

4a. Subanal plate (formed by the fusion of the two subanal lobes and the median fusion plate) trilobed (Fig. 5).....	<i>Paracapnia</i>	5
4b. Subanal plate pointed (Fig. 4).....	<i>Capnia vernalis</i>	
5a. Supraanal process angulate at base (Fig. 2).....	<i>P. angulata</i>	
5b. Supraanal process evenly rounded at base (Fig. 3).....	<i>P. opis</i>	
6a. Species with a dorsal process on tergite seven or eight, or on both.....		7
6b. Species without dorsal process on tergites (Fig. 8).....	<i>Capnia labradora</i>	
7a. Dorsal process on tergite seven only (Figs. 6, 7).....		8
7b. Dorsal process on tergite eight, or on both seven and eight (Figs. 10-19).....		9
8a. Supraanal process formed of two slender elements (Fig. 6).....	<i>Capnia manitoba</i>	
8b. Supraanal process thicker; the inferior element hook-like (Fig. 7).....	<i>Capnia nearctica</i>	
9a. Dorsal process on tergite eight only (Figs. 10-15).....		10
9b. Dorsal processes on both tergites seven and eight (Figs. 16-19).....		15
10a. Wings vestigial; dorsal process of tergite eight plate-like and evenly rounded (Fig. 10).....	<i>A. vivipara</i>	
10b. Wings short; dorsal process otherwise.....		11
11a. Dorsal process on tergite eight produced backwards and overlapping tergite nine (Figs. 11, 12).....		12
11b. Dorsal process of tergite eight perpendicular to the tergite (Figs. 13-15).....		13
12a. Species small, less than 5 mm in length; process of tergite eight nipple-like in sagittal view (Fig. 11).....	<i>A. minima</i>	
12b. Species large, more than 6 mm in length; process of tergite eight bilobed in sagittal view (Fig. 12).....	<i>A. granulata</i>	
13a. Dorsal process of tergite eight large and massive; not conspicuously notched at tip (Fig. 13).....	<i>A. recta</i>	
13b. Process notched in sagittal view (Figs. 14, 15).....		14
14a. Notch in dorsal process very wide and deep (Fig. 14).....	<i>A. rickeri</i>	
14b. Notch shallow (Fig. 15).....	<i>A. pygmaea</i>	
15a. Process on tergite seven plate-like and inconspicuous (Fig. 16).....	<i>A. nivicola</i>	
15b. Process on tergite seven knob-like.....		16
16a. Process on middle or hind half of tergite seven (Fig. 17).....	<i>A. illinoensis</i>	
16b. Process on anterior half of tergite seven (Figs. 18, 19).....		17
17a. Process on tergite eight slightly notched at tip; that on tergite seven nipple-like (Fig. 18).....	<i>A. maria</i>	
17b. Process on tergite eight bearing two wide knobs separated by a distinct notch; that on tergite seven, slightly notched in sagittal view (Fig. 19).....	<i>A. pechumani</i>	

FEMALES

18a. Vannus of hind wing exceptionally large, extending considerably beyond the cord (Fig. 23).....	<i>Allocapnia</i>	25
18b. Vannus of normal size (Figs. 20-22).....		19
19a. First anal vein of forewing bent beyond the cubitoanal crossvein; second anal vein long (Figs. 20, 22).....		20
19b. First anal vein of forewing straight; second anal vein short and lying on the margin of the wing (Fig. 21); subgenital plate as in Fig. 24.....	<i>Paracapnia angulata</i> and <i>P. opis</i>	
20a. Vein R ₁ distinctly bent forward near its origin with R _s , an oblique crossvein in the marginal cell beyond the subcosta (Fig. 22).....	<i>Capnia</i>	21
20b. Vein R ₁ straight; no crossvein in the marginal cell beyond the subcosta (Fig. 20); subgenital plate as in Fig. 25.....	<i>Nemocapnia carolina</i>	
21a. Margin of subgenital plate pointed; without an apical notch (Fig. 26).....	<i>C. sugluka</i>	
21b. Margin of subgenital plate otherwise.....		22
22a. Margin of subgenital plate entire medially (Figs. 27, 28).....		23
22b. Margin of subgenital plate notched medially (Figs. 29, 30).....		24

23a. Median sclerotized area of subgenital plate narrow; sclerotized connection between sternites eight and seven wide (Fig. 27).....	<i>C. manitoba</i>
23b. Median sclerotized area of subgenital plate wide; the lip darkened; sclerotized bridge between sternite eight and seven narrow (Fig. 28).....	<i>C. vernalis</i>
24a. Median notch of subgenital plate small; eighth sternite with a conspicuous pattern (Fig. 29).....	<i>C. labradora</i>
24b. Median notch of subgenital plate wide and shallow (Fig. 30).....	<i>C. nearctica</i>
25a. With a heavily sclerotized band (which is also shiny and glabrous) on the middle of the subgenital plate (Figs. 31-34).....	26
25b. Sclerotization absent, or only on lip of plate.....	29
26a. Sclerotized band with sides more or less parallel, just as wide anteriorly as posteriorly (Figs. 31, 32).....	27
26b. Sclerotized band wider posteriorly (Figs. 33, 34).....	28
27a. Sclerotized band narrow, about one-fifth of sternite width (Fig. 31).....	<i>A. minima</i>
27b. Sclerotized band wider, about one-third of sternite width (Fig. 32).....	<i>A. maria</i> and <i>A. pechumani</i>
28a. Large species, more than 8 mm in length; lip of sclerotized band convex (Fig. 33).....	<i>A. granulata</i>
28b. Small species, 7 mm or less in length; lip of sclerotized band straight or slightly concave (Fig. 34).....	<i>A. illinoensis</i>
29a. Eighth sternite divided into a central and two lateral sclerotized areas, at least near the posterior margin (Figs. 36-39).....	30
29b. Eighth sternite unmodified, hind margin straight (Fig. 35).....	<i>A. recta</i>
30a. Wings short, covering half the abdomen or less; subgenital plate as in Fig. 36.....	<i>A. vivipara</i>
30b. Wings longer, reaching the tip of the abdomen at least in teneral (not yet oviparous) females.....	31
31a. Margin of subgenital plate evenly rounded, the posterior lip heavily sclerotized medially (Fig. 37)....	<i>A. rickeri</i>
31b. Margin of subgenital plate straight, with a narrow band of heavy sclerotization (Figs. 38, 39).....	<i>A. nivicola</i> and <i>A. pygmaea</i>

Preliminary Key to the Nymphs of the Capniidae of Eastern Canada

(The nymphs of *A. maria*, *C. nearctica*, and *C. sugluka* are unknown)

1a. Cerci with a well-developed vertical fringe which consists of several long bristles from each segment (Fig. 46).....	<i>Nemocapnia carolina</i>
1b. Cercal fringe loose, containing at the most, on the middle segments, one dorsal and two ventral bristles from each segment (Figs. 47-49).....	2
2a. Species hirsute, bristles very conspicuous and somewhat purplish (Fig. 56); head capsule with a reticulate purplish pattern.....	<i>Paracapnia</i> 3
2b. Species not so hairy, bristles inconspicuous; head capsule without an elaborate pattern.....	4
3a. Middle and distal segments of cerci with a long intermediate bristle at the ventral base of the segment (Fig. 48); bristles on the inner surface of the tibiae short, half as long as the width of the tibia (Fig. 50).....	<i>P. angulata</i>
3b. Cercal segments without intermediate bristles (Fig. 47); bristles on the inner surface of the tibiae long, as long as the width of the tibia (Fig. 51).....	<i>P. opis</i>
4a. Tip of galea expanded, with a fringe of long hairs (Fig. 41).....	<i>C. vernalis</i>
4b. Tip of galea evenly tapered or pointed (Figs. 40, 42-45).....	5
5a. Species covered with a short and dense pubescence, with no erect hairs on the abdomen; pronotum densely pubescent in lateral view (Fig. 53).....	<i>C. manitoba</i>
5b. Species with erect hairs on the abdomen; pronotum with distinctive anterior and posterior fringes of hairs; hairs on pronotal disc usually few and short (Figs. 54-64).....	6
6a. Abdominal tergites clothed with erect hairs throughout (Fig. 64).....	<i>A. illinoensis</i>
6b. Erect hairs not evenly distributed, but more abundant near posterior margin and sometimes at midlength of tergites (Figs. 54-63).....	7

- 7a. Abdominal tergites bearing, in addition to the prostrate clothing hairs, terminal and intermediate rows of erect hairs (as seen in side view) (Figs. 61–63)..... 13
- 7b. Abdominal tergites bearing, in addition to the prostrate clothing hairs, only a terminal row of erect hairs (as seen in side view) (Figs. 54, 57, 60)..... 8
- 8a. Galea of maxilla pointed as in Fig. 42, with a well-developed fringe of hairs; very small species (up to 5.5 mm).....*A. minima*
- 8b. Galea gradually tapered, tip rounded (Figs. 43–45)..... 9
- 9a. Erect bristles on posterior margin of abdominal tergites very long, nearly as long as the middorsal length of the segment (Fig. 54); species restricted to northern areas.....(?) *C. labradora*
- 9b. Erect bristles shorter, half or less the middorsal length of the tergite (Figs. 57–60)..... 10
- 10a. Galea with a wide fringe of setae on the outer surface (Figs. 43, 44)..... 11
- 10b. Galea with a narrower fringe, usually with fewer than 10 hairs (Fig. 45)..... 12
- 11a. Longest hairs in fringe of galea shorter than the width of the galea at the point of insertion (Fig. 44); clothing hairs numerous; supraanal lobe of mature male nymph long (Fig. 59); species common and widespread.....*A. pygmaea*
- 11b. Longest hairs in fringe of galea longer than the width of the galea (Fig. 43); clothing hairs much fewer, inconspicuous (Fig. 43); supraanal lobe of mature male nymph short (as in Fig. 57); species found only in Southern Quebec.....*A. pechumani*
- 12a. Terminal abdominal tergites with intermediate erect hairs only on the lateral margins; supraanal lobe of mature male nymph long (as in Fig. 59); species found only in Southern Quebec.....*A. nivicola*
- 12b. Terminal abdominal tergites with intermediate erect hairs on the lateral thirds of the tergite; as none occur on the middle third of the segment, none are seen in a side view of the abdomen; supraanal lobe of mature male nymph short (Fig. 60); species found in Southern Ontario and Southwestern Quebec.....*A. recta*
- 13a. Erect bristles on margin of tergites long, about half as long as mid-dorsal tergite length; intermediate bristles few (Fig. 61); species of moderate size (6–8 mm); species restricted to Southern Ontario.....*A. rickeri*
- 13b. Erect bristles on margin of tergites short, about one-third as long as middorsal length of tergite; intermediate bristles numerous (Figs. 62, 63); large species (8–10 mm) inhabiting Southern Ontario and Southwestern Quebec..... 14
- 14a. Head and pronotum hairy in side view (Fig. 63); mature male nymph without wing-pads; supraanal lobe of mature male nymph, twice as long as the 10th abdominal segment (Fig. 63).....*A. vivipara*
- 14b. Head and pronotum with fewer hairs (Fig. 62); mature male nymph with short wing-pads; supraanal lobe of mature male nymph short, about as long as 10th tergite (Fig. 62).....*A. granulata*
1. *Allocapnia granulata* (Claassen 1924) (Figs. 12, 33)
1925, *Capnella granulata*, Needham and Claassen, Plate 50, Figs. 6, 7, male and female genitalia.
1929, *A. granulata*, Frison, Fig. 71, female genitalia.
1935, *A. granulata*, Frison, Figs. 220, 227, male and female genitalia.
Distribution—Southern Ontario and Southwestern Quebec eastward to the Montreal area; distribution map in Ross and Yamamoto (1967).
2. *Allocapnia illinoensis* Frison 1935 (Figs. 17, 34)
1935, *A. illinoensis*, Frison, Figs. 212, 225, male and female genitalia.
Distribution—Southern Ontario north to the north shores of the Great Lakes, and Southwestern Quebec.
3. *Allocapnia maria* Hanson 1942 (Fig. 18)
1942, *A. maria*, Hanson, Figs. 1, 3, male and female genitalia.
1952, *A. maria*, Ricker, Figs. 116, 117, male and female genitalia.
1960, *A. maria*, Hanson, Fig. 2, male genitalia.
Distribution—New Brunswick and Nova Scotia; also extreme Southern Quebec (Hanson 1960).
Remarks—In extreme Southern Quebec, the range of this species overlaps that of *A. pechumani*; the females of these two species are apparently indistinguishable (Ross and Ricker 1964).
4. *Allocapnia minima* (Newport 1851) (Figs. 11, 31)
1925, *Capnella incisura*, Needham and Claassen, Plate 50, Figs. 10, 11, male and female genitalia.
1960, *A. minima*, Hanson, Fig. 1, male genitalia.

Distribution—Throughout Ontario, Quebec, and Newfoundland; distribution map in Ross *et al.* (1967).

5. *Allocapnia nivicola* (Fitch 1847) (Figs. 16, 39) 1942, *A. pygmaea*, Frison, Fig. 33, male genitalia.

1942, *A. nivicola*, Hanson, Figs. 2, 4, male and female genitalia.

Distribution—Quebec south of the St. Lawrence (Ricker *et al.* 1968).

Remarks—The female of this species is indistinguishable from that of *A. pygmaea*; their ranges overlap in Southern Quebec.

6. *Allocapnia pechumani* Ross and Ricker 1964 (Figs. 19, 32)

1964, *A. pechumani*, Ross and Ricker, Fig. 1, a-c, male genitalia.

Distribution—Southern Quebec north to the Lower Laurentian Highlands (Ricker *et al.* 1968).

Remarks—The female of this species is indistinguishable from that of *A. maria* (Ross and Ricker 1964); in Eastern Canada, the ranges of the two species apparently overlap only in extreme Southern Quebec near Sherbrooke.

7. *Allocapnia pygmaea* (Burmeister 1839) (Figs. 15, 23, 38)

1925, *Capnella pygmaea*, Needham and Claassen, Plate 50, Figs. 1, 2, 3, male and female genitalia.

1935, *A. torontonensis*, Ricker, Figs. 14-16, male genitalia.

1943, *A. pygmaea*, Hanson, Figs. 1, 2, male and female genitalia.

Distribution—Southern Ontario and Southern Quebec; distribution map in Ross *et al.* (1967).

Remarks—The female of this species cannot presently be separated from that of *A. nivicola*; the ranges of the two species overlap in Southern Quebec.

8. *Allocapnia recta* (Claassen 1924) (Figs. 13, 35)

1925, *Capnella recta*, Needham and Claassen, Plate 50, Figs. 8, 9, male and female genitalia.

1929, *A. recta*, Frison, Fig. 70, female genitalia.

1935, *A. recta*, Frison, Figs. 213, 221, male and female genitalia.

Distribution—Southern Ontario and Southwestern Quebec (Ricker *et al.* 1968).

9. *Allocapnia rickeri* Frison 1942 (Figs. 14, 37) 1929, *A. pygmaea*, Frison, Fig. 75, female genitalia.

1935, *A. pygmaea*, Frison, Figs. 215, 224, male and female genitalia.

1942, *A. rickeri*, Frison, Fig. 36, male and female genitalia.

Distribution—Extreme Southern Ontario; map in Ross (1965).

10. *Allocapnia vivipara* (Claassen 1924) (Figs. 10, 36)

1925, *Capnella vivipara*, Needham and Claassen, Plate 50, Figs. 4, 5, male and female genitalia.

1929, *A. vivipara*, Frison, Fig. 74, female genitalia.

1935, *A. vivipara*, Frison, Figs. 218, 228, male and female genitalia.

Distribution—Southern Ontario and Southwestern Quebec (Ricker *et al.* 1968).

11. *Capnia* (s.s.) *manitoba* Claassen 1924 (Figs. 6, 27)

1925, *C. manitoba*, Needham and Claassen, Plate 49, Figs. 8, 9, male and female genitalia.

Distribution—Southern Ontario and throughout Quebec; map in Ricker (1963).

12. *Capnia* (s.s.) *nearctica* Banks 1918 (Figs. 7, 30)

1925, *C. nearctica*, Needham and Claassen, Plate 49, Figs. 2, 3, male and female genitalia.

1938b, *C. hantzchi*, Ricker, Figs. 1, 2, male and female genitalia.

1944, *C. nearctica*, Ricker, Fig. 44, female genitalia.

Distribution—Found throughout the Northwest Territories; in the East, the species has been collected only from Baffin Land; map in Ricker (1964).

Remarks—This species is very close to the European *C. atra* Morton of Northwestern Europe; there are, however, constant differences (Ricker 1965).

13. *Capnia* (s.s.) *sugluka* Ricker 1965 (Fig. 26) 1965, *C. sugluka*, Ricker, Fig. 29, female genitalia.

Distribution—Known only from Payne Bay and Sugluk in Ungava (Ricker 1965).

Remarks—Only the female of this species is known; its structure is reminiscent of that of *C. vidua* Klapalek of Northwestern Europe (Ricker 1965).

14. *Capnia* (s.s.) *vernalis* Newport 1851

(Figs. 1, 4, 22, 28)

1938a, *C. vernalis*, Ricker, Figs. 10–12, male and female genitalia.

Distribution—Northern Ontario and Quebec; map in Ricker (1963).

15. *Capnia* (*Utacapnia*) *labradora* Ricker 1954

(Figs. 8, 29)

1944, *C. columbiana*, Ricker, Figs. 4, 7, 11, male genitalia.

1965, *C. labradora*, Nebeker and Gaufin, Figs. 14, 15, male genitalia.

1967, *C. labradora*, Nebeker, Figs. 1, 2, female genitalia.

Distribution—Ungava, Labrador, and Quebec North Shore (Ricker *et al.* 1968).

16. *Nemocapnia carolina* Banks 1938

(Figs. 9, 20, 25)

1942, *N. carolina*, Frison, Figs. 28–30, thorax and male and female genitalia.

Distribution—There is only one record from Eastern Canada, from the Quebec North Shore.

17. *Paracapnia angulata* Hanson 1961 (Fig. 2)

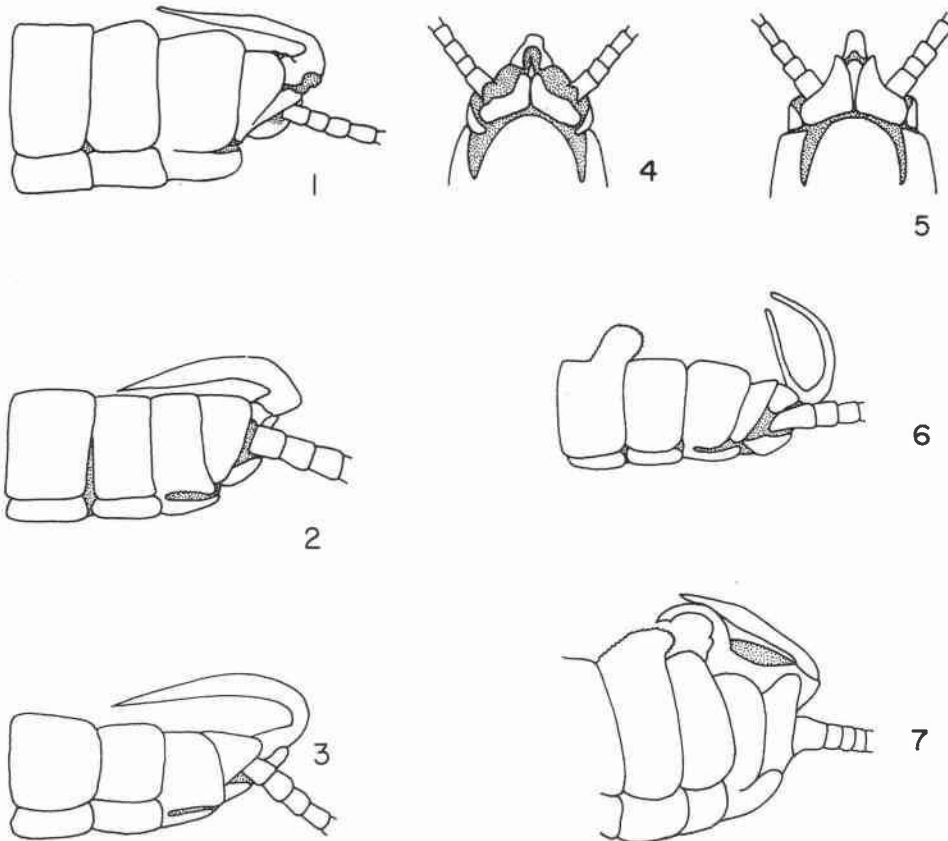
1942, *Capnia opis*, Frison, Fig. 32, male and female genitalia.

1946, *P. opis*, Hanson, Fig. 52, male supraanal process.

1961, *P. angulata*, Hanson, Figs. 1–4, male supraanal process.

Distribution—Southern Ontario and Southern Quebec (Ricker *et al.* 1968).

Remarks—The female of this species is apparently identical with that of *P. opis*; the species occurs in both macropterous and brachypterous forms.



FIGS. 1–3. Male genitalia, side view. 1. *Capnia vernalis*. 2. *Paracapnia angulata*. 3. *P. opis*.
FIGS. 4–5. Subanal plates of male, ventral view. 4. *Capnia vernalis*. 5. *Paracapnia opis*.
FIGS. 6–7. Male genitalia, side view. 6. *C. manitoba*. 7. *C. nearctica*.

18. *Paracapnia opis* (Newman 1839)
(Figs. 3, 5, 21, 24)
1946, *P. curvata*, Hanson, Fig. 53, male genitalia.

1961, *P. opis*, Hanson, Figs. 5-8, male supraanal process.

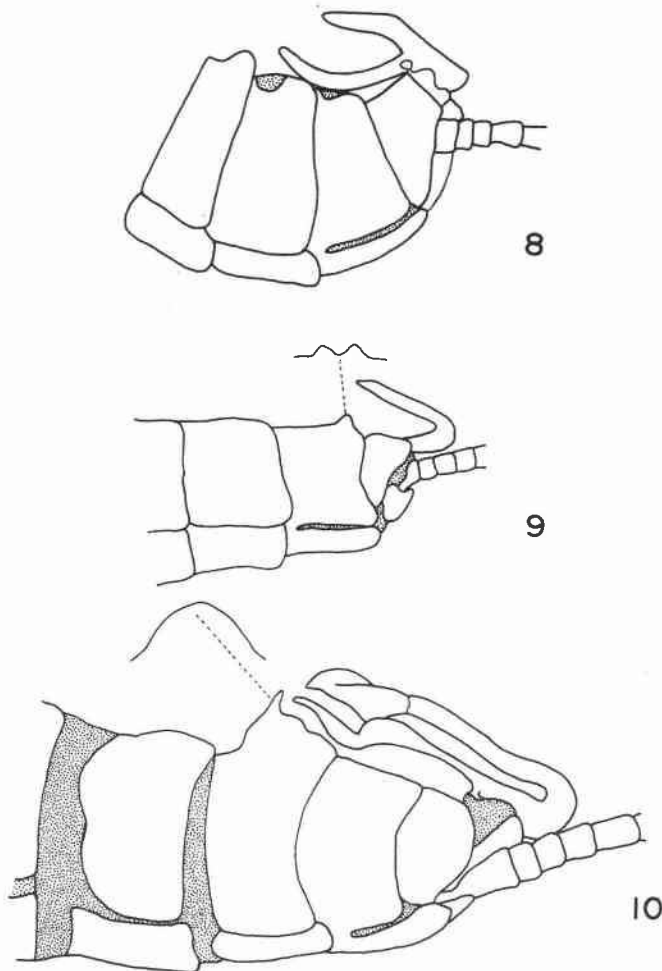
Distribution—Southern Ontario, Southern Quebec, Newfoundland (Ricker 1944; Ricker *et al.* 1968).

Remarks—The female is indistinguishable from that of *P. angulata*. Both macropterous and brachypterous forms are known.

B. The Nymphs

The nymphs of the Capniidae are a very frustrating group taxonomically; they are disappointingly homogenous and possess few dis-

tinctive features. This is also true of the Western European species, which, although few, are difficult to distinguish (Brinck 1949; Hynes 1955; Aubert 1959; Berthélemy 1969). All previous attempts to produce keys to the North American species (Frison 1929, 1935; Claassen 1931; Harden and Mickel 1952) have been based exclusively on adult characters seen through the nymphal skin or nymphal modifications related to adult characteristics, such as wing-pad length or supraanal lobe development; these keys thus apply only to mature male nymphs. The present discussion is the first attempt to propose a key to any North American species based principally on nymphal characters. The key will be found somewhat unsatisfactory because of the lack of reared material of one



FIGS. 8-10. Male genitalia, side view. 8. *Capnia labradora*. 9. *Nemocapnia carolina*. 10. *Allocapnia vivipara*.

uncommon species (*A. maria*) and of those restricted to inaccessible northern areas (*C. nearctica* and *C. sugluka*).

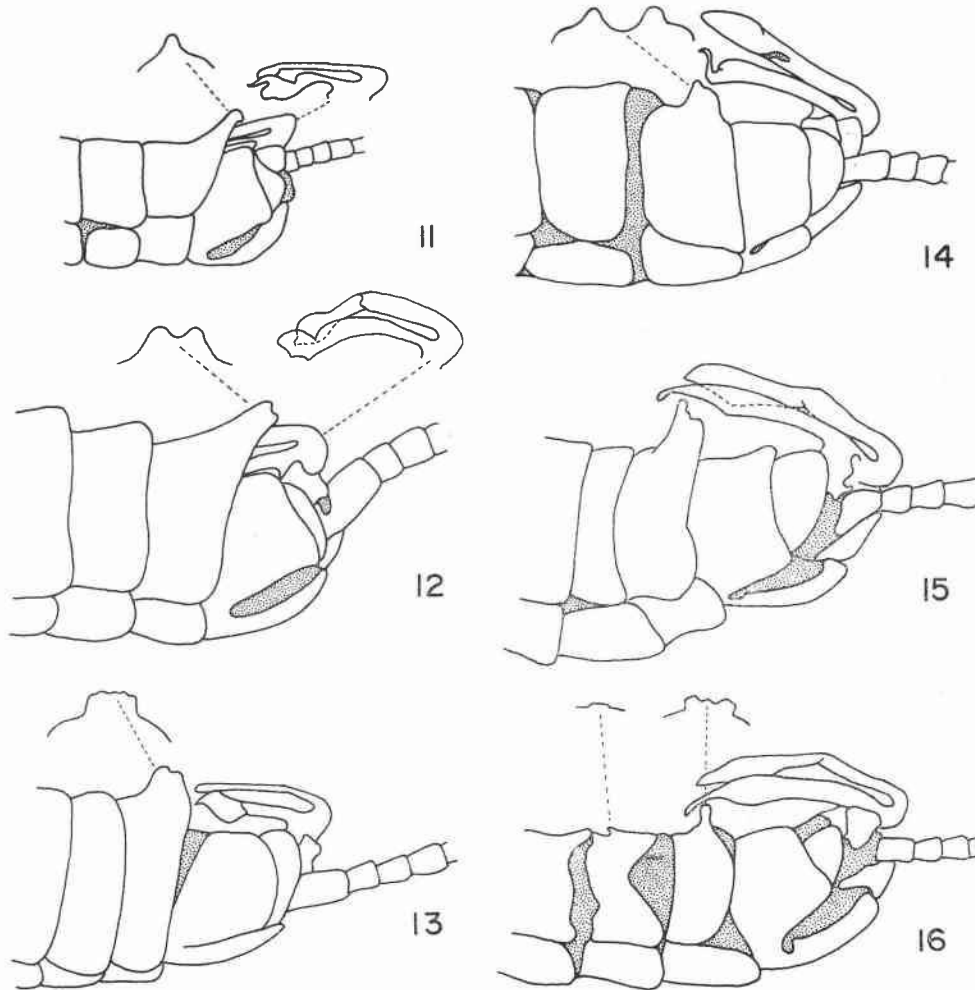
TAXONOMIC CHARACTERS

Identification of the nymphs requires very careful examination of their morphology; the main characters used are the following.

(1) *Color*—All the species have a more or less uniform color ranging from light yellow to dark brown; the venter and the appendages are normally lighter. In *Paracapnia*, however, the dorsum of the head capsule bears a purplish reticulate pattern which is distinctive. Most

other color patterns seen in nymphs are those of the adult showing through the nymphal skin of ripe specimens.

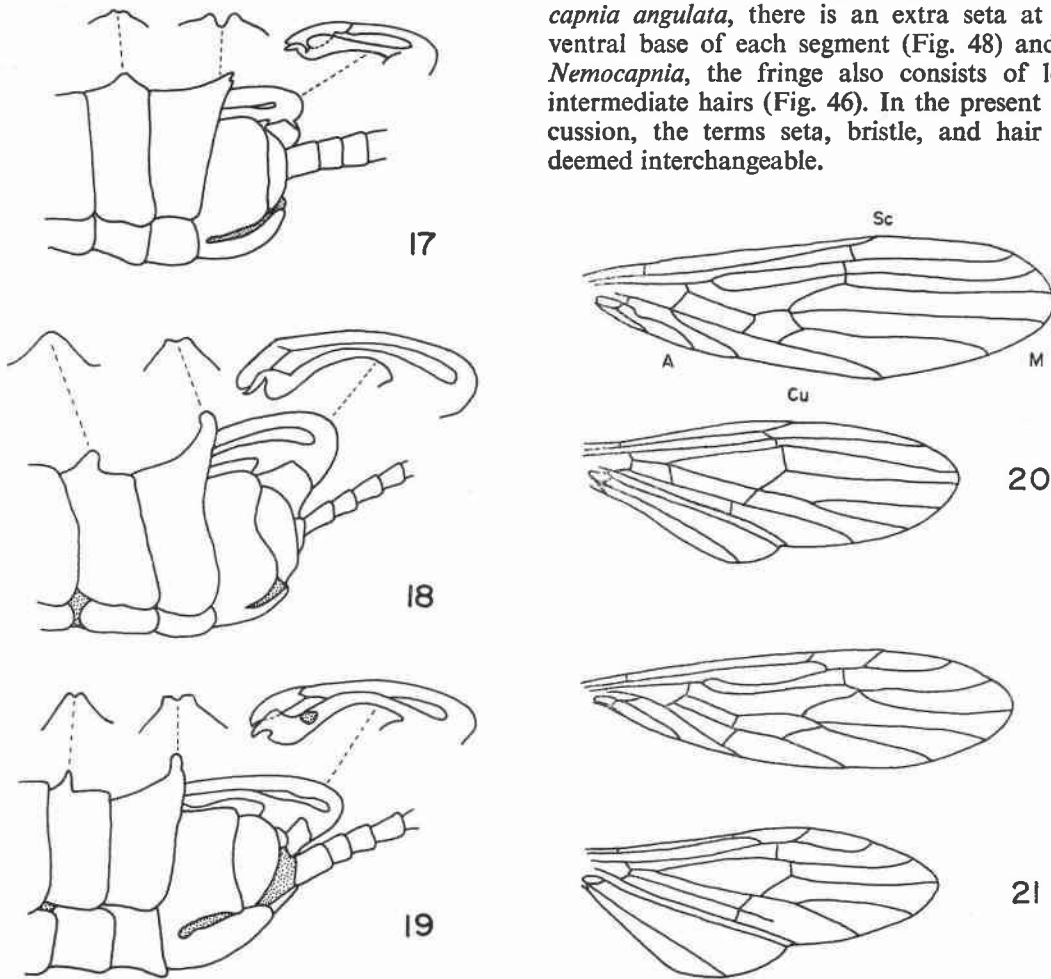
(2) *Mouthparts*—The mouthparts of many species have been described and illustrated (Frison 1929, 1935; Claassen 1931; Harden and Mickel 1952); most of these are remarkably similar and are of little taxonomic importance. In a few species, however, e.g. *Capnia vernalis*, *Allocapnia minima*, *A. pechumani*, *A. pygmaea*, there are modifications of the galea which are distinctive (Figs. 41–44); the mandibles and the lacinia are of no use, since they are subject to much wear and breakage during the life of the nymph.



FIGS. 11–13. Male genitalia, side view. 11. *Allocapnia minima*. 12. *A. granulata*. 13. *A. recta*.
FIGS. 14–16. Male genitalia, side view. 14. *Allocapnia rickeri*. 15. *A. pygmaea*. 16. *A. nivicola*.

(3) *Setation*—The most important character is unquestionably the distribution and the size of the bristles covering the body; this was first used successfully by Hynes (1955) to distinguish the three *Capnia* species of the British fauna. Hynes (1955) has given a detailed account of the general distribution of the setae on the body of a capniid and this applies in most respects to the North American species. The dorsum of the head is beset with short clothing bristles and a few long hairs; the antennal segments bear terminal whorls of short bristles which become progressively shorter distally. The pronotum is bordered with a fringe of long bristles and there are often bristles of various lengths on the disc;

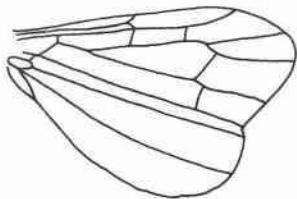
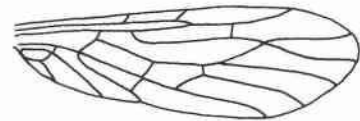
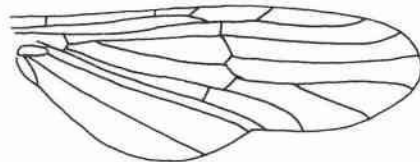
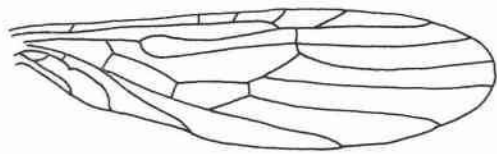
the meso- and meta-nota are covered with bristles, some of which are usually longer on the anterior and posterior border; the legs are densely covered with a pubescence and bear a conspicuous fringe of long silky hairs on the tibiae and the tarsi, especially the distal joint. The abdomen is covered with prostrate clothing hairs and, often, erect hairs, especially on the middle and the posterior margin of the segments; the distribution of these hairs is very important taxonomically and is best seen in profile against a transmitted light. The cerci have various arrangements of setae; in most species, each segment bears a distal whorl of setae, of which one dorsal and one ventral seta are much longer and form a vertical fringe (Fig. 49); in *Paracapnia angulata*, there is an extra seta at the ventral base of each segment (Fig. 48) and in *Nemocapnia*, the fringe also consists of long intermediate hairs (Fig. 46). In the present discussion, the terms seta, bristle, and hair are deemed interchangeable.



FIGS. 17-19. Male genitalia, side view. 17. *Allocaupnia illinoensis*. 18. *A. maria*. 19. *A. pechumani*. FIGS. 20-21. Wing venation. 20. *Nemocapnia carollina*. 21. *Paracapnia opis*.

(4) *Modifications related to adult characteristics*—The main taxonomic characters of the adults are the wings and the genitalia, especially the supraanal process of the male; these structures are represented, in mature nymphs, by the wing-pads and the supraanal lobe of the 10th tergite. Reference is made to these structures in the descriptions and occasionally in the key; since they appear only in full-grown individuals, they are not considered of great importance, but they may be used to corroborate the identifications when ripe nymphs are available.

These various characters are best seen in preserved nymphs, and are difficult to recognize on cast nymphal skins or on material mounted on slides. It must also be remembered that the various setae are fewer but longer in smaller specimens as compared with more developed individuals. Finally, because of a certain amount of variability in the structures, it is best to base the identifications on a series of nymphs from one locality.



22

23

FIGS. 22-23. Wing venation. 22. *Capnia vernalis*. 23. *Allocapnia pygmaea*.

The illustrations presented have been drawn with help of a camera lucida; only the setae seen in profile have been indicated.

Description of the Nymphs

FAMILY Capniidae

The nymphs of this family are recognized by the following combination of characters: the glossae and the paraglossae are of equal length; the second tarsal segment is very short, and the third is longer than the first two combined; there are no gills of any sort; the wing-pads are set parallel to the body axis. All the characteristics cited to this point are also shared with the Leuctridae. The main distinguishing feature of the Capniidae is the presence of a pleural fold on the abdomen on segments 1-9, whereas in the Leuctridae, it extends at the most to segment 6 (and, in most species, to segment 4); this membranous fold itself is difficult to see, but it determines the shape of the abdomen, which is distinctive even in tiny nymphs. In dorsal view, the abdomen of the leuctrids has parallel sides, whereas that of the capniids gradually increases in width until segment 8, then tapers slightly; in cross section, the abdomen of the leuctrids is round, while in the capniids, the sternite is straight, so the section is that of the segment of a circle.

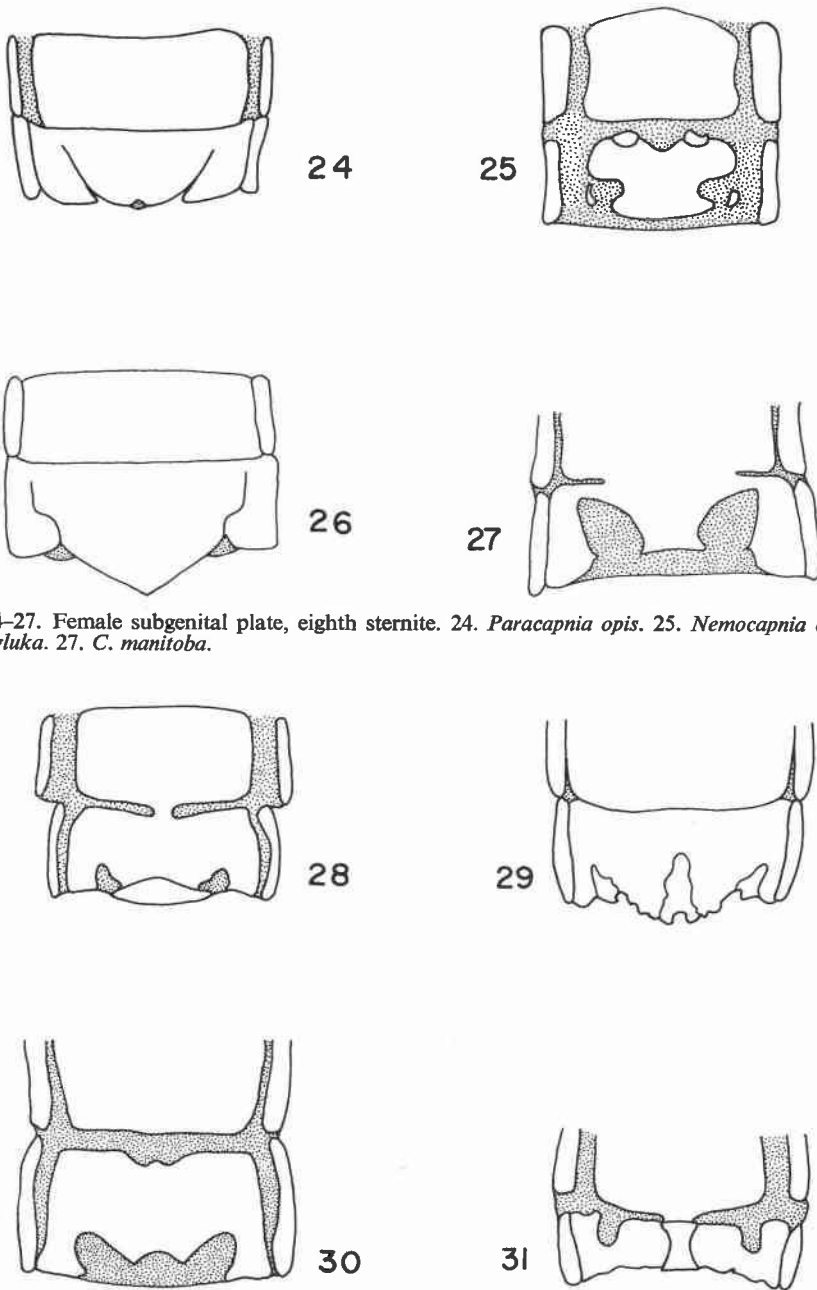
GENUS *Allocapnia* Claassen 1928

The main distinguishing features of this genus are the thoracic structure and the wing venation of the adult. It has unfortunately not been possible to find a constant character in the morphology of the nymphs which would separate them from those of *Capnia*. The shape of the hind wing-pads used by Claassen (1931) and Ricker (1959) to distinguish *Allocapnia* is a useful character, but it is seen only in the last instars. Indeed, in *Allocapnia*, the anal lobe of the hind wing extends nearly to the tip of the wing, whereas in other capniids it barely reaches the middle of the wing; this is clearly reflected in the structure of the wing pad.

The nymphs of *Allocapnia* are very similar and a general description applicable to all known species can be given here; structures characteristic of each species will be listed under the heading of that particular species.

The color is uniform, ranging from very light yellow to dark brown. The mouthparts are of the typical capniid type (Figs. 40, 45) except in *minima* (Fig. 42), *pechumani* (Fig. 43), and

pygmaea (Fig. 44). The head is covered with a more or less dense pubescence as well as a few long hairs near the anterior corners of the frons and in the proximity of the compound eyes. The

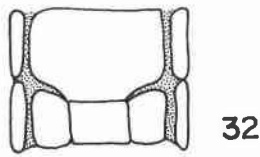


FIGS. 24-27. Female subgenital plate, eighth sternite. 24. *Paracapnia opis*. 25. *Nemocapnia carolina*. 26. *Capnia sugluka*. 27. *C. manitoba*.

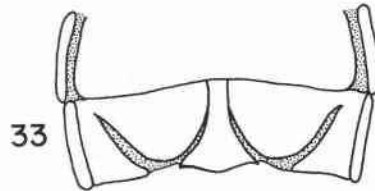
FIGS. 28-31. Female subgenital plate, eighth sternite. 28. *Capnia vernalis*. 29. *C. labradora*. 30. *C. nearctica*. 31. *Allocapnia minima*.

antennae are about three-quarters as long as the body. The pronotum typically bears anterior and posterior fringes of long setae; the lateral fringe is poorly developed and few bristles ordinarily occur on the disc of the pronotum. The meso- and meta-nota bear long bristles anteriorly and posteriorly. In all species, the wing-pads are much reduced in the males, or even absent in *vivipara*; in the females, they are about half developed in all the species, except in

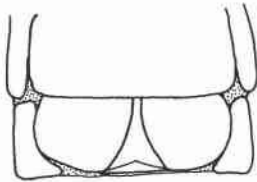
vivipara where they are very small. The adult male *vivipara* is actually almost wingless and its female is brachypterous (though a few specimens with wings of various lengths have been reported (Frison 1935; Harden and Mickel 1952)); the males of the other species are micropterous and the females are brachypterous. The large development of the anal lobe in the hind wing pad is also distinctive. The legs of all the species are similar, though the bristles on the outer



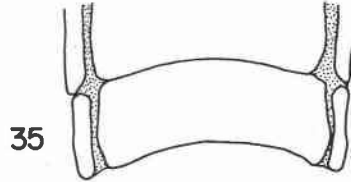
32



33

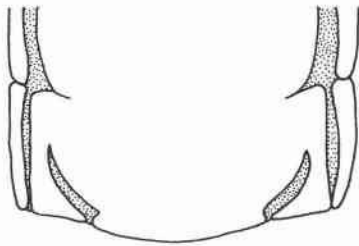


34

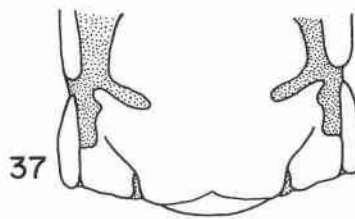


35

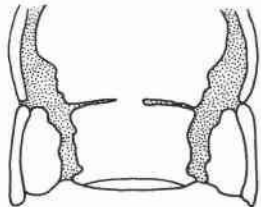
FIGS. 32-35. Female subgenital plate, eighth sternite. 32. *Allocapnia pechumani*. 33. *A. granulata*. 34. *A. illinoensis*. 35. *A. recta*.



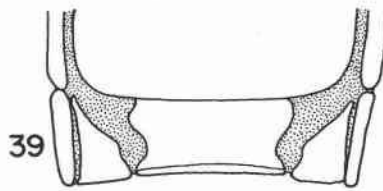
36



37



38



39

FIGS. 36-39. Female subgenital plate, eighth sternite. 36. *Allocapnia vivipara*. 37. *A. rickeri*. 38. *A. pygmaea*. 39. *A. nivicola*.

surface of the femora are shorter in some species; a fringe of long silky hairs occurs on the tibiae and the tarsi. The abdomen is covered with a dense pubescence with some erect bristles which vary from one species to another and are of prime taxonomic importance. In the mature male nymphs the 10th tergite is prolonged into a large supraanal lobe containing the developing supraanal process of the adult; the shape and size of the lobe are often characteristic of each species. In all species, the cerci are identical; they are slightly banded at the base of each segment and are as long as the abdomen. Each segment bears a terminal whorl of bristles but no intermediate bristles; one dorsal and one ventral bristle of each whorl are much longer than the others, usually as long as the corresponding cercal segment, and they form a loose vertical fringe.

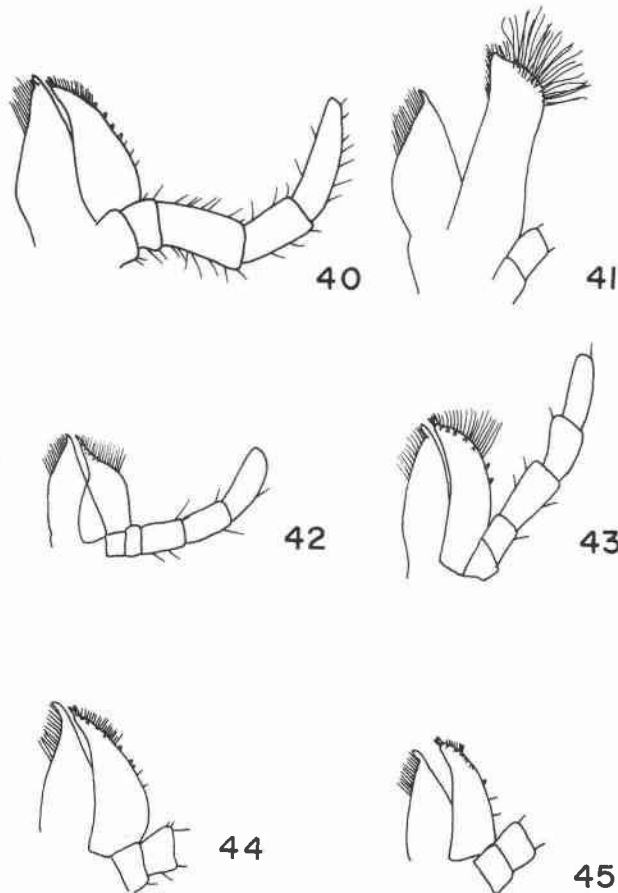
For each species, reference is given to previous descriptions, but these are to all intents and purposes of very little use. When known, the habitat of the nymph is also indicated.

Ten species of *Allocapnia* are reported in the fauna of Eastern Canada; the nymphs of nine species are described below. Missing is *A. maria*, a species common only in the Maritimes.

1. *Allocapnia granulata* (Claassen 1924)

1929, *A. granulata*, Frison, brief description, Figs. 35, 50, photographs of female nymphs. 1935, *A. granulata*, Frison, reference in key, Fig. 289 is Fig. 50 of Frison (1929).

1952, *A. granulata*, Harden and Mickel, descriptions of male and female nymphs, Plate III, 1, female nymph, Plate IX, 1, 2, mandible and maxilla.



FIGS. 40-45. Maxilla of the nymph. 40. *Capnia manitoba*. 41. *C. vernalis*. 42. *Allocapnia minima*. 43. *A. pechumani*. 44. *A. pygmaea*. 45. *A. nivicola*.

Description—Total length of mature nymph: 7–9 mm. One of the larger *Allocapnia*, color medium to dark yellowish brown, appendages much lighter.

Head and pronotum covered with a sparse pubescence, so the fringe of the pronotum is very conspicuous (Fig. 62); the tergites, seen in profile, bear, in addition to the prostrate clothing bristles, a well-developed series of intermediate and terminal erect bristles; these are about one-third as long as the middorsal length of the tergite.

The wing-pads are typical of the genus; the lobe of the 10th segment in the mature male nymph is small, being about as long as the 10th tergite (Fig. 62).

Source of material examined—Carroll Ck., Salem, Wellington Co., Ontario.

Habitat—Apparently restricted to large (sometimes muddy) eutrophic streams.

Remarks—This species closely resembles *A. vivipara*, which is slightly hairier; the absence of wings and the large supraanal lobe of the mature male nymph of *vivipara* (Fig. 63) will, however, immediately distinguish them.

2. *Allocapnia illinoensis* Frison 1935

Though we have no reared material of this species, we have seen a series of nymphs (mostly females) collected by the late T. H. Frison at the type locality and believed by him to be *illinoensis*. The series is not homogenous, since it contains

at least two species; however, the more common one appears to be *illinoensis*. The description below should thus be considered preliminary, but the association is probably quite valid, since Frison collected repeatedly in the stream and *A. illinoensis* appears to be the most abundant species there (Frison 1935).

Description—Total length of mature nymph 8–10 mm. General color, yellowish brown, venter and appendages lighter; no conspicuous pattern.

Whole body covered with a short and dense pubescence, with few bristles that are markedly longer than the others. The tergites are covered throughout with erect bristles, in addition to the usual prostrate clothing bristles (Fig. 64). This characteristic will distinguish *A. illinoensis* from any other local capniid.

Mouthparts typical; lobe of 10th segment in mature male nymphs short, about as long as the 10th tergite.

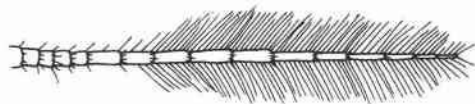
Source of material examined—Tributary of Rocky Branch, Dolson (Clarksville), Illinois (type locality).

Habitat—Unknown.

3. *Allocapnia minima* (Newport 1851)

1931, *A. incisura*, Claassen, reference in key but no description.

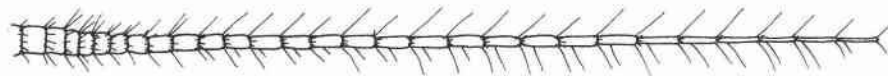
1952, *A. minima*, Harden and Mickel, descriptions of male and female nymphs, Plate III, 2, male nymphs, Plate IX, 3, 4, mandible and maxilla.



46



47



48



49

FIGS. 46–49. Cercus of the nymph, side view. 46. *Nemocapnia carolina*. 47. *Paracapnia opis*. 48. *P. angulata*. 49. *Allocapnia pygmaea*.

Description—Total length of mature nymph: 4.0–5.5 mm. The smallest of the local *Allocapnia*, general color, very light yellowish brown.

Galea of maxilla (Fig. 42) very distinctive.

Pronotum with a well-developed anterior and posterior fringe and a few short bristles on the disc. Abdominal tergites covered with prostrate clothing setae and with a few long erect setae on the posterior margin, these about as long as the middorsal length of the corresponding segment (Fig. 57); there are no erect setae on the middle of the segment.

Supraanal lobe of the male about one and one-half times as long as the 10th tergite (Fig. 57).

Source of material examined—Brébeuf, Labelle Co.; Baie St. Paul, Charlevoix Co., Quebec.

Terra Nova, Dufferin Co.; Noisy R., Dunedin, Simcoe Co., Ontario.

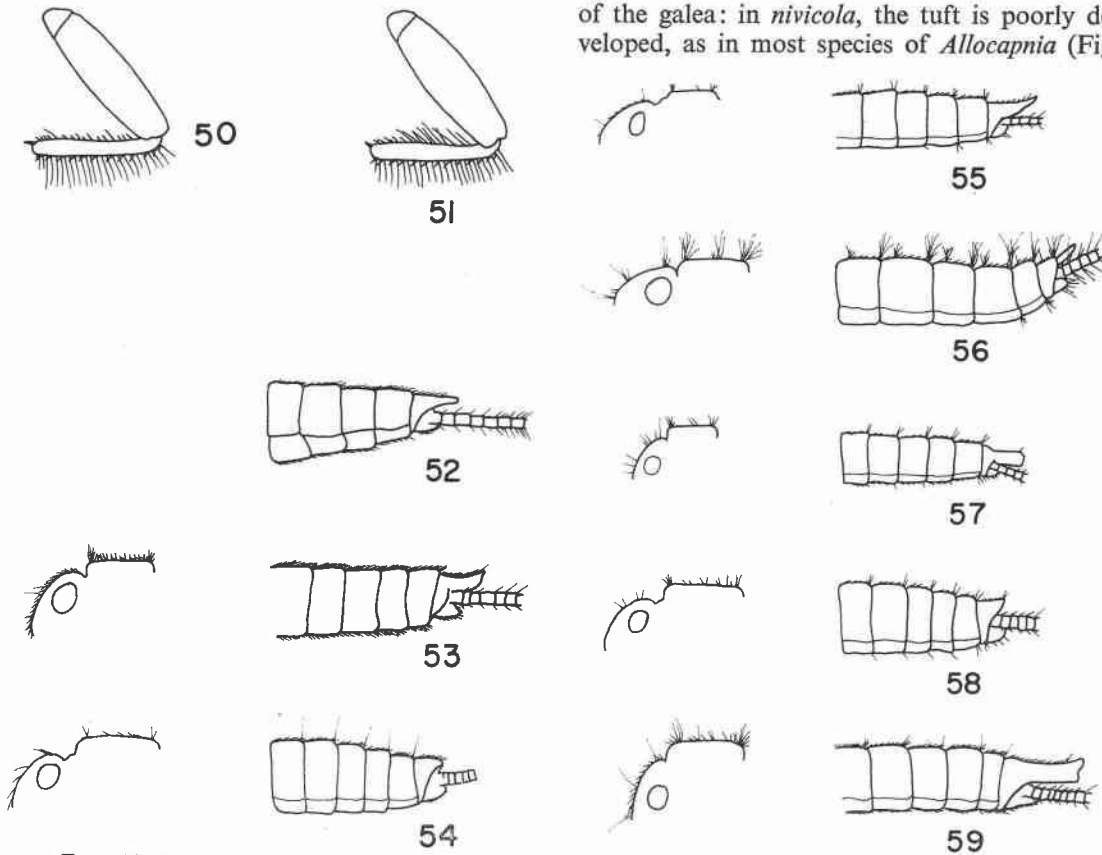
Habitat—Large streams and rivers.

Remarks—This species is closely related to the Maritime species *A. maria*, with which it may interbreed (Hanson 1960). The nymph of *A. maria* is presently unknown, but it is probably similar to that of *minima*.

4. *Allocapnia nivicola* (Fitch 1847)

Description—Total length of mature nymph: 6–7.5 mm.

This species resembles *A. pygmaea* in most respects especially in the distribution of the bristles on the abdomen (Fig. 59). The only difference that could be found between the two species is in the tuft of setae on the outer surface of the galea: in *nivicola*, the tuft is poorly developed, as in most species of *Allocapnia* (Fig.



Figs. 50–51. Setation of the tibia of the nymph. 50. *Paracapnia angulata*. 51. *P. opis*.

Figs. 52–54. Setation of the nymph. Only the setae which can be seen in profile on the top of the head, on the pronotum and on the abdomen have been indicated; the eye has been outlined as a point of reference. 52. *Nemocapnia carolina* (male nymph). 53. *Capnia manitoba* (male nymph). 54. *C. labradora* (half-grown nymph × 2).

Figs. 55–59. Setation of the nymph. Only the setae which can be seen in profile on the top of the head, on the pronotum and on the abdomen have been indicated; the eye has been outlined as a point of reference. 55. *Capnia vernalis* (male nymph). 56. *Paracapnia opis* (male nymph). 58. *A. pechumani* (female nymph). 59. *A. pygmaea* (male nymph).

45), whereas in *pygmaea* it is twice as wide (Fig. 44); in *nivicola*, there are rarely more than 10 hairs in the tuft of the galea.

Source of material examined—West Creek, Mont St. Hilaire, Rouville Co., Quebec (leg. R. Mackay).

Habitat—Inhabits small streams.

5. *Allocapnia pechumani* Ross and Ricker 1964.
Description—Total length of mature male nymph, 5–6 mm.

We have seen only one female nymph of this species. In many respects it resembles the nymph of *minima* (Figs. 42, 57) from which it differs by the structure of its galea (Fig. 43), which is closer to that of *pygmaea* (Fig. 44). The nymphs of *pygmaea* and of *pechumani* are quite distinct in appearance, though there are few readily communicable differences between them; *pechumani* is a smaller species; it is less hairy, a character best seen in the clothing on the abdominal tergites (Fig. 58); the mature male nymph of *pechumani* also certainly has a short supraanal lobe about as long as the 10th segment, while in *pygmaea*, it is twice as long (Fig. 59).

Source of material examined—Small stream near Rawdon, Montcalm Co., Quebec.

Habitat—Unknown, probably small and medium-sized streams.

6. *Allocapnia pygmaea* (Burmeister 1839)

1931, *A. pygmaea*, Claassen, description, Figs. 153–158, leg. mouthparts, Fig. 218, male nymph.

1952, *A. pygmaea*, Harden and Mickel, Plate XI, 2, female nymph, Plate XII, 1, 2, mandible, maxilla.

Description—Total length of mature nymph: 6–7.5 mm. General color, yellow, venter and appendages lighter.

Head and pronotum moderately hairy; a few long hairs on the head capsule; a well-developed anterior and posterior fringe on the pronotum as well as a few shorter bristles on the pronotal disc. Galea with a well-developed fringe of hairs on the outer surface (Fig. 44).

Bristles on femora about half as long as the greatest diameter of the femora; those on the anterior and the posterior surface, of equal length.

Abdomen covered with prostrate clothing bristles and some erect bristles on the middle of the segment (Fig. 59).

Supraanal lobe of mature male nymph large, about twice as long as the 10th segment (Fig. 59).

Source of material examined—Speed R., Belwood, Wellington Co., Ontario.

Habitat—The most common and widespread species; inhabits a wide range of permanent streams, from medium-sized to large.

7. *Allocapnia recta* (Claassen 1924)

1929, *A. recta*, Frison, brief descriptions of male and female nymphs, Figs. 36, 37, 39, photographs of male and female nymphs.

1935, *A. recta*, Frison, Figs. 290, 291, reproductions of Figs. 36, 39 of Frison (1929).

Description—total length of mature nymph: 6–7.5 mm. Species of moderate size; general color, light yellowish brown.

The femora are covered with short bristles, those on anterior surface equal in length to those on posterior surface.

Abdominal tergites covered with prostrate clothing bristles and erect bristles on the posterior margin; these about one-third as long as the middorsal length of the corresponding segment; intermediate erect hairs present only on last four or five tergites, not on the middle of the tergite, but on the lateral thirds; they are thus not visible in side view (Fig. 60).

Supraanal lobe of mature male nymph short, just about as long as the 10th segment (Fig. 60).

Source of material examined—Small tributary of the Credit R., east of Forks of the Credit, Peel Co., Ontario.

Habitat—Inhabits small streams; it is apparently the only species found in spring-fed streams (which do not freeze in winter).

8. *Allocapnia rickeri* Frison 1942

1929, *A. pygmaea*, Frison, brief description (at least in part).

Description—total length of mature nymph: 6–7.5 mm. Species of moderate size; general color very light to medium yellowish brown.

Pronotum with well-developed anterior and posterior fringe; the setae on the disc few and not much shorter than those in the fringe.

Abdomen covered with short prostrate setae; a few long erect bristles on the posterior margin, these about half as long as the middorsal length of the corresponding segment; a few erect intermediate setae on the middle of each segment, about three-quarters as long as the corresponding segment (Fig. 61).

Supraanal lobe of mature male nymph twice as long as the 10th segment.

Source of material examined—Small tributary of Oakville Ck., Speyside, Halton Co., Ontario.

Habitat—Small- and intermediate-sized streams.

9. *Allocapnia vivipara* (Claassen 1924)

1929, *A. vivipara*, Frison, descriptions, Figs. 15, 19, 23, mouthparts, Fig. 27, hind leg, Figs. 33, 34, photograph of male and female nymphs.

1931, *A. vivipara*, Claassen, description.

1935, *A. vivipara*, Frison, Figs. 57, 87, 117, 144, mouthparts, Fig. 257, hind leg, Figs. 297, 298, male and female nymphs.

1952, *A. vivipara*, Harden and Mickel, reference in key.

Description—Total length of mature nymph: 7–10 mm.

The setation pattern of this species (Fig. 63) is almost identical with that of *granulata* (Fig. 62); it can often be distinguished by the slightly hairier head capsule and pronotum.

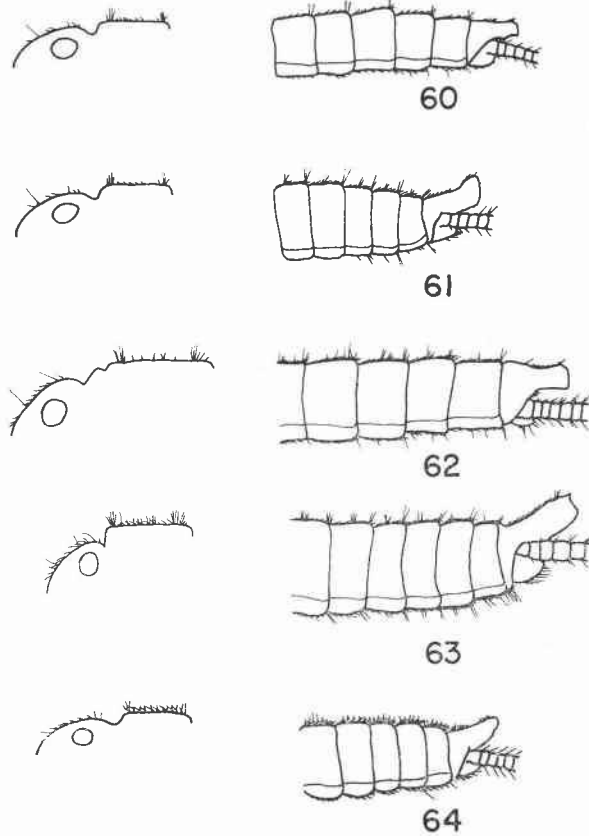
The mature male nymphs can be separated by the absence of wing-pads and the long supraanal lobe (twice the length of the 10th tergite) (Fig. 63); in *granulata*, the wing-pads are normal, and the supraanal lobe is short (Fig. 62).

Source of material examined—Tributary of Sunfish Lake, Waterloo, Waterloo Co.; Carroll Ck., Speyside, Halton Co., Ontario.

Habitat—Small eutrophic streams; often inhabits temporary streams.

GENUS *Capnia* Pictet 1841

The nymphs of none of the Eastern species have been described. Three species are described



FIGS. 60–64. Setation of the nymph. Only the setae which can be seen in profile on the top of the head, on the pronotum and on the abdomen have been indicated; the eye has been outlined as a point of reference. 60. *Allocapnia recta* (male nymph). 61. *A. rickeri* (male nymph). 62. *A. granulata* (male nymph). 63. *A. vivipara* (male nymph). 64. *A. illinoensis* (male nymph).

below and these differ from one another in so many respects that it is presently inadvisable to try to determine generic characteristics.

The nymphs of the two other species are unknown; these are the northern *C. nearctica* and *C. sugluka*, which are respectively related to the Western European species *C. atra* Morton and *C. vidua* Klapalek.

10. *Capnia* (s.s.) *manitoba* Claassen 1924

Description—Total length of mature nymph: 6–8 mm. General color, light to medium brown, lighter ventrally, appendages and wing-pads yellow; no conspicuous color pattern.

Head covered with a dense and short pubescence, no markedly longer hairs near eyes and at the anterior angle of frons; mouthparts typical (Fig. 40).

Pronotum covered with a dense pubescence, the hairs on the anterior and posterior margins somewhat longer (Fig. 53); meso- and meta-nota and wing-pads similarly pubescent. Legs covered with many short setae; a fringe of long hairs on the tibiae and the tarsi.

Abdomen covered with a short and dense pubescence, without distinct erect bristles either on the middle or the hind margin of the tergites (Fig. 53); cerci about three-quarters of the body length, typical. Supraanal lobe of male as in Fig. 53.

Source of material examined—Baie St. Paul, Charlevoix Co.; St. Hippolyte, Terrebonne Co., Quebec. Tributary of west branch of Speed R., Fergus, Wellington Co., Ontario.

Habitat—Small streams, often springfed.

11. *Capnia* (s.s.) *vernalis* Newport 1851

Description—Total length of mature nymph 6–8 mm. General color, uniformly yellowish brown.

Head mostly glabrous with a few long setae on top of the head, the longest about as long as the diameter of the eye; galea of the maxilla very distinctive (Fig. 41).

Pronotum with a few long bristles on the anterior and posterior borders and a few very short ones on the disc; a few stout bristles on the anterolateral angles of meso- and meta-nota; wing-pads appear glabrous; legs with the usual fringe on the tibia and the tarsus; outer surface of femur beset with many short bristles and a few interspersed longer ones.

Abdomen covered with short prostrate clothing hairs; a few stout bristles on the posterior margins of the tergites (Fig. 55); cerci of the usual type.

Source of material examined—Ste. Anne R., Beaupré, Montmorency Co., Quebec.

Habitat—Medium-sized rivers.

12. *Capnia* (*Utacapnia*) *labradora* Ricker 1954 (?)

We have no associated material of this species, but we have seen a long series of half-grown nymphs from an Ungava stream where the species was present; so were *C. manitoba*, *C. vernalis*, and *A. minima*; since the nymphs are not any of the three last-mentioned species, there is a chance that they may be *labradora*. They also fit the description of the closely related *C. (Utacapnia) columbiana* Claassen by Ricker (1943), but not the figure of *C. (Utacapnia) lemoniana* Nebeker and Gaufin given by Nebeker and Gaufin (1965).

The nymphs were collected in early September and have very short wing-pads, so they are about half-grown since the adults are macropterous. The mouthparts, antennae, and cerci are typical. The body is covered with surprisingly short and sparse clothing hairs; the disc of the pronotum bears a few very short bristles; on the margins of the pronotum and the posterior margins of the tergites, there are very long erect bristles: on the abdomen these are nearly as long as the mid-dorsal length of the tergum; there are no intermediate erect bristles (Fig. 54).

The species resembles most *C. vernalis* from which it can be separated by the shape of the galea; it can also be confused with some of the *Allocapnia* that do not have intermediate erect bristles on the abdomen; however, the length of the terminal erect bristles on the abdomen and the scanty body pubescence are distinctive.

A definite association should, however, be sought.

Source of material examined—Small tributary of Koksoak R., Ungava, Quebec (leg. J. R. Coleman).

Habitat—Unknown.

GENUS *Nemocapnia* Banks 1938

The vertical fringe of hairs on the cerci (Fig. 46) will distinguish this genus from any other described North American genus; the western

Isocapnia Banks also possesses a well-developed fringe, which, however, is horizontal (Ricker 1959).

13. *Nemocapnia carolina* Banks 1938

1942, *N. carolina*, Frison, no description, Fig. 29, mouthparts, Fig. 31, male nymph.

Description—Total length of mature nymph: 6–7 mm.

The following description is made from exuviae collected about 30 years ago; some of the features could not be clearly seen and are omitted (such as the distribution of the setae on the head and thorax).

General color, uniformly yellowish brown; most of the body covered with well-developed and prostrate clothing hairs; no erect hairs (Fig. 52).

Antennae short, about half of body length; legs very short, with the usual fringe on the tibiae and tarsi.

Abdomen covered with prostrate clothing hairs but with no erect hairs (Fig. 52); cerci short, about two-thirds the length of abdomen; each segment bears a terminal whorl of short bristles; the dorsal and lateral bristles of the whorl plus a large number of intermediate bristles from a distinct vertical fringe (Fig. 56).

Source of material examined—Exuviae from Rappahannock R., Remington, Va. (leg. T. H. Frison).

Habitat—Unknown.

GENUS *Paracapnia* Hanson 1946

The genus contains but two species, which are described below. The heavy pilosity of the nymphs (Fig. 56) and the dorsal head pattern will immediately separate them from any other genus. Early descriptions of the nymph of *Capnia vernalis* Claassen *nec* Newport (Claassen 1931) apply to a species of this genus, but are not sufficiently detailed to be assigned to a species.

14. *Paracapnia angulata* Hanson 1961

Description—Total length of mature nymph: 6–8 mm. General color, reddish brown with distinct purplish markings on the head, appendages and wing-pads yellow; nymph generally hirsute, some of the hairs with a purple tinge.

Head beset with long bristles, especially on the anterolateral margins of frons and near

compound eyes; antennae long, about three-quarters of body length.

Pronotum trapezoidal, narrower anteriorly, margins beset with numerous long bristles (Fig. 56); meso- and meta-nota with tufts of long bristles on anterior angles; wing-pads bordered with long bristles; the species occurs in both brachypterous and macropterous forms; outer margin of legs with long bristles; inner margin of femur with equally long hairs, that of tibia with short bristles, less than half the width of the tibia.

Abdominal segments hirsute; clothing hairs yellowish; many erect purplish hairs on the tergite margins and on a line about one-third of the middorsal length from the anterior border; others interspersed; cerci about as long as the abdomen; each segment with a terminal whorl of short bristles, of which one dorsal and one ventral are much longer and form a loose fringe; in addition, there is an extra long bristle at the ventral base at each middle and distal segment (Fig. 48); this extra bristle is less conspicuous in brachypterous specimens. Supraanal lobe of male long and slender as in Fig. 56.

Source of material examined—Small tributary of west branch of Speed R., Fergus, Wellington Co., Ontario (macropterous specimens). Stream at Station de Biologie, St. Hippolyte, Terrebonne Co., Quebec (brachypterous specimens).

Habitat—Small streams, often spring-fed.

15. *Paracapnia opis* (Newman 1939)

1952, *P. curvata*, Harden and Mickel, descriptions of male and female nymphs, Plate II, 1, male nymph, Plate VIII, 3, 4, maxilla and mandible.

Description—Total length of mature nymph: 6–8 mm.

The nymph of *opis* resembles that of *angulata* in most regards and it also occurs in both macropterous and brachypterous forms.

The main differences found between them are the following.

On the inner surface of the femur of *opis*, the bristles are long, nearly as long as the width of the tibia (Fig. 51), whereas in *angulata*, they are only half as long (Fig. 50).

The cerci are similar to those of *angulata*; however, they lack the extra bristle on the ventral base of the middle and distal segments (Fig. 47).

Source of material examined—Stream at Station de Biologie, St. Hippolyte, Terrebonne Co., Quebec.

Habitat—Warm streams and rivers.

Acknowledgments

We thank Dr. J. R. Coleman, Ontario Department of Lands and Forests, Glenora; Mrs. Rosemary Mackay, McGill University; Mr. J. E. H. Martin, Canadian National Collection of Insects, Ottawa; Dr. W. E. Ricker, Fisheries Research Board of Canada, Nanaimo; and Dr. D. W. Webb, Illinois Natural History Survey, Urbana, Ill., for the loan of specimens. The financial assistance of the National Research Council of Canada and the Ontario Department of University Affairs is gratefully acknowledged.

- AUBERT, J. 1959. Plecoptera. *Insecta Helv. Fauna*, 1: 1-140.
- BERTHÉLEMY, C. 1969. Les *Capnioneura* des Pyrénées. *Ann. Limnol.* 5: 25-47.
- BRINCK, P. 1949. Studies on Swedish stoneflies (Plecoptera). *Opuscula Entomol. Suppl.* 11: 1-250.
- CLAASSEN, P. W. 1931. Plecoptera nymphs of America (north of Mexico). *Thomas Say Found. Publ.* 3: 1-199.
- FRISON, T. H. 1929. Fall and winter stoneflies, or Plecoptera, of Illinois. *Ill. Natur. Hist. Surv. Bull.* 18: 340-409.
- 1935. The stoneflies, or Plecoptera, of Illinois. *Ill. Natur. Hist. Surv. Bull.* 20: 281-471.
- 1942. Studies of North American Plecoptera with special reference to the fauna of Illinois. *Ill. Natur. Hist. Surv. Bull.* 22: 233-355.
- HANSON, J. F. 1942. Studies on the Plecoptera of North America. III. *Allocapnia*. *Bull. Brooklyn Entomol. Soc.* 37: 81-88.
- 1943. Studies on the Plecoptera of North America. IV. Further notes on the Capniidae. *Bull. Brooklyn Entomol. Soc.* 38: 155-163.
- 1946. Comparative morphology and taxonomy of the Capniidae (Plecoptera). *Amer. Midland Natur.* 35: 139-249.
- 1960. A case of hybridization in Plecoptera. *Bull. Brooklyn Entomol. Soc.* 55: 25-34.
- 1961. Studies on the Plecoptera of North America. VIII. The identity of the species of *Paracapnia*. *Bull. Brooklyn Entomol. Soc.* 56: 25-30.
- HARDEN, P. H., and C. E. MICKEL. 1952. The stoneflies of Minnesota (Plecoptera). *Univ. Minn. Agr. Exp. Sta. Tech. Bull.* 201: 1-84.
- HYNES, H. B. N. 1955. The nymphs of the British species of *Capnia* (Plecoptera). *Proc. Roy. Entomol. Soc. London*, 30: 91-96.
- ILLIES, J. 1966. Katalog der rezenten Plecoptera. *Tierreich*, 82: 1-632.
- NEBEKER, A. V. 1967. The female of *Capnia labradora* Ricker (Capniidae, Plecoptera). *Entomol. News*, 78: 225-226.
- NEBEKER, A. V., and A. R. GAUFIN. 1965. The *Capnia columbiana* complex of North America (Capniidae: Plecoptera). *Trans. Entomol. Soc. Amer.* 91: 467-487.
- NEEDHAM, J. G., and P. W. CLAASSEN. 1925. A monograph of the Plecoptera or stoneflies of America (north of Mexico). *Thomas Say Found. Publ.* 2: 1-397.
- RICKER, W. E. 1935. New Canadian perlids (Part II). *Can. Entomol.* 67: 256-264.
- 1938a. Notes on specimens of American Plecoptera in European collections. *Trans. Roy. Can. Inst.* 22: 129-156.
- 1938b. A new stonefly from Baffin Land (Plecoptera, Capniidae). *Can. Entomol.* 70: 173-174.
- 1943. Stoneflies of Southwestern British Columbia. *Indiana Univ. Publ. Sci. Ser.* 12: 1-145.
- 1944. Some Plecoptera from the far North. *Can. Entomol.* 76: 174-185.
- 1952. Systematic studies in Plecoptera. *Indiana Univ. Publ. Sci. Ser.* 18: 1-200.
- 1959. Plecoptera. *In Fresh-water biology*. 2nd ed. Edited by W. T. Edmondson. John Wiley and Sons, New York. pp. 941-957.
- 1963. Distribution of Canadian stoneflies. *Fish. Res. Board Can. Rep.* 770: 1-24.
- 1964. Distribution of Canadian stoneflies. *Gewässer Abwässer*, 34-35: 50-71.
- 1965. New records and descriptions of Plecoptera. *J. Fish. Res. Board Can.* 22: 475-501.
- RICKER, W. E., R. MALOIN, P. HARPER, and H. H. ROSS. 1968. Distribution of Quebec stoneflies (Plecoptera). *Natur. Can.* 95: 1085-1123.
- ROSS, H. H. 1965. Pleistocene events and insects. *In The Quaternary of the United States*. Edited by H. E. Wright, Jr. and D. G. Frey. Princeton Univ. Press, Princeton, N.J. pp. 583-596.
- ROSS, H. H., and W. E. RICKER. 1964. New species of winter stoneflies, genus *Allocapnia* (Plecoptera, Capniidae). *Trans. Ill. State Acad. Sci.* 57: 88-93.
- ROSS, H. H., and T. YAMAMOTO. 1967. Variations in the winter stonefly *Allocapnia granulata* as indicators of Pleistocene faunal movements. *Ann. Entomol. Soc. Amer.* 60: 447-458.
- ROSS, H. H., G. L. ROTRAMEL, J. E. H. MARTIN, and J. F. MCALPINE. 1967. Postglacial colonization of Canada by its subboreal winter stoneflies of the genus *Allocapnia*. *Can. Entomol.* 99: 703-712.

This article has been cited by:

1. Literature Citations 1022-1194. [[CrossRef](#)]
2. D. B. Strongman D. Strongman. 2007. Trichomycetes in aquatic insects from Prince Edward Island, Canada. *Canadian Journal of Botany* **85**:10, 949-963. [[Abstract](#)] [[Full Text](#)] [[PDF](#)] [[PDF Plus](#)]
3. D. B. Strongman D. B. Strongman, Merlin M. White M. M. White. 2006. New species of *Lancisporomyces*, *Orphella*, and *Paramoebidium*, endosymbionts of stonefly nymphs from streams in Nova Scotia, Canada. *Canadian Journal of Botany* **84**:9, 1478-1495. [[Abstract](#)] [[Full Text](#)] [[PDF](#)] [[PDF Plus](#)]
4. William L. Hilsenhoff Diversity and classification of insects and collembola 661-731. [[CrossRef](#)]
5. M. P. Singh, S. M. Smith, A. D. Harrison. 1984. Emergence patterns of the stoneflies (plecoptera) from a wooded stream in southern Ontario. *Aquatic Insects* **6**:4, 233-243. [[CrossRef](#)]
6. David R. Barton. 1980. Observations on the life histories and biology of Ephemeroptera and Plecoptera in northeastern Alberta. *Aquatic Insects* **2**:2, 97-111. [[CrossRef](#)]