# Northern Canadian mayflies (Insecta; Ephemeroptera), records and descriptions

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Sixty-eight species are recorded from the northern regions, tundra and open boreal forest, of Canada. The Eurasian *Ephemerella mucronata* (Bengtsson) is reported for the first time from North America and ***Caenis candida*** n.sp. is described from the James Bay drainage in Quebec. The mayfly fauna of Northern Canada is composed of a distinctive tundra element (five species, three of which are holarctic), a north boreal element containing a few characteristic but not exclusive species, together with the most tolerant species of the eastern and, to a limited extent, western temperate faunas. Eighty-two species are now reported from Canada north of the closed boreal forest, roughly one fourth of the known Canadian fauna of mayflies.

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Soixante-huit espèces d'Ephéméroptères sont signalées dans le nord du Canada, dans la toundra et la taïga. L'espèce eurasienne *Ephemerella mucronata* (Bengtsson) est signalée pour la première fois en Amérique du Nord. Une nouvelle espèce, ***Caenis candida*** n.sp., a été trouvée dans le bassin hydrographique de la Baie de James au Québec; on en trouvera ici la description. La faune des Ephéméroptères du Nord canadien est composée de plusieurs éléments: un groupe typique de la toundra comprenant cinq espèces dont trois sont holarctiques, un groupement d'espèces caractéristiques de la région nord-boréale mais qui n'y vivent pas exclusivement, ainsi qu'une majorité d'espèces qui sont les éléments les plus robustes des faunes tempérées de l'est et de l'ouest du continent. Ces données portent à 82 le nombre d'espèces recensées au nord de la forêt boréale au Canada, soit environ le quart des expèces connues au pays.

Cobb and Flannagan (1980) recently reviewed the distribution of mayflies in Central Canada north of latitude 60° N; they compiled previous scattered records and analyzed their own extensive collections of larvae from the Keewatin, the Boothia Peninsula, the Mackenzie drainage in the Northwest Territories, and the Porcupine drainage in the Yukon. They list 55 taxa including 32 named species. Harper *et al.*(1975) give a list of some Quebec mayflies north of the 50th parallel. The only other previous study of northern Canadian mayflies was that of Ulmer (1932), who mentioned six species from North America north of the arctic circle; only two of these are still recognized however, viz. *Ephemerella grandis* and *Chitonophora aronii* (now respectively *Drunella grandis* and *Ephemerella aurivillii*).

We are now reporting on two other sources of material: the collections made during the Canadian Northern Insect Survey (NIS), from 1947 to 1957 (Freeman 1959) and those gathered in the course of ecological studies in 1973, 1974, and 1975 by the Service de l'Environnement de la Société d'Energie de la Baie James (SEBJ) in northwestern Québec (Magnin 1977).

## Materials and methods

The specimens from the NIS are in the Canadian National Collection of Insects in Ottawa and they are either dried or in alcohol. Those from the SEBJ are in the Collection Entomologique de l'Université de Montréal (Département de Sciences Biologiques) and are all preserved in alcohol; they were collected in emergence or in light traps.

Most dried material could be identified readily, but some specimens were relaxed when necessary in a trisodium phosphate solution in order to study the genitalia. In some cases, the genitalia were cleared in potassium hydroxide.

Three localities could not be localized on the map: one from Alaska, Sham Creek; two from the Northwest Territories, McConnell River and Chesterfield; this latter locality could actually be Chesterfield Inlet, but since there is no assurance of that, it was omitted on the map.

Under the heading of each species will be found numbers corresponding to the localities on the map (numbers in parentheses), the extreme dates at which it was collected, and for rarer species, the number of specimens examined. The nomenclature follows Edmunds *et al.* (1976), but recent changes in some groups, *Baetis* (Mohihara and McCafferty 1979*a*), *Stenonema* (Bednarik and McCafferty 1979), and Ephemerellidae (Allen 1980) have been taken into account. Keffermuller (1980) recently included the genus *Pseudocloeon* in the genus *Baetis*, but since her study is based on one European species only, this change has not been retained for the time being.

## Species collected

*Ameletus* gr. *velox* Dodds; (18) 2 August, 1♂. This specimen is damaged and can only be assigned to a species group. It resembles somewhat *A. celer* McDun-

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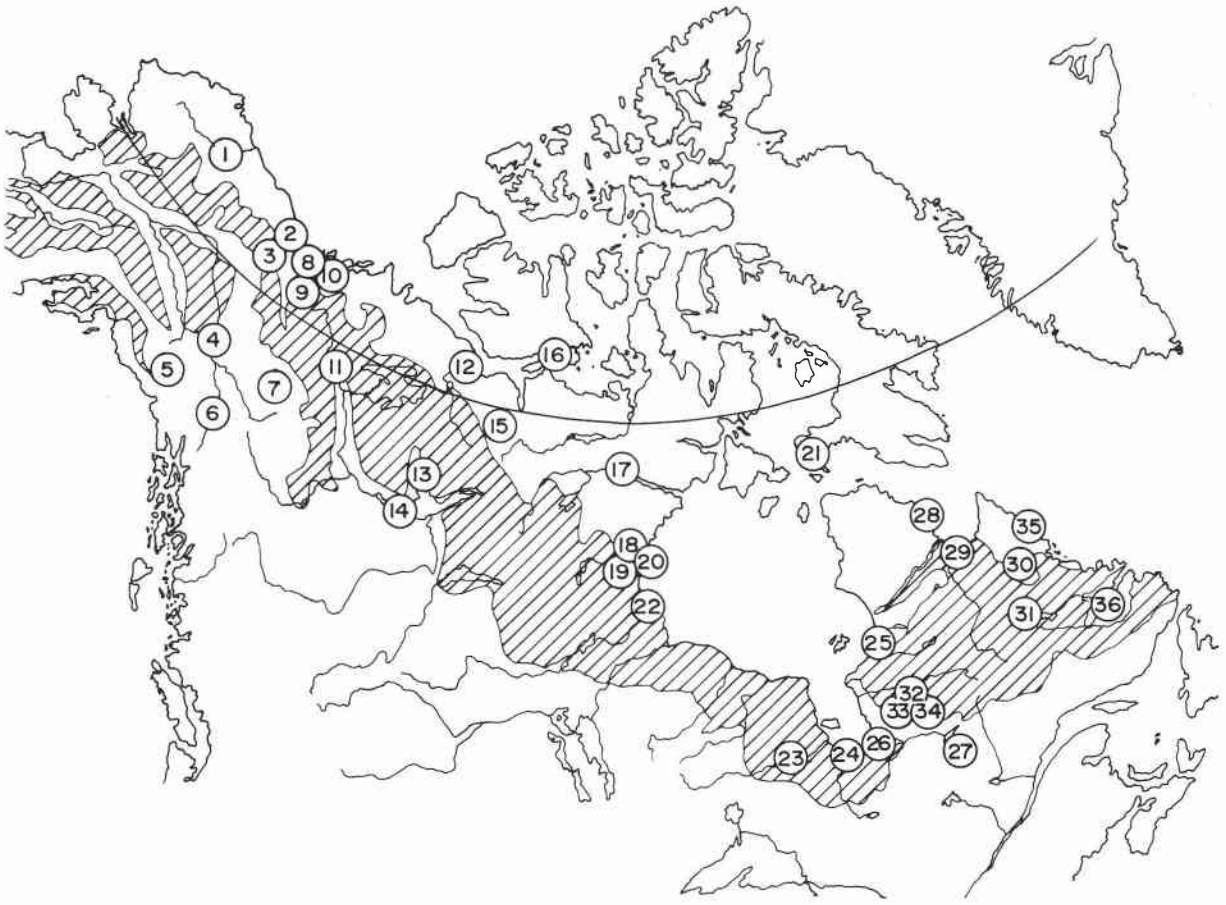


FIG. 1. Map of Northern Canada showing the positions of the collection sites. The hatched area represents the open boreal forest, a transition zone between the barren lands or tundra to the north and the (closed) boreal forest to the south.

The collection sites are listed below and their position indicated on a map (Fig. 1).

| | | | |
|---|---|---|---|
| Alaska | (1) Umiat | Manitoba | (22) Churchill and areas nearby: |
| Yukon | (2) Firth River | | Warworth Creek |
| | (3) Rampart House | | Fort Churchill |
| | (4) Dawson (altitude 335.3 m) | | Farnworth Lake |
| | (5) Shag | | Deer River |
| | (6) Whitehorse | Ontario | (23) Ogoki |
| | (7) Swim Lake (altitude 975.4 m) | | (24) Moose Factory |
| N.W.T. | (8) Aklavik | Quebec | (25) Poste de la Baleine |
| | (9) Fort McPherson | | (26) Rupert-House |
| | (10) Reindeer Depot | | (27) Baie du Poste |
| | (11) Normal Wells | | (28) Bellin (Payne) |
| | (12) Coppermine | | (29) Fort Chimo |
| | (13) Yellowknife | | (30) Lac de la Hutte Sauvage |
| | (14) Hay River | | (31) Lac Knob |
| | (15) Muskox Lake | | (32) SEBJ Lac Attila |
| | (16) Cambridge Bay | | (33) SEBJ Bassin de la Rivière |
| | (17) Baker Lake | | du Castor |
| | (18) Padley (or Padlei) | | (34) SEBJ Lac Low |
| | (19) Geillini Lake | Labrador | (35) Hebron |
| | (20) Eskimo Point | | (36) Goose Bay |
| | (21) Cape Dorset | | |

nough, but it lacks the characteristic spinules on the inner bases of the penes.

*Parameletus chelifer* Bengtsson; (1, 8, 10) 3–16 August, ♂♂ ♀♀.

*P. midas* McDunnough; (22) 16 August, 1♂.

*Parameletus* sp.; Sham Creek, Alaska and McConnell rivers, N.W.T., ♀♀.

*Siphlonurus alternatus* (Say); (10, 110, 32, 33, 34) 8 June–20 August, ♂♂ ♀♀.

*S. occidentalis* Eaton; (3) 8 July, 1♂ 1♀.

*S. phyllis* McDunnough; (13, 22) 22 July–10 August, 6♂ 2♀.

*S. quebecensis* (Provancher); (33) 17 June–1 August, ♂♂ ♀♀.

*S. rapidus* McDunnough; (29, 33) 17 July–17 August, ♂♂ ♀♀.

*Metretopus borealis* Eaton; (4, 33) 20 June–6 September, ♂♂ ♀♀.

*Siphloplecton basale* (Walker); (23, 33) 5 June–5 July, ♂♂ ♀♀.

*Baetis brunneicolor* McDunnough; (22, 33) 8 July–19 September, ♂♂ ♀♀.

*B. flavistriga* McDunnough; (22, 25, 33) 20 July–20 August, ♂♂. Our material from Churchill, Manitoba, has been identified with some doubt; there appeared to be much variation in characters such as size, colour, abdominal tracheation, number of intercalaries in the hind wing, and outline of genital forceps; it was thus not always possible to distinguish this species from the preceding. Similarly in the James Bay material, it was rarely possible to separate the subimagines of *B. flavistriga* from those of *B. tricaudatus*.

*B. lapponicus* (Bengtsson); (1, 21, 28, 35) 25 July–27 August, ♂♂ ♀♀.

*B. macani bundyae* Lehmkuhl; (1, 2, 15, 16, 17, 19, 20, 21, 22, 25, 35, Chesterfield, N.W.T.) 7 July–29 August, 213 ♂ 10 ♀.

*B. propinquus* (Walsh); (33) 24 June–16 August, ♂♂ ♀♀.

*B. pygmaeus* (Hagen); (22, 33) 19 June–5 September, ♂♂ ♀♀.

*B. tricaudatus* Dodds; (33) 20 June–18 September, ♂♂.

*B.* prob. *hageni* Eaton; (20) August, 1♂ 1♀. These two specimens are probably correctly identified on the basis of their forked second vein in the hind wing, even though they are darker than is usual for the species (the abdominal tergites are brown). Cobb and Flannagan (1980) have found the species (reported as *B. parvus*) as far north as the Boothia Peninsula.

*Baetis* spp.; (15, 19, 20, 22, 25, 33, 36, Chesterfield, N.W.T.), ♂♂ ♀♀.

*Callibaetis ferrugineus* (Walsh); (33) 11–22 June, ♂♂ ♀♀.

*C.* prob. *coloradensis* Banks; (6) 15 June, 2♂. The taxonomy of this genus is in need of a revision; on the basis of existing keys (Needham *et al.* 1935) and more recent comments (Thew 1959; Jensen 1966), the name *coloradensis* seems the most appropriate.

*Centroptilum album* McDunnough; (33) 22 June–2 September, ♂♂ ♀♀.

*C. rufostrigatum* McDunnough; (33) 7 June–5 September, ♂♂ ♀♀.

*Cloeon inanum* McDunnough; (22) 22–23 July, 2♂.

*C. rubropictum* McDunnough; (33) 24 July–13 September, ♂♂ ♀♀.

*Cloeon* spp.; (6, 22, 33), 1♂ subimago, ♀♀.

*Pseudocloeon parvulum* McDunnough; (33) 11 June–1 September, 4♂.

*P.* cf. *carolina* Banks; (30) 23–26 July, 7♂ 2♀. The specimens resemble *carolina*, but they are dull brown rather than "dark polished brown" as is more typical; moreover, the forceps are less arcuate than those illustrated by Needham *et al.* (1935).

*P.* cf. *dubium* (Walsh); (22) 7 August, 1♂. The absence of spiracular dots on the abdomen of this specimen prevents us from making a definite identification; nonetheless, Needham *et al.* (1935) have included in *P. dubium* a series of specimens from New York State which lacked these markings.

*Pseudocloeon* sp.; (33) 27 June, 1♂. This is very likely an undescribed species of *Pseudocloeon*, but we do not wish to describe it formally, as we have only one specimen. The following notes should make it possible to recognize it again if it is encountered. Length of body, 5 mm; length of fore wing, 4.5 mm. Head tan, scape and pedicel tan, flagellum becoming lighter at tip. Turbinate eyes oval, as seen from above. Thorax tan. Legs yellowish white, unmarked, with coxae tan. Wings hyaline, except subcosta which is very slightly tinged with yellow on basal half. Stigmatic area of fore wing with five or six slanting crossveins. Abdominal tergites 2–6 hyaline, faintly tinged with tan along posterior and lateral margins. No markings except the spiracular dots which are joined by a faint dark line. Tergites 7–10 light tan. Sternites 2–6 white. Sternites 1 and 7–9 light tan. No dark markings on the sternites. Genitalia and caudal filaments white. The specimen resembles *P. dubium* as described by Needham *et al.* (1935) and Burks (1953) by the coloration of its abdomen, the length of its wings, and the number of crossveins in the stigmatic area. It differs however by the colour of its thorax which is tan instead of black and its turbinate eyes which are less circular; furthermore, the legs lack the dark markings characteristic of *dubium* and the forceps of the genitalia are less arcuate and their terminal joint stockier.

*Pseudocloeon* spp.; (22, 36), ♀♀.

*Cinygmula par* (Eaton); (1) 16 August, 2♂.

*Epeorus* (*Iron*) *vitreus* (Walker); (33) 21 June–8 August, ♂♂ ♀♀.

*Heptagenia hebe* McDunnough; (33) 2 July–21 August, ♂♂ ♀♀.

*H. lucidipennis* (Clemens); (33, 34) 8–24 August, ♂♂ ♀♀.

*H. pulla* (Clemens); (11, 23, 24, 30, 32, 33, 34) 14 June–19 September, ♂♂ ♀♀.

*Rhithrogena futilis* McDunnough; (1, 3) 25 July–16 August, 7♂.

*R. jejuna* Eaton; (30, 36) 15 July–29 August, 3♂.

*R.* probl. *undulata* Banks; (6) 27 July, 1♂ subimago.

*Rhithrogena* spp.; (4, 5), ♀♀.

*Stenacron interpunctatum canadense* (Walker); (24, 27, 33) 21 June–11 September, ♂♂ ♀♀.

*S. interpunctatum frontale* (Banks); (32, 33) 5 July–6 August, ♂♂ ♀♀.

*Stenonema femoratum* (Say); (27, 32, 33) 17 June–25 August, ♂♂ ♀♀.

*S. vicarium* (Walker); (33) 13–23 June, ♂♂ ♀♀.

*Arthroplea bipunctata* McDunnough; (33) 22 June–2 August, ♂♂ ♀♀.

*Habrophlebia vibrans* Needham; (33) 5 July, 1♀.

*Leptophlebia cupida* (Say); (27, 29, 30, 33, 36) 9 June–13 August, ♂♂ ♀♀.

*L. nebulosa* (Walker); (7, 9, 19, 24, 27, 33) 7 June–19 July, ♂♂ ♀♀.

*L. johnsoni* McDunnough; (33) 1 July–22 August, ♂♂ ♀♀.

*Leptophlebia* spp.; (7, 13, 14, 18, 19, 24, 27, 29, 33, 34) ♂ subimagines and unassociated ♀♀.

*Paraleptophlebia adoptiva* (McDunnough); (33) 9 June–1 July, ♂♂ ♀♀.

*P. debilis* (Walker); (33) 11 July–10 October, ♂♂ ♀♀.

*P. moerens* McDunnough; (10) 5 August, 2♂.

*P. mollis* (Eaton); (33) 28 June–5 July, ♂♂ ♀♀.

*P. praepedita* (Eaton); (22) 7 July–22 August, ♂♂ ♀♀.

*Paraleptophlebia* sp.; (31) 1♀.

*Drunella walkeri* (Eaton); (23) 24 July, 1♂ 2♀.

*Ephemerella aurivillii* (Bengtsson); (15, 18, 30, 33) 14 June–13 August, ♂♂ ♀♀.

*E. invaria* (Walker); (33) 13 June–16 July, ♂♂ ♀♀.

*E. mucronata* (Bengtsson); (3, 10, 11) 2 July–8 August, 12♂. The configuration of the genitalia (Fig. 2) of our specimens indicate a close resemblance to *E. krieghoffi* (Ulmer) of Central Europe (photographs in Keffermüller 1979); it is however very probable that *E. krieghoffi* is nothing more than a southern race of the northern Eurasian *E. mucronata* (Keffermüller 1979) which ranges from Scandinavia to Eastern Siberia (Tshernova 1958; Bajkova 1972). Our North American material must then be referred to *E. mucronata* which becomes a new holarctic species.

*E. needhami* McDunnough; (33) 23 June–4 August, ♂♂ ♀♀.

*E. rotunda* Morgan; (23) 20 June, 10♂.

*E.* prob. *excrucians* Walsh; (33) 1–31 July, 8♂ subimagines.

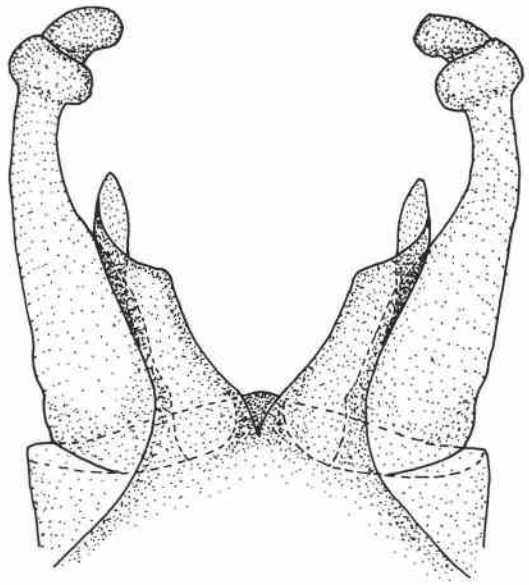

FIG. 2. Male genitalia of *Ephemerella mucronata* (Bengtsson) drawn from North American specimens, dorsal view.

*Eurylophella prudentalis* (McDunnough); (33) 26 June–18 July, 4♂ 1♀.

*E. temporalis* (McDunnough); (32, 33) 22 June–5 August, ♂♂ ♀♀.

*E. verismilis* (McDunnough); (32, 33) 24 June–31 July, ♂♂ ♀♀.

Ephemerellidae spp.; (9, 10, 12, 15, 22, Deer River, Man.) ♀♀.

*Brachycercus* prob. *prudens* (McDunnough); (33) 26 August, 1♀. The identification is tentative and is based on the small size (3 mm) and the immaculate abdominal tergites.

*Caenis forcipata* McDunnough; (27, 32, 33) 12 July–5 August, ♂♂ 3♀.

*C. simulans* McDunnough; (32, 33, 34) 1 July–9 September, ♂♂ 5♀.

***Caenis candida*** n.sp.; (33, 34) 18 July–13 August, 40♂ 2♀.

MALE IMAGO: Length of body 4–4.5 mm; of fore wing 3.5–4 mm. Head yellowish white; vertex more or less mottled with black, its posterior margin finely outlined with black, this colour extending into roughly triangular marks behind the lateral ocelli. Antennae yellowish white; flagellum about five times as long as pedicel. Pronotum yellowish white; on each side a blackish suffusion extends from lateral edge of notum into a triangular mark pointing towards the middle. Fore coxa margined with dark brown. Fore femur suffused with tan, a dark streak extending its full length on the outer side; rest of fore leg dirty white, articulations brown. Meso- and meta-nota dark tan, darker at sutures. Thoracic pleura tan. Meso- and meta-sterna yellowish white. Wings hyaline, veins tan at base. Middle and

hind legs entirely pale yellowish, without any markings. Abdomen pale yellowish, hyaline, without any dark markings dorsally or ventrally, except the usual sclerifications on tergite 10; no spiracular marks. Genital forceps rather long and slender, slightly arcuate (Fig. 3); penes covered with small stocky spines (125×). Caudal filaments white.

FEMALE IMAGO: Length of body and of fore wing 5 mm. Same colour pattern as male, except fore leg suffused with tan right down to tip.

HOLOTYPE ♂: Lac Low, Quebec, 11 August 1973 (Pierre Pellerin).

ALLOTYPE ♀: Rivière du Castor, Quebec, 18 August 1975 (Jean-Louis Fréchette).

PARATYPES: One ♂, Lac Low, 8 August 1973 (P.P.); 1♂ 1♀, Lac Low, 13 August 1973 (P.P.); 37 ♂, Rivière du Castor, 18 July 1975 (J.-L.F.).

*Caenis candida* can be distinguished from other species of *Caenis* either in North America or in Europe by the combination of its size, its completely unmarked abdomen, its unmarked middle legs, and its long and pointed forceps. The species seems related by its genitalia to *C. forcipata* and *C. latipennis*. In Burks (1953), *C. candida* will key to couplet 6 together with *C. anceps* and *C. ridens*; however, both of these are small species (2 mm) and their forceps are short and stocky (*anceps*) or hooked (*ridens*).

*Baetisca laurentina* McDunnough; (23, 32, 33) 20 June–3 August, 5♂.

*Ephemera simulans* Walker; (23, 24, 26, 33) 23 June–24 July, ♂♂ ♀♀.

*Ephemera* sp.; (13), ♀♀.

*Hexagenia limbata* Serville; (13, 27, 32, 33) 23 June– 23 August, 4♂ ♀♀.

*Litobrancha recurvata* (Morgan); (30, 33) 18 June–13 August, ♂♂ ♀♀.

## Discussion

The present records of *Baetis lapponicus* confirm its existence on the mainland, first reported by Cobb and Flannagan (1980), and its apparent restriction to the tundra; its presence in Alaska indicates that although its dispersal was seemingly transatlantic (Cobb and Flannagan 1980), it was extremely successful in spreading over the northern range of the continent.

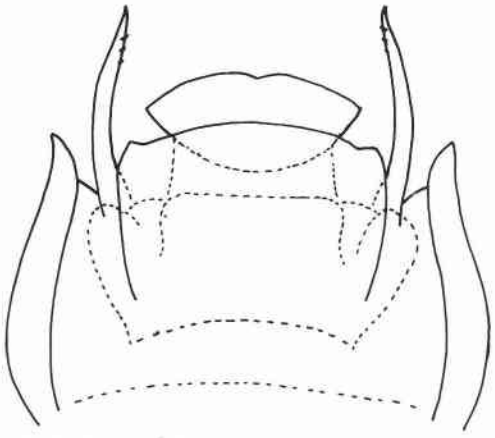

FIG. 3. Male genitalia of *Caenis candida* n.sp., ventral view.

The range of *Baetis macani*, formerly considered to be restricted to northern Europe and the district of Keewatin (Cobb and Flannagan 1980), is now extended to the Mackenzie Valley, Victoria Island, the Yukon, and Alaska; the species is typically a tundra species (Mohihara and McCafferty 1979*a*, 1979*b*).

No attempt was made to identify the females and the subimagines of *Baetis*, so it is quite probable that the presence of *Baetis foemina* McDunnough and *B. hudsonicus* Ide (both thought to be parthenogenetic) has escaped our investigation.

The discovery of *Ephemerella mucronata* in North America constitutes one of the most interesting results of our study. Its presence in Western North America and throughout Northern Eurasia (where it is sometimes known as *Chitinophora mucronata*) suggests a dispersal along a North Pacific route. Its discovery as far north as Rampart House (3) and Reindeer Depot (10) pushes the northern limit of the genus to 68°42′ N, beyond the arctic circle, much further than was generally thought (Allen 1980); other Ephemerellids were also collected within the arctic circle (9, 10, 12).

It is undoubtedly still premature to initiate a discussion of the zoogeography of Northern mayflies, since collecting has been generally haphazard in most areas. It is nonetheless possible to distinguish a number of components of the fauna of Northern Canada from previous publications and our present data.

(1) A few species appear to be exclusive tundra dwellers; three of these are holarctic (*Parameletus chelifer*, *Baetis lapponicus*, and *Baetis macani*) and the others are nearctic (*Baetis foemina* and *B. hudsonicus*). Other species can venture beyond the tree line. From our list, there is *Cinygmula par*, *Rhithrogena futilis*, and some Ephemerellidae; similarly Slack *et al.* (1979) listed *Pseudocloeon* and Heptageniidae from an Alaskan tundra stream.

(2) Another group of species is transcontinental, particularly over northern latitudes. In our list this includes *Siphlonurus alternatus*, *S. phyllis*, *Metretopus borealis*, *Siphloplecton basale*, *Baetis tricaudatus*, *B. hageni*, *Centroptilum album*, *Pseudocloeon parvulum*, *Leptophlebia cupida*, *L. nebulosa*, *Paraleptophlebia debilis*, *Ephemerella aurivillii*, *Caenis simulans*, *Ephemera simulans*, and *Hexagenia limbata*. Three of these (*S. alternatus*, *M. borealis*, and *E. aurivillii*) are holarctic.

(3) The third component is composed of the typical western species; these are species common west of the Rocky Mountains that extend to the north, such

as *Siphlonurus occidentalis*, *Callibaetis coloradensis*, *Cinygmula par*, *Rhithrogena futilis*, *R. undulata*, *Ephemerella mucronata* (holarctic), and *Cloeon inanum*; this last species seems to have reached Central Canada.

(4) The fourth component includes all the other species and constitutes the main block of the northern fauna. The majority of these species are primarily eastern but one fourth of them are distributed as far west as the Mackenzie Valley; such are *Baetis propinquus*, *Heptagenia pulla*, *Stenonema femoratum*, *S. vicarium*, *Arthroplea bipunctata*, *Paraleptophlebia moerens*, and *Ephemerella excrucians*.

The northern fauna of mayflies in Canada is thus richer than would have been presumed; however, few species survive beyond the tree line, except for a highly specialized group, mainly of *Baetis* species.

The species inhabiting the open boreal forest (boreal forest – barren lands transition) are generally species with marked eastern or western affinities; they represent the most tolerant elements of the boreal and temperate faunas; no species appears to be restricted to this zone, but some seem to be more abundant there than anywhere else. These are either holarctic species, such as *M. borealis*, *E. aurivillii*, and *E. mucronata*, or transcontinental ones, such as *Siphloplecton* and *Parameletus* spp.

Our list contains 68 species to which can be added an additional 14 from Cobb and Flannagan's (1980) records; thus, more than 80 species, roughly one fourth of the known Canadian fauna (310 species, see paper by Lehmkuhl (1978)), have now been collected in the northern regions of Canada, despite the fact that very few systematic inventories have been conducted; indeed, only three areas have been investigated seriously: the Mackenzie Valley, the Keewatin–Boothia area, and the James Bay drainage in Quebec. Collecting from Alaska and the Yukon, as well as from the North Atlantic region, will be necessary before we can gain a thorough comprehension of the distribution of mayflies in the northern regions of our continent.

## Acknowledgments

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