NEW SPECIES AND PREVIOUSLY UNDESCRIBED NAIADS OF SOME MINNESOTA MAYFLIES (EPHEMEROPTERA)[1]

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The abundance and diversity of aquatic habitats in Minnesota make this state an ideal region for the study of aquatic insects. Until comparatively recently, the aquatic insects have been more or less neglected as far as intensive biological and taxonomic studies have been concerned. The increased interest in Minnesota's lakes and streams as an important economic resource has stimulated limnological studies as well as investigations of its aquatic insect fauna.

The mayflies, as one of these groups of aquatic insects, have not been well known in the state. In fact, since the work of Walsh (1862–64) at Rock Island, Illinois, on the Mississippi River, no general studies on the biology of mayflies have been made in the Middle West as a whole. With this in mind, an intensive survey of the Minnesota mayfly fauna was carried on during the period 1936–1941.

Collections of naiads and adults were made in every part of the state during those years. A large part of the study was devoted to life histories, and extensive rearings were carried out in the laboratory.

Since Minnesota is located at the junction of three important faunal regions—prairie, deciduous forest, and coniferous forest, a relatively large number of mayfly species was to be expected. The survey has shown that the bulk of the state's mayfly fauna closely resembles that of northeastern United States and Canada. In fact, the many new distribution records showed that a large number of these species reach their western limits here. The list of recorded species is further augmented by certain southern and western forms which evidently reach their northern and eastern limits within the state.

As a result of this widespread survey, a number of undescribed species have been found; and with extensive rearings, a number of gaps in life cycles have been filled. In this paper are included descriptions of these new forms and of naiads which have previously been unknown. All types and additional material are deposited in the University of Minnesota entomological collections.

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Family **Heptageniidae**

Stenonema bipunctatum (McDunnough)

Naiad (Fig. 6).—Length: body 10 mm., tails 8 mm.

A light brown naiad with the two dark, submedian dashes of the imago usually visible.

Head light brown, thickly sprinkled with fine yellow dots. Pale areas around ocelli and postero-laterad and antero-laterad to the compound eyes. Basal segments of antennae dark brown, flagellum paler brown. Thoracic notum reddish-brown, pronotum with a fine, dorsal median line; a sprinkling of pale dots laterally, and three larger pale spots in the antero-lateral corner. Femora with thick sprinkling of fine, dark brown freckles and two irregular pale bands. Tibiae largely yellow, brown basally with a fainter brown band near distal end. Tarsi and claws yellowish, a wide dark, median band on tarsus.

Abdominal terga reddish-brown, rather thinly sprinkled with pale dots. Pale areas in antero-lateral angles, largest on basal segments, reduced in size posteriorly. In some specimens, a broken dark median band on abdomen, most distinct on middle segments. Posterior margin of tergum 10 blackish. The paired dark submedian dashes on the posterior margins of the adult can frequently be seen in mature naiads. Extent of dark ventral markings variable. Sternum 9 with a wide dark-brown band around outer margin leaving a median yellow area, a less distinct lateral margin on 8, fainter or absent on the more anterior segments. Paired submedian posteriorly diverging dashes on sterna 2–8, sometimes very faint or absent, especially on basal sterna. Gills as in other members of the *pulchellum* group. Tails banded with light and dark areas.

Specimens from which the above description has been taken were collected and reared from rapids in the Mississippi River at Minneapolis, Coon Rapids and Fridley and from the St. Croix River at Taylors Falls. The species has previously been known from Ontario, Illinois, and Iowa.

Stenonema exiguum Traver

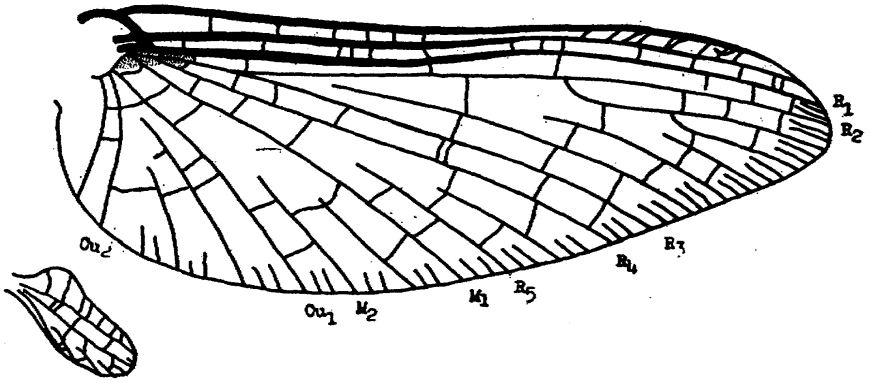
Naiad (Fig. 7).—Length: 9–11 mm., tails 13 mm.

Chocolate-brown in color, strikingly marked with yellow. Head brown, heavily sprinkled with fine yellow dots. A yellow area between compound eye and each lateral ocellus. A yellow hat-shaped area anterior to median ocellus. Pale semi-transparent areas antero-lateral and postero-lateral to compound eye, a dark horizontal strip between these two pale areas on each side of head. In some specimens, a small median pale area on vertex. Basal antennal segments dark brown, flagellum brown at base, paler distally.

Pronotum dark brown with a scattering of fine yellow dots. A large distinct yellow spot on either side near anterior margin, halfway between median line and lateral margin. Posterior half of lateral margin pale yellow, a tonguelike extension running inward anteriorly. Mesonotum brown with the usual fine dots, a small pale area in extreme antero-lateral angle. A pale area anterior to wing bases with an indistinct pale strip between. The triangular portion of the mesonotum

between the wing pads and the wing pads themselves dark brown, more or less separated from remainder of the mesonotum by the pale horizontal strip between the wing bases (Fig. 7).

Femora brown, densely covered with small dark brown spines. Pale at both apical and basal ends, more extensive apically, with a row of three pale oval dots across the middle of the femur and a row of three smaller pale dots in the basal half. Tibiae yellow with distinct wide, dark brown basal and median bands. Tarsi pale in apical third, dark brown basally. Claws pale, dark tipped.



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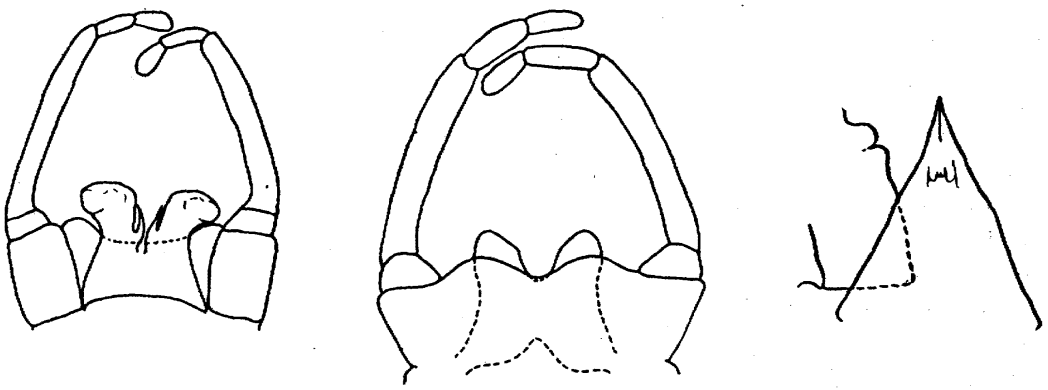

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TEXT FIGURE 1. Wings and genitalia.
Fig. 1. *Callibaetis brevicostatus* n. sp.; Fig. 2. *Stenonema wabasha* n. sp.; Fig. 3. *Rhithrogena pellucida* n. sp.; Fig. 4. *Baetisca bajkovi* Neave.

Abdominal terga brown, marked with varying amounts of yellow. Except in very dark specimens, terga 1, 2, 3, and 7 are largely yellow with brown markings while the others are largely brown with yellow markings. Terga 4–5 largely brown, usually with extensive triangular yellowish markings. Tergum 6 largely dark brown, a pair of submedian yellow dots at anterior margin, and often a smaller yellow dot in antero-lateral angle. Tergum 7 in most specimens largely yellow

except lateral margins. A pair of small submedian brown dots in center of this tergum, not distinct in darker specimens. Three triangular brown patches with bases on anterior margin extend posteriorly halfway across tergum, median triangle slightly longer. In dark specimens, the lateral triangles may not be distinct, the median one usually so. Terga 8–10 almost entirely dark brown with a sprinkling of fine yellow dots. A pair of large submedian yellow dots near anterior margin of 8. A slight yellow mark in antero-lateral angles of 8–9, occasionally on 10, except in dark individuals. Sterna almost entirely yellow, no distinct brown markings except dark brown lateral margins on sternite 9.

Lamellar gills truncate, light purple-gray in color. Seventh gill fringed laterally, without a trachea. Tails long, alternately banded with yellow and brown.

Specimens of these naiads were collected in the Mississippi River at Minneapolis and Fridley, from the St. Croix River at Taylors Falls and Stillwater, from Coon Creek in Anoka Co., from the Root River at Chatfield, and from Little Bear Creek near Hinckley. Naiads were also collected from the Revell River east of Dryden, Ontario. Since previous records were from North Carolina, Georgia, and Alabama, the Minnesota and Ontario records greatly extend the known distribution of this species.

Stenonema minnetonka n. sp.

This species is a member of the *interpunctatum* group, distinctive because of the presence of stigmatic dots combined with the lack of the dark streaks on the pleura below wing bases so characteristic in other closely related species. A black dash at the bulla, black markings on face and pronotum, no median band on hind femur, basal tarsal segment about one-third length of the second.

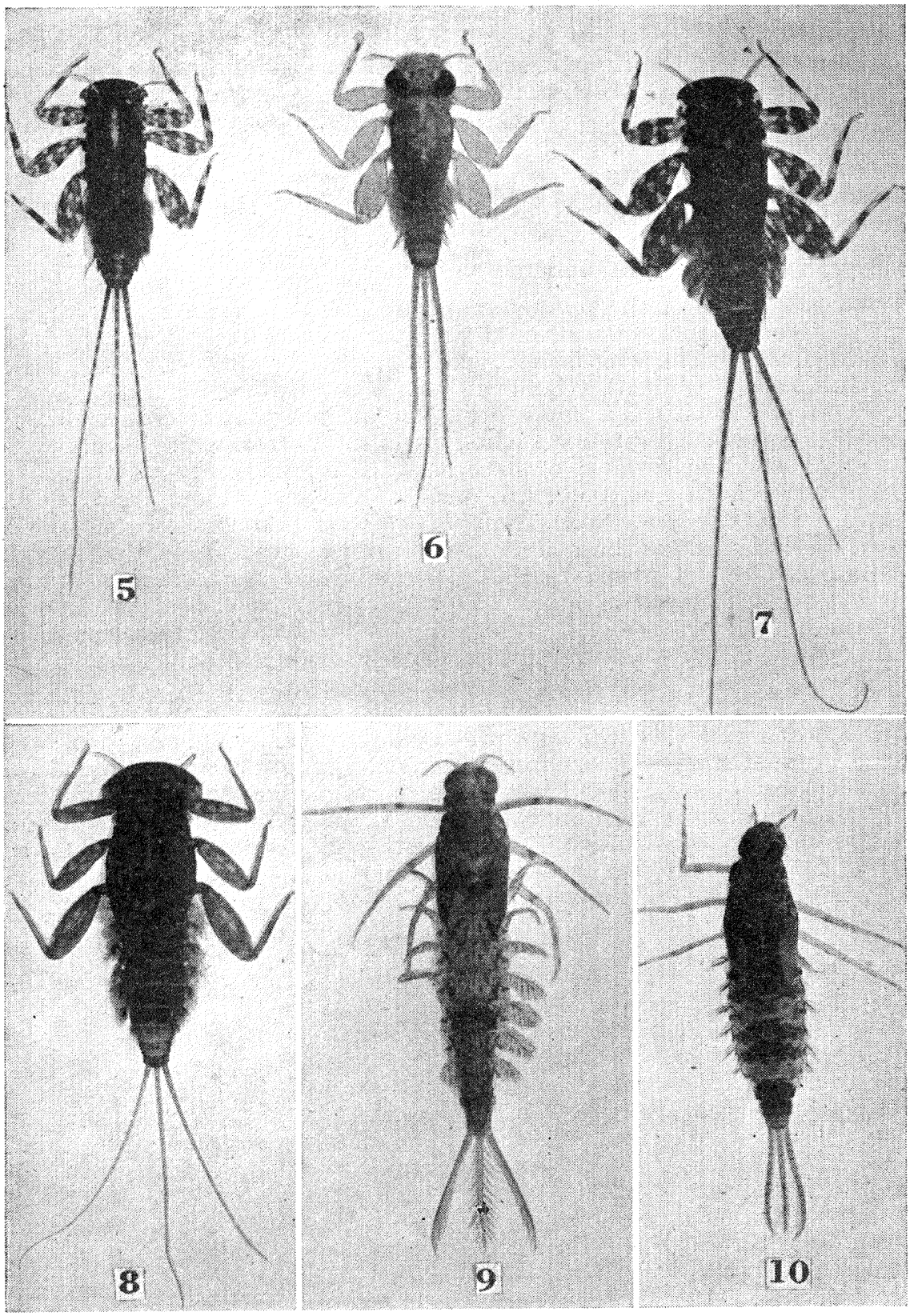
Male Imago (pinned).—Length: body 9 mm., wings 10 mm.

Head yellowish, face yellow with black dash beneath antennal bases and a black dot on carina. Ocelli black-ringed around base. Antennal fllament dusky, pale at tip. Vertex largely reddish-brown, posterior margin blackish, a black dot at inner margin of each eye. Pronotum yellowish with usual black lateral streak on each side. Mesonotum reddish-brown, a black line at antero-lateral margins. Pleura and sterna yellowish, no dark pleural streaks, a brownish raised area between fore and middle coxae.

Legs pale yellowish-hyaline. Fore femur darker, with wide median and apical blackish bands. Middle and hind femora with fainter apical bands, median band faint on middle leg, absent on hind femur. Basal tarsal joint about one-third length of second joint. Wings hyaline, cross veins in basal costal, subcostal and radial spaces margined with blackish, a black dash at bulla. Stigmatic area tinged with yellowish-brown, continued around bend of wing apex. Hind wing distinctly dark margined.

EXPLANATION OF PLATE I

Naiads. Fig 5. *Stenonema wabasha* n. sp.; Fig. 6. *Stenonema bipunctatum* (McDunnough); Fig. 7. *Stenonema exiguum* Traver; Fig. 8. *Rhithrogena pellucida* n. sp. Fig. 9. *Siphloplecton interlineatum* (Walsh); Fig. 10. *Centroptilum bistrigatum* n. sp.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Abdominal segments 1–7 pale yellowish-hyaline, posterior margins narrowly blackish, distinct spiracular dots present, fainter on basal terga. Segments 8–10 opaque, shaded with reddish-brown dorsally. Tergum 9 darkest, somewhat suffused with blackish dorsally. Lateral margins pale yellowish-white. Sterna pale yellowish. Tails pale, joinings faintly brownish. Forceps pale, genitalia of the *interpunctatum* type.

The naiad is unknown.

Holotype.—Male imago (pinned), Mound, Minnesota, June 14, 1930 (C. E. Mickel). *Paratypes*: 3 male imagoes, same data.

Stenonema wabasha, n. sp.

A new species of the *pulchellum* group, allied to *bellum* Traver, but differing from that species in the slightly larger size, in head and thoracic markings and in the white, unringed tails.

Male Imago (pinned).—Length: body 7 mm., wing 8 mm.

Head pale whitish, a small dark dot at inner lower corner of eye opposite antenna. Antennae wholly white. Vertex white, slight yellow-green shading around ocelli bases. Thorax creamy-white. Pronotum white with a fine ,curved, dark lateral line. Pleura and sterna white, a raised yellow-green area between 1st and 2nd leg bases. A short, brown dash at base and apex of fore coxa. Legs white with median and apical purplish-red bands on the femora, faint on hind femur. Apex of fore tibia dusky, a purplish-red streak near the base of the middle and hind tibiae. Wings hyaline with a very faint, pinkish-amber stain in the stigmatic area, scarcely visible in some specimens. Hind wing without dark margin, venation colorless.

Abdominal segments 1–7 white-hyaline, posterior margins of terga narrowly margined with black, most evident dorsally. Short purplish-black, oblique streaks in stigmatic area, extending forward from ends of black posterior margins. Traces of a dark, median streak on terga 3 and 6, sometimes a faint indication on 2. Terga 8–10 opaque-white, shaded with yellowish medially, ventrally opaque-white. Genitalia as in Fig. 2, forceps and tails white, unmarked.

Female Imago.—Female imago similar to the male except for the usual sex differences.

Naiad.—Length: body 7.5 mm., tails 9.5 mm.

A dark brown naiad with conspicuous yellow markings on the terminal terga as shown in Fig. 5.

Head dark brown, thickly sprinkled with fine pale dots, small pale median spot and a larger lateral spot on frontal margin. An irregular pale area extends from antero-lateral corner of eye to frontal margin, a smaller pale area between eye and lateral ocellus. A pale spot on posterior margin of head near postero-median corner of eye. A broad pale stripe begins near posterior margin of head, continues across pronotum, tapering off at middle of mesonotum.

Pronotum with median pale stripe, an additional pale area on either side near anterior margin, and an irregular pale area extending inward from lateral margin. Mesonotum and wing pads dark brown, the broad median pale stripe tapering off before reaching the posterior margin. Legs dark brown, femora with pale spot basally, other pale

spots form three irregular bands across femora. Tibiae with pale band near base and at apex, tips of tarsi and claws pale.

Abdomen dark brown dorsally, with submedian yellow streaks on anterior portions of terga 2–7. A conspicuous yellow median patch, bifurcate on tergite 7, extending across 8–9 and in some specimens to the anterior portion of tergum 10. Yellow lateral markings on terga 2–8, usually concealed by the purplish-gray gills. Tails brown, ringed with white, most conspicuous in outer two-thirds.

Ventrally pale, extent and distinctness of dark markings variable. Typically, these consist of paired submedian dark dots on sterna 2–8, a dark patch laterad of these, and a dark brown lateral streak. Sternum 9 with dark lateral patches, a tendency for these to coalesce anteriorly in some specimens to form a dark U-shaped mark. The extent of the dark lateral patches is quite variable.

Holotype: Male imago (pinned), Mississippi River, Wabasha, Minn., July 7, 1940, reared (RHD). *Allotype*: Female Imago (pinned), same data. *Paratypes*: Minnesota (pinned specimens): 8 m., 12 f, Mississippi River, John Latsch State Park, Winona Co., June 30, 1939, reared (RHD); 1 m, Wabasha, August 2, 1941, at lights (RHD); 1 m, 1 f, Winona, Mississippi River, July 3, 1937, at lights (RHD); 1 f, Pine Island, June 25, 1939, at lights (RHD); 1 m, 3 f, Pine City, July 6, 1938, at lights (RHD); 1 m., Grand Rapids, August 2, 1938 (D. G. Denning); 1 m, Virginia, August 3, 1938, at lights (D. G. Denning); 1 f, Beroun, July 6, 1938, at lights (RHD); 3 f, Little Falls, July 10, 1938, at lights (D. G. Denning); 2 f, Stillwater, July 17, 1938, at lights (RHD).

(Alcohol): 7 m, 27 f, Mississippi River, Winona, July 5, 1937, at lights (RHD); 1 m, 1 f subimago, Mississippi River, John Latsch State Park, Winona Co., June 25, 1939, reared (RHD); 1 f, and 1 m, 1 f subimagoes, same locality, June 28, 1939, reared (RHD); 1 m, 2 f, same locality, July 1, 1939, reared (RHD); 1 f, 1 f subimago, Mississippi River, Wabasha, July 7, 1940, reared (RHD); 1 f, Coon Creek, Anoka Co., August 20, 1939, reared (RHD).

Naiads.—3 m, 2 f, Mississippi River, John Latsch State Park, Winona Co., June 25, 1939 (RHD); 2 f, same locality, June 28, 1939 (RHD); 3 m, 1 f, same locality, July 1, 1939 (RHD); 2 m, 4 f, Mississippi River, Wabasha, July 7, 1940 (RHD).

Heptagenia elegantula (Eaton)

This species is widely distributed in western United States and extends eastward to Minnesota and Manitoba. It occurs very commonly in the southern hardwood and western prairie portions of this state, no records being available from the northeastern coniferous belt. The Iowa, Minnesota, and Manitoba specimens collected represent the easternmost records for the species.

The naiad (Fig. 12) has been very sketchily described by Needham and Christenson (1927) who have figured the naiad in their bulletin on Utah stream insects. Neither the description nor the figure is complete enough for recognition of the naiads, in fact the figure is quite misleading, at least as far as the Minnesota material is concerned. During the present study, a large number of naiads were reared from a number of different localities; so that an abundance of material was available for naiad description.

The naiads are brown in color, varying from deep mahogany to light brown, the terga with yellow, submedian, longitudinal dashes. These dashes vary in distinctness, being less distinct and almost absent in the darker naiads. The gills immediately distinguish these naiads from the superficially similar *Stenonema* naiads which occupy the same situations. The gills of *elegantula* are held out laterally from the sides of the abdomen, the fibrillar portion in living naiads being held dorsal and posterior to the lamellar portion which slants downward anteriorly. In *Stenonema* naiads, the gills are held more dorsally, not extending from the sides, with the lamellar part covering the fibrillar portion. In *Stenonema*, the gills move in wave-like rhythmic movements, while in *elegantula*, each gill moves at about the same time. The seventh gill remains motionless in each instance.

Naiad (Fig. 12).—Length: body 12 mm., tails 12 mm.

Head almost wholly dark brown with pale yellow markings around ocelli. A yellow dot from each lateral ocellus continues laterally in a narrow line around the eye, expanding in a funnel-shaped mark laterally and anteriorly until it reaches the margin of the head. A distinct yellow dot on the vertex between the eyes. Epicranial suture a thin yellow line. Antennae pale.

Median line from vertex continues posteriorly as a narrow line over the pronotum, widens suddenly on anterior mesonotum and gradually narrows again until it suddenly expands at the posterior edge to form a subtriangular or diamond-shaped, cream-colored mark.

Pronotum brown, lateral edges with transparent flange. Yellow lateral marks midway from median line to lateral edge consist of a round dot with a comma-shaped mark immediately below and angling medially. In some specimens, these two marks are fused. A transparent, pale dot present in anterior-lateral angle of pronotum. Mesonotum with median, arrow-shaped mark as described (Fig. 12), more reddish-brown in color than head and pronotum.

Femora largely grayish-brown marked with variable yellow patches. The most common pattern appearing as three over-lapping triangles. Tibia grayish-brown with yellow bands at basal and distal ends. Tarsi grayish-brown, claws lighter in color.

Abdominal terga dark brown with submedian ( )-shaped markings on 1–7. These dashes are not continuous and do not attain the anterior or posterior margins. Markings indistinct or absent on terga 8–10. No pale blotches or light patches as indicated in Needham and Christenson's figure (1927) and in Traver's key (1935). Sterna with thin, dark, lateral margins bounding a pale lateral area. Two wide, submedian brown bands with sinuate outer margins bound a rather dusky, pale central area. This sinuate character most evident on sterna 1–5. Sterna 8–10 with extensive, median yellow areas.

Lamellar gills tinged with brown, fibrillar gills more extensive than indicated in Needham and Christenson's figure. Tails long, alternately banded with light and dark areas. Median filament with darker bands

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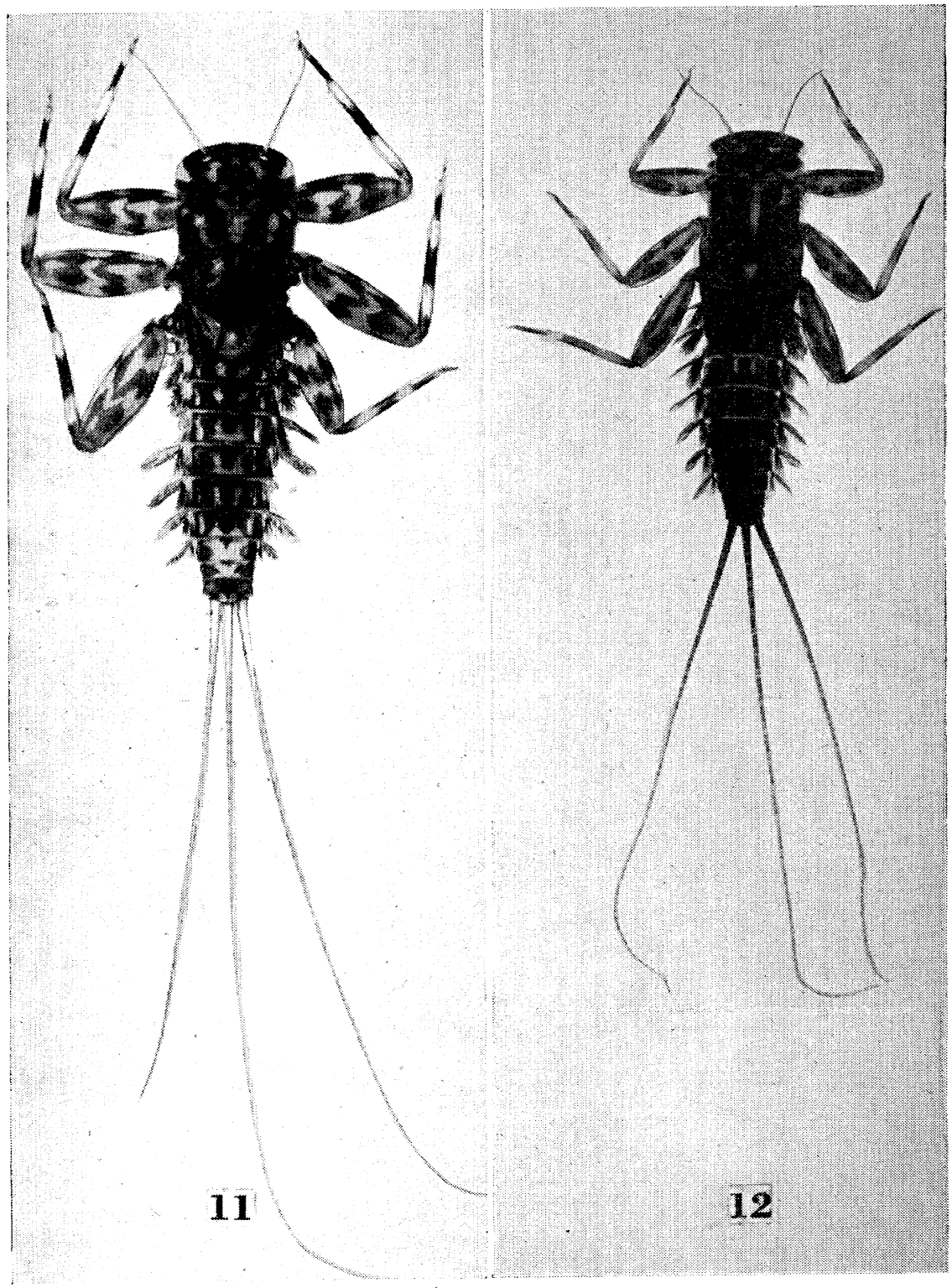
EXPLANATION OF PLATE II

Naiads. Fig. 11. *Heptagenia flavescens* (Walsh); Fig. 12. *Heptagenia elegantula* (Eaton).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than laterals. The light bands are much reduced at the base giving a dark appearance to the basal sections of the tails.

Specimens from which the above naiad description was drawn were collected in the Zumbro River at Wabasha, Winnebago Creek in Houston Co. and adjacent Iowa, Buffalo Creek near Glencoe, Florida Creek near Marietta, Beaver Creek near Olivia, Root River at Chatfield, Coon Creek in Anoka Co., and the St. Croix River at Stillwater. Adults have also been collected along the entire western border of the state and northward as far as Winnipeg, Manitoba.

Heptagenia flavescens (Walsh)

This interesting species, the genotype, is known from central United States and adjacent Canada. A single male specimen collected in Clark Co., Georgia, at lights, May 23, 1938 (Horace O. Lund) is an interesting record from the southeastern states.

The naiad of this important genotypic species has remained unknown since Walsh first described the species in 1862. When imagoes were collected along the Mississippi River in the southeastern part of the state, an intensive search was made for the naiads in nearby areas of the river. Four naiads were finally collected from under logs in shallow water near the shore at John Latsch State Park in Winona Co. These were returned to the laboratory and one male and one female reared to complete the life cycle. The cast skins and two naiads were preserved for description of the immature stages. The photographed specimen (Fig. 11) is somewhat paler than the others and may have molted recently. Thus the majority of *flavescens* naiads may prove to be darker than the photograph indicates, but the distinctive color pattern will be similar.

Naiad (Fig. 11).—Length: body 15 mm., tails 20 mm. (tips broken).

This is the largest species in the genus and belongs to the *flavescens-pulla-elegantula* group characterized by having the pronotum widest at the anterior margin, by having claws without spines at the tip, and by the presence of the fibrillar portion of gill 7. The dorsal maculation is clearly shown in Fig. 11, darker specimens may have the light markings somewhat obscured.

Head dark brown with pale yellow-brown markings as follows: pale median spot on frontal margin; smaller spot laterally on front margin; a small pale spot medially of each antenna, each spot connected by a thin yellow line to a light area in front of the median ocellus; a pale hour-glass shaped area between antennal bases and compound eyes, bordering the lateral margins of the ocelli. Epicranial suture a thin, yellow line somewhat swollen posteriorly. Head pale on posterior margin between compound eyes. A funnel-shaped pale area extending from the antero-lateral corners of the compound eye anteriorly and laterally to open on the lateral margin of the head. These pale markings may be somewhat obscured on darker specimens, but the three pale marginal frontal spots are distinct in all specimens examined, although the lateral ones may be fainter in dark specimens.

Pronotum dark brown with paler flange and a yellow spot in the antero-lateral angle. A pale area in center and pale lateral bands curving medially at posterior margin to form a U-shaped mark. Meso-

notum brown, mottled with lighter areas. Femora brown, marked with two pale irregular jagged bands. Tibiae pale brown, somewhat darker proximally, with wide, dark brown median band. Tarsi with basal two-thirds dark brown, tip pale; claws pale, tips brownish.

Abdomen dark brown dorsally with pale yellow brown markings. Tergum 1 almost entirely pale except for brown posterior-lateral angles. Succeeding pairs of terga differ in markings but the members of each pair are similar. Terga 2–3 with a pair of submedian yellow spots, on 4–5 these spots unite posteriorly to form pale U-shaped marks, these are not as distinct on 6–7, terga 8–9 with broad pale V-shaped areas, tergum 10 largely dark brown except for a pair of pale submedian areas on posterior margin. In the darker specimens, the lighter markings on the terga are not as extensive, the median light areas reduced to pale dots; but terga 8–9 still have the most prominent yellowish markings. A pale flange and pale lateral areas in addition on terga 2–8.

Entire venter pale except for the brown curved outer margin of sternum 9. Darker specimens may show more extensive ventral markings when more material is available. These are faintly indicated in the naiad skins as well as in the pale naiad which may have molted shortly before preservation. These skins seem to show narrow lateral dark markings in one, and in the other, a pair of oblique lateral lines in addition to the dark lateral markings on all sterna. The fibrillar portion present on all gills. Tails pale, faintly dark ringed.

Naiads have been collected from the Mississippi River in Winona Co. and at Minneapolis, and from the Root River at Chatfield.

Rhithrogena pellucida, n. sp.

This is a small dark brown species of the *jejuna-undulata* group with pale transparent venation and white, unmarked tails. Anastomosing of the cross veins in the stigmatic area is weak or wanting on one or both wings. The femora bear a distinctive median brown dash.

Male Imago (pinned).—Length: body 6–7 mm., wings 6–7 mm.

Eyes dark blackish-green in life, blackish in dried specimens, contiguous apically. Vertex dark brown, much darker, almost black at bases of ocelli. Basal antennal segments pale, filament dusky. A cream-colored band between lower corner of eyes through antennal bases, widened somewhat on carina and antennal bases. Face below band dark greenish-brown.

Pronotum dark reddish-brown. Mesonotum dark olivaceous-brown marked with orange-brown posteriorly. Lateral margins often yellowish both anteriorly and posteriorly. Scutellum dark brown. A distinct reddish area extending from the wing bases to the prothorax, containing a yellow streak anteriorly. Pleura greenish-brown marked with darker brown and yellow. Wings hyaline, venation pale, transparent except for first three longitudinal veins which are somewhat dusky at bases, the costa for almost half its length. A pale, milky cloud in stigmatic area, anastomosing of cross veins weak or almost entirely absent. Legs amber-yellow, slightly green-tinged. All femora with a distinct, dark brown, median dash which becomes lighter in diffusing laterally, tending to form a median band. Tibiae paler, unmarked; tarsi with joinings narrowly darkened, claws dark. Fore

femur with first joint one-third the length of the second, second slightly longer than the third, the fourth half that of the second, and the fifth slightly shorter than the fourth.

General color of abdomen reddish-brown. Terga 2–6 semi-hyaline, with a large diffuse, darker red-brown area on each side, almost as wide as tergum but becoming paler at margins. A pair of submedian, transparent dots on each of these terga. Terga 7–10 opaque-brown marked with orange-brown. Sterna paler. Tails white, unmarked. Genitalia of the *jejuna* type, see Fig. 3.

Female Imago (pinned).—Head triangular from above, carina only slightly elevated. Vertex orange-brown, a reddish-brown ridge running between the lateral ocelli marks off the paler face. A cream-colored band through the antennae, wider than in the male, expanded at the carina. Face below band dusky-brown. In some specimens, a pair of dark dots, one on each side of carina, between antennae. Antennal bases yellow, filament dusky, pale at tip.

Pronotum orange-brown, similar to vertex. Mesonotum olivaceous-brown, lighter than the male. Scutellum and area anterior yellow-brown, streaked with reddish in some specimens. Lateral margins pale anteriorly with pinkish tinge posteriorly, slightly extending over the wing bases. Pleura yellow-brown marked with paler areas and occasional short, reddish streaks. A reddish-brown area, pink-tinged in some individuals, anterior to wing bases. Wings and legs as described for the male. Abdomen brown, paler than in the male. Sterna paler. Tails white, unmarked.

Specimens of both sexes preserved in alcohol lose much of the distinctive green and reddish shading present in the dried specimens. In alcohol, the general body coloration consists of different shades of yellow and brown, while the femoral dash tends to fade out.

Naiad (Fig. 8).—Length: body 7 mm., tails 5 mm. Head and thorax dark brown, concolorous with the abdomen. Ocelli white marked, a yellow line connecting the lateral ocelli to the lateral margins. Antennal segments dark at base becoming paler distally. Pronotum uniformly dark brown, except for two comma-shaped yellow markings in each antero-lateral angle. Mesonotum slightly paler brown, with a median pale line. Thoracic sterna largely pale with dark brown markings. Femora broad with scattered, minute reddish freckles, especially in basal half. A median, pale oval area in center of femora, within which is a dark brown spot which persists in the imago as the median, femoral dash. A smaller pale area is present at bases of all femora.

General color of abdomen dark brown, except for terga 8–9 which are bright yellow and contrast sharply with the solid brown of the remaining terga. A pair of faint, submedian, pale dots are usually visible on abdominal terga. Venter flattened, paler. Sterna 2–8 with a dark brown median rectangular patch containing a narrow dark transverse line near posterior margin. A pale, round spot ventrally at posterior margins above gill bases. Lateral margins of sterna dark brownish-black. Lamellar gills whitish, fibrillar gills with greenish tracheae. The sucking disk formed by modifications of the first and last pairs of gills is typical of the genus. Tails light brown, darker at base, joinings narrowly dark brown.

In some naiads collected, the bright yellow patch covering terga 8–9 is absent. In these cases, all terga are more or less uniformly colored, but there are variations of all degrees between the extremes. Typically, the yellow patch is present and is a distinctive mark for collecting naiads in streams.

Holotype: Male imago (pinned), Minneapolis, Minnesota, July 1, 1939, at lights (RHD). *Allotype:* Female imago (pinned), same data. *Paratypes:* (pinned), Minnesota, 2 m, 5 f, same data as holotype; 1 f, same locality, July 12, 1938, at lights (RHD); 1 m, 5 f, same locality, July 14, 1938, at lights (RHD); 4 m, same locality, July 15, 1938, at lights (RHD); 6 f, same locality, August 3, 1938, at lights (RHD); 1 f, St. Paul, Midland Hills golf course light trap, July 25, 1938 (A. A. Granovsky); 1 f, St. Paul, August 3, 1938, at lights (RHD); 9 m, 5 f, Fridley, September 28, 1938 (RHD); 6 f, Anoka, July 25, 1938 (RHD); 16 f, St. Cloud, July 7, 1939, at lights (RHD); 1 f, Pine City, July 6, 1938, at lights (RHD); 5 f, same locality, August 15, 1938, at lights (D. G. Denning). (Alcohol): 17 m, 7 f, and 2 m subimagoes, Mississippi River, Minneapolis, July 1, 1939, at lights (RHD); 2 m, same locality, July 10, 1939, at lights (RHD); 4 f, same locality, July 9, 1939, reared (RHD); 2 f, same locality, June 20, 1939, at lights (RHD); 1 m, and 3 m, 2 f subimagoes, same locality, June 29, 1939, at lights (RHD); 1 f, 1 f subimago, same locality, June 24, 1939, reared (RHD); 2 m, same locality, August 15, 1938, at lights (RHD); 1 m, same locality, May 31, 1939 (M. Gotschall, M. McClintock); 1 f, Mississippi River, Coon Rapids, July 15, 1939, reared (RHD); 2 m subimagoes, Mississippi River, Fridley, June 11, 1937, reared (RHD); 1 f, Anoka, September 7, 1937, at lights (RHD); 9 f, same locality, July 24, 1939, at lights (RHD); 28 f, Mississippi River, St. Cloud, July 7, 1939, at lights (RHD); 2 f subimagoes, Temperance River, Cook Co., August 10, 1939, reared (RHD).

Naiads.—1 m, 2 f, Mississippi River, Minneapolis, August 25, 1938 (RHD); 9 f, 7 immature, same locality, June 17, 1939 (RHD); 1 f, same locality, June 24, 1939, (RHD); 7 m, 6 f, same locality, July 9, 1939 (RHD); 1 m, 1 f, Mississippi River, Fridley, May 23, 1939 (RHD); 1 m, Mississippi River, Coon Rapids, June 24, 1939 (RHD); 1 m, 4 f, same locality, July 12, 1939 (RHD); 1 f, Cascade River, Cook Co., July 6, 1938 (RHD); 1 m, 2 f, Mississippi River, Elk River, July 7, 1939 (John Moyle); 3 f, Mississippi River, Bowlus, July 28, 1939 (John Moyle). Michigan: 2 m, Sturgeon River, Cheyboygan Co., August 5, 1936 (F. E. Lyman) also seem to belong here.

This swift-water species is allied to *Rhithrogena jejuna* Eaton, *undulata* (Banks), and *impersonata* (McDunnough) in lacking a lateral spine or spine-bearing process on the penes divisions near the base. It can readily be separated from these other members of the *jejuna* group by its pale transparent venation (hence the name *pellucida*), white tails, and distinctive genitalia (Fig. 3). Its relation to *fuscifrons* Traver, described from the female, cannot be fully ascertained until that species is also known in the male sex.

The species was first noticed by the writer in collecting at lights on the University of Minnesota campus at Minneapolis, near the Mississippi River. Since the only swift water nearby was located below the St. Anthony's Falls dam, the naiads were expected to be found there. This

proved to be the case. Large numbers of naiads were collected with no difficulty and imagoes were reared to complete the life history. Other naiads were found in rapid parts of the Mississippi River farther north at Coon Rapids and at St. Cloud. The species also occurs in the rapid Snake River at Pine City and in the swift streams emptying into the north shore of Lake Superior as evidenced by the Cascade and Temperance River specimens.

Family **Baetidae**

Siphloplecton interlineatum (Walsh)

This is another species described by Walsh from the Mississippi River at Rock Island, Illinois in 1862. The naiad has remained unknown until the present study when specimens were collected in the Mississippi River in Winona Co. and imagoes reared to complete the life history.

Naiad (Fig. 9).—Length: body 15–16 mm., tails 5 mm.

Face pale yellow-brown with brown sclerotized areas, antennae yellowish. Occiput dark, gray brown, base of epicranial suture darker. Thorax marked dorsally with a pattern of brown and yellow, ventrally entirely pale. Wing pads pale yellow with dark brown venation. Legs light yellow-brown with dark brown markings as follows: a dark spot on each coxa, proximal and subapical bands on femora, a median band on tibiae, proximal band on tarsi. Front claws bifid, others long, sharp pointed.

Dorsum of abdomen with terga 1, 6, and 9 largely dark brown, others largely pale, yellow-brown with dark brown markings. On the lighter terga, a narrow median brown line, a pair of submedian dark triangular spots, an additional pair of dark areas anterior and lateral to these. These fuse with other brown areas on the anterior and posterior segments but are distinct on middle segments. Tergum 6 largely brown, with a pair of pale submedian spots on the posterior margin, two pale spots in each antero-lateral angle. All terga with a blackish-brown lateral area, medially of flange, which extends in a narrow black line across the posterior margins of the terga forming a broad U with the arms of the U meeting the base at almost right angles and thicker than the base. The flange of all terga with a median, lateral brown spot.

Venter of abdomen pale, yellowish-white with three brown longitudinal stripes on sterna 2–9, one median and two lateral. These may not be complete in all specimens or in immature specimens as is true of similar markings in *S. basale* (Walker). Gills single on all segments, not double on 1–3 as in other described naiads in this genus. Tails pale, yellowish-brown, dark banded in distal third.

The female differs from the male in not having the decided contrast in coloration of the various terga. The color pattern is more or less alike for all tergites in the female.

A variation of one male naiad has been noted in which a broad dark median dorsal stripe obscures other markings. The median tail is dark in this abnormal specimen.

Naiads from which the above description has been taken were collected in the Mississippi River at John Latsch State Park in Winona Co. and from the St. Croix River at Stillwater.

Isonychia rufa McDunnough

This species, originally described by McDunnough (1931) from specimens taken in Kansas and Iowa, is evidently the common *Isonychia* of the Great Plains region. It has been taken in numbers at lights during the present study in the southern and western prairie portions of the state and in South Dakota. The naiad has not been described previously. A number have been reared and many naiads collected. They were usually very abundant wherever they occurred.

Naiad.—Length: body 14 mm., tails 7 mm.

This is a dark reddish-brown naiad with an interrupted pale median stripe on abdominal tergites, a pale median spot near the lateral margin on each tergum, and tergum 10 distinctly divided into a pale anterior half and a dark brownish-black posterior half. Laterad of the interrupted median line, a pair of faint, pale submedian curved dashes, most conspicuous on posterior terga. In some specimens examined, the interrupted line on the terga becomes indistinct posteriorly.

Basal antennal segments pale, flagellum brown, paler distally. A pale dorsal stripe on head and thorax, widest on pronotum. Medially of compound eyes, a pale stripe runs posteriorly but does not attain posterior margin, not as apparent in male because of the size of the compound eyes. Additional pale, curved lateral markings on pronotum.

Middle and hind legs pale with dark brown markings. Coxae and trochanters largely dark brown, femora twice banded, the bands almost fused on hind femora in some specimens. Tibiae with a wide median band, tarsi banded near the base, claw-tips reddish brown. In mature naiads, the fore leg has the reddish tinge of the imago.

Ventral abdomen dark reddish-brown with a dark round spot at anterior portion of each sternum near lateral margin, a paler spot lateral to this. The dark spot often connected laterally to a curved dark lateral mark. Submedian clusters of two or three small pale dots on sterna in most specimens; in some, these are fused to form irregular pale submedian marks. Gills with a large, diffuse, purplish area in center, very faint in some preserved specimens. Tails greenish or olive-brown, blackish-brown at base, a dark band in distal third, pale yellow beyond, the tips often broken. Fringe dark, anterior to band, pale beyond.

Variation: In a series collected from the Root River at Chatfield, there appeared a number of naiads with a striking modification of the above described color pattern. Since all specimens of the series grade into one another, these specimens are treated as one species until rearings can prove otherwise. The anterior half of each tergum in these specimens is distinctly dark brown, the posterior half paler, giving a distinct ringed appearance dorsally. The interrupted pale dorsal line is somewhat obscured by this variation. Other markings are as described above.

Specimens from which the above description was drawn were collected at Park Rapids, in the Root River at Chatfield, from Coon Creek in Anoka Co., and from the Blue Earth River at Rapidan.

Baetisca bajkovi Neave

This species has been previously known only from the naiads described by Neave (1934) from material collected in Manitoba and has not been recorded since the original description. A series of imagoes and subimagoes of both sexes were reared from naiads collected in the Mississippi River at Fridley in 1937 and again in 1939 and 1940. Hence a description of the imago is now available.

The seasonal distribution of this species is apparently very limited. The adults have been taken only between May 25th and June 14th. Mature naiads are not found after the middle of June, all having evidently emerged by that time.

Male Imago (alcohol).—Length: body 9 mm., wing 10 mm.

Thorax and abdomen brown dorsally. Ventrally the thorax is pale brown and the sterna whitish in both sexes, contrasting sharply with the brown terga as in *lacustris* McDunnough. Wings hyaline, first three veins brown at the base, somewhat yellowish throughout their length. Stigmatic area white, opaque. Legs whitish; fore leg with tibia brown at tip; tarsal joinings, last tarsal segment and claws dusky. Other legs white with faint, narrow, dusky tarsal joinings. Tails white, unmarked. Penes tapering evenly to a thin sharp point (Fig. 4).

Female slightly larger, somewhat paler dorsally. In all other respects like the male except for the usual sexual differences.

This species is evidently closely related to *B. lacustris* McDunnough, a species known only from the Great Lakes at present. *Bajkovi* seems to differ in habitat, the latter being taken only from rivers. The imagoes of *bajkovi* are apparently larger than *lacustris*, and the apical abdominal terga are not ruddy-tinged as described for that species.

The naiads of *bajkovi* and *obesa* are apparently easier to separate. Both lack dorsal spines, but *bajkovi* has well developed shelf-like genal projections. Another useful recognition character seems to be the presence of a large black dot between the second and third pairs of coxae in all the *bajkovi* naiads examined.

Specimens from which the above descriptions have been drawn were taken from the Mississippi River at Fridley, Red Wing, and Frontenac; from the Root River at Chatfield, and the St. Croix River at Taylors Falls.

Callibaetis brevicostatus, n. sp.

This is an apparently new species closely related to *Callibaetis semicostatus* Banks, but it can be distinguished at once from that species by the more restricted pigmentation in the male wing. The reddish-brown pigment occupies a distinct but restricted area about 1 mm. in length near the base of the wing, bounded anteriorly by the third vein.

This species may fall as a synonym of one of Bank's species described from females only. Further rearing and correct association and identification of the female will be necessary to prove this. Until this can be shown, the writer regards the species as new and offers a description of the male imago.

Male Imago (pinned).—Length: body 8 mm., wing 8 mm.

Turbinate eyes in life dark orange-brown (dark reddish-brown dried), lower eyes pale green with red-brown ring through center. Basal antennal segments dark brown, flagellum pale at extreme base and whitish at tip, middle of flagellum dark brown.

Mesonotum with dark brown median stripe, median suture a fine pale line. Paler laterally, cream colored markings near anterior and posterior margins. Pleura reddish-brown marked with pale areas and sprinkled with brown dots especially above leg bases. Venter of thorax pale brown, heavily freckled with brown dots medially.

Legs pale yellowish-white, femora slightly if at all freckled. Fore tibia darker, tarsi darker at joinings.

Wings distinctive (Fig. 1), pigment restricted to a small area about 1 mm. in length near the base of the fore wing, bounded anteriorly by the third vein and posteriorly by the base of the cubitals. Main longitudinal veins brown, cross veins pale. Marginal intercalaries paired. Hind wing unpigmented.

Abdomen brown, heavily dotted. Medially a darker brown band with few brown dots (occasionally a pale area at anterior margin of each tergum in this band) bounded laterally by a pair of dark, longitudinal ( )-shaped markings on each tergum. A prominent reddish diffuse spot on anterior margin halfway between the submedian parenthetical marks and lateral margins of terga. A paler area between these red marks and the median band, giving a faintly striped appearance to the abdomen. Sterna paler, finely dotted except for sprinkling of larger red dots in postero-median region of each sternum. Paired submedian longitudinal dashes with reddish-brown dash near antero-lateral corner of sterna 2–8.

Tails and forceps white, except for penultimate joint of forceps which is reddish in distal half.

Holotype: Male (pinned), Ramsey Co., Minn., small pond near Carver's Lake, Sept. 22, 1937, reared (RHD). *Paratypes:* Nine males (seven in alcohol, two pinned), same data except for the following dates: one male, March 7, 1937; two males, Sept. 7, 1937; four males, Sept. 8, 1937, (alcohol); one male, Sept. 7, 1937; and one male Nov. 26, 1937 (pinned).

Centroptilum bistrigatum, n. sp.

This species is characterized by the abdominal terga 2–6 in the male imago being hyaline-white, bearing a distinct pair of reddish, submedian dashes on the posterior margin. These markings are distinctive and separate *bistrigatum* from other described species in the genus.

Male Imago (pinned).—Length: body 5 mm., wing 5–5.5 mm.

Turbinate eyes of dried imago dark reddish-brown; bright yellow in life with a distinct narrow black margin around the top of the turbinate portion, visible in alcohol material. Head dark brown with a pale, crescent-shaped area at ventral margin of antennal bases. A pale colored area on either side of median carina. Carina and frontal margin of head dark reddish-brown.

Thorax deep chocolate-brown. Pleura and antero-lateral margins of mesonotum shaded with reddish-brown; mesonotum olive-tinged.

Wings hyaline, venation pale, 4–7 cross veins in stigmatic area. Hind wing long, narrow, five times as long as wide, with two longitudinal veins. Costal projection long, well-developed. Legs pale yellowish-white.

Abdominal segments 2–6 hyaline-white. Each tergum with a pair of reddish, submedian bold dashes on posterior margin, separated at the median line by a space equal in length to one of the dashes. In some specimens, including the holotype, a faint median, reddish, geminate line is present on terga 2–4, most distinct on 4. In those specimens where these markings are most distinct, there is also a small, faint reddish, lateral diffuse area on 4. These geminate markings and diffuse reddish areas are not visible on all the paratypes. Terga 7–10 opaque, dark chocolate-brown. The red dashes are also present on terga 7–8, but are usually visible on these segments only in alcohol material. Sterna 7–10 white contrasting sharply with the dark brown terga. Forceps and tails white; second forceps joint without an inwardly projecting tubercle or swelling.

Female Imago (pinned).—General body color reddish-brown, pleura and margins of metanotum marked with reddish. Abdominal terga reddish-brown somewhat obscuring the reddish dashes which are present but not as distinct as in the male. These dashes can be more readily seen in living material and in females preserved in alcohol. Middle abdominal terga with blackish, lateral blotches as is common in females of this genus. Entire venter white, contrasting sharply with the reddish-brown dorsum. Wings, legs, and tails as in the male.

Alcohol Material.—Coloration is generally paler in both sexes as is usual in alcohol preservation. The reddish dashes so distinctive of this species may gradually fade out in alcohol since they already appear fainter in specimens collected in 1938. In some of the female paratypes, these markings are almost gone (1939).

Naiad (Fig. 10).—Length: body 6 mm., tails 2 mm.

Head with a narrow, pale band between compound eyes, a dark brown band on each side. Thorax brown with an intricate pattern of light areas. Legs pale, femora brown-banded near distal end, tarsi somewhat dusky. Abdominal segments 1, 4, 7, and 10 usually light in well marked specimens, although there is much variation in intensity of dark coloration on the various segments in different individuals even from the same locality. Terga 2–3, 5–6, and 8–9 mainly brown with a similar pattern of light markings on each of these terga. In those specimens where there is little distinction between light and dark terga, this pattern is found on each segment dark enough to make it visible. The pattern (Fig. 10) consists of a small, median, crescent-shaped spot on the anterior margin, from which extend a pair of narrow submedian, posteriorly diverging, pale lines with a pale dot just beyond their distal ends. A round pale area laterad of these central markings is located halfway to lateral margin. An irregular pale area is present in the antero-lateral corner, with a narrow extension toward the median line. When terga 4 and 7 are largely pale, a round brown patch is found on each lateral half-tergum. In some specimens, these are faint or the segment is entirely pale. Abdominal terga 1–8 with the paired submedian dashes of the imago visible as dark brown dashes in the naiad.

The segments are produced laterally into flaring margins with a sharp spine in the postero-lateral angle. All abdominal terga with close-set, fine, sharp spines on their posterior margins; segments 8–10 with sharp spines on their lateral margins.

Gills single on all segments, the pigmented tracheae branching almost entirely on the inner side. Tails pale, unbanded, short and stout with more strongly sclerotized annuli occurring at about every fourth segment.

Holotype: Male imago (pinned), Mississippi River, Fridley, Minnesota, taken from water surface, September 28, 1938 (RHD). *Allotype:* Female imago (pinned), same locality, June 24, 1939 (RHD). *Paratypes* (pinned): Minnesota, 13 m, 4 f, same data as holotype; 2 m, same locality, September 26, 1938 (RHD); 1 m, 1 f, same locality, June 25, 1939, reared, (RHD); 2 f, same locality, June 24, 1939 (RHD); 1 m, Little Falls, July 16, 1938, at lights (D. G. Denning); 1 m, 2 f, Pine City, August 15, 1938, at lights (D. G. Denning); 1 m, 1 f, Minneapolis, July 19, 1930, at lights (RHD). (Alcohol): 2 f, Princeton, August 18, 1935 (RHD); 1 f, Pine City, July 6, 1938, at lights (RHD); 1 f, Coon Creek, Anoka Co., August 26, 1937 (RHD); 1 m, Mississippi River, Fridley, September 26, 1938 (RHD); 5 m, 2 f, same locality, September 28, 1938 (RHD); 2 f, same locality, June 27, 1939, reared (RHD); 1 m, 1 f, Mississippi River, Coon Rapids, June 26, 1939, reared (RHD); 2 m, 7 f subimagoes, St. Louis River, Jay Cooke State Park, July 6, 1938 (RHD).

Naiads.—1 m, 2 f, Blue Earth River, Rapidan, July 30, 1938 (RHD); 1 f, St. Croix River, Taylors Falls, October 11, 1936 (RHD); 1 m, 4 f, Mississippi River, Coon Rapids, June 23, 1939 (RHD); 1 m, 2 f, same locality, July 6, 1939 (RHD); 1 m, 6 f, same locality, June 26, 1939 (RHD); 3 f, Mississippi River, Fridley, June 27, 1939 (RHD); 1 f, Rum River, St. Francis, July 18, 1939 (John Moyle).

Pseudocloeon anoka, n. sp.

This is a new species closely related to *punctiventris* McDunnough in possessing median ventral dots, but differs from that species and others in the genus by the possession of a large, dark median spot on tergum 2 and a similar spot on tergum 6.

Male Imago (pinned).—Length: body 5 mm., wing 5 mm.

Turbinate eyes almost circular, reddish-brown. Face dark brown, pale area around antennal bases. Basal antennal segments dark brown, flagellum pale. Thorax deep reddish-brown, with scutellum and a spot at each anterior-lateral angle of mesonotum pale yellowish. Pleura brown, marked with yellowish, membranous areas pink-tinged. Sterna dark brown. Legs whitish. Wings hyaline.

Abdominal segments 2–6 white-hyaline, a distinct large dark median spot on tergum 2 and a similar spot on tergum 6. These terga narrowly orange-brown at posterior margins. Ventrally with small dark median dots on sterna 4–7. Terga 7–10 light ruddy-brown, ventrally opaque-white. Tails white.

Holotype: Male imago (pinned), Coon Creek, Anoka Co., Minnesota, August 21, 1939, reared (RHD). *Paratype:* Male imago (alcohol), same locality, September 14, 1937, reared (RHD).

In the paratype preserved in alcohol, there are very minute median dots on terga 3–5 and on 7 in addition to the large spots on 2 and 6.

A single naiad which seems to be this species was collected in the Long Prairie River, Todd Co., Minnesota, September 11, 1939 (John Moyle). Although considerably faded by earlier preservation in formalin, the following description of the naiad seems to fit the markings of the imago.

Naiad.—Length: body 4 mm., tails 2 mm. (immature).

Pale yellowish-brown, probably greenish in life. Traces of a pale median band. Faint paired, dark submedian dots on terga. A large median dark spot on terga 2 and 6, a smaller one on 7. Midventral dark dots on sterna 5–9. Legs pale with a distinct dark dot at each femur-tibial junction. A dark dot at each leg base, and a larger dark dot between leg bases 1–2, and 2–3. Tails pale, banded at middle, tips darker.

This species is evidently most closely related to *punctiventris* McDunnough and may even be an oddly marked variation of that species, but the collection of two imagoes and a naiad in two different localities suggests that it may be new and it is described as such.

Pseudocloeon elliotti, n. sp.

Male Imago (pinned).—Length: body 4.5 mm.; wing 4.5 mm.

Turbinate eyes reddish-brown, broadly oval. Face deep brown, antennae similarly colored except for white membranous area around antennal bases. Thorax deep blackish-brown with a distinct yellow spot on mesonotum at antero-lateral angles, postero-lateral margins with yellowish border, a faint yellow-brown area anterior to scutellum. Pleura deep blackish-brown, sclerites margined with yellow. Membranous area tinged with reddish, a reddish area anterior to bases of forewings.

Wings hyaline, usually 4–5 slanting cross veins in stigmatic area. Legs white-hyaline, except fore femora which are smoky-brown basally, becoming somewhat paler distally. All femora with faint apical and obvious median orange-brown bands, sometimes very faint apically.

Abdominal segments 2–6 white-hyaline, a rather large median reddish spot on tergum 2, sometimes faintly geminate. A distinct mustard-yellow flush on each side of tergum 4. No paired submedian red dots dorsally and no ventral markings. Tracheae in stigmatic area faintly dark penciled. Terga 7—10 umber-brown, paler laterally. Sterna 1–6 white hyaline, unmarked, 7–10 opaque-white. Forceps and tails white.

Holotype: Male imago (pinned), Mississippi River, Fridley, Minnesota, September 28, 1938 (RHD). *Allotype:* Female imago (pinned), same data. *Paratypes:* 41 m, 13 f (pinned) same data.

The entire series was captured from the water surface in late afternoon on the Mississippi River. They were placed alive in drying jars before being killed and mounted.

This species seems most closely related to *dubium* (Walsh) but differs in the presence of the large reddish spot on tergum 2, the femoral bands, and the mustard-yellow flush on tergum 4—these markings being absent in *dubium*. It is similar to *ida* n. sp., described below, in colora-

tion and markings, but lacks the paired submedian reddish spots present on terga 2–6 of that species.

In addition to the type material, five additional male pinned specimens are placed here. They were collected at the same time and place, but three of them lack the reddish spot on 2, the other two have the abdomen too badly shriveled to make identification of markings possible. In all other respects, the above descriptions hold for these specimens, but they are not placed in the type series.

A vial of 11 males and 1 female were collected with the type series, notes on markings taken, and then placed in alcohol. As a result of the alcohol preservation, the characteristic specific markings have completely faded.

One vial of 16 males, 2 females and another vial of 11 females were collected at the same place two days later (September 28) and probably also belong here, but the markings have all disappeared in alcohol. Since the characteristic markings fade readily in alcohol, specific determinations in this genus cannot be made from alcohol material with any degree of certainty.

Pseudocloeon ida, n. sp.

Male Imago.—Length: body 4 mm., wing 4 mm.

Turbinate eyes broadly oval, deep reddish brown in dried specimens. Thorax deep blackish-brown, paler laterally on posterior margins and a paler area anterior to mesoscutellum. Mesonotum marked with yellow at antero-lateral corners. Metanotum similarly colored, lighter brown at antero-lateral angles. Pleura dark brown, some sclerites margined with yellowish, membranous areas ruddy-tinged. Venter of thorax dark brown, similar to dorsal coloration.

Wings clear, hyaline, five slanting cross veins in stigmatic area, traces of others apically. Fore femora smoky-brown basally, becoming pale amber at tip, tibiae and tarsi white. Middle and hind legs whitish, femora faintly tinted with amber. Middle and hind femora with a faint median orange-brown band, dark penciling near their ventral margins.

Abdominal segments 2–6 white-hyaline, with paired, submedian, red dots dorsally, and no ventral markings. Tergum 2 with a large median geminate reddish spot between the small pair of submedian reddish dots. Tergum 4 with a mustard-yellow flush laterally. Dark spiracular dots and a black irregular hairline along tracheae in spiracular area. Terga 7–10 umber-brown, opaque-whitish ventrally. Tails and forceps white.

Holotype: Male imago (pinned), Mississippi River, Fridley, Minnesota, September 26, 1938, from water surface (RHD).

An additional male imago collected at the same time and place was placed in alcohol after markings were noted in the fresh specimen as being of this species. Unfortunately, all reddish submedian dots have completely faded away and only a trace remains of the dot on tergum 2. The yellow lateral area on tergum 4 has likewise disappeared. Obviously, it becomes impossible to make determinations in this genus with alcohol material.

This species seems most closely related to *virile* McDunnough in possessing the paired, submedian, reddish dots on terga 2–6 and femoral bands, but differs in the absence of ruddy dots on sterna 5–6 and in the lighter color of the thorax and terga 7–10. The species is also similar to the new species *elliotti* described above, except for the reddish submedian dots which are wholly lacking in that species.

P. ida has been described from a single dried male specimen. The perfect condition of the specimen and the fully inflated abdomen show the described markings to be distinct from those of any species previously described in the genus. Hence the description is offered even though only from a single specimen.

Pseudocloeon minutum, n. sp.

The following description is taken from notes on freshly killed specimens. Unfortunately only two dried imagoes were available to supplement the description from alcohol material.

Male Imago (living).—Length: body 3.5 mm., wing 3.5 mm.

Turbinate eyes strikingly large for the size of the insect, deep orange in life, base of stalk darker, dark red in dried specimens. Height of turbinate eye almost equal to its longitudinal diameter. Face mostly dark green in life, pale yellowish-brown when dried. Pale ring around antennal bases, brownish around bases of ocelli. Carina and anterior margin pale. Antenna with basal segment dusky, second segment yellow, flagellum white-hyaline.

Pleura dark brown marked with yellow, a ruddy area anterior to wing base. Mesonotum yellow-brown with a narrow black median line, scutellum and postero-lateral margins yellowish. No ventral thoracic markings. Wings hyaline, with six slanting cross veins in the stigmatic area. Paired intercalary veins absent in first interspace. Legs whitish-hyaline, unmarked except for faint yellow tinge on apices of fore femora.

Abdominal terga 2–6 white-hyaline with black spiracular dots. Faintly orange-yellow on posterior margins, most distinct anteriorly, less so posteriorly. Terga 8–10 pale brown, tergum 7 paler and yellowish laterally, tergum 8 darkest. Ventrally, sterna 8–10 are opaque yellowish-white, tails white.

In the female (pinned), the vertex is orange-brown with a ruddy spot below each eye. Thorax yellow-brown, fainter ventrally. Pleura with faint ruddy markings. Legs, wings and tails as in the male. Abdomen yellow-brown, somewhat discolored by presence of eggs.

Holotype: Male imago (pinned), Mississippi River, Coon Rapids, Minnesota, July 7, 1937, reared (RHD). *Allotype:* Female imago (pinned), same data. *Paratypes:* (alcohol) 1 f, same locality, June 23, 1937, reared (RHD); 4 m, 1 f, and 1 m, 2 f subimagoes, same locality, July 6, 1939, reared (RHD).

This species seems most closely related to *cingulatum* McDunnough in possessing narrow orange-brown margins on terga 2–6; but differs in its smaller size, in the paler color of the thorax and posterior terga, and in possessing black spiracular dots rather than the double, black, spiracular line in *cingulatum*. The naiad is completely different from that of the latter species.

The naiads are of unusual interest in that they possess three tails of equal length and thickness as in naiads of the genus *Cloeon*. Because of this unusual three-tailed condition in a *Pseudocloeon*, the naiads alone would probably run down to *Cloeon* in most keys to immature stages. The single gills on all segments and the two-jointed maxillary palp are characteristic of *Pseudocloeon* as are the paired intercalary veins of the imago.

Naiad.—Length: body 3 mm., tails 1.5 mm.

A tiny, pale yellow-brown, spotted naiad with a large pale, round spot on tergum 2 bordered with brown, tergum 9 mostly dark brown except for median and lateral pale areas. In life, rich reddish-brown with the central spot on tergum 2, a bright metallic green color—a very striking field mark not seen in any other naiads.

Head pale yellow-brown, a subtriangular brown spot at inner ventral margin of the eye, another brown spot above antennal bases. Antennae pale, whitish. Maxillary palp 2-jointed, tip slightly longer than the galea-lacinia. Vertex sprinkled with coarse, brown dots, a pale median line posteriorly.

Pronotum pale yellow-brown with two pairs of brown, submedian dots, the anterior pair larger. Mesonotum similarly colored, sprinkled with coarse brown dots of varying size. Wing pads pale yellow, venation brown streaked with darker brown. Sclerites above coxae darker brown. Legs pale, margined with dark brown at the knees, tibio-tarsal junction narrowly ringed. Claws long, slightly curved, half the length of the tarsus.

Abdomen pale yellow-brown dorsally. Terga 4–8 with paired submedian dots in posterior half, a median spot near anterior margin. A brown median spot on lateral margin of terga 1–7, an additional brown spot mesal and slightly anterior to the first, usually a small brown spot mesal to the second. Other small spots sparsely scattered on terga. Tergum 2 with a large, median, window-like, pale spot on posterior margin, bordered with dark brown. In living naiads, this is bright metallic green and makes a unique field mark for this naiad. Tergum 3 with a dark brown median area on anterior margin, otherwise like middle terga. Tergum 9 largely dark brown, contrasting strongly with the paler terga on either end. On 9 a median pale spot and a lateral, oval, pale spot occupy most of the lateral margin except for a narrow, dark brown border around the pale area. Tergum 10 wholly pale except for a small brown spot on lateral margin. Ventrally the abdomen is pale yellow-brown with no markings except for dark posterior margins confined to center of sterna only. Tails three, of equal length and thickness as in *Cloeon*.

The above markings are readily seen in the cast naiad skin.

Naiads from which the above description was taken include four males and seven females taken in the Mississippi River at Coon Rapids, June 23 and July 6, 1939 (RHD).

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TEMPO AND MODE IN EVOLUTION, by GEORGE GAYLORD SIMPSON. xviii+ 237 pages. 1944. Columbia University Press. Price, $3.50.

Whatever one's personal views on evolution, he must regard this as an important book. The writer is a palaeontologist. Forsaking the usual attitude of his field, he embarks on an analysis of certain aspects of evolution in an attempt to synthesize evidence from his own speciality and the abundant contributions of genetics. The modesty of his approach and his expressed respect for other fields of knowledge are a model worthy of emulation. The reviewer, in fact, regards more cooperation and more mutual respect among biologists as a *sine que non* of broad progress in this difficult field which Dr. Simpson attains in unusual degree.

The two major theses, as expressed in the preface, are rates of evolution under natural conditions and the "way, manner or pattern" of evolution. The consideration of rates involves a study of variation, mutation and selection, as might be expected, but it includes some striking and thought provoking conclusions which suggest to the reader that the broad horizons of the palaeontologist may have valuable influence on the evaluation of the minute observations of the geneticist. Chapter III on Micro-Evolution, Macro-Evolution, and Mega-Evolution is a thoroughly logical analysis of the broad view of evolutionary progress and Chapters IV and V, on Low-Rate and High-Rate Lines and Inertia, Trend and Momentum are a detailed development of the first thesis concluding with a series of significant generalized conclusions on the varied nature of progress in evolving lines. The remaining chapters, on Organism and Environment, and Modes of Evolution, present a nicely organized study of the traditional materials. The last includes the author's concept of quantum evolution which bears a strong flavor of Cuenot's preadaptation (briefly dismissed elsewhere by the writer) but proceeds to a more thorough analysis of its implications. Our language contains so many expressive words that it seems a pity to seek new forms of statement!

The reviewer's own bias in evolution leads him to regret that the book does not go back to what he regards as fundamentals. It does, indeed, touch upon the problem in such statements as "It is well known that evolutionary change can occur without the introduction of any new hereditary factors" (p. 32) and in commenting on the neo-Lamarckian approach, "Experiments in heredity in the present century, however, not only have failed to corroborate that there is such a process but also have shown that it is highly improbable, if not impossible" (p. 75). But this book makes its own fine contribution to establish more firmly the conclusion that the net result of all processes of evolution is the establishment of diverse kinds of organisms successfully in diverse environments, and since individuals do adapt to conditions immediately surrounding them, it seems necessary to inquire into the relationship of this general adaptability to the origin and preservation of hereditary potentialities. The author deals with the varied fates of such potentialities, but, as in so much of the literature of the subject, their origin is neglected. It shares this neglect, however, with most writings on evolution, and to them it is a fine and scholarly addition.—A. W. L.