Two new Canadian species of the genus *Tricorythodes* Ulmer, with additional studies on other North American species (Insecta, Ephemeroptera: Leptohyphidae)

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Abstract: Two new mayfly species (*Tricorythodes mosequs* n.sp. and *T. cobbi* n.sp.) are described from the Assiniboine River, Manitoba, Canada. Taxonomic knowledge of the North American species of the genus *Tricorythodes* is summarized. The type material of *T. stygiatus* McDunnough, *T. atratus* (McDunnough), and *T. peridius* Burks was studied and additional characteristics of these species are described. New drawings of the genitalia of these species are presented. *Tricorythodes peridius* and *T. atratus* are considered to be junior synonyms of *T. allectus* (Needham). A key to the imagines of *Tricorythodes* in Canada is included.

Résumé : On trouvera ici la description de deux nouvelles espèces d'éphémères (*Tricorythodes mosegus* n.sp. et *T. cobbi* n.sp.) originaires de la rivière Assiniboine, Manitoba, Canada. Le statut taxonomique des espèces nord-américaines de *Tricorythodes* est révisé. Les types de *T. stygiatus* McDunnough, *T. atratus* (McDunnough) et *T. peridius* Burks ont été réexaminés et de nouvelles caractéristiques de ces espèces sont présentées ici, de même que des illustrations de leurs genitalia. *Tricorythodes peridius* et *T. atratus* sont considérés comme des synonymes récents de *T. allectus* (Needham). Une clé permettra l'identification des imagines de *Tricorythodes* au Canada.
[Traduit par la Rédaction]

Introduction

The genus *Tricorythodes*, established by Ulmer (1920), has been considered a widely distributed genus of the western hemisphere. It is highly diversified within the Neotropical region, suggesting an austral origin (Allen and Brusca 1973*a*). However, Peters and Peters (1993) recently synonymized the genus *Tricorythafer*, established by Lestage (1942) for the African species *T. fugitans*, with the genus *Tricorythodes*.

In North America (Mexico, the United States, and Canada), 19 species of *Tricorythodes* are known (Edmunds et al. 1976; Allen 1977), of which 6 are known only in the winged stages (*T. angulatus* Traver, 1959, *T. comus* Traver, 1959, *T. fictus* Traver, 1935, *T. mulaiki* Traver, 1959, *T. peridius* Burks, 1953, and *T. ulmeri* Allen and Brusca, 1973*b*). Five species are known only in the nymphal stage (*T. corpulentus* Kilgore and Allen, 1973, *T. curvatus* Allen, 1977, *T. edmundsi* Allen, 1967, *T. notatus* Allen and Brusca, 1973*b*, and *T. ulmeri* Allen and Brusca, 1973*b*). Eight species are known from both the nymphal and the winged stages (*T. albilineatus* Berner, 1946, *T. allectus* Needham, 1905, *T. atratus* McDunnough, 1923, *T. condylus* Allen, 1967, *T. dimorphus* Allen, 1967, *T. explicatus* (Eaton, 1892), *T. minutus* Traver, 1935, and *T. stygiatus* McDunnough, 1931). The nymph of *T. atratus* is undescribed, but was drawn by Burks (1953, Fig. 96, p. 45). Similarly, the nymph of *T. stygiatus* is drawn in Leonard and Leonard (1962, Fig. 19, p. 36).

The taxonomy of this genus is difficult and confusing because not all species are known in the same stage, and because some species are poorly described. For this reason, Allen and Brusca (1973*b*) recognized that some of the species they described from nymphs could be the immature stage of species previously described from imagines. The best available key to the North American species of *Tricorythodes* is still that provided by Traver (in Needham et al. 1935), but it includes only the imagines of eight valid species. Keys to distinguish the nymphal stages of a few species have been published (Allen 1977; Allen and Murvosh 1987). Thus, Kluge and Naranjo (1990) concluded that since many species are known only from nymphs, the nymphal characters used by Burks (1953) and Allen (1967) to separate the genera *Tricorythodes* and *Leptohyphes* are inadequate, and the allocation of described species of Leptohyphidae to *Leptohyphes* and *Tricorythodes* may be random and artificial.

While studying the emergence of mayflies from the Assiniboine River above Winnipeg, we collected material (subimagines, imagines, and a few nymphs) of two *Tricorythodes* species that did not agree with the descriptions of other species. We examined the literature dealing with this family in North America and the available type material

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of the species known from central and northeastern North America, and decided that the Assiniboine River species were new. We describe them as *T. mosegus* n.sp. and *T. cobbi* n.sp. We were unable to obtain sufficient associated material to describe the nymphal stage; however, with the detailed description of eggs herein provided, it is possible to identify mature female nymphs of the new species.

Material and methods

Pinned paratypes of *T. atratus* and *T. stygiatus* were rehydrated using the method of Alba-Tercedor (1987). The genitalia and eggs were mounted in CMC10 medium and drawn and measured using a drawing tube on a phase-contrast and (or) a dissecting microscope. Eggs extracted from recently captured females of the two new species from the Assiniboine River were preserved in 70% ethanol, dehydrated using 100% ethanol for 0.25 h, oven-dried at 70°C for 0.25 h, coated with 15 nm gold, and examined using a Cambridge S90/100 scanning electron microscope (SEM).

Tricorythodes mosegus n.sp.
Figs. 1–29

MATERIAL: Holotype ♂ (93-07-02, genitalia on one slide). Paratypes: 1♀ imago (93-06-22); 3♀♀ subimagines, 3♂♂ imagines, 2♂♂ subimagines, 2♀♀ imagines (some eggs on one slide) (93-06-25); 5♂♂ imagines (93-07-23); 1♂ imago (93-06-29); 1♂ imago (93-06-23); 4♂♂ imagines (93-06-24); 1♂ imago (93-06-30); 1♂ imago (93-07-06); 1 ♂ subimago, 3♂♂, 4♀♀ imagines (93-07-02); 11♂♂ subimagines, 2♀♀ (93-07-06); 1♂ subimago, 1♂ imago, 2♀♀ subimagines (93-07-09). The type material is preserved in 70% ethanol in 18 vials.

TYPE LOCALITY: Assiniboine River, upstream of Winnipeg, at Lido Plage Rd., Municipality of Cartier, Manitoba, Canada, 97°30′35″W, 40°52′24″N, 235 m asl.

The holotype and most paratypes are deposited in The Canadian National Collection of Insects, Centre for Land and Biological Resources Research (CLBRR), Ottawa, Ontario. In addition, 4♂♂ and 4♀♀ are deposited in the collection of Prof. W.P. McCafferty, Department of Entomology, Purdue University, West Lafayette, Indiana, and 1♂ is deposited in the collection of Prof. W.L. Peters, Center for Studies in Entomology, Florida Agricultural and Mechanical University, Tallahassee.

ETYMOLOGY: The new species is named after *moseg*, meaning "mayfly" in the Ojibway language of the Anicinabe people.

Male (in alcohol)
Body length 3.8–4.4 mm; wing length 4.3–4.6 mm; length of femora: fore 0.60–0.65 mm, middle 0.71–0.81 mm, hind 0.87–0.93 mm. Ratio of femora to tibiae: foreleg 0.60–0.62, middle leg 1.20–1.21, hind leg = 1.10–1.20 (N = 10).

Head
Posterior margin dark, heavily pigmented (Fig. 5); ocelli white with black pigmentation on base; front, between lateral ocelli, yellowish with some brown pigmentation; antennae yellowish brown, scape and pedicel faintly pigmented along basal 2/3, flagellum yellowish (white at base) and slightly enlarged basally (Fig. 4).

Thorax
Pronotum sprinkled with grey or black pigmentation on yellowish background; mesonotum brown with dark-shaded sutures, coxal membranous cavities yellow; in lateral view, dorsal outline appears slightly convex; metanotal membranes short, slightly projecting beyond tip of metanotum (Fig. 14); central sclerite of mesosternum (the furcisternum of Needham et al. (1935) and the furcasternum of Kluge (1994)) square (Fig. 15). Fore coxae and trochanters with pattern shown in Fig. 13. Femora and tibiae yellowish with longitudinal dark chitinized lines; femora without black dots, sometimes shaded smokey grey, and with very fine, tiny punctuation (especially on middle and hind legs). Tibiae pigmented basally, fore tibiae whitish or grey, middle and hind tibiae yellowish with pigmented edges (Figs. 9–12); claws of forelegs similar, blunt-lobed. Longitudinal veins of wings (C, Sc, R, Rs, M) shaded grey (especially veins Sc and R), the remaining longitudinal veins lighter; cross-veins shaded grey–brown (especially those between veins C and R, and R-Rs).

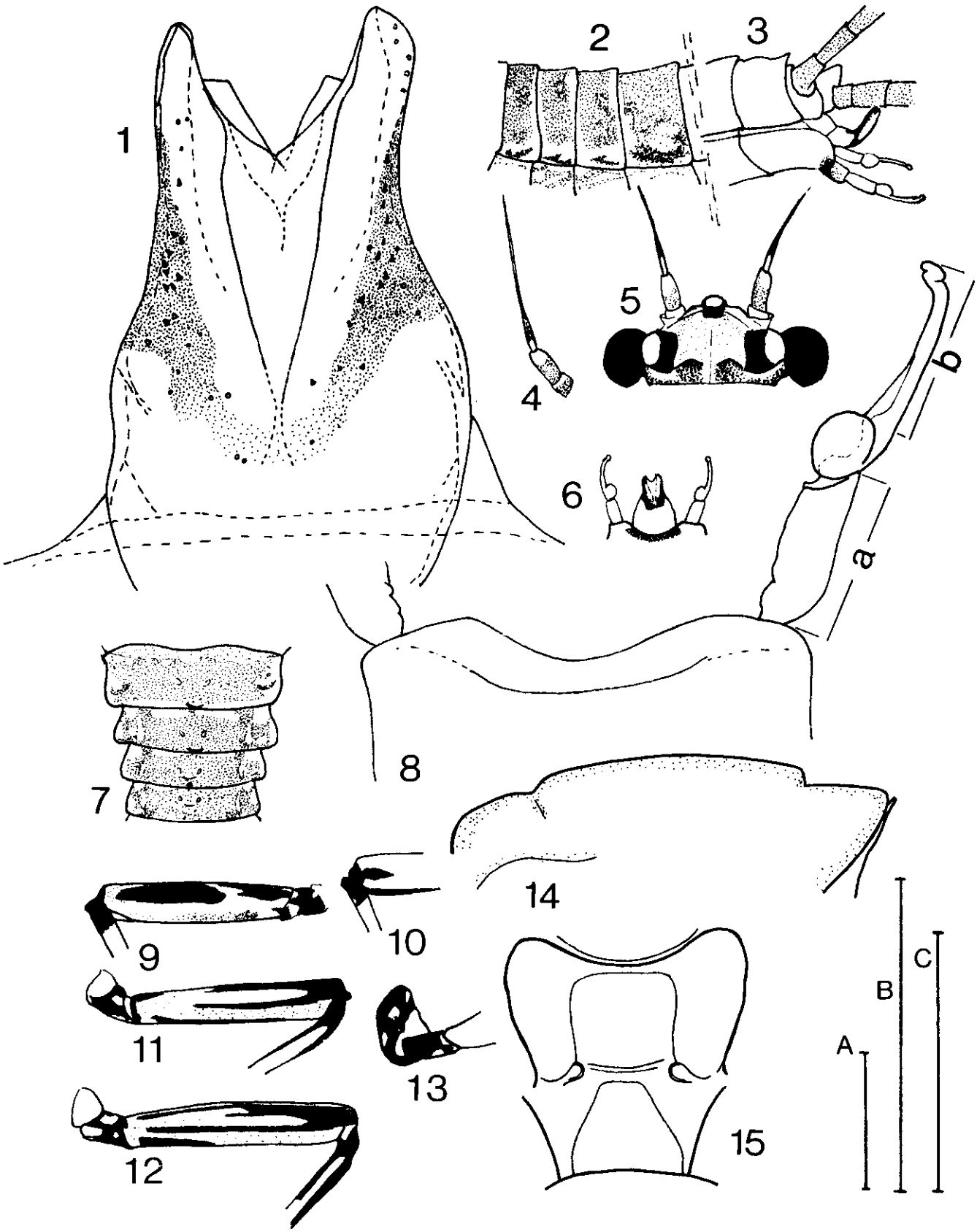
Abdomen
Dorsally yellowish with grey pigmentation extending to lateral margins of segments, except on terga 3–6, where pigmentation is interrupted at lateral edges, edge of each tergum may have a dark longitudinal stripe (Fig. 2); ventrally abdomen almost uniformly pigmented yellow to light-brown, pattern as in Fig. 7; basal 3 or 4 segments of terminal filaments shaded with grey (Fig. 3).

Genitalia (Figs. 1, 3, 6, and 8)
Penis curved dorsally almost at right angle with a very distinct chitinized pattern on margins of penial lobes, and a wide and deep distal emargination, nearly V-shaped. Styliger plate with a shallow emargination. Length of first segment of forceps equal to distance between tip of forceps and basal swelling of second segment (Fig. 8; $a \simeq b$).

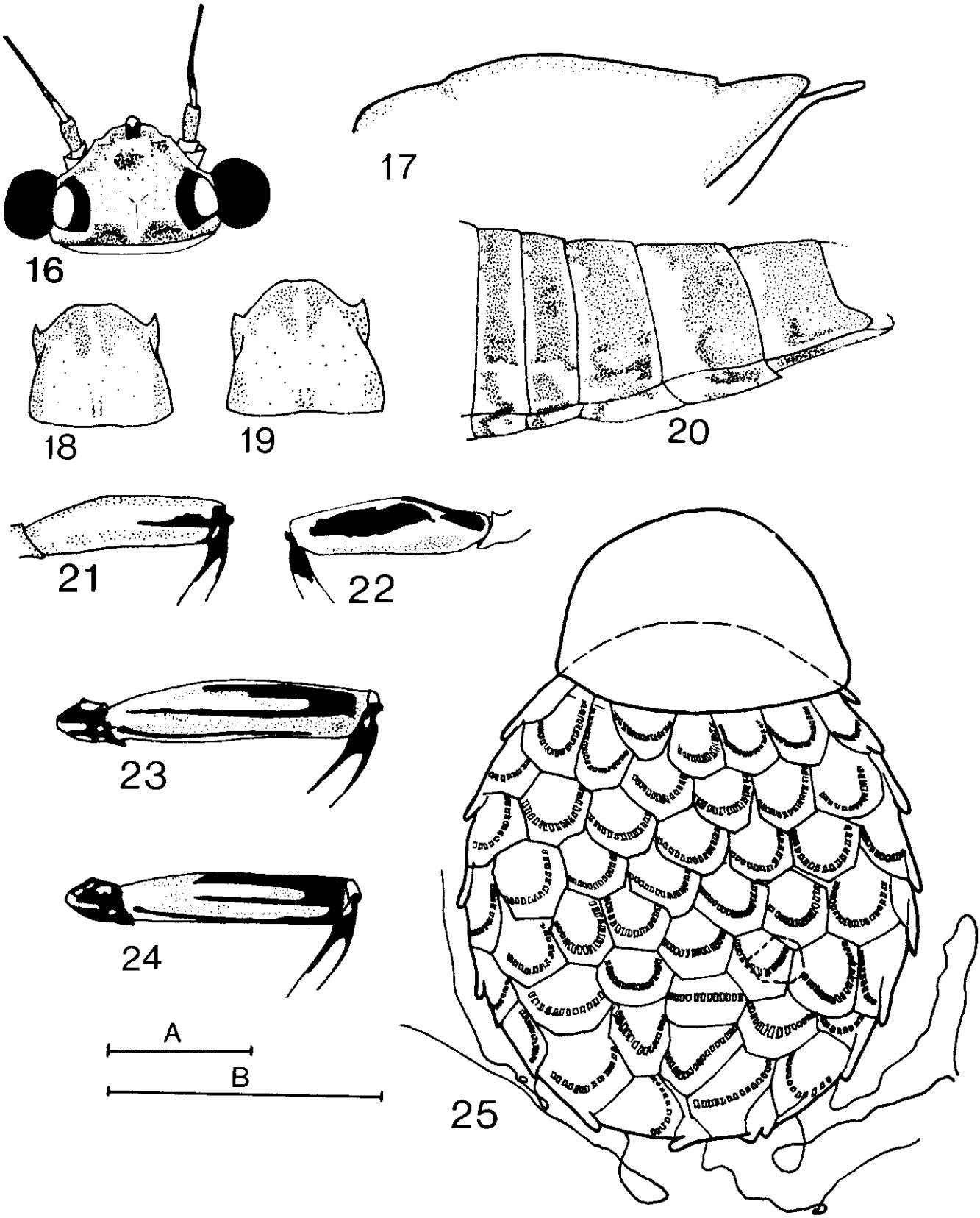
Female (in alcohol) (Figs. 16–24)
Body length 4.3–4.7 mm; wing length 5.3–5.5 mm; length of femora: fore 0.65–0.68 mm, middle 0.78–0.87, hind 0.90–0.93. Ratio of femora to tibiae: foreleg 1.20–1.40, middle leg 1.23–1.50, hind leg 1.10–1.20 (N = 10). In general, colours and patterns same as those of male. Metanotal membranes long, extending well beyond tip of metanotum (Fig. 17). Ninth sternite as in Figs. 18 and 19, hind margin slightly emarginate.

Eggs (Figs. 25, 26, 28, and 29)
Length 170–190 μm, width 130–140 μm (N = 10). Chorion with overlapping plates and U-shaped ornamentation. Ornamentation more refringent under light microscope, seeming to be formed by tiny square pieces (Fig. 25), but under SEM appear as indistinct light bumps (Fig. 28). Micropyles open laterally in a concavity on chorion (Fig. 28). Koss and Edmunds (1974) noted that one micropyle, near

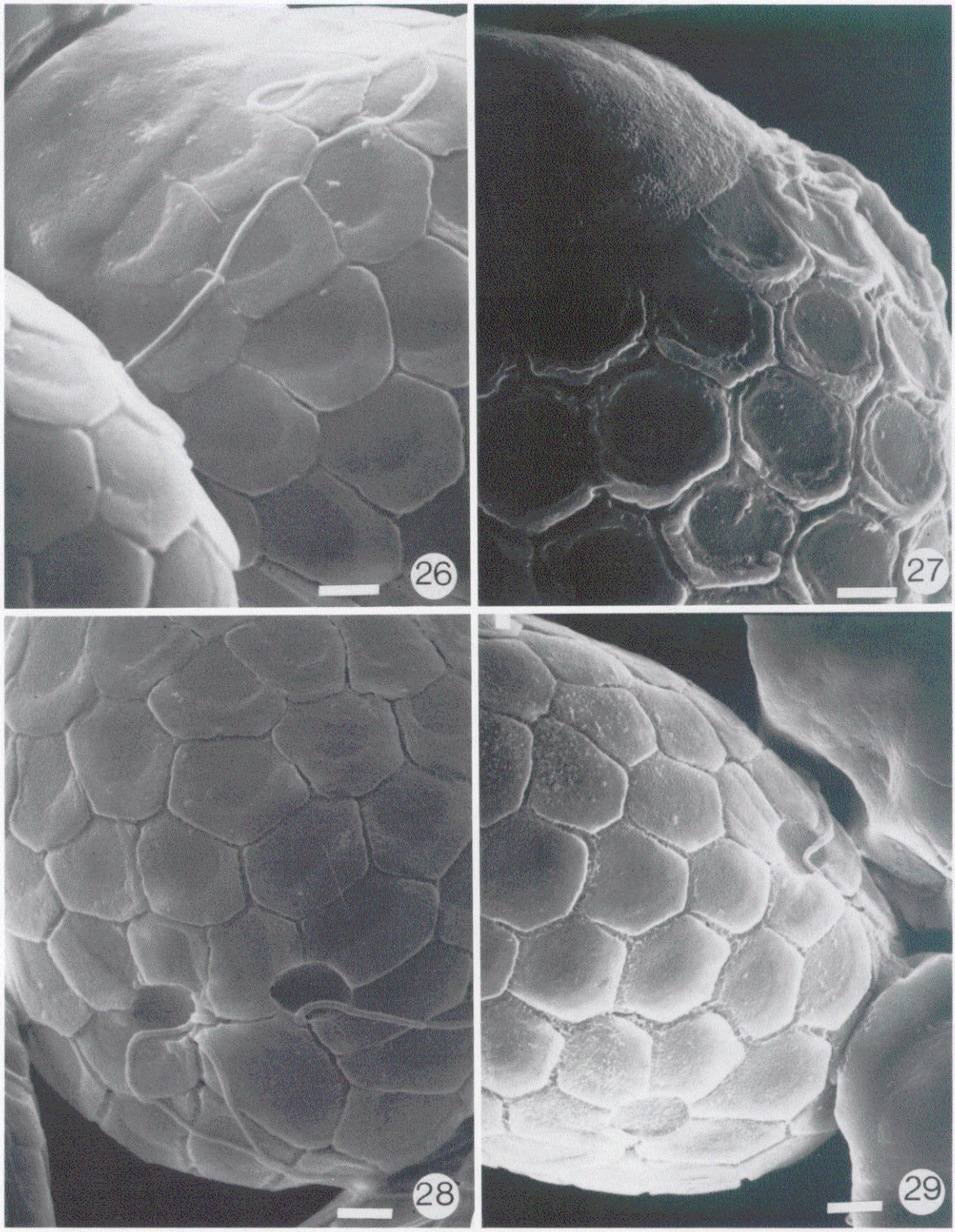
Figs. 1–15. *Tricorythodes mosegus* n.sp., male. Fig. 1. Penis, mounted on a slide. Fig. 2. Abdominal segments 4–7 in lateral view. Fig. 3. Tip of the abdomen in lateral view. Fig. 4. Antenna. Fig. 5. Head in dorsal view. Fig. 6. Genitalia, before being slide-mounted, showing the shape. Fig. 7. Abdominal sternites 2–5. Fig. 8. Styliger plate and forceps. Figs. 9–12. External surface of fore, middle, and hind femora and basal part of tibia respectively. Fig. 10. Internal tip of fore femur. Fig. 13. Fore coxa and trochanter in ventral view. Figs. 14 and 15. Metanotum and metasternum, respectively, in dorsolateral view. Scale bars: A: 0.5 mm (Figs. 2–7 and 9–15); B: 0.25 mm (Fig. 8); C: 0.1 mm (Fig. 1).



Figs. 16–25. *Tricorythodes mosegus* n.sp., female. Fig. 16. Head in dorsal view. Fig. 17. Metanotum in dorsolateral view. Figs. 18 and 19. Ninth sternite. Fig. 20. Abdominal segments 5–9 in lateral view. Fig. 21. Internal surface of fore femur. Fig. 22. Dorsal surface of fore femur. Fig. 23. Dorsal surface of hind femur. Fig. 24. Dorsal surface of middle femur. Fig. 25. Egg. Scale bars: A: 0.5 mm (Figs. 1–24); B: 0.1 mm (Fig. 25).



Figs. 26–29. Eggs of *T. mosegus* n.sp. (Figs. 26, 28, and 29) and *T. cobbi* n.sp. (Fig. 27) by SEM. Scale bar = 10 μm.



the uncapped pole, is characteristic of this genus. In this species, two micropyles often present (Figs. 28 and 29), sometimes very close to one another (Fig. 29). A polar cap and four threads close to uncapped pole are present as adhesive structures.

Tricorythodes cobbi n.sp.
Figs. 27, 30–32, 37–43

MATERIAL: Holotype ♂ imago (93-08-16; genitalia and body on one slide). Paratypes: 3 ♀ ♀ imagines (some eggs

on one slide), 2♂♂ imagines (one set of genitalia on a slide; 93-07-09); 1♂ imago (93-07-15); 1♂ imago (93-07-17; genitalia and body on one slide); 11♀♀ imagines (one set of genitalia on a slide), 2♂♂ imagines, 3♀♀ subimagines (some eggs on a slide) (93-07-20); 1♂ imago, 2♀♀ imagines (93-07-27); 11♀♀ imagines, 4♂♂ imagines (93-07-23); 1♂ imago, 1♀ imago (93-07-26); 1♂ imago (93-08-20); 1♀ subimago (93-08-23); 1♂ imago, 1♂ subimago, 2♀♀ imagines (93-08-24); 1♂ (93-08-26); 5♀♀ imagines, 3♂♂ imagines (93-08-27); 1♂ subimago, 1♀ (93-08-31); 1♂ imago, 16♀♀ imagines (93-09-02); 2♀♀ (93-09-07). The type material is preserved in 70% ethanol in 25 vials.

TYPE LOCALITY: Assiniboine River, upstream of Winnipeg, at Lido Plage Rd., Municipality of Cartier, Manitoba, Canada, 97°30′35″W, 40°52′24″N, 235 m asl.

The holotype and most paratypes are deposited in the Canadian National Collection of Insects, CLBRR, Ottawa, Ontario. In addition, 2♂♂ and 1♀ are deposited in the collection of Prof. W.P. McCafferty, Department of Entomology, Purdue University, West Lafayette, Indiana, and 5♂♂ and 15♀♀ are deposited in the collection of Prof. W.L. Peters, Center for Studies in Entomology, Florida Agricultural and Mechanical University, Tallahassee.

ETYMOLOGY: The new species is named after Mr. Don Cobb, hydrobiologist, for his encouragement and friendship.

Male (in alcohol)

Body length 3.1–4.2 mm; wing length 4.3–4.6 mm; length of femora: fore 0.60–0.70 mm, middle 0.74–0.90 mm, hind 0.74–0.87 mm. Ratio of femora to tibiae: foreleg 0.60–0.62, middle leg 0.90–1.051, hind leg 1.00–1.05 (N = 10).

Head

Posterior margin with a darkly pigmented band interrupted laterally, appearing as three black zones (similar to female; see Fig. 37); ocelli white with black pigmentation on base; front, between lateral ocelli, yellowish, sometimes with a longitudinal dark band extending along cranial suture from frontal ocellus to vertex; antennae yellowish, scape and pedicel faintly pigmented, flagellum yellowish (lighter on the base), and enlarged basally.

Thorax

Pronotum sprinkled with black pigmentation on a yellowish background (similar to female; see Fig. 38), often three longitudinal dark bands present, continuous with the hind margin of head; mesonotum dark brown, sometimes almost black, in lateral view dorsal outline appears barely convex, metanotal membranes are generally projected beyond tip of metanotum, similar to those of females (see Fig. 38); central sclerite of mesosternum rectangular (longer than wide); coxae and trochanters pigmented but without a distinct pattern; femora and tibiae yellowish, femora quite densely sprinkled with black dots, especially those of middle and hind legs (similar to those in female (see Figs. 41 and 42); claws of forelegs similar, blunt-lobed. Longitudinal veins of wings (C, Sc, and R) shaded grey, or purplish grey (especially Sc and R), cross-veins between the costal area and the media slightly pigmented.

Abdomen

Dorsally pigmented black or grey on a yellowish background. On terga 3–6, pigmentation interrupted well before edge (similar to female; see Fig. 40), so that in lateral view a characteristic light patch can be seen (not easy to distinguish in some very dark specimens), and a dark stripe on lateral margins of sternites 3–6 (sometimes 3–7); lightly pigmented ventrally with a transverse stripe on posterior margin of each segment; terminal filaments white, basal segments 3 and 4 shaded with grey.

Genitalia (Figs. 30–32)

Penis only slightly curved dorsally with very deep V-shaped emargination; styliger plate with moderately deep emargination; length of first segment of forceps similar to distance between tip of forceps and basal swelling of second segment (Fig. 32; $a \simeq b$ (see a and b in Fig. 8)).

Female (in alcohol) (Figs. 37–42)

Body length 3.2–4.6 mm; wing length: 4.6–5.3 mm; length of femora: fore 0.60–0.63 mm, middle 0.82–0.93 mm, hind 0.88–1.08 mm. Ratio of femora to tibiae: foreleg 1.20–1.40, middle leg 1.00–1.50, hind leg 1.00–1.03 (N = 10). In general, colours and patterns same as those of male. Metanotal membranes long, extending well past tip of metanotum (Fig. 38). Ninth sternite as in Fig. 39, with the hind margin blunt, somewhat pointed, and not emarginate.

Eggs (Figs. 27 and 43)

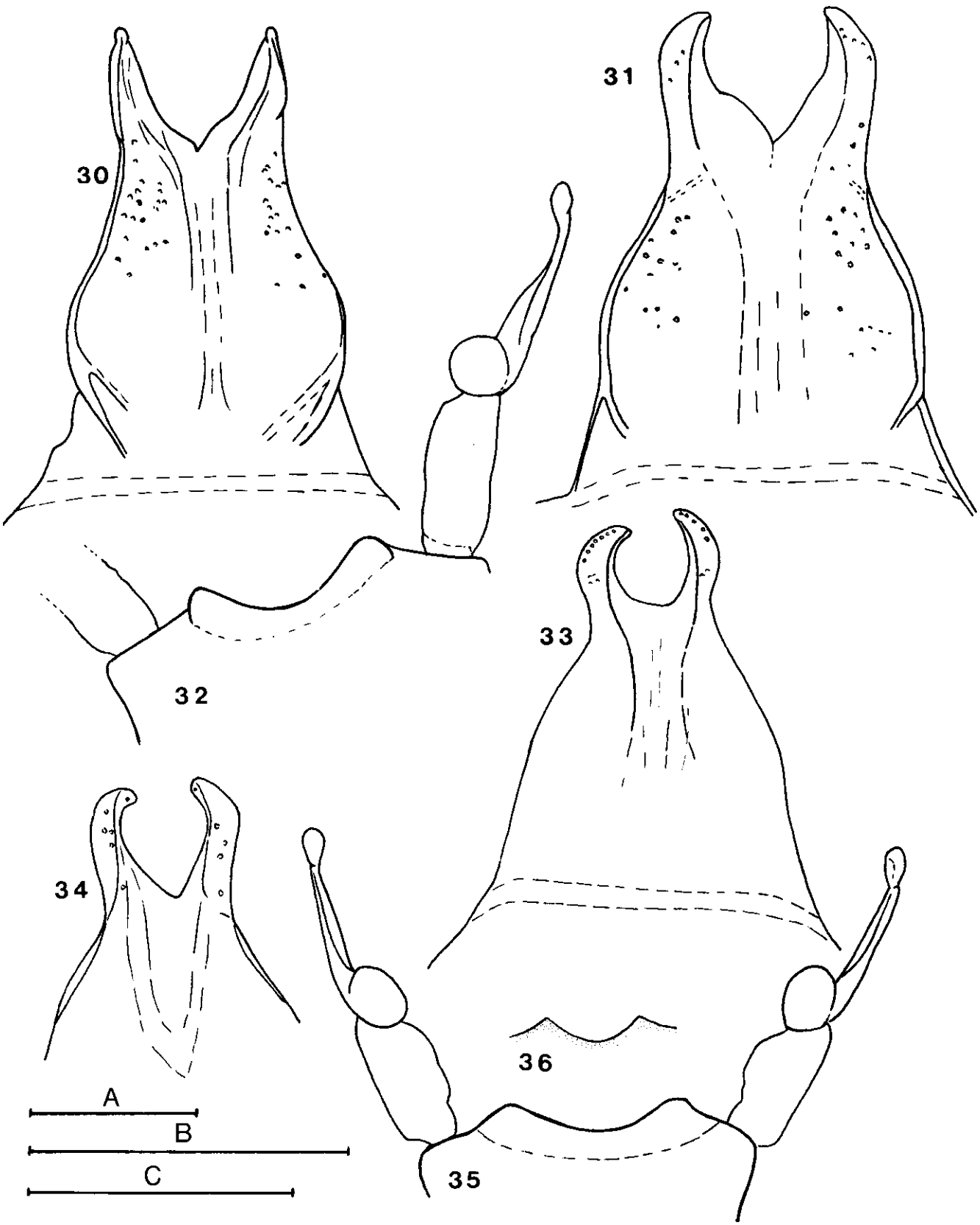
Length 170–190 μm, width 130–140 μm (N = 10). Chorion with nonoverlapping hexagonal plates, each with ringed ornamentation. Under light microscope, ring appears to be formed by several rows of tiny points (Fig. 43) and under SEM appears to be a circular groove (Fig. 27). One micropyle present, similar in shape to that of *T. mosegus* (Figs. 28 and 29), situated near uncapped pole. Polar cap and four threads close to uncapped pole present as adhesive structures.

Tricorythodes stygiatus McDunnough, 1931
Figs. 45–48

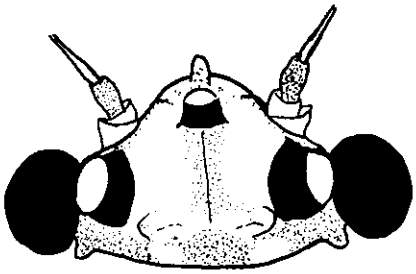
Tricorythodes stygiatus McDunnough 1931: 267, Fig. 12.
Tricorythodes stygiatus: Burks 1953: 47, Fig. 101.

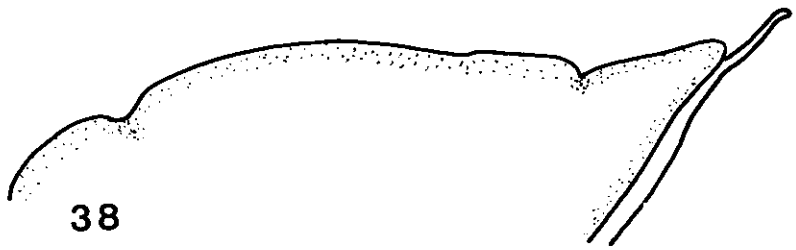
We studied four paratypes that basically agreed with the original description. However, we found that the posterior tubercles of the head are reddish brown, not shiny black as originally described by McDunnough (1931). The antennae have the following characteristics: the pedicel is twice as wide basally as distally, and in lateral view appears to be bent upwards; flagellum is distinctly enlarged basally (Fig. 45); central sclerite of the mesosternum is longer than wide; genitalia as in Figs. 46–48, first segment of forceps shorter than distance between tip of forceps and basal swelling of second segment (Fig. 48, $a < b$, see a and b in Fig. 8).

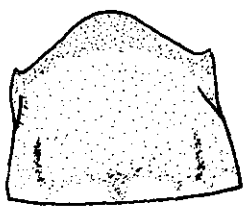
Figs. 30–32. *Tricorythodes cobbi* n.sp., penis (Figs. 30 and 31) and forceps and styliger plate (Fig. 32). **Figs. 33–35.** Paratype of *T. atratus*; penis (Figs. 33 and 34) and styliger plate and forceps (Fig. 35). **Fig. 36.** Paratype of *T. peridius*; emargination of styliger plate. Scale bars: A: 0.25 mm (Fig. 36); B: 0.25 mm (**Figs. 32 and 35**); C: 0.1 mm (Figs. 30, 31, 33, and 34).

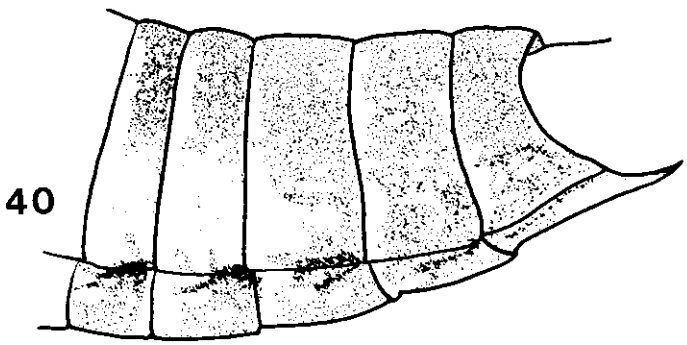


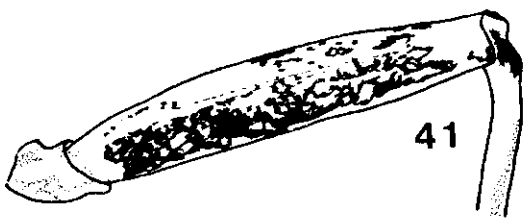
Figs. 37–43. *Tricorythodes cobbi* n.sp., female. Fig. 37. Head in dorsal view. Fig. 38. Metanotum in dorsolateral view. Fig. 39. Ninth abdominal sternite. Fig. 40. Abdominal segments 5–9 in lateral view. Figs. 41 and 42. Dorsal surface of hind and middle legs, respectively. Fig. 43. Egg. **Fig. 44.** Hind leg of a paratype male of *T. atratus*.

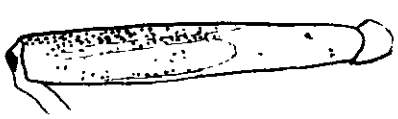


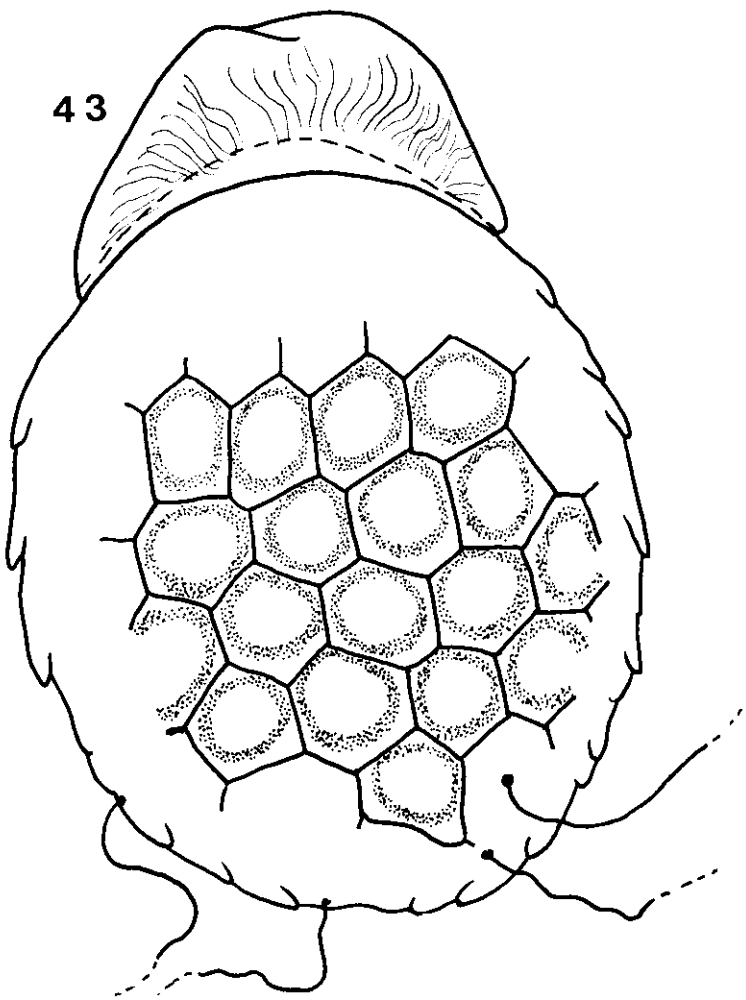


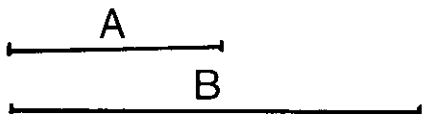




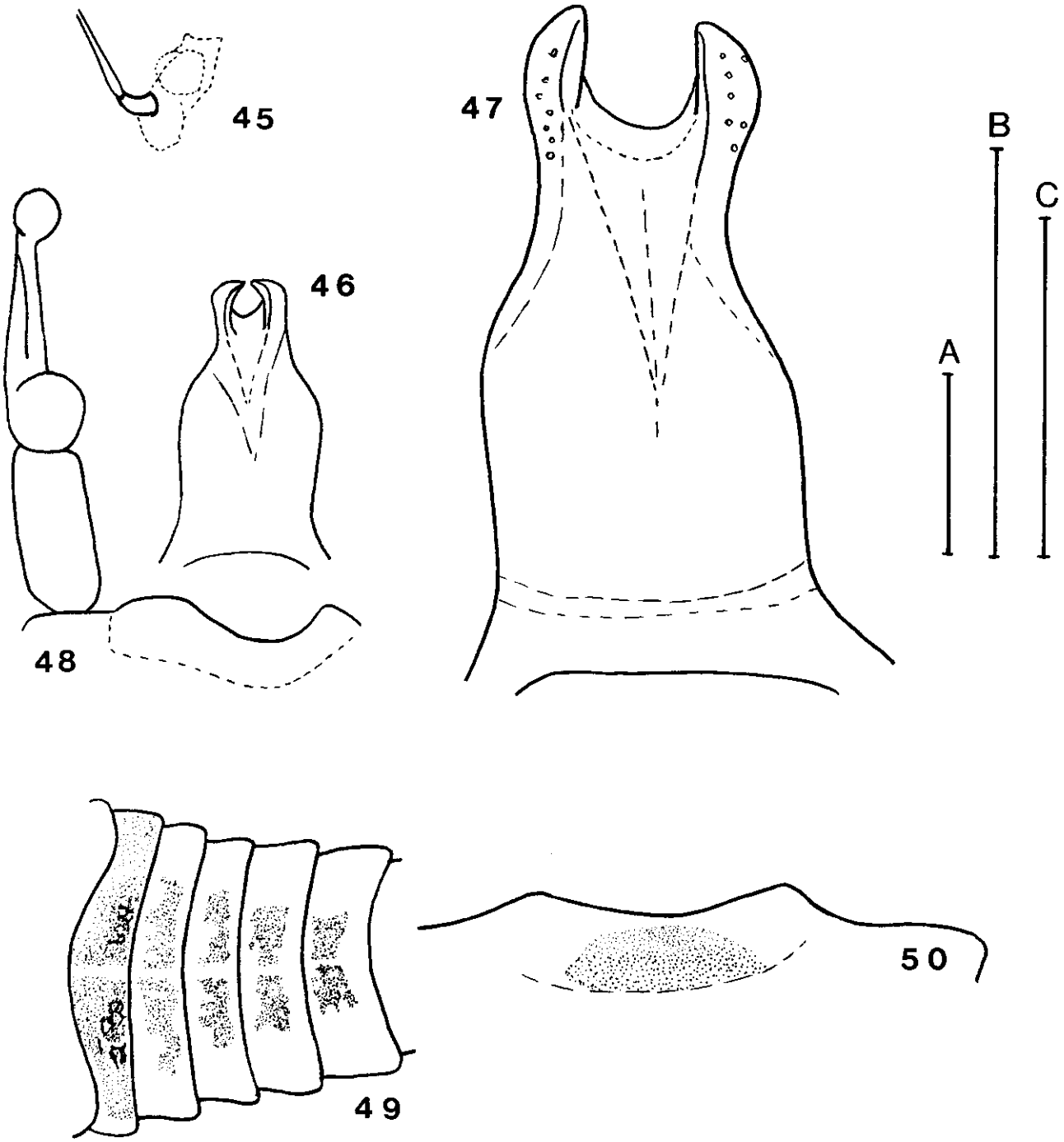








Figs. 45–48. *Tricorythodes stygiatus*, paratype male. Fig. 45. Lateral view. Figs. 46 and 47. Penis before and after slide-mounting, respectively. Fig. 48. Styliger plate and forceps. **Figs. 49 and 50.** *Tricorythodes minutus*; pattern of abdominal terga 2–6 and styliger plate, respectively. Scale bars: A: 0.5 mm (Figs. 45 and 49); B: 0.25 mm (Figs. 46 and 48); C: 0.1 mm (Figs. 47 and 50).



Tricorythodes allectus (Needham, 1905)
Figs. 33–35 and 44

?*Caenis allecta* Needham 1905: 47, Figs. 8 and 9.
Trycorythus atratus McDunnough 1923: 39. NEW SYNONYM.
Tricorythodes atratus: McDunnough 1931: 265, Fig. 11.
Tricorythodes atratus: Burks 1953: 47, Fig. 100.
Tricorythodes peridius Burks 1953: 48, Fig. 99. NEW SYNONYM.

This species, originally described from Ithaca, New York, is distributed in the eastern United States, but is apparently replaced by *T. atratus* in Canada (Edmunds et al. 1976). The synonymy that we now formally establish was suspected by McDunnough (1931), who after a thorough comparison of the material that he described as *T. atratus* with the type material of *T. allectus*, noted the similarity in genitalia of both species, and only slight differences in colour. He noted: "The identity of this species still puzzles me and while I

incline to think the name will eventually be found to take priority over *atratus* .... The genitalia ... seem identical with my slides of *atratus* .... Based on this material I should not have much hesitation in sinking *atratus* to *allectus*." In spite of a lack of evidence to support maintaining *T. atratus* as a species, no formal synonymy was established. Burks (1953) and Needham et al. (1935) had similar doubts, but considered *T. atratus* a valid species because of the poor condition of the types of *T. allectus*.

Burks (1953) described *T. peridius* from Illinois as a species very close to *T. atratus* in all aspects except the colouration of vertex of the head (black in *T. atratus* and light yellow in *T. peridius*) and the subgenital plate (deeper in *T. atratus* than in *T. peridius*) (Burks 1953, Figs. 99 and 100). However, when we studied the paratypes of *T. atratus* and the holotype and some paratypes of *T. peridius*, it was clear that the vertex of *T. atratus* is not black but pale, as in *T. peridius*. The shallow subgenital plate of *T. peridius* falls within the range of variability for the species, because the genitalia of one paratype of *atratus* has a shallow subgenital plate (Fig. 35), similar to Burks' (1953) drawing of *T. peridius*, whereas another paratype of *T. peridius* possesses a deep subgenital plate (Fig. 36) similar to that in the drawings of *atratus* by Burks (1953) and McDunnough (1931). Thus, we consider *T. peridius* a junior synonym of *T. atratus*.

The supposedly characteristic U-shaped emargination of the penis of *T. atratus*, shown in the original drawing by McDunnough (1931), is a character that can be affected by the mounting medium. Based on our work, the U-shaped emargination of the penis became V-shaped a week after being mounted in CMC10 medium (cf. Figs. 33 and 34).

General remarks

Allen (1977) tentatively separated the species of *Tricorythodes* into the *albilineatus*-group and the *curvatus*-group, based on nymphal characteristics, although the nymphs of many species were unknown. Later, Allen and Murvosh (1987) created three subgenera (*Tricorythodes*, *Tricorythyphes*, and *Homoleptohyphes*) based on nymphal characteristics. The two new species we possess could be assigned to the subgenus *Tricorythodes* on the basis of nymphal characteristics (without frontal shelf or genal projection, maxillary palpi 2 and 3 segmented, and operculate gills triangular, with the anteromesal corner rather sharply angled). With the creation of the subgenus *Homoleptohyphes*, characterized by obovate operculate gills, we support the suggestion of Kluge and Naranjo (1990) that a complete taxonomic review is needed to establish the generic nymphal characteristics of *Tricorythodes* and *Leptohyphes* and subsequently place the known species into their appropriate genus.

From the relative length of the forceps ($a \simeq b$; see Fig. 8), both new species are related to *T. allectus* and *T. angulatus*. *Tricorythodes mosegus* n.sp. can easily be distinguished by the lack of black dots on the femora and by the shape of the penis. In addition, *T. cobbi* n.sp. could be associated with *T. albilineatus*, *T. angulatus* and *T. allectus* by the black dots on the femora; however, it is clearly separated from *T. albilineatus* by the male foreclaws, and the lack of the abdominal pale line typical of *T. albilineatus*. *Tricorythodes angulatus* can easily be distinguished by the non-angulated lateral edges of the penis. In general, the colouration of *T. cobbi* n.sp. is close to that of *T. allectus*, but the former can easily be distinguished by the white lateral ocelli, the denser covering of larger black dots on the femora, and the shape of the penis.

As we pointed out in the Introduction, identification of the North American species is not easy, owing to the poor descriptions and scarce figures of many species, and because not all the known species of this genus are based on the same developmental stage. For this reason, only a key for the identification of the Canadian species is included.

Keys for the identification of the imagines of the Canadian species of *Tricorythodes*.

Five species have been recorded in Canada: *T. allectus*, *T. atratus*, *T. minutus*, *T. explicatus*, and *T. stygiatus*. Canadian specimens identified as *T. explicatus* are "unquestionably *T. minutus*" (Allen and Murvosh 1987). Five known Canadian species are included in the following key because we synonymized *T. atratus* and *T. peridius* with *T. allectus* and added the two new species.

1. Femora heavily sprinkled with numerous black dots (Figs. 41, 42, and 44) 2
   Femora not as above 3
2. Dark dots on femora small and sparse (Fig. 44); lateral ocelli black; genitalia as in Figs. 33–35 ..... *T. allectus* (Needham, 1905)
   Femora densely covered with larger dark dots (Figs. 41 and 42); lateral ocelli white; genitalia as in Figs. 30–32 ..... *T. cobbi* n.sp.
3. Pattern on abdominal terga as in Fig. 49; emargination of styliger plate very shallow and pigmented as in Fig. 50 ..... *T. minutus* Traver, 1935.
   Not as above 4
4. Lateral ocelli white; length of first segment of forceps similar to distance between the apex of forceps and basal swelling of second segment (Fig. 8, $a \simeq b$); penis as in Fig. 1 ..... *T. mosegus* n.sp.
   Lateral ocelli black; first segment of forceps shorter than distance between apex of forceps and basal swelling of second segment (Fig. 48); penis as in Figs. 46 and 47 ..... *T. stygiatus* McDunnough, 1931.

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References

Alba-Tercedor, J. 1987. Une méthode simple pour ramoullir et réhydrater les éphéméroptères de collection piqué à sec. Ann. Soc. Sci. Nat. Archeol. Toulon Var (S.S.N.A.T.V.), **39**: 95–96.

Allen, R.K. 1967. New species of new world Leptohyphinae (Ephemeroptera: Tricorythidae). Can. Entomol. **99**: 350–375.

Allen, R.K. 1977. A new species of *Tricorythodes* with notes (Ephemeroptera: Tricorythidae). J. Kans. Entomol. Soc. **50**: 431–435.

Allen, R.K., and Brusca, R.C. 1973*a*. The known geographic distribution of the Mexican mayfly genera in North America (Insecta: Ephemeroptera). *In* Proceedings of the First International Conference on Ephemeroptera, Tallahassee, Fla., August 17–20, 1970. *Edited by* W.L. Peters and J. Peters. E.J. Brill, Leiden, pp. 49–63.

Allen, R.K., and Brusca, R.C. 1973*b*. New species of Leptohyphinae from Mexico and Central America (Ephemeroptera: Tricorythidae). Can. Entomol. **105**: 83–95.

Allen, R.K., and Murvosh, C.M. 1987. Mayflies (Ephemeroptera: Tricorythidae) of the southwestern United States and northern Mexico. Ann. Entomol. Soc. Am. **80**: 35–40.

Berner, L. 1946. New species of Florida mayflies (Ephemeroptera). Fla. Entomol. **28**: 60–82.

Burks, B.D. 1953. The mayflies or Ephemeroptera of Illinois. Ill. Nat. Hist. Surv. Bull. No. 26.

Eaton, A.E. 1892. Insecta, Neuroptera, Ephemeridae. Biol. Cent. Am. **38**: 1–16.

Edmunds, G.F., Jensen, S.L., and Berner, L. 1976. The mayflies of North and Central America. University of Minnesota Press, Minneapolis.

Kilgore, J.I., and Allen, R.K. 1973. Mayflies of the Southwest: new species, descriptions, and records (Ephemeroptera). Ann. Entomol. Soc. Am. **66**: 321–332.

Kluge, N.Ju. 1994. Pterothorax structure of mayflies (Ephemeroptera) and its use in systematics. Bull. Soc. Entomol. Fr. **99**: 41–61.

Kluge, N.Ju., and Naranjo, J.K. 1990. Mayflies of the family Leptohyphidae (Ephemeroptera) from Cuba. [In Russian.] Entomol. Obozr. **69**: 564–578. [Translated by Scripta Technica, Inc., 1991; UDC 595.734 (729.1).]

Koss, R.W., and Edmunds, G.F. 1974. Ephemeroptera eggs and their contribution to phylogenetic studies of the order. Zool. J. Linn. Soc. **55**: 267–349.

Leonard, J.W., and Leonard, F.A. 1962. Mayflies of Michigan trout streams. Cranbrook Institute of Science, Bloomfield Hills, Mich.

Lestage, J.A. 1942. Contribution à l'étude des Ephéméroptères. XXV. Notes critiques sur les anciens Caenidiens d'Afrique et sur l'indépendence de l'évolution Tricorythido-Caenidienne Bull. Mus. R. Hist. Nat. Belg. **18**: 1–20.

McDunnough, J. 1923. New Canadian Ephemeridae, with notes. Can. Entomol. **55**: 39–50.

McDunnough, J. 1931. New North American Caeninae with notes (Ephemeroptera). Can. Entomol. **63**: 254–268.

Needham, J.G. 1905. Mayflies and midges of New York. N.Y. State Mus. Bull. No. 86. pp. 17–62.

Needham, J.G., Traver, J.R., and Hsu, Y.-C. 1935. The biology of mayflies (with a systematic account of North American species). Comstock Publishing Co., Inc., Ithaca, N.Y.

Peters, W.L., and Peters, J. 1993. Status changes in Leptohyphidae and Tricorythidae (Ephemeroptera). Aquat. Insects, **15**: 45–48.

Traver, J.R. 1935. Part II. Systematics. The biology of mayflies (with a systematic account of North American species). *Edited by* J.G. Needham, J.R. Traver, and Y.-C. Hsu. Comstock Publishing Co., Inc., Ithaca, N.Y. pp. 239–739.

Traver, J.R. 1959. The subfamily Leptohyphinae. Part II: Five new species of *Tricorythodes* (Ephemeroptera, Tricorythidae). Proc. Entomol. Soc. Wash. **61**: 121–131.

Ulmer, G. 1920. Neue Ephemeropteren. Arch. Naturgesch. **85** (Abt. All): 1–80.