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THE EASTERN NORTH AMERICAN SPECIES OF THE GENUS
EPHEMERELLA AND THEIR NYMPHS (EPHEMEROPTERA)*

Ottawa, Ont.

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In a recent paper (1931, Can. Ent., LXIII, 30 *et seq.*) I reviewed the *bicolor* group of the genus *Ephemerella* and in the present one I purpose dealing with the remainder of our eastern species and tabulating the results of breeding experiments, carried on during the past three years by Messrs. Walley, Milne and myself, as far as they relate to this genus.

Leaving out of consideration for the present the members of the *bicolor* group, there have been thirty-one names proposed for *Ephemerella* species from eastern North America; further one holarctic species, *aurivillii* Bngtssn. (*norda* McD.), has been found to occur in Ontario and Quebec Labrador. Of these species *consimilis* Walsh and *unicornis* Needh. still remain unidentified; the former was described from a single male from Rock Island, Illinois, the type has been destroyed and the description is too brief to be of much service; the latter name was based on a male subimago from Elkhart, Indiana, and the distinguishing character given, *viz.* the presence of a small horn-like protuberance on the mid-anterior section of the mesothorax, occurs sporadically in several species very similar in the subimago stage. Until extensive collections can be made in the type localities of these two species their identity must for the present remain problematic.

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Five of the above thirty-one names become synonyms; *atrescens* McD. falls to *deficiens* Morg., *inflata* McD. to *lata* Morg., *bispina* Needh. to *fuscata* Wlk., *vernalis* Banks (♂) and *feminina* Needh. (♀) to *rotunda* Morg. Of the remainder, five species are still unknown to me in the nymphal stage; these are *frisoni* McD. described from Illinois and belonging in the *serrata* group; *molita* McD., known only from two female specimens from Quebec Labrador and New Brunswick; *excrucians* Walsh, *semiflava* McD. and *fratercula* McD. which all belong to the typical section of the genus (type, *excrucians*) and, judging by the similarity of the male genitalia in the group, will probably be found to possess nymphs very closely allied to those of *invaria* and *rotunda*.

Various attempts have been made to separate off from this rather complex group individual species whose characters have at the time been considered of sufficient importance to warrant subgeneric or even generic names. My own studies in *Ephemerella* nymphs have not proved to my satisfaction the correctness of the existing subdivision; on the contrary it has seemed to me as if the importance of individual characters, caused largely by environmental conditions during the nymphal stage, has been overemphasized. When we find that a nymphal character, such as the notched frontal shelf, which is said to characterize the subgenus *Eatonella* Needh. (1927, Ann. Ent. Soc. Am. XX, 108) is present in one nymph (*fuscata* Wlk.) and not in another one (*tuberculata* Morg.) but that the two adults are so closely related in genitalic structure and other details as to be almost inseparable, we are forced to ask ourselves whether the separation of these two obviously closely related species under different subgeneric titles is helping to put our classificatory system on a sounder basis than it possessed previously. Does it not rather seem as if an individual character which crops up in isolated instances among a group of nymphs capable of extraordinary structural diversification has been accorded greater taxonomic value than it deserved?

I am a firm believer in the axiom that the only completely satisfactory classificatory system will be one in which *in all stages* the characters dovetail in with and supplement one another, but when I find, as I have shown for *Chitonophora* Bngtssn. (1930, Can. Ent. LXII, 55), and as anyone by a study of the present illustrations can demonstrate to their satisfaction, that, by using solely the nymphal characters said to pertain to the genus or subgenus, a completely different arrangement of our North American species is obtained to one which is based on the given adult characters, then, I maintain, such characters are not capable of being used for purposes of subdivision other than specific.

Now that the larger proportion of our North American species of *Ephemerella* can be recognized in both the adult and nymphal stage a certain grouping or arrangement of species according to characters drawn from *both* stages seems possible. The typical section of the genus would comprise the eastern species *excrucians* Walsh, *semiflava* McD., *dorothea* Needh., *rotunda* Morg., *invaria* Wlk., *subvaria* McD. and *fratercula* McD. as well as the western *inermis* Eat. and *infrequens* McD. In all these species the male adults show a very similar type of genitalia, the united penes broadening out somewhat apically with the lateral edges projecting in the form of short blunt processes.

thus forming the sides of a shallow excavation; there is an armature of minute spines scattered over the apical section (*vide* Can. Ent. 1925, LVII, 169, Pl. 4, fig. 1; Trans. Roy. Soc. Can. 1925, (3) XIX, Sec. 5, Pl. 1, figs. 5, 6). The apical portion of the second joint of the forceps may or may not be enlarged but this is purely a specific character and has no value in a generic or subgeneric sense; the third joint is short and conical.

The nymphs, as far as known, belong to a rather generalized type and are difficult to separate; the head and thorax are smooth, the legs show no particular modifications; overlapping gills occur on segments III-VII and the lateral edges of the abdominal segments are somewhat flattened with the posterior angle forming a slight projection; the abdomen dorsally may be smooth or provided with a double row of small, flat spines, quite distinct from the erect tubercles found in other members of the genus. They frequent the swifter parts of streams and are most frequently met with along the banks among grass roots and refuse.

The three species *aurivillii* Bngtssn. (*norda* McD.), *septentrionalis* McD. and *needhami* McD. must be regarded, to my mind, as slight modifications of or developments from this typical section. In the male genitalia (*vide* Can. Ent., 1924, 223, Pl. 5, fig. 5; 1925, 171, Pl. 4, figs. 2, 3) the lateral apical edges of the penes have been drawn out to form longer and sharper projections; the armature of small spines is still present in a somewhat modified degree in the first two species but lacking in *needhami*, which further shows none of the apical lateral expansion of the typical section. Whilst in *aurivillii* there has been no change in leg structure we meet with a lengthening of the male fore-tibia in *needhami* which is carried to a remarkable extent in *septentrionalis*, where all the tibiae are extraordinarily long.

The nymphs of all three species still show smooth heads and thoraces; in general appearance *aurivillii* bears the greatest resemblance to the nymphs of the previous group, the postero-lateral edges of the abdomen being rather more drawn out and the flat spines of the dorsum somewhat longer; in *needhami* a development of strong erect dorsal abdominal tubercles has occurred whilst in *septentrionalis* we find the same abnormal leg development that is present in the adult, the nymphs presenting a very spidery appearance. All these species show a great preference for living among grass-roots or mossy growths below overhanging banks and are seldom found beneath stones.

A second compact group of quite small species includes *deficiens* Morg., *serrata* Morg., *serratoides* McD., *sordida* McD., and *frisoni* McD. These are characterized in the male genitalia by the presence of a small barb-like process on the lateral apical edge of the penes, projecting dorsally and best seen when viewed from the side; the forceps are of the normal type with short third joint and no apical swelling to the second one (*vide* Trans. Roy. Soc. Can. 1925, (3) XIX, Sec. 5, 212, Pl. 1, fig. 1). The nymphs have smooth or at the most slightly roughened heads and thoraces and overlapping gills on segments III-VII; with the exception of *deficiens*, they show a double dorsal abdominal row of broad, short, blunt tubercles or warts, covered with short spicules and based on the posterior margin of the segment; the length of the postero-lateral prolongations of the abdominal segments is variable and the tails are provided with whirls of short spinules, situated at the segmental joints.

A third section comprises *fuscata* Wlk., *tuberculata* Morg., *lata* Morg., *cornuta* Morg., *cornutella* McD., *depressa* Ide and several of our western species of the *coloradensis* group. The adults are rather heavy and clumsy in appearance and blackish in coloration. In the male genitalia the third joint of the forceps is at least twice as long as wide and the second joint is either strongly curved or irregularly swollen; the penes are quite simple, narrowed apically with a small apical notch and bent upwards almost at right angles about half-way between base and apex (*vide* Bull. 86, N. Y. Stat. Mus., 1905, Pl. x, fig. 9; Trans. Am. Ent. Soc., 1923, XLIX, Pl. viii, figs. 2 and 4). The nymphs are very highly specialized and show a great amount of diversification in respect to head-structures and abdominal tubercles but all agree in having broad and tuberculate anterior femora and overlapping gills on segments III-VII, (Morgan's statement that in *lata* and *tuberculata* the gills are on segments III-VIII is a *lapsus calami*); they may be very hairy or almost glabrous but the tails, in contrast to those of the preceding group, are clothed with long hairs and not spinose. They are all distinctly inhabitants of swift water and occur under rocks or submerged pieces of wood, frequently at considerable depth and in places where the current is full of silt.

Attenuata McD. and *simplex* McD. are two rather aberrant species which appear to connect up the *fuscata* with the *bicolor*-group. The male genitalia of the former species show a greatly drawn-out third joint of the forceps whilst in *simplex* this joint is scarcely longer than broad. The western *margarita* Needh., known definitely only from the nymph, also belongs here. The nymphs agree in possessing overlapping gills only on segments IV-VII, those of III being lacking; in other respects, as a reference to the following key to the nymphs will show, there is only a general similarity between them.

The *bicolor*-group forms the last section in the genus. I have already fully discussed this group and would only note the distinguishing features of the nymphs are the presence of gills on segments IV-VII, covered almost entirely by the operculum of the fourth segment, and further the prolongation of the postero-lateral angles of the abdominal segments into long spines. The western *hecuba*, for which Needham has proposed the subgeneric term, *Timpanoga*, is probably only an extreme development of this type.

In the following key to nymphs I have omitted the species of this last section; a key to these may be found in my previous paper.

KEY TO KNOWN EASTERN SPECIES OF EPHEMERELLA NYMPHS

1. Gills on segments 4-72
Gills on segments 3-75
2. Gills almost entirely covered by operculum of 4th segment. *bicolor* group
Gills overlapping but not covered by operculum3
3. Abdominal tergites without double row of tubercles*simplex* McD.
Abdominal tergites with double row of tubercles projecting from rear margin of segment4
4. Vertex of head with pair of strong tubercles; prothorax similarly armed;
length 10 mm.*attenuata* McD.
Vertex of head unarmed; tubercles of prothorax reduced to slight warts;

- length 5-6 mm. *margarita* Needh.
5. Head with a broad notched frontal shelf; all femora broad and flat
..... *fuscata* Wlk.
Head without notched frontal shelf 6
6. Fore femora much broader than those of hind pairs of legs, with anterior
margin toothed or tuberculate 7
All femora of more or less equal thickness; no teeth on front pair. 10
7. Vertex of head with pair of long tubercles *tuberculata* Morg.
Vertex of head smooth 8
8. Head with triangular ledge projecting over base of each antenna. *lata* Morg.
Head with curved, horn-like projection arising at base of each antenna. 9
9. Size large (body length 10 mm.); small tubercle about middle of lateral edge
of pronotum; mid and hind tibiae moderately long. *cornuta* Morg.
Size small (body length 6-7 mm.); lateral edge of pronotum almost smooth;
mid and hind tibiae relatively considerably shorter. *cornutella* McD.
10. Legs noticeably long and spidery, size 7-8 mm. *septentrionalis* McD.
Legs of normal length and thickness 11
11. Abdominal tergites with double row of elevated, finger-like tubercles
..... *needhami* McD.
Abdominal tergites otherwise 12
12. Abdominal tergites entirely without tubercles or spines; small species. 13
Abdominal tergites with at least traces of two rows of spines or tubercles. 14
13. Color blackish with frequently a pale median thoracic stripe; caudal setae
with whorls of short spines situated intersegmentally. *deficiens* Morg.
Color brown with sprinkling of pale dots; caudal setae with apical half
clothed with long fine hairs. *dorothea* Needh.
14. Armature of abdominal tergites consisting of short, sharp, flattened spines,
often much reduced; caudal setae clothed with long hair in apical section;
size moderate to large 18
Armature of abdominal tergites consisting of small, rounded, spicule-bearing
warts; caudal setae with whorls of short spines only; size small. 15
15. Prothorax with pair of small median warts near posterior margin; a lateral
row of black dashes ventrally. *serrata* Morg.
Prothorax smooth 16
16. Posterolateral edges of abdominal tergites 8 and 9 strongly flattened and
drawn out into long spines; no ventral maculation. *sordida* McD.
Abdominal tergites 8 and 9 not drawn out into long spines; ventral macu-
lation of dark dots and dashes. 17
17. Color brown with heavy sprinkling of pale dots. *serratoides* McD.
Color black with white patches on head below antennae and median and
submedian thoracic pale stripes; abdominal tergites 5 and 6 whitish with
pink median and submedian dashes. ? *serratoides* form
18. Posterolateral edges of abdominal tergites drawn out into long spines, that
of the eighth segment being fully twice as long as wide at base; legs
moderately long, hind tibia slightly longer than femur. *aurivillii* Bngtssn.
Posterolateral edges of abdominal tergites less drawn out, the spine of the
eighth segment being scarcely longer than broad at base; legs considerably

- shorter with hind tibia shorter than or subequal to the femur.....19
19. Abdominal spining much reduced, at times obsolescent.....*invaria* Wlk.
Abdominal spines short but distinct, larger species.....20
20. Abdominal spines quite short; color evenly dark with a double row of pale spots on abdominal tergites at base of spines.....*rotunda* Morg.
Abdominal spines longer; color on abdomen more variegated, tergites 6 and 7 being at times almost entirely pale*subvaria* McD.

Section I (typical section)

The eastern species of this section may, as already noted, be divided into two groups. In the first, which includes *excrucians* Wlsh. and *semiflava* McD., the second joint of the male forceps is not enlarged apically as is the case in the second group, comprising *dorothea* Needh., *subvaria* McD., *rotunda* Needh., *invaria* Wlk. and *fratercula* McD. The three modified species, *aurivillii* Bngtssn., *septentrionalis* McD. and *needhami* McD. I place at the end of the section as noted in the introduction.

Ephemerella excrucians Walsh

Ephemerella excrucians Walsh, 1862, Proc. Acad. Nat. Sci. Phil. 377; Eaton, 1884, Rev. Mon. Rec. Ephem. 130; McDunnough, 1925, Can. Ent. LVII, 169, Pl. IV, fig. 1; Ide, 1930, Can. Ent. LXII, 211.

I am basing my identification of this species on the specimens in the Cambridge Museum which I believe to be the only authentic Walsh material now in existence. Needham's identification is something entirely different and probably contains a mixture of species as I have previously noted.

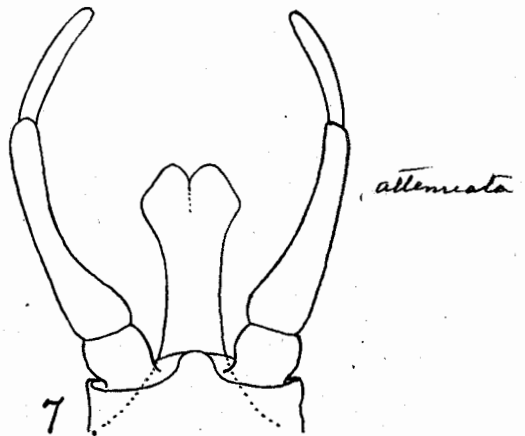
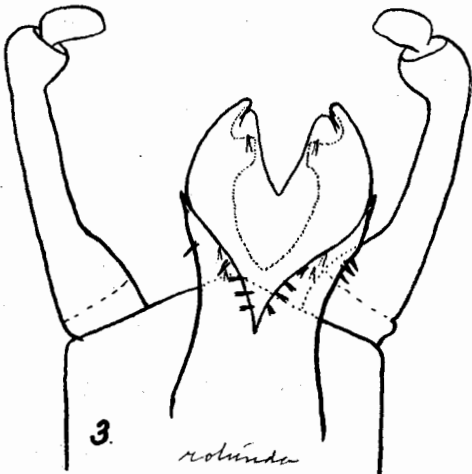
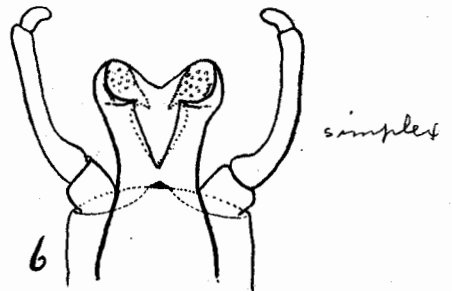
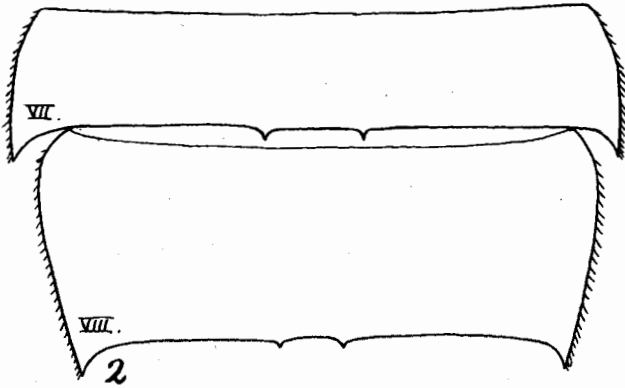
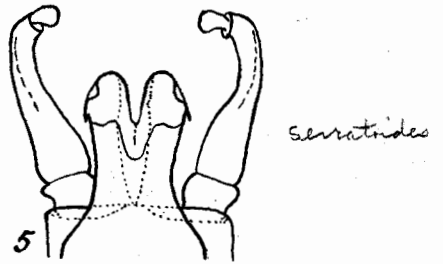
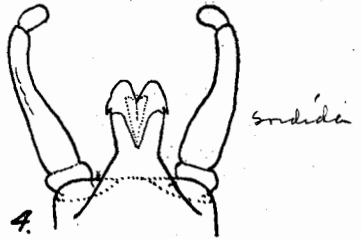
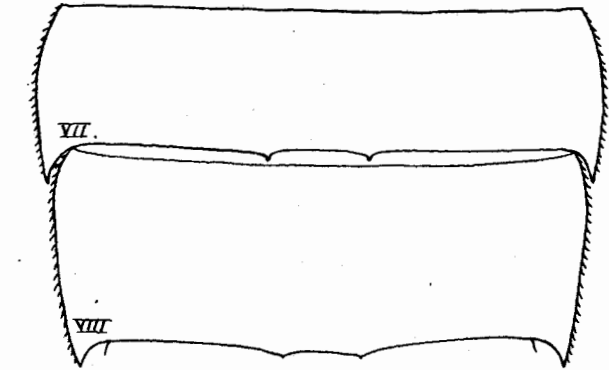
I would call particular attention to the fact that Walsh definitely states that the eyes are *egg-yellow* in the living male, which is rather a rare occurrence and should render the species readily identifiable when collections can be made at Rock Island, Ill., the type locality.

Specimens before me from the Upper St. Lawrence river (Kingston, Prescott) as well as single males from Knowlton, Que. and Fredericton, N. B. agree in genitalia with a toptotypical specimen in the Canadian National Collection, collected by Walsh in 1863, which I consider identical with the male specimen at Cambridge, marked by Banks as the type. Our St. Lawrence specimens are, however, duller in color and, as far as I can tell from dried material, more likely to have red-brown eyes when living than egg-yellow ones; there is therefore a likelihood that they are not Walsh's species but until we can secure data on the nymphs I prefer to let the matter rest. The nymph is unknown.

Ephemerella semiflava McD.

Ephemerella semiflava McDunnough, 1926, Can. Ent., LVIII, 300.

I believe now that there is a great likelihood that this species will fall as a synonym of *excrucians* Walsh. The color of the eyes in the living male points very strongly in this direction as does the similarity of genitalia. The paler abdominal and thoracic coloration is probably merely due to the type specimen being rather teneral. Further collections and nymphal associations are needed from the Tilsonburg region to settle the matter.



Ephemerella dorothea Needh.

Pl. XIII, fig. 5.

Ephemerella dorothea Needham, 1908, 23rd Rep. St. Ent. N. Y., 190; McDunnough, 1925, Trans. Roy. Soc. Can. (3), XIX, Sec. 5, 212, Pl. X, figs. 3, 4.

My note regarding this species and *cornuta* in the "Canadian Entomologist," 1928, p. 238 should be disregarded; it was based on a misassociation of nymph and adult. Our direct breeding experiments at Knowlton, where the nymphs were very abundant in the small mountain brooks, showed conclusively that my original reference of the Covey Hill specimens to *dorothea* was correct. The falsely associated nymphs occur in the same brooks as *dorothea* and prove to be those of the recently described *cornutella* McD.

The living males have bright red eyes which with their pale yellowish bodies renders them very beautiful objects; in the females the vertex of the head is rather bright red in well-colored specimens and the dorsal portion of the abdomen suffused with ruddy. The wings of the subimago are very pale smoky. Needham's figure of the male genitalia gives a good general idea of this organ but the position of the spines on the penes is not distinct; as in *invaria* there are lateral and dorsal groups and in addition scattered ventral spines in the same apical area as in *fratercula*.

The small brown, pale-speckled nymph with smooth head and no abdominal, dorsal spines has been well described in Needham's paper; in general characters it fits in excellently with the other known nymphs belonging to this section. It might easily be confused with the darker colored nymphs of *invaria* but apart from its rather slimmer shape and smaller size it is less hairy, showing scarcely any of the long hairs which clothe the dorsal edge of the femora in *invaria*, their place being taken by a single row of spicules; the postero-lateral spines are short, and the entire lack of dorsal abdominal spining is also useful as a means of separation as *invaria* nymphs usually show at least a trace of such spines.

MATERIAL EXAMINED. *Adults*:- Series of both sexes from Covey Hill, Que., Knowlton region, Que.; 2 ♂, Boiestown, N. B.; 3 ♂, 1 ♀, Gorham, N. H.; 1 ♂, 4 ♀, Blount Co., Tenn.; 1 ♂, Black Mts., N. C. *Nymphs*:- Long series from the Knowlton region.

Ephemerella subvaria McD.

Pl. XI, fig. 2.

Ephemerella invaria (dark form), McDunnough, 1925, Trans. Roy. Soc. Can., Ser. 3, XIX, Sec. 5, 213; Ide, 1930, Can. Ent., LXII, 211.

Ephemerella subvaria McDunnough, 1931, Can. Ent., LXIII, 84.

As noted in the original description this species is best separated from *rotunda* and *invaria* by the generally darker and duller coloration of the body and by the decidedly dark veins and crossveins on the wings. The male genitalia appear to offer no very good characters for separation although it might be noted that the two small apical ventral spines are generally lacking. The wings of the subimago are much deeper in color than the rather pale smoky ones of both *invaria* and *rotunda*. The nymph was first associated in 1930 from material collected in the St. Lawrence river at Cascades Point, Que. by Messrs. Walley and Milne. It is scarcely as large as that of *rotunda* and the dorsal abdominal spines are much better developed than in this species and not so flattened; the lateral prolongations are much as in *rotunda*. The coloration is frequently paler,

the dorsum of abdominal segments VI and VII being at times almost entirely pale and V with only a median subtriangular patch, contrasting strongly with the dark segments VIII and IX; the double dorsal row of pale spots is not present in the specimens examined. From the St. Lawrence form of *invaria*, mentioned later, which occurs in the same locality, it is readily separated by the presence of the dorsal spines. It also emerges a week or two earlier, being one of the first species to appear around Ottawa in the spring.

MATERIAL EXAMINED. *Adults*:- Long series of both sexes (including type material), from Cascades Pt., Lachine, Coteau du Lac, Que.; Prescott, Ottawa, Horning's Mills, Ont. *Nymphs*:- Series from Cascades Pt., Que.; Horning's Mills, Ont., including nymphal skins of bred specimens.

***Ephemerella rotunda* Morg.**

Pl. XI, fig. 1, 3; Pl. XIII, fig. 1.

Ephemerella sp. Needham, 1905, Bull. 86, N. Y. Sta. Mus., 45, Pl. X, fig. 7.

Ephemerella rotunda Morgan, 1911, Ann. Ent. Soc. Am., IV, 113; McDunnough, 1926, Can. Ent., LVIII, 188.

Ephemerella vernalis Banks, 1914, Proc. Acad. Nat. Sci. Phil. LXVI, 614; McDunnough, 1925, Trans. Roy. Soc. Can. (3), XIX, Sec. 5, 213.

Ephemerella feminina Needham, 1924, Psyche, XXXI, 309.

The name was based originally on a female imago and several nymphs from the vicinity of Ithaca, N. Y. Later Needham, under the name *feminina*, called attention to the interesting fact that in that section of the state the species apparently only occurred in the female sex and reproduced parthenogenetically.

In 1930 in the late afternoon of June 4 Messrs. Walley and Milne found subimagos of both sexes emerging freely from a brook about 3 miles south of Knowlton, Que. and a series was secured which later produced adults; full grown nymphs were taken at the same spot and several of these bred through to adults to verify the tentative association. On returning to Ottawa it was found that the nymphs corresponded exactly with material of *rotunda*, kindly presented by Dr. Needham.

A careful study of slides of the male genitalia showed their absolute similarity to those of *vernalis* Banks, based on a male paratype in the Canadian National Collection; I have already noted the resemblance in genitalia between this species and *invaria* Wlk. but with more material at my disposal believe that the two may be satisfactorily distinguished by means of the spining of the apical section of the penes. *Invaria* (see my figure *op. cit.*, 1925, Pl. I, fig. 6) shows several lateral spines, dorsal spines at the apex of the V, and a single ventral apical spine; in *rotunda* (*vernalis*), besides these there are two small clusters of ventral spines (1-4) immediately beneath the dorsal ones which I have not found in any of the many slides of *invaria* before me. *Fratercula* McD. also shows ventral spines but these are situated more apically than those of *rotunda* and in addition the dorsal spines are lacking.

Apart from the larger size it is difficult to point out any satisfactory characters whereby the females of *rotunda* and *invaria* may be separated, the greater width of the head and the longer hind femur in *rotunda* are often useful but must be used with caution; direct breeding or more or less definite association with the male sex remains for the present the best means for correct determination. In the Knowlton region the species appears a week or ten days earlier than *invaria*, as far as our records go, and this is the only

Canadian locality in which *rotunda* is definitely known to occur although some unbred female specimens from Covey Hill, Que. and the Gatineau region look suspiciously like the species. Females, apparently parthenogenetic, have been taken in numbers along the Rideau river at Ottawa; these I place provisionally with *rotunda* as female nymphs, unbred as yet, from the same stream certainly are very close to our Knowlton nymphs although considerably lighter in color and with dorsal spines slightly less evident.

The nymph has already been described and certain of its details figured by Needham and Morgan; as compared with *invaria* it is larger, the double row of flat dorsal spines is better developed, each spine, although small, being distinctly evident and based on a small, round, pale spot situated on the posterior margin of segment; the postero-lateral edges of the segment are slightly more drawn out; the convexity of the outer margin of the pronotum is greater; the color of both thorax and abdomen is dark, sprinkled with fine pale dots, with little tendency to form any pattern except the above-noted double row of pale dots which, however, is not specific, being found generally in the nymphs of this section.

MATERIAL EXAMINED. *Adults*:- ♂ Paratype, *vernalis* Bnks.; ♀ series, McLean, N. Y. May 3, ♀ series, Rideau riv. Ottawa, Ont., (June); 8 ♂, 32 ♀, Knowlton, Que., June 20, 1927, June 12-14, 1928, June 4-13, 1930. *Nymphs*:- series from McLean, N. Y.; Rideau riv. Ottawa, Ont.; Knowlton, June 4, 1930, including nymphal skins of bred specimens.

***Ephemerella invaria* Wlk.**

Pl. XIII, fig. 3.

Baetis invaria Walker, 1853, List Neurop. Ins. Brit. Mus., III, 568.

Ephemerella invaria Eaton, 1884, Rev. Mon. Rec. Ephem., 129; McDunnough, 1925, Trans. Roy. Soc. Can. (3), XIX, Sec. 5, 212, Pl. I, fig. 6; Ide, 1930, Can. Ent. LXII, 211.

This species, very similar to *rotunda*, appears to have a more northerly distribution. It occurs commonly in both sexes around all the smaller streams of the Gatineau region in early June and will probably be found throughout northern Ontario as the type specimens came from the Albany river; in the Ottawa river it is replaced by *subvaria* McD. and in the Rideau river by the form mentioned under *rotunda*; in the St. Lawrence region, however, a female form occurs along with *subvaria* which I assign here for the present, although the nymphs are rather larger and paler than typical; apparently the same tendency towards parthenogenesis crops up occasionally in this species as was found in *rotunda*. In southern Quebec it occurs at Covey Hill, Fulford, and throughout the Knowlton region, and most probably extends into the Adirondacks.

The nymph is smaller than that of *rotunda* and, as already noted, has less pronounced dorsal abdominal spining, these spines in many cases being practically obsolete. The color is apparently variable; nymphs from the La-peche river, Wakefield, Que. and from Fulford, Yamaska river, Que. are pale ochreous, heavily sprinkled with brown dots; this sprinkling may be evenly distributed, or it may form crossbands of dark color across the anterior portion of the pronotum and between the bases of the wing pads on the mesonotum; the abdominal rows of pale dots found in *rotunda* are frequently present and in addition segments V and VI often show large lateral pale patches, the tendency being towards a coalescing of the pale areas to form an almost en-

tirely pale dorsum. Twenty miles north of Wakefield, in the Kazubazua river, the nymphs are considerably darker with heavier and more evenly distributed dark sprinkling whilst in the entire region south of Knowlton they are very dark, resembling in this respect small *rotunda*, brown being the predominant color with the ochreous reduced to mere sprinkling. Finally female nymphs from the St. Lawrence river (Cascades Pt.) besides being rather larger, are entirely without dorsal spines; they are as pale as our palest Wakefield ones and segments V and VI show only slight median brown sprinkling; they resemble considerably our Rideau river *rotunda* but the postero-lateral edges of the segments are scarcely produced enough for them to be placed here. More extensive breeding will be necessary to decide the status of these forms but so far I have been able to detect no sufficient differences in the adults to warrant specific separation.

MATERIAL EXAMINED. *Adults*:- Series of both sexes from Burk's Falls, Ont.; Kearney, Ont.; Wakefield, Que.; Kazubazua, Que.; Covey Hill, Que.; Fulford, Que.; and the Knowlton region, Que.; females from St. Lawrence region (Lachine, Vaudreuil). *Nymphs*:- Series from Wakefield, Kazubazua, Fulford, Knowlton and the St. Lawrence region, all early June; nymphal skins of bred specimens from Wakefield and Knowlton.

***Ephemerella fratercula* McD.**

Ephemerella fratercula McDunnough, 1925, Trans. Roy. Soc. Can. (3), XIX, Sec. V, 213, Pl. I, fig. 5.

I have nothing to add to the original description where the points of distinction from *invaria* were noted and illustrated. The nymph is still unknown and the type locality, Covey Hill, Que., is the only one at which the species so far is known to occur.

***Ephemerella aurivillii* Bengtssn.**

Pl. XIII, fig. 2.

Chitonophora aurivillii Bengtsson, 1908, K. Sven, Vet. Akad. Arsbok, VI, 243; *id.* 1909, Lunds Univ. Arssk. N. F. Afd. 2, V (4), 8; *id.* 1930, *op. cit.* XXVI, (3), 3.

Ephemerella aronii Eaton, 1908, in Esb. Pelt., Tromso Mus. Aarsh. XXV, 149; Walley, 1930, Can. Ent. LXII, 17, Pl. II, fig. 6; McDunnough, 1930, Can. Ent. LXII, 55; *Id.*, 1930, Can. Ent. LXII, 211.

Ephemerella norda McDunnough, 1924, Can. Ent. LVI, 223, Pl. V, fig. 5.

Chitonophora aurivilliusi Lestage, 1930, Bull. & Ann. Soc. Ent. Belg., LXX, 204.

This species has already been very fully discussed in the above-mentioned literature and I have nothing further to add on the subject.

(to be continued)

Excerpt from Canadian Entomologist Sept. 1931.

THE EASTERN NORTH AMERICAN SPECIES OF THE GENUS
EPHEMERELLA AND THEIR NYMPHS (EPHEMEROPTERA)*

BY J. MCDUNNOUGH,
Ottawa, Ont.

(continued from page 197)

Ephemerella septentrionalis McD.

Pl. XIII, fig. 4.

Ephemerella septentrionalis McDunnough, 1925, Can. Ent., LVII, 171, Pl. IV, fig. 2.

This species, described from a single rather imperfect male specimen, was found very abundantly in certain sections of the Knowlton, Que. region in 1929 and 1930, the adults swarming at dusk and mating on warm evenings in the latter half of June. The very striking nymph was also secured in the small brooks of the Bolton Pass section, four or five miles south of Knowlton. The following notes on the species are offered to supplement the original description.

Subimago. Pale dull yellowish with light greyish wings and setae; the rear segments of the abdomen in the male are slightly shaded with brown; traces of a brown dorsal line on anterior abdominal segments; ventrally a brown median line, extending on to the thoracic segments and four black dots on each segment, arranged in a curved row across the segment. Legs pale yellowish with apex of each femur tinged with brown.

Imago. *Male*. Eyes (living), light orange-red; head brownish; thorax and dorsum of abdominal segments 1-7 similar in color, being a dull olive to smoky brown, with traces of poorly defined black lateral dashes on the abdomen; segments 8-10 dorsally bright brown with a ruddy tinge; thoracic pleura and sterna yellowish with ruddy tinges; abdomen ventrally pale yellowish hyaline with the last two segments opaque and deeper in color; a broken brown median stripe frequently is present, often extending forward to the base of the forelegs and the four dark dots of the subimaginal stage are present. Legs very long, pale yellowish with the femora tipped with brown; length of joints of foreleg as follows: 35 : 50 : 22 : 25 : 20 : 9. Setae whitish, faintly ringed with red-brown.

Female. Light yellowish, tinged with brownish on mesonotum and dorsum of abdomen; head behind the ocelli bright ruddy brown with a narrow yellow strip next each eye. Maculation as in the male sex but the mid-ventral brown stripe usually better defined. Subanal plate rather flat and broadly truncate at apex. Legs as in male but the fore tarsi greatly reduced in length, being about half the length of the tibia.

Nymph (in alcohol). Long, narrow, with very long legs; color light yellow-brown, caused by a heavy sprinkling of minute brown dots on a pale yellow ground-color. Head smooth, narrow, considerably longer than wide, with heavier brown shading in median area than at sides. Prothorax smooth,

about twice as wide as long, with fairly well defined subdorsal brown longitudinal stripes, between which the color is paler than elsewhere. Mesothorax with anterior margin rather heavily shaded with black-brown and with a prominent pale spot on each side about midway between the median line and the antero-lateral angle; faint traces of paler lateral spots at base of scutellum; wing pads sprinkled evenly with brown. Abdomen smooth, heavily sprinkled with brown dots and with a narrow brown median stripe; traces of pale stripes laterally near inner margin of gills; the lateral edges are flattened and drawn out posteriorly to moderately long spines and frequently show a prominent dark brown patch in the middle; gills on segments 3-7 of the normal type; there are no dorsal spines but the posterior margin of segments 2-7 is somewhat bent upward in the median area to form a slight protuberance. Setae light brown at base, banded light yellow and deep brown in median area, and pale yellow in apical third; apical half clothed with long hairs, basal portion with whorls of shorter hairs at segmental joints. Ventrally the abdomen shows on each segment two distinct black spots, situated submedianly in a slightly paler area near anterior margin; posterior to these and closer to the median line are two fainter and smaller dark dots, often obscured by the general brown sprinkling; a black dot at the bases of each of the two hinder pairs of legs. Legs light yellow, longer than in any other *Ephemerella* nymph known to me, spidery and sparsely clothed with longish hairs; femora banded with brown at base, middle and apex; tibiae and tarsi with median brown band, obsolescent on hind tibia. Length of body 9 mm.; of tails 5 mm.

With the exception of the type, all of the material before me is from the Knowlton region.

***Ephemerella needhami* McD.**

Pl. XIII, figs. 6, 7.

Ephemerella excrucians Needham (*nec* Walsh) 1905, Bull. 86, N. Y. Sta. Mus. 47, Pl. X, fig. 8, (*partim*, ♂ adult).

Ephemerella bispina Needham, 1905, Bull. 86, N. Y. Sta. Mus. 43 (*partim*, nymph, not adult).

Ephemerella needhami McDunnough, 1925, Can. Ent., LVII, 171, Pl. IV, fig. 3.

Considerable confusion has existed regarding this species; it has been misidentified as *excrucians* Wlsh. by Needham and, to complicate matters, its nymph has been misassociated with *bispina* Needh. which belongs in another section of the genus. We have bred similar nymphs at both Wakefield, Que. and Fulford, Que. and while so far we have only been successful in securing subimagos from such nymphs, these subimagos, in conjunction with other material collected at the same time and places, make the association practically certain.

The eyes in the living male are rather bright orange-red; the amount of wine-colored suffusion on the ventral segments and on the hind femora seems variable, some specimens from the St. Lawrence valley being quite pale in this respect as compared with the types and with Fulford and Wakefield material. The presence of a curved transverse row of four minute dark dots on the abdominal sternites, best seen on the anterior ones, is a very useful character (not mentioned in the original description) and one that occurs in all stages; it can therefore be used satisfactorily in associating sexes, subimagos and nymphs and as a means of separation from the closely allied females and subimagos

of the *invaria* group. The lack of definite ruddy rings on the caudal setae, except at the extreme base, is a further character.

The *female* (heretofore undescribed) varies in color from ruddy brown to deep purplish; the vertex of the head is generally entirely bright reddish with the anterior portion pale yellowish; in some of our specimens the venter is suffused with vinous as in the male whilst in others it is yellowish with only slight traces of suffusion and in these latter specimens the ventral dots are more clearly defined than in the darker ones. In certain specimens there is evident a broad dark lateral longitudinal band on the abdominal tergites best seen in transmitted light and presumably carried over from one of the nymphal color-forms. As in the males the legs may be considerably suffused with vinous or with only traces of ruddy tinges; the setae are pale, ringed with ruddy only on the basal segments.

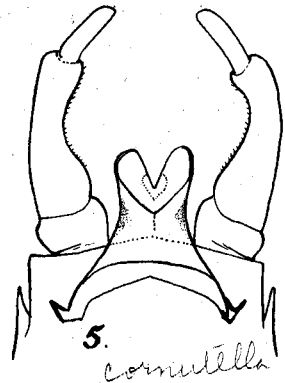
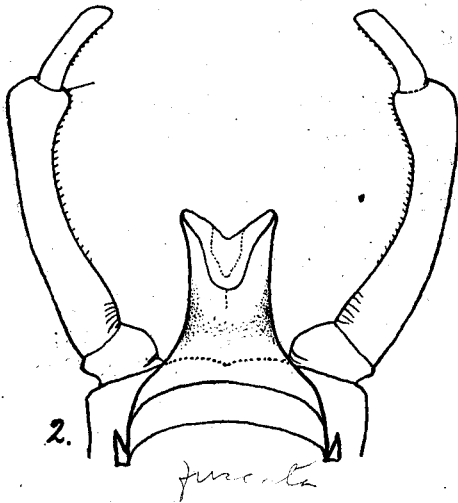
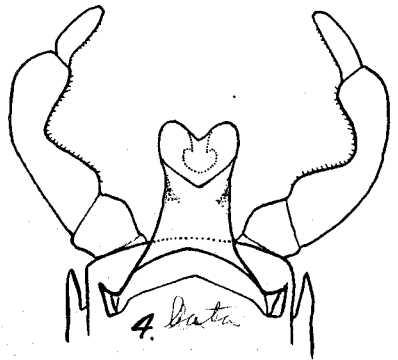
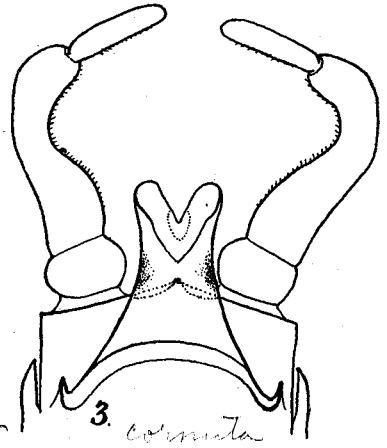
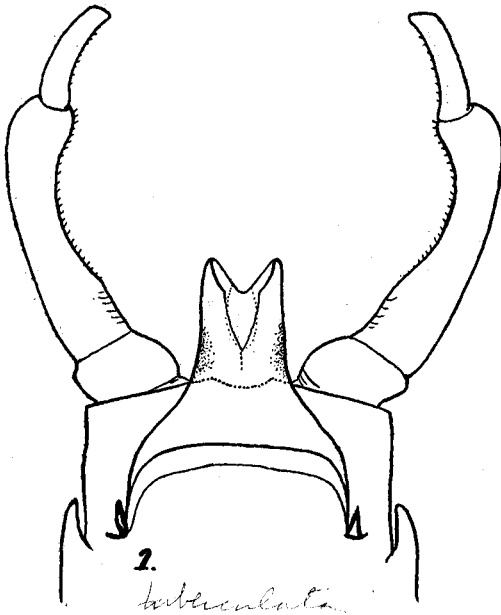
The *subimago* has very pale smoky unicolorous wings; in the male the body is nearly as dark as in the adult, in the female rather dull olivaceous; the legs in both sexes show mere traces of ruddy shades and the setae are unicolorous pale.

The *nymph* is found along with that of *invaria* among grass-roots and trash and is at once distinguished by the erect, finger-like dorsal tubercles; it is quite slender and shows very distinctly the curved row of four dots on the abdominal sternites as well as a lateral row of short dark streaks. Needham's characterization gives the other main details but it should be mentioned that two color forms occur (as figured). The ground-color varies from brown to black; generally there is a broad pale dorsal stripe from the back of head to the tenth segment, which may contain a dark median line or may be further modified into two pale subdorsal lines; this stripe is bordered by dark stripes, which, as I have pointed out, may be carried over to the adults; at times the pale stripes or lines are indistinct and the general appearance much more unicolorous brown. The lateral edge of the prothorax is pale and there is at times on the abdomen a medio-ventral series of small round pale spots one to a segment. The setae are pale, banded with dark in the apical section only, and with the long hairs of this section rather sparser than in the *invaria* group.

MATERIAL EXAMINED. *Adults*:- Type material from Laprairie, Que.; 1 ♂, Cascades Pt., Que., July 4; 1 ♂, Laprairie, Que., July 7, 1925; 2 ♂, Lachine, Que., July 6; 1 ♂, 2 ♀, St. Lambert, Que., July 3, 4; 1 ♂, St. Chrysostome, Que., June 28; 1 ♂, 2 ♀, 1 ♂ sub. (bred), Fulford, Que., June 19, 22; 1 ♂, 1 ♀, 1 ♀ sub. (bred), Wakefield, Que., June 11, 13; 1 ♂, Prescott, Ont., June 30. *Nymphs*:- Long series from Fulford, Que., June 12, 13; 4 specimens, Wakefield, Que., June 6; odd specimens from S. Bolton, Que., June 19 and Knowlton, Que., June 12.

Section II

Small species, characterized in the male adults by the presence of a short barb-like process on the lateral apical edge of the penes, projecting upward. The nymphs are either entirely without dorsal tubercles or, when these are present, they take the form of small blunt warts, feebly spiculate; the caudal setae are furnished for their entire length with whorls of fine spines, situated intersegmentally; the maxillary palpi are much reduced or entirely lacking.



***Ephemerella deficiens* Morg.**

Pl. XIII, fig. 8.

Ephemerella deficiens Morgan, 1911, Ann. Ent. Soc. Am. IV, 111, Pl. VI, fig. 4, Pl. VII, fig. 4, Pl. IX, fig. 4; McDunnough, 1929, Can. Ent., LXI, 170; Ide, 1930, Can. Ent., LXII, 211.

Ephemerella atrescens McDunnough, 1925, Can. Ent., LVII, 43; *id.* 1925, Trans. Roy. Soc. Can. (3), XIX, Sec. 5, 212, Pl. I, figs. 1, 2.

Both adults and nymphs have been satisfactorily described and I have little to add concerning the species which is a very common and widespread one.

There seems to be considerable variation in the time of appearance of the adults according to locality; at the Rideau river, Ottawa, Ont., the species first appears in early June and again about the middle of August; in the vicinity of the small streams emptying into the Ottawa river west of Hull, Que. and in the Gatineau region it occurs normally about mid-July and extends into August and the same applies to the Knowlton region where there would appear to be only a single brood each year in the mountain streams. The dates on our material from the St. Lawrence valley and Covey Hill, Que. range from late June to early July.

In 1929 on the afternoons of July 5 and 6 the species was swarming in countless numbers on the banks of the Yamaska river near the Foster Power Plant, along with *sordida* McD. From this species with which it is liable to be confused the males may be distinguished by the deep black-brown color of the abdominal tergites, the strong dark apical patch on the femora of the two hind pairs of legs, the narrow but distinct banding on the setae and the fact that the apical half of the penes is generally distinctly blackish, contrasting sharply with the basal white portion, when this latter is visible. In the female the vertex of the head is deep wine-red with slight black shading whereas in *sordida* the head is paler, being ochreous with ruddy shading.

The nymphs are generally decidedly blackish in coloration with a pale median thoracic stripe; specimens, however, occur in which either this stripe is lacking or the general body-color is a dull brown with blacker shading on the dorsal tergites. The entire lack of abdominal spining and the arrangement of the hairs on the setae serve to separate *deficiens* from other small nymphs of this genus.

MATERIAL EXAMINED. *Adults*:- Long series of both sexes from Ottawa, Ont., (June - Aug.) including type series of *atrescens*; Wakefield, Que., (June, July); Lachine, Que., Vaudreuil, Que., Laprairie, Que., (late June - Aug.); Covey Hill, Que., (June - July); Knowlton, Que. including bred series, (June, July); Fredericton, Boiestown, N. B. (July); Annapolis, N. S., (July); 1 ♂, Gorham, N. H. (July 19). *Nymphs*:- Series from Rideau River, Ottawa, Ont.; Wakefield, Que.; Covey Hill, Que.; various localities in the Knowlton region, but chiefly Foster and Fulford, Que., including nymphal skins of bred specimens.

***Ephemerella sordida* McD.**

Pl. XI, fig. 4; Pl. XIII, fig. 10.

Ephemerella sordida McDunnough, 1925, Can. Ent., LVII, 42; *id.*, 1930, *op. cit.*, LXII, 55; Ide, 1930, Can. Ent., LXII, 212.

Apart from the type series only odd specimens of this species had been

picked up until in 1929 it was found swarming on July 5 and 9 along with *deficiens* on the banks of the Yamaska river at the Foster Power Plant; two females, taken with the male swarms, tied this sex down definitely. In 1930 a few nymphs were secured and one was bred through to a female imago.

The general color of *sordida* is duller than in *deficiens*, the abdominal tergites being dull olive-brown with an obsolescent row of blackish subdorsal spots more or less visible in both sexes; the setae are unbanded, white, and in the male the apical portion of the penes, while sometimes slightly smoky is not nearly so dark as in *deficiens*; the hind femora show traces of the apical dark band of *deficiens* but this is not so pronounced. In the female the head is light ruddy ochreous with slight black sprinkling, much paler than that of *deficiens*.

The nymph is rather pale ochreous to light olive in color and is at once distinguished from its allies by the fact that the postero-lateral edges of the abdominal tergites are drawn out into long flat spines, covered with spinules, the spines of segment IX extending well beyond the posterior margin of X. The head is smooth, without much maculation but covered rather closely with short hair; the thorax is also hairy, without any definite color pattern but at times with two pale subdorsal spots between the wing-pads. The abdomen is suffused somewhat dorsally with smoky, except segments V and VI which are generally contrastingly pale; there is usually present a dorsal and lateral rows of blackish spots or dashes; the two rows of dorsal warts are most prominent on segments IV-VII and are finely spiculate, the spicules occurring also on the segments around the bases of the warts; gills are present as usual on segments III-VII. The setae are furnished with the usual whorls of spinules and show no marked banding. The legs are quite hairy with a few spinules along the dorsal edge of the femora; in well-marked individuals the femora are dark with pale median and apical bands; the tibiae are pale with a median dark band and the basal half of the tarsus is dark. Ventrally there are no dark markings. Length of body, 4-5½ mm.

MATERIAL EXAMINED. *Adults*:- Type series; 2 ♂, 3 ♀, Ottawa, Ont., July 15, 24, Aug. 7, 10, 13; 1 ♂, Cascades Pt., Que., Aug. 27; 26 ♂, 2 ♀; Foster, Que., July 5, 9; 1 ♀, Foster, July 25 (bred); 1 ♂, 1 ♀, Trinity Bay, Que., Aug. 18. *Nymphs*:- Small series from the Mid Yamaska river, Foster, Que., early July.

***Ephemerella frisoni* McD.**

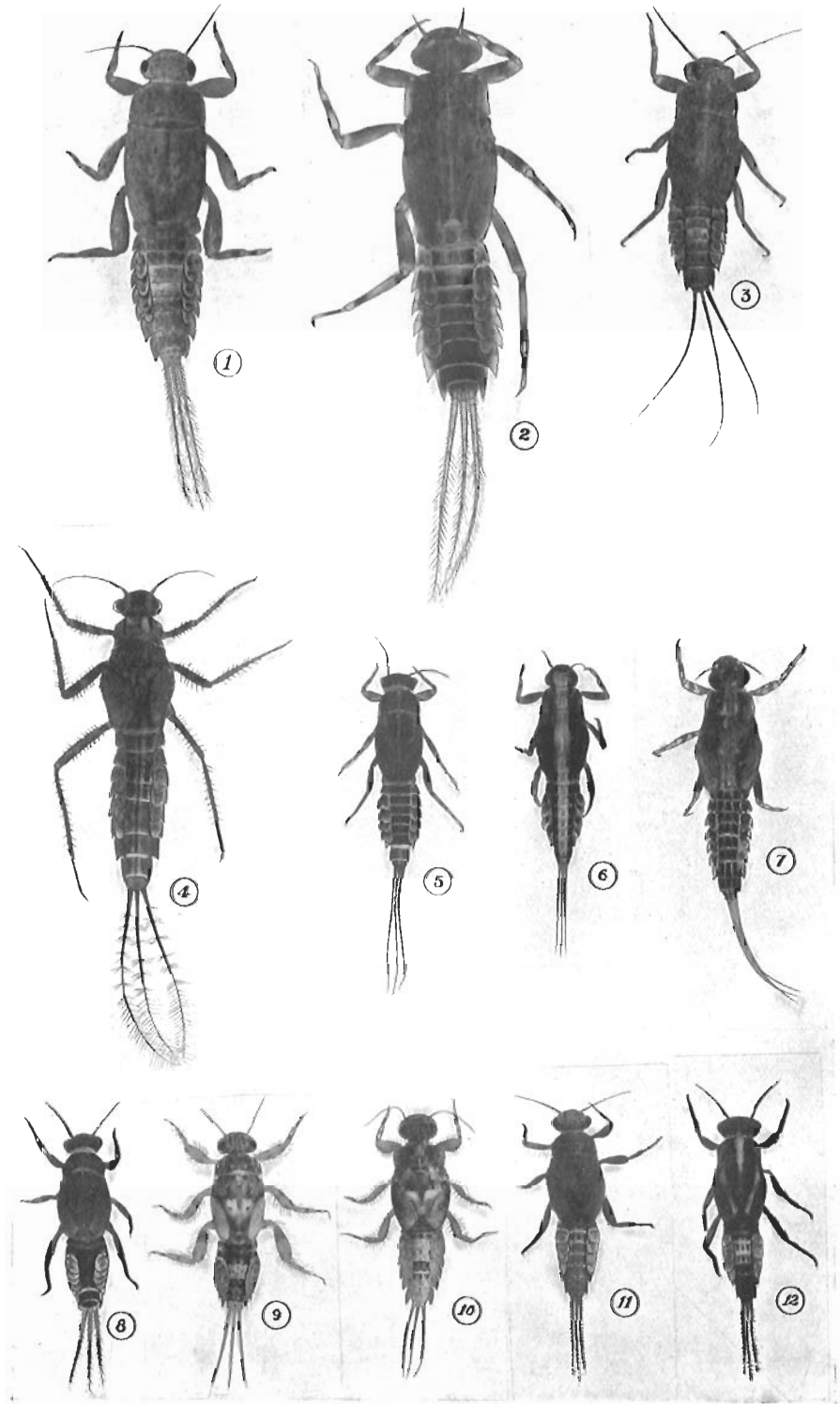
Ephemerella frisoni McDunnough, 1927, Can. Ent., LIX, 10.

The specimens of the type series are the only ones known to me. On account of the small lateral barbs at the apices of the penes I am placing the species in this group; it is at once distinguished by the pale whitish anterior abdominal segments. The nymph is unknown.

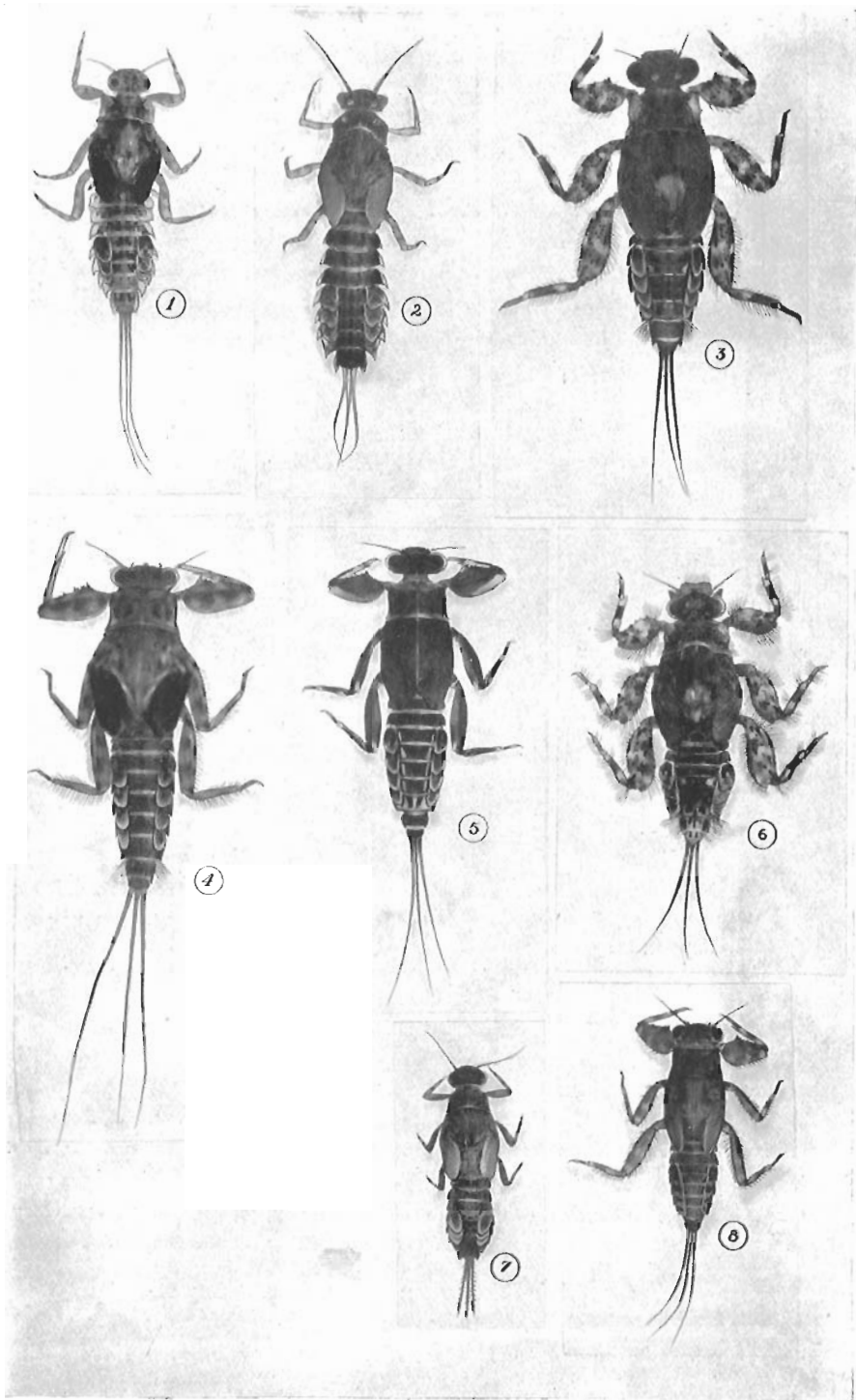
***Ephemerella molita* McD.**

Ephemerella molita McDunnough, 1930, Can. Ent., LXII, 57.

Known only from the two type females and possibly not even correctly placed in this association. It is characterized by the rather extensive brown shading at the bases of the wing.



EASTERN EPHEMERELLA SPECIES



EASTERN EPHEMERELLA SPECIES

Ephemerella serrata Morg.

Pl. XIII, fig. 9.

Ephemerella serrata Morgan, 1911, Ann. Ent. Soc. Am., IV, 110, Pl. VI, fig. 5, Pl. VII, fig. 2, Pl. VIII, fig. 2, Pl. IX, fig. 3.

Morgan's descriptions of both adult and nymph are quite adequate for correct identification. I had previously (Can. Ent., 1930, 55) confused the species with *serratoides* but the breeding of both at Knowlton in 1930 enabled me to clear up the difficulty.

The males are brighter brown in color than either *deficiens* or *sordida* with the living eyes orange-red, not chestnut-brown; the females are close to those of *sordida* with the same ruddy ochreous vertex of head; they are, however, rather brighter in thoracic coloration and generally show distinct ruddy banding on at least the basal section of the setae. Ventrally in both sexes the abdomen is without the curved row of four dark dots which characterizes *serratoides*.

In the nymph the prothoracic warts mentioned by Morgan are feeble; there is also a slight roughness noticeable on the vertex of the head. The statement that the abdomen beneath is "pale with a *median* row of linear brown spots" is liable to misinterpretation. An examination of some of the type nymphal material, kindly presented by Dr. Needham, shows that there are in reality two rows of these dark dashes ventrally, each situated about half-way between the medioventral line and the lateral edge of segment; the term *median* was probably a *lapsus calami* for *lateral* or *submedian*. Between these two rows of dashes there is no curved transverse row of four spots as in *serratoides* nymphs and this is one of the best characters for a rough identification of living material.

MATERIAL EXAMINED. *Adults*. 2 ♂, Wakefield, Que., July 13; 1 ♂, Fulford, Que. Aug. 10; 8 ♂, 6 ♀, (all bred), Foster, Que., July 17-31, Aug. 12. *Nymphs*:- Long series from the Mid Yamaska river at Foster and Fulford, Que., (July); small series from Mississquoi river, S. Bolton, Que., (July); Wakefield, Que., (July 23).

Ephemerella serratoides McD.

Pl. XI, fig. 5; Pl. XIII, figs. 11, 12.

Ephemerella serrata McDunnough (*nec* Morgan), 1930, Can. Ent., LXII, 55.

Ephemerella serratoides McDunnough, 1931, Can. Ent. LXIII, 83.

Differentiated from *serrata* as a result of breeding at Foster, Que. The present species in all stages shows a curved transverse row of four small dots on the abdominal sternites, not present in *serrata*. In the female the vertex of the head is much paler than in *serrata*, being light yellow, shaded with blackish. Numerous Ottawa specimens, collected August 23, 1924, are considerably larger than the type series but cannot be differentiated otherwise; until I can secure a knowledge of the nymph I leave them as *serratoides* for the present. The male genitalia are almost identical with those of *serrata*.

The *nymph* is brown, rather smooth, with none of the long hair on head, thorax or legs which characterizes *sordida*. Head and thorax smooth and evenly sprinkled with pale dots. Abdomen dorsally rather evenly brown, with lateral portions of V and VI paler and with traces of broken dark median line and similar lateral ones; lateral edges of segments flattened, spiculate, and drawn

out into short points, not however, as long as in *sordida*. Gills and abdominal warts as usual in the group. Setae brown, paling apically with the usual whorls of spinules. Ventrally paler with a curved transverse row of four dark dots on abdominal sternites, in addition to the lateral rows of dashes found in *serrata*. Legs brown, sprinkled with pale dots and sparsely spiculate along dorsal edges of femora. Length of body, 5-6 mm.

The type series was bred from nymphs corresponding to the above description. Along with such nymphs occurred others strikingly different in color pattern but not in structure. Adults bred from these latter could not be separated from the types of *serratoides* and for the present, until more extensive breeding of the two forms can be done, I am treating them as belonging to one species. These latter nymphs are almost black in color marked with whitish as follows (see figure); two patches anterior to the antennae, a streak between the eyes, a mid-thoracic stripe, broadest on prothorax, broad lateral stripes on pro- and mesothorax, those on the latter converging posteriorly, a stripe on each wing-pad. Abdominal segments V and VI and the median portion of IV are whitish, the former with pinkish dorsal and subdorsal streaks. The femora are dull yellowish with a broad dark stripe on the outer side. The setae are generally black with an apical pale band.

MATERIAL EXAMINED. *Adults*:- Type series (all bred); long series of both sexes, Ottawa, Ont., Aug. 23; 2 ♂, Annapolis, N. S.; 1 ♂, Trinity Bay, Que.; 1 ♂, 8 ♀, Foster, Que., July 25 - Aug. 13, (bred from second nymphal form). *Nymphs*:- Several specimens, Wakefield, Que., July, (typical form); long series of both forms from Foster and Fulford, Que., including nymphal skins of bred material.

Section III

This section includes three species which, while possibly not very closely connected according to adult characters, all possess nymphs with overlapping gills on segments IV-VII only, and thus appear to form connecting links between two of the sections. The maxillary palpi of the nymphs are well-developed and the caudal setae show at least sparse long hairs in their apical portion.

***Ephemerella simplex* McD.**

Pl. XI, fig. 6; Pl. XIV, fig. 1.

Ephemerella simplex McDunnough, 1925, Can. Ent. LVII, 41; Ide, 1930, Can. Ent. LXII, 211.

The species was bred in 1930 both in the St. Lawrence region (Cascades Pt.), where it is very abundant, and also at Knowlton, where it occurred in several of the larger streams in a smaller form. In the above year the main flight took place during the first part of July but some of our records for previous years are as early as June 20.

It is quite possible that the name will sink to *unicornis* Needh. when this species becomes more fully known; Needham's unique male subimago type, which I have carefully examined, is about the size of *simplex* subimagos and with the same type of third joint in the forceps; *simplex* also shows the small tubercle on the mid-anterior portion of the mesothorax, in common with several other of the species of the preceding group, and its distribution is known to extend into southwestern Ontario.

The larger size and brown-tinted veins on forewings together with the quite distinctive genitalia separate the males from *sordida* and its allies; the deep muddy brown head of the female and the dark olivaceous legs are also characteristic.

The *nymph* occurred at Cascades Point in very swift water, clinging to the underside of the limestone slabs and being so covered with silt as to be almost unrecognizable; the smaller Knowlton nymphs were in less rapid water. The shape is rather broad and flat, especially the abdomen, the lateral edges of segments IV-VII (and to a lesser extent VIII and IX) being drawn out into long, flat, pointed spines; there are neither thoracic nor abdominal spines or tubercles but head, body and legs are covered with long hair. The color is pale olivaceous to deep brown, with little definite maculation on head and thorax but with very variable dark shading on the abdominal tergites; this deeper coloring seems to be based on broken dark subdorsal and lateral stripes which may broaden out and coalesce to a greater or less degree; segment VI has generally two large dark rectangular patches and the following segments are paler with a central dark blotch on IX. The gills on segment IV-VII are strongly overlapping, that of IV forming a rudimentary operculum when the segments are telescoped together. The setae are pale, faintly ringed at the incisions, with weak whorls of spinules and a certain amount of fine hair in the apical half. The femora are rather chunky, those of the forelegs having a transverse median zone of long hair; when well-marked they are doubly banded with brown; the tibiae show an apical dark band and the tarsi a median one. Ventrally entirely pale, immaculate or with lateral rows of dark dashes as in *serrata*. Length of body 6-8 mm.

MATERIAL EXAMINED. *Adults*:- Long series from the St. Lawrence region (Prescott, Lachine, Laprairie, St. Annes, Cascades Pt.); Knowlton and S. Bolton, Que.; 2 ♂, 1 ♀, Boiestown, N. B.; 2 ♂, 3 ♀, Normandale, Ont.; 2 ♂, 2 ♀, Niagara Glen, Ont.; 1 ♂, Grimsby, Ont. *Nymphs*:- Series from St. Lawrence river at Cascades Pt. Que.; Knowlton Creek (below town) and Mississquoi river at S. Bolton with nymphal skins of bred specimens from all localities.

***Ephemerella attenuata* McD.**

Pl. XI, fig. 7; Pl. XIV, fig. 2.

Ephemerella attenuata McDunnough, 1925, Can. Ent. LVII, 42; id, 1930, *op. cit.* LXII, 55.

In the males this species is at once recognized by the very long third joint of the forceps; the females on the whole are larger than those of *simplex*, the head is rather roughened and generally shows traces on the occiput of the head tubercles of the nymphal stage, besides being somewhat brighter brown in color; the legs are slightly paler and the femora usually longer than in the preceding species.

The *nymph* was rather uncommon in the Knowlton region in the larger streams but in 1930 a small series was secured and bred; it is a very striking rather slender form, with a pair of strong tubercles on the occiput and another smaller pair on the posterior portion of the prothorax; the mesothorax has a small median anterior tubercle and a similar posterior one. The abdomen is somewhat flattened but not as much as in *simplex* and the postero-lateral edges of segments IV-IX are drawn out into shorter and blunter spines, the

lateral margin of VIII being distinctly and characteristically sinuate in outline. There is a double dorsal row of small, blunt tubercles, most distinct on the gill-bearing segments; gills on segments IV-VII are not so overlapping as in *simplex*, the superior ones oval in shape with a rounded apical projection on inner side. The general color is light brown; there are a few black spots on the anterior portions of the pro- and mesothorax and a single dark spot near the base of the wing-pads. The abdomen is often without much maculation; in dark specimens pale subdorsal stripes are evident and lateral pale dots on the anterior margins of the first five segments; the flattened lateral edges are pale with a median brown patch. The caudal setae are rather short, pale, with traces of a subapical dark band; they are faintly spiculate in the basal section and with numerous long fine hairs in the apical two-thirds. The legs are rather slender, pale, with a narrow, broken, median dark band on each femur, a median ring of black across the tibia and a broader dark band in the basal section of the tarsus. Ventrally with a curved median row of four dark dots and lateral rows of dashes as in *serratoides* occasionally with dark median blotches based on the anterior margin of each segment. Length of body, 6-7 mm.; of setae, 2.5 mm.

MATERIAL EXAMINED. *Adults*:- Type series and other specimens from the Ottawa, Ont. region, July-August; 5 ♂, 5 ♀, Laprairie, Que., July 21, 1 ♂, Lachine, Que., July 20; bred series from Knowlton region (S. Bolton, Foster), July 8-21; 1 ♂, Trinity Bay, Que., Aug. 14. *Nymphs*:- Small series from Mississquoi river, S. Bolton and Mid Yamaska river, Foster, Que., including nymphal skins of bred specimens.

***Ephemerella margarita* Needh.**

Pl. XIV, fig. 7.

Ephemerella margarita Needham, 1927, Ann. Ent. Soc. Am. XX, 114; id., 1927, Bull. 201, Utah Agr. Exp. Sta. 9, fig. 7; Walley, 1930, Can. Ent. LXII, 14, Pl. I, fig. 5, Pl. III, figs. 7, 8.

On July 19, 1929 we found two nymphs in Moose Brook, Gorham, N. H. which I cannot separate from western nymphs of *margarita*, among the specimens examined being some topotypical ones from Dr. Needham.

The nymphal stage is the only one known at present although I have some tentatively associated adults from Alberta which, if correctly placed, bring the species in close alliance with *attenuata*. This association is borne out by the nymphs which look like diminutive *attenuata* without the tubercles of head and thorax. The species will have to be bred, however, before any definite statement concerning the adults can be made.

Section IV

Contains a number of rather large species of a dark color in which the male forceps have the third joint at least twice as long as wide. The nymphs live in rapid water and are very highly specialized, but all agree in possessing very broad and tuberculate anterior femora and in having gills on segments III-VII. As the western *grandis* Eat. would fall into this group the subgeneric name *Drunella* Needh. is available for use if so desired; *Eatonella* Needh., based on *doddsi* Needh., should, I consider, fall into the synonymy.

Ephemerella lata Morg.

Pl. XII, fig. 4; Pl. XIV, fig. 5.

Ephemerella lata Morgan, 1911, Ann. Ent. Soc. Am. IV, 112, Pl. VI, fig. 6, Pl. VII, fig. 1, Pl. VIII, fig. 1.*Ephemerella inflata* McDunnough, 1926, Can. Ent. LVIII, 187.

The original description was based on nymphal material only. We first ran across the very striking nymph in early August in the Mid Yamaska river at Fulford, Que. Numbers of nymphs were secured at the same place in 1930 and a small series was bred; similar nymphs were also found the same year in the Lapeche river at Wakefield, Que., the type locality for *inflata* McD., and from one of these a male imago emerged, establishing the above synonymy.

In the adult state the species appears very shy and our only success in securing specimens has been to capture the subimagos as they rise from the water. It closely resembles *cornutella* and can be best separated by the more inflated character of the second joint of the forceps with strong median constriction, this joint in the latter species being of more even width throughout.

MATERIAL EXAMINED. *Adults*:- Bred series of 10 ♂, 9 ♀, 3 subs, Fulford, Que., July 31 - Aug. 24. Series from Wakefield, Que., July 24 - 28, including type series of *inflata*. *Nymphs*:- 2 specimens, Phillips, Me. (part of type lot); long series from Fulford and Wakefield, Que. including nymphal skins of bred specimens.

Ephemerella cornutella McD.

Pl. XII, fig. 5; Pl. XIV, fig. 8.

Ephemerella cornutella McDunnough, 1931, Can. Ent. LXIII, 82.

As noted in the original description the species resembles a small *cornuta* but appears at a distinctly later date. The male genitalia of the two species are very similar but the third joint of the forceps in the present species is relatively somewhat shorter.

The nymphs were extremely common in 1929 in all the small shaded mountain streams around Knowlton, Que., along with those of *dorothea*; they matured very slowly and adults did not begin to emerge until early in August. In all structural details of the head, thorax, fore femora, and abdomen they agree with *cornuta* nymphs, the mid and hind tibiae are, however, relatively shorter, tibia and tarsus combined being scarcely as long as the femur; the tibia is better marked, having a dark basal spot and a broad dark band beyond the middle; the tarsus has a dark basal band. In general the whole color of the nymph may be said to be darker than that of *cornuta*; the length of the body, when mature, is only 7 mm., as compared with 9 or 10 mm. for *cornuta*.

MATERIAL EXAMINED. *Adults*:- Type series from Knowlton region, Que., 2 ♂, Annapolis, N. S., July 27. *Nymphs*:- Long series from the Knowlton region; a few specimens from Peabody Riv., Gorham, N. H., July 18; Covey Hill, Que., July 1; Boiestown, N. B., July 10.

Ephemerella cornuta Morg.

Pl. XII, fig. 3; Pl. XIV, fig. 4.

Ephemerella cornuta Morgan, 1911, Ann. Ent. Soc. Am. IV, 114 (nymph nec subimago).

The species was described from nymphs taken at Salisbury, Conn. (one of which is before me through the courtesy of Dr. Needham) and an ostensible male subimago. From my own breeding experience of this species I

cannot believe that this subimago has been correctly associated as the color of the body is given as pale luteous and of the wings as subhyaline, a character only found in the very different species *dorothea* Needh. and *septentrionalis* McD. Like all the rest of the group the subimago of *cornuta* (even in alcohol) is quite blackish and I can only surmise that a nymph of one of the two above-mentioned species (probably *dorothea*) had been accidentally introduced into the breeding cage of *cornuta*, thus giving rise to the error. There would be nothing surprising in this as both nymphs occur in the same type of stream and at Thompson Falls Brook, 10 miles along the road between Gorham, N. H. and Jackson, I captured at a considerable altitude large subimagos of *dorothea* on July 20 along with those of *cornuta*. I have already indicated under *dorothea* that my note in the Canadian Entomologist for 1928 (p. 238) should be disregarded; as the name *cornuta* was very evidently based on the nymphal stage I propose employing it in this sense.

The species is one of the earliest of the group to appear; in the lower-lying regions of Knowlton adults emerged in 1929 (a not particularly early year) from June 27 - July 17; in the Sutton Mts. and in the vicinity of Gorham, N. H. they appeared a week or two later, owing to the altitude. The nymph frequents the most rapid portions of the mountain streams and is easily recognized by the details illustrated by Dr. Morgan.

Subimago: blackish (not pale luteous) with deep smoky setae and wings, primaries are produced backward into short, blunt processes. In general appearance it is very similar to the same stage of *tuberculata*.

Adult. Male. Head and thorax blackish, paler, with a ruddy tinge, in the pleural sutures, the axillary cords produced shortly backward into thin, blunt processes. Abdomen dorsally and ventrally deep black-brown, tinged faintly with ruddier brown on the last three segments; at times the posterolateral corner of each segment is pale ochreous. Forceps, penes and setae soiled whitish, the second joint of the forceps thickened at base and apex and narrowed in middle, the third joint about three times as long as wide and considerably longer than that of *cornutella*; the penes only slightly bent upwards. Forelegs with femur and tibia black-brown, tarsi paler, more smoky brown; two hind pairs of legs pale to dark amber or olive-brown, with occasional faint ruddy tints; hind femur rather long and narrow, longer than the tibia and almost equal to tibia and tarsi combined. Wings hyaline with pale venation except in costo-apical area where the veins are slightly tinted with brownish.

Female. Very similar to the male but somewhat paler in color; head more or less tinged with wine-red over an underlying deep clay-color. Subanal plate short and evenly rounded apically. Length of wings and body 8-9 mm.

MATERIAL EXAMINED. *Adults*:- Series of bred and captured specimens from Knowlton, Que. region; 1 ♂, 1 ♀, Thompson Falls, N. H., July 20, 21. *Nymphs*:- 1 specimen, Salisbury, Conn. (part of type lot); long series from the Knowlton region and specimens from Thompson Falls, N. H.

***Ephemerella depressa* Ide**

Ephemerella depressa Ide, 1930, Can. Ent. LXII, 212, Pl. XVII, fig. 6.

This recently described species is only known from the female sex in

the adults; these show a tendency in the forewings to a fusion of the second cubital and first anal veins towards their bases which is not evident in my series of *cornuta*. In the nymph, apart from the shape of the maxillary palpus, Ide differentiates his species from *cornuta* "by the form of fore femur which is much stouter and has a more convex posterior border". I have compared the Salisbury nymph, mentioned under *cornuta*, with Ide's illustration and while somewhat less chunky it shows the same type of posterior convexity towards the base, more so than in Morgan's figure, which may have been either based on a rather flattened specimen or inaccurately delineated. More material is needed to settle the status of the species.

MATERIAL EXAMINED. *Adults*:- 1 ♀ Paratype, deposited in the Canadian National Collection, Ottawa.

***Ephemerella tuberculata* Morg.**

Pl. XII, fig. 1; Pl. XIV, fig. 3.

Ephemerella tuberculata Morgan, 1911, Ann. Ent. Soc. Am. IV, 112, Pl. VI, fig. 2, Pl. VII, fig. 5, Pl. VIII, fig. 3.

Nymphs which agree very well with Morgan's description were found in 1929 very plentifully in the Mid Yamaska River just below the Foster Power Plant between July 5 and July 9; at the same time subimagos were emerging in numbers during the afternoon but were difficult to capture as they mostly rose at once to a height of 20-30 feet and allowed themselves to be carried on the wind away from the river. The swallows which were patrolling the stream secured many more specimens than we did; in fact at the time it seemed as if scarcely a subimago escaped their maws. Besides a limited number caught on the wing other subimagos were bred from caged nymphs and a fair series of both male and female adults obtained in due course. No imagos were seen on the wing nor could it be determined where the subimagos eventually came to rest.

Morgan's characterization of the nymph is good but it might be noted that the gills are on segments 3-7, not 3-8 as stated, (evidently due to a *lapsus calami*), no *Ephemerella* species being known with gills on the eighth abdominal segment. Also the term "median" for the double row of dark dashes ventrally might better be "submedian" as these dashes are situated about midway between the midventral line and the lateral margin, as in *serrata* and several other species.

On adult characters the species falls next to *fuscata* Wlk. and in fact is difficult to distinguish from this species, the best means of separation being apparently found in the ventral maculation of the sternites, which is absent in *fuscata*. From other species of the group it may readily be separated on account of the black dots on the femora. The male genitalia are strikingly similar to those of *fuscata* but the third joint of the forceps appears somewhat thicker and longer.

A fuller description of the heretofore unknown adult stages follows:

Subimago. Blackish with unicolorous blackish wings, being very similar to other species in the same group.

Adult. Male. Head, thorax and dorsum of abdomen blackish; laterally the abdominal tergites are shaded with light ochreous and each contains a

large, more or less circular, blackish patch; these patches tend to fuse with the dark dorsal shades on the anterior tergites but on the seventh and eighth are generally distinct, being separated dorsally by a narrow band of pale color; the lateral flange is mostly pale. Ventrally the abdominal segments 1-8 are light ochreous, sometimes with ruddy tinge and with slight blackish suffusion on the anterior ones; segment 9 is contrastingly black. Each pale segment shows a black lateral streak close to the flange and four black dots arranged in a curved transverse row. Forceps and setae smoky brown; penes blackish, swollen in the median section, with the apices bent characteristically upwards. Legs with all coxae and trochanters yellowish; fore femur and tibia black, tarsi smoky brown; two hind pairs of legs yellowish, femora suffused with blackish to a varying degree and strongly sprinkled with black dots. Wings hyaline with the longitudinal veins only faintly tinged with smoky.

Female. Much as in the male but somewhat paler, with oliveaceous tinges on the pleura and rear abdominal segments; ventrally segments 8 and 9 are olive-brown, the subanal plate being short and evenly rounded apically with lateral edges slightly bent upward. Head deep wine-red with slight blackish shading around ocelli and on vertex. Length of body and wings 8-10 mm.

MATERIAL EXAMINED. *Adults*:- Series from Ottawa, Ont. (July, August) and Foster, Que. (July); 1 ♂, Vaudreuil, Que., July 3 (bred); 1 ♀, Kazubazua, Que. July 17. *Nymphs*:- Series from Foster, Que., including nymphal skins of bred specimens; Wakefield, Que., Vaudreuil, Que., (nymphal skin).

***Ephemerella fuscata* Wlk.**

Pl. XII, fig. 2; Pl. XIV, fig. 6.

Baetis fuscata Walker, 1853, List. Neurop. Ins. Brit. Mus. III, 570 (*partim*).

Ephemerella walkeri Eaton, 1884, Rev. Mon. Rec. Ephem., 129.

Ephemerella bispina Needham, 1905, Bull. 86, N. Y. Sta. Mus. 43, Pl. X, fig. 10 (*partim*, adult *nec* nymph).

This species, although strikingly different in the nymphal stage, shows in the adult a very close relationship to *tuberculata*. Neither Walker's nor Eaton's descriptions are sufficient for identification of the species but Mr. K. G. Blair of the British Museum to whom I sent specimens of both forms, kindly undertook a careful comparison with Walker's type male, following certain indications I had given him, and returned to me a specimen from Laprairie, Que. as agreeing with this type. I have further examined some of the type lot of *bispina* and the slide from which the figure of genitalia was made and consider that this name must fall into the synonymy of *fuscata*; I have already noted that the nymph associated by Needham with the adult types at the time of description cannot possibly belong to this species but falls into an entirely different group.

Fuscata is slightly smaller and more slender than *tuberculata* and the abdomen is more evenly deep piceous, especially on the ventral surface which shows none of the curved row of four dots found in *tuberculata*; the femora are rather deeper in color and the black dots, while present, are more sparsely distributed; the longitudinal veins on the wings are also somewhat more infuscated. The male genitalia are practically identical but there is a tendency in

some specimens for the third joint of the forceps to be more slender and somewhat shorter.

The nymph was first noticed in 1929 in some general collections made in late June from the Mid Yamaska river at Fulford, Que. In 1930 it was again taken in this locality and also found very plentifully in the St. Lawrence river at Cascades Pt., Que. along with the nymphs of *simplex*. At this latter locality we not only bred a number of specimens through to the adult but found the subimagos and adults sitting in large numbers on the small birch trees in the vicinity. The nymph is very flat in shape and covered with long hairs; these catch the silt, which forms a concealing coat of mud, under which the nymph is barely visible until it jerks up its posterior segments in characteristic fashion. The head is flat, slightly roughened on the occiput but without tubercles, a small triangular ridge above the antenna and a broad notched frontal shelf which is very characteristic; thorax smooth with the exception of a small tubercle about the middle of the lateral edge of the prothorax; abdomen flattened with the postero-lateral edges of the segments drawn out into short faintly incurved spines; double row of dorsal tubercles greatly reduced, scarcely visible as short flat spines on the gill-bearing segments; tufts of very long erect hair on the posterior margins of VIII and IX and shorter hairs on the margins of the anterior segments; gills on segment III-VII, as usual. Setae rather short, clothed with long, fine, hair. Legs with all the femora very much flattened and broadened, extremely hairy; fore femora strongly tuberculate along anterior margin, hinder pairs less so; scattered black warts on all femora; tibiae and tarsi short, somewhat flattened, hairy. The general color is a pale grayish (St. Lawrence specimens) to deep olive-brown (Fulford specimens) without much maculation; the thorax shows some black, poorly defined suffusion and there is usually a row of mid-dorsal dark spots on the abdomen. The tibiae and tarsi show traces of broad dark bands in the darker specimens. Ventrally paler with rather indistinct sublateral rows of black dashes as in *tuberculata* but no curved row of dots. Length of body 8-9 mm.; of setae 3 mm.

The nymph is the most highly specialized one of the group, due doubtless to environmental conditions in the swift water in which it lives. The notched frontal shelf cannot be considered however to be of more than specific value; it is already quite distinctly indicated in *tuberculata*.

MATERIAL EXAMINED. *Adults*:- Long series from the St. Lawrence Valley (Vaudreuil, St. Annes, Cascades Pt., Lachine, Laprairie) June-July; 1 ♂, 1 ♀, Boiestown, N. B., July 13. *Nymphs*:- Series from Cascades Pt., Que., Fulford, Que., including nymphal skins of bred specimens.

Plate XI

- Fig. 1. Abdominal segments VII and VIII of nymph of *Ephemerella rotunda* Morg.
 " 2. " " " " " " " " " " *subvaria* McD.
 " 3. Male genitalia of *Ephemerella rotunda* Morg.
 " 4. " " " " " " " " " " *sordida* McD.
 " 5. " " " " " " " " " " *serratoides* McD.
 " 6. " " " " " " " " " " *simplex* McD.
 " 7. " " " " " " " " " " *attenuata* McD.

Plate XII

- Fig. 1. Male genitalia of *Ephemerella tuberculata* Morg.
 " 2. " " " " " " " " " " *fuscata* Wlk.
 " 3. " " " " " " " " " " *cornuta* Morg.

- Fig. 4. " " " " *lata* Morg.
 " 5. " " " " *cornutella* McD.

Plate XIII

- | | | | | |
|-----|-----------------|--------------------|----------------|--|
| 1. | Mature Nymph of | <i>Ephemerella</i> | <i>rotunda</i> | Morg. (Rideau River, Ottawa) |
| 2. | " | " | " | <i>aurivillii</i> Bengt. (Bradore Bay, Que.) |
| 3. | " | " | " | <i>invaria</i> Wlk. (Kazubazua, Que.) |
| 4. | " | " | " | <i>septentrionalis</i> McD. (Knowlton, Que.) |
| 5. | " | " | " | <i>dorothea</i> Needh. (Knowlton, Que.) |
| 6. | " | " | " | <i>needhami</i> McD. (Fulford, Que.) |
| 7. | " | " | " | " (color form) |
| 8. | " | " | " | <i>deficiens</i> Morg. (Foster, Que.) |
| 9. | " | " | " | <i>serrata</i> Morg. |
| 10. | " | " | " | <i>sordida</i> McD. " " |
| 11. | " | " | " | <i>serratoides</i> McD. " " |
| 12. | " | " | " | " " (color form) |

Plate XIV

- | | | | | |
|----|-----------------|--------------------|----------------|---|
| 1. | Mature Nymph of | <i>Ephemerella</i> | <i>simplex</i> | McD. (Knowlton, Que.) |
| 2. | " | " | " | <i>attenuata</i> McD. (Foster, Que.) |
| 3. | " | " | " | <i>tuberculata</i> Morg. (Foster, Que.) |
| 4. | " | " | " | <i>cornuta</i> Morg. (Knowlton, Que.) |
| 5. | " | " | " | <i>lata</i> Morg. (Fulford, Que.) |
| 6. | " | " | " | <i>fuscata</i> Wlk. (Fulford, Que.) |
| 7. | " | " | " | <i>margarita</i> Needh. (Gorham, N. H.) |
| 8. | " | " | " | <i>cornutella</i> McD. (Knowlton, Que.) |