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THE BICOLOR GROUP OF THE GENUS EPHEMERELLA WITH
PARTICULAR REFERENCE TO THE NYMPHAL STAGES* (EPHEMER
OPTERA)

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During the course of breeding experiments in Ephemeroptera which we have been carrying on during the past few years, considerable nymphal and associated adult material of the genus *Ephemerella* has been accumulated. The main source of these collections has been the district around Knowlton, Que. where the diversified nature of the country has been particularly favorable for our studies; in addition material is also at hand from the Lachine-Vaudreuil section of the St. Lawrence Valley and from the Gatineau region in the vicinity of Wakefield, Que.

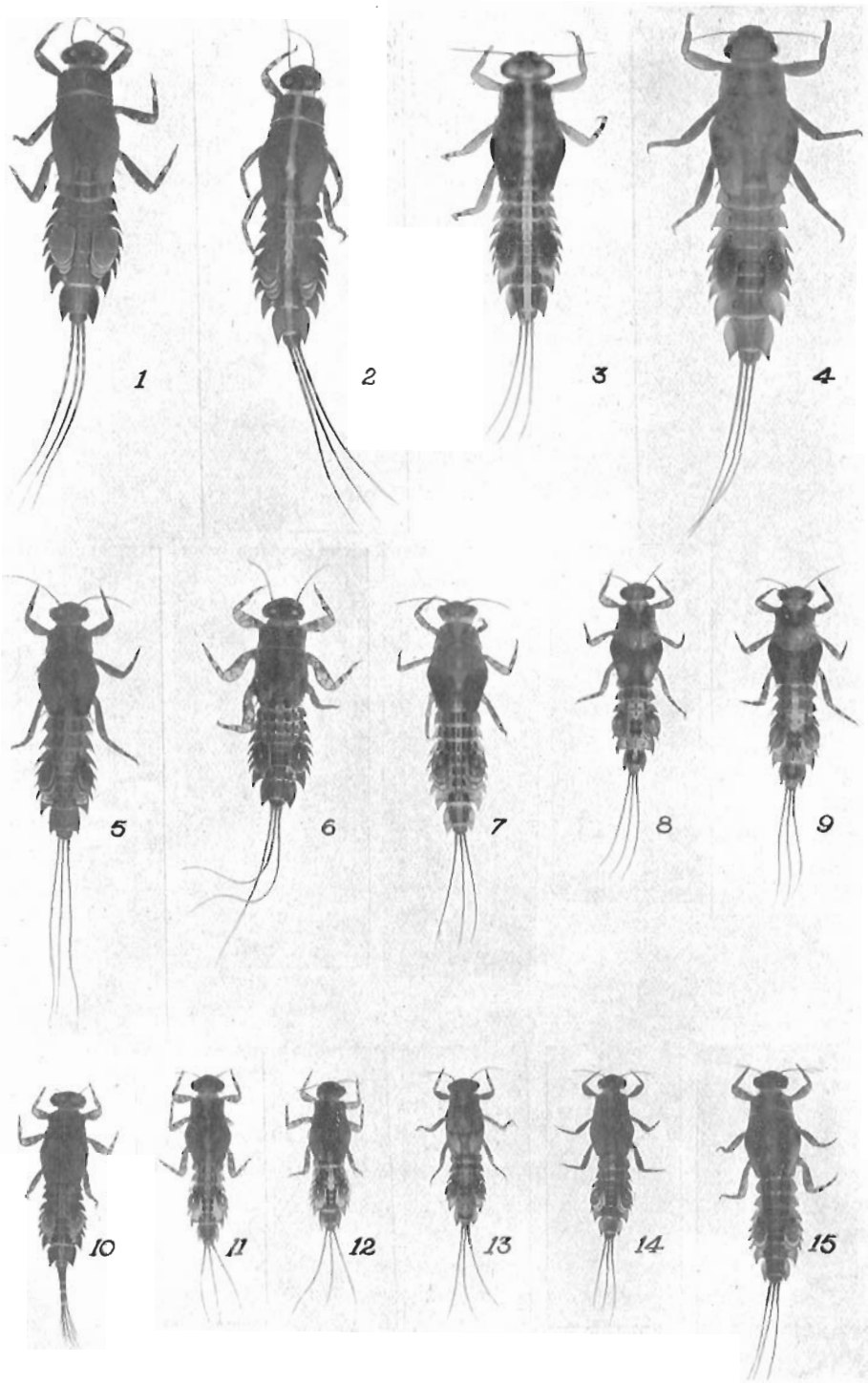
An attempt is made in the present paper to elucidate one of the most interesting and at the same time most difficult sections of the genus *Ephemerella*. The species comprising this section form a very compact little group, characterized in the nymph by the fact that there are no gills on the third abdominal segment and that the gill of the fourth segment forms a species of

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operculum which almost completely covers the gills found on segments 5-7. The lateral edges of the abdominal segments are flattened to a greater or less degree and drawn out into spines which increase in length from the second to the eighth segments. All of the species show two rows of dorsal abdominal tubercles or spines and most of them bear a pair of occipital tubercles as well; the fore femora, while somewhat thicker than those of the two hinder pairs of legs are not nearly so robust as in the *cornuta* group nor are they tuberculate or toothed along the anterior margin; the maxillary palp is lacking throughout the group. The color pattern appears to be very variable within each species and there may possibly be a certain amount of sex dimorphism; it is certain that the presence or absence of a distinct pale median stripe such as is mentioned and figured by Clemens (1913, Can. Ent., XLV, 336, Pl. V, fig. 11) cannot be used as a specific character; our breeding experiments have shown that it is merely an individual color phase which will probably be found to occur in most of the species of this group. Apart from considerable differences in size all the nymphs bear a close resemblance to each other and it is only by noting such features as general shape, the presence or absence of occipital tubercles, the length and position of the dorsal abdominal tubercles, the postero-lateral prolongations of the abdominal segments, and even the maculation of the legs or the banding of the setae that one can differentiate the various species; as these characters are mostly relative it is difficult to incorporate them satisfactorily into a key but it is hoped that the illustrations presented will help to elucidate at least some of the above-mentioned points.

The adults show the same close relationship as is found in the nymphs; the color of the males is a brown of varying shades but generally with a decided ruddy tinge, the females being paler and tending towards yellow or ochreous. The legs are normal in length and generally quite bright yellow; there is frequently a black spot on the coxa and sometimes on the trochanter as well; the setae (except in *coxalis* McD.) are distinctly banded with brown. In the male genitalia the forceps show no apical enlargement of the second joint but there is a distinct tubercle midway between their bases; the penes are closely united, broad and often swollen in the basal half, bent gently upward and tapering apically, with only a slight excision at the apex; the subanal plate of the female is rather flat, spade-shaped, with slight terminal excavation. In separating the adults the finer details of the male genitalia may in certain cases be used to advantage and there seem also to be some differences in the female subanal plate although I have not investigated this very closely; other characters may be found in the size, color and maculation but in some instances all characters seem to break down and it is only by definite nymphal association that the identity can be fixed.

As far as is known at present the species are all eastern in their distribution; *frisoni* McD. from Illinois, which at the time of description I associated with this group, I believe now should fall near *sordida* and *serrata*, as the setae are unbanded and the penes show under careful examination the same type of barb-like process near the apex. The nymphs figured by Needham (1905, Bull. 86, N. Y. Sta. Mus., Pl. IX, fig. 1) from Elkhart, Ind. and erroneously indentified as *excrucians* certainly belong in the group and may be those of *coxalis* McD.; as far as can be judged, these figures fit in very closely



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with an unassociated nymph before me from the Rideau River which I incline to think is that of *coxalis*, the only member of the group not yet bred.

The group is very nicely linked up with other sections of the genus by the species *attenuata* McD. and *simplex* McD., the nymphs of which agree in their generally flattened shape and in possessing gills on segments IV-VII only; in these two species there is, however, no operculum, the gills merely overlapping as in the *invaria* group; *simplex*, furthermore, is without dorsal tubercles.

KEY TO NYMPHS

1. Width between dorsal tubercles on abdominal tergites V-VII much less than the length of the respective tergite in the median line; large species2
 Width between dorsal tubercles on abdominal tergites V-VII more or less equal to the length of the respective tergite in the median line3
2. The two rows of dorsal tubercles converging posteriorly; occipital tubercles moderately developed*prudentialis* n. sp.
 The two rows of dorsal tubercles subparallel; occipital tubercles strongly developed*temporalis* McD.
3. Postero-lateral prolongations of segments II and III well-developed, that of III being fully twice as long as broad at the base4
 Postero-lateral prolongations of segments II and III weak, that of III being never more than equal in length to its width at base6
4. Lateral margins of segment IX subparallel with terminal spine incurved*funeralis* McD.
 Lateral margins of segment IX distinctly convex with straight terminal spine5
5. Shape elongate; dorsal tubercles on anterior segments long, finger-like, tapering; size 10-12 mm.*lutulenta* Clem.
 Shape broader and chunkier; dorsal tubercles on anterior segments broad and blunt; size 8-9 mm.? *coxalis* McD.
6. Lateral prolongations of segments II and III very weak, that of II being practically lacking; occipital tubercles lacking in ♂, much reduced in ♀7
 Lateral prolongations of segments II and III stronger, II showing a short spine; occipital tubercles present in both sexes and moderately strong8
7. Dorsal tubercles long, thin, erect and little reduced on gill-bearing segments; the two rows evenly divergent posteriorly*minimella* n. sp.
 Dorsal tubercles short, thick, considerably flattened and reduced on the gill-bearing segments; the two rows rather abruptly divergent on segment V*bicolor* Clem.
8. Hind femora short, broad; two rows of dorsal tubercles subparallel
*aestiva* n. sp.
 Hind femora longer and narrower; two rows of dorsal tubercles divergent posteriorly*verisimilis* McD.

***Ephemarella lutulenta* Clem.**

Pl. 2, figs. 3, 4; Pl. 3, fig. 1; Pl. 4, fig. 1; Pl. 5, figs. 7, 8.

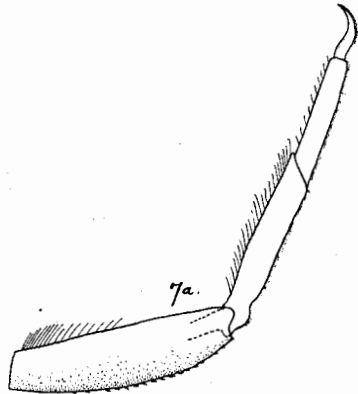
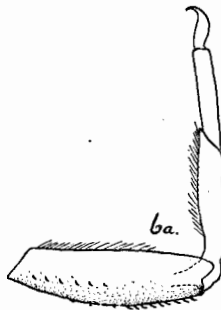
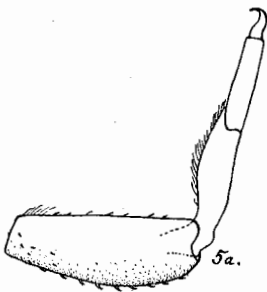
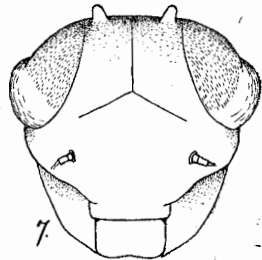
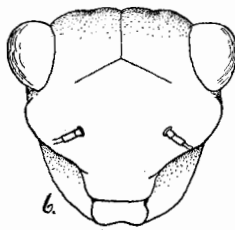
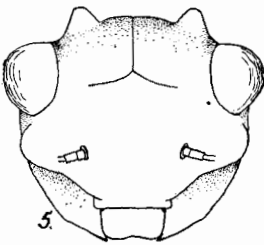
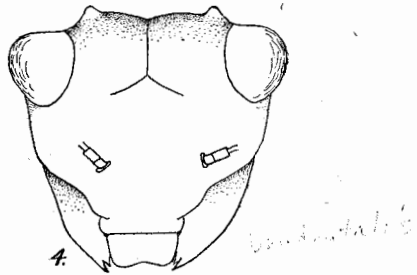
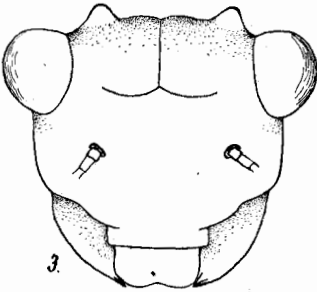
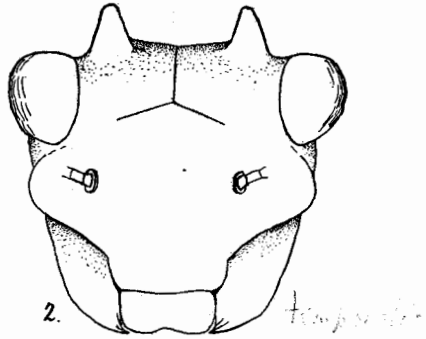
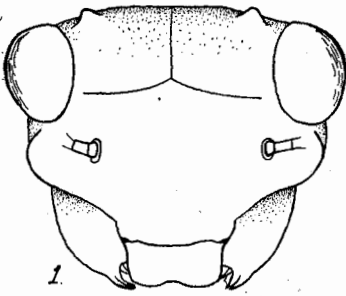
Ephemarella lutulenta Clemens, 1913, Can. Ent. XLV, 335; *id.*, 1915, Cont. Can. Biol. 121 (*partim*); McDunnough, 1924, Occ. Papers Bost. Soc. N. Hist. V, 74; *id.*, 1925, Trans. Roy. Soc. Can. (3), XIX, Sec. V, 212.

Ephemarella lineata Clemens, 1913, Can. Ent. XLV, 336; *id.*, 1915, Cont. Can. Biol. 122 (*partim*); McDunnough, 1924, Occ. Papers Bost. Soc. N. Hist. V, 74.

From a comparison of the Holotype ♀ of *lineata* and the Allotype ♀ of *lutulenta*, both in rather poor condition, I have long suspected the above synonymy; study of the actual nymphal skins from which the type material of both species was bred and which have recently been generously donated to the National Collection by Dr. Clemens, confirms my suspicion. Further, an examination of the extensive unbred nymphal material on which Clemens in part based his description shows conclusively that he had confused the nymphs of the species I later described as *temporalis* along with those of *lutulenta* and *lineata*. Using erroneously the presence of a pale medio-dorsal stripe as a specific character he had placed under *lutulenta* all more or less unicolorous nymphs of both *lutulenta* and *temporalis* whilst the striped forms of both species were placed together as *lineata*; this would account for the statement under *lineata* that the occipital tubercles are slightly longer than those of *lutulenta*, a statement which applies to *temporalis* but not to *lineata*. Fortunately the bred type specimens, as far as they are before me, are all conspecific and bear out the above synonymy.

The species is one of the largest of the group and is at once distinguished in the adult by the presence of minute black dots sprinkled over the legs, thoracic venter and abdomen; the subimago has the wings of a mottled appearance, rather similar superficially to those of *Ecdyonurus*, and is therefore easily distinguished from the unicolorous black subimagos of the other species of the group. The male genitalia are very similar to those of *temporalis*; my statement (1924, *op. cit.* 74) that the tubercle between the forceps-bases is lacking is incorrect and due to the fact that only the rather defective types were available at the time for comparison; more and better preserved material shows that this characteristic tubercle is present, although somewhat reduced.

The nymph, as far as present information goes, is an inhabitant of lakes or broad lake-like expansions of rivers; it matures early in June and is one of the earliest species of the group to appear in the adult state. It is of large size (♂, 9-10 mm.; ♀, 11-12 mm.) and the occipital tubercles are so reduced in the male sex as to be almost obsolete; in the females they are better developed and consist of distinct rounded prominences, much smaller, however, than the erect conical tubercles found in both sexes of *temporalis*. The two rows of dorsal abdominal spines or tubercles diverge slightly but distinctly from front to rear, those of segment II being about twice as wide apart as each tubercle is long, whilst on segments V-VII the distance between the tubercles is about equal to the length of their respective tergites in the median line. On segments I-III the tubercles are long erect, bluntly finger-shaped and bent backward whilst on IV-VII they are shorter, flatter and more acuminate, forming the termination of slightly oblique ridges which originate in the mid-section of the segment; on segments VIII and IX they are obsolete. The postero-lateral spine-like prolongations of the abdominal segments II-VIII are strongly developed; segment II shows a distinct, but short, spine; on III the spine is well-developed and fully twice as long as it is broad at the base; the remaining segments, as a reference to the figures will show, possess very long spines, curving regularly backward, and clothed along the lateral edge with mixed hair and spinules. Segment VIII is slightly over three times as broad as long (♂, 15: 42-45; ♀, 15: 47-50). The gill-cover or operculum of the fourth segment is without much maculation except a varying number of fine pale dots but is generally very distinctly longi-



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tuinally veined. In mature nymphs the ventral abdominal surface shows frequently a subintegumental sprinkling of fine black dots as in the imago but the curved row of four black dots on the anterior portion of each segment is very obscure and is generally only faintly represented by the two median dots; there are indications of the lateral rows of short longitudinal dashes. The setae are more or less unicolorous brown and not nearly so contrastingly banded with alternate bands of brown and pale yellow as are those of *temporalis*; this character, however may not always hold and should be used with caution.

MATERIAL EXAMINED. *Adults*:- Clemens' type series from Georgian Bay Region, Ont.; 6 ♂, 2 ♀, Orillia, Ont.; 2 ♂, 1 ♀, Ottawa, Ont.; 2 ♂, 7 ♀, Gauvreau Lake, near Wakefield, Que.; 5 ♂, Lachine, Que.; 2 ♂, Laprairie, Que.; 1 ♀, Chateauguay, Que.; 2 ♂, 7 ♀, Fredericton, N. B. *Nymphs*:- Clemens' collections from Georgian Bay Region; two specimens, Lake Simcoe, Ont.; two nymphal skins, Gauvreau Lake, Que.; 1 specimen, Mahon Lake, near Wakefield, Que.

***Ephemerella temporalis* McD.**

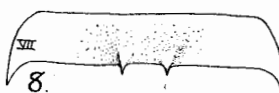
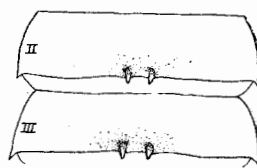
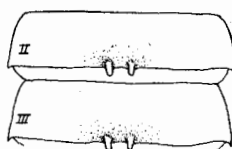
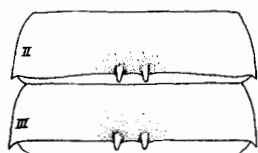
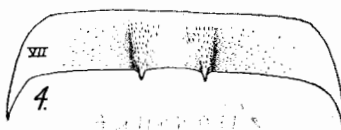
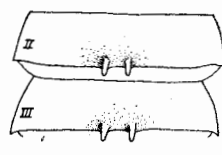
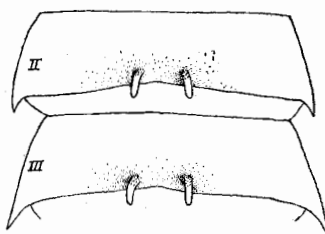
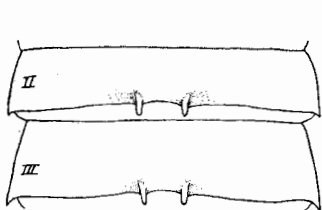
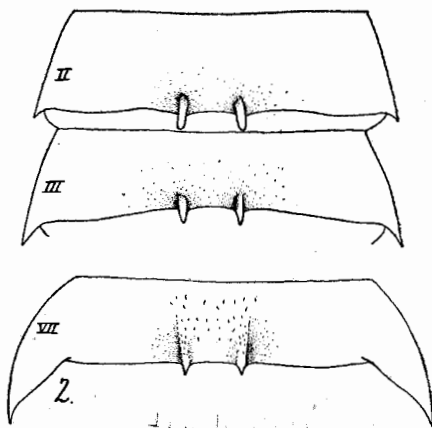
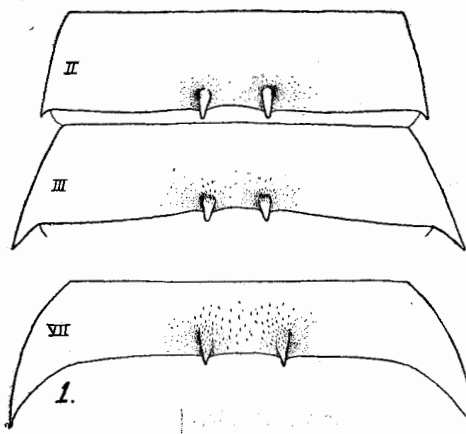
P. 2, figs. 1, 2; Pl. 3, fig. 2; Pl. 5, fig. 9.

Ephemerella temporalis McDunnough, 1924, Occ. Papers Bost. Soc. N. Hist. V, 74, Pl. VI, fig. 2; 1925, *id.*, Trans. Roy. Soc. Can. (3) XIX, Sec. V, 212; 1930, *id.*, Can. Ent. LXII, 58, Pl. VII, fig. 3.

A large species, easily separated in the adult state from *lutulenta* by the entire lack of black sprinkling on legs and abdomen, the brighter shades of brown coloration on thorax and abdomen and the presence of four black dots, arranged in a curved row across the anterior portion of the ventral abdominal segments.

The wings of the subimago are an even dull blackish, neither mottled as in *lutulenta* nor intense black as in *funeralis* and *bicolor*. Other adult characters have been dealt with in the above-cited articles but it might be well to mention that the Covey Hill record for the species, based on two females (1925, *op. cit.* 212), is probably incorrect and should be referred to a species I am describing later on as new. The species appears a week or two later than *lutulenta*.

The nymph, heretofore undescribed, is closely allied to that of *lutulenta* and, like it, is a frequenter of large bodies of open water. The two species often occur together but *temporalis* generally matures a week or so later than *lutulenta*. When mature it is normally of a deep brown color, heavily sprinkled, both dorsally and ventrally, with small pale dots; this ground-color is, however, decidedly variable and I have examined nymphs from the Lachine region which are a dull clay-color without any very decided dark maculation; as in *lutulenta* some specimens show a distinct, pale, broad, dorsal stripe (*vide* fig. 2), bordered by shades somewhat darker than the body-color; these darker stripes often persist in specimens which lack the pale median stripe. The size is large, much as in *lutulenta* (9-11 mm.). The occipital tubercles are very strongly developed in both sexes and are conical in shape. The two rows of dorsal abdominal tubercles are subparallel, diverging slightly at times on segment IV; the distance between the tubercles on segment II is from one and a half times to twice the length of each tubercle whilst on segments V-VII this distance is decidedly less than the length of the tergite in the median line. On segments I-III the tubercles are longer than in *lutulenta* and rather more tapering apically, being, however, finger-shaped and bent backward as in this



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species; on the other segments they do not differ noticeably from those of *lutulenta* except that the rows are closer together. The lateral prolongations of the abdominal segments are very similar to those of the preceding species, the spine of segment III being normally slightly shorter than in *lutulenta*. The width of segment VIII is almost four times its median length (11: 40-43). The operculum is heavily sprinkled with pale dots and frequently shows two pale patches along the joint; the longitudinal veining is generally indistinct. On the ventral surface, which is heavily sprinkled with pale dots, the curved row of four black spots on the anterior portion of each of segments I-VII (and at times VIII) is very distinct and there is besides a lateral row of short black dashes. The setae are distinctly banded with alternate bands of brown and pale yellowish.

MATERIAL EXAMINED. *Adults*:- Type specimens and long series from the Ottawa, Lachine and Knowlton, Que. regions, including bred material from Gauvreau and Mahon Lakes, near Wakefield, Que., Lachine, Vaudreuil and Brome Lake, Knowlton; further 1 ♂, Minaki, Ont. (the most westerly record), a small series from Orillia, Ont. and vicinity and specimens from Fredericton, N. B. *Nymphs*:-Specimens from Georgian Bay region, Ont. (Clemens), Gauvreau and Mahon Lakes, near Wakefield, Que., Lachine, Vaudreuil and Brome Lake, Knowlton, Que. with the cast nymphal skins of the bred specimens mentioned above.

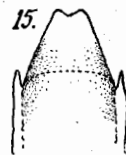
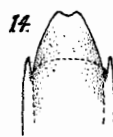
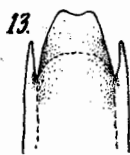
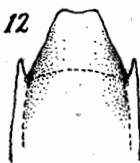
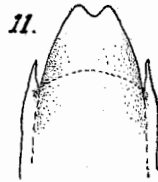
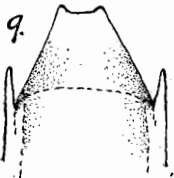
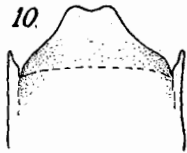
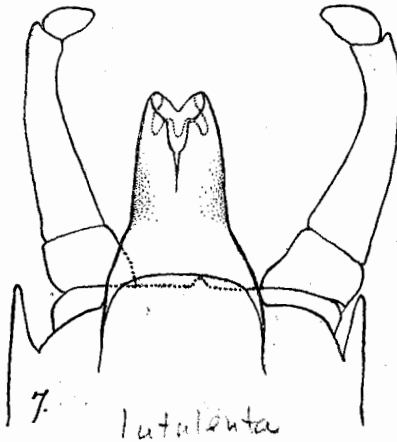
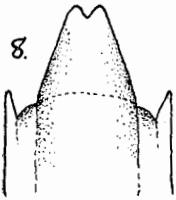
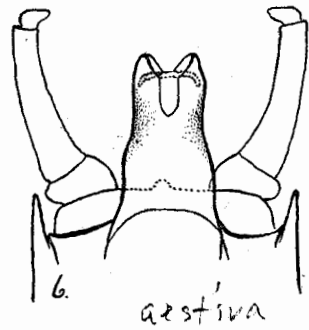
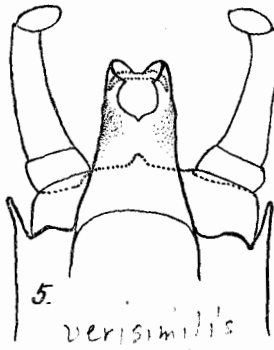
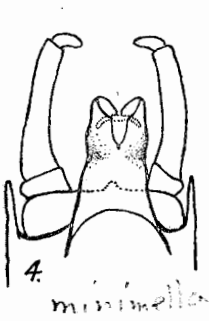
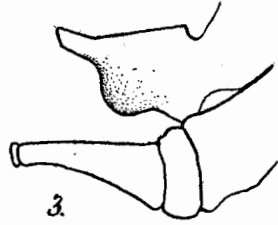
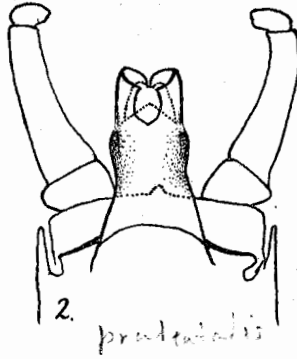
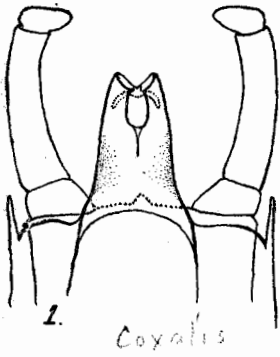
***Ephemerella coxalis* McD.**

Pl. 2, fig. 6; Pl. 5, figs. 1, 11.

Ephemerella coxalis McDunnough, 1926, Can. Ent. LVIII, 186.

Beyond figuring the male genitalia and female subanal plate I have little to add to what was said in the original description. The only other specimens before me besides the type series are 1 ♂, from Kearney, Ont. (1926) and 1 ♀, from Brome Lake, Que. (1928).

The nymph has not yet been definitely associated but I am inclined for the present to place a single nymph (fig 6) taken in 1928 in the Rideau River at Ottawa under this name; a similar nymph was taken in 1930 in the same river but attempts to breed it were unsuccessful. It is much paler in color than the other nymphs of the group, the head and thorax being heavily sprinkled with pale dots which gives them a general gray-brown appearance; the abdomen is light brown, strongly suffused laterally with pale yellowish and black and with traces of black sub-dorsal lines in the region of the tubercles; the antennae, head tubercles and dorsal tubercles are prominently whitish; the legs are pale yellowish and the usual banding, which is light brown in color is considerably reduced by pale spotting. The length of the body is over 8 mm. (the specimen before me is not quite fully grown) and the shape is broader and less elongate than usual. The occipital tubercles are not very prominent, being much as in *funeralis*; the two rows of dorsal abdominal tubercles, already well-separated on the anterior segments, diverge towards the rear until on segment VII the individual tubercles are as wide apart as the tergite is long in the median line; the tubercles of segments I-III are broad, rather short and blunt, and bent gently backward, those of segment II being about twice as wide apart as the individual tubercle is long. The lateral prolongations of segments II and III are slightly longer than in *temporalis*, those of the gill-bearing segments being much



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longer and narrower and more incurved than in either this species or *lutulenta*. The greatest width of segment VIII is to its length in the median line as 35:9. The operculum is broadly oval, shows faint dark longitudinal veining and has the joint marked by a pale line as well as a narrow, oval pale median patch. Ventrally the abdomen is largely pale, due to the partial fusing of the pale sprinkling of dots; the curved row of four black dots is present. The setae are light brown with the merest traces of pale banding.

It seems quite probable that it is this nymph which Needham erroneously figures (1905, Bull. 86, N. Y. Sta. Mus. Pl. IX, fig. 1) as that of *excrucians* Walsh, a species which I have already shown as belonging in an entirely different section of the genus.

***Ephemerella funeralis* McD.**

Pl. 2, fig. 5; Pl. 3, fig. 3; Pl. 4, fig. 4; Pl. 5, fig. 10

Ephemerella funeralis McDunnough, 1925, Trans. Roy. Soc. Can. (3) XIX, Sec. V, 210.

In contradistinction to *lutulenta* and *temporalis* the present species occurs in the vicinity of small mountain streams, where the nymph may be found in the quieter stretches of water; the main flight occurs in the latter half of June but odd specimens still appear in early July. In the vicinity of Knowlton *funeralis* is quite common and the large, very black-winged subimago can frequently be beaten from trees bordering the numerous brooks of this region. The nymph was first bred by Messrs. Walley and Milne in 1930 although the association had been suspected from similar nymphs secured the previous year; it is a noteworthy fact that in the long series of nymphs collected not a single male nymph has been found and it would therefore appear as if the species were confined to the female sex as is the case with *Ephemerella rotunda* Mørg. The doubtful male Allotype should probably be referred to *verisimilis*; in any case until actual male nymphs have been bred or the sexes taken *in coitu* it would seem wiser to consider the male as nonexistent.

A useful character in separating this species from allied forms, apart from its dark color, is found in the practically entire lack of the curved row of black dots on the ventral sternites, these dots being quite prominent in the following species with which it might otherwise be confused. The oval depression in the pronotum which I stressed in the original description is not as good a character as I imagined at the time as it is present to a greater or less degree in both *temporalis* and the following new species; it is, however, useful in separating the species from *verisimilis* in which the depression is obsolescent. As already noted the subimago has very unicolorous, deep black wings with rather bright yellow legs; there is a fairly prominent dark spot at the apex of the femora.

The nymph is rather unicolorous brown and does not seem subject to as much color-variation as is shown in the preceding species; the maculation of the femora is very indistinct and while the pattern is essentially the same as that found in *temporalis* the contrasting shades of black-brown and pale yellow usual in well-colored specimens of this latter species is entirely lacking. The normal nymph, when mature, is quite large, averaging between 8.5 and 9.5 mm., but it was noticed that in the same stream a smaller race or strain would often occur which in a full-grown state would hardly exceed 7 mm.; adults bred from these smaller nymphs exhibited no differences, other than that of size, from

the larger form. The head shows well-developed, rounded, occipital tubercles, about half the size of those of *temporalis*. The two rows of dorsal abdominal tubercles are distinctly divergent from the first to the seventh segments, the distance between the individual tubercles on segments V-VII being fully as great as the length of the respective tergites in the median line; in this feature *funeralis* agrees with *lutulenta* and differs from *temporalis*. The tubercles of segments I-III are very erect, thin and taper to a blunt point; they are longer than in either of the preceding species, being usually about two-thirds as long as the distance between the tubercles of segment II; as usual the tubercles of IV-VII are flatter, shorter and more spine-like. The lateral prolongations of segments II-VIII reach their maximum development in this species, those of II and III being very strong whilst on the following segments they are drawn out and acuminate; the lateral edges of segment IX are subparallel, each edge terminating in a distinctly incurved spine, a feature that is one of the best means of distinguishing *funeralis* from the other members of the group in which the sides of this segment are decidedly convex and the apical spine is not incurved. The greatest width of segment VIII as compared to its median length is as 32:10. The operculum of the fourth segment either shows no maculation or is very indistinctly sprinkled with paler dots; the hinge-line is not indicated in pale color. Ventrally the curved row of four dark dots is obsolete as in the imago, but traces of the lateral rows of dashes are visible under the integument. The setae are unicolorous brown with the segmental divisions of a few of the basal segments narrowly margined with deeper brown.

MATERIAL EXAMINED. *Adults*:- Type series and other specimens from Covey Hill, Que.; 4 ♀ from Kearney and Sand Lake, Algonquin Park, Ont.; long series of females from the Knowlton, Que. region including bred specimens; 4 ♀, 2 subimagos from Thunder River, Que. on the north shore of the Gulf of St. Lawrence, with one bred specimen. *Nymphs*:- Good series from both the Knowlton and Thunder River regions, and a few from Covey Hill, Que.

***Ephemerella prudentalis* n. sp.**

Pl. 2, fig. 7; Pl. 3, fig. 4; Pl. 4, fig. 3; Pl. 5, figs. 2, 3, 12.

Male. Scarcely separable from *E. temporalis* McD. except on characters of genitalia, the color of the abdominal tergites being perhaps slightly darker in dried specimens and the average size somewhat smaller. As in *temporalis* and in contradistinction to *funeralis* the black spots on the pale ventral surface of the abdomen are very distinct; there is also a distinct black spot subdorsally on each coxa. In the genitalia the penes show a ventral globular swelling about midway from base to apex at the point where they bend rather sharply upward; this swelling is best seen from a lateral view and in dried specimens has a tendency to collapse and form a depression.

Female. Somewhat darker than *temporalis* females, the head being a deep, rather than a pale, yellow with the usual darker shadings; the rear segments of the abdomen dorsally tend to pale brown rather than to ochreous and ventrally there is considerable brownish suffusion; the subanal plate is somewhat shorter than in *temporalis* but noticeably longer and narrower than in *funeralis*. Length of body 8 mm.; of wings 8 mm.

Holotype—♂, Knowlton, Que., June 25, 1929, (L. J. Milne); No. 3190 in the Canadian National Collection, Ottawa.

Allotype—♀, Knowlton, Que., June 24, 1929, (L. J. Milne).

Paratypes—28 ♂, 15 ♀, taken in the vicinity of Knowlton, June 22-26, 1929 by Messrs. Walley, Milne and McDunnough, certain ones of these captured *in coitu*.

The species was very common in 1929 swarming at dusk in the vicinity of the small mountain streams south of Knowlton on the Bolton Pass road; it was also secured at Fulford, Que. June 22, and at Waterloo, Que. June 27. There are further a few specimens in our collection from Kearney, Ont. taken by F. P. Ide. A single male from Covey Hill, Que. is before me (June 18, 1927, Walley) and it is quite probable that at least one of the females doubtfully recorded by me as *temporalis* (1925, Trans. Roy. Soc. Can. XIX, Sec. 5, 212) belongs here.

We were too late to obtain nymphs of the species at Knowlton in 1929 but fully expected to do so in 1930 when collecting was started two weeks earlier, however, the species was already swarming by June 8 and it was only by chance that a single late nymph was secured in Knowlton Creek and bred through to a ♂ imago on July 1; two other similar nymphs were found among material collected from the Mid-Yamaska River at Foster, Que. on June 11, and three more from Brome Lake collections on June 18. In the Gatineau region a single nymph was secured in 1930 from the Lapeche River at Wakefield, Que. and a number were taken in Gauvreau Lake, four miles distant, early in June; from one of these latter a female imago was bred. I also have examined a single nymph from Kazubazua, Que.

The nymph is about the size of *funeralis* (8-9 mm.) and resembles in color of abdomen and legs a dark *temporalis*; occasional specimens with the pale dorsal stripe are met with. The occipital tubercles are present in both sexes but only moderately developed, being hardly more than rounded excrescences. The tubercles comprising the two dorsal rows on the abdominal segments I-VIII are widest apart on the anterior segments and converge distinctly towards segment VII where the width between them is scarcely one-half the median length of the tergite. Those of segments I-III are finger-like and bluntly tapering but shorter, flatter and less curved than in any of the preceding species, the distance between the two on segment II being greater than twice the length of a tubercle; the tubercles of segments IV-VII do not differ so decidedly from those of the anterior segments as was the case with the preceding three species, being merely slightly shorter and flatter and rather more acuminate. The lateral prolongation of segment II is short, but still forms a distinct spine, that of III is longer, the spine being, however, much shorter than in *funeralis*; the other prolongations are much as usual. The greatest width of segment VIII as compared to its median length is as 32:9. The operculum is well sprinkled with pale dots and the hinge-line is defined by pale; there is also a small, oval, pale patch in the centre of the anterior portion. Ventrally, as in the imago, the curved row of four dots and the lateral longitudinal dashes are present on segments I-VII. The setae are not noticeably banded but the segmental incisions are defined by a darker ring.

• From *lutulenta* and *funeralis* the nymph is easily separable through the much closer proximity of the dorsal tubercles on V-VII; *temporalis* differs in the stronger occipital tubercles and the longer and more approximate dorsal tubercles on I-III.

(to be continued)

Excerpt from Canadian Entomologist, March, 1931.

THE BICOLOR GROUP OF THE GENUS EPHEMERELLA WITH PARTICULAR REFERENCE TO THE NYMPHAL STAGES* (EPHEMEROPTERA)

BY J. MCDUNNOUGH

Ottawa, Ont.

(Continued from page 42)

The following four species are very closely allied and in the adults possess no very definite characters for specific distinction, even the male genitalia failing in this respect. This leads me to believe that we are dealing with a group the individuals of which have split away either from each other or from a parent form at a comparatively recent date and that even now fresh species may be in the act of formation. The nymphs offer much better specific characters and, once recognized, are not readily confused; long series of bred material may result in the discovery of good adult characters but for the present I am basing my conception of the different species largely on nymphal distinctions.

***Ephemerella bicolor* Clem.**

Pl. 2, figs. 13-15; Pl. 3, figs. 6, 6a; Pl. 4, fig. 7; Pl. 5, fig. 14

Ephemerella bicolor Clemens, 1913, Can. Ent. XLV, 336, Pl. VI, fig. 3; id. 1915, Cont. Can. Biol. 123, Pl. XIV, fig. 1; McDunnough, 1925, Trans. Roy. Soc. Can. (3) XIX, Sec. V, 212; id. 1930, Can. Ent. LXII, 57, Pl. VIII, fig. 5.

The identity of this species has been definitely established by an examination of Clemens' adult types, including the nymphal skins, and also a long series of nymphs collected by Clemens in the Go Home Bay region.

Based on our bred material *bicolor* would appear to be rather a paler-colored species than the other members of the group; in the male the brown of the abdominal tergites has a distinct olivaceous tinge whilst the sternites are pale with only slight brownish tinges on the anterior ones; apart from some black streaks near the lateral flange there is normally little maculation but some specimens (possibly those from nymphs with pale dorsal stripe) show a palish dorsal stripe which is usually bordered with fine, broken, dark, subdorsal lines and cut by a similar-colored median one. The legs are rather pale yellow with black spots on the brown-tinged coxae; there may be traces of slightly ruddy tinges at the apex of the femora but never definite dark spots. In the female the head is pale yellow with variable blackish shades or patches on the vertex on each side of a slight median ridge; between this black shading and the eyes is usually some brown coloration which at times extends forward to the rear of the ocelli.

The species occurs during the latter part of June and early July; in 1930. in which year the spring was earlier than usual, specimens began to appear in our cages as early as June 12.

As pointed out by Clemens the nymph is very variable in coloration, the pale specimens with black or brown bandings on the thorax and posterior segments of the abdomen presenting quite a striking appearance. The size also varies markedly in various sections of the country; Georgian Bay nymphs (Clemens' type material) when full-grown average between 6 and 7 mm.; those from the St. Lawrence river in the Lachine-Vaudreuil region are much larger, nearly 8 mm. long and correspondingly broader; at Brome Lake, Knowlton, the size at maturity is only slightly larger than that of Georgian Bay specimens whilst in the Mississquoi river at South Bolton we found very small nymphs plentifully which did not exceed 6 mm. in length at the time of emergence. There was nothing in the structural characters of all these which would indicate a specific difference. The head is without occipital tubercles in the male, although frequently there are faint indications of these in the female. The two rows of dorsal abdominal tubercles are strongly divergent from front to rear, *a rather abrupt increase in width between the individual tubercles occurring on segment V*; on this and on the two following segments the width between the tubercles is about equal to the length of the respective tergite in the median line but there is a certain amount of individual variation and in some specimens this width is scarcely that of the length of the segment. The tubercles of segments I-III are rather short, chunky and hardly tapering, on II and III being about half as long as the distance between them; on the gill-bearing segments the tubercles are somewhat shorter, flatter, more pointed and spine-like. The postero-lateral spines on segments II and III are very weakly developed, that of I being merely a slight angle in the lateral contour; on the posterior segments the spines are well-developed, curving gracefully backward and tipped with black, their outer edge furnished with short spinules interspersed with longer hairs. Segment VIII at its greatest width is about four times as wide as its length on the mid-dorsal line (23:6). On the operculum the hinge-line is generally outlined in pale color and there is frequently an oval patch in the middle. Ventrally the curved row of four black dots is normally (but not constantly) present as are also the short lateral dashes. The setae show indications of pale banding but not nearly so noticeably as in *aestiva*; the legs on the other hand, appear more distinctly banded, the femora being pale yellowish, crossed by two brown bands which are sparsely dotted with pale color, and the tarsal joint showing a very prominent dark band.

MATERIAL EXAMINED. *Adults*:- Clemens' types from Georgian Bay region, Ont.; bred adults from Lachine and Vaudreuil, Que. and long series of captured specimens from the St. Lawrence valley region (Prescott, Vaudreuil, St. Anne's, Beauharnois, Lachine, Laprairie, St. Lambert); bred adults from Brome Lake, Knowlton, Que. and Mississquoi river, South Bolton, Que.; a small series from the vicinity of Wakefield, Que. including one bred ♂ from the Lapeche river; a few odd specimens from the Ottawa region, none bred; a few doubtful specimens from Boiestown and Fredericton, N. B. *Nymphs*:- Clemens' collection from the Georgian Bay region; long series from the Lachine and Knowlton regions and a few specimens from the Lapeche river, Wakefield, Que.

Ephemerella minimella n. sp.

Pl. 2, figs. 11, 12; Pl. 4, fig. 5; Pl. 5, fig. 4

Male (in alcohol). Eyes orange; head between the eyes yellow with brown shading around the ocelli; thorax dorsally deep brown, shaded with yellowish laterally and in the sutures; abdomen dorsally deep brown on segments I-VII, shaded with paler color on VIII-X; slight smoky shading subdorsally on I-IV; a fine brown dorsal line and a pair of blackish subdorsal dots on the anterior margins of segments, becoming fainter on VII-X; on segments VIII and IX fine subdorsal lines coalesce with the dorsal line on posterior portion of segments; short, oblique black streaks and longer longitudinal black lines occur just above the lateral flange, most distinct on anterior segments. Ventrally the thoracic sternites are rather bright brown, the abdominal ones pale brown shading into light creamy on the last two segments; a curved row of four minute dots distinctly visible on segments II-VII. Forceps pale; setae pale, ringed at joints with blackish. Legs rather bright yellow with a black spot on each brown-tinted coxa and a distinct brown spot at apex of each femur. Length of body 6 mm.; of fore-wing 6 mm.

Holotype—♂, Knowlton, Que., July 7, 1930; bred from nymph taken in Knowlton Creek by L. J. Milne; No. 3216 in the Canadian National Collection, Ottawa.

As compared with alcohol specimens of *bicolor*, bred from Brome Lake and Lachine nymphs, the brown of thorax and abdomen is deeper, and the yellow of the legs is brighter. Our *bicolor* specimens show further scarcely any traces of the dorsal line and subdorsal spots of *minimella*, nor is there more than a trace of the apical brown femoral spot; whether, however, these are specific or merely individual characters can only be determined by further breeding. A *verisimilis* male in alcohol, bred from a nymph from the Yamaska river at Foster Power Plant, shows the subdorsal dark dots of *minimella* but lacks the middorsal line and the thorax is much paler in color.

The male nymph (according to the nymphal skin from which the holotype emerged) is very similar to a small *bicolor*, agreeing in the entire lack of occipital tubercles. The lateral prolongations of the abdominal segments are also similar, especially those of II and III which are very weak; the lateral edges of VIII and IX are, however, less convex and more subparallel than is the case in *bicolor*. In the dorsal abdominal tubercles is found the best point of distinction; these are much longer, thinner and more upright, especially those of segments V-VII, which are fully twice the length of those of the same segments in *bicolor*; the two rows diverge very evenly without an abrupt broadening on segment V and segments VIII and IX show also short spines. The width between the tubercles of segments V-VII is rather less than the median length of the respective segments. The setae are unbanded. Length, 6 mm.

A small series of nine nearly mature nymphs taken in the Mississquoi river at South Bolton on June 30 and July 10 appears to agree with the above nymphal skin, in these the dorsal tubercles being even longer and thinner than in the Knowlton Creek specimen. The female nymphs show slight traces of occipital tubercles, much as in *bicolor*. The femora are dark with four or five isolated yellowish spots, which sometimes coalesce to form a partial band. A

few pinned adults, taken near Sweetsburg, Que. (Knowlton region) on July 8 and 15 and a small series from Burk's Falls, Ont. (July 9-14) may belong here but it is impossible to compare dried specimens with alcoholic material with any degree of accuracy and the matter must be left until pinned bred specimens are available for study; these specimens can hardly be placed in *bicolor* on account of the darker ventral abdominal surface.

***Ephemerella aestiva* n. sp.**

Pl. 2, fig. 10; Pl. 3, figs. 5, 5a; Pl. 4, fig. 6; Pl. 5, figs. 6, 13.

Male. Hardly to be distinguished from large *bicolor*; the color of the thorax is a slightly deeper brown than in *bicolor*; the first seven abdominal tergites are rather evenly deep brown and the last three bright brown; a somewhat paler dorsal stripe, cut by a fine brown median line and bordered by similar darker lines, is present in the holotype but obscure in some of the paratypes. Ventrally segments I-VII semihyaline, the first three tinged with brown; segments VIII and IX opaque whitish, shaded with light brown; curved row of four dark dots, faint in holotype, better defined in some paratypes. Forceps pale. Setae banded with ruddy-brown at incisions. Legs light yellow with a dark spot laterally on coxae; mid and hind femora with traces of darker shading in median area and a slight dark streak terminally. The genitalia are scarcely distinct from those of *verisimilis*. Length of body 6 mm.; of forewing 6 mm.

Female. Head pale yellow, with the central portion of the vertex obscured with blackish shades between which and the eyes is some rather ruddy-brown shading. Thorax and abdomen dorsally deep brown. Ventrally the abdominal segments (as far as can be determined) are paler, segment VIII is largely a rather bright brown and segment IX is pale whitish centrally, with the lateral and posterior portions, including the subanal plate, a bright brown; the black dots of the male sex are not very evident (except in one specimen). Size similar to that of male.

Holotype—♂, Vaudreuil, Que., July 12, (G. S. Walley) (bred from nymph 153); No. 3213 in the Canadian National Collection, Ottawa.

Allotype—♀, same data (bred from nymph 254).

Paratypes—8 ♂, Vaudreuil, Que., July 6, 9, 10, 12; 1 ♀, Vaudreuil, Que., July 9; 1 ♀, Lachine, Que., July 22; 3 ♀, Foster Power Plant, Knowlton region, Que., Aug. 6, 12, all bred.

I am unable to offer any satisfactory characters whereby the adults may be separated from those of *bicolor*; the nymphs of the two species are, however, quite easily separable and for this reason I am convinced the species is a good one. Material with no definite nymphal associations must, for the present, remain only doubtfully determinable.

The nymph is rather small, averaging about 7 mm. in length. The general color is dark brown, slightly sprinkled with pale dots; there are generally traces at least of a paler median abdominal stripe, bordered by darker shades and cut by a median dark line. The legs are dark brown and the pale banding on the femora is reduced, especially on the two hind pair, to small oval spots, interspersed with sparse pale dots. The femora themselves are shorter and chunkier than in any of the allied species, the length of the ventral edge of the

hind femur being slightly more than twice the greatest width of the femur (16:7); this character, once recognized, is easily the best means of separating the species from *bicolor* and *verisimilis*. The occipital tubercles are present in both sexes and moderately prominent. The two rows of dorsal abdominal tubercles are subparallel; there is some slight variation in the distance between the individual tubercles of each pair but in general those of segments I-III are noticeably wider apart than in *bicolor* whilst those of the gill-bearing segments are scarcely as wide apart as the median length of the tergite. The tubercles themselves are moderately long, rather narrow and bluntly tapering on the first three segments, becoming, as usual, flatter and more acuminate on segments IV-VII. With respect to the lateral prolongations of the abdominal segments, the spines of II and III are somewhat stronger than in *bicolor* and those of the posterior segments, especially VIII and IX, are more produced and not so gracefully curved inward as in this species and *verisimilis*; the lateral edges of the prolongations are well furnished with spinules to the almost entire exclusion of the longer hairs predominating in *bicolor*. The operculum is well sprinkled with pale dots and shows a small oval pale patch in the middle; the joint is at times faintly defined by a pale line. Ventrally the curved median row of four black dots and the short lateral dashes are generally distinct; the two central dots of the row, however, show a tendency to become obsolescent. The setae are deep brown with alternate pale yellow bands.

We first met with the nymphs in 1929 when a few rather immature specimens were secured from the Mid Yamaska river at the Foster Power Plant in early July; later (July 24) a small series of more mature nymphs was dredged from the Massawippi river at North Hatley. At the time we supposed them to be slightly variant *bicolor* and it was only after a more careful study on returning to Ottawa that the distinctness of the species became evident. In 1930 the nymphs were found plentifully at Vaudreuil, Que., below the railway bridge, in late June and early July and the type series of adults was bred from this material and from a few specimens secured in the Yamaska river, where, however, it was quite rare. The nymph matures later in the season than any of the allied species and it is worthy of note that on June 25 at Vaudreuil—where a large race of *bicolor* also occurs—nymphs of this latter species were quite mature, whereas those of *aestiva* were still young and certainly not in their final instar; on July 4 when *aestiva* nymphs were reaching maturity, no *bicolor* nymphs at all could be found; there is probably a two-weeks difference, roughly speaking, between the times of emergence of these two species and in view of the extreme similarity of the adults the date of capture will undoubtedly prove an important factor in determining the species. In the Knowlton district the species appears even later than at Vaudreuil and apparently is not on the wing until August long after even the stragglers of *bicolor* have disappeared.

***Ephemerella verisimilis* McD.**

Pl. 2, figs. 8, 9; Pl. 3, figs. 7, 7a; Pl. 4, fig. 8; Pl. 5, fig. 15.

Ephemerella verisimilis McDunnough, 1930, Can. Ent. LXII, 57, Pl. VIII, fig. 4.

In 1930 Mr. W. J. Brown succeeded in breeding several specimens from the nymph at Brádore and definitely established the association I tentatively made at the time of description; nymphs were also found at Thunder River, Que., considerably west of the type locality.

As noted in the original description the dark color of the abdomen, particularly the ventral surface, and the deep yellow of the legs should separate the species from *bicolor* and *aestiva*.

The typical nymph from the Bradore region, while close to that of *bicolor*, is not really hard to separate. The size is larger than even that of the large Lachine form of *bicolor*, averaging well above 8 mm. in length with occasional females attaining 9 mm. The head tubercles are present in both sexes and quite well-developed. The two rows of dorsal tubercles are slightly wider apart on the anterior segments than in *bicolor*, diverging very gradually and evenly towards the rear without the sudden increase in width found on segment V of this latter species; the distance between the tubercles of segments V-VII is generally slightly less than the median length of the respective tergite although specimens occur in which the lengths are equal. The tubercles themselves are somewhat longer than in *bicolor*, especially those of the posterior segments; they are also more erect, with distinctly more pointed apices. The lateral spines of segment II and especially segment III are better developed whilst on the other segments these prolongations are much as in *bicolor*. The width of segment VIII at its widest point as compared to its length in the median line is as 10:3. The setae show absolutely no tendency toward pale banding. In the legs the dark banding of the femora has been much reduced in Bradore specimens but in the small series from Thunder River (which includes specimens even larger than those from Bradore) the darker bands are more evident and much as in *bicolor*.

Small series of nymphs taken in June in various small streams of the Knowlton region have proved very puzzling. The first lot was taken in Knowlton Creek about three miles south-east of town on June 21, 1929 but none were bred; these nymphs, (figs. 8, 9) whilst differing from *bicolor* and agreeing with *verisimilis* in the length of the lateral abdominal prolongation of segments II and III and the length and arrangement of the dorsal abdominal tubercles, are smaller (7 mm.) than typical *verisimilis* and have the occipital tubercles practically lacking in the males and reduced in the females. In 1930 a series of 5 males, 4 females was bred between June 11-20 from very similar nymphs from the Bolton Pass Creek; in these nymphs, however, the occipital tubercles were better developed, being at least indicated and frequently quite strong in the males as well as in the females; an odd male was also bred on July 4 from a similar nymph from the Mississquoi river at South Bolton. In the Mid Yamaska river, at Foster Power Plant, six miles north of Knowlton; mature nymphs were found on June 11 and a series of 4 males bred between June 13-19; in these nymphs the occipital tubercles are at least indicated in both sexes but the dorsal tubercles of segments I-IV are somewhat shorter and blunter than in the preceding lot and also consequently than in typical *verisimilis*. Finally 3 large, mature specimens (1 male, 2 females) were sorted out of collections made at Knowlton Creek near the railway bridge on June 7; these agree with the Bolton Pass series. The adults resulting from the above-mentioned breedings approach in the darker colors of the abdomen (notably the ventral surfaces), legs and female head (where this sex is definitely known), *verisimilis* rather than *bicolor*, although typical Bradore specimens are larger and still deeper in color than our Knowlton ones; the male genitalia, while not precisely similar, also bear

out this association. As the range of *funeralis* has been found to extend northward as far as Thunder River there seems no valid reason why both species should not occur around Knowlton and for the present I prefer to treat the Knowlton specimens as slight variations of *verisimilis* rather than as a new species.

MATERIAL EXAMINED. *Adults*:- Type series and numerous other specimens from Bradore, Que. collected in 1929 and 1930 by W. J. Brown and including bred material; 2 ♀, Trinity Bay, Que.; a small bred series from the Knowlton region as indicated above; also 5 ♂, (pinned) and 6 ♂ in alcohol, collected in Bolton Pass swarming at dusk (June 15) and several females from the Foster region; 1 ♂, Covey Hill, Que. (Allotype of *funeralis*) odd females from the Algonquin Park region, Ottawa and St. Lawrence districts, and a pair from Boiestown, N. B. All captured material placed here provisionally on account of the dark ventral surface of the abdomen. *Nymphs*:- Long series from Bradore Bay and Thunder River, Que.; series from the Knowlton region as noted above.

EXPLANATION OF PLATES

PLATE 2

1. Nymph of *Ephemerella temporalis* McD. ♀, Brome Lake, Que.
 2. " " " " ♀, (striped form), Brome Lake, Que.
 3. " " " *lutulenta* Clem. ♂, (striped form), Georgian Bay.
 4. " " " " ♀, Georgian Bay.
 5. " " " *funeralis* McD. ♀, Knowlton district.
 6. " " " *coxalis* McD. ?, ♀, Rideau River, Ottawa, Ont.
 7. " " " *prudentialis* McD. ♀, Brome Lake, Que.
 8. " " " *verisimilis* McD. ♂, Knowlton Creek, Knowlton, Que.
 9. " " " " ♀, " " " " " " " "
 10. " " " *aestiva* McD. ♂, Yamaska River, Foster, Que.
 11. " " " *minimella* McD. ♂, Mississquoi River, Foster, Que.
 12. " " " " ♀, " " " " " " " "
 13. " " " *bicolor* Clem. ♂, (small form), Mississquoi River, S. Bolton, Que.
 14. " " " *bicolor* Clem. ♀, " " " " " " " "
 15. " " " *bicolor* Clem. ♀, (large form), Lachine, Que.
- All enlarged to about three and a half times the actual length.

PLATE 3

1. Head of nymph of *Ephemerella lutulenta* Clem.
2. " " " " *temporalis* McD.
3. " " " " *funeralis* McD.
4. " " " " *prudentialis* McD.
5. " " " " *aestiva* McD.
- 5a. Right hind leg of nymph of *Ephemerella aestiva* McD.
6. Head of nymph of *Ephemerella bicolor* Clem.
- 6a. Right hind leg of nymph of *Ephemerella bicolor* Clem.
7. Head of nymph of *Ephemerella verisimilis* McD.
- 7a. Right hind leg of nymph of *Ephemerella verisimilis* McD.

PLATE 4

1. Abdominal segments I, II and VII of nymph of *Ephemerella lutulenta* Clem.
2. " " " " " " " " " *temporalis* McD.
3. " " " " " " " " " *prudentialis* McD.
4. " " " " " " " " " *funeralis* McD.
5. " " " " " " " " " *minimella* McD.
6. " " " " " " " " " *aestiva* McD.
7. " " " " " " " " " *bicolor* Clem.
8. " " " " " " " " " *verisimilis* McD.

PLATE 5

1. Male genitalia of *Ephemerella coxalis* McD. (Dorval, Que.)
2. " " " " *prudentialis* McD. (Knowlton, Que.)
3. " " " " " " " (lateral view)

4.	"	"	"	"	<i>minimella</i> McD. (Holotype)
5.	"	"	"	"	<i>verisimilis</i> McD. (Bolton Pass, Que.)
6.	"	"	"	"	<i>aestiva</i> McD. (Paratype)
7.	"	"	"	"	<i>lutulenta</i> Clem. (Orillia, Ont.)
8.	Female subanal plate of				<i>Ephemerella lutulenta</i> Clem. (Gauvreau Lake, Que.)
9.	"	"	"	"	<i>temporalis</i> McD. (Brome Lake, Que.)
10.	"	"	"	"	<i>funeralis</i> McD. (Covey Hill, Que.)
11.	"	"	"	"	<i>coxalis</i> McD. (Vaudreuil, Que.)
12.	"	"	"	"	<i>prudentialis</i> McD. (Knowlton, Que.)
13.	"	"	"	"	<i>aestiva</i> McD. (Lachine, Que.) (Paratype)
14.	"	"	"	"	<i>bicolor</i> Clem. (Lachine, Que.)
15.	"	"	"	"	<i>verisimilis</i> McD. (Bradore Bay, Que.)