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## NOTES ON THE HEPTAGENINE SPECIES DESCRIBED BY CLEMENS FROM THE GEORGIAN BAY REGION, ONT. (EPHEMEROP.)\*

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In order to clear up certain doubts which had arisen regarding the identity of several Heptagenine species, placed at present in the genus *Ecdyonurus*, and described by Clemens from material collected in the Go Home Bay region of the Georgian Bay (1913, Can. Ent. XLV, 246-262), Mr. G. S. Walley spent the months of June and July, 1932, in this same locality, collecting and breeding nymphal material. In the group in question he was most successful in securing both nymphs and bred adults of all the species listed by Clemens; the present article, therefore, is presented with a view not only of rendering definitely recognizable certain of Clemens' species in which the original diagnoses were rather brief and incomplete, but also of correcting some specific misidentifications occurring in Clemens' paper.

It might be well to note that most of Clemens' material, including all his types, is now contained in our Canadian National Collection; this material is unfortunately in many instances in very poor condition, due to long immersion in alcohol or the evaporation of the alcohol in the vials, but has nevertheless been of immense use to us in definitely tying down the identifications of Mr. Walley's collections. I must again in this connection reiterate what I have already stated on several occasions, *viz.* that I do not regard alcohol as an ideal medium for the preservation of adult Ephemeropterid material, although more satisfactory for nymphs. In a comparatively short period of time the alcohol dissolves nearly all the original pigmentation of the adults, notably the reds and oranges, and makes it almost impossible to distinguish between closely allied *Ecdyonurus* species, especially females. In groups such as the present one where structural characters are all so similar and where we are forced to rely on color and pattern to a very large degree to separate adults of the various species the impracticability of the alcohol method is obvious. Dried material of *mature* adults, pinned after a very short sojourn in the poison-bottle, retains, to my mind, the original coloration much more satisfactorily, and while there are certain drawbacks in handling such material, due to the fragility of the insects and a certain amount of shrivelling, there is no doubt that a much more accurate description of the insect may be obtained. The redescriptions given in the following pages are based on such material.

### ***Ecdyonurus rubromaculatus* Clem.**

*Heptagenia rubromaculata* Clemens, 1913, Can. Ent. XLV, 256, Pl. V, fig. 6; *id.*, 1915, Cont. Can. Biol. 138, Pl. XVI, fig. 2.

*Ecdyonurus rubromaculatus* McDunnough, 1930, Can. Ent. LXII, 61; *Id.*, 1930, Can. Ent. LXII, 230.

The original description was based on material collected in The Narrows, Go Home River, on June 15 and bred June 22, and 25; in the rapids of the Musquash (Muskosh) river, June 30 and bred July 3-5; and at the Chutes of the Go Home River, July 20 and 22 and bred July 24-29. No definite type was mentioned.

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When depositing his material in the Canadian National Collection, Clemens designated a male (No. 67), bred on July 27 from a nymph from The Chutes as his Holotype, and two females (Nos. 29 and 30), bred on June 22 and 25 from The Narrows as Allotype and Paratype respectively. From a study of Clemens' notes it is evident that the above male was the only one of this sex secured and that the only material from The Narrows consisted of the above two females. The male is in alcohol and in very poor condition, parts of the wings and most of the legs being missing and the whole head and thorax so bleached and discolored as to render an accurate description impossible; a slide has been made of the genitalia. The two females were pinned when received but give evidence of having been originally in alcohol and have suffered somewhat from their immersion and subsequent drying. Besides the above there are before me female adults and subimagos in alcohol from the Musquash river material and the nymphal skins of nearly all of the bred material, these latter in rather fragmentary condition.

Mr. Walley first found undoubted nymphs of this species at the rapids at the mouth of the Musquash river, which is really only the southern branch of the Go Home river, on June 9; most of these were quite immature at the time and attempts at breeding were unsuccessful although one or two which died in the cages on June 15 were almost mature. No nymphs were seen in The Narrows but at Flat Rock Falls on the Go Home River, a couple of miles above The Chutes, a few nymphs were secured on June 17 and July 6 and from these three males, one female and one subimago were bred on July 4, 10 and 12. On July 9 a second visit to Musquash rapids was made and fairly mature nymphs found in numbers but owing to difficulties of transportation no adults could be bred.

Based on the male holotype, Clemens' material from The Chutes, Go Home River, and Musquash River and Walley's material from the latter locality and Flat Rock Falls, Go Home River, it seems evident that in the Georgian Bay region at least *rubromaculatus* occurs as a nymph in very swift water and reaches adult stage in the main during the month of July. Before proceeding to a discussion of the distribution and variability of the species I append a detailed description of both sexes of the adult, drawn up from the above-mentioned material from Flat Rock Falls; in male genital characters this material matches well with the type genitalic slide and from the dates of capture and Clemens' brief description, I believe I am justified in presupposing that the holotype, when fresh, corresponded in coloration with these specimens.

*Male.* Eyes (living) *pale* pearly gray. Face and median carina whitish with faint oblique brownish streak on each side of carina and a minute brown dot near base of same; bases of antennae and a lateral streak next eye on antennal level, rusty or tawny brown; antennae whitish. Vertex of head pale creamy tinged with yellowish around lateral ocelli, with a light rusty or tawny brown patch behind median ocellus and two oblique tawny-brown streaks (at times slightly smoky-tinged as in female) extending backward from median line to eyes; caudad of these streaks the posterior portion of head is hyaline. Faint yellow-brown shades between lateral ocelli and eyes. Prothorax whitish with slight median smoky shade; mesonotum *light olive gray or pale clay*, bordered in latero-anterior portion with alabaster white and with the entire scutellum white, the lateral ele-

variations and the hollow behind the scutellum being tinged with pale sepia brown. Pleura and sterna whitish with the area cephalad to base of mid legs tinged with brownish; a black dot on the pleura caudad of the mid-coxa and a slight brownish shade dorsad of same. Metasternum with anterior portion, including median projection, alabaster-white, posterior portion pale sepia brown. Abdominal segments 1-7 pale hyaline, with very narrow transverse dark lines across posterior margin *dorsally* and fine dark stigmatal dots on segments 2-7. Segments 8-10 opaque alabaster white, shaded dorsally with pinkish brown, which is *reduced to a narrow median streak on 8* and is lacking on posterior portion of 10. Forceps dull whitish; setae whitish, finely ringed intersegmentally with black-brown. Fore-leg with the coxa *tinged with ruddy brown laterally* and with a fine black oblique streak extending upwards from this coxal streak towards prothorax; femur and tibia subequal, very faintly amber-colored, the former shaded with smoky and with a median purple-red transverse band and a fainter apical one; apex of tibia shaded with black, extending on to base of first tarsal joint; tarsi pale with intersections and claw segment smoky; first segment slightly less than half the length of second; ratio of segments approximately as follows: 2.75 : 6 : 5 : 3 : 2. Mid and hind legs with coxae and trochanters alabaster white, with slight brown apical shade; bases of coxae shaded with tawny brown, faintly so on hind legs. Femora and tibiae very pale amber with faint median and apical purplish bands; femur slightly longer than tibia; tarsi pale whitish with smoky claw-segment and faint dark intersegmental shading.

Wings hyaline with the whole pterostigmatic area amber-tinted and with a distinct purple-red shade in same area between subcosta and radius. Longitudinal veins deep smoky amber; crossveins, especially in costal and subcostal areas darker, more black-brown; basal costal cross-vein heavily blackish; costal crossveins before bulla moderately fine and rather widely spaced (3-5); in bullar region between costa and first branch of radial sector there are 5-7 cross-veins, normally arranged as 2, 2, 3; in pterostigmatic area the costal crossveins number 11-13; towards anal section of forewing the crossveins become very fine; hindwings hyaline with only the veins in costal area darker in color.

The genitalia are of the *tripunctatus* type, the penes being very sharply L-shaped with the apical edges in an almost straight transverse line and forming practically a right angle with the vertical portion, laterally and dorsally each penis curves inward to a fine hook-like point. There is a minute dorsal spine in the inner apical area of each penis and the whole apical section is very minutely and sparsely setose. The two median stimuli are well-developed.

*Female.* Maculation of head very similar to that of male, but more distinct on account of smaller size of eye; brown markings on carina, bases of antennae and margins of eyes as in male; next inner anterior corner of eye is a black dot (probably present in male but hidden by eye when dried); the oblique rusty brown streaks on vertex are very distinct and are often slightly suffused with smoky. The prothorax shows a distinct triangular smoky median patch. Other maculation as in male except that first seven abdominal segments are yellowish due to the included eggmasses and that the posterior segments dorsally show scarcely a trace of ruddy brown shading; the stigmatal dots are better defined than in male (probably a variable feature). The subanal plate is whitish and broadly rounded apically. The ruddy pterostigmatic shading of forewing is less evident

than in male and the crossveins are slightly thicker. The three joints of the foreleg are subequal and the first tarsal segment is about two-thirds the length of the second and slightly shorter than the third.

To summarize, typical *rubromaculatus* may be recognized in the male by the dull clay-colored thorax with white scutellum, the black lateral abdominal dots and fine postero-dorsal lines, the reduction of the ruddy dorsal shading on the eighth abdominal segment to a narrow median band and (to a greater or less extent) by the ruddy pterostigmatic shade and the scattered crossveins in the bullar region of the forewing. In the female the rusty-brown lateral shading of the fore coxae seems an important feature.

Series are before me, agreeing with the above characterization, from Sparrow Lake, Ont., June 16-22 (taken emerging as subimagos from a small fall in the Koshee river a short distance from its mouth); Burks Falls, Ont., (1 ♀), July 9; Mid Yamaska river, at Foster and Fulford, Que., July 6-Aug. 6, (includes a number of bred specimens); Laniel, Que., Aug. 17, (1 ♀, bred); Trinity Bay, Que., Aug. 20, (1 ♀); Fredericton, N. B., June 29-July 17; Annapolis Royal, N. S., July 21-24; Charles River, Mass., (1 ♂); and an odd specimen or so from Oakwood, Ill., concerning which I am rather doubtful.

In these above mentioned specimens the range of variation is not very great and is limited to the greater or less suffusion of the rusty-brown shades on head and the distinctness of the abdominal spots and cross-lines. There is, however, another form which deserves mention and which, as far as present knowledge goes, seems to be a seasonal one. It occurs in spring and early summer and while the females and nymphs remain practically similar to those of typical *rubromaculatus*, except as a rule for their somewhat larger size, the males are characterized by the darkening of the thoracic and abdominal shades. On the vertex of the head the rusty-brown shading is generally deeper and more extended; the mesonotum is suffused with deep smoky brown with the exception of the scutellum and the lateral sections anterior to same; the smoky shading of the pleura is extended and the mesosternum is generally decidedly brownish; there are ruddy streaks anterior to the wing-bases and heavier dark shading at the bases of the legs; the metanotum is almost entirely dark. The abdomen shows a decided pale smoky tinge on the hyaline segments with generally a slight broadening of the dark posterior banding and an increase in size of the stigmatal dots; the rusty-brown shades of the posterior segments are obscured by smoky shading. The crossveining of the wings is somewhat heavier and the ruddy pterostigmatic shade is not so evident. Owing to the fact that the females and nymphs exhibit no definite differences from the typical form and that the male structural characters in both forms appear similar, a specific separation of these two forms seems scarcely warranted at the present time, especially when we take into consideration the fact that the same two color-forms are found to occur in the closely allied *tripunctatus* Banks, without apparently any seasonal significance. Series of this darker form are before me from Miner's Bay, Ont., May 28-29 (includes bred specimens, the nymphs being plentiful in a small creek connecting Clear Lake with Gull Lake); Kearney, Ont., June 23; Kazubazua, Que., June 7-10; Gauvreau Lake and La Peche river, Wakefield, Que., May 31-June 13; Knowlton, Que., June 14-27 (including female bred June 7, 1930).

The *nymph* is fairly adequately described and figured by Clemens. It is characterized by the coffee-brown color of the abdomen dorsally, without definite color pattern but with a fairly heavy sprinkling of minute pale dots which give it (as noted by Clemens) a granular appearance. It might be noted that the dark median dots and lateral black dots, representing the stigmatal dots of the adult, are frequently relieved by pale shading, especially in the males and on the anterior abdominal segments which later are largely covered by the wing-pads. As a result of this there may at times be a more or less evident series of six short pale dashes along the anterior margin of segments 8 and 9. The lateral margin of the head is broadly pale in its posterior half, this pale area generally being cut in half by a transverse dark band; there are also three pale spots in the interocular area, representing the ocelli of the adult.

As regards the ventral abdominal maculation this is, as stated by Clemens, quite variable; in its simplest form it consists of two pairs of median dots, one pair on the anterior portion and the other on central portion of each segment; laterad and caudad to the first pair is another pair of subventral dots; each of these dots is most frequently joined to the antero-median dot by an oblique dark line. There is a faint lateral row of dark longitudinal streaks on each side (much less evident than in *tripunctatus*) which on segment 9 is generally replaced by a broader dark lateral border-stripe. In better marked specimens (notably those of the typical midsummer form) slightly curved dark bands extend on each side between the anterior and posterior median dots and when the intervening space between these two bands fills up partially with dark suffusion, we have the typical mushroom-like marks mentioned by Clemens. In such cases the lateral rows of brown dashes are more prominent and there is frequently a partial second row just interior to this, consisting of small patches on the posterior margin of each segment. On the rear segments the mushroom markings are generally reduced to anterior blotches or streaks which on segment 9 almost or quite touch the dark lateral border, forming the 3-sided square of Clemens' description, whilst anteriorly the dark shadings are found on the thoracic segments in the median area. The lateral spine of the ninth segment is quite short. Full grown nymphs of early spring, which emerge into the darker color-form, show a decided tendency to uniform brown dorsal abdominal coloration and a reduction of the mushroom ventral marks to almost complete extinction; in many of them the banding on the femora is fainter than in midsummer's brood but none of these points appears constant.

In the Ottawa and St. Lawrence valleys *rubromaculatus* seems to be entirely replaced by a very similar species, scarcely separable except on color characters in the adults, but offering in the nymph some good distinguishing features. In the Gatineau and Knowlton regions both species occur and it was in this latter region that we first succeeded in establishing by breeding the correct association between nymph and adult. As no name appears to be available it is described as follows:

***Ecdyonurus nepotellus* n. sp.**

Very close to *rubromaculatus*; distinguished in the males by the rather bright ocher-brown color of the thorax and the broader extent of the ruddy dorsal suffusion on the eighth abdominal segment; in the female the ruddy lateral shading on fore coxae is absent. The nymph is at once distinguished by the ventral

abdominal maculation, which consists of transverse curved brown bars, much as in *ithaca* Clem. & Leon. which it greatly resembles.

*Nymph.* Head brown, sprinkled with fine pale dots; the posterior half of the lateral margin pale yellowish cut at times by a transverse brown band; three small pale spots in the positions of the adult ocelli and a faint pale median triangle on posterior margin; eyes posteriorly slightly bordered with yellowish. Pronotum brown with pale speckles; entire lateral edge broadly pale with faint smoky tinge at anterior angle, a large pale median spot separated from the pale edge by an oblique dark bar and containing a slight dark streak; on each side of the median line is a much smaller and fainter pale patch with similar dark streak; mesonotum brown, with no decided maculation. Abdomen dorsally pale yellowish, maculate with brown, segments 6 and 10 being almost entirely brown, the brown areas finely speckled with pale dots. There is a broken brown median band, reduced on the pale segments to triangular marks based on anterior portion of each segment, and lengthened considerably on segments 7-9; a pair of dark submedian dots situated laterad of the apex of the dark triangle. Segments 1 and 2 almost entirely pale, segments 3-5 crossed by rather faint longitudinal dark bands laterad of the submedian dots and with further faint dark shades in the extreme lateral area, the dark stigmatal dots of the adult appearing subcutaneously in mature specimens; segment 6 largely brown, anterior margin very narrowly pale, sending at times short submedian and lateral projections into the dark area; segment 7 with the whole central area around the submedian dots pale, a couple of dark triangular patches flanking the median triangle and a lateral dark band from which a narrow band projects L-shaped inward along the posterior margin to a point on a line with the submedian dots; segment 8 similar to 7 but with the brown markings more extended, the yellow area in consequence reduced and the two posterior dark bands almost meeting in the median line; at times 8 is almost as suffused with brown as 6; in segment 9 the posterior marginal band is now complete but the anterior brown submedian markings are reduced; segment 10 is largely brown with faint pale shading on each side of the median band. The lateral spine of segment 9 is long and equals or exceeds half the length of the lateral margin of 10. Setae rather pale greenish yellow in basal half; banded alternately with brown and pale apically. Ventrally pale, each abdominal segment crossed by a curved brown bar, the bars becoming wider and longer on the posterior segments and on 9 forming a large inverted U-shaped mark (at times the apical cross-section is lacking). Femora spiculate and hairy, pale, with broad, but not very distinct, brown median and subapical bands and traces of dark shades basally and apically; tibiae strongly hairy along outer edge, pale yellowish with only faint traces of dark banding on fore tibiae beyond the middle; tarsi with broad brown band in basal half. Length (exclusive of setae) ♂, 8 mm., ♀, 10 mm.

*Male.* Head much as in *rubromaculatus*. Mesonotum ocher-brown with the anterior lateral edges narrowly whitish; the scutellum and the lateral edges extending backward to base of forewing are also white. Pleura yellowish-white, tinged with brown as in *rubromaculatus* and with light ruddy suffusion anterior to bases of forewings. Metanotum largely ocher-brown, except the median elevation which is whitish. Abdomen with first seven segments pale yellowish-white, hyaline, with narrow black dorsal posterior borders, slightly more pronounced than in *rubromaculatus*, and well-defined black stigmatal dots; segments 8-10

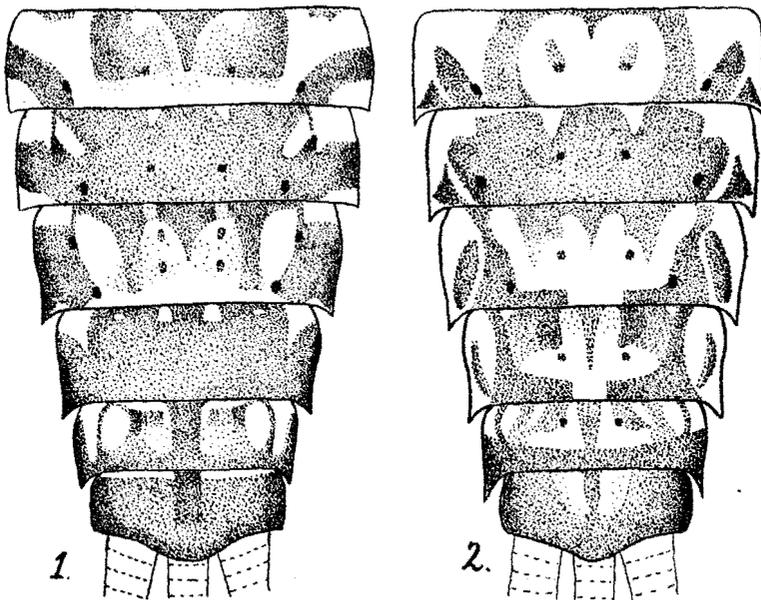
opaque white, with most of the tergites suffused with pinkish brown, leaving slight wedge-shaped submedian pale marks on anterior margin of 8, the posterior margin of 10 being also white. Setae pale, narrowly banded with brown intersegmentally. Legs much as in *rubromaculatus*; forecoxa with the posterior margin narrowly black but with less ruddy suffusion laterally than in *rubromaculatus*; purplish banding on femora rather faint (at times wanting on hind femora). Wings much as in *rubromaculatus*. The genitalia are also extremely close to those of *rubromaculatus*, the penes being sharply L-shaped apically; apart from the fact that in the present species they appear to be rather chunkier, no distinctive character could be noted. Size as in *rubromaculatus*.

*Female*. Very similar to same sex of *rubromaculatus*; vertex of head possibly slightly more yellowish, but ruddy maculation similar. Mesonotum whitish with slight pale brown shading centrally. Black posterior bands of abdomen well-defined. Coxa and trochanter of foreleg with fine apical ruddy dots, but *no ruddy shading laterally* on coxa; fine black streak or shading behind coxal base.

*Holotype*—♂, Fulford, (Knowlton region), Que., July 15, (L. J. Milne). Bred from nymph (No. 264) taken in Mid-Yamaska river. No. 3475 in the Canadian National Collection.

*Allotype*—♀, same data, July 13, breeding No. 257.

*Paratypes*—5 ♂, 3 ♀, all bred from same locality, July 2, 13, 15, 18, 20.



Last six abdominal segments of mature nymph (dorsal view) of 1. *Ecdyonurus pulchellus* Walsh (Go Home River, Ont.); 2. *E. nepotellus* n. sp. (Fulford, Que.)

I have restricted my type series to the above bred specimens; there are, however, before me long series of both adults and nymphs from the Ottawa region (Rideau river, June; Ottawa river, July-August); Vaudreuil, Que., July 3-5; Cascades Pt., Que., Aug. 27-30; Wakefield, Que. region, June (including a bred ♀, June 24); Orillia, Ont., June 13-17; single males from Tillsonburg and

Cayuga, Ont., June. A small series from Oakwood, Ill., June 6, also appears to belong here, but without a knowledge of the nymphs the association is somewhat doubtful.

In this species there does not seem to be the marked darkening of coloration in the spring male specimens which was noted in *rubromaculatus*; some of my Wakefield specimens, however, show a certain amount of this darkening. In the holotype male the relation of the tarsal joints of the forelegs is about as 2.5:4:4.5:3:1.5, but this is a rather abnormal condition, due to a shortening of the second and third joints; normally joint 1 appears to be more than one-third and less than one-half the length of 2.

The nymph is disconcertingly close in maculation to that of *ithaca*, although the adults may easily be separated. Our only Canadian records for *ithaca* are Covey Hill, Que., and the Knowlton region south of Brome Lake, including one bred male from Knowlton Creek. Roughly speaking the dorsal abdominal region appears more suffused with brown in *ithaca*, especially on the anterior segments and the pattern on the paler segments is slightly different, but further study will be necessary to determine the essential points of distinction.

### ***Ecdyonurus pulchellus* Walsh**

*Palingenia pulchella* Walsh, 1862, Proc. Acad. Nat. Sci. Phil., 375; *id.*, Proc. Ent. Soc. Phil. II, 203.

*Ecdyonurus pulchellus* McDunnough, 1926, Can. Ent. LVIII, 193.

*Heptagenia luridipennis* Clemens (*nec* Burmeister) 1913, Can. Ent., XLV, 258, Pl. VI, fig. 2; *id.*, 1915, Contr. Can. Biol. 139, Pl. XV, fig. 3.

Breeding of a good series by Mr. Walley has satisfactorily proved the identity of Clemens' *luridipennis* with *pulchellus* Walsh. Clemens' nymphal description is distinctly good but his figure is not so satisfactory and does not bear out very well the features mentioned in the description; his specimens were secured at Sandy Gray Falls on the Go Home River on Aug. 23. Mr. Walley found the nymphs abundant at Flat Rock Falls, about a mile lower down the same river, on June 17 and July 6, and from these a series of eight males and five females was bred (June 30, July 4, 8, 11, 12); these nymphs agree in general pattern with a few nymphs from Tillsonburg, Ont., a locality from which we have adults of *pulchellus*. It might be noted that there is a distinct tendency in these southern Ontario nymphs to a reduction of the dark dorsal maculation, especially on the anterior segments; the sixth, eighth and tenth segments, however, remain more or less completely dark. The ventral pattern, besides the lateral dark stripes and median spot of segment 9 (most prominent in males) usually shows small dark spots in the posterior corners of segment 8 and sometimes of 7.

The adults are somewhat paler than those of our long series of *pulchellus* from Pleasant Valley, Ia., which are practically topotypical, having been taken immediately across the river from Rock Island, Ill.; they agree, however, in all essential features, including male genitalia (see figure of an Iowa specimen). The species is superficially quite like *rubromaculatus* but is smaller and lacks the prominent ruddy pterostigmatal shade on forewing; the male has a smaller eye; a darker thorax than the typical *rubromaculatus*, with a slight ruddy shade anterior to the wing-base; the first joint of the foretarsus is distinctly longer; the genitalia are smaller, the penes decidedly less sharply L-shaped (quite evident in dried specimens) and with the lateral hook reduced. The female has no dark or ruddy shading either on or behind the forecoxa; on the head the carina shows

a smoky streak rather than a ruddy one and the ruddy shading of the vertex does not extend along the eyes further than a point opposite the lateral ocelli.

This record extends the range of *pulchellus* in Canada considerably further northward; heretofore it has only been taken in the Lake Erie region of Ontario (Pelee Island, Bothwell, Cayuga, Tillsonburg, Niagara Falls). It also gives us a definite nymphal association which, I believe, when checked with Illinois specimens, will be found to be correct.

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FROM THE GEORGIAN BAY REGION, ONT. (EPHEMEROP.)\*

BY J. MCDUNNOUGH,

(Continued from Page 24.)

**Ecdyonurus ruber** McD.

*Ecdyonurus ruber* McDunnough, 1926, Can. Ent., LVIII, 192.

*Heptagenia flavescens* Clemens (*nec* Walsh) 1913, Can. Ent., XLV, 252, Pl. V, figs. 8, 9;  
*id.*, 1915, Cont. Can. Biol., 134, Pl. XV, figs. 4, 5.

Breeding at Go Home Bay confirmed what had already been suspected from our collections and breedings in the Ottawa and Knowlton regions, viz., that the nymph and female imago referred to by Clemens under the name *flavescens* belong to the species, *ruber* McD. Nymphs were secured at the Flat Rock Falls, the

identical locality where they had been collected by Clemens, and two males, three females bred through to the adult stage (June 19, 21, July 2). The abdominal tergites of the nymph are not always as immaculately brown as indicated by Clemens; there are frequently traces of pale dashes laterally and subdorsally along the anterior margins of the segments, serving to a certain extent to define the usual median and submedian dark bands and submedian dots. Such paling of coloration is particularly noticeable on segments 7 and 9 and occurs most frequently in our long series of nymphs from the St. Lawrence river (Cascades Point, Que.); those from more northerly localities tending to much more uniform dark abdomens. Such specimens show, however, none of the pale granulation characteristic of *rubromaculatus* and furthermore have the distinct ventral abdominal pattern, consisting of a large, inverted U-mark on segment 9 and a medium hemispherical dark patch on 8; there are also at times indications of the six dark dots as in *rubromaculatus*. Diminution in size of the median patch and occasionally the lack of the cross-bar of the U fall under the heading of pattern-variation.

According to male genitalia the species falls into the the *pulchellus* group and its distinguishing characteristics have already been given in the original description. Apart from genitalia the smaller size and longer first tarsal joint of male foreleg serve to separate it from dark *rubromaculatus*. Along the Rideau river at Ottawa and in the Gatineau region (Wakefield, Que.) its main flight appears to be in mid-June but in the Ottawa and St. Lawrence rivers and the Mid Yamaska river at Fulford and Foster, Que. (Knowlton region) it does not usually gain maturity until July and August.

#### ***Ecdyonurus luteus* Clem.**

*Heptagenia lutea* Clemens, 1913, Can. Ent., XLV, 252, Pl. V, fig. 2; *id.*, 1915, Cont. Can. Biol. 135, Pl. XV, fig. 2.

This species is recorded as abundant along the open shores of the Georgian Bay Islands with occasional occurrence in the rapids of the Go Home and Musquash rivers; Mr. Walley found the same conditions prevailing and is of the opinion that *luteus* is predominantly a species of the open water region. As no type was designated by Clemens I believe, therefore, I am justified in naming as holotype a pinned male specimen in the Canadian National Collection from Long Island, Go Home Bay, the nymph taken June 14, imago emerging June 29 (Clemens No. 49); the female allotype (so designated by Clemens on pinned specimen) is one of the Musquash Falls breedings, imago emerging July 3 (No. 53). Both are in poor condition but with the details of abdominal maculation recognizable.

A series of nine males, three females, bred by Mr. Walley, is before me; these with one exception all emerged from nymphs taken along the exposed shore of Island 144, June 23-July 5; the single exception is a male from a Flat Rock Falls nymph, emerged June 27. Based on this material I offer a slightly more amplified description of the adult.

*Male.* Eyes (living) pale green. Head anterior to ocelli pale whitish ochreous with a faint oblique ruddy streak on carina and narrow ruddy rings at bases of antennae; region of ocelli and vertex yellowish to yellow-brown with ruddy brown oblique streaks posteriorly and at times a similar colored spot behind median ocellus and a narrow line along margin of eyes. Pro and mesonotum very pale ochreous with scutellum broadly creamy white; pleura whitish yellow with light brown tinge on an area between fore and mid legs and at times also on meso-

sterum; anterior and posterior margins of coxae streaked with smoky and with a faint pinkish patch behind the posterior black streak. Anterior portion of metanotum creamy, posterior portion light brown, contrasting with the pale yellowish abdomen and giving the appearance of a darker basal band. Abdominal segments 1-7 whitish yellow, hyaline, the dorsal posterior portion crossed by narrow black lines; no stigmatal dots; segments 8-10 opaque creamy-white with pink shading dorsally on 8 and 9 and at times on anterior portion of 10. Forceps and setae pale, the latter finely banded intersegmentally with smoky. Legs pale amber; forefemur shaded with smoky and all femora banded in median and apical areas with purple-red; tip of tibia, tarsal intersections and claw smoky. The foretarsal first joint is comparatively short, the relation of the joints 1.5:3:3:2:1. Wings hyaline, the pterostigmatic area of forewings light amber with slight ruddy tinges; three first longitudinal veins dark smoky amber, remainder, including the well-developed cross-veins, blackish.

*Female.* Paler than male. Head distinctly yellow in ocellar region; a spot behind the median ocellus and the whole posterior portion of vertex tawny brown, extending laterally down along edge of eyes to a point opposite lateral ocellus; occiput and face anterior to antennae pale ochreous, semi-hyaline. Thorax and abdomen dorsally as in male; pleura paler with scarcely a dark shade and no dark or pinkish shades at bases of coxae; at times slight yellowish tinges in area between bases of fore and mid legs.

The pale coloration and lack of stigmatal dots on abdomen is sufficient to distinguish the adults from allied species; the male genitalia are of the *pulchellus* type. The *nymph* has been adequately described and figured by Clemens; there should be no difficulty in recognizing it. It might be noted that immature nymphs are paler than mature ones, the posterior border lines of segments being very narrow or even entirely lacking on segment 9. Also that the few nymphs taken in the Go Home and Musquash rivers are rather darker than the Go Home Bay series, the posterior borders of segments especially being broader and more as in *fuscus*. However, the bred male mentioned above agrees with the other adults so I presume the difference to be merely varietal.

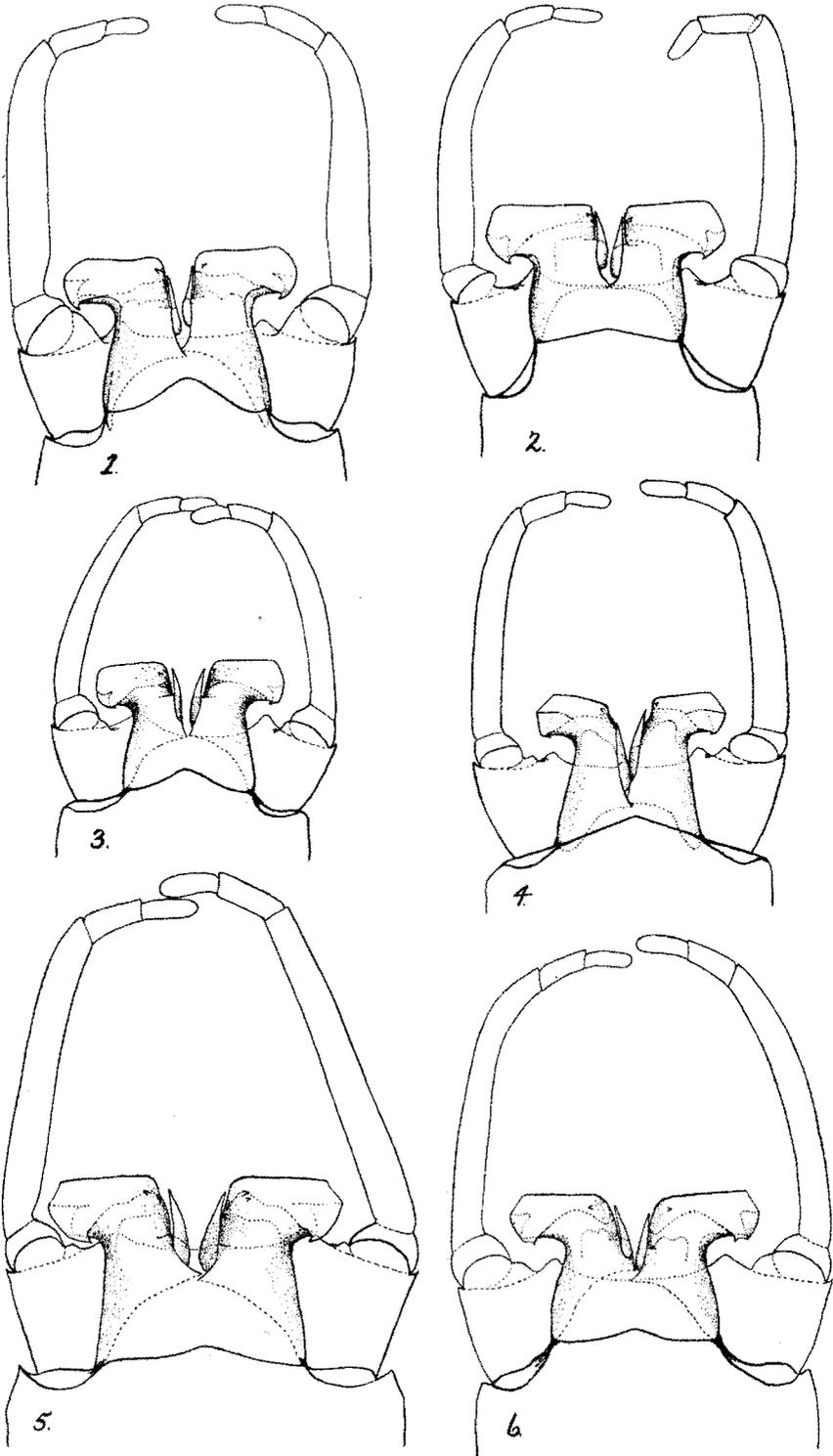
The species is not uncommon in both the Rideau river and Ottawa river districts of the Ottawa region, specimens from the latter river occurring most frequently in late July and early August and being slightly smaller in size; we also have small series from various points on the St. Lawrence river (Vaudreuil, Lachine, St. Lambert) taken in early July and a single bred female from Brome Lake, Knowlton, Que. Single females from Normandale and Southampton show that the species occurs in both Lakes Erie and Huron.

#### ***Ecdyonurus fuscus* Clem.**

*Heptagenia fusca* Clemens, 1913, Can. Ent., XLV, 254, Pl. V, fig. 7; *id.*, 1915, Cont. Can. Biol., 136, Pl. XVI, fig. 1.

*Ecdyonurus fusca* McDunnough, 1925, Trans. Roy. Soc. Can., XIX, 3rd Ser. 222.

The species was bred from nymphs secured on June 16 at Sandy Grey Falls on the Go Home river; judging by Clemens' notes only three adults were secured—the male Holotype, No. 43, emerged June 24; the female Allotype, No. 45, emerged June 25; and a male paratype, No. 42, emerged June 24, the dates June 23 and 24 given by Clemens evidently referring to the emergence of the subimagos. The holotype, as I have already noted, is a damaged alcohol specimen from which,



MALE GENITALIA OF ECDYONURUS SPECIES.

however, a genitalic slide has been made, the allotype is pinned and the paratype consists of fragments of wings. Besides these adults I have before me a number of the nymphs collected by Clemens in alcohol and the fragmentary nymphal skins of the type specimens.

Mr. Walley found the nymphs very plentiful in the rapids of the Musquash river on June 9th and from some of these bred a series of one male, six female pinned adults, one male, one female adult in alcohol and one male, one female, sub-imagos, June 9-15; from a study of this material in combination with the above mentioned type material of Clemens I offer the following notes and amplifications. Regarding the two figures given by Clemens of the nymph (evidently a female), that in the Canadian Entomologist is distinctly the better print as it shows to a certain extent (but still not sufficiently) the marked contrast between the pale yellow abdominal segments and the deep black-brown border along the posterior third-fourth of each segment dorsally. What maculation there is is in a much paler shade of brown than the border and consists in general of (1) a transverse streak along the anterior margin; (2) a broken medio-dorsal line, flanked by two slightly oblique streaks, these streaks on the posterior segments being frequently broken up into two superimposed dots, the lower of which touches the dark posterior band; (3) two slight lateral projections from the posterior band into the pale section which are quite plain in Clemens' figure. This maculation is faintest on segments 8 and 9 especially in the males, and tends in the females to become suffused on segment 6 (which, at times is quite dark dorsally) and also to a lesser extent on segments 2-4. Occasionally the ends of the transverse anterior dash bend down and are even produced to connect with the posterior band. The lateral prolongations of each segment form very long, sharp spines. Ventrally the dark posterior banding shows a pale medio-ventral spot and the anterior margin of the bands is somewhat irregular, especially in the females, where distinct lateral projections as on the upperside are evident. As a general thing the maculation of the ninth segment consists of the two dark lateral patches as mentioned by Clemens; occasionally, however, there are traces of an antero-medial spot and still more rarely this spot is joined to the lateral ones, forming an anterior dark band across the segment. Immature nymphs, in contradistinction to those of *luteus*, are much darker in color than mature ones, the abdominal segments being largely brownish with isolated pale spots and patches.

Besides topotypical nymphs there are long series before me from Gull River Falls, Minden, Ont.; the St. Lawrence river at Cascade Point and Lachine, Que.; the Rideau river at Ottawa; and the Mid Yamaska and Mississquoi rivers of the Knowlton, Que., region, including nymphal skins of bred material from the majority of these localities. From southern Ontario I have noted isolated nymphs from Dundas and Tillsonburg. In this material the amount of color and pattern variation is surprisingly small; the St. Lawrence nymphs are the palest, some of them lacking all maculation except the posterior dark banding of the segments; the Rideau river nymphs have a somewhat darker appearance and the posterior banding is not so noticeably deeper in color than the other maculation. As regards the adults Clemens' description of the male is good (especially for alcohol material) as far as it goes, but it needs a certain amount of amplification.

*Male.* Eyes (living) large, pearly-gray, becoming purple-black when dried.

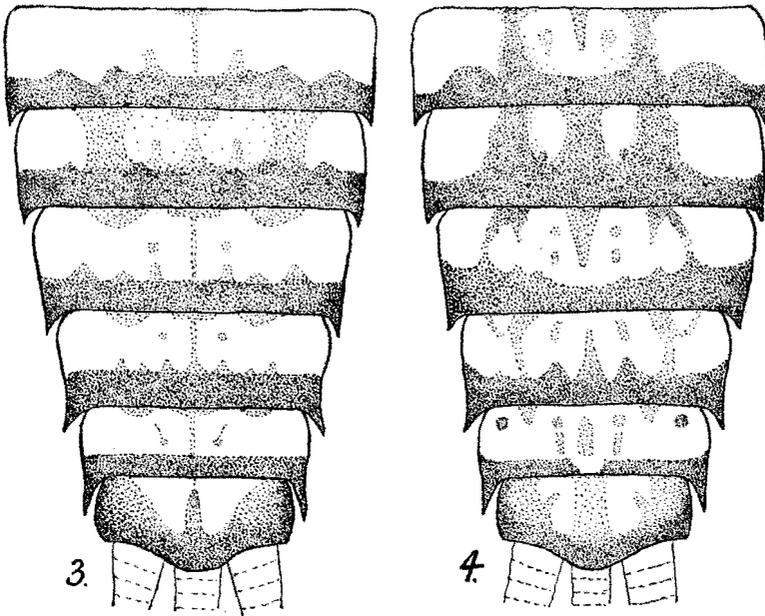
On the head the epistoma is pale smoky hyaline with smoky brown oblique streaks on each side of the carina; the section anterior to the ocelli is pale yellowish with fine ruddy rings around the bases of the antennae which are pale smoky; the vertex is rather bright brown with yellowish shades behind the lateral ocelli. The prothorax is largely smoky; the mesonotum is deep brown normally with pale ochreous or whitish shades on the rear half of the scutellum and in the median depression anterior to the scutellum, where several dark streaks are evident. In certain specimens the color of the mesonotum is a much paler brown and in these instances the pale shades around the scutellum are more extended and show traces of ruddy suffusion; in others (noticeably those from the Rideau and St. Lawrence rivers) there is a deepening of the brown color which tends to efface all the pale scutellar shades.

There is a ruddy shade split by a pale line on the pleura anterior to the base of the forewings and below this an oblique yellowish-ochre streak extends from forewing-base to base of foreleg, a somewhat similar one occurs at base of hindwing, the remainder of the pleura being clouded with brownish, as is also the sternum. The metanotum is largely deep brown with the median anterior projection paler. The abdomen dorsally presents normally a distinctly uncontrasted brown appearance; on closer examination it is seen that the tergites 1-7 are dull smoky amber, semi-hyaline, with the posterior one-third transversely banded with deeper brown, this color extending forward in spiracular area and forming indistinct marks somewhat like inverted question marks, filled out with paler color; there is a fairly complete geminate median dark line. In specimens with paler thorax (as referred to above) the contrast between the two areas is somewhat sharper, giving a slightly banded appearance. On the other hand numerous specimens occur (Rideau and St. Lawrence regions) in which the dark areas are much extended and almost the whole segment appears deep brown; in such specimens the posterior band sends broad subdorsal projections forward, the upper edges of which curve slightly upward, thus partially enclosing, in conjunction with the median line, a series of paler streaks bordering the aforementioned line. Tergites 8-10 are opaque, suffused almost entirely with rather a bright brown, and with *the lateral edges of 9 and 10 (and sometimes 8) distinctly bordered with alabaster white*, this color occasionally extending around the entire posterior border of 10. Ventrally the abdominal segments are dull, pale, smoky amber, immaculate, the three posterior segments tending to become more ochreous or light brownish; in the dark specimens mentioned above the colors become deeper and there is a trace of darker triangular brown shades alongside the medio-ventral line. Forceps and setae very pale smoky amber, the latter finely banded intersegmentally with brown. Legs with all coxae smoky brown, the edges and bases streaked with blackish; remainder of legs light amber, with fore femora suffused with smoky and all femora with median and apical purple-red bands; tarsi with joinings marked in black; claw blackish; first tarsal joint normally slightly more than one-third the length of second. Wings hyaline with slight amber suffusion in pterostigmatic region *but no ruddy shades*; first three veins smoky amber, remainder blackish; crossveins *rather fine*, blackish, with no tendency to accumulate in the bullar region.

*Female.* Head anterior to antennae as in male; ocellar region from rear

of lateral ocelli forward to antennae distinctly light yellow; vertex of head marked as follows in *bright ruddy-brown* (Ridgeway, Hay's russet, Pl. XIV, k, is closest) --a hemispherical patch behind median ocellus, bordered posteriorly by a narrow yellow band; the entire remainder of vertex except a fine median line and the lateral corners, the color extending down along the margins of eyes to the antennal region; occiput narrowly pale smoky.

Mesonotum paler than in male, dull clay or olive-brown with the scutellar area suffused with creamy or pale ochreous. Ruddy shade and pale streaks on pleura as in male; bases of legs at times with purplish tinges but blackish streaks not so prominent on coxae. Abdomen dorsally paler than in male, of a distinctly banded appearance as there is less tendency to suffusion or extension of the dark bands on posterior third of segments 1-7; median dark line present on all segments; rear segments opaque, light creamy brown, 8 and 9 banded with darker as in anterior segments; white lateral borders prominent. Ventrally very pale amber, segments 8 and 9 whitish, with slight pinkish suffusion on 8 anteriorly, extending somewhat on to 7. Remainder much as in male.



Last six abdominal segments of mature nymph (dorsal view) of 3, *Ecdyonurus fuscus* Clem. (Musquash River, Ont.); 4, *E. rivulicolus* n. sp. (Fairy Lake Cr., Hull, Que.)

The subimago has rather evenly gray wings, the crossveins being finely marked in blackish without suffusion.

The material before me comprises long series of both sexes from Georgian Bay region, Ont.; Severn, Ont.; Burks Falls, Ont.; Jordan, Ont.; Ottawa, Ont. region (both Rideau and Ottawa rivers); St. Lawrence region, including Prescott, Ont., Cascades Pt., Que., Vaudreuil, Que., Lachine, Que., St. Lambert, Que., La Prairie, Que.; Richelieu, Que.; Fulford, Que.; Boiestown, N. B.

The range of variation in the males is considerable but as no differences in the female sex can be distinguished and as our nymphal collections do not,

as yet, indicate more than one species, it seems safer, until further breeding can be done, to consider these differences as variational rather than specific.

*Fuscus* in the light of the above material appears to be distinctly an inhabitant as a nymph of the swifter water of our larger streams and rivers; emergence takes place almost entirely in the spring and early summer and after early July we have nowhere, as yet, found mature nymphs.

As a result of our intensive study of *fuscus* we have succeeded in segregating out what appears to be an undescribed but very closely allied species, in many ways intermediate between *fuscus* and the much larger *vicarius* Wlk. The nymphs are found in early spring in the small brooks and creeks in eastern Ontario and southern Quebec, the adult emerging in late May and during June, an occasional female appearing in July.

### ***Ecdyonurus rivulicolus* n. sp.**

*Subimago.* Wings greyish, much more contrastingly marked than in *fuscus*, due to a suffused dark bordering of the crossveins, resulting in a rather banded appearance.

*Male.* Eyes (living) pale gray with a decided greenish tinge (not bluish as in *fuscus*), smaller also than those of *fuscus*. Head with anterior portion much as in *fuscus*, the vertex shows a deeper brown shade which is still further intensified behind the median ocellus and along the rear margin medianly. Mesonotum deep brown with the paler scutellar areas of *fuscus* not so evident, and with rear margin tinged with blackish. Pleura deeper brown, with ruddy anterior patch as in *fuscus* but with the pale streaks from bases of wings less evident and deeper ochreous in color; rather heavy blackish suffusion above base of midcoxa, and a slight ruddy tinge also in this region. Metanotum similar in color to mesonotum. Abdomen dorsally with maculation essentially as in *fuscus* but with the contrast between the dark and pale areas much better defined; the dark posterior bands are broader, occupying on the anterior segments fully one-half the width of segment, the color is a deep purple-brown and the anterior margin is sharply defined and does not tend to suffusion as in *fuscus*; the pale areas are of a light amber color, less mixed with smoky than in the preceding species; the longitudinal median band is similar in color to posterior bands, well-defined on segments 2-9 and broader than in *fuscus*, especially in rear portion of each segment. The three opaque posterior segments are suffused with lighter brown, with paler lateral margins, but *no distinct white border* as in *fuscus*. Ventrally light yellowish on segments 1-7 with *small brown patches in the postero-lateral angles* of at least the anterior segments (best seen in alcohol material); segments 8 and 9 shaded with light brown. Forceps and setae pale smoky, the latter banded as usual. Legs much as in *fuscus* but with the black coxal streaks of mid and hind legs much broader and with black patches at the bases of all legs; the femoral bands are deeper in color (deep purple to purple-black) and *considerably broader*; the first tarsal joint is somewhat longer, being almost half the second one. The wings are hyaline with a *distinct ruddy shade* in the pterostigmatic area; the crossveins are *noticeably thicker and bordered slightly but somewhat diffusely with brown* in the costal area; there is a greater accumulation of crossveins in the bullar region than in *fuscus*. Length of body, 10 mm.; of forewing, 13 mm.

*Female.* The head, as compared with that of *fuscus*, shows a more inten-

sive yellow color in the ocellar region and the ruddy shades are much deeper, being deep wine-red with blackish suffusion along the posterior margin of the vertex. The mesonotum is light olive or yellowish ochre and there is some yellowish suffusion on pleura below base of wings and anterior to mid and hind coxae; the dark shadings around coxal area as in the male. Abdominal maculation similar to that of the male, the color of the tenth segment dorsally and the eighth and ninth ventrally (including the subanal plate) being dull clay. Other distinguishing characters from *fuscus* as in male, the ruddy pterostigmatal shade on forewings, however, being less prominent.

*Holotype*—♂, Fairy Lake Creek, near Hull, Que., May 30, 1927, (G. S. Walley); No. 3526 in the Canadian National Collection, Ottawa, Ont.

*Allotype*—♀, same data.

*Paratypes*—2♂, same data; 3♂, 1♀, Fairy Lake, Que., June 6, 1927; 1♂, 2♀, Hull, Que., May 29, 1923, (A. W. Richardson); 2♂, Broadview, Que., June 21, 1923, (R. Ozburn); 1♀, Broadview, Que., July 28, (G. S. Walley); 1♂, 1♀, Ottawa Golf Club, Que., June 11, 12, 1923, (R. Ozburn); 1♀, Ottawa Golf Club, Que., June 21, 1924, (G. S. Walley). The last two localities are also in the vicinity of Hull.

Besides the types I have before me series of specimens from Orillia, Ont., Kearney, Ont., Kazubazua, Que. and Knowlton, Que., as well as odd specimens from Caradoc, Ont., Tillsonburg, Ont. and Bothwell, Ont.; this indicates a rather wide distribution for the species.

The presumable nymph, taken mature in Fairy Lake Creek and a small creek at the Ottawa Golf Club at the time the type adults were captured, is close to that of *fuscus* as might be expected; the ventral banding is similar, with the important exception that on the ninth segment, in place of the two lateral dark marks (with occasionally a median spot) of *fuscus*, the whole posterior half of the segment, due to a fusion of these patches, is dark, with pale dots at the bases of each forcep-limb in the males and occasionally also in the females. The upper side maculation seems variable and for the figure I have chosen an average well-marked female specimen; in some nymphs, notably males, there is a great reduction of the dark maculation in the median and submedian areas of all segments but 6, the posterior dark banding being the only feature remaining; such nymphs can be distinguished from those of *fuscus* by the fact that the band of segment 9 and often of 8 is much reduced in width and broadly broken in the median section. In other cases the dark suffusion is increased until the pale median areas of all segments but 8 and 9 become very much as the sixth segment of my figure, in 8 and 9 there is generally a pale area in the anterior third of segment.

Up to the present we have only succeeded in breeding an odd female or two from nymphs similar to those above mentioned, so that there is still the possibility of another species being involved. Until, however, series of bred specimens are available and, further, the nymph of the allied species, *vicarius* Wlk., is definitely placed, it would be unwise to attempt any further separation in this difficult group.

In conclusion I venture to describe a species belonging to the *interpunctatus* group. This species is quite common in the Ottawa region along with *canadensis*

and there is a good deal of probability that the undetermined nymph figured by Clemens (1913, Can. Ent., Pl. V, fig. 4) belongs here; no definite breeding associations have as yet been made but nymphs similar to the figure have been taken in the Rideau river at Ottawa, where the new species also occurs.

The species is very similar to *interpunctatus* but differs primarily in the decidedly greater length of the first tarsal joint in the male which is about half the length of the second joint in normal specimens. In typical *interpunctatus* (which does not apparently occur in the Ottawa region but of which we have series from Illinois, Kansas and southern Ontario along the borders of Lake Erie and in the Niagara peninsula) the first tarsal joint is scarcely more than one-third the length of the second one and frequently even shorter. Furthermore, *interpunctatus* always shows quite heavy black markings on the face below the antennae and on the vertical clypeal flange as well as having a black lateral streak on the pronotum; in the new species these black markings are typically not present and only in a certain percentage of specimens do there appear traces of such maculation and then usually much reduced in extent.

***Ecdyonurus heterotarsalis* n. sp.**

*Male.* Eyes (living) light green. Head light yellow, semihyaline along anterior and posterior margins; vertex shaded with brown, deepest in a triangular patch covering posterior area, becoming almost purple-brown. Pronotum light yellow; mesonotum largely brown with the posterior area pale hyaline yellowish and the scutellum tipped with opaque ochreous; metanotum pale ochre-yellow. Pleura yellowish with a ruddy streak anterior to base of forewing and slightly deeper shading between fore and mid legs. Sterna yellowish. Abdomen dorsally pale, hyaline yellowish-white on segments 2-7, each finely bordered posteriorly by a blackish band; segments 8 narrowly in median area and 9 and 10 entirely shaded with ruddy brown; lateral portion of 8 opaque, pale yellowish; dark posterior banding on 8 and 9 as on preceding segments. Ventrally entirely pale, the opaque posterior segments 8 and 9 being almost alabaster white. Forceps and setae pale, latter very faintly dark-ringed intersegmentally. Legs light yellowish, the fore femur somewhat deeper in color; fore femora strongly, and mid femora faintly banded with blackish across middle and at apex, hind femur with only an apical dark spot; apex of fore tibia and all claws smoky; joints of fore tarsus as 3.5:6:5.5:4:2 (this is subject to considerable variation). Wings as in *interpunctatus* but the pterostigmatic area with less of a ruddy shade, merely being shaded with light amber. Length of body, 9 mm.; of forewing, 11 mm.

*Female.* General maculation much as in male but mesonotum much paler in color, being light ochreous with scutellar area scarcely paler. Head rather bright, light yellow with two black lateral dots on posterior portion of vertex, the area between being lightly shaded with ruddy (not always present) in more or less triangular form. The ruddy dorsal shading on posterior abdominal segments is not so pronounced as in the male.

*Holotype*—♂, Ottawa Golf Club, Que., July 2, 1924, (J. McDunnough); No. 3527 in the Canadian National Collection, Ottawa.

*Allotype*—♀, Ottawa, Ont., July 19, 1924, (F. P. Ide).

*Paratypes*—5 ♂, 5 ♀, Ottawa Golf Club, Que., July 2, 15, 16, 22, 1924, (J. McDunnough); 8 ♂, 1 ♀, same locality, June 27, July 16, 1923, (R. Ozburn);

5 ♂, same locality, July 15, 1924, (F. P. Ide); 2 ♂, 2 ♀, Ottawa, Ont., July 16, 19, 1924; 7 ♂, 8 ♀, Ottawa, Ont., July 19-26, Aug. 9, 1924, (G. S. Walley).

Besides numerous other specimens from the vicinity of the Ottawa river, the species is before me in series from the Rideau river at Ottawa, where it occurs mainly in June in slightly larger size. We also possess series from the St. Lawrence region (Cascades Point, Vaudreuil, Lachine), the Great Lakes region (Kingston, Normandale, Pt. Pelee) and from northern Illinois (Aurora, Oakwood, Chicago) which appear to fall here.

I have already discussed the variability with respect to the black maculation; it might be added that the male genitalia resemble greatly those of *interpunctatus* but appear to have the latero-apical margin of the penes somewhat more oblique than in this species. Of the other allied species *frontalis* may be distinguished from *heterotarsalis* by the presence of the black stigmatal dots on abdominal segments and the median dark band on hind femora and *canadensis* (which also has the short first tarsal joint) by the general dark suffusion on abdomen.

#### EXPLANATION OF PLATE I.

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Fig. 1.—Male genitalia of *Ecdyonurus rubromaculatus* Clem., Flat Rock Falls, Go Home River, Ont. Fig. 2.—Male genitalia of *Ecdyonurus nebotellus* n. sp., Fulford, Que. Fig. 3.—Male genitalia of *Ecdyonurus ruber* McD., Paratype, Ottawa, Ont. Fig. 4.—Male genitalia of *Ecdyonurus pulchellus* Walsh, Pleasant Valley, Ia. Fig. 5.—Male genitalia of *Ecdyonurus fuscus* Clem., Holotype, Go Home River, Ont. Fig. 6.—Male genitalia of *Ecdyonurus luteus* Clem., Go Home Bay, Ont.