

IV.

REARING EXPERIMENTS AND ECOLOGY OF GEORGIAN
BAY EPHEMERIDAE.

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(Plates XIII and XIV and 1 figure in the text)

The results given in the present paper are based upon a series of observations on the distribution and life histories of various species of this family, which were begun on the advice and under the supervision of Dr. E. M. Walker. Owing to the very imperfect knowledge of these species as they occur in Canadian localities, it was considered desirable to make collections of the local forms occurring in the vicinity of the Biological Station and to conduct breeding experiments to determine the identity of nymphs and imagos, and discover the time of emergence. These insects, as is well-known, are an important source of fish food. In view of the comparative abundance of the species of *Heptagenia* occurring in this region, however, and the exceptional facilities for their study, it was decided to deal with these species in a separate paper which appears elsewhere.

The life histories of comparatively few North American forms, comprising in all about 31, out of a total number of about 114, have been described. The first was that of *Baetisca obesa* Say, by Walsh in 1864. In 1901, Professor J. G. Needham reared and described six species; in 1904 he published the life histories of 11 more, and since then 2 others. In 1903, Mr. Edward Berry described the life histories of 3 forms and in 1911 Dr. Anna Morgan described 8.

The particular species are as follows: Needham (1901, 1904) *Heptagenia pulchella* Walsh; *Baetis pygmaea* Hagen; *Siphylurus alternatus* Say; *Caenis diminuta* Walker; *Hexagenia variabilis* Eaton; *Ephemera varia* Eaton; *Chirotenetes albomanicatus* Needham; *Ameletus ludens* Needham; *Choroterpes basalis* Banks; *Callibaetis skokiana* Needham; *Ephemerella bispina* Needham; *Tricorythus allectus* Needham; *Leptophlebia praepedita* Eaton; *Heptagenia interpunctata* Say; *Ecdyurus maculipennis* Walsh; *Polymitarcys albus* Say; (By W. E. Howard); *Ephemerella dorothea* Needham; *Potamanthus diaphanus* Needham; Berry (1903); *Leptophlebia americana* Banks; *Blasturus cupidus* Say; *Callibaetis ferrugineus* Walsh.

Morgan (1911) *Ephemerella cornuta* Morgan; *Ephemerella rotunda* Morgan; *Ephemerella serrata* Morgan; *Ephemerella lata* Morgan; *Ephemerella tuberculata* Morgan; *Ephemerella deficiens* Morgan; *Ephemerella plumosa* Morgan; *Ephemerella spinosa* Morgan; *Iron fragilis* Morgan; *Epeorus humeralis* Morgan.

As for Canadian forms, L'Abbé L. Provancher, in 1877, recorded the following from Quebec; *Ephemera simulans* Walk.; *Hexagenia bilineata* Say.; *Heptagenia terminata* Walsh; *H. canadensis* Walker; *H. quebecensis* Provancher; *Siphylurus*

alternatus Say, *Baetis rubescens*, Hagen. In the Monograph of Eaton, 1888, are described the imagos of 21 taken in Canada. The following is a list of the species recorded and the localities from which they were taken. Those marked with an asterisk are recorded from Canada only:

- Polymitarcys albus* Say; Winnipeg River.
- Ephemera guttalata* Pict.; Quebec.
- Ephemera simulans* Walk.; St. Martin's Falls, Albany River.
- Blasturus cupidus* Say; Nova Scotia.
- Blasturus nebulosus* Walk.; St. Martin's Falls, Albany River.
- **Ephemerella walkeri* Eaton; St. Martin's Falls, Albany River.
- **Ephemerella invaria* Walker; St. Martin's Falls, Albany River.
- **Baetis rubescens* Hag.; Quebec.
- Baetis pygmeus* Hag.; St. Lawrence River.
- Centroptilum luteolum* Müller; St. Martin's Falls, Albany River.
- Callibaetis hageni* Etn.; Puget Sound.
- Callibaetis ferrugineus* Walsh; Quesnel Lake, B.C., and Vancouver Island.
- Siphilurus alternatus* Say; North West Territory and Quebec.
- **Siphilurus bicolor* Walker; St. Martin's Falls, Albany River.
- **Rhithrogena vitrea* Walker; St. Martin's Falls, Albany River.
- **Heptagenia canadensis* Walker; Canada.
- Heptagenia verticis* Say; St. Martin's Falls, Albany River.
- **Heptagenia luridipennis* Burmeister; St. Martin's Falls, Albany River and St. Lawrence.
- Heptagenia vicarius* Walker; St. Lawrence River.
- **Heptagenia quebecensis* Prov.; Quebec.
- **Heptagenia basalis* Walker; Lake Winnipeg.

Specimens of many of these are in the British Museum, London, England. These were probably only casual captures and would seem to indicate a rich fauna in our northern inland waters.

I commenced collecting nymphs on May 25 and continued until September 6. The area covered was within a radius of about five miles of the Biological Station Island. Collections of nymphs were made in localities as varied as possible, such as along open shores, in quiet bays, quiet streams, rapids, above and below waterfalls, pools, ponds, lagoons, and in water from fifteen to forty-five feet deep.

The chief method of collecting was that of picking up stones along the shores from water three inches to two feet deep, and picking off the nymphs clinging to them with a pair of forceps, or lifting off the nymphs with the blade of a pocket knife. The dipnet was used in some localities and for deep water a dredge was dropped from the stern of a gasoline launch.

Each collection of nymphs, as it was brought in, was carefully examined under the binocular microscope and the species separated. A number of each species were then transferred to breeding jars and the remainder were killed and preserved in 70% alcohol. Glass battery jars were arranged on the centre table of the laboratory and each fitted up as nearly as possible to the conditions in which the

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nymphs were found. For instance, for most of the nymphs of the genus *Heptagenia* which for the most part inhabit the swift water, a mixture of earth and sand was placed in the bottom of the jar and a couple of stones to which the nymphs could cling. Sticks were placed in the jars for the nymphs to crawl out upon when ready to emerge and a constant stream of fresh water supplied. For the *Hexagenia* nymphs, which were taken from deep water, the jar was partly filled with mud, which was dredged up in the locality from which the nymphs were taken. This was for the nymphs to burrow in. Only a trickling stream of water was necessary. *Blasturus* and *Caenis* nymphs did not require running water, as they were taken for the most part in ponds, pools and pot-holes in which the water was often almost stagnant. However the water in the jars was changed every day or so. Some dead leaves and twigs were placed in the bottom of the jar, to imitate the natural conditions.

Usually the stones placed in the jars were covered with algal forms upon which the nymphs could feed, but often algal material scraped from the stones was added.

Wire cages were placed over the jars to catch the subimagos as they emerged. It was impossible to set up breeding cages in the open on account of the changes of level of the water in Georgian Bay and because of waves produced by winds, or passing boats. Go Home River was too far from Station Island to be available.

When the subimagos appeared they were transferred to other vessels, where they were kept in an atmosphere very slightly humid and out of the direct sunlight, until their final moult. The imagos were killed with potassium cyanide and then preserved dry or in 70% alcohol. The final nymph slough and the subimago exuvia were both preserved for future reference.

In this way about 180 specimens were bred out. Altogether there were taken 29 species belonging to 16 genera.

The following are the genera represented:

Sub-family *Ephemerinae*

1. *Hexagenia*.
2. *Ephemera*.

Sub-family *Heptageninae*

1. *Heptagenia*.
2. *Ecdyurus*.

Sub-family *Baetinae*.

1. *Baetisca*.
2. *Leptophlebia*.
3. *Blasturus*.
4. *Choroterpes*.
5. *Ephemerella*.
6. *Drunella*.
7. *Caenis*.
8. *Tricorythus*.
9. *Chirotenetes*.
10. *Siphilurus*.
11. *Baetis*.
12. *Cloëon*.

Dr. Anna H. Morgan was kind enough to identify a number of species for me.

Hexagenia bilineata Say.

(Pl. XIII, Fig. 1).

Nymphs of this species were first taken on June 6, 1912, by dredging in water 15 to 45 feet deep. The bottom was very muddy. These were taken to the laboratory and about ten were placed in a breeding-jar, $\frac{2}{3}$ filled with soft muck. The nymphs immediately began to burrow, using their fore-legs to displace the mud. They were able to bury themselves in a remarkably short time. At first the gills were left partly exposed and the position of the creatures could be detected by the waving motion of these in the thin mud. They remained this way for a short time, but later on only the round openings of their burrows could be seen.

The first subimago to emerge from the breeding-jar was on July 3, and others followed during July and August. One nymph was still alive in the jar when I stopped my work on September 9th. On June 13th the first subimago was captured at large and from this on a few subimagos and imagos were taken at various times, but not until June 28th did they appear in large numbers. On this date about dusk, a large number of females were discovered flying up and down a long narrow channel between an island and the mainland. They dipped down frequently to deposit their eggs and many fell victims to hungry fish. For a couple of weeks after this, this species appeared in immense numbers. They commenced their flight about three-quarters to half an hour before dark and swarmed about the tree-tops, forty feet high. None were observed after July 23rd. On July 12 I caught a female just after copulation and held her over a jar of water, touching her abdomen to the water occasionally and she deposited a large number of eggs. The water was changed from time to time to keep it from becoming stagnant, and on August 17 a number of very small nymphs appeared. This was a period of thirty-six days.

Description of nymph. Length of body 30-35 mm.; setæ 13-15mm.; antennae 5-6mm. Head yellowish with the dorsal surface between ocelli and between eyes entirely brown, or in some cases lighter along median line and posterior margin. Antennae very hairy at joints of basal halves, while apical halves are entirely bare and become very slender. Margin and base of frontal piece hairy. Clumps of hairs between eyes and bases of antennae, in front of lateral ocelli and posterior to eyes. Mandibular tusks, $\frac{2}{3}$ length of antennae, upcurved, brown at tips, and with three longitudinal rows of hairs. Prothorax brown for the most part dorsally. Each abdominal segment has a large almost triangular brown area with two light areas within it. These light areas often reduced to mere stripes. Ventrally on segments 6 to 8 a faint median longitudinal dark streak, while on 9th segment there are two lateral streaks. Setæ of about equal length and very heavy at joints for entire length. Gills and legs of the usual *Hexagenia* type.

Ephemera simulans Walker.

For some inexplicable reason I was unable to find *Ephemera* nymphs at Go Home Bay, although the imagos were very abundant and the shore was strewn with the nymph sloughs. Dredging failed to bring them up, although *Hexagenia* nymphs were dredged up almost everywhere in Go Home Bay. However, Mr.

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R. P. Wodehouse kindly gave me a number of specimens which he took at Shawanaga Bay, about fifteen miles north of Parry Sound on June 9 in 2 to 8 feet of water; some from the south east shore of Manitoulin Island, June 26th, in water two to five feet, and at Waubaushene on May 31 in 6 to 9 feet of water. Nymph sloughs were taken at Go-Home Bay from June 24 to July 9.

The first imago of this species was taken on June 5th at Giant's Tomb Island, 4 miles south west of Station Island, but none were taken at Station Island until June 21. After this date they became very abundant and remained so until July 27th. The males occurred in fairly large swarms all along the shore. They maintained their position in the air by a dancing motion, at a height of 10 to 35 feet. They appeared shortly before 8 'clock in the evening and continued until dark. When a female appeared among them quite a commotion was noticed. The successful male flying up beneath the female would grasp her around the prothorax with his fore-legs, and, bending up his abdomen, would put his forceps around her abdomen. His setæ usually aided him in securing and maintaining his hold, by being bent up over the female's body. The couple would then go off on a gradual downward slant toward the water, before reaching which the male would disengage himself and fly back to the swarm, while the female would fly out over the water close to the surface and soon begin depositing her eggs, by skimming the water with her abdomen. A peculiar thing was noticed, namely, that the male *Ephemera* frequently attempted copulation with the male *Hexagenia* evidently being deceived by the colour.

Heptagenia.

This proved to be a very abundant and interesting genus and is treated separately elsewhere. The nymphs of eight species were taken and the imagos of all of them reared, three of which proved to be new species. The life histories of none of these have been previously described. Besides these eight, Mr. R. P. Wodehouse gave me several nymphs of another species which he discovered along the east shore of Manitoulin Island, June 26th, 1912. These were not bred, so the species has not been determined.

Genus Ecdyurus.

Ecdyurus maculipennis Walsh.

(Pl. XIII, Fig. 2).

The nymphs were quite widely distributed, being common along open stony shores and in rapids. They were taken as follows:

- (1) At Station Island, on July 2.
- (2) At Giant's Tomb Island on July 14, in a large stony bay commonly called the "Gap," on the west side.
- (3) On August 19th at the South Watcher Island, 6 miles from the mainland. This island is about 3 acres in extent and composed entirely of loose stones, with a clump of small poplar, willow and alder trees in the centre, and was the breeding-ground of hundreds of gulls.

(4) In the rapids above Sandy Gray Falls, on August 23rd.

The imagos of these collections emerged on July 6th, 17, August 23 and 30th respectively. Only a few imagos were taken at large.

Ecdyurus lucidipennis Clemens*

(Pl. XIII, Fig. 3).

Male imago:

Measurements: Body 6 mm.; wing 7 mm.; fore-leg 6.5 mm.

Face very slightly obfuscated. Dorsal surface of head dark brown or reddish. Notum dark brown; sides of thorax and ventral surface light yellow. Dorsum of abdomen a blackish brown and venter considerably lighter. Penis lobes and bases of forceps yellow. Forceps tinged with black. Setæ: basal half slightly tinged with black, minutely hairy. Fore femora dark, middle and hind yellowish. Wings hyaline; longitudinal veins slightly dusky, especially costa and subcosta; cross veins entirely colourless.

Female imago:

Measurements: Body 6 mm.; wing 7.5; fore-leg 4.

Thorax and abdomen lighter in colour than male.

Nymph:

Measurements: Body 7-8 mm.; setæ 3-4 mm.

Head brown with numerous light spots, chief of which are 6 along anterior margin; 2 lateral to each antenna, 4 elongated ones between antennæ and 2 small round spots anterior to these latter. Thorax lighter brown with numerous light areas. Anterior part of each abdominal segment brown. Four light spots along anterior margin, one large spot at each lateral margin and 3 along posterior margin. Setæ of about equal length and fringed with hairs; middle one slightly smaller in size than lateral ones. Femora flattened, fringed with spines along anterior margin and with hairs along the posterior; rather light in colour with two zigzag brown marks about middle and brown areas at distal and proximal ends. Tibiæ banded about the middle with brown. Tarsi with distal and proximal ends dark.

Nymphs of this species were collected at Station Island, July 1, and at Giant's Tomb Island, July 14th. Imagos were reared from these collections on July 4 and July 17 respectively.

Ecdyurus pullus Clemens†

(Pl. XIII, Fig. 4).

Male Imago:

Measurements: Body 10-11 mm.; wing 11 mm.; setæ 22 mm.; fore-leg 11-12 mm.

*Clemens, '13, p 329.

†Clemens, '13, p. 330.

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Face pale, slightly tinged with brown along the carina. Dark brown on dorsal surface of head between eyes. Pronotum dark brown; mesonotum lighter; a dark brown line on each side of prothorax, extending forward from base of fore wing; other dark brown marks at bases of wings and legs. Dorsal surface of abdomen dark brown, somewhat lighter laterally toward anterior margin. Ventral surface light in colour. Genitalia of usual *Ecdyurus* type. Legs light in colour, dark at joints. Tarsi of fore legs in order of increasing lengths 1, 5, 4 (3 and 2) equal. Wings with longitudinal and cross veins brown, and very slightly darkened in apical costal region.

Nymph:

Measurements: Body 12 mm.; setæ 15.

Head brown with a colourless area on each side from eye to lateral margin of head and 3 light dots between eyes; slightly fringed with hairs along anterior margin. Pronotum somewhat lighter in colour than head, colourless areas along anterior and lateral margins and a light area about the middle of each half of pronotum. Mesonotum darker with numerous light spots. Each segment of abdomen brown; 1-8 have 6 light spots; on segments 4-8 the 2 near the median line are fused, forming a large, almost rectangular spot; segment 9 with only 4 light spots; segment 10 entirely brown. Gills comparatively small; lamellæ oval. Setæ of about equal size, with each 2 alternate segments brown; sparsely fringed at joints; outer margins of lateral ones not fringed. Femora stout and flattened, brown in colour; lighter at distal and proximal ends and 2 or 3 irregular light areas toward middle; covered with minute spines and fringed along posterior margin with hairs. Tibiæ alternately light and dark banded, fringed along both anterior and posterior margins. Tarsi brown with proximal tips colourless. Ungues double on each leg; the large one well curved; the other small and lateral to the large one.

The nymphs were collected along the very stony shores of islands three and four miles out in the open bay, from June 23 to July 6. Imagos were reared on July 2 and a few captured June 27th.

In the key to the genera of Mayflies of North America by Professor Needham in Bulletin 86, New York State Museum, there is a slight error in the separation of the genera *Ecdyurus* and *Heptagenia*. In *Ecdyurus* the basal segment of the male fore tarsus is shorter not longer than the fifth segment and the second and third segments of equal lengths. In *Heptagenia* the basal segment of male fore tarsus is longer than the fifth segment and the second and third segments may be equal or unequal.

Baetisca obesa Walsh.

This very interesting nymph was taken in only two localities. The one was along the north east shore of Giant's Tomb Island. This shore is quite sandy with numerous small stones and deepens very gradually. The nymphs were abundant here May 26, clinging to the stones in water from 3 to 15 inches deep. Some

of these were put in breeding jars, but did not emerge until July 13. On July 14 I visited this place again but could not find a single specimen, nor any sloughs along the shore. The other locality was the south east shore of Station Island, but the nymphs were not abundant. Only one imago, a female, was captured.

***Leptophlebia* (?) *praepedita* Eaton.**

The only representative of this genus was a single almost mature nymph taken on July 21st in quiet water at the side of an old lumber chute. I was unsuccessful in breeding it and so am doubtful as to the species. It agrees with the description by Professor Needham, Bulletin 86, N.Y. State Museum, but this description is rather more generic than specific.

Genus *Blasturus*.

***Blasturus cupidus* Say.**

This is an early species. Nymphs were first taken May 23. Subimagos appeared May 31 and transformed next day. The imagos were never very abundant and were captured around Station Island only. The last observed was June 9.

A small nymph collected May 31 was observed to be filled with small oval brownish bodies. These, upon dissection by Mr. A. R. Cooper, were found to be a trematode of the genus *Halicometra* and its eggs. Another nymph taken some time afterwards was also discovered to be parasitized.

***Blasturus nebulosus* Walker.**

The nymph and imago of this species were first taken June 9, on a small bare granite island, a short distance out in the open bay. On the top of this island were numerous pot holes of all sizes filled with water, and in these, under loose pieces of rock and some rubbish, the nymphs were very abundant, having tadpoles, chironomid larvæ and water beetles for associates. Many were covered with *Vorticella*. Several nymphs were seen to crawl out of the water and transform on the rock. Subimagos were clinging to the sides of the rocks in sheltered places while a few imagos were flying above the pools.

This species was again taken on June 27th on an island 5 miles from the mainland. This island had an area of about 3 acres and was almost smooth bare granite. On top was a pretty lagoon margined with water plants, shrubs and a few small trees. Imagos of *B. nebulosus* were dancing over this pond in the sunlight about 3 p.m., matings frequently occurring. A few nymphs were taken from the lagoon.

Up to the present time I have not been able to find any difference between the nymphs of these two species, but am adding a description of the nymph of *Blasturus nebulosus*.

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Nymph:

Measurements: Body 9.5 to 10 mm.; setæ, 7-10 mm.

General colour blackish brown. Head with a dark area behind middle ocellus and between lateral ones; black, scroll-like markings between the eyes. Prothorax has a small light spot on each side, close to median line and near anterior margin; posterior to this and, farther from the median line is another larger oval light spot. Lateral to this is an elongated light area, beyond which is the light rounded lateral margin of the prothorax. Abdomen is blackish brown, with light brown markings. Segments 5 or 6 to 10 have a light median longitudinal stripe. On each segment is a slightly elongated incurved small light spot on each side of median line toward the anterior margin of the segment; posterior to this and more lateral is a larger round light area, which disappears usually on segments 8, 9 and 10. Ventral surface is light brown with three faint dark longitudinal lines, one median and two lateral. On each side of the median line in each segment is a very small, white oblique line near anterior margin and posterior to this is a small, white dot. Median seta shorter, slenderer and lighter in colour than the lateral ones. All fringed with hair at joints. Legs light brown. Posterior margin of tibia and tarsus fringed with hairs; anterior margin of femur fringed with spines, while anterior margin of tibia and tarsus have numerous serrated teeth. Inner margin of unguis with a row of teeth for its entire length.

Choroterpes (?) basalis Banks.

This is a late summer form. When I was beginning to think I had exhausted the collecting ground, I discovered this form in a small creek which formed the outlet of a chain of small lakes and which I had not visited for a month and a half. Large numbers of the nymphs were found here, July 30, clinging to stones in the quiet water. The next day several imagos emerged. As late as September 5th mature nymphs could be found. On July 31 a few nymphs were taken at Station Island and imagos on August 19th.

This later appearance of imagos at Station Island was noted also in the case of *Heptagenia tripunctata*. Mature nymphs of this species were taken in this creek May 31 and imagos emerged June 2, whereas no imagos appeared at Station Island until June 11th. This was probably due to the lower temperature of the water of Georgian Bay.

Genus *Ephemerella*.

Ephemerella lutulenta Clemens.*

Male imago:

Measurements: Body 8-9 mm.; wing 10 mm., setæ 12-14; fore-leg 8.

Face dark brown; a spotted reddish gray streak down carina and 2 similar

*Clemens, '13, p. 335.

lateral streaks from it to the base of antennae. Thorax dark reddish brown. Abdomen blackish brown; segments 9 and 10 slightly lighter in colour. Venter pale. Posterolateral margin of 9th segment produced into spines. Forceps pale with tips brown. Setæ reddish brown towards base but becoming pale toward tip; joinings brown. Legs greenish yellow, ungues brown. Segments of fore tarsi in order of increasing lengths 1, 5, 4, 3, 2; 1 very small; fore femur about 5/6 length of fore tibia. Wings entirely clear.

Female imago:

Measurements: Body 9-10 mm.; wings 10; setæ 10-12; fore-leg 5.

Quite similar to male. Posterolateral projection of 9th abdominal segment not as long as in male. Ninth segment ventrally produced posteriorly into a truncated triangular plate, with end emarginate.

Nymph:

Measurements: Body 10-11 mm.; setæ 6-7.

A large species, with colour varying from a dirty brown to a deep blackish brown, often of a granular appearance. Body and legs hairy. Head with a pair of occipital tubercles of varying size; in the male sometimes obscured by the developing eyes of the imago. Pronotum rectangular. Abdominal segments 2-9 produced laterally into flat spines; none on segment 1, minute on 2, increasing in size to the 9th; none on segment 10. A double row of spines on dorsal surface, very minute on segment 8-10, large on 1-7. On venter 6 small black dots on each segment, sometimes very faint. Rudimentary gills on segment 1; gill on segments 4-7; a large jointed elyroid gill cover 1.5 mm. in length. Femora stout, brown in colour with numerous round white dots and several irregular light areas. Tibiae with median brown band, distal ends light, proximal ends dark. Tarsi about same length as tibiae and with proximal half dark and distal half light. Claw with numerous pectinations. Setae well fringed with hairs along middle, almost bare at base and tip. Each 2 alternate segments brown.

The nymphs were taken almost everywhere about Go Home Bay from May 29th to June 19th. Mr. R. P. Wodehouse has also given me specimens from various places around Georgian Bay including Shawanaga Bay, Pentecost Island, French River, Sturgeon Bay.

Ephemerella lineata Clemens.*

(Pl. XIII, Fig. 5).

Female imago:

Measurements: Body 9 mm.; setæ 14; wing 10.5 mm.

Very similar to female of *E. lutulenta* but has a distinct rusty brown median longitudinal stripe on dorsal surface of abdomen. In a fresh specimen the stripe would probably extend over the thorax and thus correspond to the stripe of the nymph.

*Clemens '13, p. 336. .

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Nymph:

Measurements: Body 10 mm.; setæ 6 mm.

Slightly smaller than *E. lutulenta*, but very similar in colour, except that there is a dorsal median longitudinal white stripe from the interior margin of pronotum to the posterior margin of 10th abdominal segment. This stripe lies between the double row of spines on the abdomen. Occipital tubercles slightly longer than those of *E. lutulenta*.

The nymphs of this species were not very abundant and were found in about the same localities as *E. lutulenta* from June 3 to July 9. My bred specimens are dated June 14th and June 15th. I was unsuccessful in rearing a male.

Ephemerella bicolor Clemens.*

(Pl. XIV, Fig. 1).

Male imago:

Measurements: Body 5-6 mm.; wing 6mm.; setæ 8-9; fore-leg 6.

A small wholly brown species. It is very similar to *E. lutulenta*, in form and structure and apparently there are no satisfactory characters by which to distinguish it, except its size.

Female imago: slightly larger than male.

Nymph:

Measurements: Body 6-6.5mm; setæ 3mm.

These nymphs show a great variation in colour pattern. The light coloured specimens are of a dirty white colour with brown markings. Head for the most part brown, slightly paler towards posterior margin. Sides of pronotum brown; anterior margin of mesonotum brown and a brown area at posterior margin between the wing pads. Anterior halves of abdominal segments 2 and 3 brown and slight marks on 4th segment; brown areas on 6 and 7 about the median line, and on segment 9, there are 2 small brown dots at anterior margin and a rather semi-circular brown band posteriorly. Some specimens are almost entirely brown and between these two extremes the amount of brown and white varies. A few specimens, especially females, show a slight indication of tubercles but they are never large as in the preceding species. A double row of spines on abdominal segments 1-7. Posterolateral margin of 3-9 produced into broad flat spines. Gills on segments 4-7, covered by a large jointed elytra. Setæ light brown basally, becoming paler distally; well-fringed with hairs; joints brown. Legs rather small; femora stout; colour for the most part brown, divided into 2 areas; the proximal one large and contains a rectangular white spot; the distal one smaller and contains a perfectly round white dot. Tibiæ brown at proximal end and a brown band near distal end. Tarsi with a brown band toward proximal end; claws dark and pectinated.

The nymphs were everywhere abundant, especially along the open shore of Station Island. I have them also from Rattlesnake Harbour, Gray Island, Giant's Tomb Island, and Musquash River. The dates are from June 3 to July 9. Imagos were captured and reared from July 1 to July 12th.

*Clemens, '13, p. 336.

Genus *Drunella*.

I have two nymphs of this genus, identified for me by Dr. Morgan, but as I have not reared any imagos, I think it advisable not to describe the nymphs at the present time.

Caenis diminuta Walker.

This little nocturnal species came to the lamp in the reading room for the first time on July 2, and was taken as late as August 12th.

The nymphs are quite abundant in shallow, almost stagnant pools and lagoons from June 5 to July 30. I have them from various places around Georgian Bay.

Tricorythus allectus Needham.

The nymph was dredged up from a slightly sandy bottom in water 5 to 15 feet deep on Sept. 3. They were not reared, but imagos were taken July 3 and 9.

Chirottenetes albomanicatus Needham.

On June 16 I found a nymph slough at Sandy Gray Falls on the Go Home River but was unable to find either nymphs or imagos. I did not get up to the falls again until August 23 and then found the numerous small nymphs of the next generation.

Siphylurus flexus Clemens.*

Two beautiful *Siphylurus* nymphs were taken early in the season but both died before time of emergence. The first was found May 25th in the bottom of a canoe when some water was being emptied from it. The other was found June 3 beneath a stone in about one and a half feet of water along the open exposed shore of Station Island. Quite a number of imagos, apparently *Siphylurus*, were captured about this time and it seemed quite probable that they were the same species as the nymphs; and I think I have proved this quite conclusively by the wing venation. The wing of the imago has a very characteristic bend in Cubitus 2 at the base and the wing pad of the nymph shows this bend very distinctly. Again, the imago apparently has claws like an *Ameletus*, the two on one leg being unlike, and this can be made out in one nymph distinctly, due to the nymph dying just when about to emerge.

Male imago:

Measurements: Body 13-14 mm.; wing 12-13; setæ 23-24; fore-leg 12-13.

Head blackish brown except lower part of face, which is hyaline, tinged with brown; eyes large, meeting dorsally. Notum blackish brown. Sides of thorax marked irregularly with white. Abdominal segments 1, 8, 9 and 10 dark, segments 2-6 lighter in colour; these are light toward anterior margin and brown toward posterior; in the median line the brown is dark and forms a triangular area, the

*Clemens, '13, p. 338.

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apex extending almost to the anterior margin; from the anterior margin in the median line, 2 bands arise, composed of black dots, which pass backwards curving outwards and ending near the base of the triangular brown area; between this line and the triangular area is a light brown oval area; segments 7-10 almost entirely blackish brown dorsally, but 7 and 8 have triangular white areas on sides, and 9 a slight indication only; segment 10 has sides of dorsum white, ventrally segment 1 dark brown; remainder white with brown markings; segment 2 has 2 brown spots, 3 with 2 smaller brown spots and a slightly reddish area at anterior margin in median line; on 4 and 5 the brown spots become smaller and the reddish area larger; segment 6 the reddish area is elongated to the posterior margin; segments 7 and 8 have a median longitudinal brown line, thickened about the middle, and 2 dots of unequal size on each side of it; segment 10 brown except for a lateral white streak on each side. Forceps white; 4 jointed; setæ white with brown joints, minutely pubescent. Fore-legs brown; femur with a light area near distal end, lateral to which is a dark brown band; tarsi with segments 1, 2 and 3 about equal in length, 4 slightly shorter, and 5 about half the length of 4. Hind legs lighter in colour than fore; a brown band on femur is distal half; tibia with a brown band about middle; tarsus light but brown at joints; joint between tibia and tarsus 1 not distinct. Claws unlike. Wings with brown neuration; costal cross-veins and others towards base of wing margined more or less with brown; slightly clouded in apical costal area; a heavy brown cloud at bulla; often a small cloud at bifurcation of median vein; cubitus 2 strongly bent at base. Hind wing with a large brown cloud at base.

Nymph:

Measurements: Body 15 mm.; setæ 5 mm.

I have two of these graceful nymphs, a male and a female, both mature, but unfortunately both died when just about to emerge. On this account it is difficult to describe the colour pattern as the body of the subimago shows through the nymph skin.

Head vertical; body curved. Posterior lateral margins of abdominal segments 1-9 produced into spines. Dorsal colour pattern distinct on segments 9 and 10 only; 9th segment pale with a short brown median longitudinal stripe, commencing at anterior margin; on each side of this is a short stripe of about the same length, but placed more posteriorly; lateral to this again is a large brown area, roughly triangular, apex at posterior margin, base at anterior; at lateral margin slightly below middle line is a small brown spot; on 10th segment is a median brown longitudinal stripe with 2 dots on each side of it. Ventral surface of abdomen white with 3 longitudinal brown stripes, one median and 2 lateral. Gills on segments 1-7; double on 1, 2 and 3. Three setæ of equal length; lateral ones fringed with hair on inner margins only except towards tips; in these specimens the lateral setæ are brown, lighter towards tips, while the median one is whitish; setæ banded toward distal end with brown. Legs pale; femur with proximal end brown and a brown band beyond middle; tibia with a brown band about the middle; tarsus with brown band towards proximal end; fore tarsus much longer

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than fore tibiae; fore tarsus only slightly longer than hind tibiae; fore claw rather short, broad and bifid at tip; hind claws about twice length of the fore and very pointed.

Imagos were captured on the following dates; May 23, May 26 and June 12th. On the latter date a swarm of 12 or 15 individuals was observed flying off the west shore of Island Station from 12 to 20 feet from the surface of the water at 5.30 p.m. About 8 of these were taken.

Baetis propinquus Walsh.

The imago is described in Eaton, but my specimens do not show the subopaque area between the 2 nervures of the hind wing.

Nymph:

Measurements: Body 6 mm.; setæ 2.

Face vertical, mostly brown in colour; on dorsal surface of head on each side of median line is a row of irregularly shaped light spots. Notum brown with various light areas. Dorsum of abdomen for the most part brown; segments 2-4 brown with a light area in each half of segment and colourless margins; on segment 4 there is also a light area in median line; segment 5 quite light in colour; segment 6 brown with a light area along anterior margin and 2 faint ones posterior to it; segments 7 and 8, each with two rather large pale areas in posterior half; segment 9 almost entirely pale; segment 10 slightly brown, especially along posterior margin; on each side of the brown segments there are 2 small faint, pale, oblique, slightly curved streaks and a pale dot posterior to each. Ventrally the joinings of segments brown. Setæ slightly tinged with brown, with tips darker brown and a brown band beyond the middle; lateral setæ fringed on inner sides only. Legs pale; femora banded with brown about middle; tibiae and tarsi darker toward distal ends; each claw with a lateral row of pectinations.

Nymphs of this species were taken at Go Home Bay from June 14 to July 22; on August 19 large numbers of them were discovered in a little bay of a small bare island about three miles out in the open. This rock was the home of numerous gulls and hence is commonly called "Rookery Island." The nymphs were mature and imagos emerged on August 21 and 22

Cloëon dubium Walsh.

The imagos I have agree with the description in Eaton, except that the intercalary veins are single, not in pairs. Probably the description is in error as the genus *Cloëon* typically has the intercalary veins single.

Nymph:

Measurements: Body 4-4.5 mm.; setæ 1.5.

Face vertical with 2 large pale areas above antennæ; between eyes a large pale area partly divided into 2 and containing 2 brown stripes. Notum brown

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with irregular light areas. Dorsum of abdomen brown except lateral margins which are colourless; on each segment there are 2 small oblique pale streaks and 2 round dots posterior to the streaks. Setæ pale with brown band toward distal end; lateral setæ fringed on inner sides only. Gills double, apparently on segments 1 and 2 only; broader than gills of *Batis*; a main trachea in each, slightly to outer side and branchlets on inner side only. Legs pale; femora banded with brown in distal half; tibiæ and tarsi brown toward proximal ends; claws comparatively long, sharp-pointed, and not pectinated.

The nymphs were not very abundant; my collections date from July 30 to Aug. 12.

Imagos were reared July 30 and August 2. Adults were quite numerous at Station Island about July 10, flying in small swarms along the shore, at a height of from 10 to 15 feet. They appeared about 7.45 in the evening.

This paper and the following one on the genus *Heptagenia* contain the results of but a few months collecting and rearing. The complete life histories of 9 new species were secured and the hitherto unknown nymphal stages of 9 other species determined by rearing. Besides a few observations on the habits of several species have been recorded. The results may be taken as an indication of the richness of our inland waters in aquatic insect life.

I am adding a diagram showing the length of time imagos of these species were seen, captured or bred. I find in a number of instances that the dates are somewhat later than those given for the same species at Fall Creek, Ithaca, New York.

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EXPLANATION OF PLATES.

PLATE XIII.

- Fig. 1. *Hexagenia bilineata* Say.
- Fig. 2. *Ecdyurus maculipennis* Walsh.
- Fig. 3. *Ecdyurus lucidipennis* Clemens.
- Fig. 4. *Ecdyurus pullus* Clemens.
- Fig. 5. *Ephemerella lineata* Clemens.

PLATE XIV.

- Fig. 1. *Ephemerella bicolor* Clemens.
- Fig. 2. *Baëtis propinquus* Walsh.
- Fig. 3. *Cloëon dubium* Walsh.
- Fig. 4. Venation of wing pad of *Siphurus flexus* Clemens.
- Fig. 5. Wings of *Siphurus flexus* Clemens.
- Fig. 6. Fore-claw of nymph of *Siphurus flexus* Clemens.
- Fig. 7. Fore-claws of imago of *Siphurus flexus* Clemens.



Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 5

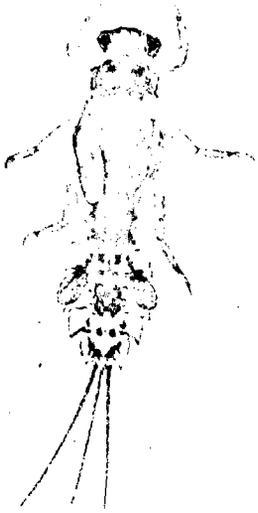


Fig. 1

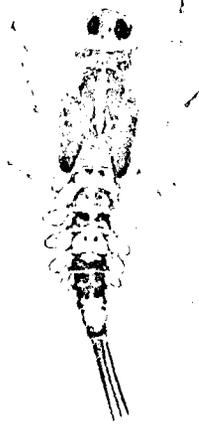
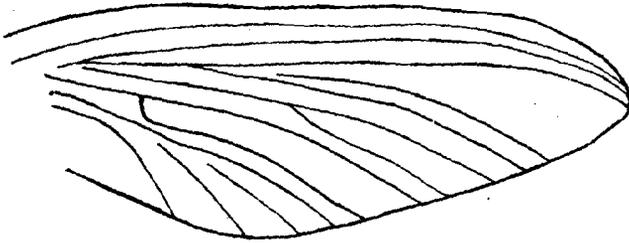


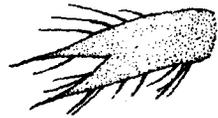
Fig. 2



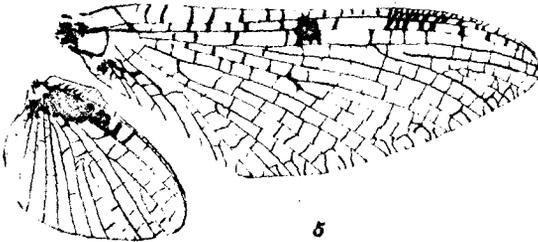
Fig. 3



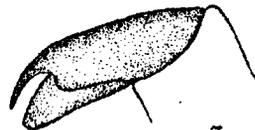
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