CONTRIBUTION TO THE BIOLOGY OF ONTARIO MAYFLIES WITH DESCRIPTIONS OF NEW SPECIES.

BY F. P. IDE,

INTRODUCTION.

During the summers of 1928 and 1929 a study was made of the mayfly fauna of several streams and lakes in Ontario, particular attention being given to associating the nymphal stages with the adults by rearing them in cages set in the streams. In the course of the work the nymphs of twelve species, hitherto unknown in this stage, were found. These are described below. Three new species were taken and are also described.

In 1928 work was done at Horning's Mills early in the summer and at Glen Major and Inglewood later. In 1929 the mayfly fauna of Lake Nipissing was studied and some collections were made in Algonquin Park also.

LOCALITIES AND HABITATS.

Horning's Mills is situated at the headwaters of the Pine river, a tributary of the Nottawasaga river in the Georgian Bay drainage area. The river has its origin in a number of spring-fed streams which flow over limestone, the stones in the water being encrusted with lime in many places. On some reaches of these streams the water is very rapid, almost torrential, in other places the streams broaden out, flowing more gently with occasional shallow rapids. At various places dams have been constructed causing the formation of small ponds.

One of these ponds, together with the stream below it and the stream flowing into it was made the subject of rather intensive study. The pond itself is about two acres in extent with two arms receiving the two inlet streams and one outlet at the mill dam. The east bank is fairly high and wooded with cedar, the west bank low and grassy with sedges along the shore. The greatest part of the bottom is covered with *Chara,* and *Potamogeton* grows up in groups here and there. The pond has a maximum depth of 7 feet, but the average depth is about five feet.

About fifty feet below the dam there is a fall of some fifteen feet and below this the stream is very rapid, flowing through a limestone gorge over broken fragments of rock with occasional falls and pools below them. The main feeding stream originates in springs in a small cedar swamp about half a mile above the pond and flows through open fields, cedar woods and open poplar woods to the pond. In the dense cedar woods the bottom is in general sandy and consequently almost devoid of vegetation and aquatic animal life. In more open places aquatic plants including water cress grow and the animal life shows a marked increase. In many places the stream widens out and becomes shallow forming shallow rapids with moss covered boulders in which locations the mayfly fauna is particularly abundant.

The water at the source had a pH of 7.4 which became 8.2 before it reached the pond and remained constant at this figure lower down the river. The oxygen content of the water varied from about 5.5 to 6.3 cc. per litre. The temperature of the water at the source was 7° to 9° C. Farther down stream it gradually rose but showed great change from day to day and also during the

day. Records taken at one time showed 15.1°C. above the pond, 17.1°C. below the pond and 18.8°C. about four miles down the river.

Other ponds in the vicinity are quite similar although usually somewhat larger, and the outlets of all join to form the Pine river. Collections were made in a number of these ponds and streams and also along the Noisy and Mad rivers, branches of the Nottawasaga river. The former is very similar in size and bottom to the Pine river and the latter is a slow-flowing deep stream with aquatic plants growing in profusion along the margins. Primrose, where collecting was also done, is situated on the Boyne river, a small stream, also a tributary of the Nottawasaga river.

Glen Major is situated on the divide between Lake Ontario and Lake Simcoe. The waters investigated here were three artificial trout ponds at the head waters of a small stream which flows south into Lake Ontario. The ponds are each about an acre in extent. The upper one is shallow (mostly under five feet), the middle one deeper (one fourth of it, five to ten feet deep), the lower one still deeper (two-thirds of it five to ten feet deep). The bottom is overgrown with *Chara* in most parts, with a little *Potamogeton* here and there. There are a few cold springs in the ponds augmenting the water of the feeding streams. The reaction of the water ranged from pH. 7.6 in one of the feeding streams to pH. 8.2 at the outlet of the lower pond with most of the water at a pH. of 7.8. The oxygen content of the water varied from about 5.5 cc. per litre at the inlets to over 7. cc. per litre at the outlets of the ponds. The temperatures in the ponds ranged from about 13° C. to 16° C. during August. The stream connecting the ponds was for the most part sandy with moss-covered stones in many places.

Inglewood is situated on the Credit river which flows into Lake Ontario at Port Credit. The pond studied here is the lowest in a series of artificial, spring-fed trout ponds, emptying into the Credit river. It has a maximum depth of about three and a half feet and an area of about two acres. The shores are low and lined with *Typha* sp. (cat-tails), and *Scirpus* sp., and the bottom is overgrown with *Chara* and a considerable amount of *Potamogeton*. On August 28th, the water contained 5.6 cc. oxygen per litre, gave a reaction represented by pH. 8.0 and the overflow water was at a temperature of 24.5°C.

Lake Nipissing is a large lake, about thirty miles long and half as wide, situated in Laurentian granite rock and emptying by the French river into Georgian bay. Some of the collections here were made around the shores of the lake and others up Sand creek, a small river flowing into the lake on the south side at Franks bay.

The surface temperature in the bay was fairly constant and always colder than in the stream. On June 14 it was 14°C., rising slowly to a maximum of 21°C on June 20. About June 28 the surface temperature dropped to 16°C. and rose gradually, reaching 19°C. on July 11; and throughout the rest of the month the surface temperature fluctuated between 19° and 21°C. The temperature of the water about one quarter of a mile up the creek was 18°C. on June 9th and 24°C. on July 14th. The reaction of the water at the same location on July 7th was acid, giving a pH. of 6.9 and an oxygen content of 4.9 to 5.0 cc. per litre at a temperature of 23°C.

At *Algonquin Park* the collections made were mainly of adults whose nymphs lived in a short, rapid stream connecting two lakes, Ragged and Smoke. These lakes are two in a chain of lakes drained by the north branch of the Muskoka river and are thus in the Georgian Bay drainage area. The stream connecting them was very rapid in most of its course but widened out in places to form shallow rapids. On August 5 in the afternoon the water showed a pH of 7.4, contained 5.5 cc. oxygen per litre and was at a temperature of 18°C.

ACKNOWLEDGEMENTS.

I wish here to express my thanks and appreciation of assistance received during this work as follows, – to the Ontario Fisheries Research Laboratory of the University for financial aid which made the investigation possible; in the Department of Biology to Dr. E. M. Walker, under whose direction the work was carried out, and to Professor J. R. Dymond for advice and helpful criticism; to Dr. J. H. McDunnough of the Entomological Branch at Ottawa for assistance in identifying some of the adults and to Dr. W. A. Clemens of Nanaimo, B.C., who kindly supplied me with his bibliography and literature; finally to Mr. W. E. Ricker of the Department of Biology for data on the physical and chemical properties of the water.

ANNOTATED LIST.

An annotated list of the species taken follows. This list cannot, however, be regarded as at all complete for the localities representated since the time spent in each was too short to make this possible. Where two dates separated by a dash are given they represent the earliest and latest dates on which specimens were taken. The arrangement adopted in this list is that of Eaton (1883-8) with some modifications made by Ulmer (1920).

Subfamily *Ephemerinae*

Ephemera simulans Wlk. Lake Nipissing, 30, VI-24, VII, 1929.

This species was not very common but a series of imagos was taken around some of the islands in the middle of the lake.

Hexagenia rigida McD. Lake Nipissing, 11-25, VII, 1929.

These mayflies were very abundant and all the specimens collected were taken on the islands in the middle of the lake.

Hexagenia limbata, var. *occulta* Wlk. Lake Nipissing, 6-25, VII, 1929.

Very numerous and taken along with the preceding species.

Hexagenia viridescens Wlk. Lake Nipissing, 21, VI, 1929.

A mating swarm of this species comprising males and females was found up Sand creek about two weeks before any of the other species of this genus appeared. They were not plentiful.

Hexagenia affiliata McD. Lake Nipissing, 17, VII, 1929; Algonquin Park, 19-30, VIII, 1929.

In a small bay of the French river about a mile below the lake a large number of females of this species were found floating in the water, just at dark. No sign of swarming males was seen. A few specimens were also taken at Wolf and Smoke Lakes in Algonquin Park where they did not seem at all abundant.

Subfamily *Baetinae*

Leptophlebia. During the two summers of 1928 and 1929 we were fortunate in being able to associate the nymphs of five eastern species of *Leptophlebia* with their adults. Descriptions are offered below and also a key to these species. There are four additional eastern species, whose nymphs are still unknown, so that, in using the key, determinations should always be checked over by referring to the descriptions. The nymph of *L. praepedita* Eat. has been described by Needham (1905).

A. Gills with tracheoles branching from tracheae.
  I. Main trachea of gill branching about 2/7 of distance from base *L. mollis* Hag.
  II. Main trachea of gill branching about 3/8 of distance from base *L. adoptiva* McD.

AA. Gills without conspicuous tracheoles.
  I. Main trachea of gill branching about 1/7 of distance from base *L. volitans* McD.
  II. Main trachea of gill branching about 1/10 of distance from base.
  (a) Second joint of maxillary palpus long, legs pale *L. guttata* McD.
  (b) Second joint of maxillary palpus short, legs barred *L. debilis* Wlk.

Leptophlebia volitans McD. Algonquin Park, 6-22, VIII, 1929.

This delicate nymph was taken in the shallow water of the stream connecting Ragged and Smoke lakes. The adults were emerging and as this was the only species of this genus in the stream, nymph and adult are definitely associated.

McDunnough's figure of the male genitalia of this species accompanying the original description (McDunnough 1924) gives an erroneous impression so that a view of these parts in profile has been added in figure 1c, Plate I.

Nymph. Length of body 6.5 mm., caudal setae 3.5 mm.

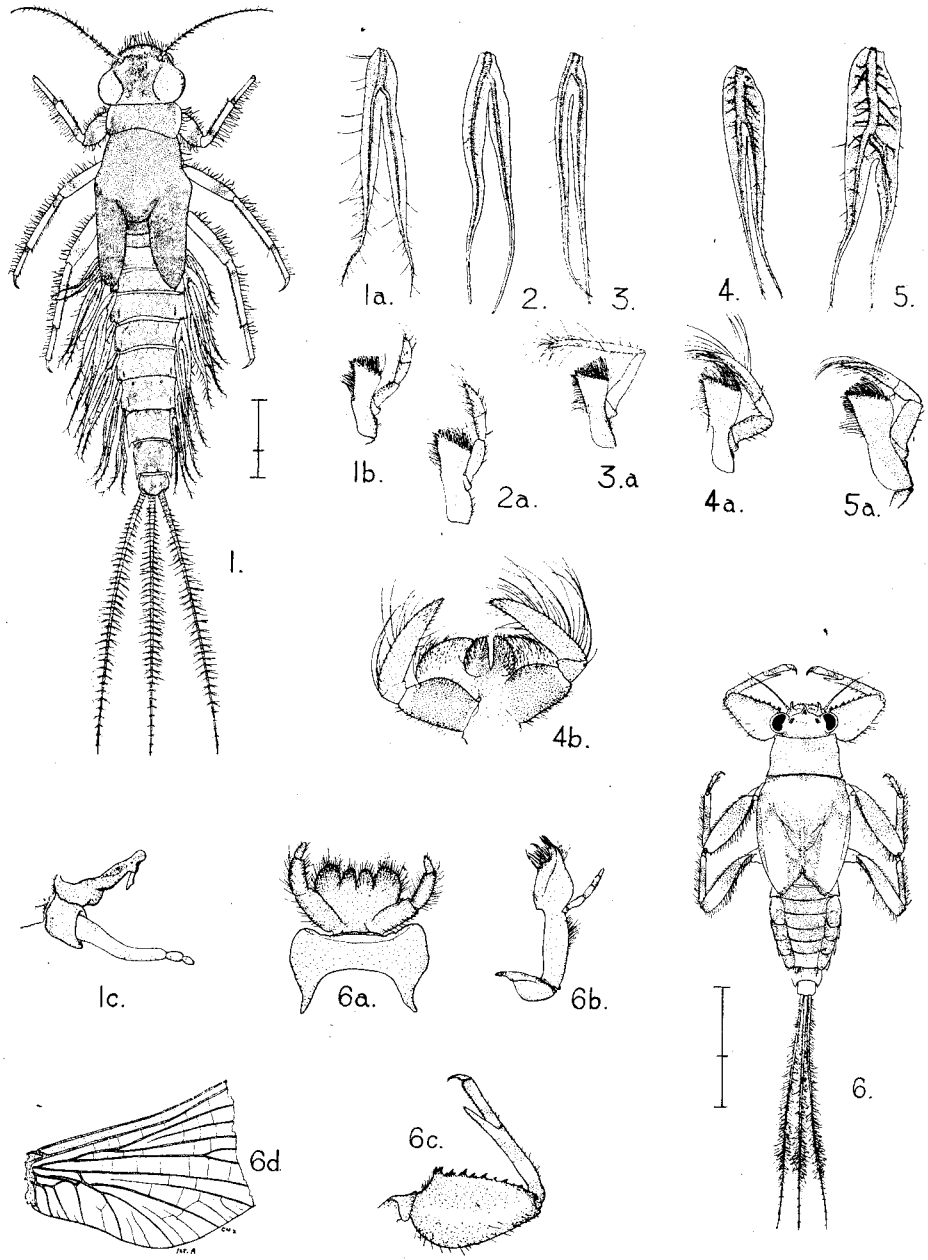
See figure 1. Plate XVII.

Head:—This nymph was just about to emerge and consequently shows the male eyes developed. Frons and vertex in front of eyes dark brown with pale spots over the ocelli; vertex between eyes paler brown with a medium pale line following the epicranial suture. Antennae pale brown and hairy; frons also with long hairs. Maxilla as in figure 1b, Plate XVII.

Thorax:—Pronotum dark brown with median pale line and pale lateral edges in the anterior two-thirds of the segment. Mesonotum uniform dark brown. Both prothorax and mesothorax with long hairs. Legs pale; prothoracic ones somewhat darker than others; dark shading distally in femora and proximally in tibiae and tarsi.

Abdomen:—Lighter brown dorsally than thorax. Segments 3-7 with a pair of sub-median pale spots in the anterior half of the segment and a pale median area on the posterior border of the segment; also a dark blackish longitudinal stigmatal dash laterally in the segment. Segments 8-10 lack the stigmatal dashes and segments 8 and 9 are provided with sharp postero-lateral spines; segment 10 has a pair of sub-median longitudinal pale areas. Caudal setae pale brown with joints darker; provided with hairs. Gills bilobed, the lobes very narrow

CAN. ENT. VOL. LXII. PLATE 17.



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and acutely pointed and hairy as shown in figure 1a. Venter of abdomen pale, narrowly brown along the joints of the segments.

Leptophlebia mollis Hag. Horning's mills, 15, VI.-21, VII, 1928.

Nymphs of this species were very plentiful in nearly all the streams about Horning's Mills where they were found among the stones in the shallow water along the banks. The species was not reared but nymphs and adults were associated when subimagos were found emerging in great numbers in the late afternoon. The subimagos were kept until they became adult.

Nymph. Length of body, 6.5-7.5 mm.; caudal setae 4.0-4.5 mm.

This is a uniformly brown nymph with few short hairs.

Head:—Depressed; mouth parts directed anteriorly; mandibles visible from above, giving the head a rectangular appearance with its long axis the median line. A pale area between the ocelli and one in front of each ocellus. Maxillae pale and as shown in figure 4a, and labium as in figure 4b, Plate XVII.

Thorax:—Pronotum transverse and light brown with clear lateral margins. Mesonotum evenly light brown; wing pads darker. Legs pale, contrasting sharply with the rest of the nymph, sometimes slightly suffused with brown but not with brown bands.

Abdomen:—Uniformly brown in most specimens; sometimes, however, the segments darker towards their lateral borders and traces of a median band and a pair of sub-median pale spots. Venter pale medially, brown along lateral borders. Segment 8 shows practically no postero-lateral spine. Caudal setae pale and very sparsely clothed with short hairs. Gills as in figure 4, Plate XVII; main trachea branching about one-third of the way from the base of the gill; small tracheoles branching from the main trachea.

Leptophlebia adoptiva McD. Horning's Mills, 13 and 14, VI, 1928.

This is a large rather pale nymph which was found in a small stream at Horning's Mills, in company with *L. mollis* Hag. The species was not common, only one nymph and six adults having been taken. The nymph bears a resemblance to *L. mollis* Hag. in the structure of the gills, and the adults also show an affinity in the form of the male genitalia (McDunnough 1929).

Nymph. Length of body exclusive of caudal setae 1 cm.

Head:—Frons brown, pale areas in front of median ocellus and lateral to the lateral ocelli; vertex paler. Mandibles pale brown above; maxilla as in figure 5a, Plate XVII; labrum hairy. Antennae pale.

Thorax:—Pronotum with lateral margins converging from middle point forward; light brown with dark area in middle and inside this a spear-shaped pale mark. Mesonotum pale brown, slightly darker in the antero-lateral angles and on the scutellum. Legs entirely pale.

Abdomen:—Segments 2-7 dark brown with lighter lateral edges; a narrow median pale area extending back nearly to the posterior border of the segment and a pair of sub-median pale dashes diverging from the median line at the anterior border. Segments 8-10 brown; segment 8 without a distinct postero-lateral spine; segment 9 with a distinct rather stout postero-lateral spine. Venter pale medially with indistinct brown shading submedially. Caudal setae pale with short hairs. Gills as in figure 5, Plate XVII; the two lamellae separating nearly one half the distance from the base of the gill to the apex; the main

tracheae with numerous tracheoles which show more branching than those in *L. mollis* Hag.

Leptophlebia guttata McD. Primrose, 10, VII, 1928; Horning's Mills, 5-21, VII, 1928.

The adults of this species were plentiful along the Noisy and Pine rivers at Horning's Mills and the nymphs were found in the shallow water along the edges. On one occasion they were found emerging and nymphs and adults were associated. For a description of the adults see McDunnough (1924).

Nymph. Length of body, 6.5-7.0 mm.; caudal setae 7.5 mm.

This rather pale, slender nymph is readily separated from the other *Leptophlebia* nymphs by the long maxillary palpus.

Head:—Uniformly brown; antennae brownish. Mouth parts pale and maxilla as in figure 3a, Plate XVII.

Thorax:—Pronotum dusky brown with paler lateral borders. Mesonotum similar with darker areas at the shoulders, and in the antero-lateral angles. Legs entirely pale.

Abdomen:—Segments 1-7 brown with indistinct dark stigmatal spots at the bases of the gills. Segments 8-10 darker brown with indistinct median pale line; segment 8 without a postero-lateral spine and segment 9 with one. Venter paler. Gills as in figure 3, Plate XVII; very narrow lamellae; the trachea branching almost immediately it emerges from the abdomen, and with no tracheoles. Caudal setae as long as nymph, median one considerably longer than others; all pale suffused with brown at base.

Leptophlebia debilis Wlk. Horning's Mills, 21 and 23, VII, 1928; Glen Major, 10 and 13, VIII, 1928; Latour creek, Algonquin Park, 1, IX, 1929.

This species was not common in any of the localities visited. Adults were taken swarming at the Noisy river at 5.30 p.m. standard time on July 21. At Glen Major a few individuals were taken emerging and nymph and adult associated. The nymphs were among the stones of the rapids in the stream connecting the two lower ponds.

Nymph. Length of body 7-8 mm.

Head:—Uniformly brown; second joint of antenna brown, remainder pale, Maxilla as in figure 2a, Plate XVII.

Thorax:—Pronotum brown with pale median line. Mesonotum and wing pads uniformly brown. Legs pale with a distinct brown band in the femur about 2/3 of the way from the base, a brown band in the middle of the tibia and a smaller brown mark at its proximal end and a brown band at the base of the tarsus.

Abdomen:—Dorsum brown with numerous rather large pale areas which are quite variable in extent. Segment 7 shows fairly typical maculation as follows; a rather large pale area medially on the posterior border, lateral to this and not reaching the posterior border a pair of smaller round pale areas, a pair of small sub-median pale dashes diverging somewhat from the anterior border, near the lateral border and not reaching the anterior border another pair of small pale spots, lateral borders margined with a pale area which is narrow anteriorly and expands towards the base of the gills. On venter a narrow brown longitudinal band near the lateral border. Segments 8 and 9 both with distinct

postero-lateral spines. Gills with main tracheae dividing almost immediately they leave the abdomen; no tracheoles present (see figure 2, Plate XVII). Caudal setae (broken off in these specimens) pale.

Leptophlebia praepedita Eat. Horning's Mills, 5 and 24, VI, 1928.

Two adults of this species were taken along one of the small streams near the source of the Pine river.

Leptophlebia moerens McD. Horning's Mills, 5-25, VII, 1928.

A long series of this species was taken swarming during the early afternoon along the Pine river, about four miles from the source on July 5. Two individuals were taken on July 25, about half a mile from the source.

Habrophlebiodes americana Bks. Horning's Mills, 2-21, VII, 1928.

Nymphs and adults of this species were quite plentiful in the moderately rapid rocky stretches of the Noisy river and two adults were taken at Primrose also.

Blasturus cupidus Say. Lake Nipissing, 10-22. VI. 1929.

Plentiful in the quiet pools in Sand creek and also along the shores of Franks bay where the adults were reared.

Blasturus nebulosus Wlk. Horning's Mills, 15. VI.-5. VII. 1928; Lake Nipissing, 22. VI. 1929.

This species was common in the very weedy parts of the streams at Horning's Mills in the cold water near the source. It was not very common at Lake Nipissing where it occurred in the upper reaches of Sand creek.

Ephemerella excrucians Walsh. Horning's Mills, 19-27. VI. 1928.

Males of this species were quite commonly found in the evening in mating swarms. The females were taken ovipositing usually later in the evening. Nymphs were not found.

Ephemerella invaria Wlk. (typical). Horning's Mills, 27. VI. 1928. One pair was taken mating.

Ephemerella invaria Wlk. (large dark form). Horning's Mills, 6. VI.-11. VII. 1928.

The nymphs of the large dark form of this species were very plentiful in the upper reaches of the stream where they climbed about in moss covering the stones of the rapids. The adult males formed mating swarms at about 6.30 p.m. standard time and flew high, dropping down occasionally within reach of a net. Emergence took place from 2.30 to 4.00 p.m. standard time.

Ephemerella aronii Esb. Pet. Horning's Mills 16-27. VI. 1928.

This interesting *Ephemerella* was taken in the nymphal stage in the very cold reaches of the stream near the source in company with *E. invaria* but was rather rare. Female adults were later taken and associated with the nymphs. This constitutes a record for this species which up till now had been taken only in Alaska, Alberta and Quebec Labrador (Walley, 1930).

Ephemerella deficiens Morg. Primrose, 10. VII. 1928; Horning's Mills, Pine river 5. VII. 1928 and Noisy river 2. VII. 1928.

Both nymphs and adults of this little species were taken. They were more abundant in the warmer parts of the rivers.

Ephemerella simplex McD. Horning's Mills, 2. VIII. 1928. One male of

this species was taken.

Ephemerella sordida McD.? Pine river, 27. VII, 1928.

Several females were taken ovipositing and were identified somewhat doubtfully as this species by Dr. McDunnough.

Ephemerella temporalis McD. Horning's Mills, 1 male 27. VI. 1928; Sand creek and Lake Nipissing 15. VI.-21. VII. 1929.

A long series of these was bred out from nymphs in cages set in Sand creek and along the shore of the lake. The nymphs were very variable in colour pattern, some showing a distinct median pale band on thorax and abdomen. Emergence took place considerably earlier in the season up the stream than in the lake.

Ephemerella bicolor Clem. Horning's Mills, 15. VI. 1928; Lake Nipissing, 8-25, VII. 1929.

One imago was taken at Horning's Mills and the nymph was also found in one of the ponds. The species was very plentiful at Lake Nipissing particularly around some of the islands in the middle of the lake.

Ephemerella depressa n. sp.

Nymphs of this mayfly were found crawling about in the moss on submerged stones in the rapids near the source of the stream studied at Horning's Mills. Although many nymphs were placed in a cage we had very little success in rearing them, three female imagos and two female subimagos being the only specimens secured in this way. One female imago with egg mass attached was caught later on the wing. Emergence took place in the forenoon.

Imago Female. Length of body 6-7 mm., setae 8 mm., wing 10-11 mm.

Head:—Vertex rather ruddy brown, darker brown around the ocelli.

Thorax:—Pronotum with prominent median carina; dark piceous, pleura paler. Mesothorax dark piceous with paler areas on either side of the median line immediately in front of the scutellum and on the pleura at the bases of the wings. Femora brown, somewhat paler than the notum, the distal end very slightly darker than the proximal end; tibiae lighter yellowish and the tarsi yellowish white. Wings very vitreous with rather pale venation, Cu_2 fused with 1st anal as shown in figure 6d, Plate XVII. although this character is not quite constant, two wings in the 12 examined showing the normal arrangement.

Abdomen:—First seven segments lighter piceous with an olive green tinge imparted by the greenish eggs. (If the individual had not oviposited the abdomen was usually quite blackish due to discoloration). Segments 8-10 somewhat darker, opaque and a very slight ruddy tinge on the pleura. Subanal plate rounded apically. Caudal setae white basally, somewhat brownish white distally.

Subimago Female. Smoky, not blackish, wings.

Nymph. Length of body 9 mm., caudal setae 7 mm.

This is a robust nymph rather depressed in form and widest across the mesothorax at the base of the wings (see figure 6, Plate XVII).

Head:—Very similar to *E. cornuta* figured by Morgan (1911); frons vertical ending ventrally in a truncate shelf above the labrum; a distinct medially curving horn above each antennal base; a median sharp tubercle below the median ocellus; two rounded prominences over lateral ocelli, Labium as in figure 6a, maxilla as in figure 6b, Plate XVII.

Thorax:—Pronotum rectangular, its length contained 1.7 times in the width; pale in colour with darker brown markings. Mesonotum broad and the wing pads extending back to about the posterior border of the 4th abdominal segment. Front femur very stout with posterior border very convex and anterior border straight and provided with teeth; middle and hind femora broad and flattened, pale in colour with two indistinct brownish bands one about ⅓ of the distance from the proximal end and the other the same distance from the distal end, hairy on anterior and posterior borders; tibiae light with an indistinct dark band in the middle; tarsi light with proximal dark band.

Abdomen:—Segments 1-7 with their terga brown; segments 8-10 paler with dark markings as in figure 6, Plate XVII. Gills on segments 3-7; not elytroid on 3; dark brown with a central pale area, Caudal setae relatively long, hairy and pale.

Holotype.—Female Horning's Mills, Ont. 18. VII, 1928 (F. P. Ide). in Royal Ontario Museum.

Paratypes.—Two females, Horning's Mills, Ont. 16. VI. 1928 and 6. VII. 1928. (F. P. Ide), one in Canadian National Collection.

This species comes very close to *E. cornuta* Morg. but can be separated from the latter readily by the form of the fore femur which is much stouter and has a more convex posterior border, and in the shape of the maxillary palpus. In *E. cornuta* also there is no fusion of Cu_2 and the 1st anal veins in the imago wing. On wing venational characters, namely, fusion of Cu_2 with 1st anal for some distance, this species would fall in Needham's subgenus *Eatonella*. The nymph, however, has not the characters which separate the species of this group and further the wing venational character is not constant, two specimens showing no fusion of these veins in one wing. This character does not seem to be a good one to use for establishing a subgenus.

(To be continued)

THE BIOTA OF NEWFOUNDLAND.

BY T. D. A. COCKERELL,

Boulder, Colo.

I have just received from Professor M. L. Fernald two papers of extraordinary interest, on "Some Relationships of the Floras of the Northern Hemisphere" (Proc. Internat. Congress of Plant Sciences, 2. pp. 1487-1507, 1929) and "Unglaciated Western Newfoundland" (Harvard Alumni Bulletin, Jan. 23, 1930, 6 pp.). He shows that a large part of Newfoundland remained unglaciated during the last (Wisconsin) continental glaciation, and consequently possesses a large relict flora of species which have persisted, probably with little or no change, since pleistocene times. In the second paper cited, Fernald says: "During the past summer . . . . . I spent practically all of July and August and part of September hunting for more of these endemic and relic species on or near the Long Range of Newfoundland, and . . . . . it is safe to say that my party . . . . . brought back more than 250 such species, many of them hitherto quite unknown anywhere in the world. These plants were excessively localized, growing as small colonies on mountain tablelands or crests or at lower levels on cliffs and gravelly barrens."