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A REVISION OF THE CRANE-FLY GENUS *NEPHROTOMA* MEIGEN, 1803, IN NORTH AMERICA (DIPTERA, TIPULIDAE). PART II: THE NON-*DORSALIS* SPECIES-GROUPS

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ABSTRACT

Seventeen nearctic species of *Nephrotoma* are revised. They are assigned to seven species-groups. Together with the 20 species of the *dorsalis*-group (Tangelder, 1983), this covers all the nearctic *Nephrotoma* species. Presented here for every species are: literature, type-material, synonyms, description with figures for most genital characters, biology and distribution. For the species-groups, it is indicated to which palaearctic species-groups they belong. For the species, the closely related palaearctic species are mentioned. This information is summarized in fig. 1. The species, with their synonyms and distribution are summarized in table 1. The species *subalterna*, *byersi*, and *tealei* are described for the first time.

CONTENTS

INTRODUCTION

Part I of this revision deals with the 20 nearctic species of the *Nephrotoma dorsalis* group (Tangelder, 1983). This paper discusses the other seven species-groups which include 17 nearctic species. The remarks made in part I about the genus *Nephrotoma* in general and about material, terminology, drawings, distribution maps and abbreviations, refer to this part as well. Furthermore, all references are given in part I. All drawings are original and made by the present author.

Most of the material was examined in 1982 during a visit to the following institutions: University of Kansas, Lawrence, Kansas: Prof. George W. Byers' extensive collection and, on loan in Lawrence, the J. Speed Rogers collection from the University of Michigan; Harvard University, Cambridge, Massachusetts: among others the collections of H. Loew and C. R. Osten Sacken; Academy of Natural Sciences, Philadelphia, Pennsylvania: type-collection of W. Dietz; United States National Museum of Natural History, Smithsonian Institution, Washington D.C.: USNM collection and the important C. P. Alexander collection. More-

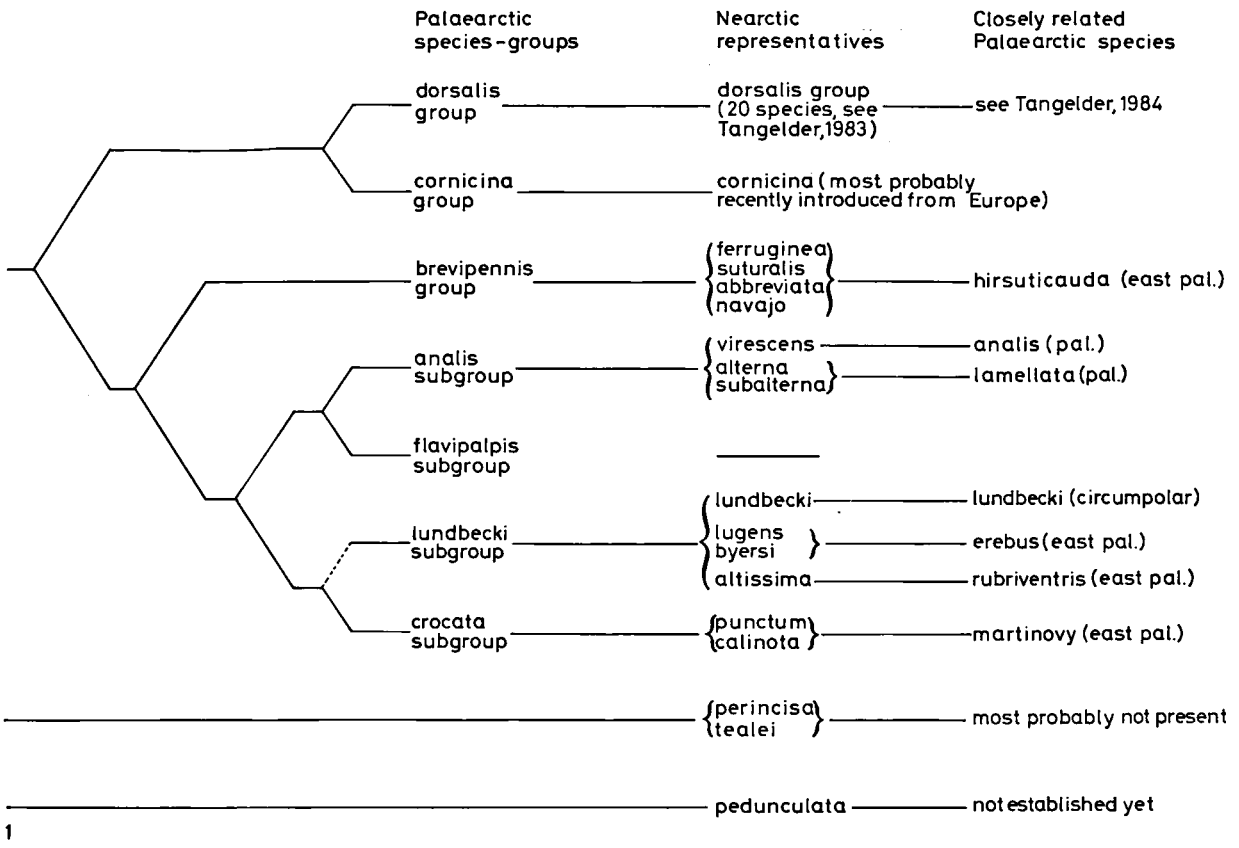

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Fig. 1. Nearctic species of *Nephrotoma* in relation to palaearctic species and species-groups.

over, an extensive collection was received on loan from the California Academy of Sciences, San Francisco.

One of the 17 species discussed here, *cornicina*, probably is recently introduced from Europe. Three species (*subalterna*, *byersi* and *tealei*) are new; for the remaining 13 species 29 names are available in literature. All nominal species are summarized in table 1, indicating the names considered junior synonyms, whether type-material was examined, and the distribution of the species (regions according to Tangelder, 1983: map 1). Table 1 also shows the sequence in which the species are discussed. This sequence is based on the phylogeny of the species-groups occurring in the western palaearctic, as proposed by Oosterbroek (1980). This phylogeny is represented here in part as fig. 1, showing which palaearctic species-groups are represented in the Nearctic and, if relevant, which palaearctic and nearctic species are closely related, the *dorsalis* group excepted. As shown in fig. 1, holarctic distributions are frequent on the species-group level. On the species level it is known only for *lundbecki* (circumpolar), *ramulifera* (*dorsalis* group, north palaearctic and Alaska), and *occipitalis* (*dorsalis* group, east palaearctic and nearctic). All palaearctic species-groups mentioned in fig. 1 possess a distribution throughout the Palaearctic. Not incorporated, because not yet studied, are the many eastern palaearctic species-groups (such as the *palloris*, *parvirostra*, *fuscescens*, *virgata*, *sinensis* and *repanda* species-groups). As far as is known these groups are limited to the eastern Palaearctic or show connections with southeastern Asia but are not represented in the Nearctic.

Table 1. List of nearctic *Nephrotoma* species and their synonyms, exclusive the *dorsalis* species-group. Type-material examined by: *, the present author; [*], Prof. Dr. G. W. Byers; [°], Dr. L. Lyneborg. Distribution given in regions according to Tangelder, 1983: map 1.

1	*cornicina* (Linnaeus, 1758) *	NE
2	*ferruginea* (Fabricius, 1805) [°]	NW, SW, NE, ME, SE
	beutenmuelleri (Dietz, 1918) *	
	latevittata (Dietz, 1918) * new synonymy	
	proxima (Bellardi, 1859)	
	quadrilineata (Macquart, 1838)	
3a	*suturalis suturalis* (Loew, 1863) *	ME, SE
	costomarginata (Dietz, 1918) *	
3b	*suturalis wulpiana* (Bergroth, 1888) new status	NW, SW
	occidentalis (Doane, 1908) [*]	
4	*abbreviata* (Loew, 1863) *	ME, SE
5	*navajo* Alexander, 1949 *	SW
6	*virescens* (Loew, 1864) *	NE, ME, SE
7	*alterna* (Walker, 1848) [*]	NW, SW, NE, ME, SE
	incurva (Loew, 1863) *	
	montana (Dietz, 1918) * new synonymy	
	evasa (Dietz, 1918) * new synonymy	
	nexilis (Dietz, 1918) * new synonymy	
	perdita (Dietz, 1918) * new synonymy	
8	*subalterna* * new species	ME, SE
9	*lundbecki* (Nielsen, 1907) *	NW, NE
	arcticola Alexander, 1919 *	
10	*lugens* (Loew, 1864) *	NW, SW, NE, ME
11	*byersi* * new species	NW, SW, NE
12	*altissima* (Osten Sacken, 1877) *	NW, SW, NE, ME
	erythrophrys (Williston, 1893)	
13	*punctum* (Loew, 1863) *	NE, ME
	opacivittata (Dietz, 1918) * new synonymy	
	sphagnicola Alexander, 1920 [*]	
14	*calinota* (Dietz, 1918) *	NE, ME
15	*perincisa* Alexander, 1949 *	SW (SE?)
16	*tealei* * new species	SW, (SE?)
17	*pedunculata* (Loew, 1863) *	NW, NE, ME

KEY TO SPECIES OF THE NON-*DORSALIS* SPECIES-GROUPS

0. Thoracic dorsum yellow with yellowish to dark brown or black stripes. Prescutum and scutum 1 uniformly polished or uniformly opaque. Katatergite shining. Abdominal sternites mid-ventrally marked with brown to black spots or stripes, sometimes vague ....(Part I: *dorsalis* species-group).

— Thoracic dorsum entirely darkened or yellow with yellowish to dark brown or black stripes. In the latter case surface of prescutum and scutum 1 dull or distinctly less shining between stripes than stripes themselves and/or katatergite dull. Abdominal sternites usually without mid-ventral markings (non-*dorsalis* species-groups) ..... 1.

1. Male sternite 8 with an elongate, knob-like, mid-ventral appendage; outer dististyle in part sclerotized (fig. 2). Female cerci pointed (fig. 3) ..... *cornicina.*

— Male sternite 8 without median appendage or with a differently shaped appendage; outer dististyle not in part sclerotized. Female cerci blunt-tipped ..... 2.

2. Lateral stripes on scutum 1 anteriorly downcurved, the downcurved part dull, or with an isolated dull spot beneath anterior end ..... 3.

— Lateral stripes on scutum 1 straight or anteriorly downcurved and shining or thoracic dorsum heavily darkened ..... 7.

3. Prescutum and scutum with four, large, dull markings on each side (fig. 38) ... ... *virescens.*

— Scutum with two dull markings on either side, one at anterior end of lateral stripe on scutum 1 and one at lateral end of transverse suture ..... 4.

4. Sides of thorax with an isolated, vague but clearly visible, brownish dash in front of lower end of basalare. Stripes on scutum 1 narrowly dull-bordered where opposing each other, dull bordering about as broad as diameter of wing-veins. Scutum 2 usually with a longitudinal dull mark over middle. Antero-lateral dull mark on scutum 1 usually isolated from lateral stripe ..... 5.

— Sides of thorax without an isolated spot in front of lower end of basalare. Stripes of scutum 1 not dull bordered, or dull bordering extremely narrow. Scutum 2 yellowish between stripes. Lateral stripe of scutum 1 anteriorly downcurved ..... 6.

5. Hind margin of male sternite 8 with a small medial lobe (figs. 100, 101). Flagellar segments unicolourous. Female abdomen

with dorsal markings broadening posteriorly and actually or almost reaching hind margins of tergites ..... *punctum*.

— Hind margin of male sternite 8 without a medial lobe (figs. 104, 105). Flagellar segments with darkened bases, in females sometimes unicolourous. Female abdomen with elongate dorsal markings, situated well in front of hind margins of tergites ..... *calinota*.

6. Mid-anterior part of mediotergite shining. Medisternal appendage of male sternite 9 without pubescence and shining, medial part not invaginated (fig. 45) ..... *alterna*.

— Mid-anterior part of mediotergite dull. Medisternal appendage of male sternite 9 pubescent, not shining, medial part invaginated (fig. 50)..... *subalterna*.

7. Abdomen with large, brown to dark brown, dorsal markings which, on tergites 3-5, occupy at least the posterior two-third; markings in the male triangular towards hind margin, in the female more rounded laterally. Scutum 1 shining between lateral and medial stripes (but dull on prescutum). Male sternite 8 with a slender, apically bifid, mid-ventral appendage (figs. 127, 128)..... *pedunculata*.

— Dorsal abdominal markings absent or otherwise (smaller, or forming an almost continuous dorsal stripe, or tergites cross-banded posteriorly). Scutum 1 dull between stripes or sides of thorax heavily darkened. Male sternite 8 without appendage or with a differently shaped appendage .... 8.

8. Sides of thorax with yellowish to light brown markings, at most with small darker markings on paratergite and in front of basalare, sometimes lateral pronotum and anatergite dark brown ..... 9.

— Sides of thorax with large dark brown to black markings or (almost) entirely darkened..... 15.

9. Antennae with 14 segments in both sexes. Occipital marking diamond shaped, dark brown and narrowly prolonged onto or over frontal tubercle. Head with small brown spots in front of and laterad of tubercle. Posterior part of inner dististyle with a small, triangular, acute process (figs. 29, 30)..... *navajo*.

— Antennae with 13 segments. Occipital marking usually faint or small, rarely dark brown. Male inner dististyle without an acute process, or process distinctly blackened..... 10.

10. Upper posterior part of inner dististyle with a slender, blackened, hook-like process oriented transversely (figs. 21, 22, 25). Female cerci broad (fig. 27). Lateral stripes on scutum 1 distinctly downcurved anteriorly, the curved part darkened and shining..... *abbreviata*.

— Posterior part of inner dististyle without a process or process robust and blackened, oriented longitudinally (figs. 4, 9). Female cerci more slender (figs. 11, 20, 123). Lateral stripes on scutum 1 rarely distinctly downcurved anteriorly ..... 11.

11. Male sternite 8 lengthened, with a short (fig. 116) or longer (fig. 112) mid-ventral appendage. Female abdomen with a continuous, infuscated or transparently brown, lateral stripe on either side of tergites 2-8 .....12.

— Male sternite 8 not lengthened, hind margin incised and set with long hairs (figs. 4, 12). Female abdominal tergites usually with a row of lateral markings, ranging from faint to dark brown, rarely without lateral markings. (Darker coloured specimens of *ferruginea* sometimes possess a lateral stripe, such specimens also show the characteristic small brown markings in front of basalare, fig. 5) ..... 13.

12. Tergite 1 broadly brown to dark brown dorsally. Gonapophyses not distinctly protruding beyond sternite 9; appendage at mid-ventral extension of male sternite 8 long (fig. 112). Female sternite 8 without large sclerotized blades underneath rostral extensions of hypovalvae (fig. 122) .... *perincisa*.

— Tergite 1 dorsally yellow, in part pale

yellow. Gonapophyses distinctly protruding beyond sternite 9; appendage at mid-ventral extension of male sternite 8 short (fig. 116). Female sternite 8 with large sclerotized blades underneath rostral extensions of hypovalvae (fig. 121). *tealei.*

13. Upper posterior part of inner dististyle with a large, blackened, hook-like process (figs. 4, 9). Upper margin of female sternite 8 evenly curved toward coxopodite of tergite 9 and upper margin of hypovalvae bent downward inside sternite 8 (fig. 11). Rostral extension of hypovalvae situated laterad of internal arch (fig. 10). Both sexes usually with two small stripes in front of basalare (fig. 5), lower stripe sometimes faint ..... *ferruginea.*

— Inner dististyle without a blackened hook-like process (fig. 13). Upper margins of female sternite 8 and of hypovalvae less curved so that upper margins of hypovalvae are visible throughout, just above sternite (fig. 20). Rostral extension of hypovalvae near internal arch, short (figs. 18, 19). Both sexes with only one stripe (the upper on paratergite) in front of basalare..... 14.

14. Apices of femora distinctly darkened. Costal margin of wing usually yellowish brown or brownish..... *suturalis suturalis.*

— Apices of femora not darkened. Costal margin of wing light yellowish..... ..... *suturalis wulpiana.*

15. Male tergites 2-6 and female tergites 2-7 with a dark brown to black dorsal stripe, about as broad as scutellum or mediotergite; hind margin of tergites usually distinctly pale yellow, stripe sometimes continuous, especially in females. Tergites with a more or less continuous stripe at each side ..... *lundbecki.*

— Abdomen in part or entirely blackened, without a longitudinal dorsal stripe... 16.

16. Area between stripes on scutum 1 and laterad of lateral stripes dull, even if thorax is entirely darkened ..... *lugens.*

— Scutum 1 uniformly (sub)shining..... 17.

17. Occipital marking usually dark reddish and, at least in part, lighter coloured than surrounding vertex. Antennae with 13 segments. Thoracic dorsum with bunches and rows of long hairs. Gonapophyses laterally compressed with an upcurved posterior corner (fig. 87) ..... *byersi.*

— Occipital marking darker than surrounding vertex, rarely equally dark (vertex blackened as well). Antennae with 13 or 14 segments. Thoracic dorsum with short hairs, in specimens from Colorado and New Mexico sometimes longer hairs. Gonapophyses posteriorly expanded as if inflated (figs. 91-93) ..... *altissima.*

THE *CORNICINA* GROUP

Nephrotoma cornicina (Linnaeus, 1758)
Figs. 2-3

Of this species, distributed throughout the Palaearctic from Great Britain to Japan and islands bordering Kamchatka (Oosterbroek, 1978), one female is known from New Brunswick, Kennebecasis River at Sussex, 8-VIII-1961, Alexander & Carson, USNM (Alexander coll.).

N. cornicina can be easily recognized by the posteriorly pointed and sclerotized outer dististyle and the presence of a knob-shaped, mid-ventral appendage on the male sternite 8 (fig. 2) and by the pointed cerci of the female (fig. 3).

N. flavescens, erroneously reported as nearctic by Alexander (1919b, as *lineata*) also belongs to the group of species with the female cerci pointed; a key to these species is given by Oosterbroek (1979c).

N. cornicina might be an introduced species in soil ballast. Many soil-dwelling species from northern Europe are found in coastal eastern Canada.

THE *BREVIPENNIS* GROUP

This group, as defined by Oosterbroek (1979b, 1980), is characterized by the structure of the intromittent organ (see description of *ferruginea*) and gonapophyses. Species from Madeira (*brevipennis* and *lucida*) possess a serrate-edged

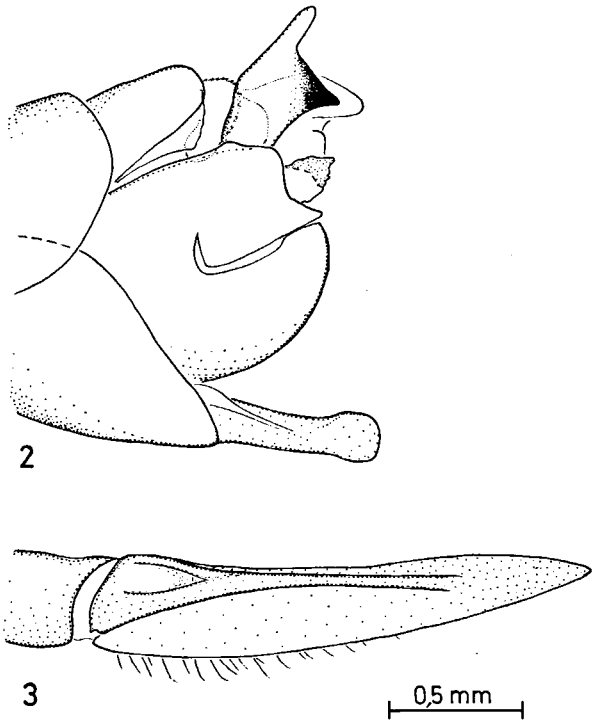


Fig. 2-3. *Nephrotoma cornicina* (Linnaeus, 1758); 2: hypopygium, lateral view; 3: cercus, outside view.

membrane near mid-length of the intromittent organ, a character also found in the nearctic *navajo* (fig. 34). As far as is known the group consists of three species from Madeira (*brevipennis*, *lucida*, *antithrix*), four nearctic species (*ferruginea*, *suturalis*, *abbreviata*, *navajo*), about 10 neotropical species, mostly from Central America and undescribed, and the eastern palaearctic species *hirsuticauda*. The latter species is closer to the nearctic species than the species from Madeira are.

Nephrotoma ferruginea (Fabricius, 1805)
Figs. 4-11, map 1

Fabricius, 1805: 28, descr (as *Tipula*); Wiedemann, 1821: 28, descr (as *Tipula*); Wiedemann, 1828: 56, descr (as *Tipula*); Walker, 1848: 73, locs (as *Tipula*); Macquart, 1850: 13, descr, 14, note (as *Pachirhina*); Osten Sacken, 1877: 211, biol, locs (partim *wulpiana*; as *Pachyrrhina*); Osten Sacken, 1878: 39, distr (as *Pachyrrhina*); Loew, 1879: 3, key (as *Pachyrrhina*); Osten Sacken, 1886: 15, key, 18, distr, locs, syn, note (as *Pachyrrhina*); Hart, 1895: 218, biol, locs (as *Pachyrhina*); Slosson, 1897: 239, locs (as *Pachyrrhina*); Williston, 1900: 228, locs (as *Pachyrrhina*); Johnson, 1903: 104, locs (as *Pachyrrhina*); McGillivray & Houghton, 1903: 12, locs (as *Pachyrrhina*); Snodgrass, 1904: 202, descr, figs (as *Pachyrrhina*); Aldrich, 1905: 98, distr (as *Pachyrhina*); Tucker, 1907: 197, locs, date (as *Pachyrhina*); Doane, 1908: 175, key, 178, comp (as *Pachyrhina*); Alexander, 1910: 253, locs (as *Pachyrhina*); Alexander, 1915b: 467, descr; Malloch, 1917: 198, key, 199, key, 206, descr, locs (as *Pachyrrhina*); Dietz, 1918: 111, key, 128, 130, 131, comp (as *Pachyrhina*); Alexander, 1919b: 782, 783, 784, 786, 817, locs, 839, biol, 877, distr, biol, 882, biol, 935, key, pl XLIV, fig wing; Alexander, 1920a: 715, descr, 728, biol, 736, note, 737, biol, locs, 738, biol, 1017, note, biol; Alexander & McAtee, 1920: 396, key, 397, biol, locs; Dietz, 1921: 261, biol, locs (as *Pachyrhina*); Alexander, 1922: 61, locs; Alexander, 1924: 61, biol, locs, date; Alexander, 1925b: 172, locs; Johnson, 1925: 34, locs; Alexander, 1926: 240, locs; Alexander, 1927b: 216, locs; Alexander, 1928: 56, locs; Leonard, 1928: 699, locs; Alexander, 1929a: 235, locs; Alexander, 1929b: 25, locs; Alexander, 1929c: 297, locs; Alexander, 1930: 272, locs; Rogers, 1930: 10, biol, 15, locs, 16, biol; Alexander, 1931a: 138, locs; Alexander, 1931b: 148, biol; Dickinson, 1932: 165-169, locs, 216, key, 220, fig wing, 221, locs, date; Winn & Beaulieu, 1932: 8, locs; Rogers, 1933: 26, note, 28, note; Brimley, 1938: 319, locs; Procter, 1938: 283, locs; Alexander, 1940b: 606, locs; Alexander, 1941: 284, locs, 287, syn, 289, locs; Alexander, 1942: 208, fig wing, 222, biol, 223, key, 224, syn, 225, syn, 227, descr, 228, distr, date, locs, 233, syn; Rogers, 1942: 19, biol, date, 46, 57, biol, 62, locs, biol; Alexander, 1945: 400, locs; Alexander, 1948: 16-17, locs; Alexander, 1949b: 101, comp; Alexander, 1954: 9, distr, 25, locs (partim, see distribution); Foote, 1956: 222, locs, date, biol; Alexander, 1962: 8, locs, date, biol; Frommer, 1963: 580, morph hyp, 592, 593, 604, 606, figs; Zimsen, 1964: 450, type-material; Alexander, 1965: 21, distr, syn, note; Cole, 1969: 53, note, distr; Alexander, 1970: 417, locs, syn; Byers, 1976: 9, note, comp; Young, 1978: 410, 413, biol, 416, locs, date, biol, distr, 432, key; Byers, 1979: 605, biol, locs, distr, 612, date; Gelhaus, 1982: 85, distr.

Nephrotoma beutenmuelleri (Dietz, 1918).
Dietz, 1918: 111, key, 130-131, comp, descr, pl V, fig wing (as *Pachyrhina*); Dietz, 1921: 261, note, locs (as *Pachyrhina*); Dickinson, 1932: 167, locs, 216, key, 220, note; Brimley, 1938: 319, locs; Alexander, 1941: 284, locs, 287, syn; Alexander, 1942: 223, key, descr, comp, distr, syn; Alexander, 1965: 21, syn.

Nephrotoma latevittata (Dietz, 1918).
Dietz, 1918: 111, key, 135, descr, comp, pl V, fig wing (as *Pachyrhina*); Alexander, 1965: 21, distr; Cole, 1969: 53, distr.

Nephrotoma proxima (Bellardi, 1859).
Bellardi, 1859: 9, descr, 10, descr, locs (as *Tipula*); Osten Sacken, 1878: 40, locs (as *Pachyrrhina*); Osten Sacken, 1886: 18, syn (as *Pachyrrhina*); Aldrich, 1905: 98, syn (as *Pachyrrhina*); Alexander, 1970: 417, syn.

Nephrotoma quadrilineata (Macquart, 1838).
Macquart, 1838: 50, descr (as *Pachyrhina*); Osten Sacken,

1878: 40, locs (as *Pachyrrhina*); Osten Sacken, 1886: 18, syn (as *Pachyrrhina*); Aldrich, 1905: 98, syn (as *Pachyrhina*); Alexander, 1970: 417, syn.

Material examined

Type-material: *Tipula ferruginea*: The specimen, considered to be the holotype (Zimsen, 1964), is preserved in the Zoological Museum, Copenhagen, and was kindly compared with *ferruginea* specimens by Dr. L. Lyneborg. According to Lyneborg (i.l., 1983) the present day interpretation of *ferruginea* is correct. The type is missing the abdomen but probably is a male and is labeled "T. ferruginea/ e Neu York". *Pachyrhina beutenmuelleri*: The collection of the ANSP contains two male types, condition good, labeled as follows: 1♂, "Black Mts. N.C. Coll. Dr. Dietz VII.6-12" "Holotype" "Holotype Pachyrhina beutenmuelleri W. G. Dietz 6458"; 1♂, "Hazleton, Pa Dr. Dietz Coll. IX.4.11" "Para-type Pachyrhina beutenmuelleri W. G. Dietz 6458" "Pachy. beutenmuelleri Dietz". Dietz (1921) gives a correction on the type-locality as presented with the description of 1918: the male from Hazleton should be considered the holotype and the male from the Black Mts the paratype. The synonymy with *ferruginea* was proposed for the first time by Alexander (1941). *Pachyrhina latevittata*: Holotype ♀, ANSP type no 9463, condition good, labeled: "South Park Col 6/17/16" "Holotype" "Holotype Pachyrhina latevittata W. G. Dietz 6463". New synonymy. *Tipula proxima*: Type-material not studied, the synonymy is based on Osten Sacken (1886). *Pachyrhina quadrilineata*: Type-material not studied, synonymy is based on Osten Sacken (1886).

Other material: 726♂, 791♀, from the following states and provinces: Alaska (49♂, 22♀), Alberta (20♂, 27♀), Arizona (21♂, 49♀), Arkansas (1♂, 1♀), British Columbia (48♂, 17♀), Colorado (17♂, 24♀), Connecticut (2♂, 4♀), Delaware (3♂, 4♀), Georgia (1♂, 7♀), Idaho (5♂, 4♀), Illinois (7♂, 9♀), Indiana (12♂, 11♀), Iowa (44♂, 38♀), Kansas (13♂, 19♀), Kentucky (1♂, 2♀), Maine (9♂, 10♀), Manitoba (3♂, 1♀), Maryland (22♂, 27♀), Massachusetts (45♂, 58♀), Mexico (6♂, 2♀), Michigan (87♂, 98♀), Minnesota (21♂, 11♀), Missouri (1♂, 2♀), Montana (2♂, 4♀), Nebraska (1♂), New Brunswick (3♂), Newfoundland (9♂, 7♀), New Hampshire (2♂), New Jersey (12♂, 23♀), New Mexico (34♂, 26♀), New York (32♂, 30♀), North Carolina (16♂, 26♀), North Dakota (5♂, 6♀), Nova Scotia (6♂, 12♀), Ohio (9♂, 5♀), Oklahoma (1♂, 2♀), Ontario (27♂, 24♀), Oregon (1♀), Pennsylvania (38♂, 52♀), Prince Edward Island (2♂, 1♀), Quebec (3♂, 4♀), Rhode Island (3♀), Saskatchewan (2♂, 4♀), South Carolina (3♂), South Dakota (8♂, 5♀), Tennessee (9♂, 8♀),Texas (3♂, 5♀), Utah (3♂, 2♀), Vermont (6♂, 13♀), Virginia (34♂, 67♀), Washington (1♂), Washington DC (2♂, 1♀), Wisconsin (5♂, 10♀), Wyoming (10♂, 2♀), Yukon (1♀).

Diagnostic features

N. ferruginea is most similar to *s. suturalis* and *s. wulpiana*, from which it differs by the two small stripes in front of the wingbase (fig. 5). This character, however, is not always very distinct, especially the lower stripe can be faint or absent. Males of *ferruginea* can be easily recognized by the large, blackened, claw-like process on the upper-posterior part of the inner dististyle (figs. 4, 9). Females of *ferruginea* and *suturalis* can be separated by the structure of the ovipositor. In *ferruginea* the upper margin of sternite 8 is evenly curved, and the upper margin of the hypovalvae is bent downwards inside sternite 8 (fig. 11). In both subspecies of *suturalis* the upper margin of sternite 8 is much less curved and the upper margin of the hypovalvae is straight so that it is visible throughout just above the sternite (fig. 20). In most instances the female terminalia have to be macerated to see these characters, but sometimes they are visible in dry specimens. Furthermore the following distinguishing characters are of relevance for *s. suturalis*, partly sympatric with *ferruginea* in the east: apices of the femora distinctly darkened in *s. suturalis*, femora uniformly coloured in *ferruginea* and *s. wulpiana*; costal margin of the

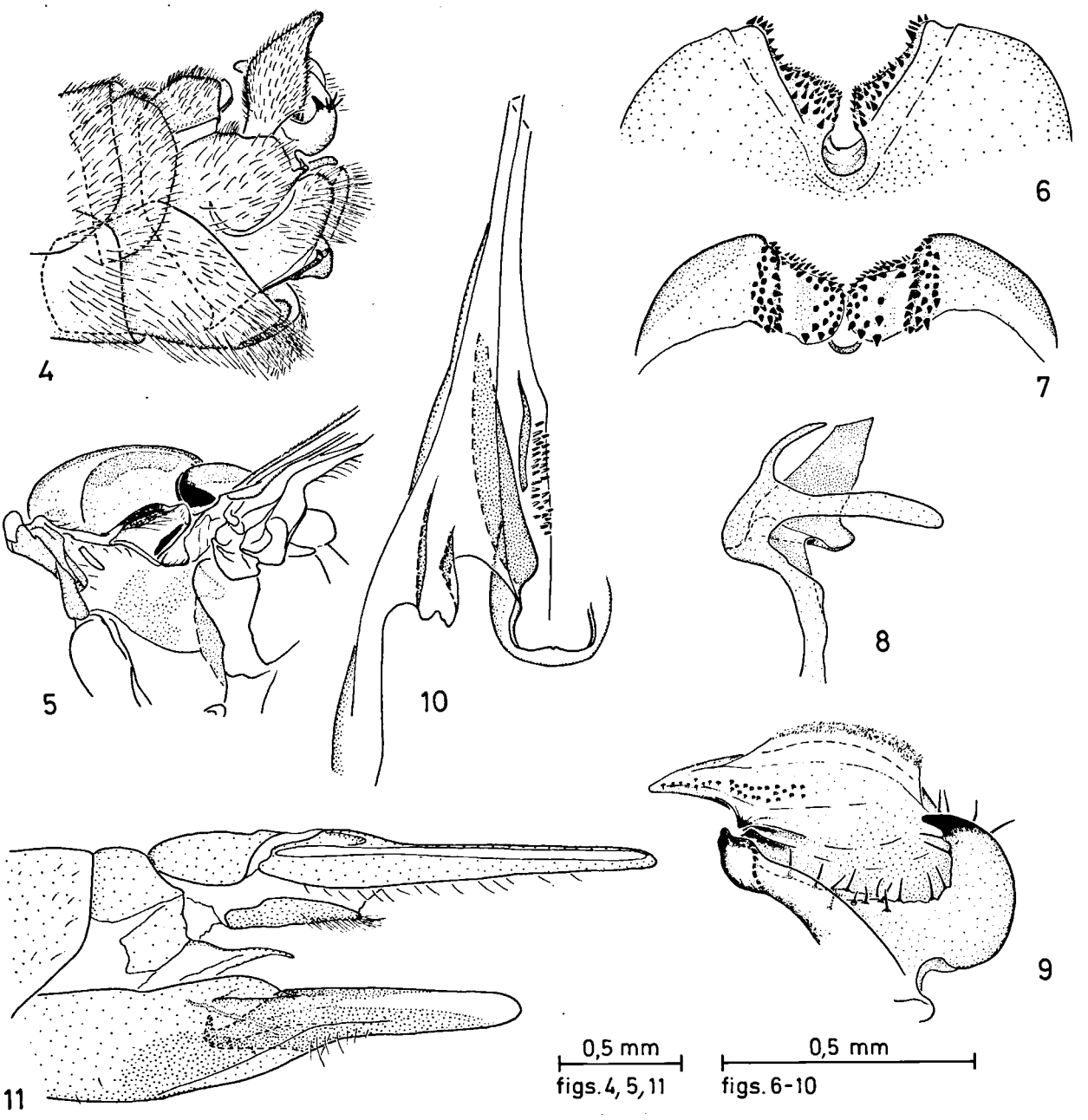


Fig. 4-11. *Nephrotoma ferruginea* (Fabricius, 1805); 4: hypopygium, lateral view; 5: thorax, lateral view; 6 & 7: extension of male tergite 9, dorsal (fig. 6) and ventral (fig. 7) view; 8: adminiculum and left gonapophyse, lateral view; 9: left inner dististyle, outside view; 10: right hypovalva, dorsal view; 11: ovipositor, lateral view.

wing yellowish brown or brownish in *s. suturalis*, light yellowish in *ferruginea* and *s. wulpiana*. The subspecies *s. wulpiana*, partly sympatric with *ferruginea* in the west, has the apical part of the cerci (fig. 20) slightly broader than in *ferruginea* (fig. 11).

Description

Body length ♂: 11-13 mm, ♀: 13-19 mm.
Wing length ♂: 11-13 mm, ♀: 11-15 mm.
Antennal length ♂: 4.5-5 mm, ♀: 3-4 mm.

Remark. *N. ferruginea* has a wide range of

variability in colour pattern. This is most distinct in specimens from the west which are described after the general description.

Head. Brownish yellow, dorsal part of rostrum slightly browner, genae and lower postgenae light yellow. Occipital marking a small, shining, brownish yellow to distinctly brownish triangle, basally at most as broad as dorsal part of pronotum, apically acute and at most reaching base of tubercle. Antennae with 13 segments. Scape and pedicel light brownish yellow; in male flagellar segments dark brown, first sometimes in part or entirely coloured as the pedicel, second and following flagellar segments somewhat nodulose basally, longest verticillar hairs slightly shorter or (apical segments) longer than segments. Female with flagellar segments sometimes lighter coloured or weakly bicolourous beyond first, with basal part darker, flagellar segments cylindrical, distinctly shorter than the longest verticillar hairs.

Thorax. Yellow with ferrugineous markings. Dorsal part of pronotum brownish yellow, lateral parts light ferrugineous. Scutum 1 with three shining stripes, usually ferrugineous but sometimes paler or distinctly coloured brown, lateral stripes straight or with a small deflection anteriorly, rarely distinctly downcurved anteriorly, deflected part usually lighter coloured than stripe. Stripes of scutum 2 coloured as those of scutum 1, sometimes paler posteriorly. Antero-lateral corners of scutum 2 bordered by a dull, dark brown to black marking (fig. 5). Scutellum usually transparent, ranging from yellow to ferrugineous brown. Mediotergite yellow with a broad ferrugineous marking posteriorly, which frequently extends less broad towards scutellum. Thorax laterally with two, small, drak brown stripes in front of wing base (fig. 5), one on posterior part of paratergite and one on membrane in front of basalare, especially latter sometimes less distinct, rarely absent. Remainder of sides of thorax with larger, light ferrugineous to light brown markings on the an- and katepisternites. Anatergite, coxae and trochanters light ferrugineous or light brown; femora light brown; tibiae light brown to brown; tarsi brown to dark brown; claws toothed in male only. Wings hyaline with a faint brownish tint; pterostigma light brown wit a few (up to 25) macrotrichia; apex of wing sometimes with a few (up to 20) macrotrichia in cell r4 + 5.

Abdomen. Light brown, usually antero-lateral parts of segments lighter, more brownish yellow. Tergites 2-6 or 2-7 dorsally usually with rounded or oval brown spots in front of the hind margins and at mid-length of tergite 2, laterally with brown spots at the posterior corners and at mid-length of tergite 2. The expression of these markings ranges from very distinct to absent, although a clear trace of the lateral markings is almost always present on the anterior segments.

Hypogium. Posterior margin of tergite 9 broadly V-shaped and basally with a rounded excavation, the latter variable in size (figs. 6, 7). Outer dististyle basally broad, apically slender (fig. 4). Inner dististyle with a dorsally pubescent crest, posteriorly with a large, blackened, spine-like process, lateral shell narrow and extended anteriorly (fig. 9). Gonapophyses bifid (fig. 8). Medisternal appendage short, protruding beyond sternite 9 (fig. 4). Hind margin of sternite 8 broadly incised, incision partly covered by a slightly protruding membrane bearing long hairs; sternite 8 also set with long hairs, especially towards hind margin (fig. 4). Semen pump large with a high and bifid compressor apodeme. Intromittent organ reaching into the fourth or third segment, basal one-tenth robust and distinctly tubular, remaining part with two sclerotized filaments on either side and apparently still tubular, especially the apical one-fourth where the filaments are gradually less developed.

Ovipositor. Cerci basally relatively broad, apically slender (fig. 11). Upper margin of sternite 8 evenly curved and upper margin of hypovalvae bent downwards inside sternite 8 (fig. 11). Hypovalvae with rostral extensions laterad of internal arch (fig. 10). Fused valvulae and coxopodite of tergite 9 connected by a narrow sclerotization.

Western States. Especially the specimens from the northwest are sometimes hardly

coloured on the sides of the thorax and the abdomen. Discrimination between *ferruginea* and *s. wulpiana* therefore must rely on genital characters. Males can be easily separated by characteristics of the inner dististyle and sternite 8. For females the only reliable character is found in sternite 8 and the hypovalvae as presented under diagnostic features.

Specimens from New Mexico and Arizona frequently have the anterior corners or the anterior lateral borders of the medial scutal stripe extensively darkened and have the lateral stripes distinctly downcurved anteriorly, the downcurved part shining and extensively darkened as well.

Biology

N. ferruginea is, especially in the eastern states, a very common and sometimes abundant species. It inhabits open woodlands, river sides, pasture land, is common in grasses of urban lawns, and can be very abundant in cultivated crops. Usually it occurs in damp or wet places or near running water but can also be found under drier conditions (such as grasslands or oak-hickory forests) which are too dry for most other crane-flies.

Larvae live in most friable soils and can be exceedingly numerous in cultivated areas. They feed on the roots of herbaceous plants and sometimes damage wheat. Hart (1895) described the larvae, and figures were given by Malloch (1917).

The period of flight ranges from the beginning of April to the end of October and is bivoltine in the north- and middle-east (in NE and ME with distinct peaks from mid May to the end of June and from mid August to mid September; almost all SE records are from early April to early June; the NW records are from early May to mid September, with a peak from mid June to mid July; the SW records are from mid April to the end of October, with a peak from late June to late August; records from early Spring and late Autumn are from indoors).

The highest altitudes are Virginia 4600′ (1400 m), N. Carolina 5300′ (1620 m), Tennessee 5800′ (1770 m), Texas 5000′ (1520 m), Arizona 9200′ (2810 m), Colorado 9400′ (2870 m), New Mexico 9600′ (2930 m).

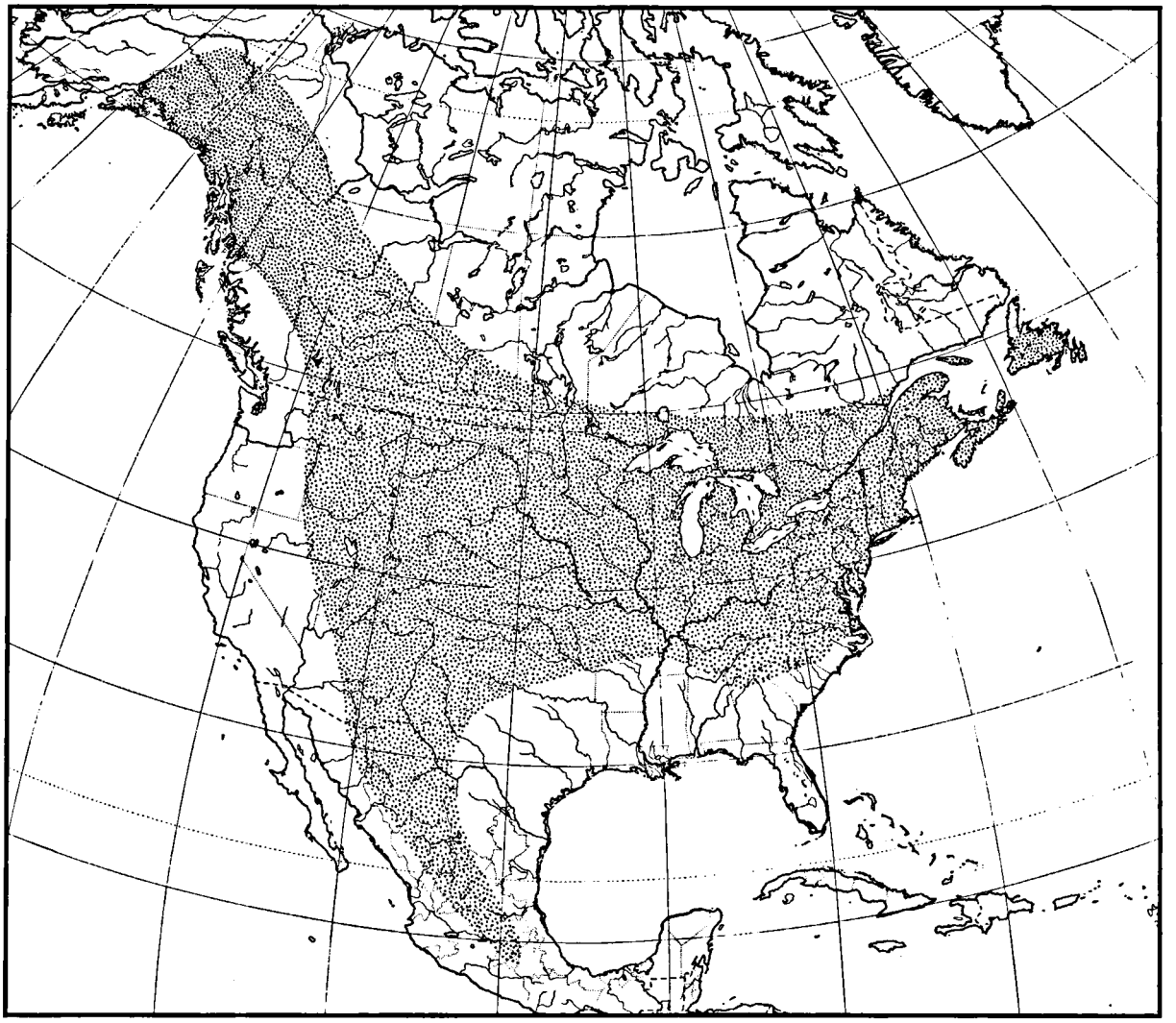
Distribution (map 1)

N. ferruginea occupies the widest range of the North American *Nephrotoma* species. Its range is limited as follows (based on examined material):

In the northeast by South Brook, Springdale, Glenwood, Hampden, St. John's, Avalon (Newfoundland), Baddeck (Nova Scotia), Anticosti Island (Quebec), Gaspé (New Brunswick), Sioux Lookout (Ontario), Aweme (Manitoba), Saskatoon (Saskatchewan) and Edmonton (Alberta). In the Yukon, *ferruginea* is known from Mayo. Material from Alaska originated from Circle Hot Springs, Steese Highway, Caribou, Fairbanks, Palmer, Anchorage, Matanuska and Kenai.

The western limit is drawn after Salmon River, Barrière and Terrace (British Columbia), Whitman County (Washington), Vale, Malheur County (Oregon; Alexander, 1954, records *ferruginea* as far west in Oregon as Hood River and Tumalo Creek, but some of this material turned out to be *s. wulpiana*), Gandy, Millard County (Utah; Alexander, 1948, also mentioned Iron and Washington counties), and Coconino County and Tucson, Pima County (Arizona). In Mexico *ferruginea* is known from "Sierra Madre", Durango, Hidalgo, Mexico, and Morelos. The only counties in Texas are Jeff Davis and Brewster.

Of the southern states material was examined from the Comanche and Ottawa counties (Oklahoma), Crawford and Washington counties (Arkansas), Murray, Towns, Whitfield, Union and Fulton counties (Georgia), Greenville and Spartanburg counties (S. Carolina), and Moore and Cumberland as the southeastern-most counties in N. Carolina. The records by Johnson (1895, 1913) and Alexander (1915a) from Florida refer to *s. suturalis*.



Map 1. Distribution of *Nephrotoma ferruginea* (Fabricius, 1805), based on material examined.

Nephrotoma suturalis (Loew, 1863)

N. suturalis is usually considered a race (Alexander, 1941, 1942) or subspecies (Rogers, 1933; Alexander, 1965) of *ferruginea*. There are, however, numerous differentiating characters between these two species, especially in the male and female genitalia, whereas there are hardly such differences between *suturalis* and *wulpiana*. Therefore, the latter two taxa are treated here as subspecies. The two subspecies are allopatric (map 2) and both partly sympatric with *ferruginea* (map 1).

Nephrotoma suturalis suturalis (Loew, 1863) Figs. 14, 15, 17, 18, map 2

Loew, 1863: 295, descr (as *Pachyrrhina*); Osten Sacken, 1878: 40, distr (as *Pachyrrhina*); Loew, 1879: 3, key (as *Pachyrrhina*); Osten Sacken, 1886: 18, note (as *Pachyrrhina*); Johnson, 1895: 320, locs (as *Pachyrrhina, suturalis* & *ferruginea*); Aldrich, 1905: 99, distr (as *Pachyrhina*); Doane, 1908: 176, key (as *Pachyrhina saturalis*); Johnson, 1913: 41, locs (as *Pachyrhina, suturalis* & *ferruginea*); Alexander, 1915a: 97, locs (as *Pachyrrhina ferruginea*); Dietz, 1918: 111, key, 136, comp (as *Pachyrhina*); Alexander, 1919b: 936, key; Dickinson, 1932: 169, locs, 215, key, 219, locs, note, fig 125, wing; Rogers, 1933: 26, note, 28, note, distr, 42, biol, locs, distr, 48, biol; Brimley, 1938: 319, locs, date;

Alexander, 1941: 284, locs, 287, note; Alexander, 1942: 224, key, 233, descr, distr, note; Alexander, 1965: 21, distr (as *ferruginea* ssp. *suturalis*).
Nephrotoma costomarginata (Dietz, 1918).
Dietz, 1918: 111, key, 129, descr, comp (as *Pachyrhina*); Rogers, 1933: 26, syn; Brimley, 1938: 319, locs: Alexander, 1941: 284, locs, 287, syn; Alexander, 1942: 23, syn; Alexander, 1965: 21, syn.

Material examined

Type-material: *Pachyrrhina suturalis*: Holotype ♀, MCZ type no 10308, condition good, labels: "Georgien" "suturalis m." "Loew Coll" "10308" "Type". *Pachyrhina costomarginata*: Holotype ♂, ANSP type no 6457, condition good, labels: "Bradentown Fl. March. M C Van Duzee" (type-locality probably Bradenton in Manatee County) "Holotype" "Holotype Pachyrhina costomarginata W. G. Dietz 6457". The synonymy of *costomarginata* with *suturalis* was proposed for the first time by Rogers (1933).

Other material: 103♂, 95♀, from the following states: Arkansas (1♂), Florida (56♂, 52♀), Georgia (9♂, 12♀), Illinois (1♀), Indiana (1♂), Kansas (2♂, 5♀), Louisiana (1♀), Missouri (2♂), New Jersey (3♂, 1♀), North Carolina (1♂, 4♀), Oklahoma (11♂, 10♀), South Carolina (8♂, 2♀), Tennessee (5♂, 4♀), Texas (1♂), Virginia (3♂, 3♀).

Diagnostic features

The characters by which *s. suturalis* can be easily separated from *s. wulpiana* and *ferruginea* are presented under the description of *s. wulpiana* and diagnostic features of *ferruginea*.

Description

Body length ♂: 10-12 mm, ♀: 14-16 mm.
Wing length ♂: 9-10 mm, ♀: 11-13 mm.
Antennal length ♂: 4 mm, ♀: 3 mm.

Head. Light brownish yellow, rostrum usually light brown dorsally, genae and lower postgenae yellow to pale yellow. Occipital marking a small shining triangle, sometimes coloured as surrounding vertex, usually more or less infuscated, rarely distinctly darkened brown and narrowly prolonged onto tubercle. Antennae with 13 segments; scape, pedicel and first flagellar segment light brownish yellow. Male with second and following flagellar segments dark brown, sometimes weakly bicolourous with basal part darker. Female with the third and following flagellar segments bicolourous, base dark brown, remainder of segment light brown or brownish yellow, sometimes second flagellar segment also bicolourous, or all flagellar segments beyond first uniformly darkened. Basal part of second and following flagellar segments not (female) or weakly (male) thickened; longest verticillar hairs of the male slightly shorter or (apically) as long as segments, in female distinctly longer than segments.

Thorax. Ground colour of thorax yellow with ferrugineous or light brown dorsal stripes and lateral markings. Medial stripe of scutum 1 posteriorly darker brown and prolonged into thoracic suture. Lateral stripes of scutum 1 straight or slightly downcurved anteriorly. Scutellum transparent, coloured as stripes or lighter. Mediotergite yellow with a broad ferrugineous or light brown marking on posterior part, which usually extends towards scutellum. Antero-lateral corners of scutum 2 bordered by a dark brown to black marking. Posterior part of paratergite with a dark brown to black stripe (as in *ferruginea*, fig. 5, but smaller), lower stripe in front of basalare at most weakly indicated (a few males from Georgia and Oklahoma possess large, shining dark brown markings at the anterior corners of medial stripe of scutum 1 and directly below anterior ends of lateral stripes; one male from Douglas County, Kansas, and the female from Jersey County, Illinois, have stripes of scutum 1 and scutum 2, scutellum and marking on mediotergite dark brown). Coxae and trochanters light yellowish brown; femora yellowish brown, the apices dark brown, dark brown part about as large as diameter of femur and pronounced at most on dorsal surface; tibiae light brown, apices darkened or tibiae steadily growing darker towards apices; tarsi brown to dark brown; claws toothed in male only. Wings hyaline with a faint, light brown tinge; cells c and sc distinct-

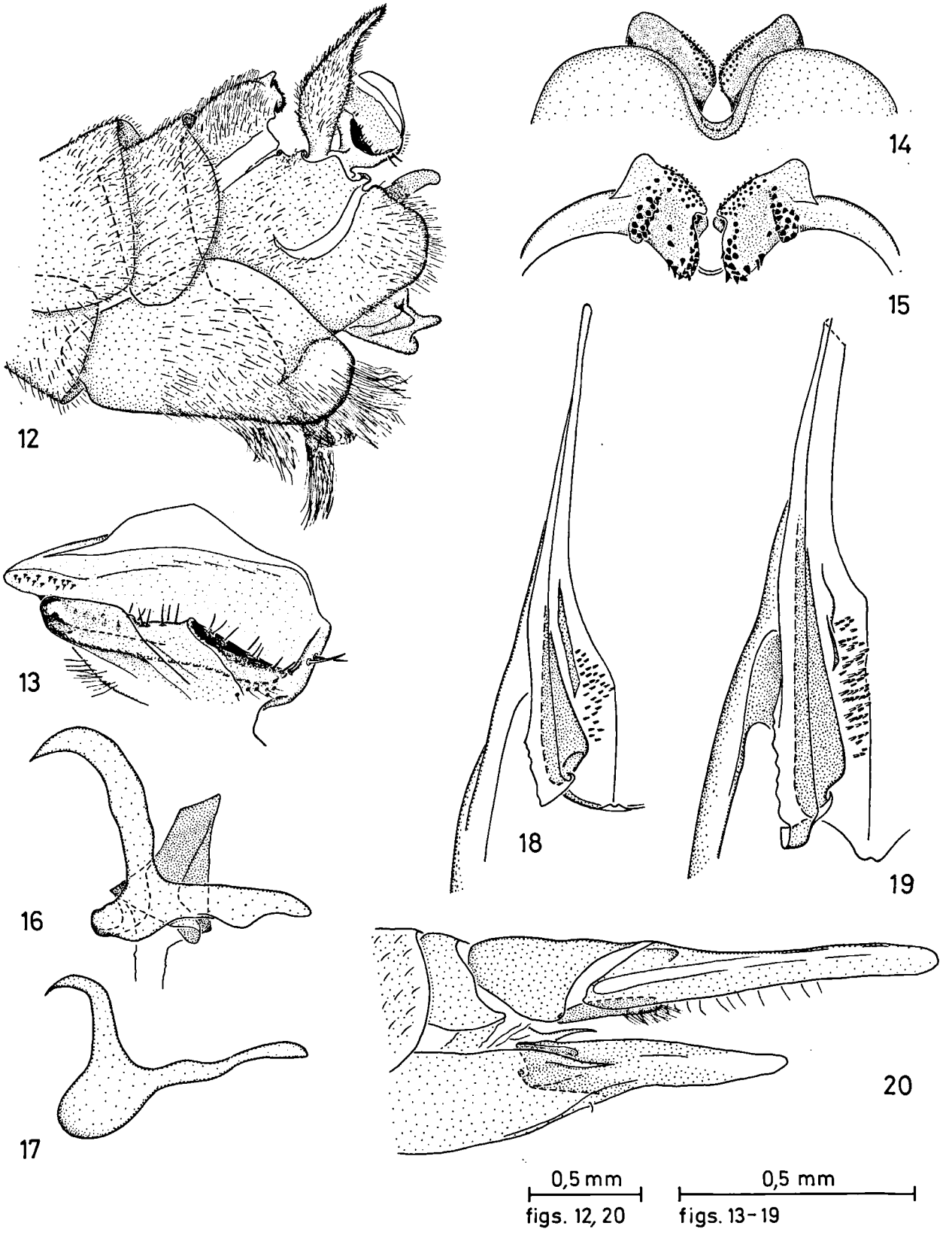


Fig. 12-20. *Nephrotoma suturalis* (Loew, 1863); 12: *s. wulpiana* (Bergroth, 1888), hypopygium, lateral view; 13: *s. wulpiana*, left inner dististyle, outside view; 14 & 15: *s. suturalis*, extension of male tergite 9, dorsal (fig. 14) and ventral (fig. 15) view; 16: *s. wulpiana*, adminiculum and left gonapophyse, lateral view; 17: *s. suturalis*, left gonapophyse, lateral view; 18: *s. suturalis*, right hypovalva, dorsal view; 19: *s. wulpiana*, right hypovalva, dorsal view; 20: *s. wulpiana*, ovipositor, lateral view.

ly darkened, brown; pterostigma faint, at most light brown, usually with 10-20 macrotrichia; apex of wing sometimes with a brownish tinge beyond stigma along costa reaching R4 + 5.

Abdomen. Brownish yellow without dorsal or ventral markings but with rounded, dark brown spots on latero-posterior corners of tergites 2-5 and near mid-length of tergite 2 (the male from Kansas and the female from Illinois with a lateral stripe on tergites 2-8 and with vaguely brown, elongate, dorsal markings in front of hind margins of tergites 2-4 and continuous on 5-7).

Hypopygium. Posterior part of tergite 9 with a widely V-shaped incision which is very narrow towards the basal excavation (figs. 14, 15). Outer dististyle elongate, basally less broad than in *ferruginea* (as in *s. wulpiana*, fig. 12). Inner dististyle with a dorsal crest, posterior part of the lateral shell flattened and blackened (as in *s. wulpiana*, fig. 13). Gonapophyses divided into dorsal arm and somewhat longer posterior arm (fig. 17). Medisternal appendage short, protruding beyond sternite 9, posteriorly with two short membranous projections (as in *s. wulpiana*, fig. 12). Latero-posterior part of sternite 8 rounded, the hind margin incurved towards medial incision, latter closed by a membrane, which is swollen over middle and protruding beyond sternite ventrally. Hind margin and ventral part of membrane set with tufts of golden white hairs, but less dense than figured for *s. wulpiana* (fig. 12). Semen pump large with a high and bifid compressor apodeme. Intromittent organ reaching into second segment, its structure as in *ferruginea*.

Ovipositor. Cerci slender, apically slightly broader than in *ferruginea*; lateral aspect of hypovalvae as in *s. wulpiana* (fig. 20). Rostral extension of hypovalvae laterally abbreviated (fig. 18). Fused valvulae connected with coxopodite of tergite 9 by a narrow sclerotization. Internal arch low (fig. 18).

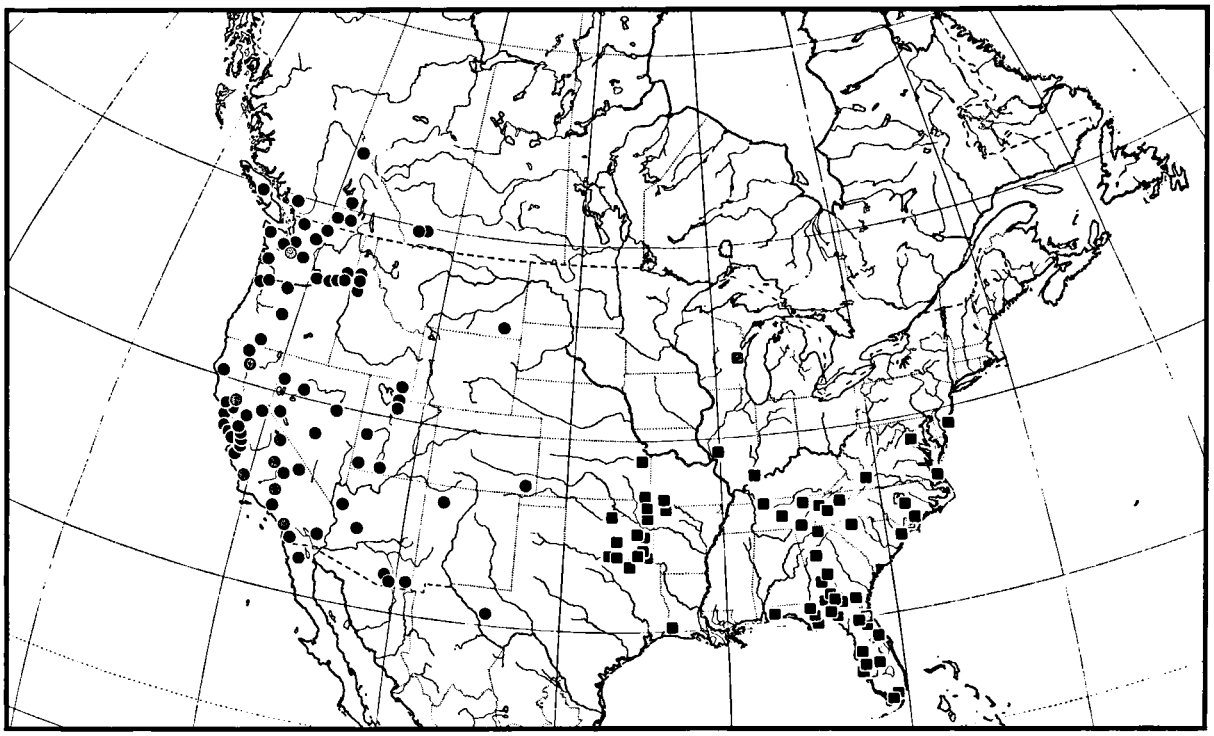
Biology

The only reference for the biology of *s. suturalis* is Rogers (1933), who mentions as typical habitats in northern Florida "open, grassy rill and brook courses; low hammocks; mesophytic hammocks; lake, pond and marsh shore lines; marshes dominated by emergent vegetation. Adult: crepuscular or nocturnal; herbage and low shrubbery, open grassy hammocks and creek margins. Oviposition into bare spots in damp, friable soil. Immature stages: wet to moderately damp, sandy soils; larvae feed on grass rootlets. Larvae and pupae were taken in numbers from cabbage plots where clean cultivation had been carried on for at least four weeks."

In the southern states (Florida, Georgia, S. Carolina, Louisiana, Texas) adults of *s. suturalis* can be found throughout the year but are most common from mid March until early June. Towards the north the period of flight is more limited, from the end of March until mid September, with a peak from mid June until early July. Altitudes are known only for Virginia, 3850′ (1170 m) and 4100′ (1250 m).

Distribution (map 2)

The distribution of *s. suturalis* is given in the literature as "coastal, S.C. to Ga." (Alexander, 1965), sometimes with an extension along the Gulf to "Ala". (Alexander, 1942) or "Louisiana" (Rogers, 1933). References outside this range are from Wisconsin, Winnebago County (Dickinson, 1932) and North Carolina, Wake County and New Hanover County (Brimley, 1938). This material was not examined during this study. All the other material revealed that *s. suturalis* is distributed as far west as Oklahoma and Kansas and as far north as New Jersey. Apart from Florida and Georgia, the specimens originated from the following localities or counties: Arkansas: near Eureka Springs, Caroll County; Illinois: Principia College, Jersey County; Indiana: Murphys Park, New Harmony, Posey County; Kansas: Univ. Kansas Nat. Hist. Res., Baldwin Woods, both Douglas County, near Baxter Springs, Cherokee County; Missouri: Exeter, Barry County; New Jersey: Cape May, Cape May County; North Carolina: Johnson,



Map 2. Distribution of *Nephrotoma suturalis suturalis* (Loew, 1863), rectangles, and *Nephrotoma suturalis wulpiana* (Bergroth, 1888), dots, based on material examined (black) and literature (stippled).

Pender, Columbus counties; Oklahoma: Adair, Choctaw, Delaware, Le Flore, Love, Marshall, Mc Curtain, Muskogee, Payne, Pontotoc, Pushmataha counties; South Carolina: Horry and Spartanburg counties; Tennessee: Fentress, Greene, Hamilton, Knox, Montgomery, Rutherford, Sevier counties; Texas: Paris, Lamar County; Virgina: Fairfax, Giles, Princess Anne counties.

Nephrotoma suturalis wulpiana (Bergroth, 1888), new status
Figs. 12, 13, 16, 19, 20, map 2

Bergroth, 1888a: 200, descr, comp (as *Pachyrrhina*); Aldrich, 1905: 99, note (as *Pachyrhina*); Doane, 1908: 176, key (as *Pachyrhina*); Dietz, 1918: 110, key, 122, comp (as *Pachyrhina*); Alexander, 1965: 22, note, distr; Alexander, 1967: 18, note, locs, 19, note, distr, locs, fig 50, wing; Cole, 1969: 53, note, distr; Byers, 1976: 8, note, distr, figs 8 & 9, hyp.
Nephrotoma occidentalis (Doane, 1908).
Doane, 1908: 175, key, 177, descr, distr, comp (as *Pachyrhina*); Dietz, 1918: 111, key, 128, 130, comp (as *Pachyrhina*); Alexander, 1946: 490, locs; Alexander, 1947: 36, locs; Alexander, 1948: 17, locs, date; Alexander, 1949a: 277, locs; Alexander, 1949b: 101, comp; Alexander, 1954: 26, locs; Alexander, 1965: 22, distr; Alexander, 1967: 18, syn; Byers, 1976: type-material, syn.

Material examined

Type-material: *Pachyrrhina wulpiana* was described from: "California borealis (Siskiyou County: Dom. J. Behrens)" based on one female. This type-material is apparently not preserved (neither in Zoological Museum of Helsinki, Lindeberg i.l., nor in any of the North American collections, Alexander, 1967). *Pachyrhina occidentalis* was described from: "Central and Southern California, Montana, Eastern and Western Washington, Nevada, Arizona (type from Stanford University, Cal.). Many males and females." This material was examined and the (holo)type figured by Byers

(1976). The synonymy of *wulpiana* and *occidentalis*, as established for the first time by Alexander (1967), is quite convincing, in spite of the loss of the type of *wulpiana*. Firstly, only one *Nephrotoma* species occurs in California, secondly, the discriptions distinctly refer to the same species, and thirdly, Bergroth (1888a) adds to the description that *wulpiana* is closely related to *suturalis*, a view presented in this paper as well.

Other material: 153♂, 153♀, from the following states or provinces: Alberta (2♀), Arizona (8♂, 4♀), British Columbia (18♂, 24♀), California (53♂, 54♀), Colorado (1♂), Idaho (2♂, 2♀), Baja California (6♂, 1♀), Montana (1♂), Nevada (20♂, 12♀), New Mexico (3♂), Oregon (6♂, 4♀), Texas (3♂, 2♀), Utah (10♂, 6♀), Washington (22♂, 42♀).

Description

Body length ♂: 11-14 mm, ♀: 14-19 mm.
Wing length ♂: 11-14 mm, ♀: 13-16 mm.
Antennal length ♂: 4-5 mm, ♀: 3-4 mm.

Colouration of male and female as described for *s. suturalis*, but with the following differences: female flagellar segments dark brown beyond first or second, sometimes with the basal part darker; wings in both sexes not darkened along costal margin and apices of femora not darkened. Genital characters with minor differences: dark spot on posterior part of inner dististyle large (fig. 13); posterior part of sternite 8 with conspicuous tufts of hairs (fig. 12); dorsal arm of gonapophyses longer than posterior arm (fig. 16); rostral extension of hypovalvae longer than in *s. suturalis* and curved down (fig. 19).

Biology

Very little is known about the biology of *s. wulpiana*. Many of the localities from which it is known are along creeks, rivers and lakes. Highest altitudes are 6900′ (2100 m) (Nevada), 5300′ (1620 m) (New Mexico), 5600′ (1710 m) (Utah), 4000′ (1220 m) (Texas), 5000′ (1520 m) (California), 9000′ (2740 m) (Baja California). The species is on the wing from early March until late November but is most abundant from the end of March until early October with a distinct peak during May and June and again in August.

Distribution (map 2)

N. s. wulpiana is distributed in the west and is the only *Nephrotoma* species known from California. The northernmost locality is Robson (British Columbia). Towards the east it is known from Powderville, Powder River County, Montana; Rocky Ford, Otero County, Colorado; Davis Mts, Jeff Davis County, Texas. Mexican material originated from the northern part of Baja California.

Nephrotoma abbreviata (Loew, 1863)
Figs. 21-28, map 3

Loew, 1863: 295, descr (as *Pachyrrhina*); Osten Sacken, 1878: 39, locs (as *Pachyrrhina*); Loew, 1879: 3, key (as *Pachyrrhina*); Aldrich, 1905: 97, locs (as *Pachyrhina*); Doane, 1908: 175, key (as *Pachyrhina*); Dietz, 1918: 111, key, 136, comp (as *Pachyrhina*); Alexander, 1919b: 936, key; Dickinson, 1932: 168, locs, 215, key, 218, locs; Alexander, 1942: 224, key, descr, locs, note; Alexander, 1965: 20, distr.

Material examined

In the literature only two specimens have been mentioned: the holotype and a specimen by Dickinson (1932). The holotype is an intersex (abdominal terminalia dorsally female, ventrally distorted male), MCZ type no 10310, condition poor to fair, labels: "Mississipi (misspelled), Schaum" "abbreviata m." "Loew Coll." "10310" "Type". The specimen mentioned by Dickinson was not examined during this study; it seems unlikely that it was correctly identified as Dickinson misidentified many specimens (Byers, i.l. 1984).

Other material is: 1♀, Florida, Leon County, 18-III-1939; 1♀, Illinois, Union County, 5 mi NE Wolf Lake, 31-VIII-1967; 1♀, Louisiana, St Charles Parish, Norco, 1-XI-1944; 1♀, Louisiana, Plaquemines Parish, Chalmette, 16-X-1944; 1♀, Missouri, Hinds County,

Jackson, 17-VIII-1929; 17♂, 4♀, North Carolina, Durham area, laboratory-reared by Arthur Forer, spring 1970; 1♂, North Carolina, Buncombe County, Ashville, 26-VI-1912; 1♂, Tennessee, Green County, Tusculum, Frank's Creek, 15-IX-1948, light trap; 1♀, Tennessee, Smoky Mts, 30-VII-1939, 6400′; 1♂, Texas, Galveston County, Galveston, V; 1♂, Texas, Harris County, Houston, 21-VI-1968, at light; 1♀, Texas, Nacogdoches County, Nacogdoches, 28-VI-1962; 1♀, SS Essex, 40 mi off Cape Charles (Va), 6-VI-1928.

Diagnostic features

N. abbreviata is characterized by the following combination of characters. Flagellar segments light brown, the basal nodes blackened beyond the first flagellar segment in both sexes. Lateral stripes of scutum 1 distinctly downcurved anteriorly, the curved part darkened and shining. Pterostigma light brown to dark brown. A brown seam along basal part of vein R4 + 5 and cross-vein r-m. Upper-posterior part of inner dististyle with a slender, blackened, hook-like process, oriented in the transverse plane (figs. 21, 22, 25). Female cerci very broad (fig. 27).

Description

Body length ♂: 11-12 mm, ♀: 16-19 mm.
Wing length ♂: 11-12 mm, ♀: 13-15 mm.
Antennal length ♂: 4.5 mm, ♀: 3.5 mm.

Head. Brownish yellow, dorsal part of rostrum darker, genae and lower postgenae pale yellow. Occipital marking a small shining triangle, usually narrowly prolonged onto tubercle, basal part coloured as vertex, anterior part more or less infuscated, sometimes even dark brown. Antennae with 13 segments; scape brownish yellow; pedicel and first flagellar segment light brown; second and following flagellar segments weakly reniform in male, cylindrical in female, light brown with basal part blackened; longest verticillar hairs in male slightly shorter or (apically) slightly longer than segments, in female distinctly longer than segment.

Thorax. Pronotum brownish yellow dorsally, light ferrugineous to dark brown laterally. Stripes of scutum 1 brown to dark brown, shining with lateral margins of medial stripe and inner margins of lateral stripes narrowly dull; anterior end of lateral stripes downcurved and large, almost or actually reaching paratergite, usually darker than stripes themselves. Stripes of scutum 2 brown to dark brown, antero-lateral corners surrounded by a velvety black marking that is broadest laterally. Transverse suture darkened in middle. Scutellum brown to dark brown. Mediotergite with a broad, light brown to dark brown stripe over the middle, anteriorly as broad as scutellum and gradually broadening posteriorly. Lateral markings of thorax light ferrugineous to light brown, anatergite ranging from light brown to dark brown. Posterior part of paratergite with a dark brown stripe. Coxae and trochanters brownish yellow to light brown; femora light brown, extreme apices darkened dorsally; tibiae brown, apices darker; tarsi dark brown; only claws of male toothed. Wings hyaline with a faint light brown tinge; pterostigma distinct, light brown to dark brown with 5-20 macrotrichia; just below pterostigma a brown seam along basal part of vein R4 + 5 and cross-vein r-m; apex of wing sometimes weakly clouded brown.

Abdomen. Brownish yellow, sternite 8 usually somewhat darker. Tergite 1 infuscated or brown on antero-dorsal part. Tergites 2-6 or 2-7 with brown markings in front of hind margins and near mid-length of tergite 2; markings in male medially partly or completely divided in two, especially on anterior tergites; in female larger, more transverse and less divided along mid-line. Tergites 2-6 or 2-7 in male with brown to dark brown spots on latero-posterior corners and halfway tergite 2, in female more elongate.

Hypopygium. Notch in extension of tergite 9 widely V-shaped with a rounded basal excavation (figs. 23, 24). Outer dististyle of moderate length (fig. 21). Inner dististyle with

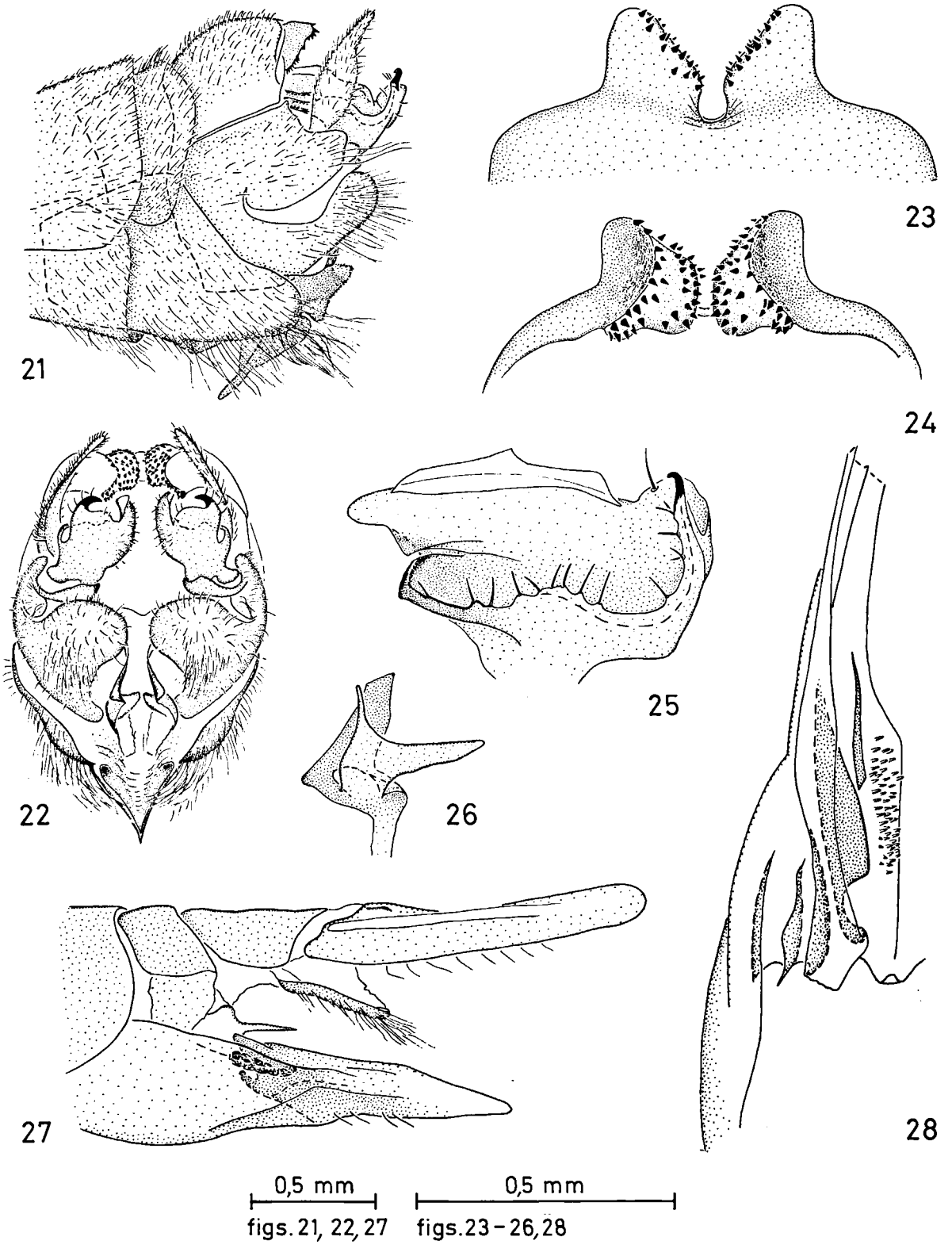
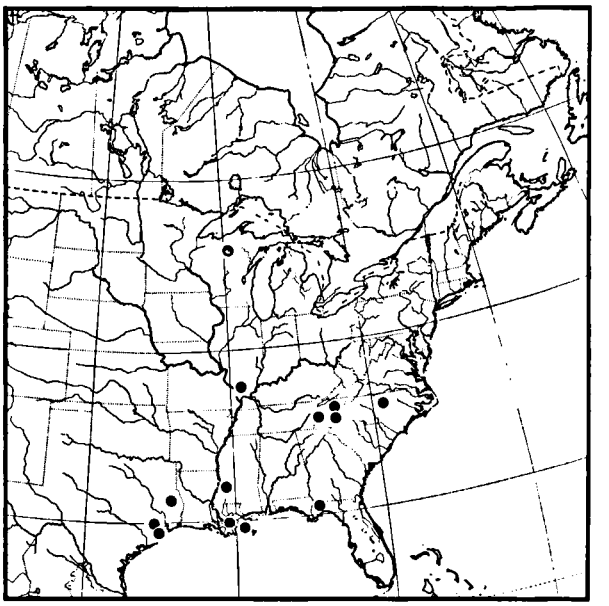


Fig. 21-28. *Nephrotoma abbreviata* (Loew, 1863); 21: hypopygium, lateral view; 22: hypopygium, rear view; 23 & 24: extension of male tergite 9, dorsal (fig. 23) and ventral (fig. 24) view; 25: left inner dististyle, outside view; 26: adminiculum and left gonapophyse, lateral view; 27: ovipositor, lateral view; 28: right hypovalva, dorsal view.

low dorsal crest and broad lateral shell; posterior margin of lateral shell terminating in a slender, blackened, hook-like process, oriented transversely (figs. 21, 22, 25). Gonapophyses bifid, dorsal arm short and slender (fig. 26). Medisternal appendage short, protruding beyond sternite 9 (fig. 21). Posterior part of sternite 8 which large incision, closed by a triangular membrane which distinctly protrudes ventrally beyond sternite (figs. 21, 22); posterior part of sternite 8 set with loose tufts of long hairs. Semen pump large with high bifid compressor apodeme. Intromittent organ reaching into segment two, its structure as in *ferruginea*.

Ovipositor. Cerci very broad towards apex; hypovalvae narrowed towards acute apex (fig. 27). Coxopodite of tergite 9 and fused valvulae connected by a narrow sclerotization. Dorsal aspect of rostral extension of hypovalvae as in fig. 28.



Map 3. Distribution of *Nephrotoma abbreviata* (Loew, 1863), based on material examined (black dots) and literature (stippled dot).

Biology

Largely unknown. The 12 collecting dates cover the period March 18 to November 1; June to September records are from the northern part of the range only, March to November records from the south. The species is apparently (also) active during the evening and night. It was collected at 6400′ (1950 m) in the Smoky Mts. (Tennessee).

Distribution (map 3)

In the literature *abbreviata* is known only from Mississippi (type-locality) and, with some doubt, Vilas County, Wisconsin (Dickinson, 1932). During this study specimens were examined from seven other states, as given under material examined, and one specimen collected on board of SS Essex, 40 mi off Cape Charles (Va).

Nephrotoma navajo (Alexander, 1949)
Figs. 29-36, map 4

Alexander, 1949b: 98, descr, 99, comp; Alexander, 1965: 21, note; Cole, 1969: 53, note.

Material examined

N. navajo has been known only from the type-series, 5♂. During this study the following material was examined: Holotype ♂, USNM (Alexander coll.), condition good, labels: "Mc Nary, Apache Co. Ariz White Mts 7400′ jul 22 '48" "holotype ♂ Nephrotoma navajo C. P. Alexander"; 4 ♂ paratypes, USNM (Alexander coll.), labeled as the holotype but "paratype" in stead of holotype; 5♂, Arizona, Pima County, Sta Catalina Mts, 1-VIII-1938; 1♂, Arizona, Cochise County, Chiricahua Mts, Turkey Flat, 22-VII-1927, 8000′; 1♂, Arizona, Cochise County, Chiricahua Mts, Bar Foot Ridge, 5-VIII-1927, 85-9700′; 1♂, 1♀, Arizona, Cochise County, Chiricahua Mts, Rustler Park, 26-VII-1927, 8-9000′; 4♂, 1♀, Arizona, Graham County, Pinaleno Mts, Hospital Flat, 2-VIII-1965, 8950′; 1♀, Arizona, Apache-Navajo counties, White Mts, Mc Nary, 1-VIII-1925, 7500′; 1♂, New Mexico, Lincoln County, White Mts, Rio Ruidoso, 1-VIII, 6500′.

Diagnostic features

N. navajo is similar to *abbreviata*, *ferruginea* and *suturalis*. It differs from these species among others by the following combination of characters. Antennae with 14 segments in both sexes. Occipital marking diamond shaped, dark brown and prolonged onto or over tubercle as a narrow stripe. Head with small brown spots in front of tubercle in between antennae and at sides of tubercle, adjoining eyes. Scutal stripes dark brown, medial stripe of scutum 1 usually somewhat or distinctly lighter coloured in the middle anteriorly, lateral stripes of scutum 1 usually downcurved anteriorly. Posterior part of inner dististyle with a claw-like, acute process (figs. 29, 30).

Description

Body length ♂: 11-12 mm, ♀: 15-16 mm.
Wing length ♂: 11-12 mm, ♀: 15-16 mm.
Antennal length ♂: 3.5-4 mm, ♀: 2.5 mm.

Head. Brownish yellow, dorsal part of rostrum brown, sometimes even dark brown, genae and lower postgenae yellow to pale yellow. Small brownish spots in front of tubercle between antennae and on either side of tubercle, adjoining eyes. Occipital marking shining dark brown, diamond shaped and sharp pointed in front, prolonged into a narrow line onto or sometimes crossing the tubercle. Antennae with 14 segments in both sexes. Scape brownish yellow to brown, apex usually darker ventrally; pedicel brown; flagellar segments dark brown, basal part of first usually coloured as pedicel; second and following flagellar segments somewhat nodulose in male, cylindrical in female; longest verticillar hairs distinctly shorter than segments in the male, about as long as segments in female.

Thorax. Dorsal part of pronotum yellow, lateral parts brown to dark brown. Stripes of scutum 1 dark brown to black, medial stripe usually somewhat or distinctly lighter coloured over middle anteriorly; lateral stripes downcurved anteriorly, curved part shining (not "more opaque" as in original description) and of moderate size, sometimes small or even absent. Stripes of scutum 2 dark brown to black, antero-lateral corners bordered by a velvety marking. Medial part of transverse suture darkened. Stripes of scutum 1 and scutum 2 sometimes more ferrugineous along margins. Scutellum transparent, ranging from brownish yellow to dark brown, usually with a narrow darker stripe along mid-line. Mediotergite with a longitudinal brown to dark brown stripe on anterior part, marking on posterior part much broader, more transparent and usually lighter coloured. Markings on lateral parts of thorax ferrugineous to light brown, anatergite yellow, posterior part of paratergite with a narrow dark brown stripe. Wings hyaline with faint light brown tinge; pterostigma light brown without or with up to 25 macrotrichia. Coxae, trochanters and femora light brown, coxae 1 usually darkened below pronotum, apices of femora usually broadly darkened, sometimes apical dorsal surface darkened only; tibiae brown to dark brown; tarsi dark brown; claws toothed in male only.

Abdomen. Brownish yellow. Tergite 1 brown to dark brown on antero-dorsal part. Tergites 2-6 or 2-7 with brown to dark brown markings in front of hind margins, markings at most as broad as scutellum and elongate in male, almost forming a continuous stripe, especially on distal tergites; usually more triangular in female, about as broad as mediotergite. Lateral margins of male tergites without or with vague, elongate, light brown markings, in female forming a continuous stripe.

Hypopygium. Hind margin of tergite 9 with a deep and basally rounded incision, the two parts shell-like in ventral aspect with short, spiny rods laterally (figs. 31, 32). Outer dististyle of moderate length (fig. 29). Inner dististyle with a dorsal crest, posterior part of lateral shell with a sharp-curved, almost claw-like projection (figs. 29, 30). Gonapophyses distinctly bifid, posterior arm with small spines ventrally and apically (fig. 33). Medisternal appendage short, protruding beyond sternite 9 (fig. 29). Hind margin of sternite 8 with a large

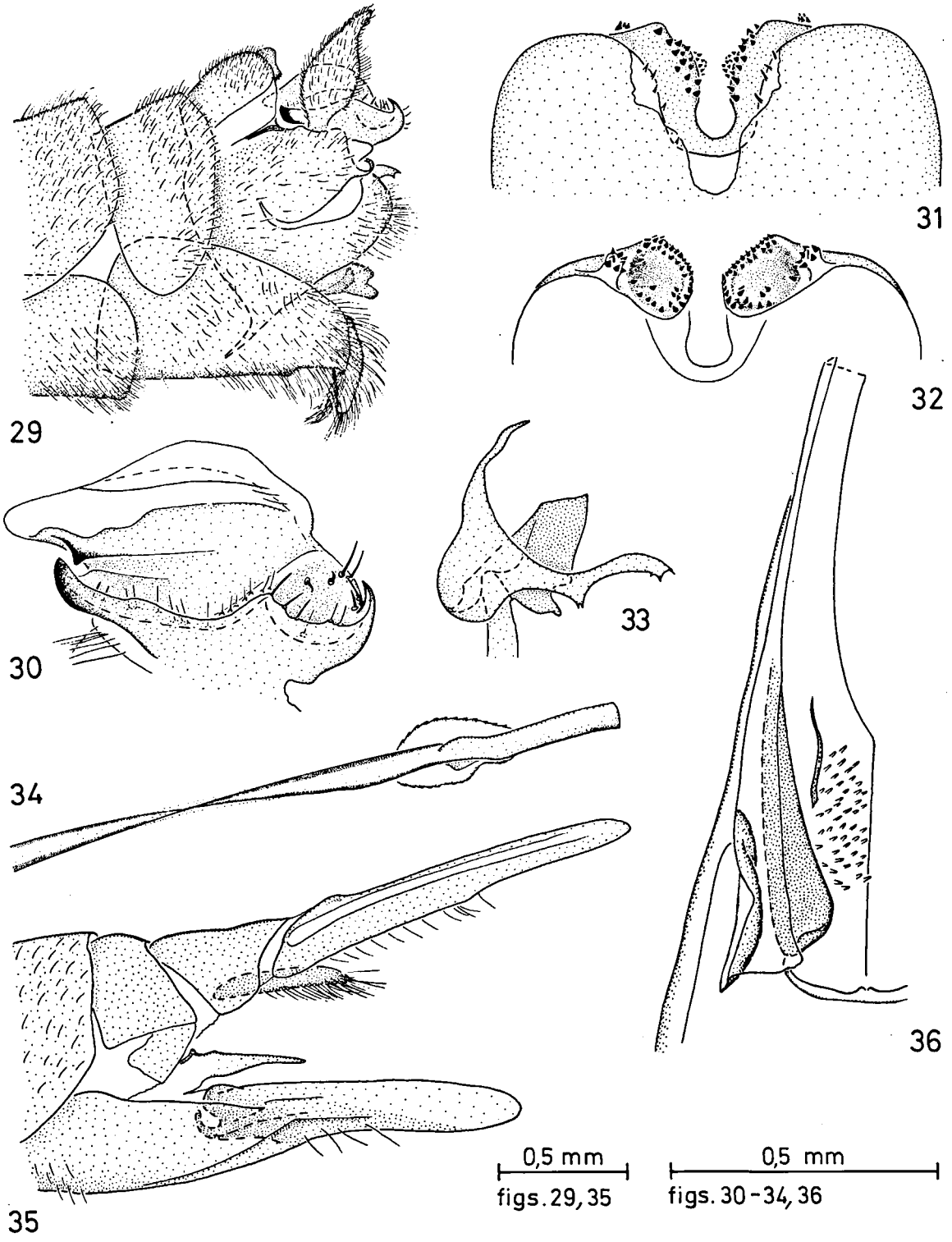


Fig. 29-36. *Nephrotoma navajo* (Alexander, 1949); 29: hypopygium, lateral view; 30: left inner dististyle, outside view; 31 & 32: extension of male tergite 9, dorsal (fig. 31) and ventral (fig. 32) view; 33: adminiculum and left gonapophyse, lateral view; 34: part of intromittent organ showing serrate membrane; 35: ovipositor, lateral view; 36: right hypovalva, dorsal view.

incision, closed by a membrane which protrudes beyond sternite posteriorly and ventrally; hind margin and ventral part of membrane loosely set with long golden-white hairs (fig. 29). Compressor apodeme of semen pump distinctly bifid. Intromittent organ reaching into segment 5 or 6, its structure as described for *ferruginea*, with a round, serrate membrane on either side at the transition from tubular to filamentous (fig. 34).

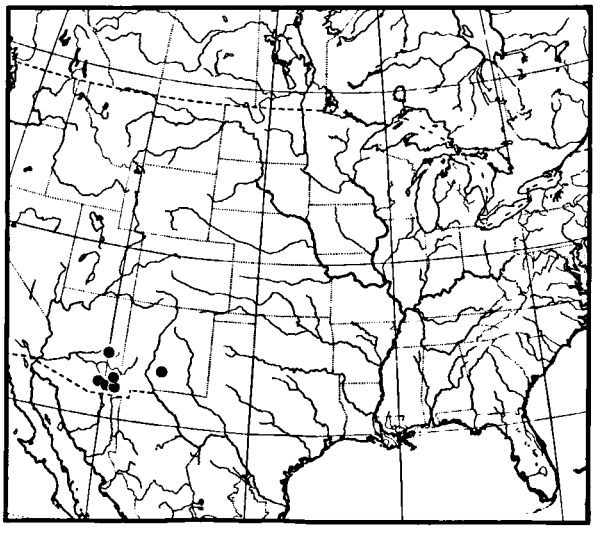
Ovipositor. Cerci slender towards rounded apex; hypovalvae relatively broad and rounded (fig. 35). Rostral extension of hypovalvae laterally indented (fig. 36).

Biology

Unknown. The period of flight seems to be very short, the end of July and the beginning of August. All records except one are from altitudes between 6500′ (1980 m) and 9700′ (2960 m).

Distribution (map 4)

N. navajo is known from Arizona and New Mexico only (see material examined).



Map 4. Distribution of *Nephrotoma navajo* (Alexander, 1949), based on material examined.

THE *ANALIS* SUBGROUP

Oosterbroek (1980) devides the *crocata* group into four subgroups, the *analis*, *flavipalpis*, *lundbecki* and *crocata* subgroups. The *analis* subgroup is defined among others by the, in most European species triangular, flange between the lateral and medial protuberances of the extension of the male tergite 9 and by the shape of the inner dististyle, the anterior beak not being pointed ventrally. These characters are found in the nearctic *virescens*, *alterna* and *subalterna* as well. The first of these species is closely related to the palaearctic *analis*, the other two species with the palaearctic *lamellata*.

Nephrotoma virescens (Loew, 1864)
Figs. 37-44, map 5

Loew, 1864: 62-63, descr (as *Pachyrrhina*); Osten Sacken, 1878: 40, locs (as *Pachyrrhina*); Loew, 1879: 2, key (as *Pachyrrhina*); Aldrich, 1905: 99, locs (as *Pachyrhina*); Doane, 1908: 174, key (as *Pachyrhina*); Johnson, 1913: 41, locs, note (as *Pachyrhina*); Alexander, 1915a: 97, locs (as *Pachyrrhina*); Dietz, 1918: 109, key, 117, comp (as *Pachyrhina*); Alexander, 1919b: 787, locs, 819, locs, 833, biol, 878, biol, 935, key; Alexander, 1920a: 1017, biol, locs; Alexander & McAtee, 1920: 395, key, 397, biol, locs; Dietz, 1921: 260, locs (as *Pachyrhina*); Alexander, 1925b: 172, locs, biol; Johnson, 1925: 35, locs; Leonard, 1928: 699, locs; Rogers, 1930: 10, biol, 16, locs, 17, biol; Alexander, 1931b: 140, biol; Rogers, 1933: 42, biol, locs, distr, 48, biol; Brimley, 1938: 319, locs, date; Alexander, 1940b: 608, locs; Alexander, 1941: 284, locs, 289, locs; Alexander, 1942: 222, key, 234, descr, distr, date, locs; Rogers, 1942: 20, biol, 46, biol, 63, locs, date, biol; Foote, 1956: 222, biol, locs, date; Frommer, 1963: 581, morph; Alexander, 1965: 22, distr; Young, 1978: 411, biol, 413, biol, locs, distr, 432, key; Gelhaus, 1982: 85, distr.

Material examined

Type-material: Holotype ♂, MCZ type no 10309, condition good, labels: "D.C." "Im leben sind Kopf und Thorax halb-grün. Abdomen gelblich" "virescens m." "Loew Coll." "10309" "Type".

Other material: 154♂, 185♀ from the following states: Alabama (2♂, 11♀), Connecticut (1♂), Florida (9♂, 3♀), Georgia (3♂, 11♀), Illinois (1♂), Indiana (2♂, 5♀), Maryland (2♂, 6♀),

Massachusetts (7♂, 7♀), Michigan (10♂, 5♀), Missouri (1♀), New Hampshire (1♂, 1♀), New Jersey (5♂, 10♀), New York (3♂, 4♀), North Carolina (30♂, 24♀), Ohio (4♂, 3♀), Pennsylvania (13♂, 14♀), South Carolina (3♂, 2♀), Tennessee (24♂, 34♀), Virginia (31♂, 44♀), Washington DC (3♂).

Diagnostic features

N. virescens can be very easily recognized by the four, large, velvety black markings on the lateral parts of the prescutum and scutum (fig. 38).

Description

Body length ♂: 11-13 mm, ♀: 17-19 mm.
Wing length ♂: 11-12 mm, ♀: 12-14 mm.
Antennal length ♂: 4.5 mm, ♀: 3-3.5 mm.

Head. Yellowish, dorsal part of rostrum and nasus usually darker, brownish. Occipital marking not darkened. Antennae with 13 segments; scape yellow; pedicel light brown; basal flagellar segments light brown, apical segments darker; especially flagellar segments 2-4 distinctly darkened basally and in male somewhat reniform, the following segments more slender and slightly thickened at base; longest verticillar hairs in male slightly shorter or (apically) as long as segments, in female distinctly longer than segments.

Thorax. Yellow with distinct markings on prescutum and scutum, with vague indications of markings on anepisternite, katepisternite and posterior mediotergite. Scutal stripes shining, ranging from reddish brown to dark brown. Medial stripe lighter coloured along mid-line, lateral stripes of scutum 1 usually darker at anterior and posterior ends, stripes of scutum 2 usually darker posteriorly. Lateral parts of prescutum and scutum with eight large, dull, dark brown to black spots (fig. 38): one at either side of anterior end of medial stripe, one at and below anterior end of each lateral stripes, one around anterior end of each stripe on scutum 2 and crossing transverse suture to contact lateral stripes and one latero-posteriorly of stripes on scutum 2. Wings hyaline; pterostigma light brown with 0-25 macrotrichia. Coxae yellow, sometimes in part light brown; trochanters and femora light brown, latter usually darkened at tip; tibiae brown to dark brown; tarsi dark brown; only male claws toothed.

Abdomen. Brownish yellow, sometimes with brownish markings on posterior part of tergites 2-6 and near mid-length of tergite 2, especially in female.

Hypopygium. Posterior extension of tergite 9 with a narrow medial incision, lateral projections slender (figs. 40, 41). Outer dististyle elongate (fig. 37). Inner dististyle with a distinct crest and a lateral shell, the anterior beak not pointed ventrally (fig. 42). Gonapophyses as in fig. 39. Medisternal appendage with two sclerotized lateral plates, membranously connected ventrally. Medial incision of hind margin of sternite 8 covered by a membranous pouch which protrudes beyond sternite (fig. 37). Hind margin and pouch covered with long yellowish white hairs. Semen pump of moderate size, compressor apodeme apically bifid. Intromittent organ tubular, reaching into segment 2 or 3.

Ovipositor. Cerci slender, hypovalvae parallel-sided, with rounded tip (fig. 43). Fused valvulae connected with coxopodite of tergite 9 by narrow sclerotization. Rostral extensions of hypovalvae short, unmodified (fig. 44).

Biology

N. virescens is found most frequently in wet or damp situations of upland forests, slope forests and swamps. It also occurs in woods and thickets along creeks, rivers and on flood plains, and is apparently rare in more open habitats. The highest altitude from which *virescens* is known is 4900′ (1490 m) (N. Carolina, Haywood County). The species is most active during the evening and night (Rogers, 1930: "Pairs in copulation were found at night on leaves of tall shrubbery and undergrowth. Both sexes came freely to light"). The period of flight is from mid May until mid September (NE: early June to mid September, most frequent throughout July; ME: mid May to early

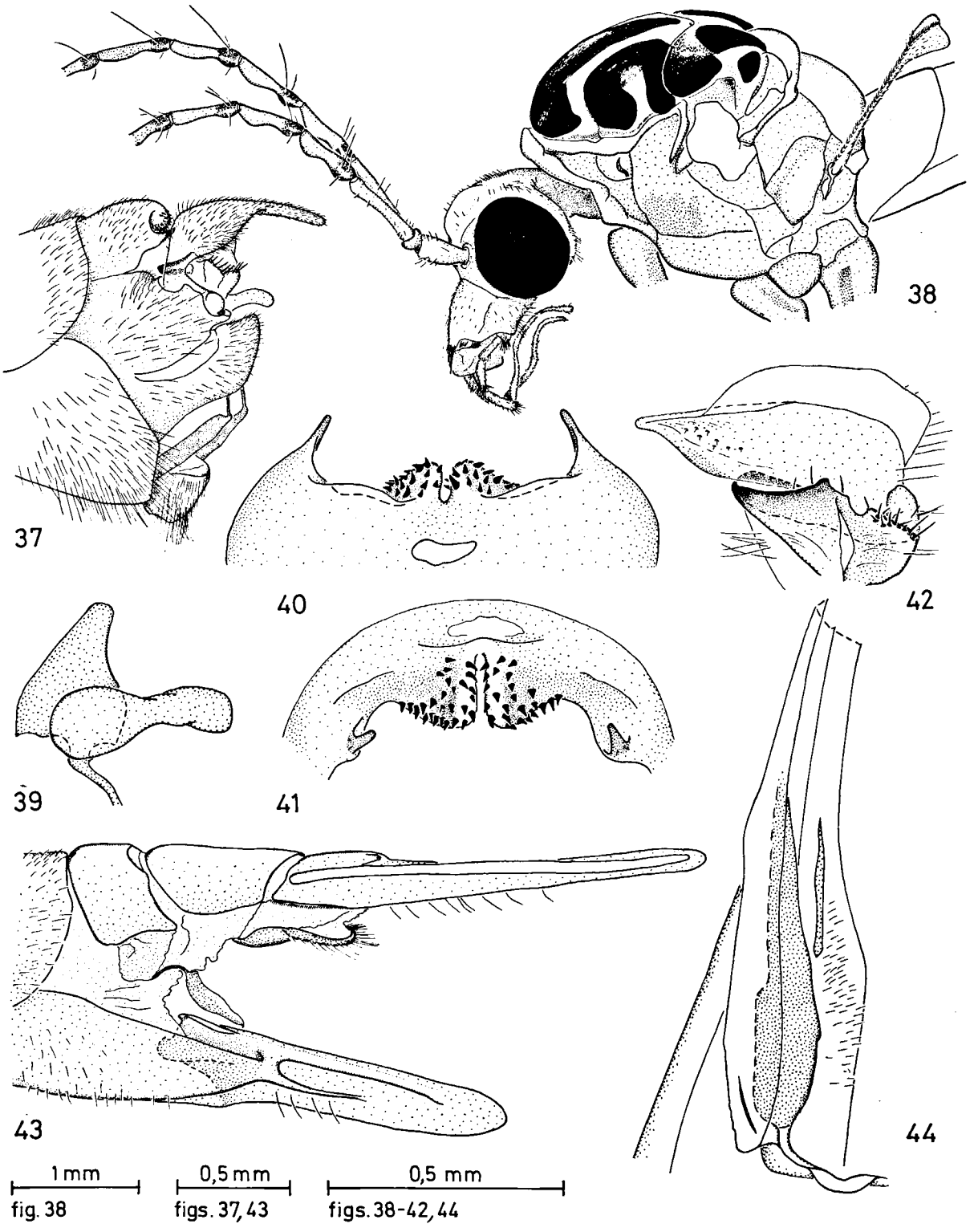
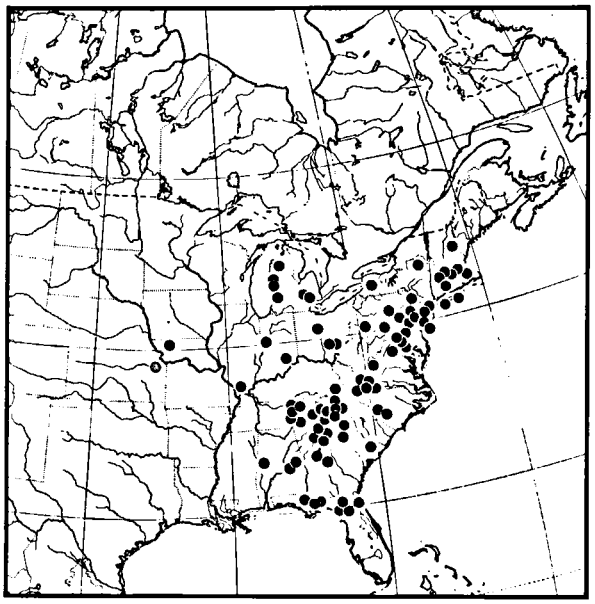


Fig. 37-44. *Nephrotoma virescens* (Loew, 1864); 37: hypopygium, lateral view; 38: male head and thorax, lateral view; 39: adminiculum and left gonapophyse, lateral view; 40 & 41: extension of male tergite 9, dorsal (fig. 40) and ventral (fig. 41) view; 42: left inner dististyle, outside view; 43: ovipositor, lateral view; 44: right hypovalva, dorsal view.

September, most frequent from early June to early August; SE: mid May to early August, most frequent from end May to end June). The immature stages are unknown. According to Alexander (1920a), the larvae live in moss.

Distribution (map 5)

Apart from the states mentioned under material examined, *virescens* is also known from Kansas, Douglas County (Young, 1978). The species is not known from Canada. The distribution is limited as follows: New Hampshire, Carroll County; New York, Fulton and Erie counties; Michigan, Grand Traverse County; Indiana, Parke County; Missouri, Harrison County; Kansas, Douglas County (Young, 1978);



Map 5. Distribution of *Nephrotoma virescens* (Loew, 1864), based on material examined (black dots) and literature (stippled dot).

Illinois, Johnson County; Alabama, Hale County; Florida, Hamilton, Alachua, Jackson, Liberty, Leon, Gadsden, Dixie and Duval counties. The other counties from which material was examined are: Alabama: Lee and Montgomery counties; Connecticut: New Haven County; Georgia: Lumpkin, Dawson, Bibb, Hall, Towns and Lamar counties; Indiana: Jefferson County; Maryland: Montgomery, Calvert, Prince Georges, Baltimore and Harford counties; Massachusetts: Norfolk, Middlesex, Worcester, Dukes, Franklin and Hampshire counties; Michigan: Wayne, Muskegon, Oceana, Livingston and Allegan counties; New Jersey: Atlantic, Essex, Camden and Mercer counties; New York: Nassau and Suffolk counties; North Carolina: Mc Dowell, Macon, Transylvania, Haywood, Jackson, Cumberland, Buncombe and Moore counties; Ohio: Hocking, Delaware and Athens counties; Pennsylvania: Luzerne, Berks, Fulton, Centre, Westmoreland, Montgomery, Delaware, Perry and Philadelphia counties; South Carolina: Abbeville, Spartanburg and Dorchester counties; Tennessee: Grundy, Morgan, Fentress, Cumberland, Carter, Hamilton, Sevier and Blount counties; Virginia: Patrick, Giles, Floyd, Montgomery, Wise, Carroll, Fairfax and Rockbridge counties; Washington DC.

Nephrotoma alterna (Walker, 1848)
Figs. 45-49, 53-55, map 6

Introduction

The following names are considered junior synonyms of *alterna*: *incurva* Loew, 1863, *montana* Dietz, 1918, *evasa* Dietz, 1918, *nexilis* Dietz, 1918, and *perdita* Dietz, 1918. The synonymy is based on examination of the type-material. *N. subalterna* nov. spec. is closely related to and sympatric with *alterna*. Therefore a number of references to *alterna* or one of its synonyms might include reference to *subalterna* as well and are separated as such below.

Literature referring to *alterna*
Walker, 1848: 72, descr (as *Tipula*); Osten Sacken, 1878: 40, note (as *Pachyrrhina*); Aldrich, 1905: 98, note (as *Pachyrhina*); Byers, 1963: 148, note, type-material, descr, syn; Alexander, 1965: 20, syn (as *alterna alterna*); Young, 1978: 408, distr, 409, 413, biol, 415, locs, biol, distr, 432, key; Byers, 1979: 605, biol, date, distr, syn; Gelhaus, 1982: 85, distr (as *alterna alterna*).
Nephrotoma incurva (Loew, 1863).
Loew, 1863: 293, descr (as *Pachyrrhina*); Osten Sacken, 1878: 40, note, distr (as *Pachyrrhina*); Loew, 1879: 2, key (as *Pachyrrhina*); Bergroth, 1888b: 40, comp (as *Pachyrrhina*); Aldrich, 1905: 98, note, distr (as *Pachyrrhina*);

Doane, 1908: 174, key, note (as *Pachrhina*); Tucker, 1909a: 298, locs, date (as *Pachyrhina*); Tucker, 1909b: 306, date (as *Pachyrhina*); Alexander, 1910: 253, locs (as *Pachyrhina*); Van Duzee, 1911: 238, locs (as *Pachyrhina*); Rogers, 1918: 3, locs, biol (as *Pachyrhina*); Alexander, 1919b: 782-786, 818, locs, 831, 877, biol, 935, key, pl XLIV, fig wing; Alexander, 1922: 61, locs; Alexander, 1924: 59, locs; Alexander, 1925b: 172, locs; Johnson, 1925: 34, locs; Alexander, 1926b: 240, locs; Alexander, 1928: 57, locs; Leonard, 1928: 699, locs; Alexander, 1929a: 235, locs; Alexander, 1929b: 25, locs; Alexander, 1929c: 297, locs; Alexander, 1930: 272, locs; Alexander, 1931: 138, locs; Winn & Beaulieu, 1932: 8, locs; Rogers, 1933: 42, 48, biol; Procter, 1938: 283, locs; Rogers, 1942: 19, 46, 62, biol; Alexander, 1962: 8, locs; Byers, 1963: 148, syn; Alexander, 1965: 20, syn; Byers, 1979: 605, syn.

Nephrotoma montana (Dietz, 1918).

Dietz, 1918: 110, key, 122, comp, 123, descr, comp, pl IV, fig wing (as *Pachyrhina*).

Nephrotoma evasa (Dietz, 1918).

Dietz, 1918: 110, key, 122, comp, 124, descr, comp, pl IV, fig wing (as *Pachyrhina*); Alexander, 1919b: 937, descr; Alexander, 1942: 223, key, 227, descr; Alexander, 1965: 21, syn.

Nephrotoma nexilis (Dietz, 1918).

Dietz, 1918: 110, key, 122, comp, 125, descr, comp, pl IV, fig wing, pl VII, fig hyp (as *Pachyrhina*); Alexander, 1965: 20, distr (as *alterna nexilis*); Cole, 1969: 53, distr (as *alterna nexilis*); Byers, 1979: 605, distr (as *alterna nexilis*).

Nephrotoma perdita (Dietz, 1918).

Dietz, 1918: 109, key, 116, descr, comp (as *Pachyrhina*); Alexander, 1919b: 936, descr, locs; Alexander, 1965: 20, syn.

Literature referring to either *alterna* or *subalterna*

As *Nephrotoma alterna alterna*: Alexander, 1965: 20, distr.

As *Pachyrrhina*, *Pachyrhina* or *Nephrotoma incurva*: Snodgrass, 1904: 201, descr, pl XI, figs hyp; Alexander, 1915b: 466, descr, 468, comp; Dietz, 1918: 109, key, 117, comp; Alexander, 1920b: 110-111, comp; Alexander & McAtee, 1920: 395, key, 397, locs; Dietz, 1921: 260, locs; Rogers, 1930: 11, biol, 16, locs, biol; Dickinson, 1932: 165, locs, 214, key, 216, note, distr, fig wing; Brimley, 1938: 319, locs; Alexander, 1940b: 606, locs; Alexander, 1941: 284, note, 287, comp, 289, locs; Alexander, 1942: 222, key, 229, descr, distr; Foote, 1956: 222, biol.

As *Nephrotoma montana*: Brimley, 1938: 319, locs; Alexander, 1941: 284, note, 287, comp; Alexander, 1965: 21, distr.

As *Nephrotoma perdita*: Dickinson, 1932: 165, 168, locs, 214, key, 217, distr, fig wing; Alexander, 1942: 222, key, 231, comp, distr, note.

Material examined

Type-material: *Tipula alterna*: Holotype ♀, BMNH, condition good, labeled: "R" "Tipula alterna, ♀, Walker (Type)" "Type" "One of Walkers series so named, E.A.W.". Examined and labeled holotype by Byers (see Byers, 1963). The type-locality is given by Walker (1848) as "Nova Scotia". *Pachyrhina incurva*: Lectotype ♂, MCZ type no. 10263, condition fair, labeled: "3" "incurva m." "Loew Coll." "10263" "Type"; Paralectotype ♂, MCZ type no. 10263, condition poor, labeled: "Packard" "Loew Coll." "10263" "Type". The synonymy with *alterna*, already proposed by Osten Sacken (1878), was established by Byers (1963). The paralectotype, examined by Byers in 1961, was not found in the ANSP collection in 1982. *Pachyrhina montana*: Holotype ♀, ANSP type no. 6451, condition fair, labels: "Black Mts. N.C. Coll Dr Dietz VI-10-12" "Holotype" "Holotype Pachyrhina montana W. G. Dietz 6451". New synonymy. *Pachyrhina evasa*: Holotype ♀, ANSP type 6452, condition good (ovipositor in microvial), labeled: "Schoolcraft Co. Mich. Floodwood VII 1915 J. S. Rogers" "Holotype" "Holotype Pachyrhina evasa W. G. Dietz 6452". Alexander (1965), refers to *evasa* as "? = calinota"; examination of the ovipositor showed that *evasa* is identical with *alterna*, although in colouration it more nearly resembles *subalterna* (see discussion). New synonymy. *Pachyrhina nexilis*: Holotype ♂, condition good, ANSP type no. 6453, labels: "10/20/16" "Oslar. Clear Creek Col." "Holotype Pachyrhina nexilis W. G. Dietz 6453"; Paratype ♂, ANSP type no. 6453, condition good, labels: "7/26/15" "Oslar. Clear Creek Col." "Paratype Pachyrhina nexilis W. G. Dietz 6453"; 2♂ paratypes, ANSP types no. 6453, condition good, labels: "8/23/16" "Oslar. Bear Creek Morrison Col." "Paratype Pachyrhina nexilis W. G. Dietz 6453". New synonymy. *Pachyrhina perdita*: Holotype ♀, ANSP type no. 6465, condition poor (ovipositor missing), labels: "Aweme Manitoba E. Criddle VII 7 13" "Holotype" "Holotype Pachyrhina perdita W. G. Dietz 6465". New synonymy.

Other material: 178♂, 193♀, from the following states and provinces: Alabama (1♀), British Columbia (2♀), Colorado (1♀), Con-

necticut (2♀), Florida (3♂, 2♀), Georgia (3♂, 2♀), Illinois (5♀), Indiana (7♂, 12♀), Kansas (7♂, 16♀), Kentucky (1♀), Maine (2♂, 4♀), Manitoba (3♀), Maryland (1♂, 1♀), Massachusetts (2♂, 3♀), Michigan (51♂, 37♀), Minnesota (7♂, 2♀), Missouri (1♀), Newfoundland (2♀), New Hampshire (2♂, 2♀), New Jersey (5♂, 5♀), New York (21♂, 14♀), North Carolina (7♂, 19♀), Nova Scotia (2♀), Ohio (3♀), Ontario (11♂, 5♀), Pennsylvania (12♂, 16♀), Quebec (2♂), South Dakota (3♀), Tennessee (7♂, 4♀), Vermont (4♂, 1♀), Virginia (16♂, 24♀), Wisconsin (5♂, 1♀).

Diagnostic features

N. alterna and *subalterna* are closely related species. Apart from the colouration, they differ as follows. Males: Inner dististyle of *alterna* (fig. 49) with an upright latero-posterior outgrowth, a lower posterior outgrowth in *subalterna* (fig. 52); medisternal appendage of sternite 9 not invaginated, without pubescence and shining in *alterna* (fig. 45), medially invaginated and pubescent in *subalterna* (fig. 50); lower arm of gonapophyses longer in *alterna* (fig. 46), upper arm longer in *subalterna* (fig. 51); compressor apodeme of semen pump larger in *alterna* (fig. 54) than in *subalterna* (fig. 57); vesica of semen pump small in *alterna* (fig. 54), swollen in *subalterna* (fig. 57); intromittent organ reaching into segment one or two in *alterna*, into segment four or five in *subalterna*. Females: dorsal part of hypovalvae not or only slightly extending beyond internal arch in *alterna* (fig. 55) and distinctly so in *subalterna* (fig. 56); connection between internal arch and major ridge short and strongly curved in *alterna* (fig. 55), more elongate in *subalterna* (fig. 56). Males of both species can be easily recognized by external characters of the hypopygium (inner dististyle and medisternal appendage as described above), females only by internal characters of the ovipositor. To facilitate the recognition of females, colourational characters are therefore to be preferred, but these are not always reliable, especially because specimens of *alterna* can have their thoracic and abdominal markings less conspicuous. Usually females can be separated on the following grounds: occipital marking large, dull bordering reaching base of tubercle in *alterna*, occipital marking smaller in *subalterna*, not reaching tubercle and usually without, rarely with a small dull anterior border; flagellar segments dark brown in *alterna*, basal segments brownish yellow or brown in *subalterna*, apical ones darker, usually with lighter coloured bases; ground colour of thorax and abdomen pale yellow in *alterna*, deep yellow in *subalterna*; anatergite darkened in *alterna*, yellowish in *subalterna*; anterior part of mediotergite with a darkened stripe over middle in *alterna*, in *subalterna* yellowish, rarely with a narrow stripe over middle; abdominal markings usually very conspicuous in *alterna*, less conspicuous and not distinctly prolonged towards preceding tergites in *subalterna*; basal part of sternite 8 darkened in *alterna*, usually yellowish in *subalterna*.

Description

Body length ♂: 11-14 mm, ♀: 18-20 mm.
Wing length ♂: 11-12 mm, ♀: 13-15 mm.
Antennal length ♂: 5-6 mm, ♀: 3.5-4 mm.

Head. Pale yellow to yellow, vertex brownish yellow. Dorsal part of rostrum shining brown to dark brown. Occipital marking dark brown to black, marking usually about as broad as dorsal part of pronotum, shining central part with rounded lateral margins, marking usually diamond shaped by way of distinctly dull bordering which is usually broadened antero-laterally and acute rostrally, reaching base of tubercle, rarely prolonged onto tubercle. Area between eyes and tubercle usually brown, rarely connected with occipital marking. Antennae with 13 segments; scape yellow, in the male dorsally infuscated; pedicel light brown to dark brown; flagellar segments dark brown to black, in male nodulose basally, longest verticillar hairs slightly shorter or (apically) as long as segments; in female cylindrical, longest verticillar hairs distinctly longer or (apically) twice as long as segments.

Thorax. Ground colour of thorax pale yellow. Pronotum dorsally yellow, laterally darkened. Scutal stripes, scutellum and markings on mediotergite usually dark brown to black but sometimes much paler, medial stripe only darkened over middle, lateral stripes brownish, the stripes of scutum 2 darkened only anteriorly, scutellum with a narrow medial line, mediotergite with a narrow, darkened, medial stripe on its anterior half. Lateral stripe of scutum 1 always distinctly downcurved anteriorly, curved part dark brown and dull. Antero-lateral corners of scutum 2 distinctly dark brown and dull bordered. Lateral parts of thorax with markings very variable in expression, ranging from hardly indicated to dark brown or black, anatergite and posterior half of katatergite darkened, usually dark brown. Coxae and trochanters pale yellow, coxae with darkened spots on upper parts; femora light brown, tips broadly darkened, femora 1 in both sexes gradually darkening beyond basal one-third or half; tibiae light brown to brown, the tips darkened; tarsi dark brown; claws toothed in male only. Wings hyaline; pterostigma dark brown, rarely without, usually with 15-30 macrotrichia; just below pterostigma a distinct seam along basal part of R4 + 5 and cross-vein r-m; a less distinct seam along m-cu, M4 and apical part of CU; wingtip broadly clouded.

Abdomen. Ground colour of abdomen pale to brownish yellow. Brown to black dorsal markings very variable in expression, especially in female. Male: tergite 1 usually broadly darkened except laterally; tergites 2-5 or 2-6 with elongate markings, anterior one-fourth or one-fifth of each tergite yellowish, markings gradually broadening towards hind margins and posteriorly as broad as mediotergite; a more rounded spot on anterior half of tergite 2; sides of tergites with narrow infuscated line well above margin; sternites unmarked; segments 7 and 8 dark brown to black; markings sometimes less conspicuous on tergites 4-6; segment 7 sometimes darkened posteriorly only. Female: tergite 1 darkened dorsally, rarely entirely except lateral corners; tergites 2-7 with transverse markings along hind margins occupying posterior one-third or one-fourth of each tergite, markings prolonged dorsally towards preceding tergite, most distinctly so on anterior tergites, sometimes forming a continuous stripe as broad as scutellum on tergites 2-3 or 2-4; markings usually in contact laterally with brown to dark brown lateral markings or stripes; tergite 2 with a more rounded spot near mid-length; sternites unmarked; tergite 8 and basal part of sternite 8 dark brown to black; markings on tergites 2-7 sometimes not prolonged over middle and somewhat triangular only; sometimes not extended laterally but forming a row of dorsal spots, rarely a continuous stripe, rarely a row of spots well separated from hind margins.

Hypopygium. Extension of tergite 9 consisting of two concave parts, separated by a narrow medial incision, laterally distinctly protruding beyond tergite (figs. 45, 47, 48). Outer dististyle slender (fig. 45). Inner dististyle with small rounded crest and large blackened outgrowth on posterior part of lateral shell (fig. 49). Gonapophyses situated beside adminiculum and largely bifid, lower arm longer and somewhat curved (fig. 46). Medisternal appendage of sternite 9 rounded, not pubescent, not invaginated medially and in dry specimens conspicuously shining (fig. 45). Hind margin of sternite 8 without incision. Semen pump with large anterior appendages and large bifid compressor apodeme (fig. 54). Intromittent organ tubular and reaching into first or second segment.

Ovipositor. Cerci relatively short, hypovalvae broad (fig. 53); dorsal part of hypovalvae not or only slightly extended beyond internal arch (fig. 55). Fused valvulae and furca small and slender, the former only membranously connected with coxopodite of tergite 9.

Biology

N. alterna occurs in and along borders of deciduous forests, at moist to wet places near lakes, ponds, rivers, creeks and the like. It can also be found, although less frequently, in wet

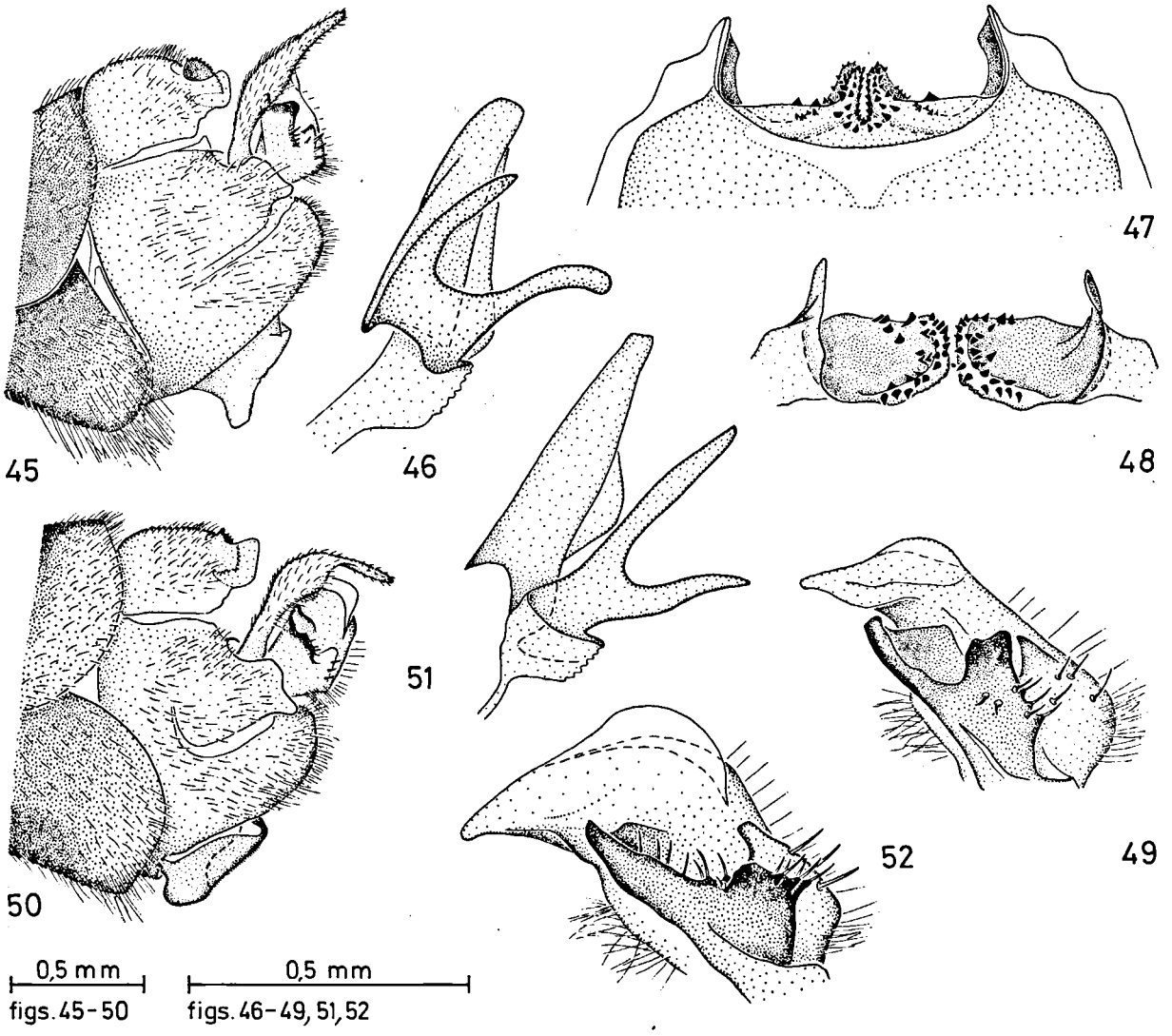


Fig. 45-49. *Nephrotoma alterna* (Walker, 1848); 45: hypopygium, lateral view; 46: adminiculum and left gonapophyse, lateral view; 47 & 48: extension of male tergite 9, dorsal (fig. 47) and ventral (fig. 48) view; 49: left inner dististyle, outside view. Fig. 50-52. *Nephrotoma subalterna* (nov. spec.); 50: hypopygium, lateral view; 51: adminiculum and left gonapophyse, lateral view; 52: left inner dististyle, outside view.

meadows and grasslands, marshes, or on the grassy banks of streams. Oviposition is into moist to wet soils. The larvae are unknown. Rogers (1933) reports for northern Florida "Adults crepuscular or nocturnal, the few Florida records are from deep shaded ravines or low hammocks". Altitudes are known for the following states: Maryland, 3000′ (910 m), North Carolina, 2300-4900′ (700-1500 m), Tennessee, 3000′ (910 m), Virginia, 3900′ (1190 m). In the SE states the period of flight is from the beginning of March until early June. In the ME and NE states from early May until the end of August, with a clear peak during the second half of June and the first half of July. The single latest record is October 12 (Colorado, holotype of *nexilis*).

Distribution (map 6)

In the east the range of *alterna* extends from northern Florida (Liberty and Leon counties;

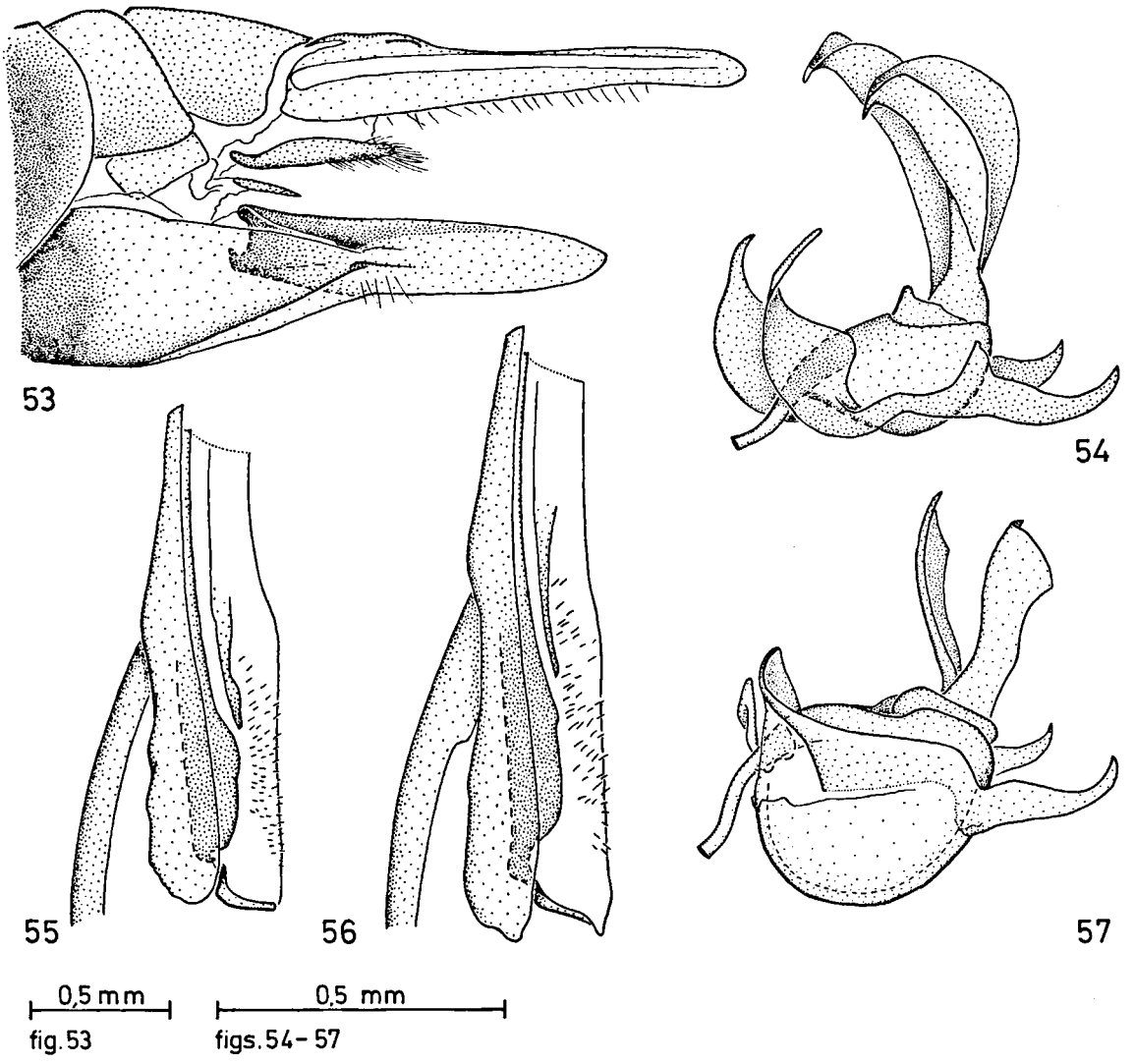
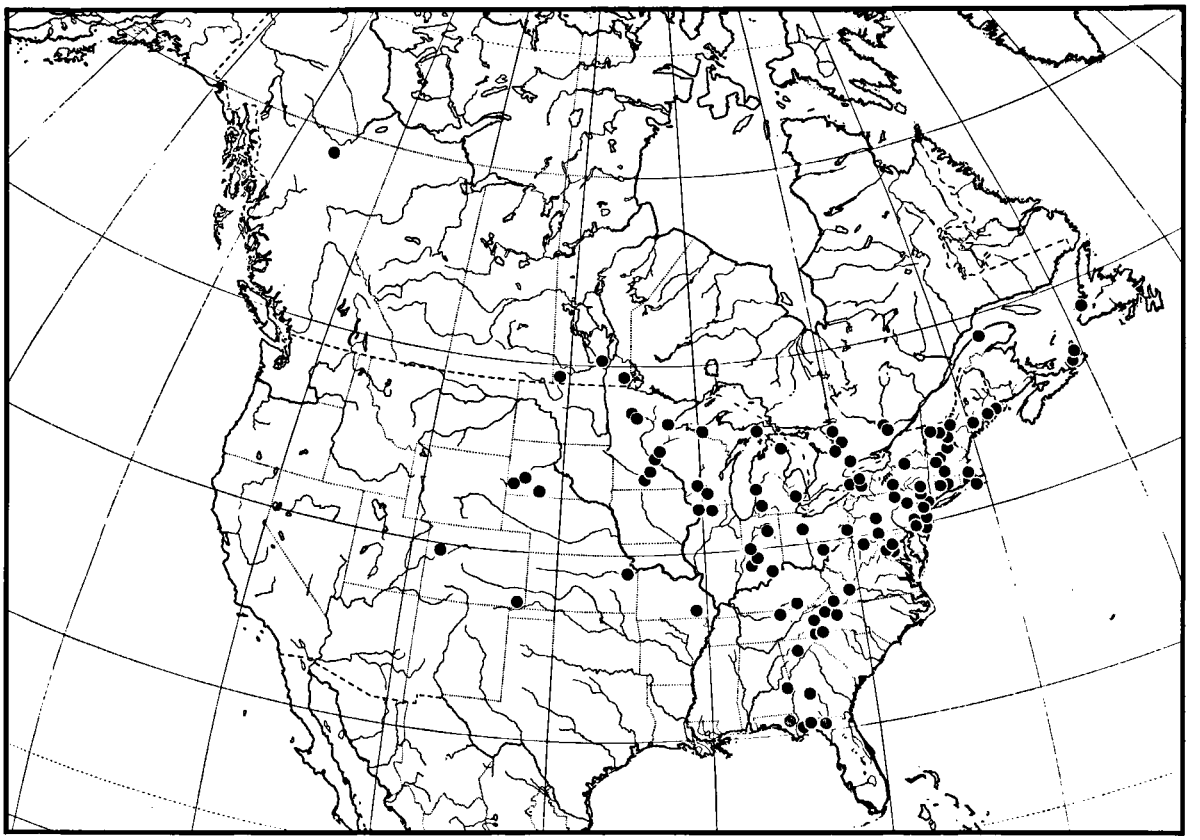


Fig. 53-55. *Nephrotoma alterna* (Walker, 1848); 53: ovipositor, lateral view; 54: semen pump, lateral view; 55: right hypovalva, dorsal view. Fig. 56-57. *Nephrotoma subalterna* (nov. spec.); 56: right hypovalva, dorsal view; 57: semen pump, lateral view.

Rogers (1933) also Jackson and Jefferson counties) along the Appalachians to Nova Scotia (Baddeck, Breton Cove) and Newfoundland (Romainec Brook near Port au Port). Other northern localities are Aylmer and Mont Joli (Quebec), Toronto and Kearney (Ontario), Schoolcraft County (Michigan), West Hawk Lake, Teulon, and Aweme (25 km S of Brandon) (Manitoba) and, far outside the general range, Muncho Lake (British Columbia; material collected by C. P. Alexander on his 1952 trip to Alaska). Other western material was examined from South Dakota (Custer, Bennett and Pennington counties), Colorado (type-material of *nexilis*, Clear Creek apparently in Garfield County and Bear Creek in Baca County), Kansas (Douglas County) and Missouri (Carter County).



Map 6. Distribution of *Nephrotoma alterna* (Walker, 1848), based on material examined (black dots) and literature (stippled dots).

Nephrotoma subalterna spec. nov.
Figs. 50-52, 56-57, map 7

Type-material

All *subalterna* specimens examined during this study are mentioned here. Holotype ♂, UKaL, condition good, labeled: "Virginia Giles Co. No. elev. 3850 ft Mt. Lake Biol. Sta. 8 August 1961 George W. Byers" "taken at light". Paratypes: 6♂, 10♀, paratopotypes with the following dates: 1♀, 9-VII-1935, R. E. Bellamy, UMMZ, 1♀, 13-VII-1935, R. E. Bellamy, UMMZ, 1♀, 23-VI-1939, J. S. Rogers, UMMZ, 1♂, 2-VII-1943, J. S. Rogers, UMMZ, 1♂, 13-VI-1946, J. S. Rogers, UMMZ, 1♂, 1-VIII-1961, 4100′, G. W. Byers, apparently collected first by an asilid pinned with the ♂, UKaL, 1♀, 15-VI-1965, 3900′, G. W. Byers, UKaL, 1♂, 1♀, 19-VI-1965, 3450′, G. W. Byers, UKaL, 1♀, 26-VI-1965, 3450′, G. W. Byers, UKaL, 1♀, 30-VI-1965, 3900′, G. W. Byers, UKaL, 1♀, 2-VIII-1967, 3850′, G. W. Byers, UKaL, 1♂, 1♀, 23-VI-1969, 3850′, G. W. Byers, ZMA, 1♂, 10-VII-1969, 3850′, G. W. Byers, ZMA, 1♀, 14-VIII-1971, G. W. Byers, ZMA; 3♀, Virginia, Giles County, Wind Rock, 5 mi N Mt Lake, 4100′, G. W. Byers, UKaL, 26-VII-1961 (1♀), 9-VIII-1971 (1♀), 22-VI-1975 (1♀); 1♂, 1♀, Virginia, Giles County, Cold Spring, Va hwy 700, 3450′, G. W. Byers, UKaL, 15-VI-1975 (♂), 8-VII-1975 (♀), 2♀, Virginia, Giles County, Mt Lake-Doe Crk, 3100′, G. W. Byers, UKaL, 21-VI-1969 (1♀), 27-VI-1969 (1♀); 1♀, Virginia, Giles County, 5 mi NE Pembroke, 8-VIII-1961, G. W. Byers, UKaL; 1♀, Virginia, Giles County, Mt Lake vicinity,

21-VI-1969, 3450′, G. W. Byers, UKaL; 1♀, Virginia, Giles County, Bald Knob, 26-VII-1961, 26-VII-1961, 3850′, G. W. Byers, UKaL; 1♀, Virginia, Rockbridge County, Blue Ridge Pkwy, 2-VIII-1982, P. Oosterbroek, ZMA; 1♂, 1♀, North Carolina, Transylvania County, 9-VI-1934, 3400′, J. S. Rogers, UMMZ; 1♂, Tennessee, Fentress County, Buffalo Cove, 11-VI-1925, D. M. Bates, UMMZ; 1♂, 5♀, Indiana, Parke County, Turkey Run Pk, G. W. Byers, with the following dates: 1♀, 19-VI-1950, UMMZ, 1♀, 22-VI-1950, UMMZ, 2♀, 28-VI-1950, UMMZ, 1♂, 1♀, 31-V-1963, ZMA; 2♂, 2♀, Indiana, Montgomery County, Shades St Park, 28-VI-1950, G. W. Byers, UKaL; 1♂, 1♀, Georgia, Union County, Neel's Gap, 3000′, 10-VI-1958, G. W. Byers, UKaL; 1♀, Georgia, Rabun County, Rabun Bald, 3900-4600′, 20-VI-1967, G. W. Byers, UKaL.

Diagnostic features

See under *alterna*.

Description

Body length ♂: 11-14 mm, ♀, 18-20 mm.
Wing length ♂: 11-12 mm, ♀,: 13-15 mm.
Antennal length ♂: 5-6 mm, ♀: 3.5-4 mm.

Head. Sides of rostrum, genae and postgenae pale yellow, vertex brownish yellow, dorsal part of rostrum more brownish. Occipital marking dark brown, not as broad as dorsal part of pronotum and not reaching tubercle, in male with a shining central part, narrowly bordered by a dull seam, more conspicuous anteriorly giving marking a diamond shape, in female usually without a dull border and marking more triangular or oval, rarely diamond-shaped by way of dull anterior border. Antennae and verticils as in *alterna*; antennae in male coloured as in *alterna* with flagel 1 usually lighter; in female pedicel and basal flagellar segments brownish yellow to brown, apical segments gradually darker, bases usually lighter coloured.

Thorax. Ground colour of the thorax in male pale yellow to yellow, in female deep yellow. Pronotum dorsally yellow, laterally brownish. Scutal stripes usually dark brown in male, sometimes in part lighter coloured as in female, in female medial stripe dark brown along mid-line, lateral margins broadly lighter coloured, brownish, lateral stripes brownish, stripes of scutum 2 brownish, sometimes anterior ends darker. Lateral stripes distinctly downcurved anteriorly, curved part dull and usually dark brown. Antero-lateral corners of scutum 2 broadly dark brown and dull-bordered. Scutellum ranging from brownish yellow to dark brown. Mediotergite in male with a brown to dark brown stripe on anterior half which distinctly broadens posteriorly, in female anterior part deep yellow, rarely with a darkened stripe along mid-line, posterior part transparently brownish yellow. Markings on lateral parts of thorax weakly indicated, at most posterior part of katatergite dark brown in male. Wings hyaline with yellowish tinge, especially along costal area; pterostigma dark brown, rarely without, usually with 15-30 macrotrichia; seams along veins as in *alterna*; wing tip broadly clouded. Legs as in *alterna*.

Abdomen. Pale yellow to deep yellow in male, largely deep yellow in female. Tergite 1 unmarked in female, rarely with a brown spot dorsally as in male. Male tergites 2-6 with triangular transverse bands along their hind margins, largest on anterior tergites and occupying posterior one-third; a small rounded spot on anterior part of tergite 2; female with triangular bands along hind margins of tergites 2-4 and sometimes 7 as well, with smaller bands or spots on tergites 5 and 6, sometimes distinct markings on tergites 2 and 3 only and remainder of abdomen unmarked; usually a smaller spot on anterior part of tergite 2. Lateral parts of tergites and sternites usually unmarked, sometimes with weak indication of lateral line (male) or lateral spots (female). Male segments 7 and 8 dark brown, sometimes only posterior part of segment 7 darkened or tergite 9 darkened as well. Female tergite 8 ranging from entirely yellowish to entirely dark brown, basal part of sternite 8 rarely darkened.

Hypopygium. Very much as in *alterna* but

differing in details as presented under diagnostic features of *alterna*.

Ovipositor. As in *alterna*, differing in a few internal characters of the hypovalvae; see diagnostic features under *alterna*.

Biology

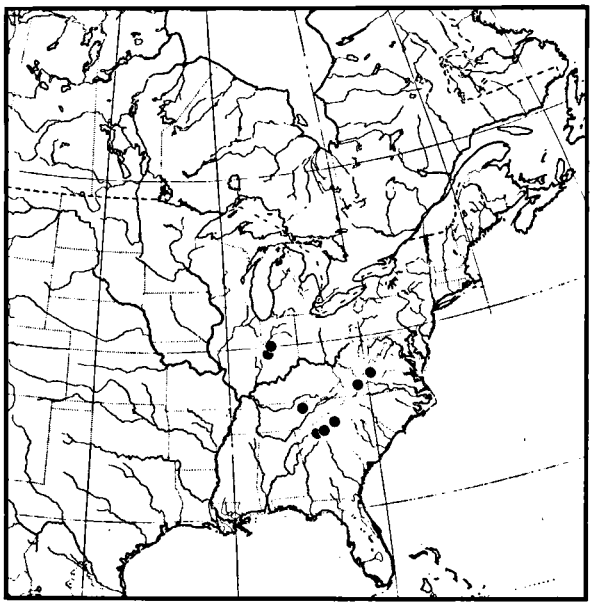
The recorded period of flight lies between May 31 and August 14. Altitudes are mentioned with most of the material studied and run from 3000 to 4100 (4600) feet (910 to 1250 (1400) metres).

Distribution (map 7)

As given under type-material, *subalterna* is known from the following states: Indiana (Parke and Montgomery counties), Virginia (Giles and Rockbridge counties), Tennessee (Fentress County), North Carolina (Transylvania County) and Georgia (Union and Rabun counties).

Discussion

The female holotype of *evasa* Dietz possesses practically all the colour characters of *subalterna*, except that the occipital marking is intermediate between *alterna* and *subalterna*. Nevertheless the name *evasa* is synonymized with *alterna* for the following reasons. 1.) The hypovalvae are of the *alterna* type (fig. 55). 2.) The specimen looks as if it was collected or preserved for some time in liquid which can have influenced the expression of colouration (moreover, for some reason, many of the specimens in the Dietz collection show an abberant colouration, giving Dietz the opportunity to describe a number of junior synonyms). 3.) The type-locality (Floodwood, Schoolcraft County, Michigan) lies far outside the apparent range of *subalterna* but not outside that of *alterna*.



Map 7. Distribution of *Nephrotoma subalterna* (nov. spec.).

Etymology

The name *subalterna* indicates that the species is closely related to *alterna*.

THE *LUNDBECKI* SUBGROUP

In the Nearctic four species occur which belong to the *lundbecki* subgroup: *lundbecki* (circumpolar), *lugens* and *byersi*, both related to the eastern palaearctic *erebus*, and *altissima*, related to the eastern palaearctic *rubriventris*. Defining characters are the shape of the extension of the male tergite 9, the inner dististyle and the adminiculum. The subgroup belongs to the *crocata* group but the position within the group remains uncertain. The subgroup comprises the above-mentioned six species and probably also the eastern palaearctic *villosa*. The species *altissima* as discussed here, however, might well represent a species-complex of about three species.

Nephrotoma lundbecki (Nielsen, 1907)
Figs. 58-68, map 8

Introduction

N. lundbecki has a circumpolar and eastern palaearctic distribution. Literature, types, synonyms, description, variability, biology and

distribution are presented by Oosterbroek (1979c), with emphasis on the Palaearctic. The text below deals with the Nearctic only.

Nielsen, 1907: 390, descr (as *Pachyrhina*); Alexander, 1934b: 4, locs, distr; Alexander, 1965: 21, distr; Oosterbroek, 1979c: 171, lit, 172, types, syn, 173, locs, 174, descr, 175-178, figs hyp, figs ovipositor, 178, biol, 179, 180, distr, 180, note.

Nephrotoma arcticola.

Alexander, 1919c: 10c-11c, descr, pl 1, fig wing, pl 2, fig antenna, pl 3, figs hyp; Alexander, 1934b: 4, syn; Alexander, 1965: 21, syn.

Material examined

Type-material: *Pachyrhina lundbecki*: Although the original description does not account for localities, number of type-specimens and their sex (except for both sexes being described and for stating that the species is hitherto known from East Greenland only), the type-series, examined by the present author in 1978, is thought to comprise the following specimens, preserved in the Copenhagen Museum: Lectotype ♂, condition good, labeled: "Hekla Havn, 19.6.92, Deichmann" (lectotype designation by Mannheims, 1962). Paralectotypes: 4♂, Hekla Havn, 18.6.92 (1♂), 5.7.92 (1♂), 17.7.92 (2♂), Deichmann; 2♂, 5♀, Sabine I., 7.1900, Deichmann; 1♂, Jameson Land, Nordost Bucht, Deichmann; the lectotype and the females from Sabine I. bear a small red label with handwritten "Type". *Nephrotoma arcticola*: The type-series includes 1♂ holotype and 5♂, 2♀, paratopotypes, from "Bernard harbour, Northwest Territories", out of which 2♂ paratopotypes preserved in CNCO and 1♂, 1♀ paratopotypes preserved in USNM (Alexander coll.), were examined by the present author. The synonymy with *lundbecki* was established for the first time by Alexander (1934b).

Other material: 32♂, 14♀, from Alaska (25♂, 12♀, McKinley Nat. Park, Toklat River, Fairbanks and Umiat), North West Territories (6♂, 2♀, Bernard Harbour, Banks Island and Hazenkamp, Ellesmere Island) and Michigan (1♂, Shiawassee County, see distribution).

Diagnostic features

The species of the *lundbecki* subgroup are extensively dark coloured. Almost entirely darkened forms are found in *lugens*, *byersi* and *altissima*. Characters by which the four species can easily be recognized are: *lundbecki*: abdomen with longitudinal dorsal markings or a dorsal stripe; *lugens*: region between stripes of scutum 1 dull; *byersi*: occipital marking at least in part lighter coloured than surrounding vertex; *altissima*: occipital marking darker coloured than surrounding vertex, rarely entire head darkened.

Description

Body length ♂: 12-13 mm, ♀: 17-19 mm.
Wing length ♂: 12-13 mm, ♀: 14-15 mm.
Antennal length ♂: 4.5 mm, ♀: 3 mm.

Head. Dorsal part of rostrum broadly dark brown to black, lateral part usually largely darkened as well, especially on lower half. Ring around eyes usually broadly pale yellow to yellow, with a small but distinct dark brown to black spot between frontal tubercle and eyes; caudal part of ring sometimes darkened brown. Remainder of head darkened, brown to black, with a white-grey pruinosity, especially on ventral half. Occipital marking dark brown to black, large, occupying area between eyering, more or less shining except for dull anterior margins and broad anterior prolongation which crosses the tubercle and contacts the rostrum. Antennae with 13, dark brown to black segments, scape with traces of yellow sometimes; male segments slightly nodulose basally beyond flagel 1 and longest verticillar hairs two-third to three-fourth the length of segments; flagellar segments cylindrical in female, longest verticillar hairs somewhat longer than segments.

Thorax. Ground colour yellow with extensive dark brown to black markings and with a white-grey pruinosity, which is less developed on the scutal stripes. Pronotum dorsally brown, sometimes in part yellowish, laterally dark brown to black. Scutal stripes black, usually separated but sometimes broadly in contact on scutum 1 and almost in contact on scutum 2.

Lateral stripes broadly downcurved to contact paratergite, curved part shining although less distinct because of pruinosity. Antero-lateral corners of scutum 2 with a dull seam. Scutellum ranging from brown to black, sometimes more yellowish with a darkened stripe along mid-line. Mediotergite with a broad stripe on the anterior half which distinctly broadens posteriorly. Lateral markings very conspicuous, dark brown to black, sometimes entire lateral thorax darkened with a large yellowish area between basalare and pronotum and more restricted yellow below basalare and on anterior part of katatergite. Coxae dark brown to black with a white-grey pruinosity, apices of coxae sometimes lighter; trochanters shining brown to black; femora light brown to brown, broadly darker towards tip; tibiae and tarsi brown to dark brown; claws toothed in male only. Wings hyaline, sometimes with a light brown tinge; pterostigma usually dark brown, sometimes brown, without or with up to 10 macrotrichia; basal part of vein R4 + 5 with a minor brown shade only.

Abdomen. Segment 1 almost entirely dark brown and with a white-grey pruinosity, which is only faintly developed or absent on the remaining segments. Male tergites 2-6 and female tergites 2-7 with a dark brown to black dorsal stripe about as broad as scutellum or mediotergite. Hind margin of tergites usually distinctly pale yellow, stripe sometimes more or less continuous in females. Lateral part of tergites with a broad, more or less continuous stripe, tergal margin itself narrowly pale yellow. Area between dorsal and lateral stripes yellow to brownish yellow. Male sternites 2-6 and female sternites 2-7 darkened, brown to black, with lighter coloured hind margins, especially in female. Male segments 7 and 8 and tergite 9 largely dark brown to black, sternite 9 with smaller or larger dark brown to black areas. Both tergite 9 and sternite 8 with a distinct, pale-yellow, sickle-shaped spot along hind margin. Female tergite 8 yellowish brown, sternite 8 and tergites 9 and 10, cerci and hypovalvae shining reddish brown.

Hypopygium. Posterior extension of tergite 9 with distally spined lateral blades and with narrow medial incision (figs. 61, 62). Outer dististyle basally broad, slender towards tip (fig. 58). Inner dististyle with irregular dorsal crest and with well developed lateral shell, which terminates posteriorly into a small process (fig. 68). Gonapophyses large, more or less rectangular, the outer margin very variable in expression (figs. 65-67). Medisternal appendage relatively flat and largely concealed by sternite 8. Hind margin of sternite 8 broadly membranous and pale coloured between slightly protruding lateral corners which bear stiff, inwardly directed bristles; central part of hind margin with a short membranous projection, shape of the projection rather variable (figs. 59, 60). Intromittent organ tubular, reaching into segment 6. Compressor apodeme and anterior appendages of semen pump distinctly darkened.

Ovipositor. Cerci and hypovalvae as in figs. 63 & 64, rostral extensions of hypovalvae distinctly beyond internal arch. Furca slender; fused valvulae elongate and triangular, without sclerotized connection with coxopodite of tergite 9.

Biology

N. lundbecki is a tundra species, found in cold, exposed and open habitats of the northern taiga zone as well. The period of flight seems to be short, from the second half of June until the end of July (known from Greenland until October).

Distribution (map 8)

Map 8 is taken from Oosterbroek (1979c) with the addition of the localities mentioned under material examined, and Southampton Isl (Alexander, 1934b). The record for Michigan, based on one male in the UMMZ collection from "Shiawassee River, Shiawassee County, 19-VI-1931, study specimen 2277, J. S. Rogers" is omitted from the map until further confirmation. Hennig (1973) mentioned that the northernmost latitude for Diptera is 82°33′ (a Chironomidae) at Greenland. The *lundbecki* records from Ellesmere and Peary Land are of approximately the same latitude.

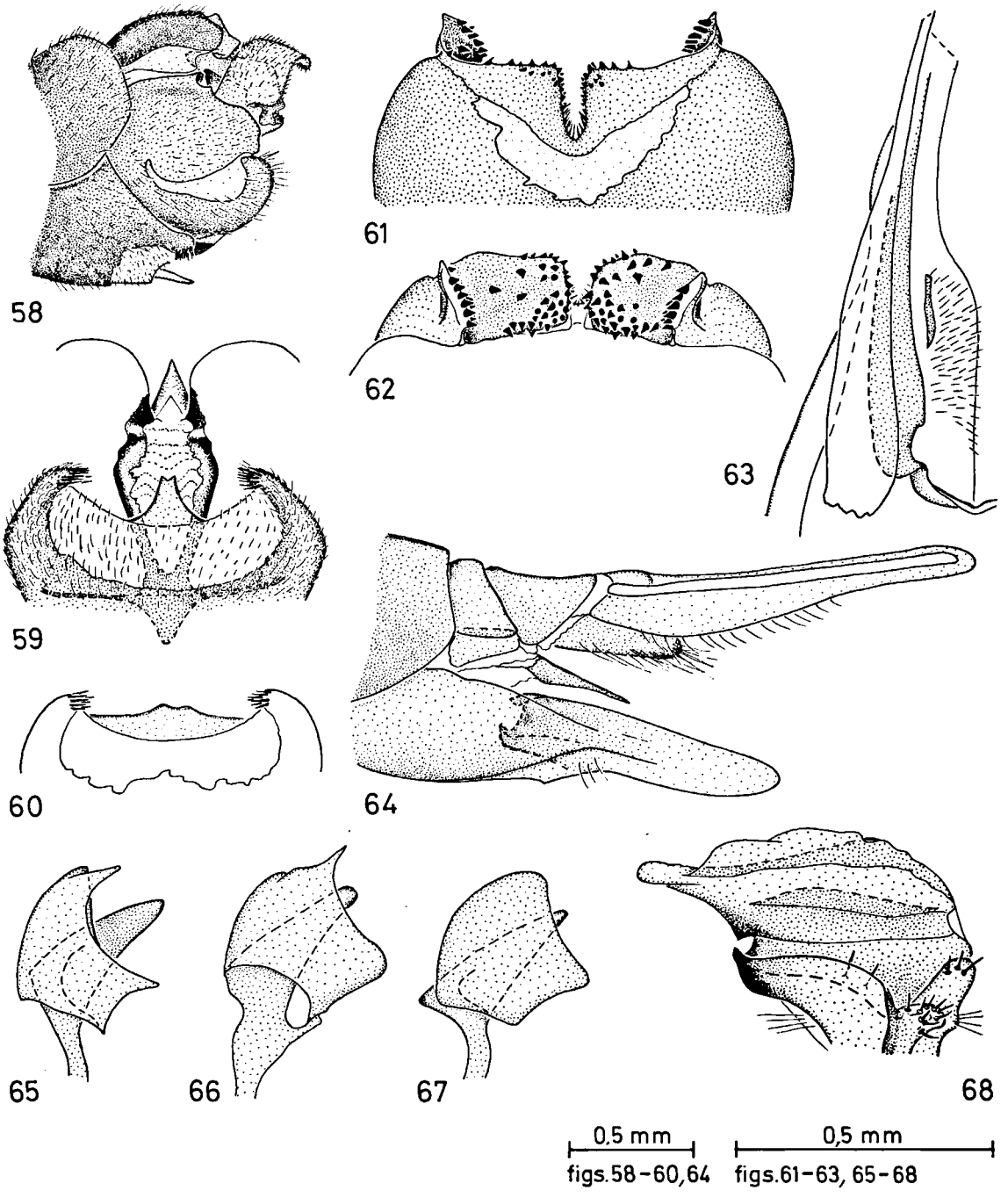


Fig. 58-68. *Nephrotoma lundbecki* (Nielsen, 1907); 58: hypopygium, lateral view; 59: male sternite 8 and ventral part of sternite 9, ventral view; 60: male sternite 8, ventral view; 61 & 62: extension of male tergite 9, dorsal (fig. 61) and ventral (fig. 62) view; 63: right hypovalva, dorsal view; 64: ovipositor, lateral view; 65-67: adminiculum and left gonapophyse, lateral view; 68: left inner dististyle, outside view; fig. 58-59, 61-65: Alaska, Umiat; fig. 60, 66: N.W.T., Hazenkamp; fig. 67, 68: N.W.T., Banks Island.

Map 8. Distribution of *Nephrotoma lundbecki* (Nielsen, 1907), based on material examined (black dots) and literature (stippled dots).

Discussion

The marked variability of *lundbecki* in colouration and copulatory structures was discussed by Oosterbroek (1979c), concluding that the variability apparently is non-clinal. Examination of more material from the Nearctic supports this view, although there seems to be less variability in colouration (extensively dusted grey specimens as known from Greenland were not found). However, conclusive statements can be made only on the bases of large series from several localities. Such series were not available for this study.

Nephrotoma lugens (Loew, 1864)
Figs. 69-76, map 9

Loew, 1864: 63, descr (as *Pachyrrhina*); Osten Sacken, 1878: 40, locs (as *Pachyrrhina*); Loew, 1879: 2, key (as *Pachyrrhina*); Snodgrass, 1904: 200, morf, comp, pl XI, figs hyp (as *Pachyrrhina*); Aldrich, 1905: 98, locs (as *Pachyrhina*); Doane, 1908: 175, key (as *Pachyrhina*); Alexander, 1915b: 466, morf; Dietz, 1918: 109, key (as *Pachyrhina*, = *lugens*?); Alexander, 1919b: 782-784, 818, locs, 831, 836, 878, biol, 935, key, pl XLIV, fig wing; Alexander, 1922: 61, locs; Alexander, 1924: 60, locs; Alexander, 1925b: 172, locs, biol; Johnson, 1925: 34, locs; Leonard, 1928: 699, locs; Alexander, 1929a: 235-236, locs; Alexander, 1929b: 25, locs; Alexander, 1930: 272, locs; Alexander, 1931a: 138, locs; Dickinson, 1932: 165-169, locs, 215, key, 217, note, distr, fig wing; Winn & Beaulieu, 1932: 8, locs; Brimley, 1938: 319, locs; Procter, 1938: 283, locs, biol; Alexander, 1941: 284, locs; Alexander, 1942: 222, key, 225, note, 229, descr, distr, date, locs; Rogers, 1942: 54, distr; Alexander, 1943a: 155, note; Alexander, 1962: 8, locs; Frommer, 1963: 581, morf, 593, fig hyp; Alexander, 1965: 21, distr; Byers, 1979: 605, biol, distr, locs; the references by Alexander, 1945, 1946, 1948 and 1954, as *lugens erythrophrys*, do not refer to *lugens* but to species of the *altissima*-complex.

Material examined

Type-material: Holotype ♀, MCZ type no 10307, condition good, labels: "N.H." "182" "lugens m." "Loew Coll." "10307" "Type".

Other material: 61♂, 131♀, from the following states and provinces: Alberta (1♂), Colorado (1♀ without locality), Connecticut (2♂, 1♀), Iowa (1♂, 2♀), Maine (8♂, 5♀), Massachusetts (11♂, 6♀), Michigan (72♂, 36♀), Minnesota (16♂, 14♀), Montana (1♀), New Brunswick (1♂, 1♀), New Hampshire (6♂, 18♀), New York (12♂, 15♀), North Carolina (1♂, 4♀), North Dakota (1♂), Nova Scotia (1♀), Ohio (3♂, 2♀), Ontario (11♂, 4♀), Pennsylvania (11♂, 2♀), Quebec (1♂, 6♀), Rhode Island (1♀), Tennessee (6♀), Vermont (2♂, 2♀), Virginia (1♀), Wisconsin (1♂, 2♀).

Diagnostic features

See under *lundbecki*.

Description

Body length ♂: 10-14 mm, ♀: 14-17 mm.
Wing length ♂: 9-11 mm, ♀: 10-13 mm.
Antennal length ♂: 7-8 mm, ♀: 4-5 mm.

Head. Dorsal part of rostrum broadly dark brown, sometimes lighter coloured along midline. Tubercle and vertex yellow to dark brownish yellow. Genae, postgenae and lateral parts of rostrum usually lighter, sometimes lateral parts of rostrum and surroundings of the eyes with brownish patches. Large occipital marking shining dark brown with margins narrowly dull, lateral margins convex, marking as broad as or broader than dorsal distance of eyes, pointed in front or narrowly prolonged onto tubercle. Small dark brown spots in front of tubercle, between antennae and lateral of tubercle, at short distance of or adjoining eyes.

In dark coloured specimens entire head dark brown to black with brownish yellow markings lateral of occipital marking behind eyes, and tubercle brownish yellow. Antennae with 13 segments. Scape and pedicel brown, flagellar segments dark brown, usually scape in part darkened, sometimes scape and pedicel coloured as flagellar segments. Male flagellar segments somewhat reniform beyond first, the verticillar hairs half as long or (apically) as long as segments; female flagellar segments cylindrical, verticillar hairs about as long as segments.

Thorax. Pronotum dorsally brownish yellow, laterally dark brown to black. Prescutum, scutum 1 and scutum 2 brownish yellow and dull between shining dark brown to black scutal stripes except for area just behind prescutal suture and area lateral of stripes of scutum 2 which are shining. Lateral stripes of scutum 1 straight or, rarely, downcurved anteriorly to contact paratergite, curved part shining. Scutellum dark brown to black. Anterior part of mediotergite with a narrow, dark brown to black longitudinal stripe which distinctly broadens on the posterior part of mediotergite, antero-lateral parts of mediotergite dull brownish yellow. Lateral parts of thorax with large dark brown to black markings, anatergite and posterior half of katatergite entirely darkened. Dark coloured specimens have the entire thorax dark brown to black with small areas around and between scutal stripes that are lighter coloured and with anterior part of the katatergite velvety brown. Basal two-third of wing with a strong brownish tinge; pterostigma dark brown with 5-25 macrotrichia; a brown seam along basal part of vein R4 + 5 and along cross-vein r-m, a weaker seam along apical veins, cross-vein m-cu and CU. Coxae almost entirely dark brown to black; trochanters light brown; femora light brown to brown, apices broadly darkened; tibiae brown to dark brown; tarsi dark brown to black; claws toothed in male only. Legs darker coloured in darker specimens.

Abdomen. Abdominal colouration very variable, in general as follows. Segment 1 brown to dark brown, usually with yellow spots laterally. Tergites 2-5 brownish yellow with dark brown to black transverse bands along hind margins, bands triangular or dorsally distinctly prolonged towards thorax; lateral parts of these tergites in male brownish yellow or with brown spots at anterior and posterior corners, in female with a continuous dark brown stripe along margin. Sternites 2-5 brownish yellow, hind margin of male sternite 5 usually darkened, in the female usually all hind margins of sternites 2-5 darkened and sternites sometimes infuscated over the middle, especially sternites 3 and 4. Male segments 6-9 dark brown to black, anterior part of segment 6 and outer part of sternite 9 lighter coloured. Female segment 6 and 7 brownish yellow with darkened lateral margins, dorsal part of tergite 6 usually darkened, especially anterior part, sometimes hind margins narrowly darkened, tergites 8 and 9 ranging from yellowish brown to dark brown, sternite 8 and tergite 10 largely dark reddish brown, cerci and hypovalvae light reddish brown. In dark coloured specimens the entire abdomen can be dark brown to black. Males sometimes have the segments 2-5 or 2-6 entirely yellowish brown with the extreme hind margins darkened only. Some males and females possess rounded dark brown spots, situated in front of the hind margins, in stead of transverse bands.

Hypopygium. Extension of tergite 9 medially incised and with protruding lateral corners which form ridges ventrally (figs. 71, 72). Outer dististyle moderately slender (fig. 74). Inner dististyle with low dorsal crest set with short bristles, lateral shell situated rather low, posteriorly with a firm, apically rounded and bristly process (fig. 76). Sternite 9 prolonged beyond basistylus (fig. 74). Gonapophyses large, more or less rectangular, spinulose at upper posterior corner (fig. 73). Medisternal sclerotizations of sternite 9 broad and elongate, terminating in a short and broad ventral stem (fig. 75). Medial incision of sternite 8 closed by a membrane which forms an elongate appendage ventrally, hind margin and appendage set with bristle-like hairs (fig. 74). Compressor

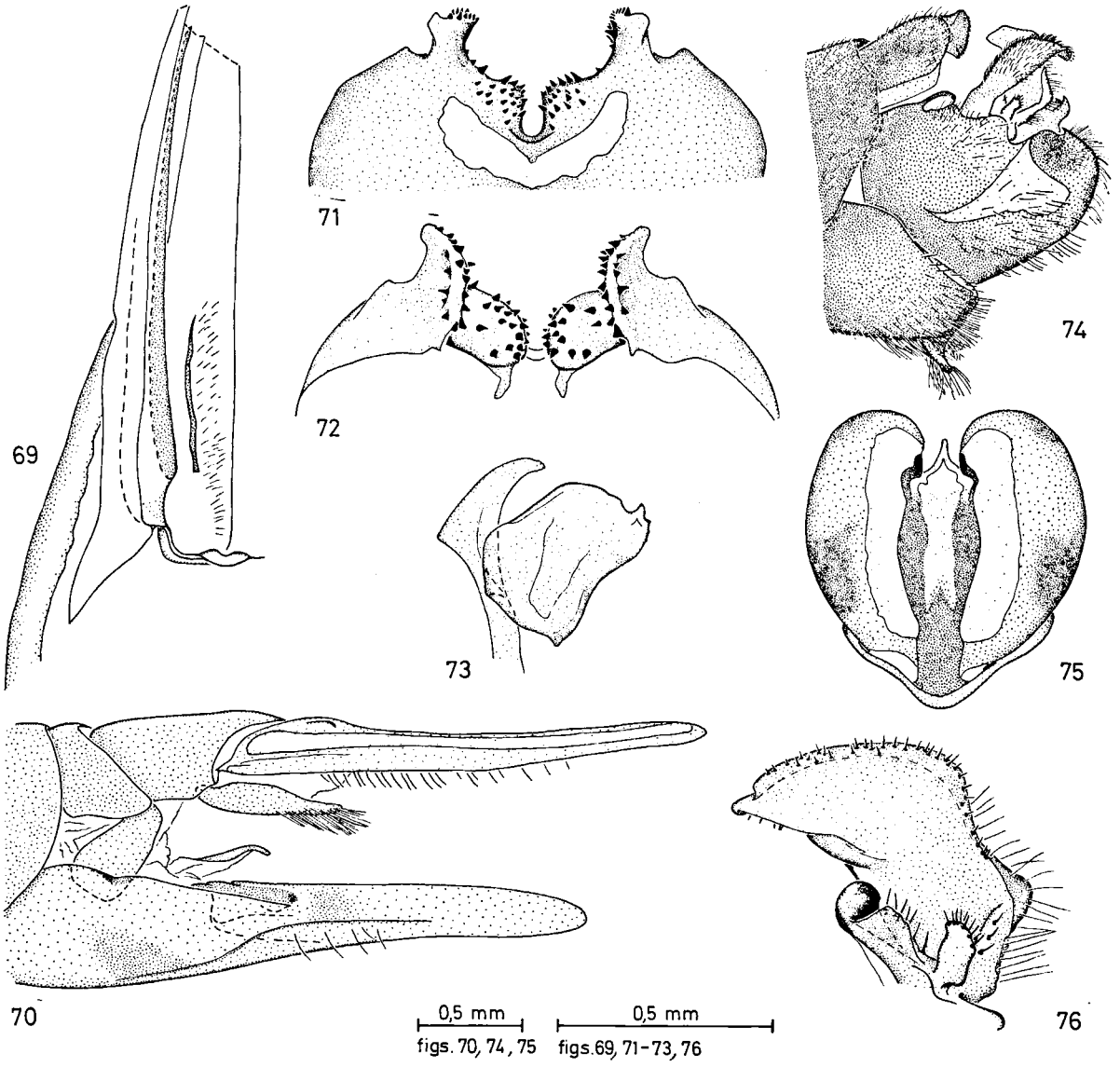


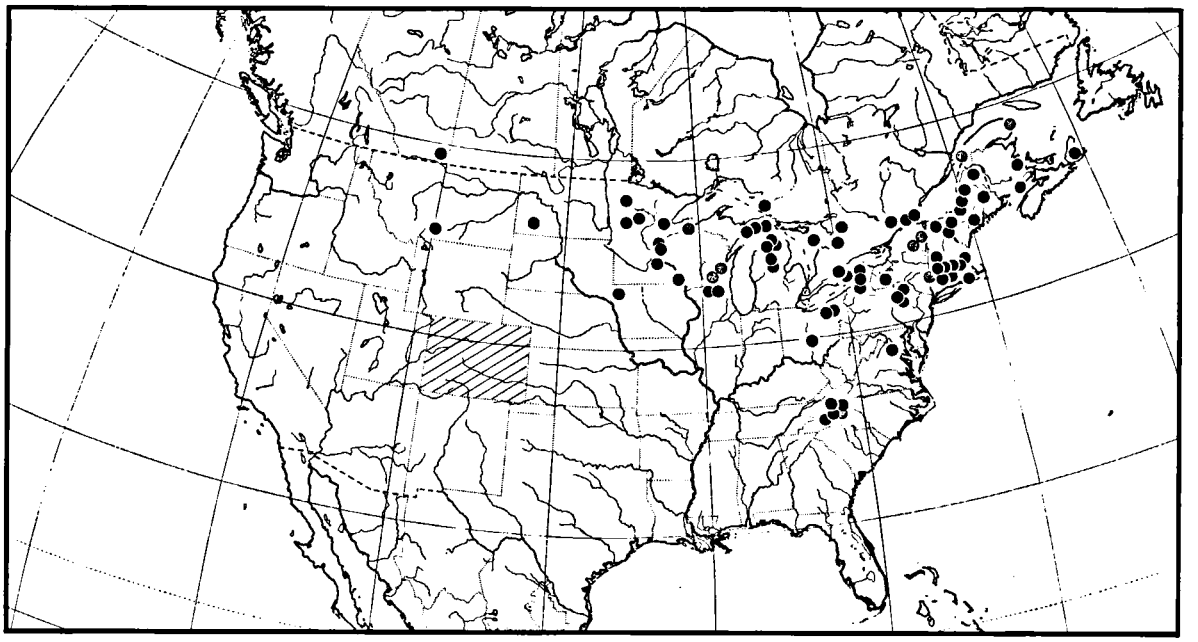
Fig. 69-76. *Nephrotoma lugens* (Loew, 1864); 69: right hypovalva, dorsal view; 70: ovipositor, lateral view; 71 & 72: extension of male tergite 9, dorsal (fig. 71) and ventral (fig. 72) view; 73: adminiculum and left gonapophyse, lateral view; 74: hypopygium, lateral view; 75: ventral aspect of male sternite 9; 76: left inner dististyle, outside view.

apodeme of semen pump large and distinctly bifid. Intromittent organ reaching into segment 6, tubular throughout its length, diameter near semen pump about four times diameter near adminiculum.

Ovipositor. Cerci elongate and slender; hypovalvae broad towards rounded tip (fig. 70). Fused valvulae membranously connected with coxopodite of tergite 9. Rostral extension of hypovalvae triangular (fig. 69).

Biology

N. lugens is found near running waters, lakes, ponds and the like, especially in shaded places in and around mesophytic woodlands. Accord-



Map 9. Distribution of *Nephrotoma lugens* (Loew, 1864), based on material examined (black dots) and literature (stippled dots); the species is known from Colorado without locality.

ing to Procter (1938), eggs are deposited in loose sandy soils. The period of flight is from the second half of May until the end of July (two further records in the first decade of September) with a distinct peak from the end of May until the end of June in the ME states, a shorter peak-period, June only, in the NE states. *N. lugens* apparently prefers low altitude habitats, the only known higher altitude is from Tennessee, 4200′ (1280 m).

Distribution (map 9)

Map 9 is towards the north, west and south based on the following localities: Quebec: Gaspé (Alexander, 1929a), Riviere du Loup (Winn & Beaulieu, 1932); Ontario: Bruce Pen; North Dakota: Mott, Hellinger County; Alberta: Medicine Hat; Montana: Stillwater County; Colorado: one female without locality (coll. Rogers); Iowa: Sioux City, Sioux County; Ohio: Columbus, Franklin County; Virginia: Falls Church, Fairfax County; Tennessee: Iron Mt, Johnson County; North Carolina: Spruce, Mitchell County (Brimley, 1938); Mt Mitchell, Yancey County; near Waynesville, Haywood County; Cranberry, Avery County.

Nephrotoma byersi nov. spec.
Figs. 77-88, map 10

Type-material

Holotype ♂, labeled: Alaska, MP 68 july 19 1952 Carson" "McKinley Muldraw Gl." "D. L. Carson collector" (UNSM). Paratypes: 4♂, 6♀ (1♂, 1♀, pinned with the holotype), labeled as the holotype (2♂, 5♀ USNM, 2♂, 1♀ ZMA). 1♂, Alaska, McKinley Park, Toklat R., 20-VII-1952, Carson coll. (USNM); 1♂, Alaska, Anaktuvuk Pass, 68°20′N-151°30′W, 9-VII-1949, Weber coll. (USNM); 1♂, 1♀, Alaska, McKinley Park, Wonder Lake, 16-VII-1952, Alexander coll. (ZMA); 2♀, Alaska, McKinley Hway M.P. 29, Teklanika Camp at river, 20-VII-1952 (1♀), 21-VII-1952

(1♀), Alexander coll. (USNM); 2♂, 1♀, Alaska, Umiat, 21-VII-1959 (1♀), 22-VII-1959 (2♂) (USNM); 1♂, British Columbia, Trout River, N.P. 476, 28-VI-1952 (USNM); 1♂, British Columbia, Hector, 15-VII-1928 (USNM); 1♂, 1♀, British Columbia, Field, 29-VI-1908 (ANSP); 1♂, Oregon, Wallowa County, Wallowa Mts, Slick Rock Creek, 3-VIII-1950, Sperry coll. (USNM); 5♂, 1♀, idem, 5850′, Crickmer coll. (4♂ USNM, 1♂, 1♀ ZMA); 17♂, 5♀, Ontario, Cape Henrietta Maria, Hudson's Bay, 6-VII-1948 (7♂, 5♀), 4-VII-1948 (10♂) (16♂, 4♀ UMMZ, 1♂, 1♀ ZMA).

Diagnostic features

See under *lundbecki*.

Description

Body length ♂: 10-13 mm, ♀: 13-16 mm.
Wing length ♂: 9-12 mm, ♀: 11-13 mm.
Antennal length ♂: 4-5 mm, ♀: 2.5-3 mm.

Head. Usually entirely dark brown to black with occipital marking shining reddish brown, always at least in part lesser dark than surrounding vertex; lateral sides of tubercle yellowish brown or reddish brown, sometimes these lighter coloured markings extended caudally. Occipital marking at most as broad as dorsal part of pronotum, triangular or with more rounded lateral margins and pointed in front, reaching base of tubercle. Ventral and lateral parts of head with a weak light grey pruinosity. Rostrum, vertex and lower postgenae with numerous, long, reddish brown to black hairs. Antennae with 13 segments, dark brown to black; male segments beyond flagel 1 somewhat nodulose basally with longest verticillar hairs slightly longer than segments; female flagellar segments cylindrical or somewhat nodulose basally, longest verticillar hairs slightly longer than segments.

Thorax. Male thorax usually almost entirely dark brown to black with lower margin of prescutum, anterior corners of paratergites, posterior part of area between the stripes of scutum 1, area between the stripes of scutum 2 and membranous area below paratergite more brownish, rarely thorax entirely darkened or with clear yellow markings on mid-anterior part of scutum 2 or with dorsal pronotum and anterior part of katatergite brownish as well. Females sometimes have thorax as dark as in males but others have dorsal pronotum, areas between scutal stripes, latero-posterior parts of scutum 1 and 2 and lateral mediotergite brownish. Entire thorax shining or sub-shining, usually with posterior part of paratergite, antero-lateral corners of scutum 2 and anterior katatergite dull. Thorax, especially dorsally, with bunches and rows of very long hairs, about as long as apical diameter of femora, on lateral and dorsal pronotum, on lateral parts of the prescutum, between the stripes of scutum 1, on latero-posterior parts of scutum 1, along stripes of scutum 2, on anterior parts of scutum 2, on scutellum, on mediotergite and sometimes on katepisternum. Thorax especially on lateral and ventral surface with a weak light grey pruinosity. Coxae and trochanters darkened, the former with a distinct light grey pruinosity; femora and tibiae reddish brown with darkened apices, sometimes femora and tibiae entirely darkened; tarsi dark reddish brown to black; male claws toothed only. Wings hyaline with a brownish tinge; pterostigma dark brown without or with up to 20 macrotrichia; basal part of vein R4 + 5 below stigma with a weak seam; extreme wingtip sometimes weakly clouded.

Abdomen. In the male ranging from entirely dark chocolate brown to segments 1, 7, 8 and 9 darkened and segments 2-6 light reddish brown with a broad lateral stripe along tergal margins, in latter males hind margin of tergite 1 reddish brown, hind margin of segment 6 darkened or anterior part of segment 7 reddish brown. Female sometimes have entire abdomen dark chocolate brown as well, but usually possess reddish brown or yellowish brown markings on anterior part of tergites or have anterior part of tergites lighter coloured except for continuous lateral stripe, giving the abdomen a banded appearance, in these females there is usually a dorsal row of darker coloured, rounded spots, female abdomen rarely with the posterior bands brownish and situated in front

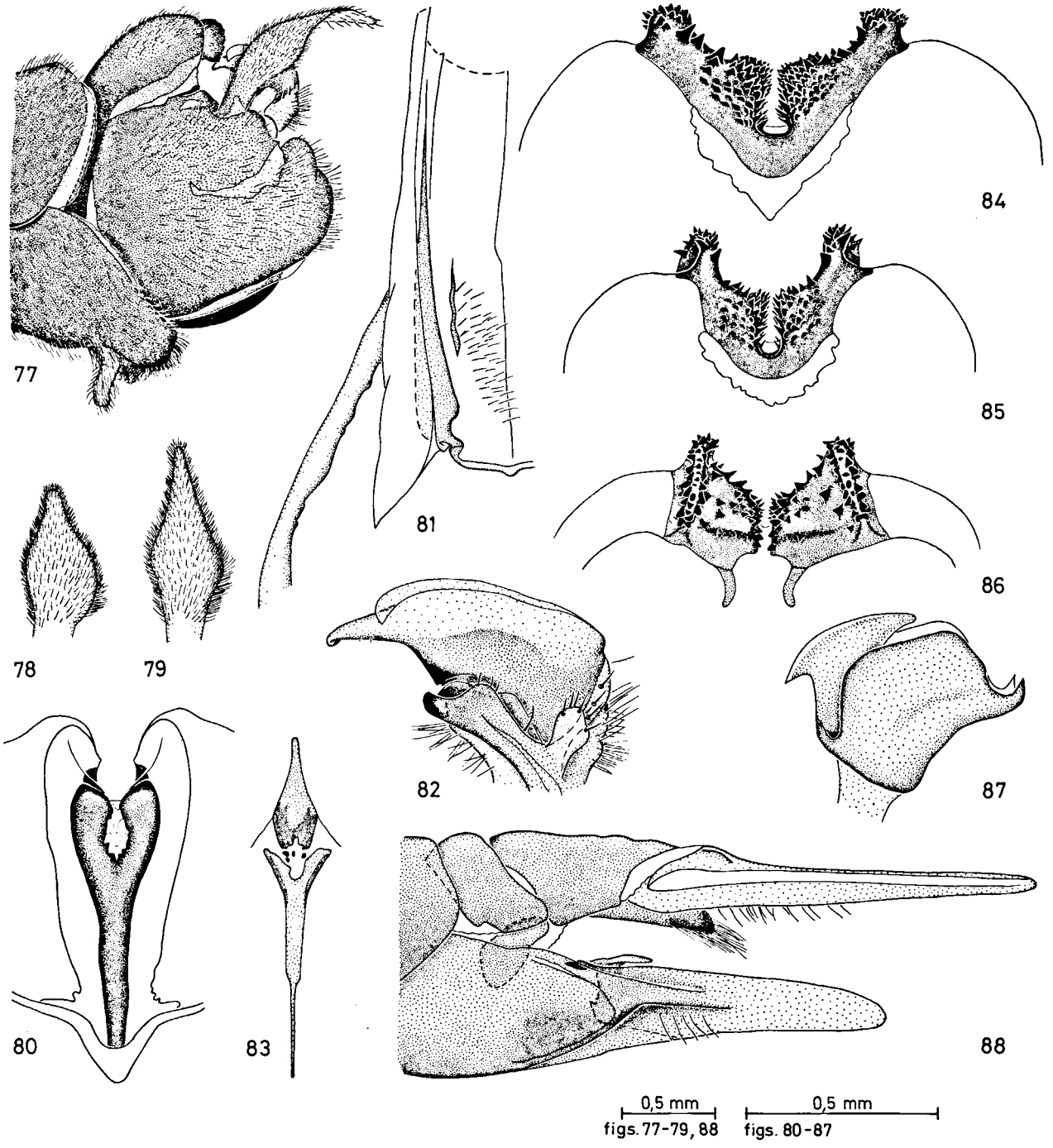


Fig. 77-88. *Nephrotoma byersi* (nov. spec.); 77: hypopygium, lateral view; 78 & 79: left outer dististyle, outside view; 80: medisternal sclerotization of male sternite 9, ventral view; 81: right hypovalva, dorsal view; 82: left inner dististyle, outside view; 83: furca and fused valvulae, dorsal view; 84-86: extension of male tergite 9, dorsal (fig. 84, 85) and ventral (fig. 86) view; 87: adminiculum and left gonapophyse, lateral view; 88: ovipositor, lateral view; fig. 77, 81, 83, 85, 86, 88: Ontario, Cape Henrietta Maria; fig. 78, 84: Alaska, McKinley Muldraw Gl.; fig. 80, 82, 87: Brit. Col., Field; fig. 79: Oregon, Wallowa Mts.

of the hind margins or abdomen entirely reddish brown or brownish yellow except for segment 1 and lateral stripes. In both sexes abdomen sometimes covered with a light grey pruinosity.

Hypopygium. Extension of tergite 9 with two lateral projections which form ventral ridges, size of projections variable, area between projections distinctly bulbous, creating a narrow medial incision (figs. 84-86). Outer dististyle basally broad, apically slender, variable in length (figs. 77-79). Inner dististyle with low crest which is distinctly outcurved anteriorly, outer margin of lateral shell upcurved in the middle, posterior projection flattened and less darkened (fig. 82). Gonapophyses large with a curved and acute posterior corner (fig. 87). Medisternal plates heavily sclerotized with a long ventral stem (fig. 80). Hind margin of sternite 8 somewhat incised in front of small appendage, incised part closed by a membrane, bristle-like hairs along mid-ventral part of hind margin distinctly incurved (fig. 77). Compressor apodeme of semen pump whether or not bifid, usually darkened as anterior appendages. Intromittent organ tubular, reaching into segment 4, 5 or 6.

Ovipositor. Cerci slender, especially towards tip, hypovalvae broad (fig. 88); the latter with triangular rostral extensions and a low internal arch (fig. 81). Fused valvulae without a sclerotized connection with coxopodite of tergite 9; furca very long and broadened in front (fig. 83).

Biology

N. byersi apparently has a very short flight-period, from the end of June until the beginning of August. Information about the habitats where the species was collected was not available. Specimens from Oregon were collected at an altitude of 5850′ (1780 m).

Distribution (map 10)

All the localities from which *byersi* is known are mentioned with the type-material. Hector in British Columbia could not be traced.

Etymology

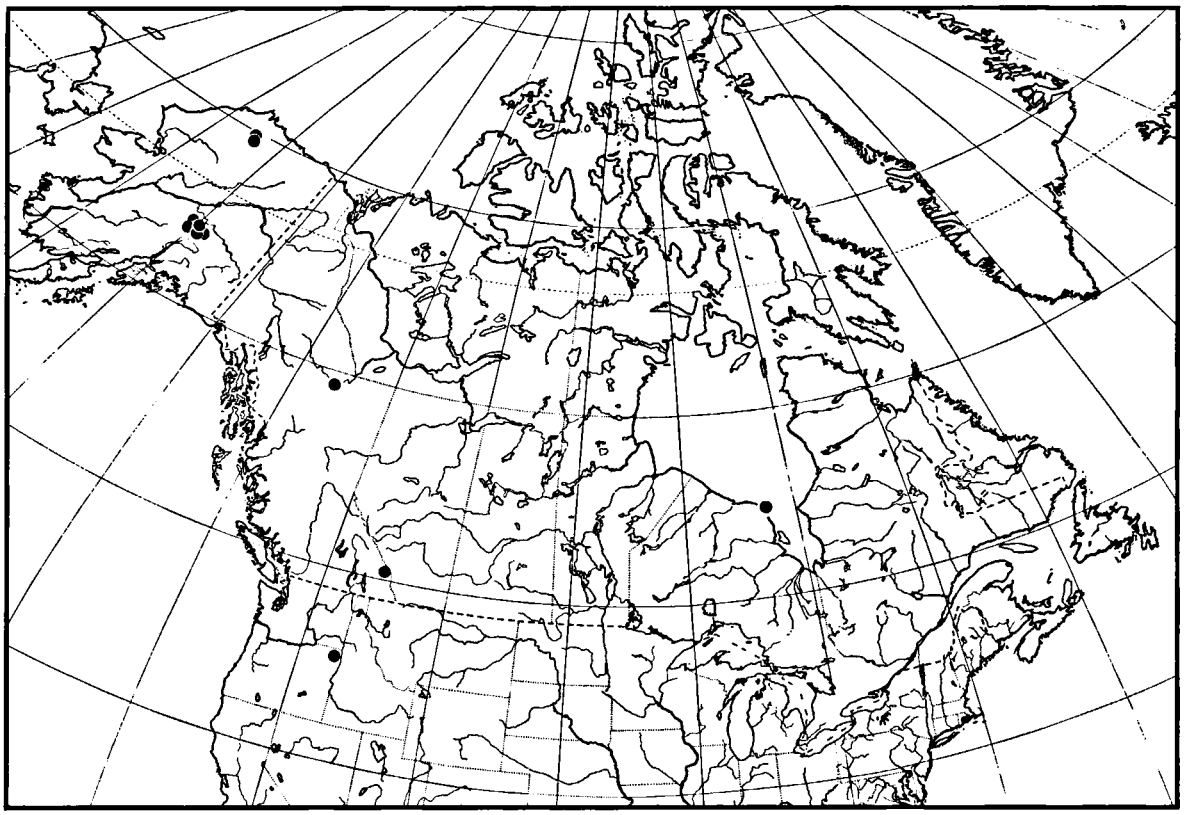
The species is named after Prof. Dr. George W. Byers in order to express my gratitude towards him.

Nephrotoma altissima (Osten Sacken, 1877)
Figs. 89-99, map 11

Introduction

N. altissima was described by Osten Sacken (1877), after three males and three females from Taos Park, New Mexico and Pike's Peak, Colorado. The "species" varies in colouration from entirely black to black with reddish marks on thorax and, especially, basal abdominal segments. The reddish form was described by Williston (1893), as *erythrophrys* after "One [male] specimen, Manitou Park, Colorado, Prof. F. H. Snow". *N. erythrophrys* was synonymized with *altissima* by Alexander, 1927b as "being obviously a variant showing erythrism to a greater or less degree". In 1942 and 1943a *erythrophrys* was treated by Alexander as a subspecies of *altissima*, adding the note, based on the observations of Rogers, that both forms "represent extreme melanistic types of *lugens* and (may) be placed as subspecies under that species", as practiced by Alexander in his 1943b, 1945, 1946, 1948 and 1954 papers.

During this study 470 specimens of *altissima* were examined. From this it became apparent that the variability is not restricted to colouration but is found also in size, hairiness of head and thorax (several specimens from Colorado, including the lectotype, are as hairy as *byersi*), and in hypopygial and ovipository features (exemplified in figs. 89-99). It seems reasonable to conclude that the "species" *altissima* as treated here, apparently consists of a species-complex of three or more species. The unraveling of this complex could not be handled in a satisfactory manner during this study. In Amsterdam a limited amount of material was available only, with few fresh material. Furthermore very little is known about habitat preference of the several forms with no information about the occurrence of hybridization.



Map 10. Distribution of *Nephrotoma byersi* (nov. spec.).

Finally the several forms seem to be sympatric and always a few intermediate specimens were found. Comments on the several forms recognized are presented in the discussion. For the aim of further and, comparable to this study, more appropriate research on *altissima*, a complete list, indicating where the studied material is preserved, is given as an appendix. *N. erythrophrys* is dealt with here as a synonym of *altissima* although the male holotype of *erythrophrys* could not be studied (it is in all probability not preserved anymore).

Osten Sacken, 1877: 210, descr (as *Pachyrrhina*); Osten Sacken, 1878: 39, locs (as *Pachyrrhina*); Aldrich, 1905: 97, locs (as *Pachyrhina*); Doane, 1908: 174, key (as *Pachyrhina*); Dietz, 1918: 109, key (as *Pachyrhina*); Alexander, 1927b: 215, distr, 216, note; Dickinson, 1932: 166, locs, 214, key, 216, fig wing, locs; Alexander, 1965: 20, distr, syn; Alexander, 1967: 18, locs, descr; Cole, 1969: 53, distr.

Nephrotoma erythrophrys (Williston, 1893).

Williston, 1893: 63, descr (as *Pachyrrhina*); Johnson, 1903: 101, locs, 104, locs (as *Pachyrrhina*); Snodgrass, 1904: 201, descr, hyp (as *Pachyrrhina erythophagus*); Aldrich, 1905: 97, locs (as *Pachyrhina*); Doane, 1908: 174, key (as *Pachyrhina*); Dietz, 1918: 109, key (as *Pachyrhina*); Alexander, 1927b: 216, syn; Alexander, 1942: 222, key, 224, descr, distr, note (as *altissima erythrophrys*); Alexander, 1943a: 155, locs, note (as *altissima erythrophrys*); Alexander, 1943b: 725, locs (as *lugens erythrophrys*); Alexander,.1945: 400, locs (as *lugens erythrophrys*); Alexander, 1946: 490, locs (as *lugens erythrophrys*); Alexander, 1948: 17, locs (as *lugens erythrophrys*); Alexander, 1954: 26, locs (as *lugens erythrophrys*); Frommer, 1963: 581, descr, hyp; Alexander, 1965: 20, syn; Alexander, 1967: 18, syn; Cole, 1969: 52, figs head, wing.

Material examined

Type-material: *Pachyrrhina altissima*: The three syntype males, MCZ, condition fair, type no 10333, are glued on separate cards which are pinned together on one pin, bearing the labels: "O. Sacken. West. Dipt." "Type 10333" "Taos Peak, N.Mex July 15 1875 Above timberline. Wm L. Carpenter" "Pachyrrhina

altissima O.S.". Syntype (paralectotype) female with the labels: "Type 10333" "Pikes Peak 13000 feet" "O. Sacken West. Dipt.". Of the males the one in the middle is selected here as lectotype and the upper and lower as paralectotypes because the male in the middle has the head and thorax very hairy, as also found in the lower male (head missing) and the female. *Pachyrrhina erythrophrys*: Holotype male apparently lost.

Other material: 353♂ and 113♀ from the following states and provinces (given in detail as appendix): Alaska (2♂, 2♀), Alberta (48♂, 23♀), Arizona (25♂, 3♀), British Columbia (8♂, 3♀), Colorado (106♂, 23♀), Idaho (1♀), Manitoba (18♂, 4♀), Minnesota (40♂, 17♀), Montana (6♂, 5♀), New Mexico (12♂, 2♀), North Dakota (16♂, 9♀), Ontario (7♂, 1♀), Oregon (21♂, 7♀), Saskatchewan (10♂, 4♀), Utah (2♂, 1♀), Wisconsin (6♂, 1♀), Wyoming (25♂, 5♀), Yukon (1♂, 2♀).

Diagnostic features

See under *lundbecki*.

Description

Below a general description of "*altissima*" is given. More detailed information about the several forms is presented in the discussion.
Body length ♂: 9-15 mm, ♀: 13-21 mm.
Wing length ♂: 7-11 mm, ♀: 9-15 mm.
Antennal length ♂: 4.5-6 mm, ♀: 3-4 mm.

Head. Head and antennae largely dark brown to black, rarely entirely darkened, in general with, usually large, reddish brown spots on postgenae laterad of occipital marking, these spots sometimes contacting the eyes and/or prolonged rostrally to make contact in front of occipital marking or prolonged on either side of the tubercle. Head shining except for areas on tubercle, laterad of tubercle adjoining the eyes and around antennal sockets. Antennae in both sexes with 13 or 14 segments; male flagellar segments slightly nodulose basally; in female cylindrical; longest verticillar hairs in male usually distinctly shorter than segments, at most as long as segments; in female as long as segments or somewhat shorter. Head abundantly set with long hairs, as in *byersi*, in some specimens from Colorado and New Mexico.

Thorax. Thorax and coxae usually entirely chocolate brown, dark brown or black, shining, scutum sometimes subshining in hairy specimens, region below paratergite usually more brownish. Especially females sometimes much lighter coloured with yellow to reddish brown colouration of dorsal pronotum, of region between and laterad of scutal stripes, of paratergite and lateral mediotergite, and anterior halves of paratergite and katatergite. Dorsal thorax with rows of long hairs, as in *byersi*, in some specimens from Colorado and New Mexico. Legs usually entirely darkened, femora and tibiae sometimes with darkened apices only, rarely legs entirely brownish. Male claws toothed.

Abdomen. Male: ranging from entirely black to black with segments 2-6 reddish brown, in the latter specimens always with a continuous lateral stripe and usually with more reddish brown on tergites than on sternites, frequently hind margins of segments broadly banded. Female: less frequently entirely black, usually tergites 2-5 and sternites 2-3 anterolaterally reddish brown with a transverse reddish-brown band on anterior part of tergite 2. Much lighter coloured females can have segments 2-6 (7) reddish brown with a continuous lateral stripe and whether or not with a row of darkened dorsal spots or transverse posterior bands.

Hypopygium. Lateral aspect as figured for *byersi* (fig. 77) with medial appendage of sternite 8 as long or much shorter. Extension of tergite 9 blackened with a broad, convex, V-shaped or concave medial incision (figs. 89, 90). Outer dististyle elongate (as figured for *byersi*, fig. 79). Inner dististyle variable in shape (figs. 96-99), medial part of lateral shell with more bristles than in *byersi*. Gonapohyses strongly curved, posterior part balloon-shaped with a few spines (figs. 91-93). Medisternal plates elongate with a short ventral stem (fig. 95). Compressor apodeme of semen pump large and bifid. Intromittent organ tubular, reaching into segment 6 to 4.

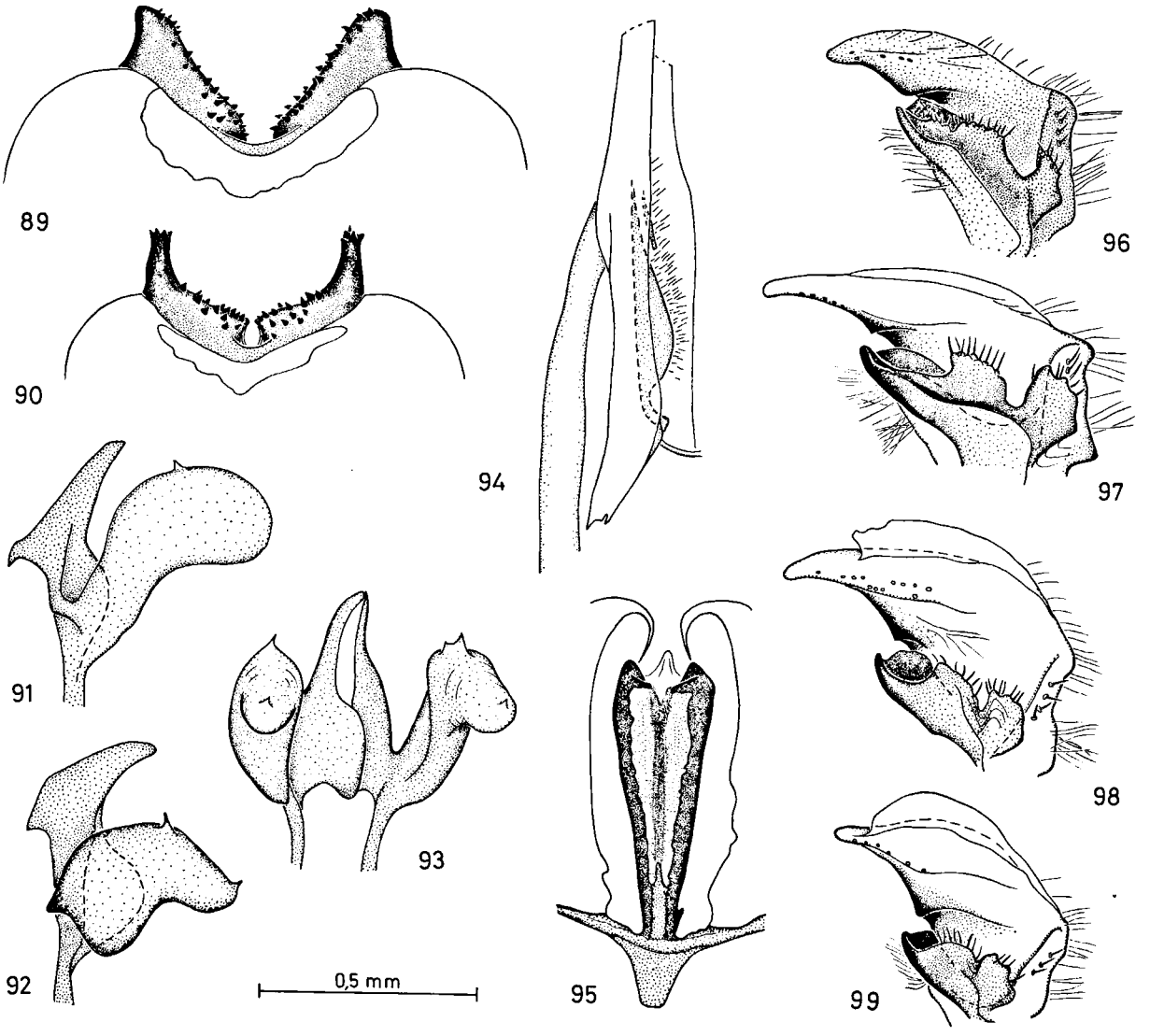
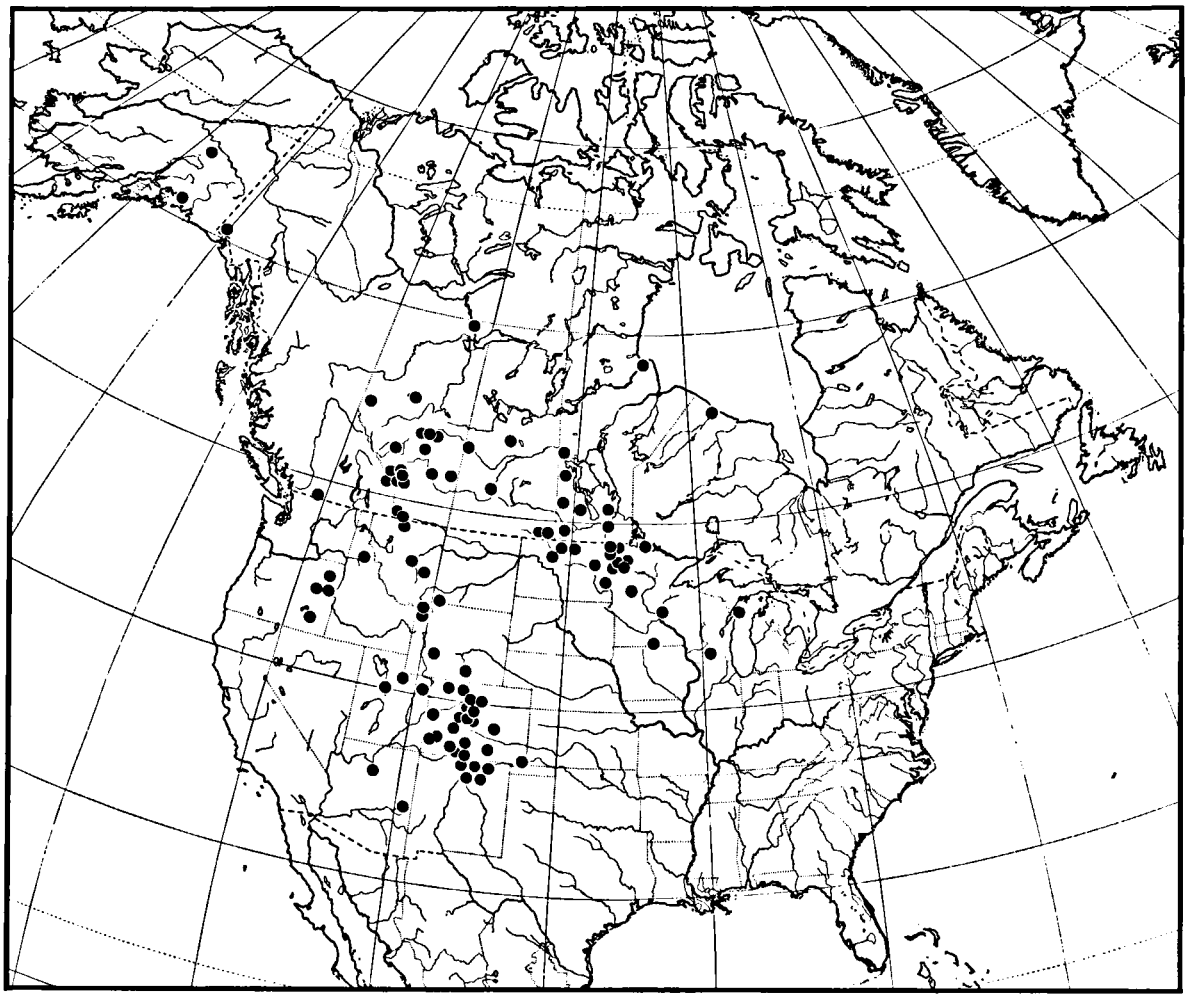


Fig. 89-99. *Nephrotoma altissima* (Osten Sacken, 1877); 89 & 90: extension of male tergite 9, dorsal view; 91 & 92: adminiculum and left gonapophyse, lateral view; 93: adminiculum and gonapophyses, rear view; 94: right hypovalva, dorsal view; 95: medisternal sclerotization of male sternite 9, ventral view; 96-99: left inner dististyle, outside view; fig. 89, 91, 98: Colorado, Long's Park Inn; fig. 90: Brit. Col., Fernie; fig. 92, 93, 95: Arizona, 3.5 mi S Springerville; fig. 94, 97: Montana, Glacier Natn. Pk.; fig. 96: Utah, Park City; fig. 99: Alberta, Bilby.

Ovipositor. As described and figured for *byersi*, sometimes dorsal margin of sternite 8 more in line with hypovalvae and rostral extensions more abbreviated (fig. 94).

Biology

The period of flight of "*altissima*" ranges throughout the distribution area from mid May to end August with the majority of the records in July and early August. Recorded altitudes are for Alberta: 3770′ (1150 m), Arizona: 8000-9200′ (2440-2800 m), Colorado: 9000-12700′ (2740-3870 m), New Mexico: 8950′ (2730 m), Oregon: 5200-7850′ (1580-2390 m), Utah: 10050′ (3060 m) and Wyoming: 7800-9650′ (2380-2940 m).



Map 11. Distribution of *Nephrotoma altissima* (Osten Sacken, 1877), based on material examined.

Distribution (map 11)

The easternmost localities are in Wisconsin (Dane and Door counties) and in Ontario ("James Bay" and Ft Severn). From northern Ontario the range extends towards the northwest via Manitoba (The Pas), Alberta (Beaverlodge) and the Yukon (Alaska Hwy, Burwash Flats) to Alaska. Apparently there is a distributional gap covering southern North Dakota, eastern Montana, South Dakota, eastern Wyoming, Nebraska and Iowa. Towards the west the range covers the eastern half of British Columbia, eastern Oregon, northeastern Utah and northeastern Arizona. Localities in New Mexico are in the north.

A rough estimate of the distribution range of the three different forms is given with the discussion.

Discussion

For reasons stated with the introduction, I have refrained from naming and describing the several forms of *altissima*. From the material at hand in Amsterdam, about 100 specimens covering the entire distribution range, the

	Form 1	Form 2	Form 3
Colouration	entirely black or showing erythrism	as form 1	entirely black
Antennae (♂ & ♀)	13 or 14 segments	13 segments	13 segments
Head & thorax	without long hairs	without long hairs	with long hairs
Dorsal thorax	shining	shining	subopaque
Abd. tergites	if red usually posteriorly banded	if red usually not banded	black
Tergite 9	as in fig. 89, or incision more convex	as in fig. 90, distinctly concave	as in fig. 89, widely V-shaped
Crest of id	absent (fig. 96) or low (fig 97)	high (fig. 99)	high (fig. 98)
Lateral shell of id	with an anterior rim	without anterior rim	without anterior rim
Posterior part of id	lengthened (figs. 96, 97)	shortened (fig. 99)	intermediate (fig. 98)
Base of gonaphyses	broad (fig. 92)	narrow (fig. 91)	narrow (fig. 91)
Intromittent organ reaching	into segment 6	into segment 6	into segment 4
Size	large	small	large
Distribution	Alaska to New Mexico -Arizona, eastward to Manitoba	Alaska to Oregon -Arizona, eastward to Minnesota	Colorado-New Mexico

following remarks can be made with respect to these forms.

In general three forms can be recognized. Their characteristics are as given above, with the features of intermediate specimens mentioned below.

Intermediate specimens are as follows. Specimens belonging to form 2 can have the intromittent organ reaching into segment 4 (some males from Ontario, Minnesota and Oregon); males of form 2 are usually small (9-11 mm), but several males are distinctly larger, including the males from Arizona, Apache County, 1.7 mi W Alpine (13-15 mm), the Yukon and Ontario. Males assigned to form 3 sometimes have the lateral margins of the incision of tergite 9 more concave as in form 2, also the posterior part of the inner dististyle is sometimes not lengthened but as oblique as in form 2 (fig. 99).

With regard to assigning names to the different forms it can be stated that form 1 corresponds the most to the original description of *erythrophrys* and that form 3, by lectotype designation, is *altissima* sensu stricto.

Material examined of *altissima* (types not included), nt = not traced, nc = without county, nl = without locality, nd = without date.

ALASKA. Valdez, 8.VI.21, USNMA, 1♀; McKinley Natn Pk, Toklat R, 16.VII.52, USNMA, 1♂1♀; idem UMMZ, 1♂.

ALBERTA. Banff, 4-12.VII.49, USNMA, 2♀; Battle R, 18.VI.81, ZMA, 1♂; Beaverlodge, 21.VI.31,USNMA, 1♂; Bilby, 3-4.VII.21, CAS, 2♂1♀; Bilby, 12-16.VII.24, CAS, 12♂1♀; idem USNMA, 2♂; Bilby, 20-21.VII.24, CAS, 1♂2♀; Bilby, 10.VIII. 24, CAS, 1♀; Calgary, VII, MCZ, 2♂2♀; Calgary, 3.VI.24, USNMA, 1♀; Calgary, 25-29.VI.74, ZMA, 1♂4♀; Calgary, 30-31.V.24, CAS, 4♂; Cochrane, 27.VII.49, 3770′, USNMA, 1♀; Consort, 21.VI.35, USNMA, 1♀; Edmonton, 3.VI.16, MCZ, 1♂; Edmonton, 23.VII.24, USNMA, 1♂; Edmonton, 1932, CAS, 1♂; Edmonton, 2.VI.34, USNMA, 1♂; Edmonton, 19.V.37, USNMA, 1♀; Edmonton, 2.VI.37, USNMA, 2♂; Edmonton, 24.VI.45, USNMA, 1♀; Fitzgerald, 11.VII.30, USNMA, 3♂; Gull Lake, 14-27.VI.29, USNMA, 3♂;

Gull Lake, 27-30.VII.32, USNMA, 2♂1♀; Morrin, 27.V.25, USNMA, 1♂; Nordegg, 22-27.VII.36, USNMA, 2♀; Okotoks, 11.VII.58, CAS, 1♂; Sherwood Park, 8-12.V.81, ZMA, 3♂2♀; Slave Lake, 25.VIII.24, CAS, 1♂; Waterton Lake, 8.VII.23, USNMA, 1♂; Pipo Lake (nt), 1.VI.45, USNMA, 1♂.

ARIZONA. *Apache County*: 3.5 mi S Springerville, 13-19.VIII.53, 9200′, UMMZ, 9♂1♀; 1.7 mi W Alpine, 9.VIII.35, 8000′, UMMZ, 2♂; White Mts, 28.VII.26, USNMA, 5♂1♀; nl, 23.VIII.35, 9200′, UMMZ, 1♀; *Coconino County*: S Francisco Mts, 15.VII., UMMZ, 3♂; S Francisco Mts, 4.VII.52, UKaL, 3♂; S Francisco Mts, 20.VIII.53, 9000′, CAS, 1♂; 12 mi N Flagstaff, 26.VII.61, UMMZ, 2♂.

BRITISH COLUMBIA. Fernie, 7.VII.49, CAS, 3♂2♀; Field, 1.VII.06, ANSP, 1♂; Carbonate (nt), 12.VII.08, ANSP, 2♂1♀; Hector (nt), 15.VII.28, USNMA, 1♂; Similkameen, E. side Manning Park, 24.VII.06, UMMZ, 1♂.

COLORADO. *Baca County*: Bear Cr Canyon, 15.VII.97, MCZ, 1♂; *Boulder County*: Pine Cliffe, 30.V.16, UMMZ, 3♂; idem ANSP, 2♂2♀; Long's Peak, 15.VI.22, 9980′, UKaL(L), 3♂; Long's Peak Inn, 30.VI-3.VII.26, 9000′, CAS, 4♂1♀; Raymond, 7.VI.52, UKaL(L), 3♂; nl, 24.VI.62, 10350′, UKaL(L), 2♂; *Clear Creek County*: Mt Evans, Summit Lake, 12.VII.61, alpine, UKaL(L), 1♂; Mt Evans, Timberline, 22.VII.61, 11700′, UKaL(L), 1♂; Mt Evans, 11.VII.62, 12700′, UKaL(L), 4♂; Mt Evans, 12.VII.62, alpine, UKaL(L), 1♂; Mt Evans, Summit Lake, 13.VII.68, 12280′, CAS, 1♀; Mt Evans, Summit Lake, 2.VIII.82, 3870 m, UKaL, 1♀; *Conejos County*: nl, 6-9.VII.67, 10000′, UKaL(L), 11♂4♀; *Eagle County*: Tennessee Pass, nd, 10240′, USNM, 2♂; *El Paso County*: Pike's Peak, 20.VII.06, 10000′, UMMZ, 1♂; Pike's Peak, nd, UKaL(L), 1♀; Colorado Spr, 19.VII.38, UMMZ, 1♂; *Jackson County*: North Park, VII, UMMZ, 5♂; *Jefferson County*: Chimney Gulch, Golden, 25.V.12, ANSP, 1♂1♀; idem, 20.VI.12, ANSP, 1♂1♀; *Grand County*: nl, 21.VI.63, UKaL(L), 1♂; *Gunnison County*: Gothic, 1.VII.34, 9500′, USNMA, 1♂; Above Monarch Pass, 29.VII.41, USNM, 1♀; nl, 11-12.VII.49, UKaL(L), 4♂; Gothic, 4.VII.52, 9500′, UMMZ, 1♀; nl, 14-15.VII.52, UMMZ, 2♂; nl. 20-27.VII.63, UKaL(L), 1♂; nl, 3.VII.70, 9400′, UKaL(L), 5♂; *Huerfano County*: nl, 26.VII.68, 9400′, UKaL(L), 1♂; nl, 6.VII.75, 11000′, UKaL(L), 1♂; nl, 7.VII.75, 10000′, UKaL(L), 2♂; 8 mi N Walsenburg, 11.VII.75, UKaL(L), 1♂; *Mesa County*: nl, 20.VII.63, UKaL(L), 1♂; *Mineral County*: Wolf Fall Cr, 20.VI.19, UKaL(L), 1♂; *Ouray County*: Ouray, 13.VII.19, UKaL(L), 1♂; *Park County*: Florissant, 31.VII.07, CAS, 1♂; Florissant, 24.VI.14, USNM, 3♂; 12 mi W Florissant, 5.VI.59, 9525′, UKaL(L), 18♂2♀; nl, 20-21.VII.67, 97-10600′, UKaL(L), 10♂3♀; South Park, 18.VI.16, ANSP, 1♀; *Park-Summit counties*: nl, 22.VII.67, 11541-12000′, UKaL(L), 1♂3♀; *Routt County*: nl, 19.VI.76, UKaL(L), 1♂; *Saguache County*: Cochetopa N.F., 4.VII.13, USNM, 2♂; *San Miguel County*: Cornett Cr, Telluride, 9.VII.19, UKaL(L), 1♂.

IDAHO. Salmon R (= *Idaho County*?), 25.VIII.27, ANSP, 1♀.

MANITOBA. Aweme, 20.VII.12, ANSP, 1♀; Aweme, 6-12.VIII.12, ANSP, 1♂1♀; Aweme, 5-18.VI.13, ANSP, 3♂; Aweme, 3.VIII.13, ANSP, 3♂1♀; idem UNSM, 1♂; Birch River, 3.VIII.37, ANSP, 1♂; Churchill, 25.VI.30, USNMA, 1♂; Kelwood, 12.VII.25, USNMA, 1♂; The Pas, 15.VII.43, USNM, 1♀; Rusell, 1.VIII.37, ANSP, 1♂; Sandy Hook, 23-24.VI.12, ANSP, 2♂; Winnipeg, 1-8.VI.12, ANSP, 3♂; Mt Creasy (nt), 29.VII.36, UMMZ, 1♂.

MINNESOTA. *Beltrami County*: nl, 5-9.VIII.10, UMMZ, 2♂; *Clearwater County*: nl, 15.VIII.24, UMMZ, 3♂4♀; *Chisago County*: Taylors Falls, 8.VIII.25, UMMZ, 1♀; *Freeborn County*: nl, 11.VIII.36, UMMZ, 2♂; *Kittson County*: nl, 26.VI.26, UMMZ, 1♂; nl, 10.VIII.36, UMMZ, 4♂; Hallock, 17.VI.37, USNM, 1♀; *Marshall County*: Middle River, 25.VII-10.VIII.35, UMMZ, 7♂4♀; Middle River, 9.VIII.36, UMMZ, 5♂; Warren, 5.VIII.35, UMMZ, 1♂; nl, 28.VII.10, UMMZ, 1♂; *Polk County*: Crookston, 27.VIII.12, UMMZ, 1♀; nl, 15.VIII.24, UMMZ, 1♂5♀; *Red Lake County*: nl, 15.VIII.24, UMMZ, 1♂; *Roseau County*: nl, 16.VIII.24, UMMZ, 6♂1♀; *Wadena County*: Sebeka, 10.VIII.35, UMMZ, 4♂; Central, 10.VIII.35, UMMZ, 1♂1♀.

MONTANA. *Carbon County*: Beartooth Plateau, 9.VII.63, UKaL(L), 3♂1♀; *Flathead-Glacier counties*: Glacier Natn Pk, 30.VI.30, CAS, 1♂3♀; Glacier Natn Pk, 6.VII.49, USNMA, 1♂; *Lewis & Clark County*: Helena, 9.VIII.09, CAS, 1♂; *Meagher County*: White Sulphur Spr, 29.VI.30, CAS, 1♀.

NEW MEXICO. *Colfax County*: Therma, 25.VII, USNM, 1♂; *Rio Arriba County*: nl, 6.VII.78, 2987 m, UKaL(L), 2♂; *Santa Fe County*: nl, nd, UMMZ, 1♂; *San Miguel County*: Beulah, 29-30.VI.02, MCZ, 1♂; idem ANSP, 1♂1♀; Sapello Canyon, 27.VII.02, ANSP, 1♂; Rociada, 10.VIII, MCZ, 1♂; *Taos County*: Red River, 4.VIII.58, UMMZ, 1♂; nl, 2.VI.81, 8950′, UKaL(L), 1♂; Morino Valley (nc, nt), 1.VII, MCZ, 1♂; Pecos R (nc), nd, ANSP, 1♂1♀.

NORTH DAKOTA. *Bottineau County*: Bottineau, 15.VI.18, UMMZ, 2♂; Bottineau, 1.VIII.20, UMMZ, 1♂; *Cass County*: Fargo, 3.VI.01, UMMZ, 1♂; Tower City, 5.VI.04, USNM, 1♀; Tower City, 26.VI.05, USNM, 1♀; Tower City, 5.VI.06, USNMA, 1♂; Tower City, 11.VI.06, USNM, 2♂1♀; Leonard, 25.VII.37, ANSP, 1♂3♀; *Nelson County*: Stump Lake, 6.VII.21, USNM, 1♂; *Rolette County*: Turtle Mts, 20.VI.18, USNM, 1♀; Turtle Mts, 6.VII.20, UMMZ, 1♀; Turtle Mts, 30.VII-4.VIII.20, UMMZ, 5♂; Turtle Mts, 13.VI.21, USNM, 1♀; *Ward County*: Minot, 18.VI.18, USNM, 1♂; University (nc, nt), VI.96, USNM, 1♂.

ONTARIO. Ft Severn, 15-22.VII.40, UMMZ, 4♂1♀; Gold Rock, 29.VIII.05, MCZ, 1♂; James Bay, 23.VII.42, UMMZ, 2♂.

OREGON. *Baker County*: Baker, 5.VII.22, USNMA, 1♀; *Grant County*: Fall Mt, 14.VII.36, 52-5600′, USNMA, 1♀; Summit Prairie, 20.VII.36, 5300′, USNMA, 1♂; Onion Cr, 18.VII.36, 7700′, USNMA, 1♂; *Harney County*: Fish Lake, Steens Mts, 25.VI.23, USNMA, 1♂1♀; Fish Lake, Steens Mts, 9-11.VII.27, 7000′, USNMA, 12♂3♀; *Union County*: Hot Lake, 13.VII.31, ANSP, 1♂; North Powder, 13.VII.31, ANSP, 2♂; Anthony Lake (= *Union Co*?), 11.VII.31, ANSP, 2♂; Blue Mts (= *Union Co*?), 8.VIII.29, 71-7850′, USNMA, 1♂; Blue Mts, Anthony Lake (= *Union Co*?), 9.VIII.29, 7100′, USNMA, 1♀.
SASKATCHEWAN. Macrorie, 29.V.41, UMMZ, 1♂; Macrorie, 11-16.VII.41, UMMZ, 2♂; Macrorie, 2.VIII.41, UMMZ, 1♂; Montreal Lake, 24.VII.41, UMMZ, 2♀; Oxbow, 15-19.VI.07, USNM, 3♂2♀; Roche Perce, 4-5.VII.27, USNMA, 2♂; Farewell Cr (nt), VII, MCZ, 1♂.
UTAH. *Summit County*: Park City, 3.VII.22, CAS, 1♂; *Uintah County*: Paradise Park, 29.VII.47, 10050′, USNMA, 1♂; *Utah County*: Mt Timpanogos, 16.VII.33, CAS, 1♀.
WISCONSIN. *Dane County*: nl, 18.VI.97, ANSP, 1♂; *Door County*: Fish Creek, 14-24.VIII.26, ANSP, 5♂1♀.
WYOMING. *Carbon County*: Bridger Basin, nd, MCZ, 3♂; Silver Lake, 30 km W Centennial, 10.VI.81, 3179 m, UKaL(L), 1♂; *Teton County*: Grand Tetons, 9.VII.42, 9650′, USNMA, 1♂; W side Togwotee Pass, 18.VII.67, UMMZ, 1♂; idem CAS, 1♀; nl, 25.VII.57, UKaL, 1♂; *Yellowstone Natn Pk*: Indian Cr, 8.VII.23, USNM, 11♂2♀; idem USNMA, 1♂; Beach Spring, 19.VII.23, USNMA, 1♂; Turbid Lake, 20.VII.23, USNMA, 1♂; Canyon Station, 4.VII.24, 8000′, UMMZ, 1♂; Dumravea Pass, 25.VI.30, CAS, 1♀; nl, 22.VI.41, 7800′, USNMA, 2♂; nl, 29.V.30, USNMA, 1♀; *Fremont County*: near Lander, VI, 5-8000′, UMMZ, 1♂.
YUKON. Alaska Hway MP 1143, 7.VII.52, USNMA, 1♀; Alaska Hway MP 1103, Burwash Flats, 16.VI.57, UMMZ, 1♂1♀.

THE *CROCATA* SUBGROUP

The species *punctum* and *calinota* belong to the *crocata* subgroup. A striking character of this subgroup is the presence of a spine on the ventral surface of the intromittent organ. In the above-mentioned species the spine is rather large (fig. 108). This character is also found in the eastern palaearctic *martinovy*, which has the extension of the male tergite 9 as figured for *punctum* (fig. 102). The subgroup has a few representatives in the eastern Palaearctic and about ten in the western Palaearctic.

Nephrotoma punctum (Loew, 1863)
Figs. 100-103, 107-110, map 12

Loew, 1863: 294, descr (as *Pachyrrhina*); Osten Sacken, 1878: 40, locs (as *Pachyrrhina*); Loew, 1879: 2, key (as *Pachyrrhina*); Aldrich, 1905: 98, locs (as *Pachyrhina*); Doane, 1908: 175, key (as *Pachyrhina*); Dietz, 1918: 110, key, 122, comp (as *Pachyrhina*); Alexander, 1919b: 782, 826, locs, 935, key; Alexander & McAtee, 1920: 396, key, 397, locs; Johnson, 1925: 34, locs; Rogers, 1930: 13, biol, 15, locs, biol, note (as *calinota*); Dickinson, 1932: 167, locs, 215, key, 219, note, locs; Alexander, 1942: 223, key, 232, descr, distr; Rogers, 1942: 20, biol, 63, biol, locs; Alexander, 1962: 8, locs; Frommer, 1963: 581, descr hyp; Alexander, 1965: 22, distr.
Nephrotoma opacivittata (Dietz, 1918).
Dietz, 1918: 110, key, 122, comp, 123, descr (as *Pachyrhina*); Alexander, 1919b: 937, descr, comp (as *opacivitta*); Dickinson, 1932: 166, locs, 215, key, 220, locs (partim; as *opacivitta*); Alexander, 1936: 275, locs; Alexander, 1942: 223, key, 231, descr, distr; Alexander, 1965: 22, distr.
Nephrotoma sphagnicola (Alexander, 1920).
Alexander, 1920b: 110, descr, comp, note, biol; Dickinson, 1932: 221, locs; Alexander, 1942: 222, key, 232, descr, comp, 233, distr; Alexander, 1965: 22, distr.

Material examined

Type-material: *Pachyrrhina punctum*: Holotype ♀, condition good, MCZ type no 10268, labeled: "punctum m." "Loew Coll." "10268" "Type" (the type-locality "Illinois" and collector "Osten Sacken" is mentioned with the description only, there is another female in the MCZ Osten Sacken collection labeled "Ill. O. Sacken" but without type-labels). *Pachyrhina opacivittata*: Holotype ♂, condition fair, ANSP type no 6450, labeled: "Aweme Manitoba E. Criddle VI 18 13" "Holotype" "Holotype Pachyrhina opacivittata W. G. Dietz 6450". New synonymy. *Nephrotoma sphagnicola*: Alexander (1920b) described *sphagnicola* after one female from "Antioch, Lake Co., June 5, 1919 (T. H. Frison)", which is preserved in the collection of the Illinois Natural History Survey, Urbana. According to Byers (i.l.), who examined the type in 1962, it is conspecific with *punctum* and labeled: "VI-5-1919, Antioch, Ill., Coll. T.H.F." "Tamarck-Sphagnum bog" "Holotype, Nephrotoma sphagnicola C. P. Alexander". During this study a slide out of the

Alexander collection was examined, containing one antenna, one wing, one leg and the hypopygium of what Alexander called a "metatype" of *sphagnicola*, from Michigan, Gr. Traverse County. This "metatype" also is *punctum*.

Other material: 119♂, 73♀, from the following localities and counties in: Illinois (1♀, without locality), Indiana (1♂, Michigan City, La Porte County), Maine (1♂, 1♀, Brunswick, Sagadahoc County, Mt Desert, Hancock County), Massachusetts (1♂, Chesterfield Gorge, Hampshire County), Michigan (101♂, 63♀, 26 counties), New Hampshire (2♂, 1♀, N Conway and SE Twin Mountain, Caroll County), New Jersey (4♂, 3♀, Burlington, Warren and Gloucester counties), Ohio (1♀, Sandusky, Erie County), Ontario (3♂, Belfountain in Peel County NW of Brampton, Ridgeway west of Buffalo, N.Y., Pt Pelee), Quebec (1♂, Knowlton), Tennessee (2♂, 3♀, Clear Fork near Burrville, Morgan County), Vermont (1♂, Stowe, Lamoille County), Wisconsin (1♂, Crawfish R, Columbia County; 1♂, Sheboygan County).

Diagnostic features

N. punctum and *calinota* are closely related species. Both differ from the other North American *Nephrotoma* species with a dull mark below the anterior end of the lateral stripes of scutum 1 by the presence of a small, dull, brown to dark brown dash on the lateral thorax just in front of the antero-ventral end of the lower (posterior) basalare. Males of both species can be easily separated by hypopygial characters (hind margin of sternite 8, for example, with a small medial lobe in *punctum* (figs. 100, 101), without a lobe in *calinota* (figs. 104, 105)) and by the colouration of the second and following flagellar segments: unicolourous in both sexes of *punctum*, bicoulourous with darkened bases in males of *calinota*. Females of *calinota* usually also have the flagellar segments bicoulourous but sometimes the basal darkening is very faint or absent. Other characters to separate such females are: dorsal pronotum with a brown spot on the lower medial part (at most a brown line along the medial part of the lower anterior border in *punctum*), anterior border of tergite 1 with a narrow brown line, at most occupying the anterior one-sixth of the tergite (a much broader line, if present, in *punctum*), dorsal abdominal markings elongate and usually situated well in front of the hind margins (in *punctum* markings broadening towards hind margins and actually or almost reaching the hind margins), inner part of hypovalvae above major ridge evenly curved towards internal arch (fig. 111) (strongly curved in *punctum*, fig. 110).

Description

Body length ♂: 13-16 mm, ♀: 18-21 mm.
Wing length ♂: 12-13 mm, ♀: 13-15 mm.
Antennal length ♂: 4-5 mm, ♀: 3-3.5 mm.

Head. Pale yellow at genae, postgenae and lateral parts of rostrum, dorsal part of head more brownish yellow, sometimes with a brownish dash on dorsal rostrum. Occipital marking usually not or hardly indicated, rarely present as a small, shining, dark brown triangle on posterior vertex or as a longitudinal brownish stripe reaching tubercle. Between tubercle and eyes usually at least an indication of brownish spots along eyemargins. Antennae 13 segmented; scape and pedicel yellowish, sometimes in part brownish; male flagellar segment 1 brown, darkened towards apex, following flagellar segments dark brown and basal ones slightly reniform, longest verticillar hairs slightly shorter or (apically) as long as segments; female flagellar segments cylindrical, basal ones brownish yellow to brownish, apical ones usually somewhat darker, longest verticillar hairs about as long as or (apically) distinctly longer than segments.

Thorax. Ground colour of thorax pale yellow to yellow. Pronotum laterally yellow or brownish, sometimes dark brown, dorsal part brownish yellow, usually with a brown line along medial part of lower anterior margin. Scutal stripes very variable in expression, ranging from dark brown and partly black to hardly darker coloured than ground colour;

medial stripe in general darkened along mid-line; scutum 2 in general with an isolated dull spot or stripe between lateral stripes; lateral stripes of scutum 1 with a narrow dull seam along inner margins, medial stripe with such a seam only along the borders opposing lateral stripes; lateral stripes of scutum 1 with a dark brown dull spot below anterior end, spot sometimes very small or broadly in contact with stripe, giving stripe a downcurved shape; antero-lateral corners of scutum 2 with a broad brown to dark brown dull seam. Scutellum usually somewhat infuscated. Mediotergite yellow with a weak indication of the anteriorly narrow and posteriorly broad marking. Lateral markings of thorax usually faint, at most posterior half of katatergite dark brown. A small, dull, brown to dark brown dash just in front of the antero-ventral corner of the lower (posterior) basalare. Coxae and trochanters pale yellow to yellow; femora yellow, light brown towards apices, apices narrowly darkened; tibiae yellow to light brown, apices narrowly darkened; tarsi brown to dark brown; claws toothed in male only. Wings hyaline with a yellowish brown or light brown tinge; pterostigma usually distinct, dark brown, with a few macrotrichia, rarely without or with up to 15 macrotrichia; wing sometimes with a weak seam along the cord, most distinct just below stigma, wings usually with a narrow cloud at tip.

Abdomen. Pale yellow to brownish yellow with a row of dorsal and lateral markings. Tergite 1 usually with a broad stripe along the anterior margin, broadly extending caudally along mid-line. Tergites 2-6 with irregular shaped but more or less triangular (especially in female) markings at posterior part of tergites, markings largest on tergites 2-4 and almost or actually reaching hind margins, markings usually about as broad and long as mediotergite, posterior markings gradually smaller. A smaller spot on the anterior part of tergite 2. Lateral margins of tergites 2-6 or 2-7 in male with large rounded or elongate spots in middle, a more continuous stripe in females starting near mid-length of tergite 2, lateral parts rarely unmarked. Sternites unmarked. Male terminalia usually darker brown, in extremely darkened specimens posterior part of tergite 6 and segments 7 and 8 black, female terminalia usually not darkened.

Hypopygium. Extension of tergite 9 with two long lateral horns, central part with a relatively narrow and deep V-shaped incision (figs. 102, 103). Outer dististyle slender (fig. 100). Inner dististyle with dorsal crest largely reduced, anterior beak pointed below, lateral shell large (fig. 107). Medisternal appendage U-shaped (fig. 101). Adminiculum apically spined, gonapophyses narrowing towards apex (fig. 108). Intromittent organ tubular, reaching into segment 7 and with a large spine on ventral surface (fig. 108). Compressor apodeme of semen pump bifid. Hind margin of sternite 8 with a small blade-like projection in the middle (figs. 100, 101).

Ovipositor. Cerci long and slender, hypovalvae relatively broad, somewhat narrowing towards apex (fig. 109). Inner part of hypovalvae above major ridge strongly curved towards internal arch (fig. 110). Fused valvulae broad, connected with coxopodite of tergite 9 by narrow sclerotizations. Furca slender.

Biology

N. punctum is recorded from flood plain forests (Rogers, 1930), the margins of grass-sedge-fern marshes (Rogers, 1942) and a sphagnum bog and the surrounding areas (Alexander, 1920b). The period of flight is from the end of May until the middle of August with a few records in September. The species is most abundant in June and early July. The long period of flight is apparently due to more than one generation a year, although Rogers (1942) mentions "Probably a single generation a year, the long season correlated with local differences in habitats" with a period of flight from "May 30-July 30".

Distribution (map 12)

All the localities and counties from which material was studied are mentioned under

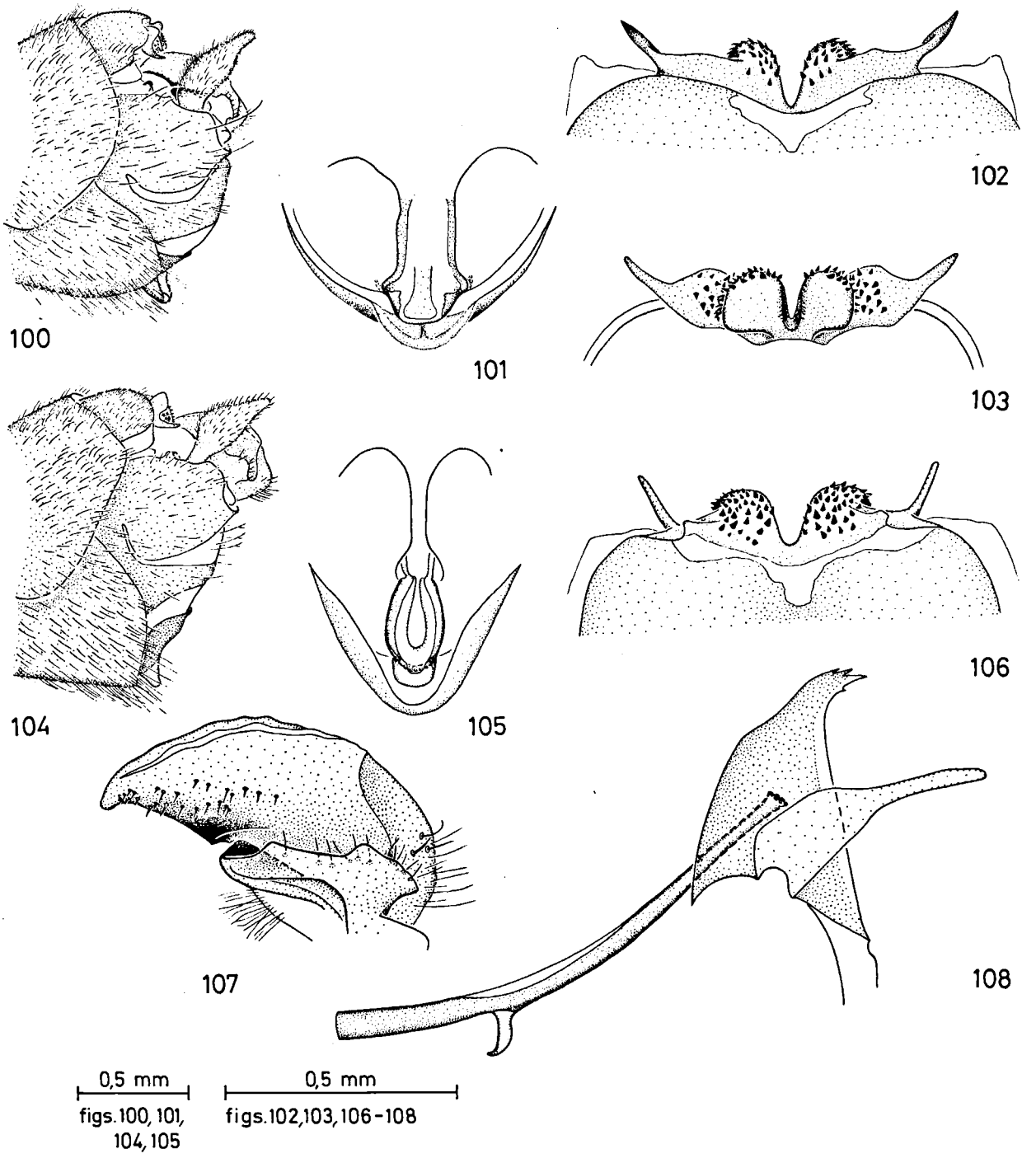


Fig. 100-103. *Nephrotoma punctum* (Loew, 1863); 100: hypopygium, lateral view; 101: ventral part of hypopygium, rear view; 102 & 103: extension of male tergite 9, dorsal (fig. 102) and ventral (fig. 103) view. Fig. 104-106. *Nephrotoma calinota* (Dietz, 1918); 104: hypopygium, lateral view; 105: ventral part of hypopygium, rear view; 106: extension of male tergite 9, dorsal view. Fig. 107-108. *Nephrotoma punctum* (Loew, 1863); 107: left inner dististyle, outside view; 108: adminiculum, left gonapophyse and apical part of intromittent organ, lateral view.

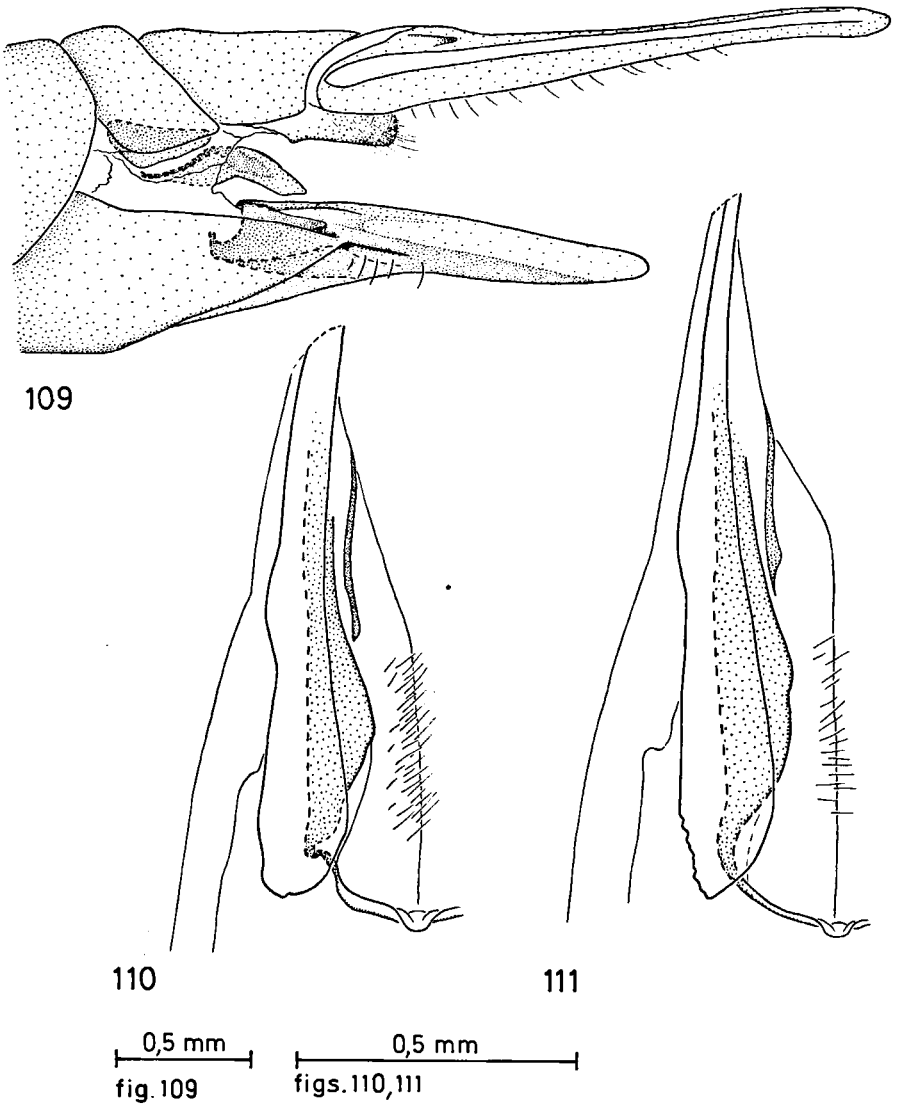


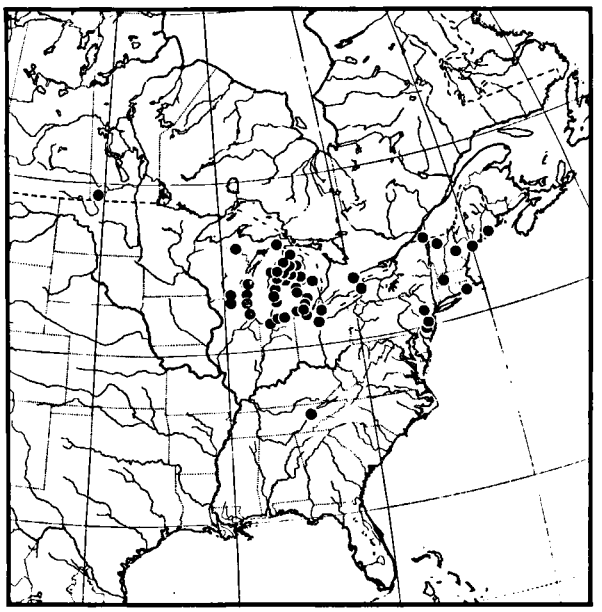
Fig. 109-110. *Nephrotoma punctum* (Loew, 1863); 109: ovipositor, lateral view; 110: right hypovalva, dorsal view.
Fig. 111. *Nephrotoma calinota* (Dietz, 1918), right hypovalva, dorsal view.

Material examined. The distribution of *punctum* is given by Alexander (1965) as Michigan to Maine, south to Illinois and New Jersey. From outside this range material was studied from Ontario, Quebec, Wisconsin (reported also by Dickinson, 1932: 219, 220 from Manitowoc, Dane and Milwaukee counties) and Manitoba (Aweme, 25 mi S of Brandon, type-locality of *opacivittata*). Illinois (Dane County) refers to the type-locality of *sphagnicola*, Rhode Island to Johnson (1925).

Nephrotoma calinota (Dietz, 1918)
Figs. 104-106, 111, map 13

Dietz, 1918: 106, note, 110, key, 121, descr, 123, 125, 126, comp, pl IV, fig wing (as *Pachyrhina*); Alexander, 1919b: 817, locs, 936, descr, distr, 937, comp; Alexander & McAtee, 1920: 396, locs, key; Leonard, 1928: 699, locs; Alexander, 1942: 223, key, 226, descr, distr, 227, comp, note, 231, comp; Alexander, 1965: 21, distr, syn.

The reference by Rogers, 1930: 13, 15, refers to *punctum* (material examined during this study); for the references by Alexander, 1940b: 606, locs, biol, and Alexander, 1941: 289, locs, it is not certain whether they refer to *calinota* or *punctum*.



Map 12. Distribution of *Nephrotoma punctum* (Loew, 1863), based on material examined (black dots) and literature (stippled dots).

Material examined

Type-material: Holotype ♂, ANSP type no 6448, condition fair, labeled: "Schoolcraft Co. Mich. Floodwood VII 1915 J. S. Rogers" "Holotype" "Holotype Pachyrhina calinota W. G. Dietz 6448". Paratypes: 6♂, 5♀, ANSP, 1♀, USNM, 1♂, USNM (Alexander coll.), labeled as the holotype but "Paratype" in stead of Holotype; 1♀, ANSP, labeled: "Plummers I 14.VII 07 Md" "A K Fischer Collector" "Paratype" "Paratype Pachyrhina calinota W. G. Dietz 6448"; 1♀, ANSP, labeled as the former but with the date "June 8-13" and the collector "A Wetmore".

Other material: 37♂, 13♀, from the following states: Indiana (20♂, 3♀, Allen County and Turkey Run Pk, Parke County), Maryland (6♂, 1♀, Plummers Isl), Michigan (4♂, 4♀, Lake County and Floodwood, Schoolcraft County), New Hampshire (1♂, SE Twin Mtn, Carroll County), New York (1♂, 1♀, Ulster County and Sports Isl, Sacandaga R, Hamilton County), North Carolina (1♂, Wilkesboro, Wilkes County), Ohio (1♂, Madison, Fairfield County), Pennsylvania (1♂, 1♀, Swartmore, Delaware County), Virginia (2♂, 3♀, Mountain Lake and Sinking Creek, Giles County, Great Falls, Fairfax County).

Diagnostic features

See under *punctum*.

Description

Body length ♂: 13-16 mm, ♀: 18-21 mm.
Wing length ♂: 12-13 mm, ♀: 13-15 mm.
Antennal length ♂: 4-5 mm, ♀: 3-3.5 mm.

Head. As in *punctum*, flagellar segments yellowish with blackened bases beyond first in male and usually also in female but latter sometimes with basal blackening very weak or absent.

Thorax. As in *punctum*, scutal stripes sometimes in part even lighter coloured than ground colour.

Abdomen. Pale yellow to brownish yellow. Tergite 1 usually with a narrow line along anterior margin, occupying at most anterior one-sixth of tergite. Male tergites 2-4 or 2-5 with a dorsal stripe, interrupted on anterior and posterior parts of tergites, stripe about as broad as scutellum, female with such a stripe on tergites 2-6 or 2-7 and usually more broadly interrupted on posterior part of tergites. Lateral parts of tergites, sternites and terminalia as in *punctum*.

Hypopygium and Ovipositor. In general as in *punctum*, differing in some details. Hypopygium more laterally compressed. Central part of the extension of tergite 9 with protruding corners (fig. 106). Inner dististyle with a low crest. Medisternal appendage with a ventral outgrowth and more distinctly protruding beyond sternite 9 than in *punctum* (fig. 104). Hind margin of sternite 8 without a lobe in the middle (fig. 105). Inner part of hypovalvae above major ridge evenly curved towards internal arch (fig. 111).

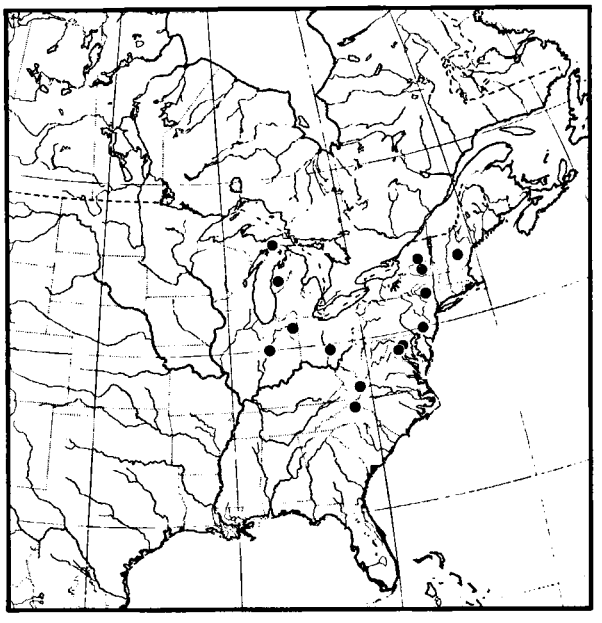
Biology

Largely unknown (the references by Rogers, 1930, refer to *punctum*). The recorded period of

flight is in June and July with more than twice as much catches in June (22) as in July (9).

Distribution (map 13)

All the localities and counties from which material was studied are mentioned under Material examined. Alexander (1919b), mentions further Sacandage Park, Fulton County, New York.



Map 13. Distribution of *Nephrotoma calinota* (Dietz, 1918), based on material examined (black dots) and literature (stippled dot).

THE *PERINCISA* GROUP

This group contains the nearctic species *perincisa* and *tealei*, the Central American *alexandriana* and about four undescribed Central American species. The hypopygial and ovipository characters of the group are rather peculiar and it is not known which other species-group is related to the *perincisa* group. It is almost certain that such groups are not to be found in the Palaearctic.

Nephrotoma perincisa (Alexander, 1949)
Figs. 112-115, 118-120, 122, 124, map 14

Alexander, 1949b: 99-101, descr, comp; Alexander, 1965: 22, distr; Byers, 1968: 402, comp; Cole, 1969: 53, distr.

Material examined

Type-material: The three males after which *perincisa* was described were examined in the USNM (Alexander coll.). The holotype and one paratype are labeled: "McNary, Apache Co. Ariz White Mts 7400′ Jul 22 '48" "Holotype, resp. Paratype, ♂ Nephrotoma perincisa C. P. Alexander", the paratype with "F. Werner" added on the first label. Both males have the abdominal end, leg(s), antenna(e) and one wing dissected and on slides; both slides are labeled in addition "boree; ant." "(Floyd, Werner) The Alexander Collection of Crane-Flies" "9006". The third male is labeled: "Arizona Graham Mts W. Slope 9000′ VIII-5.48 F. Werner" "Paratype ♂ Nephrotoma perincisa C. P. Alexander".

Other material: 2♂, 1♀, Arizona, Cochise County, Chiricahua Mts, Turkey Flat, 22.VII.1927, ZMA; 1♂, idem, Rustler Park, 26.VII.1927, ZMA; 1♂, New Mexico, Santa Fe County, Hyde St Pk, 8 mi NE Santa Fe, 29.VII.1964, UKaL; 2♀, New Mexico, San Miguel County, Storrie St Pk, 24.VII.1965, 6500′, UMMZ; 2♀, New Mexico, Mora County, US Hwy 85, 0.8 mi N Watrous, 24.VII.1965, 6400′, UMMZ; 1♀, New Mexico, Catron County, 5 mi NE Glenwood, 1.VIII.1965, UMMZ; 1♂, New Mexico, Lincoln County, Bonito Lake, 28.VII.1965, 7400′, UKaL; 4♀, Colorado, Teller County, Florissant, Big Spring Ranch, 22.VII-8.VIII.1962, UKaL(L); 1♀, idem, 5.VIII. 1965, UKaL(L); 1♂ Texas is mentioned under distribution.

Diagnostic features

N. perincisa is closely related to *tealei*. The differentiating characters are discussed with the description of *tealei*.

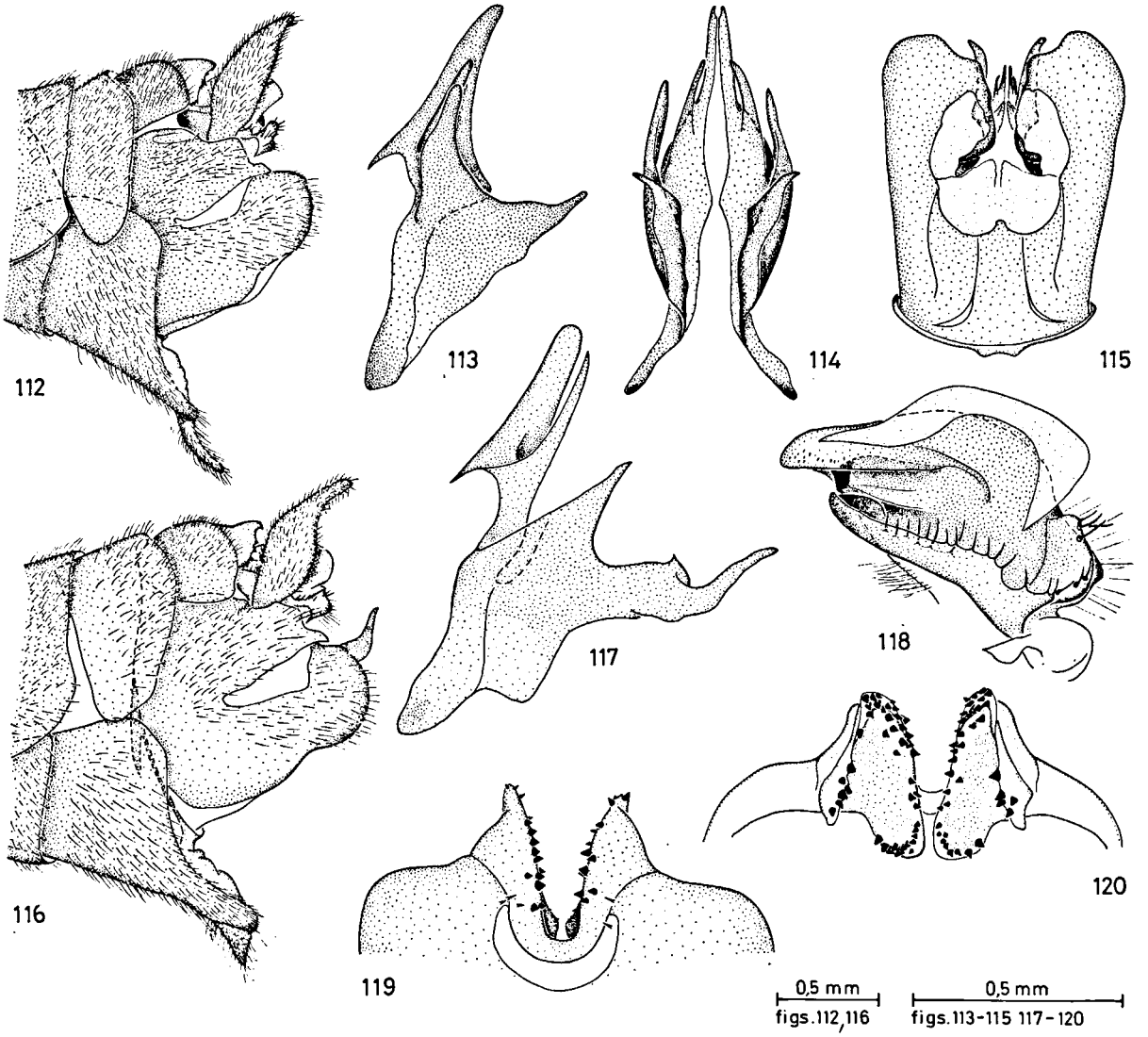


Fig. 112-115. *Nephrotoma perincisa* (Alexander, 1949); 112: hypopygium, lateral view; 113: adminiculum and left gonapophyse, lateral view; 114: adminiculum and gonapophyses, rear view; 115: ventral aspect of male sternite 9. Fig. 116-117. *Nephrotoma tealei* (nov. spec.); 116: hypopygium, lateral view; 117: adminiculum and left gonapophyse, lateral view. Fig. 118-120. *Nephrotoma perincisa* (Alexander, 1949); 118: left inner dististyle, outside view; 119 & 120: extension of male tergite 9, dorsal (fig. 119) and ventral (fig. 120) view.

Description

Body length ♂: 13-15 mm, ♀: 17-21 mm.
Wing length ♂: 14-15 mm, ♀: 16-18 mm.
Antennal length ♂: 4.5-5 mm, ♀: 3.5-4 mm.

Head. Pale yellow, on dorsal part of rostrum brownish, on vertex and usually on tubercle brownish yellow to brownish. Occipital marking shining, brown, less broad than dorsal part of pronotum and reaching base of tubercle, triangular in shape or with lateral margins more parallel-sided on caudal part. Antennae with 13 segments; scape, pedicel and basal half of male flagel 1, or in female almost entire flagel 1, pale yellow to brownish yellow, remainder of flagel dark brown to black, in the female sometimes with bases lighter coloured; male and female flagellar segments slightly nodulose

basally beyond flagel 1; longest verticillar hairs in male somewhat shorter or (apically) as long as segments, in female up to 1.4 times as long as segments.

Thorax. Pronotum dorsally yellow, sometimes with a brown spot on the rostral surface, lateral pronotum brownish. Scutal stripes brown, sometimes in part dark brown; lateral margins of medial and lateral stripes of scutum 1 narrowly dull where stripes are opposing each other; lateral stripes usually straight, sometimes distinctly downcurved anteriorly, the curved part shining and much lighter coloured than lateral stripe; medial stripe of scutum 1 crossing transverse suture, forming a dull medial stripe on scutum 2, which sometimes reaches scutellum. Antero-lateral corners of scutum 2 with a dull brown seam. Scutellum brownish with a darker stripe along mid-line. Anterior part of mediotergite with a broad, longitudinal, brown stripe which distinctly widens and usually becomes more transparent posteriorly. Markings on lateral part of thorax usually brownish but sometimes faint or in part dark brown. Coxae brownish yellow, sometimes in part brown; trochanters brownish yellow; femora and tibiae light brown to brown with the extreme apices darkened dorsally; tarsi brown to dark brown; claws toothed in male only. Wings hyaline with a light brown tinge; pterostigma light brown, without or with up to 30 macrotrichia.

Abdomen. Pale yellow to brownish yellow with a row of brown to dark brown, elongate, dorsal spots. Dorsal part of tergite 1 largely brown to dark brown in front of yellowish hind margin. Tergites 2-6 or 2-7 with elongate dorsal spots, anterior part of tergites yellowish, posterior part of tergites yellowish or hind margin only, spots about as broad as scutellum, rarely as broad as mediotergite, in female spots smaller on posterior tergites; lateral parts of tergites usually yellowish in male, sometimes with a weakly infuscated lateral stripe, female with a continuous, infuscated or transparently brown lateral stripe on tergites 2-8. Remainder of abdomen yellowish.

Hypopygium. Extension of tergite 9 with a narrow and deep medial incision, lateral parts narrowly triangular and distinctly protruding beyond tergite (figs. 119, 120). Outer dististyle with posterior margin more or less straight (fig. 112). Inner dististyle with high dorsal crest and large lateral shell (fig. 118). Adminiculum itself with slender lateral appendages, gonapophyses broadly excavated with the dorsal and posterior arm of about equal length and not distinctly protruding beyond sternite 9 (figs. 113, 114). Medisternal appendage not present, mid-ventral part of sternite 9 sclerotized, region surrounding ventral appendages of adminiculum membranous (fig. 115). Mid-ventral part of sternite 8 conspicuously lengthened, the apex with a long and slender appendage (fig. 112). Compressor apodeme of semen pump large and bifid. Intromittent organ tubular, reaching into segment 7.

Ovipositor. Cerci long and slender as in *tealei* (fig. 123), hypovalvae broad (fig. 124). Fused valvulae large, apical part acute, without a sclerotized connection with coxopodite of tergite 9, furca elongate with a tripartite caudal end; rostral extension of hypovalvae long and broad; internal arch present; inbetween rostral extensions a small sclerotized plate on either side of furca (fig. 122).

Biology

The period of flight apparently is very short, the records are inbetween July 22 and August 8. Altitudes are for Arizona 7400′ (2260 m) and 9000′ (2740 m), for New Mexico 6400′ (1950 m) and 7400′ (2260 m).

Distribution (map 14)

All material known of *perincisa* is mentioned under Material examined. In general the distribution in New Mexico lies more towards the north than for *tealei*. The two species are at least partly sympatric, both are known from McNary White Mts in Arizona and from Bonito Lake in New Mexico (in the latter case with identical labels). For the material from Texas (1♂, Big Bend Park, Brewster County,

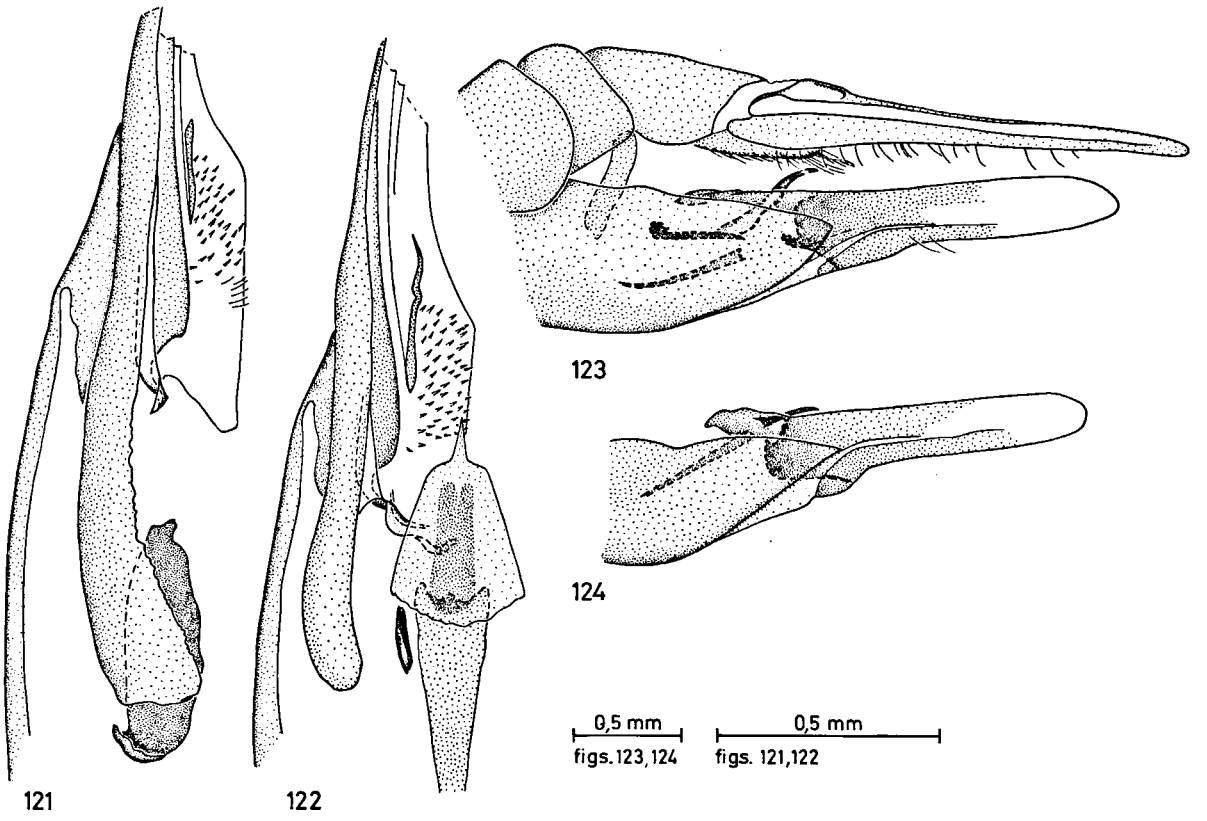


Fig. 121, 123. *Nephrotoma tealei* (nov. spec.); 121: right hypovalva, dorsal view; 123: ovipositor, lateral view. Fig. 122, 124. *Nephrotoma perincisa* (Alexander, 1949); 122: right hypovalva, dorsal view; 124: left hypovalva, lateral view.

8.VII. 1937, USNMA) it is not known whether this specimen belongs to *perincisa* or *tealei*.

Nephrotoma tealei (spec. nov.)
Figs. 116, 117, 121, 123, map 15

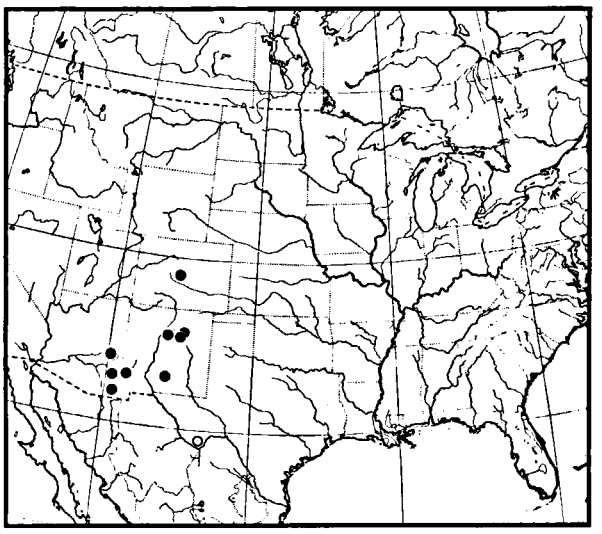
Type-material

Holotype ♂, condition good, UKaL, labeled: "New Mexico, Otero County, Silver Spr. Cany. 6 mi. NE. Cloudcroft at light 8125 ft. 27 July 1965 George W. Byers".

Paratypes: 3♂, 3♀, labeled as the holotype (2♂, 2♀, UKaL; 1♂, 1♀, ZMA). 3♂, 3♀, New Mexico, Otero County, Sleepy Grass Cmp, 1.6 mi E Cloudcroft, 27.VII.1965, 8675′ (1♂, UKaL, 2♂, 3♀, UMMZ). 2♂, New Mexico, Otero County, White Mts, 7000′, 20.VII.1927 (UMMZ). 3♂, 1♀, idem, 20.IX.1925 (UMMZ). 2♂, idem, 10.IX.1925 (UMMZ). 6♂, 4♀, New Mexico, Lincoln County, Alto Reserve, Alto, 7400′, 26.VII.1965, at light (6♂, 2♀, UKaL; 1♀, UMMZ; 1♂, ZMA). 3♂, idem, 2.5 mi NW Ruidoso, 27.VII.1965, at light (2♂, UKaL; 1♂, ZMA). 1♂, 2♀, idem, Cedar Cr Can, 2 mi NW Ruidoso, 26.VII.1965, 7100′ (UMMZ). 4♂, 1♀, idem, Bonito Lake, 28.VII.1965, 7400′ (UKaL). 1♀, Arizona, Apache-Navajo counties, Mc Nary White Mts, 2.VIII. 1925, 8000′ (UMMZ).

Description

Body length ♂: 14-16 mm, ♀: 18-22 mm.
Wing length ♂: 14-15 mm, ♀: 17-19 mm.
Antennal length ♂: 4.5-5 mm, ♀: 4 mm.
Very similar to *perincisa* but in general larger



Map 14. Distribution of *Nephrotoma perincisa* (Alexander, 1949), based on material examined (black dots); circle refers to a specimen which belongs to either *perincisa* or *tealei*.

and differing in the following characters: Female flagellar segments uniformly darkened or with bases even darker coloured beyond flagel 1; longest verticillar hairs in female up to 1.2 × length of segments (in *perincisa* up to 1.4). Tergite 1 in both sexes without a brown or dark brown spot dorsally but entirely yellowish, in part pale yellow. Hypopygium with outer margin of outer dististyle more sinuate (fig. 116). Gonapophyses situated low and with a lengthened posterior arm (fig. 117) which distinctly protrudes beyond hypopygium in dried specimens (fig. 116); appendage at mid-ventral extension of sternite 8 much shorter than in *perincisa* (fig. 116). Ovipositor with fused valvulae and furca situated lower (fig. 123), fused valvulae somewhat larger and with large sclerotized blades laterad of base and below rostral extensions; internal arch not developed; rostral extensions very long (fig. 121).

Biology

The major period of flight is, as in *perincisa*, very short, from July 20 to August 2, but there are also two records from September. Altitudes are for Arizona 8000′ (2440 m) and for New Mexico inbetween 7000′ (2130 m) and 8675′ (2646 m).

Distribution (map 15)

See under *perincisa*.

Etymology

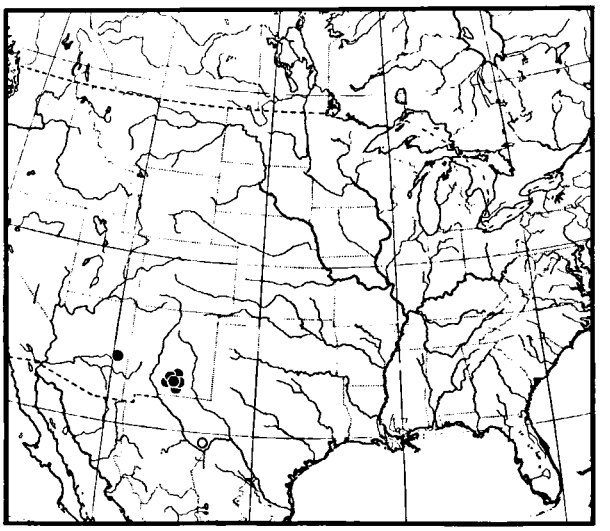
The species is named after Steve Teale of the University of Kansas, Lawrence, in appreciation for the help received in many ways.

THE *PEDUNCULATA* GROUP

The species *pedunculata* is placed in a group of its own. The species has an isolated position among the nearctic species of *Nephrotoma*. It is not yet known whether it belongs to one of the many palaearctic species-groups.

Nephrotoma pedunculata (Loew, 1863)
Figs. 125-132, map 16

Loew, 1863: 293, descr (as *Pachyrrhina*); Osten Sacken, 1878: 40, locs (as *Pachyrrhina*); Loew, 1879: 2, key (as *Pachyrrhina*); Slosson, 1898: 252, locs (as *Pachyrrhina*); Johannsen, 1903: 14, locs, note (as *Pachyrrhina*);



Map 15. Distribution of *Nephrotoma tealei* (nov. spec.); circle refers to a specimen which belongs to either *tealei* or *perincisa*.

McGillivray & Houghton, 1903: 12, locs (as *Pachyrrhina*); Snodgrass, 1904: 201, descr hyp, pl XI, figs hyp (as *Pachyrrhina*); Aldrich, 1905: 98, locs (as *Pachyrhina*); Doane, 1908: 174, key (as *Pachyrhina*); Alexander, 1915b: 467, descr, 468, comp; Dietz, 1918: 109, key (as *Pachyrhina*); Alexander, 1919b: 782, 818, locs, 831, 877, biol, 935, key, 977, fig wing; Dietz, 1921: 260, locs (as *Pachyrhina*); Johnson, 1925: 34, locs; Alexander, 1927b: 216, locs; Alexander, 1928: 57, locs; Leonard, 1928: 699, locs; Alexander, 1931a: 138, locs; Winn & Beaulieu, 1932: 8, locs; Dickinson, 1932: 167, locs, 215, key, 217, fig wing, locs; Alexander, 1942: 222, key, 231, descr, distr, locs; Procter, 1938: 283, locs; Alexander, 1962: 8, locs; Alexander, 1965: 22, distr; Cole, 1969: 53, distr.

Material examined

Type-material: Lectotype ♀, MCZ type no 10267, condition good, labeled: "Saskatch., Kenic" "pedunculata m." "Loew Coll." "10267" "Type". Paralectotype ♀, labeled: "Can" "Type" "10267".

Other material: 49♂, 39♀, from the following states and provinces: Alberta (2♂, 1 ♀); Illinois (1♀ without locality); Maine (5♂, 1♀); Massachusetts (3♂, 1♀); Michigan (4♂, 5♀); Minnesota (1♂, 2♀); Newfoundland (6♂, 5♀); New Hampshire (3♀); New Jersey (1♀); New York (1♂, 3♀); Nova Scotia (1♀); Ontario (10♂, 7♀); Pennsylvania (13♂, 7♀); Quebec (2♂); Virginia (2♂, 1♀).

Diagnostic features

Males of *N. pedunculata* can be easily recognized by the medial appendage of sternite 8 (fig. 127), lacking in all other North American *Nephrotoma* species. Both sexes are characterized by the large dorsal markings of the abdominal tergites, in the female smaller on tergites 6 and 7, in combination with the broad and conspicuous occipital marking and the shining, downcurved but much lighter coloured anterior end of the lateral stripes of scutum 1.

Description

Body length ♂: 12-13 mm, ♀: 17-19 mm.
Wing length ♂: 12-13 mm, ♀: 13-14 mm.
Antennal length ♂: 5 mm, ♀: 3-3.5 mm.

Head. Genae and postgenae pale yellow; lateral parts of rostrum pale yellow to yellow, dorsal part broadly brown to dark brown; vertex brownish yellow with a large, dark brown occipital marking, marking about as broad as dorsal part of pronotum and with a rounded or oval shape, sometimes more triangular rostrally reaching base of tubercle. Antennae with 13 segments; scape yellow, sometimes in part or entirely brownish; pedicel ranging from yellow to dark brown, usually brownish; flagellar segments dark brown; in male basal flagellar segments beyond first somewhat reniform with longest verticillar hairs about three-fourth length of segments, apical segments nodulose basally and about as long as longest verticils; female flagellar segments cylindrical, longest verticillar hairs slightly shorter or (apically) slightly longer than segments.

Thorax. Yellow with brown to dark brown lateral and dorsal markings. Pronotum dorsally yellow, laterally brown to dark brown. Scutal stripes dark brown, lateral stripes of scutum 1 with a much lighter coloured downcurved part anteriorly, curved part large and shining, rarely hardly indicated as if stripes are straight. Antero-lateral corners of scutum 2 with a broad, brown to dark brown dull seam. Scutellum ranging from yellow to brown, transparent, usually with a darker stripe along mid-line. Mediotergite yellow with a brown and broad stripe along mid-line anteriorly which broadens and usually becomes paler posteriorly. Lateral markings brown to dark brown. Posterior part of paratergite with a large, brown to dark brown spot which is usually enlarged towards basalare. Coxae brownish yellow with a white pruinosity on the outer surfaces; trochanters light brown; femora basally light brown, steadily growing darker towards dark brown or black apices; tibiae brown to dark brown; tarsi dark brown; claws toothed in male only. Wings hyaline; pterostigma light brown to brown, with a few, rarely with up to 20, macrotrichia; wingtip with a weak brownish cloud.

Abdomen. Brownish yellow with large dark brown dorsal markings. Segment 1 dark brown, laterally largely yellow. Both sexes with

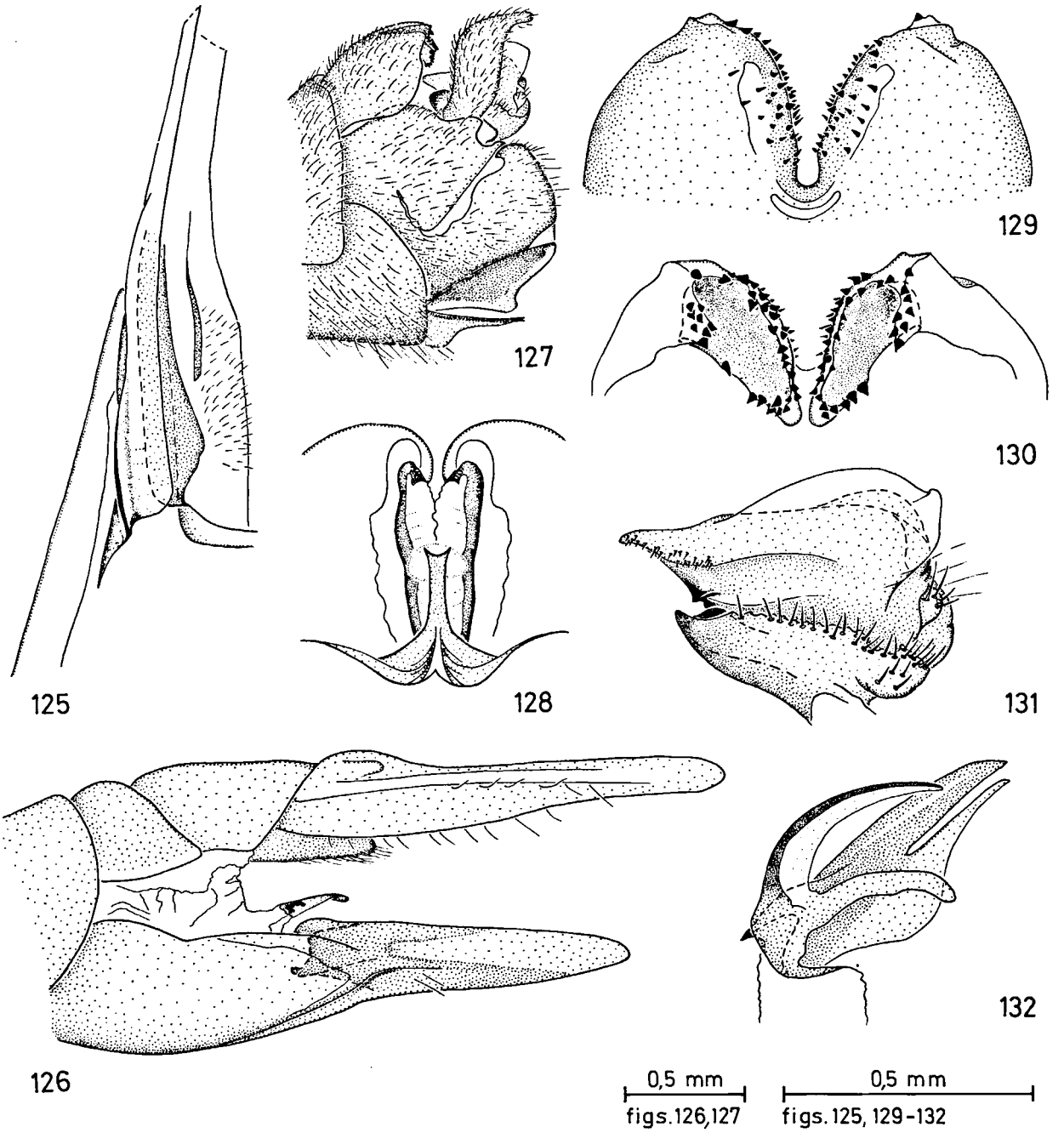
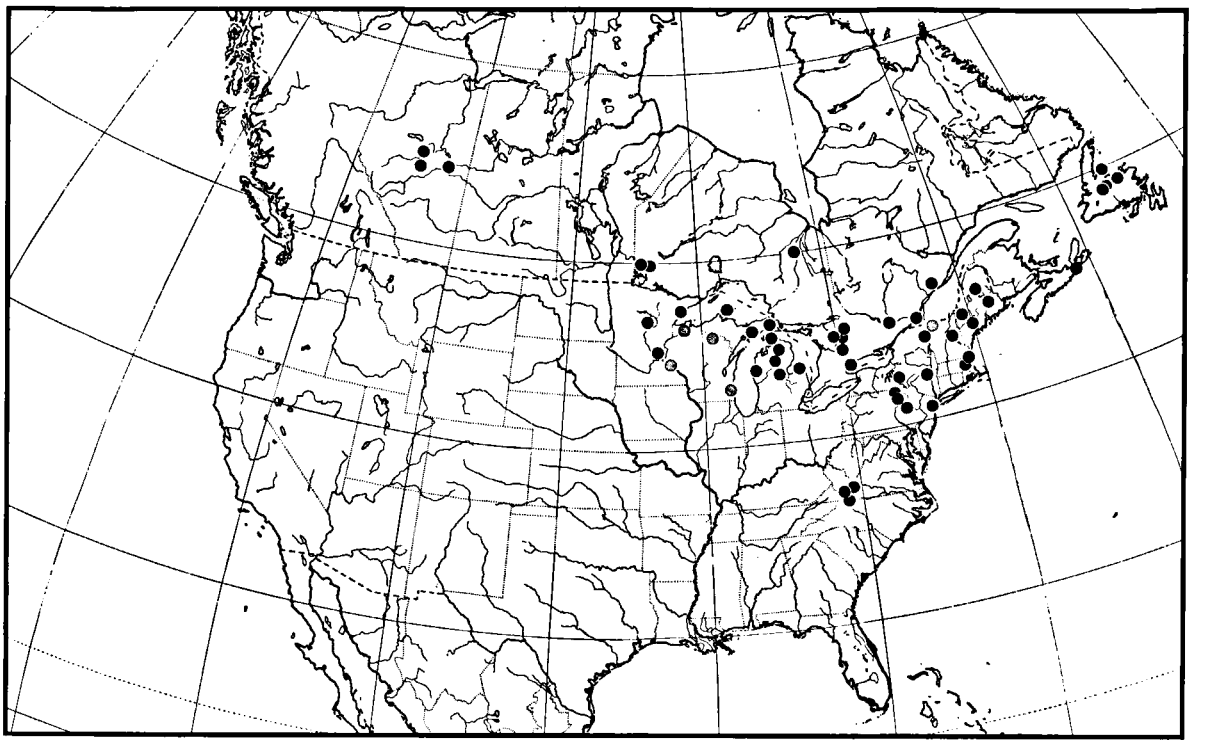


Fig. 125-132. *Nephrotoma pedunculata* (Loew, 1863); 125: right hypovalva, dorsal view; 126: ovipositor, lateral view; 127: hypopygium, lateral view; 128: appendage of male sternite 8 and ventral part of sternite 9, ventral view; 129 & 130: extension of male tergite 9, dorsal (fig. 129) and vental (fig. 130) view; 131: left inner dististyle, outside view; 132: adminiculum and left gonapophyse, lateral view.

large dark brown markings at posterior two-third or three-fourth of tergites 2-6 (male) or 2-5 (female), markings more or less triangular in male, more rectangular in female, in both sexes almost or actually reaching latero-posterior corners of tergites; tergite 2 with a more rounded spot on anterior half. Male tergite 7 dark brown except antero-laterally,



Map 16. Distribution of *Nephrotoma pedunculata* (Loew, 1863), based on material examined (black dots) and literature (stippled dots).

segment 8 reddish brown or dark brown. In female the dorsal markings are becoming less broad and usually do not reach the hind margins on tergites 6 and 7. Males possess large, lateral, brown to dark brown spots near mid-length of tergite 2 and on anterior corners of tergites 3-7. Females possess similar spots or have a more continuous lateral stripe reaching anterior corner of tergite 7. Sternites 2-7 (male) or 2-8 (female) unmarked.

Hypopygium. Extension of tergite 9 very deeply incised (figs. 129, 130). Outer dististyle relatively broad (fig. 127). Inner dististyle with a high crest and a large lateral shell (fig. 131). Apical half of adminiculum bifid, gonapophyses divided in two arms (fig. 132). Medisternal appendage large, distinctly protruding beyond sternite 9 and with the medial unsclerotized part not invaginated (fig. 127). Sternite 8 with a long, bare, apically bifurcate medial appendage (figs. 127, 128). Compressor apodeme of semen pump hardly bifid. Intromittent organ tubular, reaching into segment 6.

Ovipositor. As in fig. 126, rostral extensions of hypovalvae acute and with an upright flange (fig. 125). Fused valvulae membraneously connected with tergite 9, coxopodite of tergite 9 not sclerotized. Furca small and slender.

Biology

The only reference for the biology is by Alexander (1919b): "Wet meadows or grasslands and found along the (usually) grassy banks of streams not necessarily in deep shade". A fair number of the Newfoundland material was collected in bogs along rivers and lakes. The period of flight is from the end of May until the end of August with a distinct peak throughout July. Altitudes are recorded for Maine, 4600′ (1400 m), and Virginia, 5000′ (1520 m).

Distribution (map 16)

Material was examined from all states and provinces mentioned in literature except "New Brunswick" (Alexander, 1919b), Vermont, region "16" (Johnson, 1925) and Wisconsin, Bayfield, Milwaukee, Pierce and Vilas counties (Dickinson, 1932). The counties and localities from which material was examined are: Alberta: Fawcett, St Paul and Bilby, 30 mi W Edmonton; Illinois (without locality); Maine: Penobscot County, Millinoket, Kennebec County, Augusta, Franklin County, Rangeley, Piscataquis County, Mt Katahdin; Massachusetts: Suffolk County, Cambridge, Essex County, N Saugus; Michigan: Chippewa County, Whitefish Pt, Huron County, Sand Point, Midland County, Midland, Keweenaw County, Copper Harbour, Mason, Otsego, Emmet and Schoolcraft counties; Minnesota: Anoka County, Republic, Cass County, Cass Lake, Lake County, Two Harbours; Newfoundland: 10 localities from C. P. Alexander's 1961 trip of which were traceable: Exploits River at Bishop Falls, Buchans, Buchans Road and Baie Verte; New Hampshire: Crafton County, White Mts; New Jersey; Union County, E Orange; New York: Essex County, Keene Valley, Cortland County, Cincinnatus, Greene County, Catskill; Nova Scotia: Queens Port; Ontario: Algonquin Park, Port Sydney 10 miles S Huntsville, Toronto, Pointe au Brasil, Ottawa, Smokey Falls, Norway point (not traced), Brule Lake, Kenora district, Malachi-Minski, Gull Lake; Pennsylvania: Bradford County, Wilawana, Sullivan County, North Mts, Luzerne County, Hazleton; Quebec: Laurentides Park, Montreal; Virginia: Bland County, Wolf Creek, Grayson County, Mt Rogers St Park, Giles County, Mountain Lake.

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REFERENCES

For references see: TANGELDER, IDA R. M., 1983. A revision of the Crane Fly genus Nephrotoma Meigen, 1803, in North America (Diptera, Tipulidae). Part I: the dorsalis species-group. Beaufortia, **33** (8): 111-205.

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