

## **Description of the larva of *Somatochlora hineana* with a key to the larvae of the North American species of *Somatochlora* (Odonata: Corduliidae)**

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### **Abstract**

A detailed description of the final stadium of *Somatochlora hineana*, with brief notes on the penultimate stadium, is presented. An illustration of the entire larva and separate line drawings of the labium and dorsal and lateral views of the abdomen are also included. The habitat of the larva is discussed briefly. Combinations of diagnostic characters are used for distinguishing the *S. hineana* larva from its allied congeners. A key to the known *Somatochlora* larvae of North American species is given.

### **Introduction**

*Somatochlora hineana* was described by Williamson (1931) from a series of adults from Logan Co., Ohio, USA. Subsequently, this species has been documented from the following states and counties: Alabama: Jackson; Illinois: Cook, DuPage, Will; Indiana: Lake; Michigan: Alpena, Mackinac, Presque Isle; Missouri: Reynolds; Ohio: Lucas, Williams; and Wisconsin: Door, Ozaukee (U.S. Fish and Wildlife Service in prep). Recent attempts to confirm the presence of this species in Alabama, Indiana, and Ohio have been unsuccessful. Habitat and behavior were discussed briefly by Vogt & Cashatt (1994). It was listed as Endangered by the United States Fish and Wildlife Service in 1995 (Federal Register 60# [17]: 5267-5272) because of its narrow ecological requirements and vulnerability to habitat degradation and destruction.

The most recent keys to North American *Somatochlora* larvae (Daigle 1991; Needham et al. 2000) do not include *S. brevicincta* Robert and *S. incurvata* Walker. The larva of *S. brevicincta* was described by Hutchinson & Menard (2000). The larva of *S. incurvata* has been discovered, and a description is being prepared (Smith & Steffens in prep.). To distinguish the *S. hineana* larva from other *Somatochlora* larvae, the following description of the final and penultimate stadia and a key to the final stadia of *Somatochlora* larvae of North American species are provided.

## Materials and methods

**Material examined:** USA, Illinois, Will Co., Lockport Prairie Nature Preserve: 2 ♂ larvae reared from egg to final stadium (by J.J. Daigle), eggs collected from female, 21 June 1988, E.D. Cashatt, T.E. Vogt and J.R. Wiker leg.; 1 ♂, 1 ♀, final stadia, 1 ♂, penultimate stadium, 26 May 1992, E.D. Cashatt, B.G. Sims leg.; 29 exuviae, 5-19 June 1991, B.G. Sims, J.R. Wiker leg. — Wisconsin, Door Co., Mud Lake Wildlife Area, Lime Kiln Road: 1 ♀ exuvia, found on log jam in stream, 9 July 1992, B. Smith leg.; 1 ♀ exuvia from a larva collected by B. Smith and reared by W.A. Smith (associated with reared adult), 9 July 1992; 1 ♂ exuvia, The Ridges Sanctuary, 14 July 1992, C. Smith leg.

The description is based on 37 final stadia: 4 larvae (2 reared) and 33 field-collected exuviae. Notes on a penultimate stadium are included also. Three live larvae were reared at near room temperature (25°C). After they remained in the final stadium for about 1 year, they were preserved in 80% ethanol. All other larvae were fixed in Kahle's solution and later transferred to 80% ethanol. Dimensions are given to the nearest 0.1 mm and were made with an ocular micrometer. The range, mean, standard error of the mean, and sample size are given. The final stadium male is shown in Fig. 1.

## Larval description

**Head:** Width 6.7-7.0 ( $6.8 \pm 0.1$ ,  $n = 4$ ) widest at eyes, about twice middorsal length 3.2-3.5 ( $3.3 \pm 0.1$ ,  $n = 4$ ). Lateral margins behind eyes broadly convex, converging posteriad at slightly concave occiput. Frons, vertex, and occiput with dense, coarse setae (Fig. 1). Antennae 4.6-4.9 ( $4.7 \pm 0.1$ ,  $n = 3$ ) in length, segments 1-7 having mean lengths of 0.8, 0.9, 0.9, 0.5, 0.6, 0.7, and 0.6 respectively ( $n = 3$ ); segments 1 and 2 light to medium brown, densely clothed with coarse setae; segments 3-7 light brown to nearly white with scattered, long, fine setae. Labium light brown, extending posteriad past anterior margin of mesocoxae; prementum 4.6-4.9 ( $4.7 \pm 0.1$ ,  $n = 4$ ) at greatest width, anterior margin angulate with edge slightly concave; palps triangulate with 8 or 9 crenulations each bearing a cluster of ca 6-12 spiniform setae of varying lengths (middle crenulations with 8-12 setae), lateral margin clothed with dense, fine setae (Fig. 2). Palpal setae 7-10, usually 8 or 9 ( $8.4 \pm 0.2$ ,  $n = 33$ , larvae and exuviae). Premental setae 11-16, usually 12-14 ( $12.9 \pm 0.3$ ,  $n = 31$ ). Head measurements of penultimate stadium: head width 4.9, middorsal length 2.4; antenna 3.9, length of segments 1-7, 0.6, 0.7, 0.8, 0.4, 0.6, 0.5, 0.5, respectively; mentum 3.6 at greatest width; palpal setae 7; premental setae 9-10.

**Thorax:** Widens posteriad, slightly wider than head (ratio 13:15). Prothorax with dorsolateral protuberances and margins of prothoracic shield bearing coarse, short setae; lateral margins near procoxa bearing long, fine setae; synthorax with dorsal ridges and margins bearing coarse, short setae; lateral surfaces with scattered, long, fine setae; prosternum with small anterolateral protuberances bearing extremely small setae; mesosternum with well developed anterolateral protuberances bearing long setae, two reduced tufts of shorter setae mediad; metasternum with small anterolateral protuberances

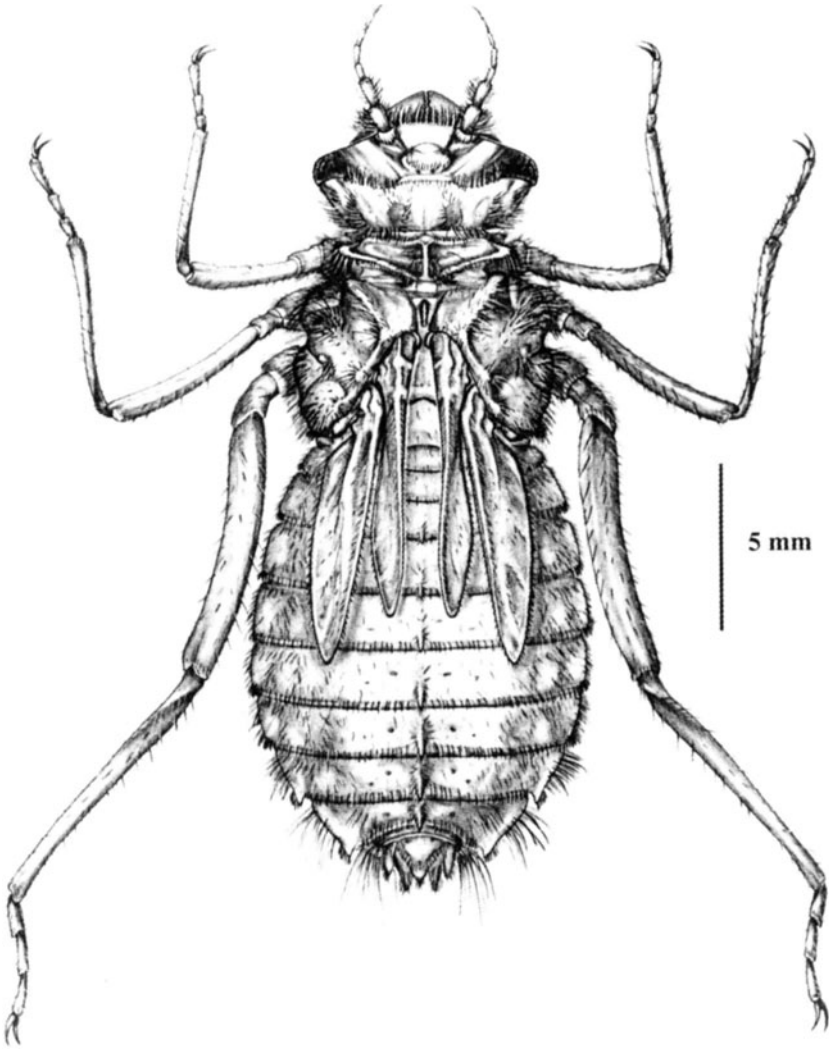


Figure 1. Dorsal view of *Somatochlora hineana* larva, scale line = 5 mm.

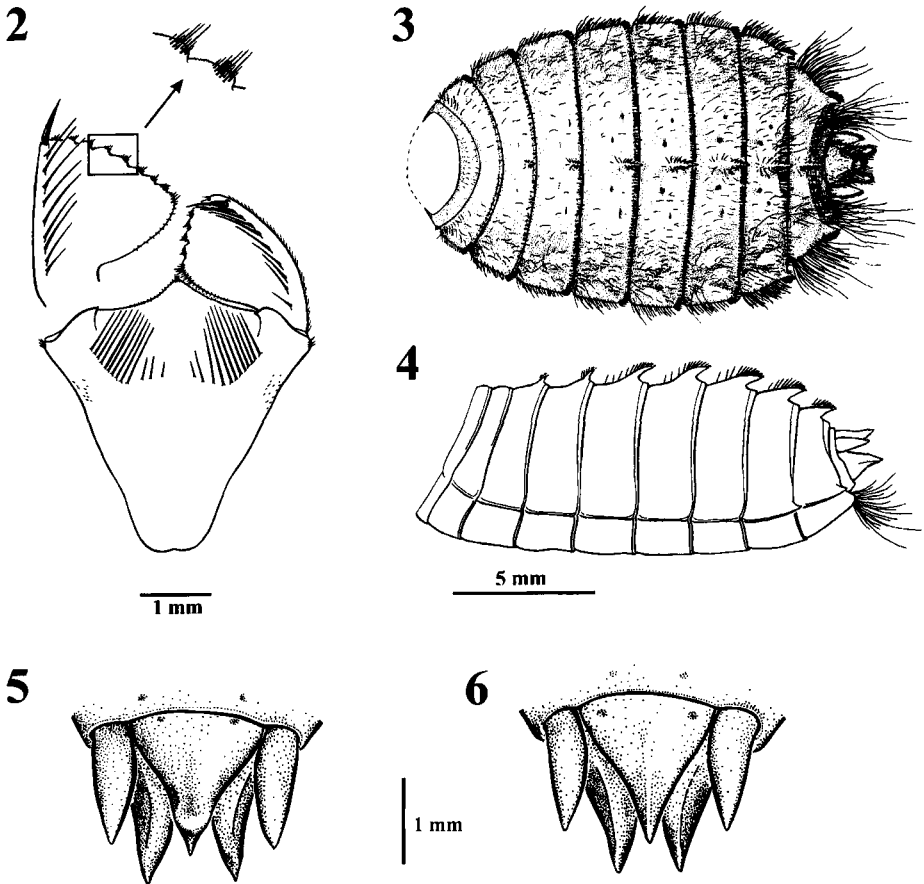
bearing setae, a large pair of setal clusters near the midline, and a small tuft of short setae laterad of the midline cluster. Legs uniformly brown, coxae and trochanters densely clothed with short setae; length of metafemur 6.8-7.6 ( $7.0 \pm 0.04$ ,  $n = 37$  larvae and exuviae), length of metatibia 7.7-8.4 ( $8.1 \pm 0.03$ ,  $n = 36$  larvae and exuviae). Hind wing sheath 8.1-8.3 ( $8.2 \pm 0.1$ ,  $n = 4$  larvae), extending from just past the anterior edge to beyond the middle of S6. Thoracic measurements of penultimate stadium: metafemur 5.8; metatibia 6.3; hind wing sheath 3.4, extending to abdominal segment (S)5.

**Abdomen:** Oval-shaped, widest at S5-7 (Fig. 3). Length, measured along the ventral midline including the terminal appendages, 13.2-14.0 ( $13.6 \pm 0.2$ ,  $n = 3$  larvae); maximum width in ventral view 8.7-9.6 ( $9.2 \pm 0.3$ ,  $n = 3$  larvae). Dorsum clothed with setae except for pattern of bare spots; scattered long, fine, hair-like setae over dorsum becoming more numerous posteriorly; posterior margin of each tergite armed with a row of short, coarse setae; lateral margins densely setose with longer and more slender hair-like setae on S8-10; those on S9 and S10 extending posteriorly past the paraprocts for a distance about equal to the length of the paraprocts (Figs 3-4). Venter of abdomen clothed with inconspicuous, short, hair-like setae; more numerous and longer on S8-10; anterolateral triangular sclerites on S3-6 and S8 on field larvae and exuviae (2 reared larvae with anterolateral sclerites on sternites 3-8). Middorsal hooks acute and falciform, usually on S3-9; dorsal hook on S3 usually small but well developed, occasionally vestigial or absent ( $n = 35$ ); largest middorsal hook on S7 or S8; middorsal hook on S9 usually extends to near the posterior margin of S10 (Figs 3-4). Lateral spines on S8 and S9, apices directed posteriorly; lateral margins with dense, short setae, those on S8 ca 0.8 length of those on S9, and ca 0.1-0.3 length of margin of S8 (anterolateral to posterolateral corners of sternite); spines on S9 ca 0.2-0.3 length of margin of S9 (anterolateral to posterolateral corners of sternite), maximum width of spine ca 0.6; length of spine (measured along medial side). Epiproct somewhat acuminate, extending slightly beyond distal ends of cerci, lateral margins slightly concave, length 1.6-1.7 ( $1.6 \pm 0.1$ ,  $n = 4$  larvae), width 1.3-1.6 ( $1.4 \pm 0.1$ ,  $n = 4$  larvae), lateral margins and venter densely setose; male with a slight antepical middorsal protuberance (Fig. 5); female slightly concave, (Fig. 6). Cerci with lateral margins nearly straight, medial margins distinctly convex (Figs 5-6); length 1.1-1.4 ( $1.3 \pm 0.1$ ,  $n = 4$  larvae), setae mostly on lateral and ventral surfaces, a few scattered dorsal setae (Fig. 4). Paraprocts densely setose, the lateral margins slightly concave, the medial margins slightly convex; length 1.4-1.5 ( $1.4 \pm 0.03$ ,  $n = 4$  larvae) (Figs 5-6). Abdominal measurements of penultimate stadium: length 11.8, width 7.7.

**Variation:** There were no apparent differences between the Illinois and Wisconsin specimens. Reared specimens seemed to be within the range of variation of field specimens, except they had fewer abdominal setae and were generally darker brown. The general body color varied from light brown to dark brown in preserved specimens. Total length of the final stadium which excludes antennae and includes terminal abdominal appendages ranged from 23-25 ( $23.9 \pm 0.7$ ,  $n = 4$ ), penultimate stadium, 20.0. Total length of exuviae ranged from 23.5-26.0 ( $24.9 \pm 0.7$ ,  $n = 32$ ).

### Larval habitat

*Somatochlora hineana* appears to have narrow habitat requirements. Most of the known sites had some notable unifying features. These included: shallow, organic soils (usually muck) overlying dolomitic bedrock; calcareous water from intermittent seeps; shallow, small channels and/or sheetflow. These seepage wetlands often dried out for a few weeks during the summer, but otherwise had thermal regimes that were relatively moderate – warmer in winter and cooler in summer – compared to nearby sites without groundwater



Figures 2-6. *Somatochlora hineana* larva – (2) dorsal view of prementum showing lateral and premental setae, closeup medial view of distal end of left palp showing crenulation and associated setae, scale line = 1 mm; (3) dorsal view of male abdomen, scale line = 5 mm; (4) lateral view of male abdomen, scale line = 5 mm; (5) dorsal view of male terminal appendages, scale line = 1 mm; (6) dorsal view of female terminal appendages, scale line = 1 mm.

influence. Vegetation was predominantly herbaceous; natural communities included marshes, sedge meadows, and fens. These communities usually were dominated by graminoid plants such as cattails (*Typha* spp.) and sweetflag (*Acorus calamus*) in marshes or by sedges (*Carex* spp.) in sedge meadows and fens. All known extant sites had forested areas and/or scattered shrubs in the near vicinity. For the adults, forest or shrubs appeared to be important for roosting and protection from inclement weather, especially thunderstorms and heat.

Larvae were found in cool, shallow, slowly moving (sometimes barely detectible) water flowing between hummocks of sedges or in shallow streamlets in spring-fed cattail marshes. The microhabitat usually contained decaying vegetation, such as cattail or

sedge leaves. Larvae of *S. hineana* utilized burrows of the crayfish *Cambarus diogenes* at sites in northeastern Wisconsin and northeastern Illinois during times of drought and when overwintering (Soluk et al. 1999).

### Comparison with other *Somatochlora* larvae

Larvae of some *Somatochlora* species are difficult to collect. Their habitats are often highly restricted, and populations may be extremely localized. As a result, the larval description for some *Somatochlora* species is based on a small series of exuviae or a few reared final stadium larvae. Although the adults are easily distinguishable by differences in the male terminalia and female vulvar laminae, several species are very similar in their larval stage to *S. hineana*.

In North America, the presence of prominent middorsal abdominal hooks, at least on S6-9, separates *S. hineana* from the 12 species that have no prominent middorsal abdominal hooks. These species include *S. albicincta* (Burmeister), *S. brevicincta* Robert, *S. cingulata* (Selys), *S. forcipata* (Scudder), *S. franklini* (Selys), *S. hudsonica* (Hagen), *S. incurvata* Walker, *S. kennedyi* Walker, *S. sahlbergi* Trybom, *S. semicircularis* (Selys), *S. septentrionalis* (Hagen), and *S. whitehousei* Walker.

In contrast, *S. hineana*, *S. elongata* (Scudder), *S. ensigera* Martin, *S. filosa* (Hagen), *S. georgiana* Walker, *S. linearis* (Hagen), *S. minor* Calvert, *S. ozarkensis* Bird, *S. provocans* Calvert, *S. tenebrosa* (Say), *S. walshii* (Scudder), and *S. williamsoni* Walker all have prominent middorsal abdominal hooks.

The larvae of *S. calverti* Williamson & Gloyd and *S. margarita* Donnelly presently are not known, however, they probably have middorsal hooks and could be similar in appearance to either *S. ozarkensis*, *S. filosa*, or *S. provocans*. No single character has been found that will separate the larvae of these 12 species reliably. In combination, the presence or absence of middorsal hooks on certain tergites, the size and shape of the middorsal hooks, the width/length of the lateral spines, the metatibia length-to-head width ratio, and the number of setae on palpal crenulations 4 or 5 are useful in distinguishing many *Somatochlora* species.

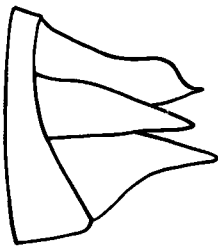
Among the species with middorsal hooks, *S. elongata*, *S. linearis*, *S. minor*, and *S. tenebrosa* are often the most difficult to distinguish from *S. hineana* (Table 1). Most *S. hineana* specimens may be distinguished from most other *Somatochlora* by the presence of a small middorsal hook on S3 (Fig. 4). However, *S. minor* also has a middorsal hook on S3, while *S. elongata*, *S. linearis*, and *S. tenebrosa* occasionally have a small or vestigial middorsal hook on this tergite. *S. elongata* usually has 5-6 palpal crenulation setae, metatibia length-to-head width ratio greater than 1.35, and comparatively erect middorsal hooks. In comparison, *S. hineana* usually has 8-12 palpal crenulation setae, metatibia length-to-head width ratio less than 1.25, and comparatively low lying middorsal hooks. *S. linearis* usually has a head width less than 6.6, 6-8 palpal setae, and 7-8 palpal crenulation setae, whereas *S. hineana* usually has a head width greater than 6.6, 8-9 palpal setae, and 8-12 palpal crenulation setae. *S. minor* usually has a head width of less than 6.0, metatibia length less than 8.0, 5-6 palpal crenulation setae, and comparatively erect middorsal hooks. In contrast,

*S. hineana* usually has a head width of greater than 6.6, metatibia length greater than 8.0, 8-12 palpal crenulation setae, and comparatively low lying middorsal hooks. *S. tenebrosa* ordinarily has a total length of 19.0-22.0, metatibia length-to-head width ratio greater than 1.25, and 6-9 palpal crenulation setae. In comparison, *S. hineana* typically has a total length of 23.5-25.0, metatibia length-to-head width ratio less than 1.25, and 8-12 palpal crenulation setae. In addition, the male epiproct of *S. tenebrosa* (Fig. 7) has a much more pronounced anteapical swelling than that of *S. hineana* (Figs 4, 5).

Table 1. Diagnostic characters of *Somatochlora* larvae similar to *S. hineana*; measurements in mm.

	<i>hineana</i>	<i>elongata</i>	<i>linearis</i>	<i>minor</i>	<i>tenebrosa</i>
S3 middorsal hook	usually present	usually absent	usually absent	present	usually absent
no. of crenulation setae	8-12	5-6	7-8	5-6	6-9
no. of palpal setae	8-9	6-8	6-8	6-8	8-10
total length	23.5-25.0	21.0-24.4	22.0-24.0	21.0-22.5	19.0-22.0
head width	6.7-6.8	6.1-6.3	6.1-6.6	5.7-5.9	6.2-6.7
metatibia length	8.1-8.4	8.3-8.8	8.1-8.7	7.4-7.8	8.0-8.8
metatibia length/head width ratio	1.19-1.25	1.35-1.40	1.29-1.41	1.30-1.34	1.27-1.31

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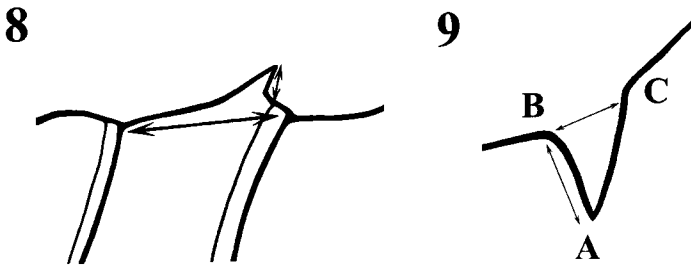
Figures 7 and 10. *Somatochlora* larvae similar to *S. hineana* – (7) *S. tenebrosa*, lateral view of male terminal appendages; (10) *S. linearis*, lateral view of dorsal hooks on S7-9.

Dunkle (1977) discussed the presence of triangular sclerites on the anterolateral margins of the abdominal sternites of some selected *Somatochlora* species and their potential taxonomic significance. He reported that triangular sclerites were found on

S3-6 and S8 on *S. linearis* and on S4-6 on *S. tenebrosa*. Triangular sclerites were found on S4-6 and S8 on all *S. hineana* examined, however, only the reared larvae had triangular sclerites on S7. We suggest that further research is needed on the taxonomic significance of these ventral sclerites.

**Key to the larvae of the North American species of *Somatochlora***  
(*S. calverti* and *S. margarita* unknown)

Total length measurements were used with caution due to differences in lengths between larvae and exuviae and differences in larval preservation methods. Middorsal hook length was determined in lateral view using the distance from the base to the apex along the posterior margin (Fig. 8). A middorsal hook was defined as vestigial, for the purposes of this key, when its length was less than 1/8 the middorsal length of its respective tergite. Lateral spine width and length were measured from a ventral view. The length of a lateral spine along its mesal margin (base to apex) was compared to the width (measured from the base extending at a right angle to the lateral margin) (Fig. 9). Palpal crenulation setae were counted only on the middle palpal crenulations (4 or 5). The generalized geographic ranges follow Needham et al. (2000) and Dunkle (2000). Characters were chosen, in part, from Walker (1925, 1941), Pritchard (1936), Walker in Whitehouse (1941), Needham & Westfall (1955), Tennessen (1975), Walker & Corbet (1975), Huggins (1983), Cannings & Cannings (1985), Daigle (1991), Hutchinson & Menard (2000), and Needham et al. (2000). The characters used to separate *S. incurvata* from other species were provided by Smith & Steffens (in prep.).



Figures 8-9. Method of measurement – (8) to determine dorsal hook and tergite length ratio; length of spine is measured from apex along posterior margin to point of inflection; (9) to determine length and width of lateral spine; length (A-B) is length measured along mesal margin of lateral spine; width (B-C) is width measured at right angle to A-B.

- 1a Middorsal hooks present at least on S6-9, usually erect, acute and falciform, sometimes low and blunt but always visible in dorsal and lateral view on S6-9 . . . . . 2



- 1b Middorsal hooks absent on all tergites, or with low, broad middorsal prominences on S4-9 (*cingulata*), not erect or falciform, visible in lateral view but not dorsal view ..... **16**
- 2a Middorsal hook apices always blunt; hooks low and not falciform; SE Canada, NE United States, and Appalachians ..... *williamsoni*
- 2b Middorsal hook apices always acute; hooks usually erect and falciform, may be erect and straight or low and falciform ..... **3**
- 3a Middorsal hooks present on S3-9, middorsal hook length on S3 greater than 1/8 middorsal length of S3 ..... **4**
- 3b Middorsal hooks present on S4-9, S5-9 or S6-9; middorsal hook on S3, if present, then less than 1/8 middorsal length ..... **5**
- 4a Palpal crenulations 4-5 each with group of 5-6 setae; palpal setae 6-8; head width <6.0; Canada, N United States ..... *minor*
- 4b Palpal crenulations 4-5 each with group of 8-12 setae; palpal setae 8-9; head width >6.5; extant in Illinois, Michigan, Missouri, and Wisconsin ..... *hineana*
- 5a S9 with lateral spines at least 3/5 as wide as long ..... **6**
- 5b S9 with lateral spines less than 3/5 as wide as long ..... **9**
- 6a Middorsal hooks on S7 and 8 with posterior margins straight (Fig. 4) ..... **7**
- 6b Middorsal hooks on S7 and 8 with posterior margins curved (Fig. 10) ..... **8**
- 7a Middorsal hooks on S3-9 or S4-9, hook well developed on S4 ..... *hineana*
- 7b Middorsal hooks on S5-9, hook may be absent or vestigial on S4; SE United States ..... *filosa*
- 8a Premental setae 12-15; vestigial middorsal hook sometimes on S3, small but well developed hook on S4; palpal crenulations 4-5 each with group of 7-8 setae; E United States ..... *linearis*
- 8b Premental setae 11-12; no middorsal hook on S3; middorsal hook on S4 small or vestigial; palpal crenulations 4-5 each with group of 5-7 setae; S central Canada, N central United States ..... *ensigera*
- 9a Middorsal hooks of S7-9 with posterior margin straight in lateral view; epiproct extending beyond cerci; palpal setae 7-8; head width 6.3-6.4; SE United States ..... *provocans*
- 9b Middorsal hooks of S7-9 with posterior margin curved; other characters variable but not in above combination ..... **10**
- 10a Palpal setae 8-9, rarely 10; head width  $\geq 6.4$  ..... **11**
- 10b Palpal setae 6-7, rarely 8; head width < 6.4 ..... **12**

- 11a Total length 20.0-22.0; palpal crenulations 4-5 each with group of 6-9 setae; middorsal hooks on S4-9 or S5-9; metatibia length-to-head width ratio > 1.25; SE Canada, E United States ..... *tenebrosa*
- 11b Total length 23.5-25.0; palpal crenulations 4-5 each with group of 8-12 setae; middorsal hooks on S4-9; metatibia length-to-head width ratio < 1.25 .. *hineana*
- 12a Metafemur length 7.2-8.8; metatibia length 8.5-10.0; SE Canada, NE United States, Appalachians ..... *elongata*
- 12b Metafemur length 6.0-7.0; metatibia length 6.8-8.4 ..... **13**
- 13a Middorsal hook on S9 not extending beyond middle of S10 in dorsal view; epiproct extending beyond cerci; S central United States ..... *ozarkensis*
- 13b Middorsal hook on S9 extends to or beyond posterior margin of S10 in dorsal view (unextended specimens); epiproct not extending beyond cerci ..... **14**
- 14a Palpal setae 8; head width 6.2-6.4; male epiproct with a pronounced antepical swelling (Fig. 7); SE Canada, E United States ..... *tenebrosa*
- 14b Palpal setae 6-7, rarely 8; head width 5.5-6.0; male epiproct without an antepical swelling ..... **15**
- 15a Middorsal hook on S4 small, but well developed, >1/8 middorsal length of tergite; total length 21.0-22.5; metatibia length 7.4-8.4; S Canada and N United States ..... *walshii*
- 15b Middorsal hook on S4 absent or vestigial, <1/8 middorsal length of tergite; total length 18.0-20.0; metatibia length 6.8-7.3; Atlantic and Gulf coastal plain of United States ..... *georgiana*
- 16a Lateral spines distinct on S8 and 9 ..... **17**
- 16b Lateral spines absent or only on S9, may be minute, best observed from ventral view ..... **20**
- 17a Low, broad middorsal prominences on S4-9 (lateral view); metatibia length 8.5-9.1; lateral margins of male epiproct with prominent tubercles; transcontinental Canada, NE United States ..... *cingulata*
- 17b No middorsal prominences on S4-9 (lateral view); metatibia length 6.7-8.5; lateral margins of male epiproct without tubercles ..... **18**
- 18a Epiproct not extending beyond cerci; palpal setae 8 or 9; femora with two dark bands; N Alaska, N Yukon; also Palearctic ..... *sahlbergi*
- 18b Epiproct extending beyond cerci; palpal setae 5-7, occasionally 8, rarely 9; femora unmarked ..... **19**
- 19a Lateral spine of S9 relatively large, about 1/4-1/3 as long as S9 sternite (along midline); metafemur length < 6.7; transcontinental Canada, NE and NW United States ..... *albicincta*

- 19b Lateral spine of S9 relatively small, about 1/10 as long as S9 sternite (along midline); metafemur length usually  $\geq 6.7$ ; W and central Canada, N Rocky Mountains of United States ..... *hudsonica*
- 20a Lateral spines present on S9, may be minute, best observed from ventral view . . . . . **21**
- 20b Lateral spines absent on S9 ..... **25**
- 21a S8 with posterior margin having a distinct median tuft of long setae, best observed in dorsolateral view; transcontinental Canada, NE United States ..... *kennedyi*
- 21b S8 without a median tuft of long setae, but distinct paired dorsolateral tufts may be present, best observed in dorsolateral view ..... **22**
- 22a Posterior margins of S9 and usually S8 with setae forming two distinct rows of dorsolateral tufts, setae between tufts distinctly shorter ..... **23**
- 22b Posterior margins of S8 and S9 with setal length relatively uniform ..... **24**
- 23a Dorsolateral tufts of setae on posterior margins of S6-9 distinct and widely separated by about the width of a tuft (S6 setae may be obscured by wing pads); head width  $\leq 5.9$ ; transcontinental, central and S Canada and NE United States ..... *forcipata*
- 23b Dorsolateral tufts of setae on posterior margin of S9 and usually S8 distinct and widely separated by ca tuft width, dorsolateral tufts less distinct and median gap narrowing progressively anteriorly, tufting of S6 absent or indistinct; head width  $>5.9$ ; SE Canada and NE United States ..... *incurvata*
- 24a Head width  $\geq 5.9$ ; total length 21-22; metafemur length usually  $> 5.8$ ; W Canada, W United States ..... *semicircularis*
- 24b Head width  $< 5.9$ ; total length 17-19; metafemur length usually  $< 5.8$ ; transcontinental Canada and N United States ..... *franklini*
- 25a Posterior margins of S6-9 with two prominent dorsolateral tufts of long setae, S6 setae may be obscured by wing pads ..... *forcipata*
- 25b Posterior margins of S6-9 without two dorsolateral tufts of long setae ..... **26**
- 26a Palpal setae usually 5, occasionally 6, rarely 4; cerci notably shorter than paraprocts (ca 2/3-4/5 length of paraproct, dorsal view); margins of cercus asymmetrical in dorsal view; transcontinental Canada, Maine ..... *brevicineta*
- 26b Palpal setae 6-9; cerci and paraprocts subequal, or if cerci distinctly shorter than paraprocts, then margins of cercus symmetrical (dorsal view) ..... **27**
- 27a Palpal setae usually 6-7, rarely 8; premental setae usually 9-10; margins of cercus symmetrical, apex acuminate (dorsal view); transcontinental Canada ..... *whitehousei*

- 27b Palpal setae usually 8-9, occasionally 7; premental setae usually 11-13; margins of cercus asymmetrical, mesal margin nearly linear, lateral margin broadly angulate, apex acute (dorsal view); transcontinental Canada . . . . . *septentrionalis*

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