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Revision of Nearctic *Nephrocerus* Zetterstedt (Diptera: Pipunculidae)

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Abstract

The Nearctic species of *Nephrocerus* Zetterstedt, 1838 are revised and include two described species, *N. daeckei* Johnson, 1903 and *N. slossonae* Johnson, 1915, and four new species: *N. acanthostylus* spec. nov., *N. atrapilus* spec. nov., *N. corpulentus* spec. nov. and *N. woodi* spec. nov. A key to species is provided and diagnostic characters, including male and female genitalia, are illustrated. *Nephrocerus* is recorded for the Neotropical Region for the first time.

Key words: Diptera, Pipunculidae, *Nephrocerus*, Nearctic, revision, species distribution

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Introduction

Unlike the closely related flower flies (Syrphidae) that encompass a huge variety of life history tactics, big-headed flies (Pipunculidae) have always been considered exclusively endoparasitoids of Auchenorrhyncha (particularly Cicadellidae, Delphacidae and Cercopidae). This narrow, specialized behaviour has been consistently recorded for species throughout the basal subfamily Chalarinae and the large Pipunculinae radiation (Skevington & Marshall1998). *Nephrocerus* has always been an enigma in the family. These flies look very different from all other pipunculids (large, yellow and black flies resembling some syrphids) and the life history of the group has remained unknown despite the keen interest of many dipterists to uncover it. *Nephrocerus* is a pivotal lineage in interpreting the phylogeny of the Pipunculidae and their relationship to Syrphidae (see Rafael & De Meyer (1992) and Skevington & Yeates (2000) for details) and knowledge of the larvae and life histories has always been sought to help unravel these relationships. Even the taxonomy of this spectacular and intriguing Holarctic genus of flies is poorly known. Nine of the 12 known Palaearctic species have been described since 1988 and no key exists for the taxa of this region. The Nearctic species are in even worse shape, with no reliable way to identify the only two known species described in 1903 and 1915. This revision attempts to rectify the situation for Nearctic species. As this manuscript was approaching completion (22 February 2005), exciting news arrived that *Nephrocerus* was recently reared for the first time by David Koenig at the Carnegie Museum of Natural History in Pennsylvania (Chen Young, pers. comm.). This discovery makes this revision very timely, and it is anticipated that the combination of this paper and the anticipated publication of a manuscript documenting these rearing results (Koenig & Young 2005) will stimulate work on this fascinating group of flies.

Materials and Methods

Specimens were obtained from the following collections (abbreviations follow Evenhuis & Samuelson (2004)).

AMNH	American Museum of Natural History, New York, NY, USA. D. Grimaldi.
CAS	California Academy of Sciences, San Francisco, CA, USA. N. Penny.
CMNH	Carnegie Museum of Natural History, Pittsburgh, PA, USA. C. Young.
CNC	Canadian National Collection of Insects, Ottawa, ON, Canada. J. Cumming.
CSCA	California State Collection of Arthropods, Sacramento, CA, USA. S. Gaimari.
DEBU	University of Guelph Insect Collection, Guelph, ON, Canada. M. Buck, S. Marshall.
DENH	University of New Hampshire, Durham, NH, USA. D. Chandler.

FSCA	Florida State Collection of Arthropods, Gainesville, FL, USA. G. Steck.
INHS	Illinois Natural History Survey, Champaign, IL, USA. D. Webb.
IRCW	University of Wisconsin, Madison, WI, USA. S. Krauth.
MCZ	Museum of Comparative Zoology, Cambridge, MA, USA. P. Perkins.
NYSM	New York State Museum, Albany, NY, USA. T. McCabe.
TAMU	Texas A & M University Insect Collection, College Station, TX, USA. E. Riley.
UCMS	University of Connecticut, Storrs, CT, USA. J. O'Donnell.
UMRM	University of Missouri, Columbia, MO, USA. R. Sites.
UMSP	University of Minnesota, St. Paul, MN, USA. P. Clausen.
UQIC	University of Queensland Insect Collection, Brisbane, QLD, Australia. G. Daniels.
USNM	National Museum of Natural History, Washington, DC, USA. F.C. Thompson.

Specimen preparation follows Skevington (2001, 2002, 2003). Drawings were made using a drawing tube mounted on a Nikon Optiphot compound microscope or a Leica Wild M10. Measurements were made using a graticule. When possible, at least six specimens from each species were used to obtain the recorded values. When fewer specimens were available, all were measured.

All specimens are labeled with a unique reference number, typically in the format J. Skevington Specimen # n. This has been shortened to follow the format JSS#n throughout the text. When specimens already have a unique identifier, that number is cited in the text instead of adding an extra label with a JSS#. These numbers are used in a database of Pipunculidae specimens that I maintain (available upon request). Material examined is listed in order of increasing latitude within states or provinces. States and provinces are organized alphabetically. Where square brackets are used in the material examined list, they enclose inferred data or notes that are not present on specimen labels. *Italics* are used in species descriptions to draw the reader's attention to diagnostic characters. Character states that are highlighted with ***bold italics*** are unique to that species (or genus) while *non-bold, italicized* character states are shared with one or more other species (or genera in the case of the generic description). This style of presentation is meant to help users quickly identify diagnostic characters, both those shared with a limited number of other taxa and those that are unique. Species are described in alphabetical order to facilitate cross-referencing from the key. Damaged males, and females that could not be identified with absolute confidence were not included in type series.

Morphological Terminology and Measurements

With one exception, terminology and measurements are the same as those used by Skevington (2001, 2002, 2003). Genitalic terminology nomenclature follows Sinclair (2000)

and is discussed by Skevington (2001) with specific reference to Pipunculidae. These items are summarized below for the reader's convenience and genitalic structures are labeled on Figures 3 and 4.

In males, the holoptic length (distance that the eyes are touching) may be diagnostic. This is quantified using a ratio of holoptic length: ocellar triangle length (H:O).

Body length was measured as a sum of the distances from the front of the head (excluding antennae) to the tip of the scutellum and from there to the tip of syntergosternite 8. Measurements made in this way minimize variability that is introduced by deflection of the abdomen.

Some wing characters are of taxonomic utility. The ratio of lengths of costal section 4 to costal section 3 is recorded as the costal section ratio (C_4:C_3). The position of the R-M crossvein relative to cell dm is expressed through the M-sector ratio, that is the ratio of sector 3 of the M vein (distal to R-M) to sector 2 (proximal to R-M) (S_3:S_2).

Epandrium shape is quantified using a ratio of width:length (WE:LE). These measurements are taken at the widest points.

There is little intraspecific variability in ovipositor shape. Viewing the ovipositor laterally will enable assessment of the degree of curvature of the piercer and the relative lengths of component parts of the piercer and base. The degree of curvature must be assessed visually by comparing specimens to the figures. Because of the importance of the ovipositor in species identification, all drawings are included together. Several measurements of the ovipositor are made to avoid purely visual comparisons and to help with the identification of species with structurally similar ovipositors. Ovipositor length (OL) is measured in a straight line from the piercer tip to the point where the ovipositor base articulates ventrally with sternite 6 (Fig. 4A). Piercer length (PL) is measured as a straight line from the proximal edge of the cerci to the tip of the piercer (Fig. 4A). This is represented as part of the ratio of ovipositor length to piercer length (OL:PL). The length of the ovipositor base (B) is measured as a straight line from the proximal end of the cerci to the point where the ovipositor base articulates ventrally with sternite 6 (Fig. 4A). This is given as part of the ratio of the length of the ovipositor base to piercer length (B:PL). A ratio of body length to ovipositor length (BL:OL) is also given in all descriptions.

Nephrocerus Zetterstedt (1838)

Nephrocerus Zetterstedt, 1838: 151. Type species: *Nephrocerus lapponicus* Zetterstedt, 1838, by monotypy.

Description (adapted from Morakote (1988)): **Male:** Body length 5.7–12.0 mm. **Head:** hemispherical (Fig. 1C); eyes touching on frons, *hind margin of eyes deeply excised medially* (Fig. 1C); ocellar triangle bare, ocelli slightly raised (Fig. 1B); frons and face densely silver-pubescent, pubescence longer and denser on face; ***1st flagellomere*** largest antennal

segment, ***reniform*** (Fig. 1C); anterior margin of scape and pedicel with many bristles that are slightly longer on pedicel; occiput moderately wide, sparsely covered with short hairs (Fig. 1A). **Thorax:** *proepisternum with a fan of bristles*; postpronotal lobe enlarged, protruding (Fig. 1A); *1–2 notopleural setae, 1–2 supra-alar seta; dorsocentrals increasing in size posteriorly and terminating in 1–4 strong setae; 1–4 setae on postalar callus;* scutellum with 2–8 long marginal bristles. **Legs:** long and slender, with dense pubescence and bristles; first and second tarsal segments very long, tarsi longer than femora and tibiae. **Wings:** 5.6–12.0 mm; long, about three times as long as broad; pterostigma absent; R-M situated in basal third to fourth of discal medial cell; *M_2 present, long* but never reaching wing margin. **Abdomen:** long and narrow, densely covered with pubescence and bristles; tergite 2 longest; tergites 7 and 8 twisted to the left; tergite 7 scarcely visible from above; syntergosternite 8 large, swollen. **Genitalia:** epandrium enlarged, horseshoe-shaped; surstyli asymmetrical; hypandrium reduced to small plate, articulated laterally with basal part of gonopod (Fig. 3C); *postgonites situated at ventral base of phallus, small, oval* (Fig. 3D); *phallus coiled*, long when extended (Fig. 3C); ***phallapodeme well-developed*** (Fig. 3C). **Female:** As male except: *eyes narrowly dichoptic*; ***sternite 6 with numerous, short, tack-like spines on posterior half*** (Fig. 4A); tergite 7 relatively long; ovipositor with very short base and short blade-like piercer.

Overview

Nephrocerus are large, yellow and black pipunculids that are more likely to be mistaken for flower flies (Syrphidae) than for other pipunculids. Head shape, ovipositor structure, wing venation (including the lack of a spurious vein) and general gestalt allow them to be differentiated from syrphids (Fig. 1C). They can be easily diagnosed from other pipunculids by the shape of the eyes and antennae (see above). *Protonephrocerus* (Chile only) is the only other pipunculid genus with the hind margin of the eye excised but they have the first flagellomere pointed ventrally (reniform in *Nephrocerus*). A key to the world genera of Pipunculidae is available in Skevington & Yeates (2001).

Nephrocerus is a northern temperate genus, previously documented only from the Palaearctic and Nearctic regions. The distribution of all New World specimens, including unidentified specimens, is shown in Figure 14. The New World distribution is distinctive. Only three specimens representing two species have been collected west of 100º W (basically a line running through western Manitoba south through western Kansas and the middle of Texas) in the USA and Canada. Three additional female specimens have been collected in Mexico, one as far south as Chiapas (16º45' N) (Fig. 14). This extends the known range of the genus into the Neotropical Region and suggests that we might expect to find *Nephrocerus* south into the mountains of Central America and in the West Indies.

Although the European species of *Nephrocerus* were revised in 1986 (Grootaert & De Meyer 1986), new work in both Europe and Asia means that no single key will work for all Palaearctic species. The dominant three European species can still be identified using

Grootaert & De Meyer (1986) (*N. flavicornis* Zetterstedt, *N. lapponicus* Zetterstedt, and *N. scutellatus* Macquart). However, identifications of these taxa should be checked against descriptions of species from Azerbaijan (*N. zaitzevi* Kuznetzov (1990)); Russia (*N. fatalis* Churkin (1991) and *N. nevskajae* Churkin (1991)) (to download an English translation of this paper, go to http://www.canacoll.org/Diptera/Staff/Skevington/Pipunculidae/Nephrocerus.htm); China (*N. auritus* Xu & Yang (1997)); North Korea (*N. paektusanensis* Kozánek & Kwon (1992)); and Japan (*N. flexus* Morakote (1988), *N. grandis* Morakote (1988), *N. japonicus* Morakote (1988), and *N. spineus* Morakote (1988)).

Molecular and morphological evidence suggest that *Nephrocerus* occupies a key phylogenetic position within Pipunculidae between the ancestral Chalarinae and the diverse derived subfamily Pipunculinae (Aczél 1948; Rafael & De Meyer 1992; Skevington & Yeates 2000). Only the relationship of *Protonephrocerus* and *Nephrocerus* is really disputed. The former appears to either be the sister genus to *Nephrocerus* (Rafael & De Meyer 1992) or the sister of the Pipunculinae (Aczél 1948; Skevington & Yeates 2000). Current treatment places *Nephrocerus* and *Protonephrocerus* as sister taxa in the Nephrocerinae. Resolving this relationship and discovering the hosts for these two genera will help us to understand the evolution and diversification of the family.

A species level phylogeny of *Nephrocerus* has never been attempted. Although there are good autapomorphic species level characters, there are few obvious synapomorphies to link groups of species. My efforts at creating a morphological phylogeny for all species of *Nephrocerus* met with little success. Unpublished molecular data (for Cytochrome *c* oxidase I subunit I - COI) collected for another project generally supports the presence of two main lineages within the Nearctic taxa (the *daeckei* group and the *slossonae* group) (Skevington, unpublished data). These groups are easy to recognize based on the predominant colour of bristles on their bodies. The *daeckei* group has black hairs on the legs and abdomen while the *slossonae* group has yellow hairs. It is unclear whether or not these species groups will hold up on a World scale. Any attempts at producing a meaningful phylogeny for *Nephrocerus* will almost certainly have to rely on molecular data. Because most of the taxa are rare, collecting fresh material into alcohol for molecular work will be a challenge. Data from COI suggest that the Nearctic species are a cluster of recently diverging species. This gene did not exhibit enough sequence diversity to explore species limits or phylogenetics of the genus (Skevington, unpublished data). More rapidly evolving genes or gene regions such as ITS (internal transcribed spacer) and parts of the genes coding for rudimentary (CAD) will be needed to study the phylogeny of *Nephrocerus.* Producing a cladistic hypothesis of relationships for *Nephrocerus* is clearly an important next step to research on this group of flies. This phylogeny will be useful for interpreting the interesting biogeographical pattern (essentially restricted to the Palaearctic and Eastern Nearctic Regions) exhibited by this genus. It will also serve as an important tool for understanding host-parasitoid relationships as more of these flies are reared.

Key to Nearctic *Nephrocerus*

External characters work well to separate the species groups of *Nephrocerus* and species of the *slossonae* group. Males of the *daeckei* group must be dissected for specific identification; females of this group are very difficult to distinguish and are unknown for *N. woodi* sp. nov.

1. Coxae with yellow to pale brownish hairs contrasting little with yellow legs; abdomen with hairs all yellow ..... *slossonae* group … 2
— Coxae with black hairs contrasting sharply with yellow legs; abdomen with hairs mostly dark brown to black.....*daeckei* group ... 4
2. Scutellum shining black medially with yellow around posterior and lateral margins (Fig. 1A); proepisternum entirely bright yellow (Fig. 1C); abdominal tergite 1 entirely yellow laterally (Fig. 1C); male hind tibia with ventral patch of specialized bristles (Fig. 2A); left surstylus of male with distinctive hook (Fig. 3A, C, D); right surstylus with upper lobe short, quadrate (Fig. 3B); female ovipositor short, stubby (Fig. 4A) ... . *Nephrocerus acanthostylus* sp. nov.
— Scutellum completely yellow, rarely slightly darkened basally or entirely brown (never black with yellow margins) (cf. Fig. 1B); at least anterior edge of proepisternum brown to black (cf. Fig. 1D, E); abdominal tergite 1 always at least partly brown laterally (cf. Fig. 1E); male hind tibia with circlet of bristles (Fig. 2C) or elongate apical bristles on outer edge (Fig. 2B), but without ventral specialized bristles; left surstylus of male simple (Figs 7A, C, D or 11A, C, D); right surstylus with upper lobe projecting and deflected ventrally at 90 degrees (Figs 7B or 11B); female ovipositor short and stubby (Fig. 4E) or long and narrow (Fig. 4C) 3
3. Hind tibial apex with circlet of stiff yellow bristles all about the same length (Fig. 2C); epandrium narrow (ratio of width to length 1.1–1.4 (JSS#11412 = 1.6):1) (Fig. 11C, D); right surstylus with upper lobe uniformly tapering (Fig. 11B); middle lobe stubby, with rounded tip and curving medial edge, with no similar structure on left surstylus (Fig. 11C, D); ovipositor short, stubby, 0.9 to 1.1 mm long (Fig. 4E) ....*Nephrocerus slossonae* Johnson
— Hind tibial apex with long, stiff yellow bristles restricted to outer edge of tibia, these bristles over twice length of adjacent bristles (Fig. 2B); epandrium very broad (ratio of width to length 1.60–2.00:1) (Fig. 7C, D); right surstylus with upper lobe broad basally, abruptly narrowing (Fig. 7B); middle lobe broad, straight-sided, sharply pointed, with a similar structure on left surstylus (Fig. 7C, D); ovipositor long, narrow, sharply upcurved, 1.1–1.3 mm long (Fig. 4C) ..... *Nephrocerus corpulentus* sp. nov.
4. Males 5
— Females (*N. woodi* unknown) 7
5. Right surstylus with middle lobe stubby, pointed (Fig. 6C, D) ....*Nephrocerus atrapilus* sp. nov.

— Right surstylus with no middle lobe (cf. Fig. 9C, D) 6
6. Surstylus with dorsal lobe projecting, much longer than ventral lobe (Fig. 13B, D); right surstylus with lower lobe wide, triangular (Fig. 13D) .... *Nephrocerus woodi* sp. nov.
— Surstylus with dorsal lobe short, about same length as ventral lobe (Fig. 9A–D); right surstylus with lower lobe narrow, elongate (Fig. 9D) .... *Nephrocerus daeckei* Johnson
7. Ovipositor tip attenuate (Fig. 4B) ..... *Nephrocerus atrapilus* sp. nov.
— Ovipositor tip stubby, wide (Fig. 4D) ..... *Nephrocerus daeckei* Johnson

Species Accounts

***Nephrocerus acanthostylus* sp. nov. (Figs 1A, C, 2A, 3A–D, 4A, 5)**

Type Material Examined: Holotype ♂**:** Canada, Quebec, [Vaudreuil Co., Summit of] Mount Rigaud, 45°27'59" N, 74°19'35" W, 19.v.2004, JSS#15348, J. Skevington, L. Bartels, E. St. Louis, J. King (CNC). **Allotype** ♀**:** United States, Minnesota, Becker Co., 6 mi[les] SW Detroit Lakes, [46°49' N, 95°51' W], Malaise trap, in hardwood forest, 6–8.vi.1981, JSS#13491, Mike Moher (CAS). **Paratypes: Canada: New Brunswick:** Kouchibouguac N[ational] P[ark], [46°52' N, 64°58' W], 27.vi.1977, 1♂, JSS#11449 [head and dissected genitalia in glycerin, all very faintly pigmented, apparently due to long time in KOH; all legs removed for DNA extraction], S.J. Miller, 5437C (CNC); **Ontario:** Hilton Beach, [46°15' N, 83°53' W], Malaise trap, at edge of h[ar]dw[oo]d for[est] and field, 31.v.1990, 1♂, JSS#11411 [3 legs removed for DNA extraction], 1♀, JSS#11414 [3 legs removed for DNA extraction], 6.vi.1989, 2♀♀, JSS#11417-8, 9.vi.1989, 1♀, JSS#11419, 9.vi.1990, 1♀, JSS#15952, 13.vi.1990, 2♀♀, JSS#11421-2, 19.vi.1989, 1♀, JSS#11420, J.E. Swann (DEBU); [Carleton Co.], Stittsville, [45°15' N, 75°55' W], 24.vi.1963, 1♀, JSS#11473, W.R.M. Mason (CNC); **United States: Michigan:** Emmet Co., [45°32' N, 84°55' W], 27.v.1960, 1♀, JSS#11512, R.&K. Dreisbach (USNM); Barry Co., T3N R10W, Sec. 26, [42°36' N, 85°19' W], 29.v.1968, 1♀, JSS#11511, J.P. Donahue (USNM); **Minnesota:** Becker Co., 6 mi[les] SW Detroit Lakes, [46°49' N, 95°51' W], Malaise trap, in hardwood forest, 29.v.1981, 1♂, JSS#13490, 2♀♀, JSS#13492-3, 3.vi.1981, 4♀♀, JSS#13475-8, 4.vi.1981, 2♀♀, JSS#13481, 13487, 5.vi.1981, 1♂, JSS#13485 [3 legs and tergites 2 and 3 removed for DNA extraction], 6.vi.1981, 1♀, JSS#13482, Mike Moher (CAS); **New Hampshire:** Carr[oll] Co., The Bowl, 2.5 mi[les] NW Wonalancet, [43°56' N, 71°24' W], Malaise trap, 5–8.vi.1984, 1♀, JSS#11825 [3 legs removed for DNA extraction], 21–27.vi.1984, 2♀♀, JSS#11829-30, 5–14.vi.1985, 1♀, JSS#11845, D.S. Chandler (DENH); **Virginia:** Shenandoah N[ational] P[ark], Big Meadow, [38°30' N, 78°27' W], 1300 m, Malaise trap, natural meadow, 8–20.v.1987, 1♂, JSS#11472, BRC Hym. Team (CNC).

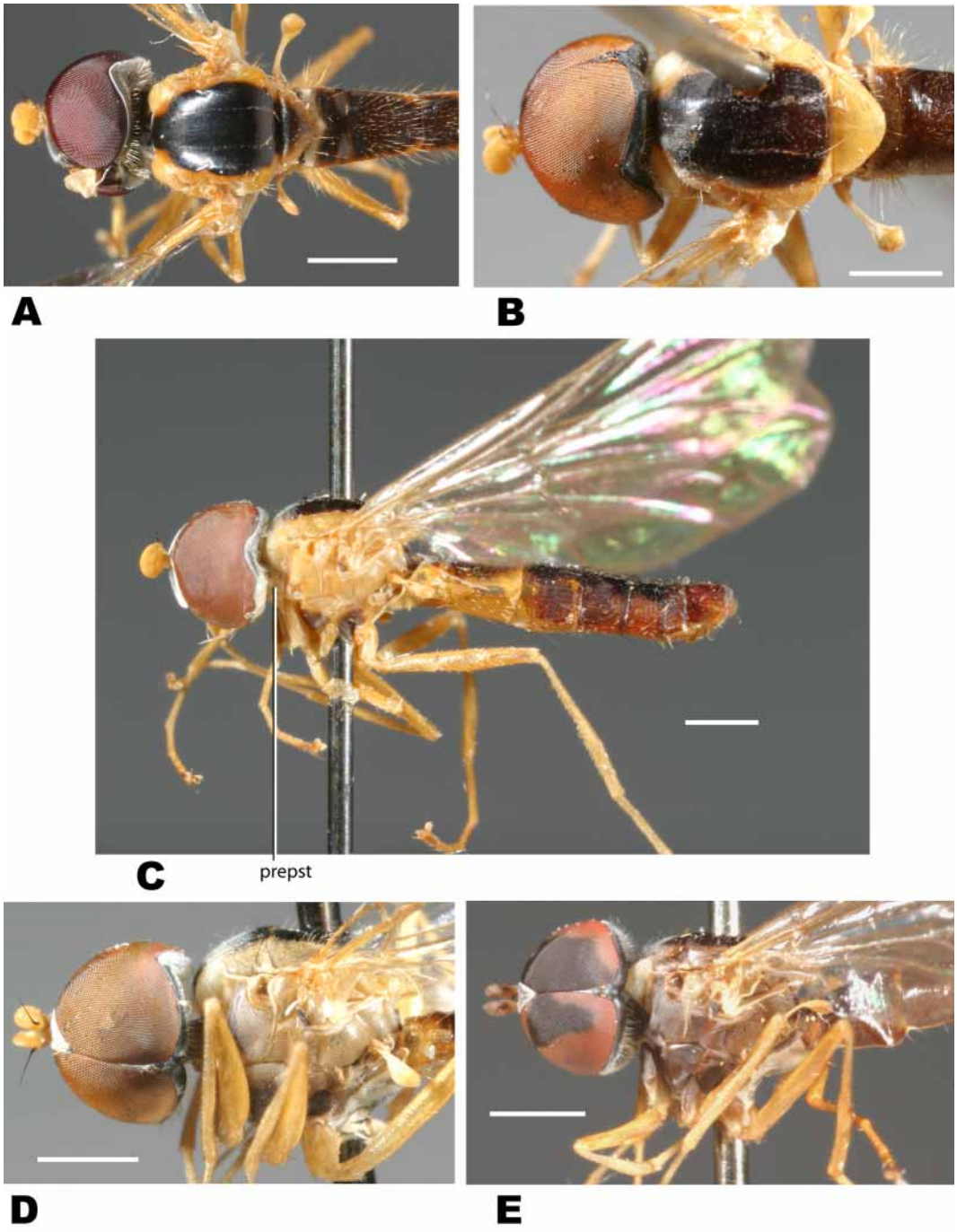

FIGURE 1. Photographs of *Nephrocerus* species. Abbreviation: prepst = proepisternum. Scale bars = 1.0 mm. A. *Nephrocerus acanthostylus*, holotype, JSS#15348, ♂, dorsal of head, thorax and base of abdomen. B. *Nephrocerus slossonae*, JSS#11834, ♂, dorsal of head, thorax and base of abdomen. C. *Nephrocerus acanthostylus*, JSS#13450, ♀, left lateral. D. *Nephrocerus slossonae*, JSS#11836, ♂, left lateral of head and thorax. E. ♂, *Nephrocerus slossonae*, JSS#11490, left lateral of head and thorax.

Other Material Examined: Allotype *Nephrocerus slossonae* ♀: [United States], N[ew] H[ampshire], Bretton Woods, 25.vi.1913, JSS#13450, C.W. Johnson, [13093] (MCZ).

Etymology: An adjective, from the Greek *akantha* for 'thorn'; in reference to the thorn-like projection off the left surstylus.

Description: Male: Body length 7.0–8.2 mm. **Head:** Holoptic, *eyes joined for length of ocellar triangle or slightly longer, H:O 0.88–1.62:1.* Arista black with yellow base. 1st flagellomere yellow. Pedicel yellow with 19–23 bristles along distal margin. Scape yellow with 3–8 dorsal bristles. Labellum and palps yellow. Occiput silver-pubescent with multiple rows of white hairs. **Thorax:** Proepisternum with a fan of 8–13 bristles. Postpronotal lobe yellow with 6–7 yellow hairs on posterior edge. Scutum black dorsally, yellow laterally, with sharply defined boundaries between the colours (Fig. 1A); with dorsocentral and intra-alar rows of short hairs, dorsocentrals increasing in size posteriorly and terminating in 1–2 strong setae. Notopleuron with 1–2 setae and numerous smaller hairs. 1–2 posterior supra-alar setae. Postalar callus with 1–3 setae and 6–7 other moderately strong bristles. ***Scutellum black with yellow around edges*** (Fig. 1A); with 2 pairs of strong posterior setae and numerous small black bristles over entire surface. Pleuron mostly yellow, black on basal four fifths of katepisternum and meron, on small sclerite below wing base, subscutellum, and in a thin band posterior to posterior spiracle; slightly darkened on anterior anepisternum and anepimeron, rarely on proepisternum. Halter yellow. **Legs:** entirely yellow, long and slender; *hairs and sockets on coxae*, trochanters and femora all *yellow*; tibiae and tarsi with yellow hairs but with black sockets. Fore and mid-tibiae slender and slightly arched dorsoventrally; ***hind tibia*** narrow on basal third, broader towards tip, laterally arched in apical half (in dorsal view); ***apex with*** circlet of stiff yellow bristles and ***a ventral patch of black specialized bristles*** (Fig. 2A). Trochanters with 1–3 dorsomedial bristles and a loosely arranged double row of shorter ventral bristles. **Wings:** Length: 5.6–7.4 mm; fourth costal section about 3 times as long as third, C_4:C_3 3.1–3.2:1; R-M position variable, situated between basal one-fourth to nearly middle of discal medial cell (dm), S_3:S_2 2.4–4.0:1. ***Cell r_1 and Sc completely microtrichose, cell bm microtrichose on distal half*** (the only exception is in JSS#13490, which has the proximal corner of r_1 bare). ***Tegula with*** 9–25 predominantly black bristles, including ***2–4 much longer, yellow bristles along posterolateral margin***. **Abdomen:** ***Tergite 1*** black dorsally, ***entirely yellow laterally.*** Tergites 2–6 black dorsally, yellow posterolaterally to laterally. Sternites 1–5 yellow to brown. Tergite 1 with 6–8 large yellowish bristles. Tergite 7 yellow. Syntergosternite 8 mostly black, yellow near junction with epandrium. *All hairs yellow.* **Genitalia:** Epandrium and terminalia mostly yellow, only phallus black. Epandrium nearly as long as wide, WE:LE 1.1–1.3:1. Surstyli asymmetrical; ***lower lobe of left surstylus with distinctive hook; right surstylus with upper lobe short, acute, with cluster of long bristles on dorsomedial surface*** (Fig. 3A, C, D). ***Distiphallus with a few weak spines*** clustered on first loop (Fig. 3A–C). **Female:** As male except: Apex of hind tibia with no specialized bristle

patch. Ovipositor short, upcurved, 0.91–1.06 mm (Fig. 4A). OL:PL 1.20–1.54:1; BL:OL 6.48–7.42:1; B:PL 0.27–0.46:1.

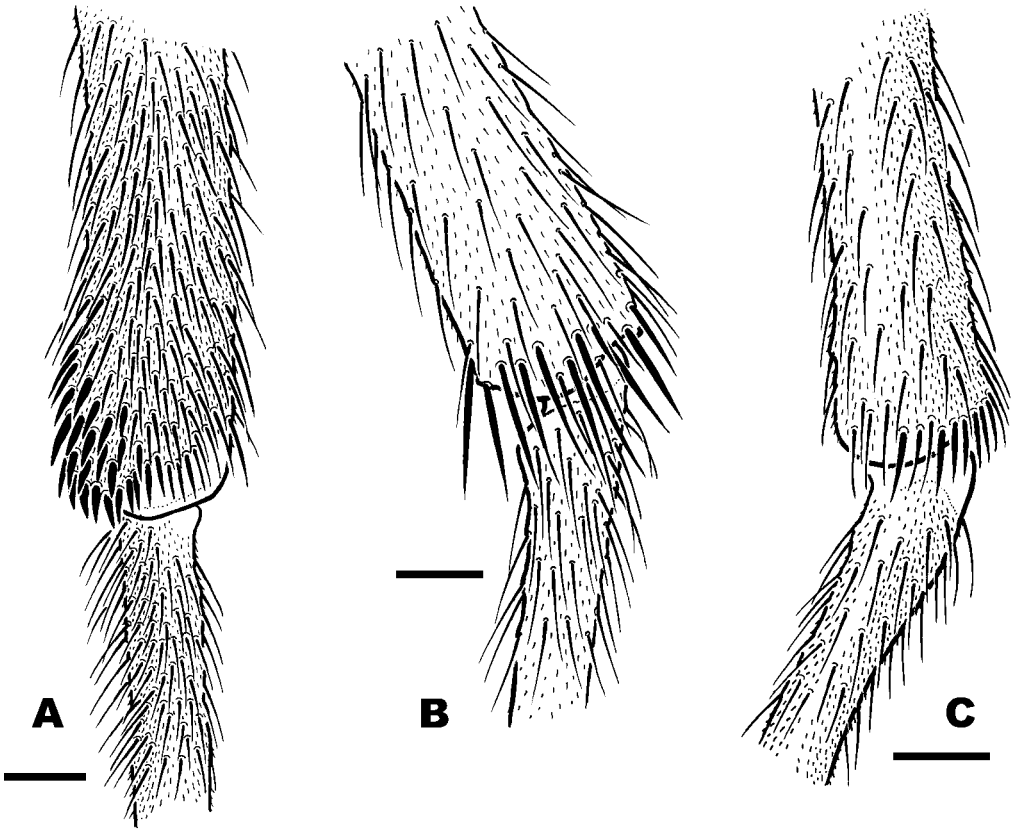

FIGURE 2. Posterior view of distal region of right hind tibia, *Nephrocerus* species. Scale bars = 0.1 mm. A. *Nephrocerus acanthostylus* JSS#13490. B. *Nephrocerus corpulentus* JSS#11470. C. *Nephrocerus slossonae* JSS#11827.

Distribution: Known from 31 specimens from NE North America, from Ontario to New Brunswick south as far as Virginia (Fig. 5).

Comments: This species has been recorded from hardwood forests and a meadow. The holotype was collected on a hilltop as it hovered and flew over a serviceberry shrub [*Amelanchier* sp.]. This behaviour was common to many other male flies present at the time, including other pipunculids and suggests that this species is a hilltopper. Four species of *Nephrocerus* have been collected hilltopping: *N. acanthostylus*, *N. atrapilus*, *N. slossonae* and *N. woodi*. This is a common mating strategy in Pipunculidae but has not been documented for *Nephrocerus* (Skevington 2001, 2002, 2003). I suspect that with additional observations, all six species of *Nephrocerus* will be discovered using this mating strategy. Parasitoid flies, particularly rare species, often employ this method of mate location (Scott 1968; Shields 1967; Thornhill & Alcock 1983).

The flight period for this species is from May 14th to June 27th with most records focused around the first week of June.

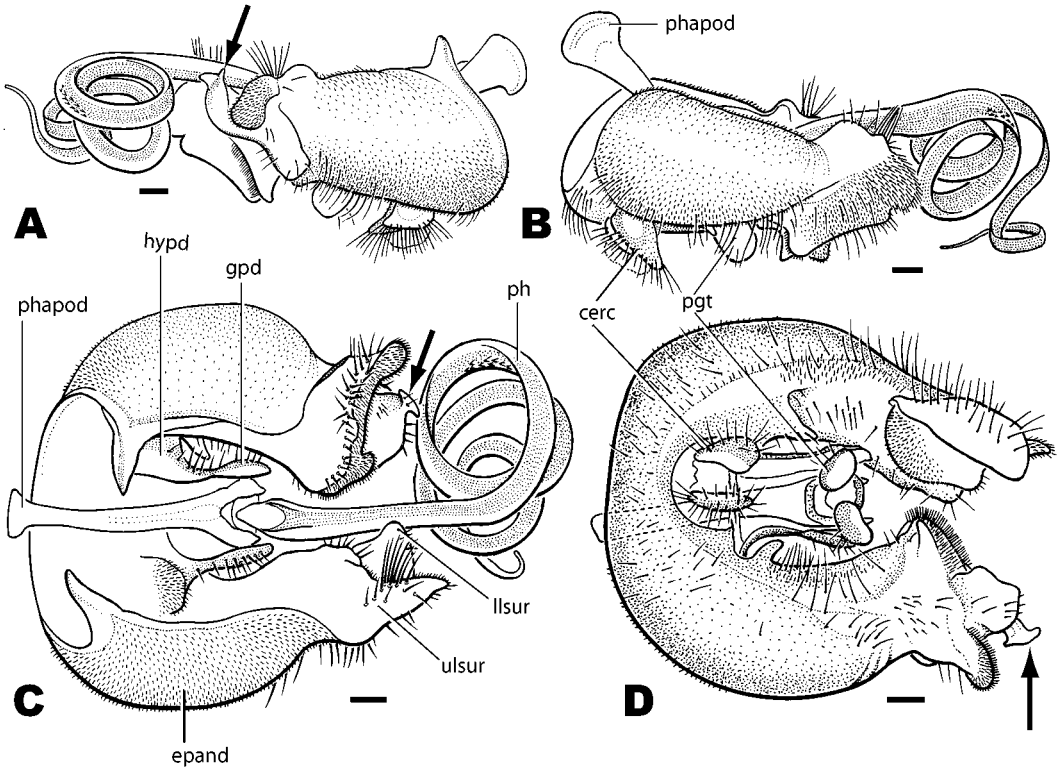

FIGURE 3. Male *Nephrocerus acanthostylus* terminalia, ejaculatory apodeme and sperm pump removed; all of JSS#11411. Abbreviations: cerc = cerci; epand = epandrium; gpd = gonopod; hypd = hypandrium; llsur = lower lobe of surstylus; phapod = phallapodeme; ph = phallus; pgt = postgonite; ulsur = upper lobe of surstylus. Arrows indicate key features. Scale bars = 0.1 mm. A. left lateral. B. right lateral. C. dorsal. D. ventral, phallus removed.

Nephrocerus atrapilus sp. nov. (Figs 4B, 5, 6A–D)

Type Material Examined: Holotype ♂: Allegheny Co., 2.4 km N Monroeville, W. Boyce Regional Park, 40°27'42" N, 79°45'26" W, 1375 m, reared from *Tipula (Lunatipula) duplex* Walker, emergence date 17.v.2004, host collection date 14.vii.2003, CMNH#356286, D.P. Koenig, C.W. Young (CMNH). **Allotype ♀:** United States: Mississippi, Lafayette Co., Oxford, [34°22' N, 89°31' W], v.1940, JSS#11488, Frank M. Hull, Frank M. Hull collection CNC 1973, (CNC). **Paratypes: Canada: Ontario:** Gatineau Co., Masham T[o]w[nshi]p, near Duncan Lake, 45°40'53" N, 76°03'01" W, oak hilltop, 6.vii.1974, JSS#11498, D.M. Wood (CNC); Puslinch, [43°26' N, 80°05' W], Malaise trap, 18–20.vi.1983, 1♂, JSS#11432, 22.vi.1983, 1♂, JSS#11433 [2.5 legs removed for DNA

extraction], Coote & Marshall, (DEBU); **United States: Florida:** Liberty Co., Torreya State P[ar]k, [30°35' N, 84°57' W], 17.v.1963, 1♂, JSS#13411, 14.v.1971, 1♀, JSS#13412, insect flight trap, 19.v.1970, 1♀, JSS#13413, H.V. Weems, Jr. (FSCA); Liberty Co., Torreya State P[ar]k, [30°35' N, 84°57' W], Malaise trap, 30.iv.–5.v.1973, 3♀♀, JSS#13414–6, 1♀, JSS#13417 [head removed for DNA extraction], 1♂, JSS#13418 [3 legs removed for DNA extraction], 1♂, JSS#13419, 1♂, JSS#13420, H.V. Weems, Jr., C.R. Artaud (FSCA); Liberty Co., Torreya State P[ar]k, [30°35' N, 84°57' W], 22.iv.1967, 1♀, JSS#11471, W.W. Wirth (USNM); **Georgia:** Rabun Co., Pine Mountain, [34°57' N, 83°11' W], 1400', [427 m], 4.v.1957, 1♂, JSS#11495, J.R. Vockeroth (CNC); Lumpkin Co., 15 mi[les] NW Dahlonega, [34°32' N, 83°59' W], 16.vi.1973, 1♂, JSS#11451 [genitalia in poor condition, epandrium broken], A.G. Lavallee (USNM); **Illinois:** [McHenry Co.], Algonquin, 42.16556º N, 88.29417º W, 19.v.1896, 1♂, 19428 (INHS); **Kansas:** [Pottawatomie Co.], Onaga, [39°29' N, 96°10' W], 1♂, JSS#13386, H. Kahl Coll.'n, C.M. Acc. 12676, 751 (CMNH); [Pottawatomie Co., Onaga, 39°29' N, 96°10' W], 2♂♂, JSS#13387–8, H. Kahl Coll.'n, C.M. Acc. 12676, 749–50 (CMNH); **Maryland:** Plummers I[slan]d, [38°58' N, 77°11' W], 29.vi.1913, 1♂, JSS#11453 [genitalia overcleared], R.C. Shannon (USNM); **Michigan:** Wayne Co., [42°15' N, 83°17' W], 11.vi.1961, 1♂, JSS#11452 [phallus broken], G. Steyskal (USNM); Wayne Co., Grosse Ile, [42°08' N, 83°09' W], 24.v.1951, 1♀, JSS#11505, G. Steyskal (USNM); **Mississippi:** [Lafayette Co.], Oxford, [34°22' N, 89°31' W], v.1942, 1♀, JSS#11474, Frank M. Hull collection CNC 1973 (CNC); Lafayette Co., Oxford, [34°22' N, 89°31' W], v.–vi.1945, 4♀♀, JSS#11475, 11477-9, 1♂, JSS#11476, v.1940, 3♀♀, JSS#11480–2, 1♂, JSS#11483, 1♂, JSS#11484, 2♀♀, JSS#11485, 11487, 1♂, JSS#11486, v.1945, 1♀, JSS#11489, Frank M. Hull, Frank M. Hull collection CNC 1973 (CNC); **Missouri:** Boone Co., 5 mi[les] E Ashland, Ashland W[ildlife] A[rea], [38°45' N, 92°12' W], Malaise trap, forest, 28.v.–4.vi.1992, 1♂, JSS#13376 [3 legs removed for DNA extraction], R.S. Gagne (UMRM); **New Jersey:** [Bergen Co.], Ramsey, [41°03' N, 74°08' W], 23.vi.1935, 1♂, JSS#13393 (AMNH); **Pennsylvania:** Allegheny Co., 2.4 km N Monroeville, W. Boyce Regional Park, 40°27'42" N, 79°45'26" W, 1375 m, reared from *Tipula (Lunatipula) duplex* Walker, emergence date 14.v.2004, host collection date 14.vii.2003, 1♂, CMNH#354180, 1♀, CMNH#352853, emergence date 15.v.2004, host collection date 5.vii.2003, 1♂, JSS#15202, emergence date 15.v.2004, host collection date 14.vii.2003, 1♀, CMNH#352701, emergence date 17.v.2004, host collection date 5.vii.2003, 2♂♂, CMNH#353341, 354670, emergence date 17.v.2004, host collection date 8.vii.2003, 1♂, CMNH#358101, emergence date 17.v.2004, host collection date 14.vii.2003, 1♂, CMNH#356286, emergence date 19.v.2004, host collection date 14.vii.2003, 1♂, CMNH#355821, emergence date 19.v.2004, host collection date 26.vii.2003, 1♂, CMNH#353893, emergence date 20.v.2004, host collection date 14.vii.2003, 1♀, CMNH#356305, emergence date 21.v.2004, host collection date 8.vii.2003, 1♀, CMNH#358340, emergence date 22.v.2004, host collection date 14.vii.2003, 1♂, CMNH#357825, emergence date 23.v.2004, host collection date

5.vii.2003, 1♀, CMNH#358422, emergence date 24.v.2004, host collection date 14.vii.2003, 1♂, CMNH#352932, 1♀, CMNH#354570, emergence date 26.v.2004, host collection date 14.vii.2003, 1♀, CMNH#352881, emergence date 27.v.2004, host collection date 14.vii.2003, 1♀, CMNH#353444, emergence date 29.v.2004, host collection date 14.vii.2003, 1♀, CMNH#353236, emergence date 31.v.2004, host collection date 14.vii.2003, 1♀, CMNH#353388, emergence date 2.vi.2004, host collection date 14.vii.2003, 1♀, CMNH#354178, emergence date 17.vi.2004, host collection date 26.vii.2003, 1♀, CMNH#356930, emergence date 17.vi.2004, host collection date 10.viii.2003, 1♂, CMNH#356395, reared from *Tipula (Lunatipula) mallochi* Alexander, emergence date 15.v.2004, host collection date 5.vii.2003, 1♀, JSS#15207, D.P. Koenig, C.W. Young (CMNH); **Texas:** Brazos Co., College Station, Lick Creek Park, [30°38' N, 96°20' W], Malaise trap, 9–23.iv.1988, 1♂, JSS#13395, 4♀♀, JSS#13396-7, 13402-3, 4♂♂, JSS#13398-9, 13401, 13404, 1♂, JSS#13400, Wharton, Praetorius (TAMU); Brazos Co., College Station, [30°38' N, 96°20' W], Malaise trap, 16.iii.–19.iv.1988, 1♂, JSS#13405, R. Wharton (TAMU); Brazos Co., College Station, Lick Creek P[ar]k, [30°33' N, 96°14' W], 2200', [671 m], Malaise trap, bottomland forest n[ea]r creek, 28–30.iii.2000, 1♂, JSS#11442, debu 00109691, M. Buck (DEBU); Brazos Co., College Station, Lick Creek P[ar]k, [30°33' N, 96°14' W], 2200', [671 m], Malaise trap, post oak savanna by creek, 28–30.iii.2000, 1♂, JSS#11443, debu 00117703, 1♂, JSS#11444, debu 00113829 [3 legs removed for DNA extraction], 30.iii.–5.iv.2000, 1♀, JSS#11445, debu 00114314, 5–9.iv.2000, 1♀, JSS#11446, debu 00114350 [3 legs removed for DNA extraction], 1♀, JSS#11447, debu 00117650, 1♂, JSS#11448, debu 00117621, M. Buck (DEBU); Montgomery Co., [W.G.] Jones State Forest, 8 mi[les] S Conroe, [30°13' N, 95°29' W], 13–19.iv.1987, 1♂, JSS#13406, 27.iv.–3.v.1987, 2♀♀, JSS#13407-8, 2♂♂, JSS#13409, 13410 [3 legs removed for DNA extraction], Wharton, Wang, Praetorius (TAMU); **Washington:** Walla Walla, [46°04' N, 118°20' W], 18.viii.1923, 1♂, JSS#11454 [genitalia in poor condition, epandrium broken], A.L. Melander, A.L. Melander collection 1961 (USNM).

Other Material Examined: Canada: Ontario: Puslinch, [43°26' N, 80°05' W], Malaise trap, 1.vii.1983, 1♀, JSS#11430, Coote & Marshall (DEBU); Puslinch, [43°26' N, 80°05' W], dry Malaise head, 28.vi.1983, 1♀, JSS#11431, Coote & Marshall (DEBU); Cambridge, Cambridge Research Station, [43°23' N, 80°19' W], Malaise trap, forest edge, 30.vi.–5.vii.1992, 1♀, JSS#11423, J. Skevington (DEBU); **United States: District of Columbia:** Washington, [38°54' N, 77°02' W], 19.vi.1944, 1♀, JSS#11506, G. Steyskal (USNM); **Maryland:** Plummers Isl[and], [38°58' N, 77°11' W], 30.vi.1960, 1♀, JSS#11502, 6.vi.1959, 1♀, JSS#11503, K.V. Krombein (USNM); Plummers Isl[and], [38°58' N, 77°11' W], 8–20.vii.1968, 1♀, JSS#11504, P. Spangler (USNM); **North Carolina:** Jackson Co., Cullowhee, Cane C[ree]k, [35°20' N, 83°11' W], 2200', [671 m], Malaise trap, 8.vi.1984, 1♀, JSS#11437, 9.vi.1984, 1♀, JSS#11438, 15.vi.1984, 1♀, JSS#11439, 26–27.vi.1984, 2♀♀, JSS#11440-1, Marshall (DEBU); **Virginia:** Clarke County, 5 miles] E Berryville, [39°09' N, 77°59' W], black light, 18.vii.1976, 1♀,

JSS#11510, G.F. Hevel (USNM); Montg[omery] Co., 8 km NW Blacksburg, [37°14' N, 80°25' W], 1000 m, 9.vi.1987, 1♀, JSS#11462, BRC Hym. Team (CNC).

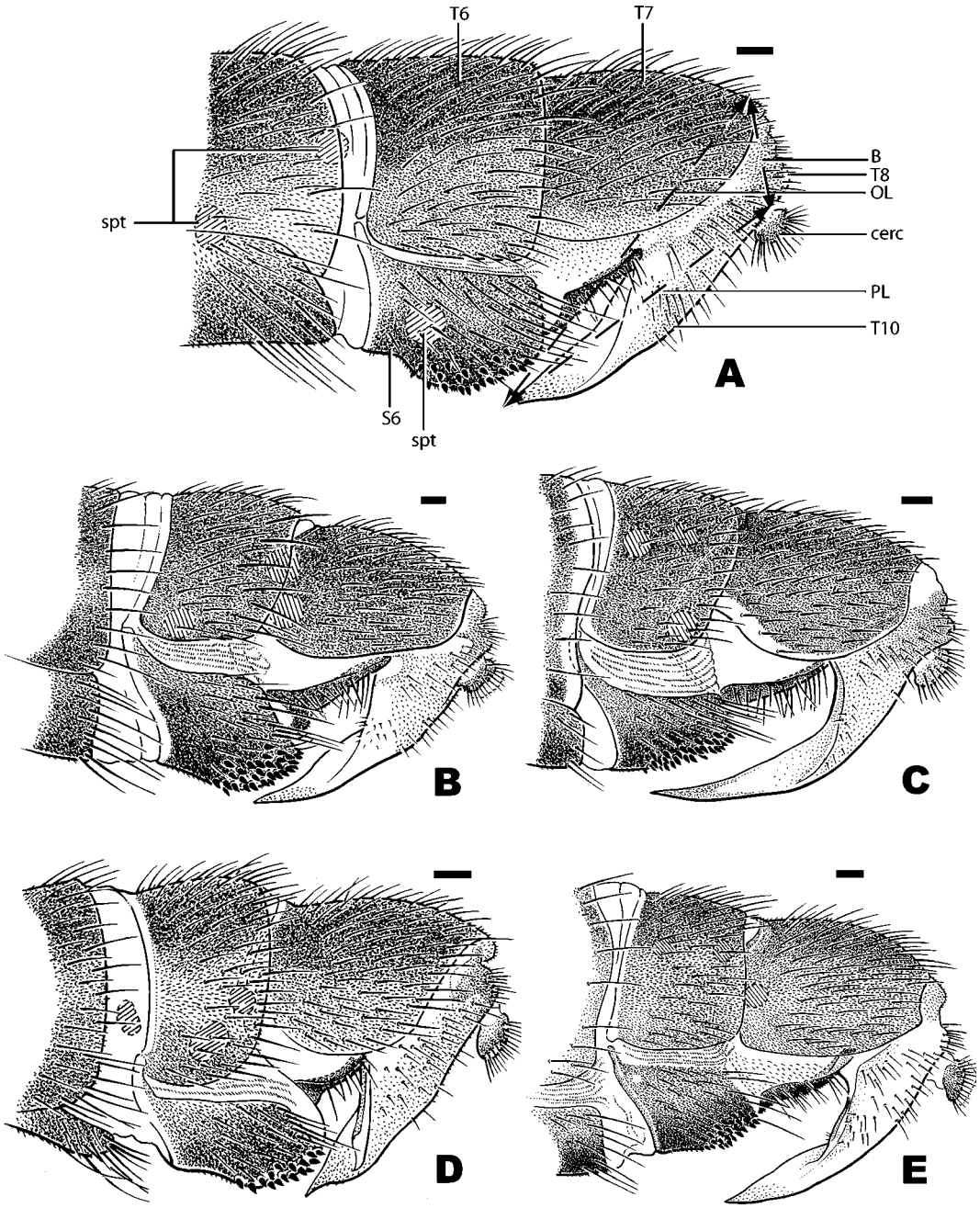

FIGURE 4. Left lateral of ovipositors of female *Nephrocerus* species. Abbreviations: B = length of ovipositor base; cerc = cercus; OL = ovipositor length; PL = piercer length; spt = spermatheca, S = sternite; T = tergite. Scale bars = 0.1 mm. A. *Nephrocerus acanthostylus*, JSS#13477. B. *Nephrocerus atrapilus*, JSS#13397. C. *Nephrocerus corpulentus*, JSS#13365. D. *Nephrocerus daeckei*, JSS#11407. E. *Nephrocerus slossonae*, JSS#11795.

Etymology: From the Latin *atra* for 'black' and *pilus* for 'hair'; in reference to the black hairs on the abdomen of this species.

Description: Male: Body length 5.7–8.9 mm. **Head:** Holoptic, *eyes joined for approximately two to four times the length of ocellar triangle, H:O 2.19–4.40:1*. Arista black with yellow base. 1st flagellomere yellow. Pedicel yellow with 14–21 bristles along distal margin. Scape yellow with 3–11 dorsal bristles. Labellum and palps yellow. Occiput silver-pubescent with multiple rows of white hairs. **Thorax:** Proepisternum with a fan of 6–8 bristles. Postpronotal lobe yellow with 4–7 yellow hairs on posterior edge. Scutum usually black dorsally, yellow laterally, with sharply defined boundaries between the colours (cf. Fig. 1C); with dorsocentral and intra-alar rows of hairs, dorsocentrals longer and increasing in size posteriorly, terminating in 2–4 strong setae. Notopleuron with 2 setae and numerous smaller hairs. 1 posterior supra-alar seta. Postalar callus with 2 setae and 6–7 other moderately strong bristles. Scutellum yellow; with 2–3 pairs of strong posterior setae and numerous small black bristles over entire surface. Pleuron mostly yellow, black on basal four fifths of katepisternum and meron, anterior anepisternum, small sclerite below wing base and subscutellum; anepimeron brown in some Texas, Florida and Mississippi specimens. Halter yellow. **Legs:** long and slender, entirely yellow; *hairs and sockets on coxae brown to black*; hairs on trochanters and femora predominantly to entirely brown to black, sometimes yellow on base of femora; tibiae and tarsi with brown to black hairs with black sockets. Fore and mid-tibiae slender and slightly arched dorsoventrally; hind tibia narrow on basal third, broader towards tip, laterally arched in apical half (in dorsal view); *apex with circlet of stiff yellow bristles all about the same length* (cf. Fig. 1C). Trochanters with 3–6 dorsomedial bristles and a row of shorter ventral bristles, most prominent on rear trochanter. **Wings:** Length: 6.1–8.1 mm; fourth costal section about 2–3 times as long as third, C_4:C_3 2.0–3.0:1; R-M situated between basal one-third to nearly middle of discal medial cell (dm), S_3:S_2 2.1–3.0:1. Cell r_1 bare basally; Sc entirely bare to microtrichose in distal corner only; cell bm entirely bare to microtrichose along distal edge only. Tegula with 9–13 black bristles. **Abdomen:** Tergite 1 brown with a yellow anterolateral patch; with 9–15 large black bristles. Tergites 2–3 brown with yellow along posterior edge and laterally. Tergite 4 similar but with less yellow. Tergites 5–7 brown to black, usually with very narrow yellow posterior and lateral edges. Sternites 1–5 brown. Syntergosternite 8 brown dorsally, yellow ventrally. *All hairs black.* **Genitalia:** Epandrium and terminalia usually light brown, occasionally yellowish brown, phallus black. Epandrium one and a third to about one and a half times as wide as long, WE:LE 1.3–1.6:1. *Surstyli* asymmetrical; *with upper lobes short, triangular* (Fig. 6C); ***middle lobe of right surstylus stubby, pointed, with no similar structure on left surstylus*** (Fig. 6C, D). Distiphallus with numerous, robust spines starting before first loop (Fig. 6C). **Female:** As male except: Ovipositor short, upcurved, 0.77–1.15 mm (Fig. 4B). OL:PL 1.25–1.36:1; BL:OL 6.21–7.79:1; B:PL 0.28–0.42:1.

Distribution: Mostly an eastern North American distribution. Known from 104 specimens distributed from southwestern Quebec and New Jersey south to northern Florida, west to eastern Texas and eastern Kansas (Fig. 5). One additional specimen was collected in SE Washington (see below).

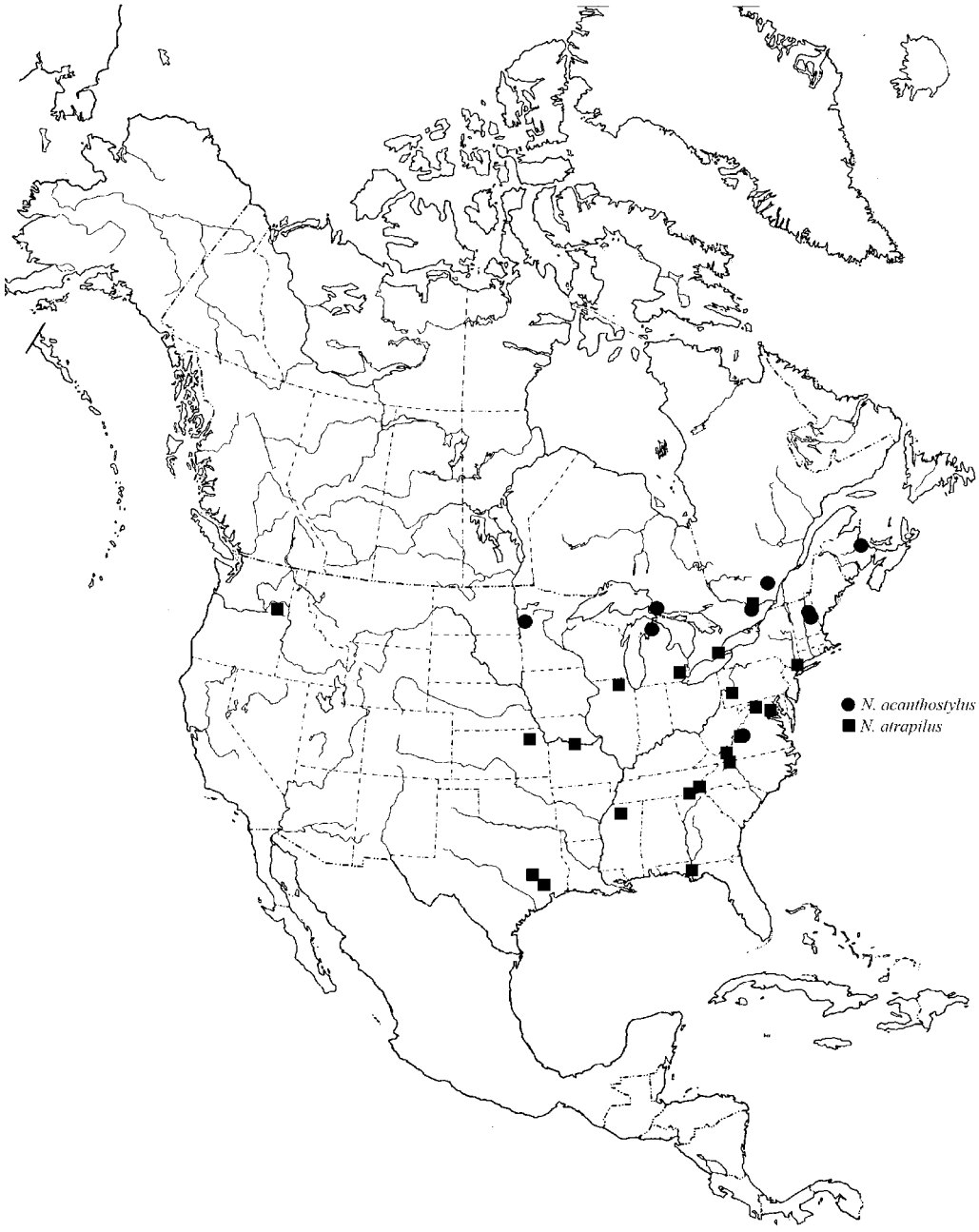

FIGURE 5. Distributions of *Nephrocerus acanthostylus* and *Nephrocerus atrapilus*.

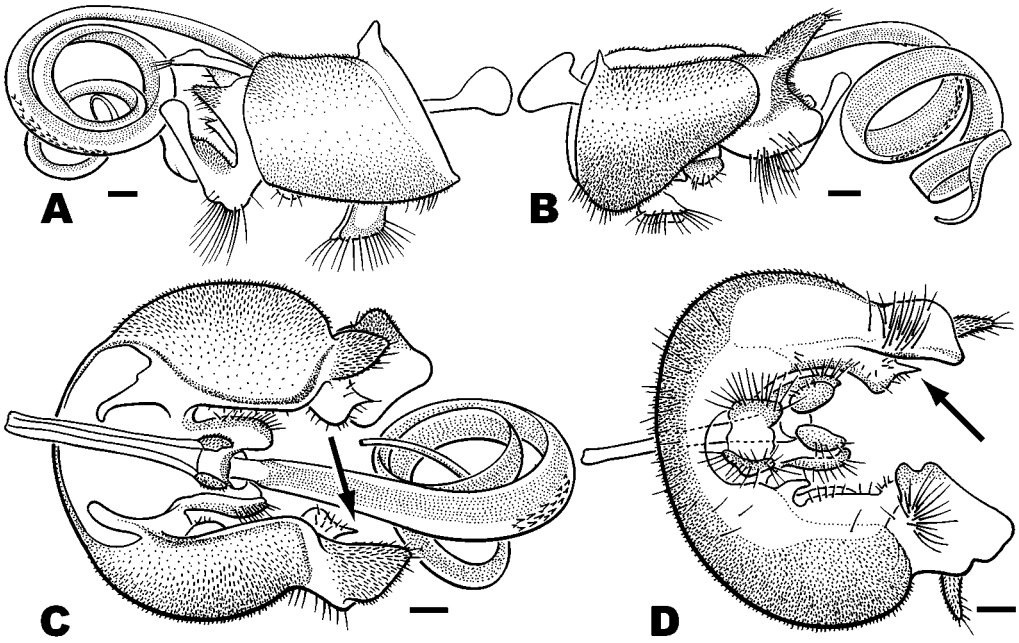

FIGURE 6. Male *Nephrocerus atrapilus* terminalia, ejaculatory apodeme and sperm pump removed. Arrows indicate key feature. Scale bars = 0.1 mm. A. left lateral, JSS#11484. B. right lateral, JSS#11495. C. dorsal, JSS#11495. D. ventral, JSS#11495, phallus removed.

Comments: This is one of the most common species of *Nephrocerus.* It has been recorded from a variety of habitats including: bottomland forest near a creek, post oak savanna near a creek and an oak hilltop. The latter specimen from Masham Township in Quebec was hilltopping (see discussion of this behaviour under *N. acanthostylus*).

The primary flight period for *Nephrocerus atrapilus* in the north is from mid-June to the end of the first week of July. In the deep south (Texas to Florida), it occurs from late March to mid-May. In the mid-eastern USA, it occurs from mid-May to mid-July, but is most common from mid-May to mid-June. There is one outlying record from August 8th 1923. This record suggests that the species may have a partial 2nd generation; however, because this specimen is the only western specimen (from Walla Walla, Washington), the situation may be more complex. The flight time in the west could be different from that of eastern populations (and in fact from all known *Nephrocerus* species) or this specimen may be entirely mislabeled (location and date both could be wrong).

Within the *daeckei* group, females of *N. atrapilus* and *N. daeckei* are very similar and females of *N. woodi* are unknown. As a result, only females of *N. atrapilus* that are associated with males are designated as paratypes.

Just before sending this manuscript off to press, Chen Young (CMNH) announced that David Koenig and he reared *Nephrocerus* in 2004 (pers. comm.). The specimens that they reared were obtained and all are *N. atrapilus*. Twenty-three of the 24 reared specimens

were reared from the adult crane fly, *Tipula (Lunatipula) duplex* Walker (Diptera, Tipulidae). The other specimen was reared from adult *Tipula (Lunatipula) mallochi* Alexander. This is the first time that any species of *Nephrocerus* has been reared and the host is a radical departure from other known pipunculid hosts. All pipunculids previously associated with hosts were reared from leafhoppers, planthoppers and their relatives (Auchenorrhyncha). These hosts are typically parasitized as 2nd instar larvae (Skevington & Marshall 1998). Only *Verrallia* and *Jassidophaga* break this pattern and attack spittlebugs (Cercopidae) just as the newly moulted adults emerge from their spittle masses (Linnane & Osgood 1977). Therefore, not only does *Nephrocerus* attack flies, they also are unconventional in attacking adults. This remarkable discovery will be detailed in an upcoming paper by Koenig & Young (2005).

Nephrocerus corpulentus sp. nov. (Figs 2B, 4C, 7A–D, 8)

Type Material Examined: Holotype ♂: United States, Pennsylvania, Berks Co., 5 km S Pine Grove, [40°33' N, 76°27' W], 375 m, 16.vi.1997, JSS#11887, D.M. Wood (CNC). **Allotype ♀:** United States, Minnesota, Becker Co., 6 mi[les] SW Detroit Lakes, [46°49' N, 95°51' W], Malaise trap in hardwood forest, 6.vi.1981, JSS#13884, Mike Moher (CSCA). **Paratypes: United States: Minnesota:** Becker Co., 6 mi[les] SW Detroit Lakes, [46°49' N, 95°51' W], Malaise trap in hardwood forest, 9.vi.1981, 1♀, JSS#13479, 6–8.vi.1981, 1♀, JSS#13483, [3 legs removed for DNA extraction], 4.vi.1981, 1♀, JSS#13484, 5.vi.1981, 1♂, JSS#13486, 1♀, JSS#13488, 1.vi.1981, 2♀♀, JSS#13489, 13494, 6.vi.1981, 2♀♀, JSS#13495-6, Mike Moher (CAS); Houston Co., Winnebago Cr[eek] Vy., 3–4 m[iles] NE Eitzen, [43°31' N, 91°16' W], 2.vi.1951, 1♂, JSS#11513 (UMSP); **Missouri:** Boone Co., 5 mi[les] E Ashland, Ashland W[ildlife] A[rea], [38°45' N, 92°12' W], Malaise trap, forest, 9–19.v.1992, 1♂, JSS#13359 [3 legs removed for DNA extraction], 1♀, JSS#13360, 20–28.v.1992, 1♂, JSS#13363, 1♀, JSS#13364, 28.v.–4.vi.1992, 1♀, JSS#13365, 20–28.v.1992, 2♂♂, JSS#13366 [3 legs, tergites 2 and 3 removed for DNA extraction], JSS#13368 [head missing, possibly this is the head on specimen JSS#13356; 1 abdominal segment removed for DNA extraction], 28.v.–4.vi.1992, 2♂♂, JSS#13371, 13377, R.S. Gagne (UMRM); **New Hampshire:** Carr[oll] Co., The Bowl, 2.5 mi[les] NW Wonalancet, [43°56' N, 71°24' W], Malaise trap, 5–8.vi.1984, 1♀, JSS#11813, D.S. Chandler (DENH). **New York:** [Tompkins Co.], Dryden, [42°29' N, 76°18' W], 1.vi.1957, 1♂, JSS#11470 [epandrium damaged, hypandrium broken in half, ejaculatory apodeme missing], G. Steyskal (USNM); **North Carolina:** Gr[eat] Sm[oky] M[oun]t[ains] N[ational] P[ark], Rainbow Falls, 700 m, Malaise trap, dry forest, 28.v.1999, 1♀, JSS#12588 [3 legs removed for DNA extraction], L. Quate (CNC).

Other Material Examined: Canada: Ontario: Dundas, [43°16' N, 79°58' W], 4.vi.1961, 1♀, JSS#11429, C. Farivar (DEBU); Lambton Co[unty], Port Franks, Karner

Blue Sanctuary, [43°13' N, 81°54' W], Malaise trap, 8–10.vi.1996, 1♀, JSS#11404 [all legs removed for DNA extraction], J. Skevington (DEBU); **Quebec:** Rigaud, [45º29' N, 74º18' W], 5.vi.1941, 1♀, JSS#19429, J. Ouellet, Collection of W.F. Rapp, Jr. (INHS); Masham Twp., Gatineau Co., 30.v.1971, 1♀, JSS#9909, D.M. Wood (CNC); **United States: Maine:** Coos Co., 1 mi[le] NE East Inlet Dam, [45°11' N, 71°09' W], Malaise trap, 27.v.–11.vi.1986, 1♀, JSS#11837, D.S. Chandler (DENH); **Missouri:** Boone Co., 5 mi[les] E Ashland, Ashland Wildlife A[rea], [38°45' N, 92°12' W], Malaise trap, forest/meadow, 20–28.v.1992, [sex unknown, head and abdomen missing], JSS#13361, 5–15.vi.1992, 1♀, JSS#13356 [abdomen mostly consumed by dermestids; 2 heads on point (1 female and 1 male clearly not belonging to this specimen); male head likely belongs to either JSS#13361 or 13368 (the sex of the former is unknown and the latter is the only definite male *Nephrocerus* from this collection missing a head); all legs removed for DNA extraction], R.S. Gagne (UMRM); **New Hampshire:** [Coos Co.], M[oun]t Wash[ington]n, [44°16' N, 71°18' W], 1♀, JSS#13391, [head glued to point], Collection of Mrs. A.T. Slosson, 26226 (AMNH); Bretton Woods, [44°15' N, 71°26' W], Malaise trap, 26.vi.1926, 1♀, JSS#11788, S.A. Shaw, 2236 (DENH); Carr[oll] Co., 2 mi[les] NW Wonalancet, [43°56' N, 71°24' W], Malaise trap, 8–14.vi.1984, 2♀♀, JSS#11792, 11807, D.S. Chandler, (DENH); Carr[oll] Co., The Bowl, 2.5 mi[les] NW Wonalancet, [43°56' N, 71°24' W], Malaise trap, 5–14.vi.1985, 1♀, JSS#11847, D.S. Chandler (DENH).

Etymology: From the Latin *corpulentus* for 'fleshy' or 'fat'; in reference to the distinctive, wide epandrium in this species.

Description: Male: Body length 7.2–10.1 mm. **Head:** *Holoptic, eyes joined for slightly more than length of ocellar triangle, H:O 1.20–1.86:1.* Arista black with yellow base. 1st flagellomere yellow. Pedicel yellow with 22–26 bristles along distal margin. Scape yellow with 9–13 dorsal bristles. Labellum and palps yellow. Occiput silver-pubescent with multiple rows of white hairs. **Thorax:** Proepisternum with a fan of 8–10 bristles. Postpronotal lobe yellow with 4–6 yellow hairs on posterior edge. Scutum black dorsally, yellow laterally, with sharply defined boundaries between the colours (cf. Fig. 1C); with dorsocentral and intra-alar rows of short hairs, dorsocentrals increasing in size posteriorly and terminating in 1–2 strong setae. Notopleuron with 2 setae, the posterior 1 longer and darker, and numerous smaller hairs. 1 posterior supra-alar setae. Postalar callus with 1–2 setae and 6–7 other moderately strong bristles. Scutellum yellow; with 1–2 pairs of strong posterior setae and numerous small black bristles over entire surface. Pleuron mostly yellow, black on proepisternum, basal four fifths of katepisternum and meron, on anepisternum and usually on anterior anepimeron, on small sclerite below wing base and on subscutellum. Halter yellow. **Legs:** entirely yellow, long and slender; *hairs and sockets on coxae*, trochanters and femora all *yellow*; tibiae and tarsi with yellow hairs but with black sockets. Fore and mid-tibiae slender and slightly arched dorsoventrally; hind tibia narrow on basal third, broader towards tip, laterally arched in apical half (in dorsal view); ***apex with long, stiff yellow bristles restricted to outer edge of tibia, these bristles over twice***

length of adjacent bristles (Fig. 2B). ***Trochanters with*** 3–6 dorsomedial bristles and ***cluster of 2–3 stout, black ventral bristles.*** **Wings:** Length: 7.2–9.0 mm; fourth costal section about 2–3 times as long as third, C_4:C_3 2.2–3.6:1; R-M situated between basal one-third to nearly middle of discal medial cell (dm), S_3:S_2 2.3–3.1:1. Cell r_1 bare on all but apical corner; Sc bare on proximal half; cell bm mostly bare, microtrichose along distal edge only. Tegula with 9–14 black bristles. **Abdomen:** Tergite 1 brown to black with yellow anterolateral area and often with yellow posterior and posterolateral edges. Tergites 2–6 sometimes entirely dark brown to black, often narrowly yellow along posterior and posterolateral edges. Sternites 1–5 brown to black. Tergite 1 with 6–8 large yellowish bristles. Tergite 7 and syntergosternite 8 brown. *All hairs yellow.* **Genitalia:** Epandrium and terminalia brown, phallus brown to black. Epandrium one and a half to two times as wide as long, WE:LE 1.6–2.0:1. ***Surstyli*** asymmetrical; *with upper lobes both projecting, upper lobe of right surstylus longest* and ***deflected ventrally at about 45 degrees, narrow throughout most of length*** (Fig. 7B); ***middle lobe of right surstylus broad, straight-sided, sharply pointed, with a similar structure on left surstylus*** (Fig. 7C). Distiphallus with numerous, robust spines on first loop (Fig. 7A, B, D). **Female:** As male except: Ovipositor long, sharply upcurved, 1.13–1.27 mm (Fig. 4C). OL:PL 1.23–1.36:1; BL:OL 6.15–6.93:1; B:PL 0.29–0.44:1.

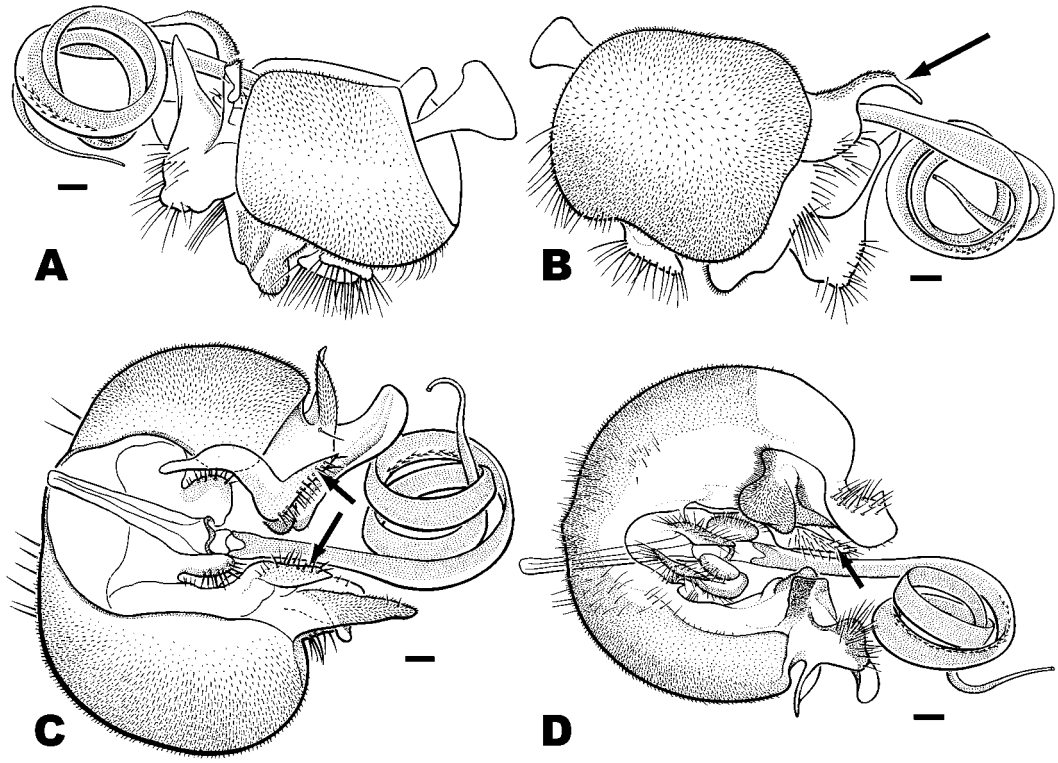

FIGURE 7. Male *Nephrocerus corpulentus* terminalia, ejaculatory apodeme and sperm pump removed; all from JSS#11513. Arrows indicate key features. Scale bars = 0.1 mm. A. left lateral. B. right lateral. C. dorsal. D. ventral.

Distribution: Known from 36 specimens from NE North America, from Minnesota to Maine south to Missouri and the mountains of North Carolina (Fig. 8).

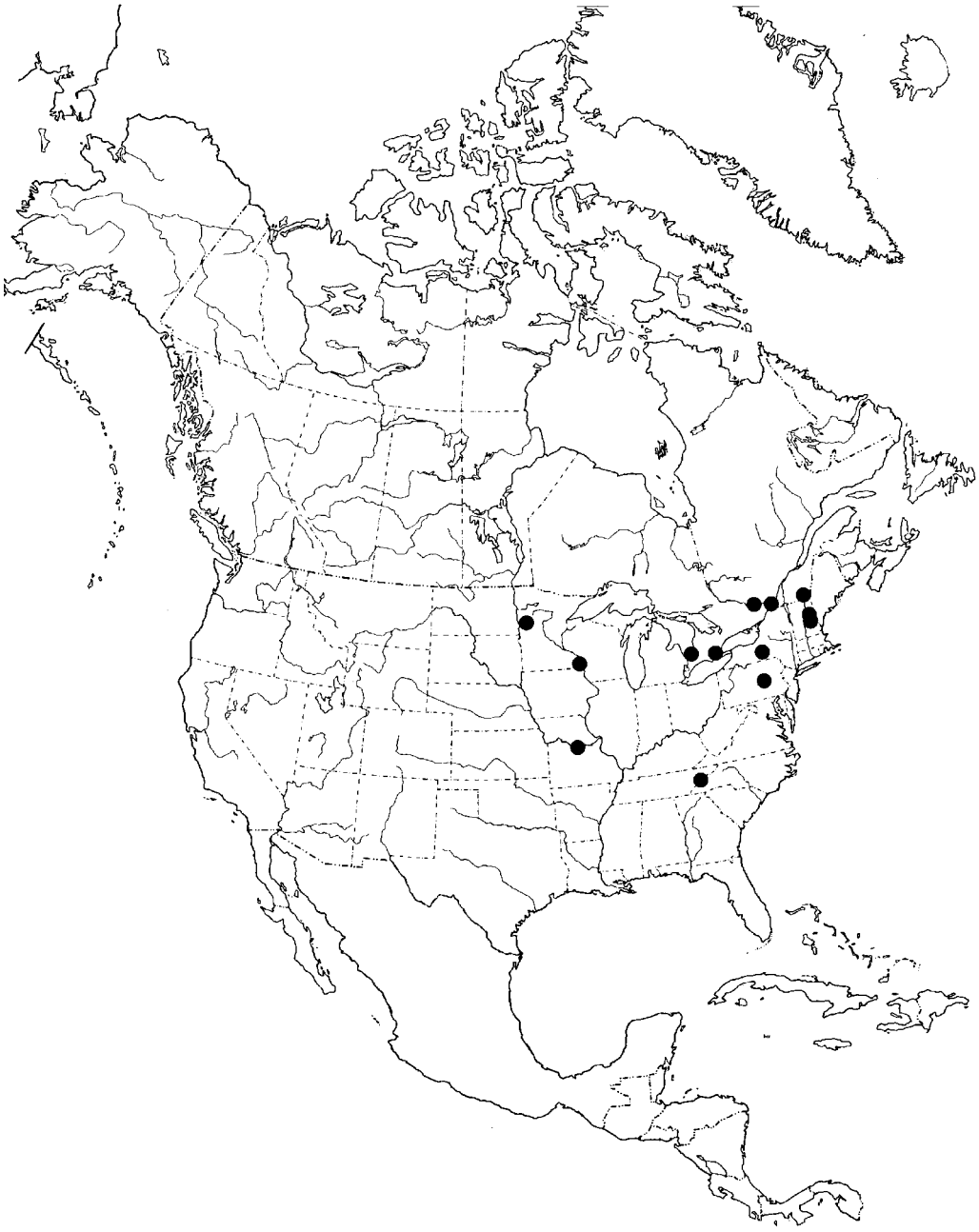

FIGURE 8. Distribution of *Nephrocerus corpulentus*.

Comments: This species has been recorded from hardwood forest and oak savanna. The flight period for this species is from May 14th to June 26th with most records between

the last week of May and the first week of June. *Nephrocerus corpulentus* is very similar to *Nephrocerus slossonae*. Females have distinctly longer ovipositors and both sexes have distinctive long, distal bristles on the outer edge of the tibia. The epandrium is very wide on *N. corpulentus* and the surstyli differ subtly from *N. slossonae*.

The wing of *N. corpulentus* tends to have more reduced microtrichia than other members of the *slossonae* group, but three specimens of *N. slossonae* have a pattern of microtrichia indistinguishable from *N. corpulentus* (JSS#943, 11405 and 11465). A cluster of 2–3 ventral bristles on hind trochanter is diagnostic for *N. corpulentus* but is not used in the key as it is difficult to use without comparative material.

Nephrocerus daeckei Johnson (Figs 4D, 9A–D, 10)

Nephrocerus daeckei Johnson, 1903: 107.

Type Material Examined: Lectotype ♂: [United States], [New York], Richmond Hill, L[ong] I[sland], 2.vii.1901, JSS#13609 [Top right corner of top label cut ('ll' in 'Hill' now mostly removed) to remove genitalia which were glued to the label. Specimen in good condition except head missing], Daecke Collection (USNM); **Paralectotype ♀:** Richmond Hill, L[ong] I[sland], 2.vii.1901, JSS#13448, C.W. Johnson, Cotype No. 7677 (MCZ).

Other Material Examined: Canada: Ontario: Puslinch, [43°26' N, 80°05' W], Malaise trap, maple swamp, 30.vi.–2.vii.1984, 1♂, JSS#11434 [phallus missing, 3 legs removed for DNA extraction] , Coote & Marshall (DEBU); Lambton County, Pinery Provincial Park, [43°15' N, 81°51' W], Malaise trap, oak savanna, 6–11.vi.1992, 1♂, JSS#11408 [3 legs removed for DNA extraction], 18.vi.–2.vii.1992, 1♀, JSS#11406 [3 legs removed for DNA extraction], J. Skevington (DEBU); Lambton County, Pinery Provincial Park, Burley Campground, [43°14' N, 81°53' W], Malaise trap, wet meadow, 15–19.vi.1995, 1♀, JSS#11407 [badly damaged by dermestids – head, most of thorax and legs missing], J. Skevington (DEBU); **United States: Connecticut:** [Tolland Co.], Storrs, TLS window, [41°48' N, 72°15' W], Malaise trap, 1.vii.1996, 1♂, JSS#13379 [3 legs removed for DNA extraction], J. O'Donnell (UCMS); **Illinois:** Ogle Co., White Pines Forest State Park, 7 mi[les] W Oregon, [42º00' N, 89º28' W], 21–26.vii.1979, 1♂, JSS#19436, 1♀, JSS#19437, D.W. Webb (INHS); **Kentucky:** Franklin Co., 1 mi NW Frankfurt, along Benson Creek, [38º12' N, 84º53' W], 26–28.vi.1985, 1♂, JSS#19435, E. A. Lisowski (INHS); **Maryland:** Prince George's Co., 2.5 mi NE Accokeek, [38º40' N, 77º02' W], Malaise, 4.vi.1989, 2♂♂, JSS#19431-2, 2♀♀, JSS#19433-4, E. A. Lisowski (INHS); Plummers Isl[and], [38°58' N, 77°11' W], Malaise trap, 8–20.vii.1968, 1♂, JSS#11456, P. Spangler (USNM); **Missouri:** Boone Co., 5 mi[les] E Ashland, Ashland W[ildlife] A[rea], [38°45' N, 92°12' W], Malaise trap, forest, 20–28.v.1992, 1♂, JSS#13367 [3 legs removed for DNA extraction], 28.v.–4.vi.1992, 1♂, JSS#13373, R.S. Gagne (UMRM); **Pennsylvania:** Berks Co., 5 km S Pine Grove, [40°33' N, 76°27' W], 375 m, 16.vi.1997, 1♂, JSS#11888

[3 legs removed for DNA extraction], D.M. Wood (CNC); **Virginia:** [Loudoun Co.], Bluemont, [39°07' N, 77°50' W], *Cornus*, 20.vi.1912, 1♂, JSS#11455 [phallus broken in half, genitalia brittle], C.T. Greene (USNM).

Description: Male: Body length 6.2–8.5 mm. **Head:** Holoptic, *eyes joined for approximately three times the length of ocellar triangle, H:O 2.57–3.38:1.* Arista black with yellow base. 1st flagellomere yellow. Pedicel yellow with 19–25 bristles along distal margin. Scape yellow with 8–10 dorsal bristles. Labellum and palps yellow. Occiput silver-pubescent with multiple rows of white hairs. **Thorax:** Proepisternum with a fan of 7–9 bristles. Postpronotal lobe yellow with 4–9 yellow hairs on posterior edge. Scutum brown to black dorsally, yellow laterally, with sharply boundaries between the colours (cf. Fig. 1C); with dorsocentral and intra-alar rows of hairs, dorsocentrals longer and increasing in size posteriorly, terminating in 1–2 strong setae. Notopleuron with 2 setae and numerous smaller hairs. 1 posterior supra-alar seta. Postalar callus with 2 (rarely 3) setae and 6–7 other moderately strong bristles. Scutellum yellow; with 3 (rarely 2) pairs of strong posterior setae and numerous small black bristles over entire surface. Pleuron mostly yellow, brown to black on basal four fifths of katepisternum and meron, anterior anepisternum, small sclerite below wing base and subscutellum. Halter yellow. **Legs:** long and slender, entirely yellow; *hairs and sockets on coxae brown to black*; hairs on trochanters and femora predominantly to entirely black, rarely yellow; tibiae and tarsi usually with black hairs with black sockets, rarely with brownish yellow hairs. Fore and mid-tibiae slender and slightly arched dorsoventrally; hind tibia narrow on basal third, broader towards tip, laterally arched in apical half (in dorsal view); *apex with circlet of stiff yellow bristles all about the same length* (cf. Fig. 2C). Trochanters with 3–6 dorsomedial bristles and a row of shorter ventral bristles, most prominent on rear trochanter. **Wings:** Length: 6.0–7.8 mm; fourth costal section about 2–3 times as long as third, C_4:C_3 2.4–3.2:1; R-M situated between basal one-third to nearly middle of discal medial cell (dm), S_3:S_2 2.2–2.8:1. Cell r_1 bare basally; Sc entirely bare to microtrichose in distal corner only; cell bm microtrichose along distal edge only. Tegula with 11–14 black bristles. **Abdomen:** Tergite 1 brown with a yellow anterolateral patch; with 7–14 large black bristles. Tergites 2–4 brown with yellow along posterior edge and laterally. Tergites 5–7 brown to black, usually with very narrow yellow posterior and lateral edges. Sternites 1–5 brown. Syntergosternite 8 brown dorsally, yellow ventrally. *All hairs black.* **Genitalia:** Epandrium and terminalia mostly light brown, yellowish along edges, phallus black. Epandrium about one and a third times as wide as long, WE:LE 1.3–1.4:1. *Surstyli* asymmetrical; *with upper lobes short, about same length as lower lobes* (Fig. 9A–D); *no middle lobes on surstyli* (Fig. 9A–D); ***lower lobe of right surstylus narrow, elongate*** (Fig. 9D). Distiphallus with numerous, robust spines starting before first loop (Fig. 9A, C). **Female:** As male except: Ovipositor short, upcurved, tip stubby, wide; 0.82–1.06 mm (Fig. 4D). OL:PL 1.24–1.39:1; BL:OL 6.74–8.17:1; B:PL 0.33–0.43:1.

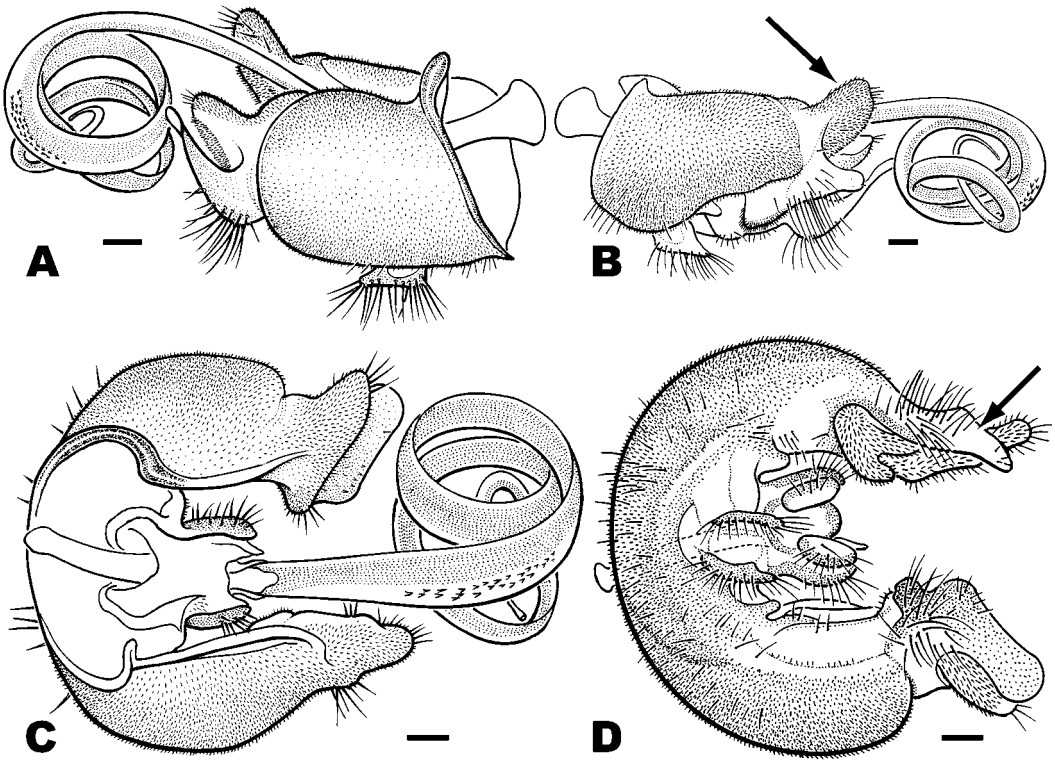

FIGURE 9. Male *Nephrocerus daeckei* terminalia, ejaculatory apodeme and sperm pump removed; all from JSS#11408. Arrows indicate key features. Scale bars = 0.1 mm. A. left lateral. B. right lateral. C. dorsal. D. ventral, phallus removed.

Distribution: Eastern Nearctic in distribution. Known from 19 specimens distributed from Connecticut west through southern Ontario to Illinois, south to Missouri and Kentucky (Fig. 10).

Comments: *Nephrocerus daeckei* has been recorded from a maple swamp, a wet meadow and oak savanna. The flight period is from late May to late July, with most records in the northern part of the range in late June and early July.

Johnson based his description on two "male" specimens from Richmond Hill collected on 2 July 1901. Later Johnson (1915: 55) noted that one of the "male" specimens was in fact a female. The male (JSS#13609) is hereby designated as the lectotype to fix the name and ensure universal and consistent interpretation of the taxon. Within the *daeckei* group, females of *N. atrapilus* and *N. daeckei* are very similar and females of *N. woodi* are unknown. An example of the potential problem of using females as primary types is illustrated by the case of the allotype female of *N. slossonae* (JSS#13450). This specimen was incorrectly associated with the male and is actually *N. acanthostylus*.

FIGURE 10. Distributions of *Nephrocerus daeckei* and *Nephrocerus woodi*.

Three female *Nephrocerus daeckei* group specimens from Mexico (JSS#11499–11501) are undoubtedly an undescribed species (pleuron and abdomen entirely dark brown), but because of the difficulty associating sexes in this species group, they should not be described until a male is discovered.

Nephrocerus slossonae Johnson (Figs 1B, D, E, 2C, 4E, 11A–D, 12)

Nephrocerus slossonae Johnson, 1915: 55.

Type Material Examined: Holotype ♂**:** [United States], N[ew] H[ampshire], Bretton Woods, [44°15' N, 71°26' W], 28.vi.[19]13, JSS#13449, C.W. Johnson Collector, Holotype No. [13093] (MCZ)**. Paratypes: UNITED STATES: New Hampshire:** same location as holotype, 25.vi.1913, 1♀, JSS#13451, 1♂, JSS#13452 [1 wing glued to label, other wing missing] C.W. Johnson (MCZ); [Coos Co.], M[oun]t Washington, [44°16' N, 71°18' W], 1♂, JSS#11463, Coquillet Collection, Paratype 19095 (USNM); M[oun]t Washington, 4.vii.1914, 1♂, JSS#13453, C.A. Frost, C.W. Johnson collection, Paratype 13093 (MCZ); M[oun]t Washington, 4.vii.1914, 1♂, JSS#13454, C.A. Frost, Paratype [13093] (MCZ).

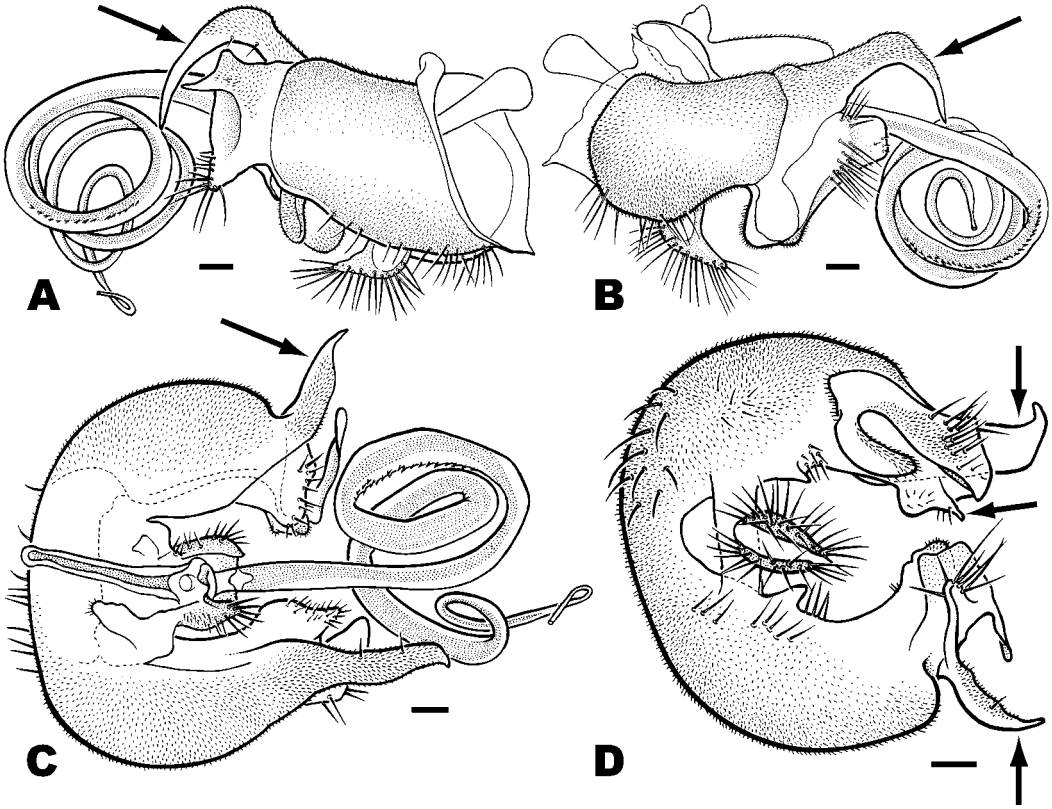

FIGURE 11. Male *Nephrocerus slossonae* terminalia, ejaculatory apodeme and sperm pump removed; all from JSS#11409. Arrows indicate key features. Scale bars = 0.1 mm. A. left lateral. B. right lateral. C. dorsal. D. ventral, phallus removed.

Other Material Examined: CANADA: Alberta: Edmonton, [53°33' N, 113°28' W], 18.vi.1947, 1♀, JSS#11497, E.H. Strickland (CNC); Kananaskis, For[est] Exp[erimental] Sta[tion] Seebe, [51°06' N, 115°04' W], 3.vii.1968, 1♂, JSS#11490, H.J. Teskey (CNC); **Ontario:** Hilton Beach, [46°15' N, 83°53' W], Malaise trap, at edge of h[ar]dw[oo]d for[est] and field, 31.v.1990, 1♂, JSS#11412 [epandrium very wide for this species, other characters are consistent with *N. slossonae*; all legs removed for DNA extraction], 1♂, JSS#11413, 1♀, JSS#11415, 6.vi.1990, 1♂, JSS#11416 [genitalia badly damaged, disarticulated; head removed for DNA extraction], J.E. Swann (DEBU); Fathom Five Nat[ional] Park, Land Base, [45°17' N, 81°40' W], sweep in dry cedar, 23.vi.1995, 1♀, JSS#11436, S.A. Marshall, debu 00075079 (DEBU); [Hastings Co.], Maynooth, [45°14' N, 77°57' W], 2–3.vi.1982, 1♂, JSS#11679 [entire specimen in glycerin], B.M. Nelson (CNC); Lambton County, Pinery Provincial Park, [43°15' N, 81°51' W], Malaise trap, oak savanna, 12–15.vi.1992, 1♂, JSS#943 [1 leg used for DNA extraction], J. Skevington (DEBU); Lambton County, Pinery Provincial Park, Burley Campground, [43°14' N, 81°53' W], Malaise trap, wet meadow, 7–14.vi.1995, 1♂, JSS#942 [1 leg removed for DNA extraction], 15–19.vi.1995, 1♂, JSS#11409, 1♂, JSS#11410 [tergites 1 and 2 removed for DNA extraction], J. Skevington (DEBU); Lambton County, Port Franks, Watson Property near L-lake, [43°13' N, 81°54' W], Malaise trap, 1–6.vi.1996, 1♂, JSS#11405, 8–10.vi.1996, 2♀♀, JSS#945, debu00224107, J. Skevington (DEBU); Hamilton, [43°14' N, 79°57' W], 19.vi.1979, 1♂, JSS#11428, S. Beierl (DEBU); **Quebec:** Gatineau Co., Masham Twp., [45°41' N, 76°03' W], 22.v.1977, 1♀, JSS#9907, 27–31.v.1974, 1♂, JSS#9908 [genitalia missing], D.M. Wood (CNC); [Gatineau Co., Masham Twp.], Duncan Lake n[ea]r Rupert, [45°41' N, 76°03' W], 30.v.1971, 1♀, D2994, JSS#11493, 5.vi.1971, 1♂, 16, JSS#11492, J.F. McAlpine (CNC); Old Chelsea, Summit King Mountain, [45°29' N, 75°52' W], 1150 feet, [351 m], 25.v.1964, 1♂, JSS#9910, Idema illustration [identified in Manual of Nearctic Diptera as *Nephrocerus daeckei*], J.R. Vockeroth (CNC); **UNITED STATES: Maine:** York Co., West Lebanon, [43°23' N, 70°57' W], Malaise trap, 29.v.–11.vi.1990, 1♂, JSS#11836, D.W. Barry (DENH); **Minnesota:** Cook Co., Min. F.S., Hovland, [47°50' N, 89°58' W], Malaise trap, 30.v.1973, 1♂, JSS#13378 (UMSP); **New Hampshire:** Coos Co., Norton Pool, 3 mi[les] NE East Inlet Dam, [45°12' N, 71°07' W], Malaise trap, 12–24.vi.1986, 1♂, JSS#11833, D.S. Chandler (DENH); [Coos Co.], M[oun]t Wash[ingto]n, [44°16' N, 71°18' W], 1♂, JSS#13392 [only abdomen remaining on point], Collection of Mrs. A.T. Slosson, 26226 (AMNH); [Coos Co.], Pinkham Notch, White M[oun]t[ain]s, [44°15' N, 71°15' W], 21–22.viii.1945, 1♂, JSS#11461, J.C. Bradley, Frank M. Hull Collection CNC 1973 (CNC); [Grafton Co.], Franconia, [44°14' N, 71°45' W], 1♀, JSS#11507, Mrs. Slosson (USNM); Carr[oll] Co., 2 mi[les] NW Wonalancet, [43°56' N, 71°24' W], Malaise trap, 8–14.vi.1984, 2♂♂, 5♀♀, JSS#11793–11796, 11808, 11810, 11828, D.S. Chandler (DENH); Carr[oll] Co., The Bowl, 2.5 mi[les] NW Wonalancet, [43°56' N, 71°24' W], Malaise trap, 5–8.vi.1984, 2♂♂, 5♀♀, JSS#11789–11791, 11812, 11814–5, 11826, 9–14.vi.1984, 2♂♂, 6♀♀, JSS#11811,11816, 11818-22, 11827, 15–

20.vi.1984, 4♀♀, JSS#11797-8, 11823-4, 20–26.vii.1984, 1♂, JSS#11832, 21–27.vi.1984, 1♂, JSS#11806 [3 legs and tergites 2 and 3 removed for DNA extraction], 1♀, JSS#11799 [3 legs removed for DNA extraction], 6♀♀, JSS#11800-5, 5–14.vi.1985, 2♀♀, JSS#11846, 11848, 23.v.–4.vi.1985, 1♂, JSS#11849, D.S. Chandler (DENH); Carr[oll] Co., 1 mi[le] N Wonalancet E Fk. Spring Brk., [43°54' N, 71°21' W], 1900', [579 m], Malaise trap, 5–14.vi.1985, 1♂, 23.v.–4.vi.1985, 5♂♂, JSS#11840–11844, 5–14.vi.1985, 1♂, JSS#11839, D.S. Chandler (DENH); Straf[ford] Co., 4 mi[les] W Durham, [43°08' N, 70°56' W], Malaise trap, 24–28.v.1982, 1♂, JSS#11787, 24–25.v.1982, 1♂, JSS#11834, R.M. Reeves (DENH); Straf[ford] Co., Spruce Hole, 3 mi[les] SW Durham, [43°08' N, 70°56' W], Malaise trap, 11–18.vi.1987, 1♂, JSS#11835, D.C. Chandler (DENH); [Cheshire Co.], M[oun]t Monadnock, [42°52' N, 72°07' W], 11.vi.1932, 3♂♂, A.L. Melander, A.L. Melander collection 1961, JSS#11466, 11468–11469 (USNM); **New York:** Essex Co., M[oun]t Hurricane, [44°14' N, 73°43' W], vi.1939, 1♂, JSS#11467, R.C. Shannon (USNM); **Pennsylvania:** [Lackawanna Co.], Spring Br[ook], [41°18' N, 75°36' W], 17.v.1945, 1♂, JSS#11464 [epandrium broken in half, surstyli separated], DDT Expt. (USNM); Dauphin Co., Hershey, [40°17' N, 76°39' W], 1.vi.1974, 1♂, CMNH#352737 (CMNH); [Philadelphia Co.], Roxborough, [40°02' N, 75°13' W], 10.vi.1911, 1♂, JSS#11465 (USNM).

Description: Male: Body length 5.1–8.5 mm. **Head:** Holoptic, *eyes joined for approximately two to four times the length of ocellar triangle, H:O 2.27–3.83:1*. Arista black with yellow base. 1st flagellomere yellow. Pedicel yellow with 20–28 bristles along distal margin. Scape yellow with 5–8 dorsal bristles. Labellum and palps yellow. Occiput silver-pubescent with multiple rows of white hairs. **Thorax:** Proepisternum with a fan of 9–15 bristles. Postpronotal lobe yellow with 5–7 yellow hairs on posterior edge. Scutum rarely entirely brown, usually black dorsally, yellow laterally, with sharply to *ill-defined boundaries between the colours* (Fig. 1D, E); with dorsocentral and intra-alar rows of short hairs, dorsocentrals increasing in size posteriorly and terminating in 1–2 strong setae. Notopleuron with 2 setae and numerous smaller hairs. 1 posterior supra-alar seta. Postalar callus with 2–4 setae and 6–7 other moderately strong bristles. Scutellum yellow (Fig. 1B), rarely brownish along anterior margin to entirely brown in two specimens (JSS#11461 and 11832); with 2–4 pairs of strong posterior setae and numerous small black bristles over entire surface. Pleuron rarely entirely brown; usually mostly yellow, black on proepisternum, basal four fifths of katepisternum and meron, all but edges of anepisternum, small sclerite below wing base, subscutellum, and in a thin band posterior to posterior spiracle. Halter yellow. **Legs:** long and slender, usually entirely yellow, occasionally with brown coxae and slightly darkened posterior surface of femur; *hairs and sockets on coxae* usually *yellow*, rarely pale brown; hairs on trochanters and femora yellow to dark brown; tibiae and tarsi with yellow to black hairs with black sockets. Fore and mid-tibiae slender and slightly arched dorsoventrally; hind tibia narrow on basal third, broader towards tip, laterally arched in apical half (in dorsal view); *apex with circlet of stiff yellow bristles all about*

the same length (Fig. 2C). Trochanters with 1–4 dorsomedial bristles and a loosely organized double row of shorter ventral bristles, most prominent on rear trochanter. **Wings:** Length: 5.4–9.3 mm; fourth costal section about 2–3 times as long as third, C_4:C_3 2.2–3.5:1; R-M situated between basal one-third to nearly middle of discal medial cell (dm), S_3:S_2 2.1–2.7:1. Cell r_1 bare basally; Sc usually mostly bare, microtrichose in distal corner only, occasionally microtrichose to level of junction of r and Sc; cell bm mostly bare, microtrichose along distal edge only. Tegula with 4–13 black bristles. **Abdomen:** Colour variable, almost entirely brown in many specimens (Fig. 1D, E); tergites 1–6 often brown with yellow along posterior edge and laterally; tergite 1 always has yellow anterolateral area. Sternites 1–5 yellow to brown. Tergite 1 with 9–15 large yellowish bristles. Tergite 7 and syntergosternite 8 brown to yellow. *All hairs yellow.* **Genitalia:** Epandrium and terminalia dark brown to yellow, phallus black. Epandrium nearly as long as wide, WE:LE 1.1–1.4 (1.6):1. *Surstyli* asymmetrical; *with upper lobes both projecting, upper lobe of right surstylus longest and deflected ventrally at 90 degrees, tapering uniformly to tip* (Fig. 11A, B)*; middle lobe of right surstylus stubby, with rounded tip and curving medial edge, with no similar structure on left surstylus* (Fig. 11C). Distiphallus with numerous, robust spines on first loop (Fig. 11A–C). **Female:** As male except: Ovipositor short, upcurved, 0.86–1.09 mm (Fig. 4E). OL:PL 1.26–1.41:1; BL:OL 5.93–7.61:1; B:PL 0.30–0.45:1.

Distribution: Known from 89 specimens collected in a narrow latitudinal band (40º to 48º N in the east, 51º to 53.5º N in the west) between Maine and Alberta (Fig. 12). Only two specimens are known from west of Lake Superior, both in Alberta.

Comments: This is one of the most common Nearctic species of *Nephrocerus*. General colouration is variable with what appears to be a pale and a dark morph. Most specimens have a predominantly yellow thorax with a contrasting black scutum but three specimens are almost entirely brown (JSS#11461, 11490 and 11832) and many have an entirely brown abdomen. These dark specimens all occur late in the season (3.vii.1968, 20–26.vii.1984 and 21–22.vii.1945). Dark morph individuals occur and may predominate in late or early season generations of some multivoltine species (for examples in Syrphidae see Dusek & Laska (1973) and Holloway *et al.* (1997)). The primary flight period for *N. slossonae* is from May 17th to July 4th with most records between May 29th and June 25th. Late July and late August records suggests that *N. slossonae* has a partial 2nd generation.

Nephrocerus slossonae has been recorded from a variety of habitats including: hardwood forest, dry cedar forest, oak savanna and wet meadow. Specimens collected in Quebec at King Mountain and Masham Township were hilltopping.

The allotype female of *N. slossonae* (JSS#13450) was examined but is not included in the material examined list here since it is actually *N. acanthostylus*.

The drawing of *Nephrocerus daeckei* in the Manual of Nearctic Diptera (Hardy 1987), Fig. 53.7) is actually *Nephrocerus slossonae*.

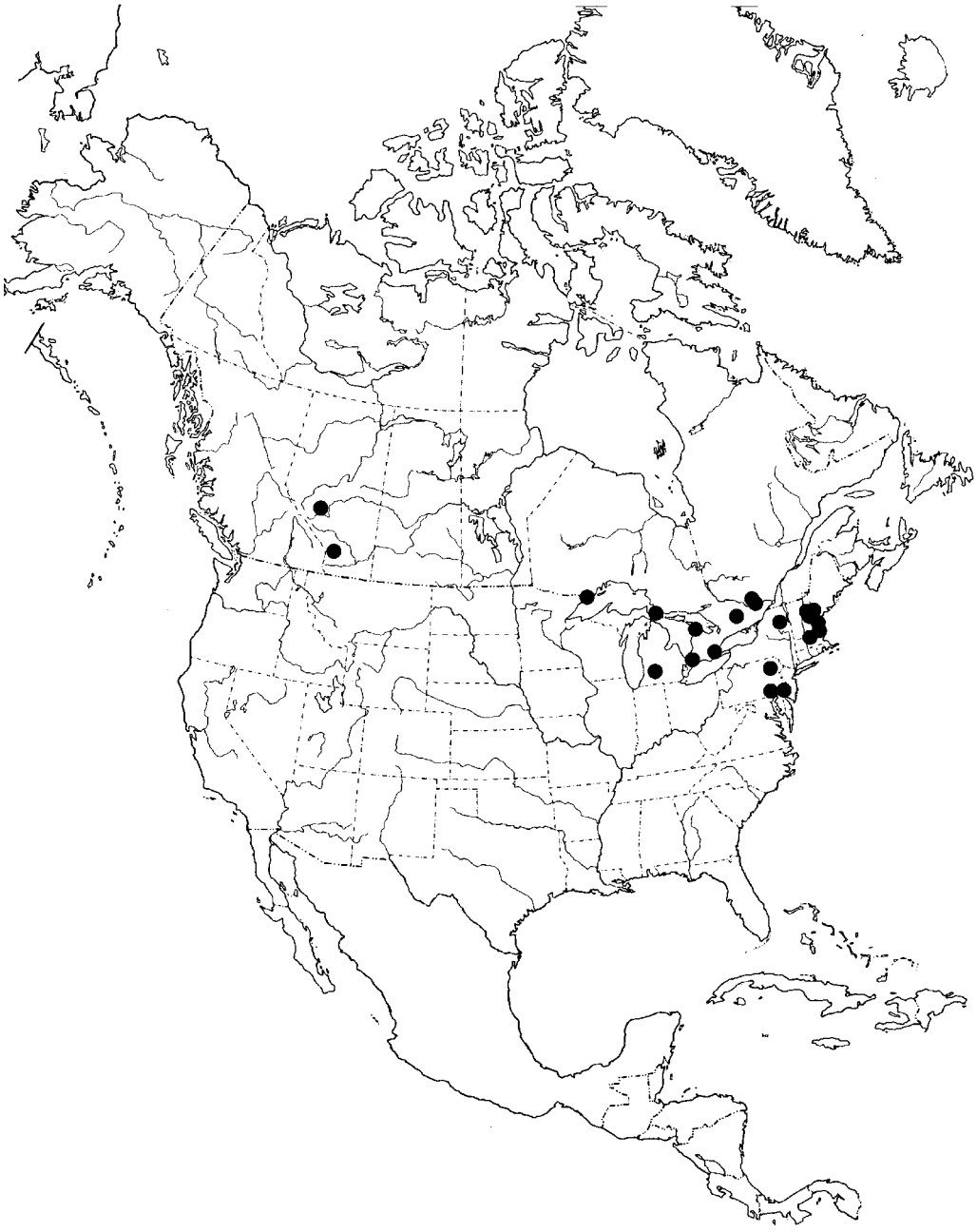

FIGURE 12. Distribution of *Nephrocerus slossonae*.

Nephrocerus woodi sp. nov. (Figs 10, 13A–D)

Type Material Examined: Holotype ♂: Canada, Quebec, Cté Gatineau, Masham [Township], Duncan Lake, [45°40'53" N, 76°03'01" W], 260 m, 2.vi.1996, JSS#15346, D.M. Wood (CNC). **Paratypes: CANADA: Quebec:** Gatineau Co., Masham Twp., [45°41' N,

76°03' W], 10–20.vii.1974, 1♂, JSS#9903 [tip of right surstylus broken, phallus missing], 22.v.1977, 1♂, JSS#9904, 5.vi.1976, 2♂♂, JSS#9905-6, D.M. Wood (CNC); Gatineau Co., Masham Twp., Hilltop Near Duncan Lake, 45°40'53" N, 76°03'01" W, 7.vi.2002, 1♂, J. Skevington, JSS#12490 (CNC); Montreal, Co. Vaudreuil, Rigaud, [45°27'59" N, 74°19'35" W], hilltop, 14.vi.1996, 1♂, JSS#9902, C. Kassebeer (CNC); **UNITED STATES: New Hampshire:** Carr[oll] Co., 2 mi[les] NW Wonalancet, [43°56' N, 71°24' W], Malaise trap, 8–14.vi.1984, 1♂, JSS#11809, D.S. Chandler (DENH); **Texas:** Anderson Co., Salmon, [31°34' N, 95°30' W], Malaise trap, 28.iv.–16.v.1975, 1♂, H.R. Burke, JSS#13394 [3 legs removed for DNA extraction] (TAMU).

Other Material Examined: CANADA: Quebec: Vaudreuil Co., Summit of Mount Rigaud, 45°27'59" N, 074°19'35" W, 13.vi.2001, 3♂♂, J. Skevington, JSS#10101-3, molecular specimens, genitalia preserved as voucher (CNC).

Etymology: Named in honour of Dr. D. Monty Wood, the first person that I am aware of to document hilltopping behaviour in Pipunculidae. Monty collected several specimens of this hilltopping species and introduced me to the hilltops in the Ottawa region where the species occurs.

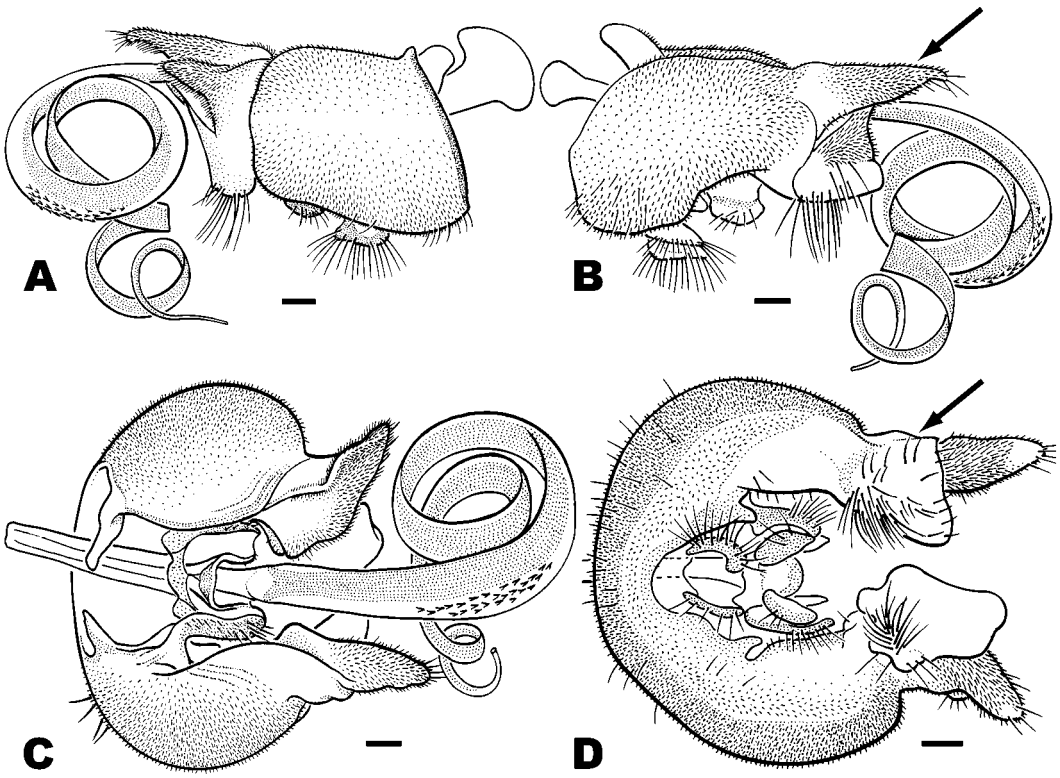

FIGURE 13. Male *Nephrocerus woodi* terminalia, ejaculatory apodeme and sperm pump removed. Arrows indicate key features. Scale bars = 0.1 mm. A. left lateral, JSS#9905. B. right lateral, JSS#9902. C. dorsal, JSS#9902. D. ventral, JSS#9902, phallus removed.

Description: Male: Body length 6.8–8.2 mm. **Head:** Holoptic, *eyes joined for approximately two to three times the length of ocellar triangle, H:O 2.33–3.27:1.* Arista black with yellow base. 1st flagellomere yellow. Pedicel yellow with 18–25 bristles along distal margin. Scape yellow with 6–8 dorsal bristles. Labellum and palps yellow. Occiput silver-pubescent with multiple rows of white hairs. **Thorax:** Proepisternum with a fan of 6–11 bristles. Postpronotal lobe yellow with 5–7 yellow hairs on posterior edge. Scutum brown to black dorsally, yellow laterally, with sharply boundaries between the colours (cf. Fig. 1C); with dorsocentral and intra-alar rows of hairs, dorsocentrals longer and increasing in size posteriorly, terminating in 1–2 strong setae. Notopleuron with 1–2 setae and numerous smaller hairs. Usually 1 (rarely 2 or 3) posterior supra-alar seta. Postalar callus with 1–2 setae and 4–7 other moderately strong bristles. Scutellum yellow; with 2–3 pairs of strong posterior setae and numerous small black bristles over entire surface. Pleuron about half yellow, brown to black on basal four fifths of katepisternum and meron, anterior anepisternum, small sclerite below wing base and subscutellum; proepisternum brown in all specimens except the one from Texas (JSS#13394); anepimeron varying from entirely brown to slightly smeared with brown medially. Halter yellow. **Legs:** long and slender, entirely yellow; *hairs and sockets on coxae brown to black*; hairs on trochanters and femora predominantly to entirely brown or black; tibiae and tarsi with black hairs with black sockets. Fore and mid-tibiae slender and slightly arched dorsoventrally; hind tibia narrow on basal third, broader towards tip, laterally arched in apical half (in dorsal view); *apex with circlet of stiff yellow bristles all about the same length* (cf. Fig. 2C). Trochanters with 3–6 dorsomedial bristles and a row of shorter ventral bristles, most prominent on rear trochanter. **Wings:** Length: 6.1–8.2 mm; fourth costal section about 2–3 times as long as third, C_4:C_3 2.1–2.8:1; R-M situated at approximately basal one-third of discal medial cell (dm), S_3:S_2 2.6–3.4:1. Cell r_1 bare on only basal corner; Sc microtrichose in distal corner only; cell bm microtrichose along distal edge only. Tegula with 11–16 black bristles. **Abdomen:** Tergite 1 brown with a yellow anterolateral patch; with 10–15 large black bristles. Tergites 2–3 brown with yellow along posterior edge and laterally. Tergites 4–7 brown to black, with narrow, dull yellow posterior and lateral edges. Sternites 1–5 brown. Syntergosternite 8 brown to black dorsally, yellow ventrally. *All hairs black.* **Genitalia:** Epandrium and terminalia mostly light brown to black, yellowish along edges and on surstyli, phallus black. Epandrium shape variable, from one and a third to nearly two times as wide as long, WE:LE 1.3–1.9:1. ***Surstyli*** asymmetrical; ***with upper lobes long, about twice as long as lower lobes*** (Fig. 13A–D); *no middle lobes on surstyli* (Fig. 13A–B); ***lower lobe of right surstylus wide, triangular*** (Fig. 13D). Distiphallus with numerous, robust spines starting before first loop (Fig. 13A–C). **Female:** Unknown. Likely indistinguishable from *N. atrapilus* and *N. daeckei*. However, the colour of the proepisternum may prove to be of use in identifying these females once more definitively associated specimens are found. All specimens of *N. daeckei* and all northern specimens of *N. atrapilus* have the proepisternum yellow. Several specimens in the collection have the proepister-

num brown – these could be specimens of *N. woodi* (JSS#11424-7, 11496, 11817, 11831, 13353, 13354, 15953).

Distribution: Eastern Nearctic in distribution. Known from 12 specimens from southwestern Quebec, New Hampshire, and Texas (Fig. 14).

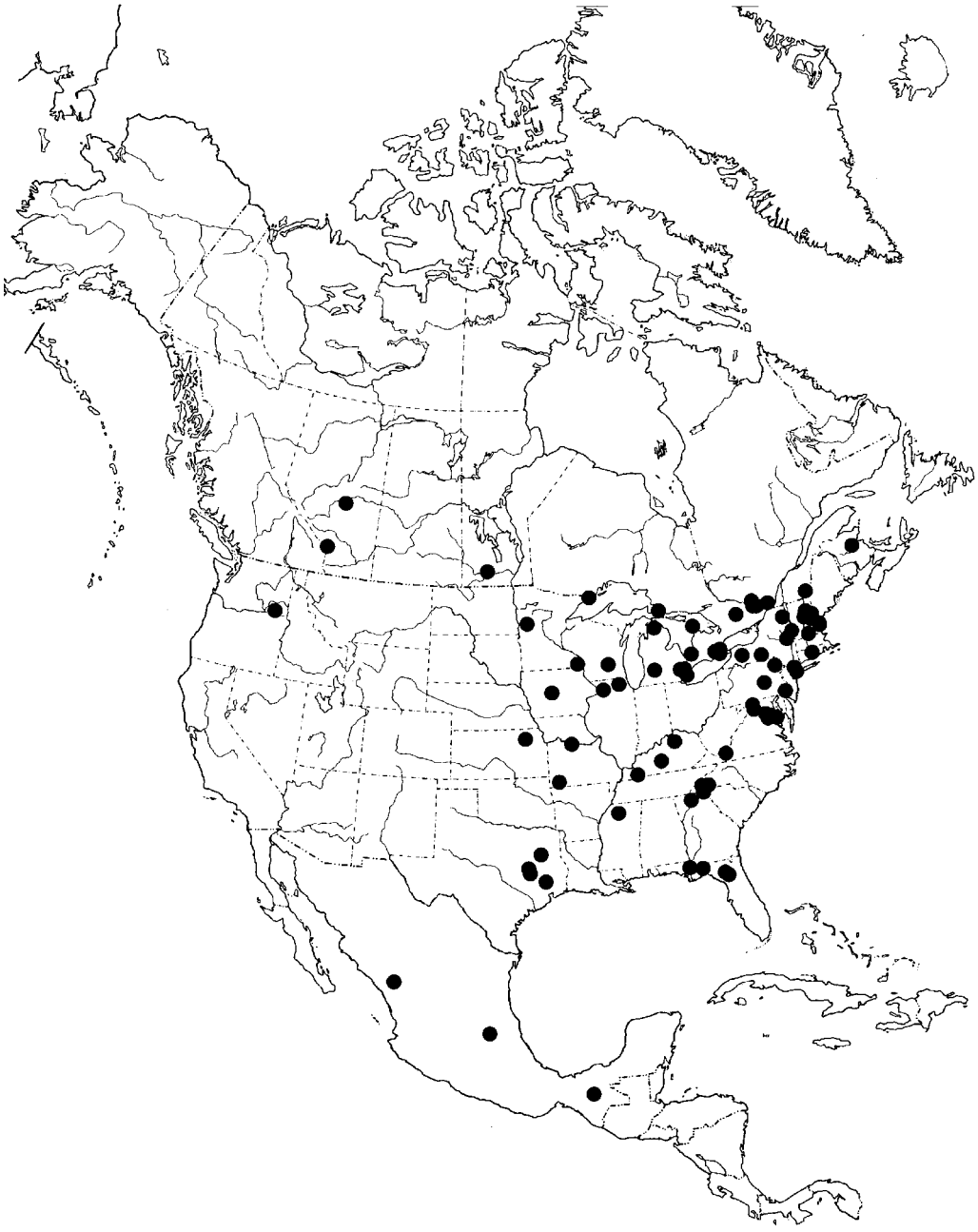

FIGURE 14. Distribution of all known New World *Nephrocerus* specimens.

Comments: Ten of the twelve specimens of *Nephrocerus woodi* have been collected hilltopping. More efforts looking for *Nephrocerus* on hilltops will help us to better understand the distribution of the species. The flight period for *Nephrocerus woodi* is from late May to mid July in the NE, with most records in the first two weeks of June. The Texas specimen was collected between the 28th of April and the 16th of May.

Nephrocerus daeckei and *N. woodi* are very similar and appear to be part of a complex of species. A male from Florida (JSS#13435) has a yellow pleuron, brown knobs on the halters, a brown scutellum with yellow margins and genitalia intermediate between the two species. Eight unidentified females (also from Florida; JSS#13421-8) have similar pleura, scutellums and halteres. The Texas specimen of *N. woodi* (JSS#13394) appears to have the same genitalia as the northeastern specimens but it is much more yellow on the pleuron. I have treated it as conspecific with *N. woodi* since the genitalia appear to be identical, but more specimens are needed from these southern populations to learn where the limits of these species are.

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