,
 A
tamalpa Ricker 1952: NW
townesi Ricker 1952: NW
urticae Ricker 1952: SE
usa Ricker 1952: SE
voinae Ricker 1948: NE, CE
vostoki Ricker 1948: NE, CE
Chloroperla Newman 1836
terna Frison 1942: SE, NE
ovibovis Ricker 1965: A
Hastaperla Ricker 1935
**brevis* Banks 1895: SE, NE, C,
 CE, CC
chilnualna Ricker 1952: NW
orpha Frison 1937: C, CE
Kathroperla Banks 1920
perdita Banks 1920: NW, CW,
 A
Paraperla Banks 1906
frontalis Banks 1902: SW,
 NW, CW, A
wilsoni Ricker 1965: CW
Utaperla Ricker 1952
sopladora Ricker 1952: SW,
 NW, CW, A

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