Identification Atlas of the Vespidae (Hymenoptera, Aculeata) of the northeastern Nearctic region

MATTHIAS BUCK, STEPHEN A. MARSHALL and DAVID K.B. CHEUNG

Department of Environmental Biology, University of Guelph, Guelph, Ontario, N1G 2W1, Canada. E-mail of corresponding author: mbuck@uoguelph.ca

Abstract. The Vespidae of the northeastern Nearctic region are reviewed to include 92 established and four adventitious species. Six undescribed species (two each in *Ancistrocerus*, *Euodynerus* and *Polistes*) are recognised for the first time. Three former subspecies, *Euodynerus blakeanus* Cameron (subspecies of *E. foraminatus* de Saussure), *Ancistrocerus albophaleratus* de Saussure (subspecies of *A. catskill* de Saussure) and *A. albolacteus* Bequaert (subspecies of *A. adiabatus* de Saussure) are re-instated as or elevated to good species. *Parancistrocerus vogti* (Krombein) is synonymized with *P. fulvipes* (de Saussure). A brief introduction to the morphology, biology and distribution of Vespidae is given. Keys to subfamilies, genera and species are provided, and illustrated with 60 photographic plates (437 images) showing most diagnostic characters. All species are illustrated on 287 separate plates by means of (*i*) a set of standard photographs of pinned specimens (habitus lateral and dorsal, head of male and female; 537 images), and, where available, (*ii*) photographs of live specimens in the field (99 images). The variation (especially colour) of most species is described in detail and supplemented with brief information on distribution and biology. Twenty-two species (including five adventitious species) are recorded for the first time from Canada and numerous new state records for the U.S. are given. *Euodynerus blakeanus*, a taxon previously known only from Texas, is recorded for the first time from the northeastern Nearctic (New Jersey, Maryland, West Virginia) and several midwestern and southeastern states (Kansas, Missouri, North Carolina). The occurrence of *E. pratensis* in the northeast (recorded from Ontario) is considered doubtful. New data on the nest sites of ten Eumeninae species is provided (*Ancistrocerus albophaleratus*, *A. catskill*, *A. unifasciatus*, *Eumenes verticalis*, *Euodynerus auranus*, *E. planitarsis*, *Parancistrocerus leionotus*, *Parazumia symmorpha*, *Stenodynerus anormis*, *S. kennicottianus*). Morphological and other scientific terms are explained in an appendix.

Polistes bellicosus Viereck, female

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A. General

1. Introduction

The family Vespidae includes some of the most common and conspicuous of all wasps so that the word "wasp" is often used to refer to common yellowjackets or paper wasps – the social species within the Vespidae – rather than members of other, much more diverse families of Hymenoptera. Besides the two social subfamilies (Vespinae, Polistinae) the North American Vespidae also include the less familiar solitary subfamilies Eumeninae (mason or potter wasps), Masarinae (pollen wasps) and Euparagiinae. Because of their sociality and (in some cases) their relevance as pest species, social Vespidae have received much attention. The fairly extensive literature on Vespinae and Polistinae can easily distract from the fact that overall the family is not very well studied, and that both the Polistinae and Eumeninae still hold significant unresolved taxonomic problems. The need for further taxonomic work is underlined by the lack of adequate keys. There are no published keys for some of the most common and diverse genera in the subfamily, and only partial keys to others. In some cases existing keys are outdated because closely related, similar species are not separated or newly introduced exotic species are not considered. There is also a need to base species identifications on a broader base of characters and to illustrate characters used by previous authors.

Our objectives in developing this "Atlas" were to review the taxonomy of northeastern Vespidae, wherever possible adding new diagnostic characters for difficult taxa, and to provide a novel, comprehensive, analytic, yet user-friendly identification tool and a taxonomic reference work of use to both professionals and skilled amateurs. The scientific terminology is fully explained in a glossary and morphological characters are extensively illustrated. Keys and species treatments are extensively illustrated, showing diagnostic characters as well as standard aspects of both sexes of every species, including castes for social species.

The emphasis of this publication is taxonomic, but some new morphological discoveries are included because of their relevance to taxonomy and species identification. Nesting habits and prey records are summarized briefly for all species. New observations are provided for some species whose biology was previously unknown.

The present work should reduce the 'taxonomic impediment' to identification of northeastern Vespidae, thereby facilitating future scientific studies on the taxonomy, biology, and behaviour of these interesting wasps. We hope that the ready availability of user-friendly identification tools will entice more amateurs to study local vespid faunas, thus filling significant gaps in our knowledge of distribution and biology.

2. Material and Methods

Geographic scope. Our keys deal with the fauna of eastern Canada (Atlantic provinces west to the Ontario-Manitoba border), and the northeastern United States south to Virginia and west to Minnesota, Wisconsin, Illinois and Kentucky. In some cases keys are applicable to more inclusive areas (e.g., eastern Nearctic for *Dolichovespula*) because no additional species occur outside the core area of the Atlas. Data for occurrence outside Canada are largely based on the literature, though many new state records are provided to document extensions of previously known ranges.

Species identification. Compared to other groups of aculeate wasps, Vespidae are relatively homogenous within their subfamilies and relatively poor in diagnostic characters. The resulting identification problems are further exacerbated by a high degree of variation, which is especially evident in the great variability of colour patterns. Colour characters have therefore been largely avoided in previously published keys. Colouration can indeed become almost meaningless when material from the entire range of a species is considered. Because of Müllerian mimicry different species follow common geographic trends of variation, sometimes with surprising accuracy. For example almost all yellow-marked species show red suffusion of yellow markings in peninsular Florida, and in Californian populations yellow markings generally become extremely expanded. Despite these problems, colour characters can be very useful when specimens from smaller geographic areas are considered. Some previously unrecognised species were first discovered in the course of this review because of their consistently different colour patterns. The taxonomic distinctness of these 'colour forms' can often be corroborated through other characters. Our keys make use of colour characters as much as possible for three reasons: (1) Colour characters are easier to assess than most morphological characters when specimens are observed in the field. (2) In a group that is generally poor in diagnostic characters one cannot afford to dismiss easily any potentially useful subset of characters. (3) While colour patterns can usually not be used for positive identifications they will

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help to narrow the range of possible species. However, it must be stressed that the colour characters mentioned in the key can only be used within the area covered by this work. The variation of colour patterns was usually studied on a large number of specimens, and is described in detail in the 'Variation' section under each species.

Taxonomy and classification. Our classification largely follows the most recent literature for each group (references listed under group headings in Taxonomic treatment), although two subspecies are reinstated as good species, and one subspecies is newly elevated to species rank. Six undescribed species discovered during the preparation of this work will be described elsewhere. The senior author is responsible for all taxonomic data and their interpretation.

Species treatments. Every species included in the keys is illustrated by a set of standard pictures including head (frontal view) and habitus (dorsal and lateral views). Because of pronounced sexual dimorphism, images of the head are provided for both sexes (including both workers and queens in Vespinae). For habitus photographs only one image of each sex (e.g., male lateral, female dorsal) was taken for species in which sexual dimorphism is low to moderate. For strongly dimorphic species the full set of images is provided for both sexes (in Vespinae also for both female castes). Variation of colour patterns, which is often considerable, is usually not documented by additional images but is described in detail in the 'Variation' section under each species.

Recommended techniques for killing and preparing specimens. Specimens are normally killed in the field using killing bottles charged with cyanide or ethyl acetate and pinned shortly thereafter. If these killing agents are not available specimens can also be collected into individual vials and killed later by freezing. Specimens should not be kept in cyanide bottles for too long because prolonged exposure to cyanide (especially at elevated temperatures) causes a reddening of yellow pigment in the cuticle. Cyanide-reddened areas usually show a different hue of red than areas that are originally red but can still cause confusion when keying out a specimen. In some groups, especially in the genera *Stenodynerus*, *Parancistrocerus*, *Euodynerus*, *Ancistrocerus* and *Vespula*, the male genitalia offer very useful diagnostic characters and thus should be pulled out and exposed when the specimen is being pinned. This can be achieved easily by reaching in between tergum and sternum 7 with a pair of fine forceps. Dissection of dry material with unexposed genitalia is very time-consuming and often causes damage to delicate structures.

Material examined. The present study is based on material from the following collections (acronyms given in parentheses): University of Guelph, Department of Environmental Biology, Guelph, Ontario (DEBU), Canadian National Collection of Insects, Ottawa, Ontario (CNCI), American Museum of Natural History, New York, New York (AMNH), Royal Ontario Museum, Toronto, Ontario (ROME), Florida State Collection of Arthropods, Museum of Entomology, Gainesville, Florida (FSCA), Sam Droege collection (USGS Patuxent Wildlife Research Center, Beltsville, Maryland), Laurence Packer collection, York University, Toronto, Ontario (PYU), United States National Museum of Natural History, Washington, D.C. (USNM); J.B. Wallis Museum of Entomology, Department of Entomology, University of Manitoba, Winnipeg, Manitoba (EDUM), Lyman Entomological Museum, McDonald College, McGill University, Ste-Anne-de-Bellevue, Quebec (LEMQ), British Museum of Natural History (BMNH), and the private collection of Brad Arnal and Harold Duggan, Waterloo, Ontario (BAR).

Photography. High resolution images (most figures in this Atlas) were taken with a Microptics Digital Lab XLT imaging system using a Canon EOS-1Ds camera and Microptics ML-1000 flash fibre optic illumination system. Each final image was assembled from a series of photographs (with different focal planes) using the computer freeware CombineZ (Hadley 2005, 2006). Images of larger specimens (mostly habitus photographs of Vespinae and Polistinae) were taken with a Nikon D70 digital camera using a Sigma 105 mm lens and Nikon SB800 or Nikon R1C1 flash. Light diffusers were used with both setups. Dissected genitalia were photographed in glycerine using either the Microptics system (see above) or a Zeiss compound microscope with Nikon Coolpix 4500 camera (images digitally stacked with CombineZ). Imaged specimens are mostly deposited in the Guelph Insect Collection except for some specimens (indicated in the Appendix) that were kindly provided by the AMNH, CNCI, ROME, USNM and FSCA.

Many species are also illustrated with field photographs, mostly taken using a Nikon D70 digital SLR camera with either a 105mm or 60mm macro lens and usually with a single remote flash. Some photographs of live specimens were taken with older, film cameras and scanned from slides for use in this Atlas.

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Copyright. The copyright for photographs of museum specimens and line drawings lies with the authors. The copyright for most photographs of live specimens, unless stated otherwise, lies with Steve Marshall. Forty-one images of live specimens were kindly provided by other contributors (most of these images are posted on the website bugguide.net). The copyright for these pictures lies with the individual contributor (noted on image), namely Perry Babin, Tom Bentley, Patrick Coin, Jack Connor, Johnny Dell, Tony DiTerlizzi, Bill DuPree, Bobby Grizzard, Jeff Hollenbeck, Stephen Luk, Brian Malow, Charles Matson, Sean McCann, Tom Murray, Richard Orr, Loren Padelford, Lynette Schimming, Steve Scott, Edward Trammel, Charles Weber, Machele White, and Hartmut Wisch.

Arrangement of figures and plates. In the PDF version the figures for each chapter are assembled in plates either at the end of the respective chapter (Sections A, *General*, and B, *Keys to subfamilies, genera and species*) or after the species treatments for each genus (Section C, *Taxonomic treatments*). Chapters are numbered starting from 1 in each of the main sections A to C of the Atlas (see Table of contents). The figure numbers are based on the section and chapter, i.e., Fig. B3.11 is Figure 11 in chapter 3, (*Key to Ancistrocerus species*), of section B (*Keys*). In citing figures, the letter pertaining to the section is only given if the figure referred to is not part of the same section (e.g., if a figure from the species treatments in section C is referred to within the keys in section B). Specimen data for each image are given in F, *Appendices*: *Image data*.

Abbreviations. The abbreviations for provinces and territories in Canada and for states in the U.S. are largely the same as the ones used by the postal systems of both countries (except we distinguish between Newfoundland and Labrador).

Canadian provinces and territories: AB – Alberta, BC – British Columbia, LB – Labrador, MB – Manitoba, NB – New Brunswick, NF – Newfoundland (excluding Labrador), NS – Nova Scotia, NT – Northwest Territories, NU – Nunavut, ON – Ontario, PE – Prince Edward Island, QC – Québec, SK – Saskatchewan, YT – Yukon Territory.

States of the United States: AK – Alaska, AL – Alabama, AR – Arkansas, AZ – Arizona, CA – California, CO – Colorado, CT – Connecticut, DC – District of Columbia, DE – Delaware, FL – Florida, GA – Georgia, HI – Hawaii, IA – Iowa, ID – Idaho, IL – Illinois, IN – Indiana, KS – Kansas, KY – Kentucky, LA – Louisiana, MA – Massachusetts, ME – Maine, MD – Maryland, MI – Michigan, MN – Minnesota, MO – Missouri, MS – Mississippi, MT – Montana, NC – North Carolina, ND – North Dakota, NE – Nebraska, NH – New Hampshire, NJ – New Jersey, NM – New Mexico, NV – Nevada, NY – New York, OH – Ohio, OK – Oklahoma, OR – Oregon, PA – Pennsylvania, RI – Rhode Island, SC – South Carolina, SD – South Dakota, TN – Tennessee, TX – Texas, UT – Utah, VT – Vermont, VA – Virginia, WA – Washington, WI – Wisconsin, WV – West Virginia, WY – Wyoming.

3. Overview of the fauna

The Vespidae fauna of northeastern North America (Tables 1 and 2) includes a total of 92 established species in three subfamilies: Eumeninae (65 spp.), Vespinae (16 spp.), and Polistinae (11 spp.). Among these, five species (5.4%), one of which was only discovered during the course of this project (Buck *et al*. 2006), were accidentally introduced from Europe (Eumeninae: 2 spp., Vespinae: 2 spp., Polistinae: 1 sp.). Six species are undescribed (Eumeninae: 4 spp., Polistinae: 2 sp.). Three western Nearctic species (Vespinae: 1 sp., Polistinae: 1 sp., Masarinae: 1 sp.) and one Caribbean species (Polistinae) have been collected only once in the area under study, and have apparently not become established. One western Nearctic eumenine species was apparently recorded erroneously from the east (Ontario), probably due to misinterpretation of label data. Fifteen established species (Eumeninae: 11 described spp. plus 3 undescribed spp., Polistinae: 1 sp.) and six adventitious species (Eumeninae: 1 sp., Polistinae: 4 spp., Masarinae: 1 sp.) are recorded for the first time from Canada.

4. Morphology

Terminology. All morphological terms are explained in the appended glossary. Most structures are illustrated and labelled in Figs 4.1–6.

Identification of sexes. Many diagnostic characters in Vespidae show sexual dimorphism. When using the keys it is therefore necessary to determine the sex of the specimen to be identified. Males can be distinguished from females as follows.

MALE: Flagellum (antenna excluding two basal segments) almost always consisting of 11 flagellomeres (last flagellomere absent in *Pachodynerus erynnis*; apical flagellomeres more or less fused and difficult to distinguish in Masarinae; Figs B1.5, B1.16); flagellum often hooked or coiled apically (e.g., Figs B2.24, B2.8). Metasoma with 7 externally visible segments (Fig. 4.3).

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Table 1. Canadian distribution and biology of solitary Vespidae of northeastern North America

Species	Nest				F	Distribution (Canada)
	c	d	m	g		
Eumeninae						
Ancistrocerus adiabatus (de Saussure, 1852)	+	(+)			L	NS to BC
***Ancistrocerus albolacteus* Bequaert, 1943	[+]					LB, NB, QC, AB, BC, NT
Ancistrocerus albophaleratus (de Saussure, 1855)	+		(r)		L	all excl. NU
Ancistrocerus antilope (Panzer, 1798)	+	(+)			L	NF to BC
Ancistrocerus campestris (de Saussure, 1852)	+	(+)			L	ON
Ancistrocerus catskill (de Saussure, 1853)	+	(+)	(r)	(p)	L	NS to BC
Ancistrocerus gazella (Panzer, 1798)	+				L	ON (introduced)
Ancistrocerus lutonidus Bohart, 1974			v		L	–
Ancistrocerus parietum (Linnaeus, 1758)	+			(p)	L(C)	NF, NS, QC to SK (introduced)
**Ancistrocerus spinolae* (de Saussure, 1855)	+	(+)			L	ON
Ancistrocerus unifasciatus (de Saussure, 1852)	(+)	+			L	PE, QC, ON
Ancistrocerus waldenii (Viereck, 1906)			r		L	all excl. NU
**Ancistrocerus* sp.n. A	+				L	all excl. LB, NU
,*Ancistrocerus* sp.n. B	[+]					ON to BC, NT, YT
Eumenes bollii Cresson, 1872			v			AB, BC
Eumenes crucifera Provancher, 1888			[+]			all excl. NU
Eumenes fraternus Say, 1824			v		L	ON
Eumenes verticalis Say, 1824			r			QC to BC, YT
Euodynerus annectens (de Saussure, 1870)			v			–
**Euodynerus annulatus* (Say, 1824)		(+)		t	L	ON, SK to BC
Euodynerus auranus (Cameron, 1906)				+		ON to BC
Euodynerus bidens (de Saussure, 1870)	[+]					–
Euodynerus blakeanus (Cameron, 1909)	[+]					–
Euodynerus boscii (Lepeletier, 1841)	+				L	–
**Euodynerus castigatus* (de Saussure, 1853)						ON, BC
Euodynerus crypticus (Say, 1823)				+	L	ON, AB
Euodynerus foraminatus (de Saussure, 1853)	+				L	NF to BC
**Euodynerus hidalgo* (de Saussure, 1857)	+	(+)		(p)	L	ON, BC
Euodynerus leucomelas (de Saussure, 1855)	+				L	NF to BC, YT
**Euodynerus megaera* (Lepeletier, 1841)	+				L	ON
Euodynerus planitarsis (Bohart, 1945)	+				L	NS to BC, NT
**Euodynerus schwarzi* (Krombein, 1962)	+				L	ON
**Euodynerus* sp.n. F	[+]					ON
Euodynerus sp.n. G				[+]		–
Leptochilus acolhuus (de Saussure, 1857)	[+]				mL	–
**Leptochilus republicanus* (Dalla Torre, 1889)	+				mC	ON
Monobia quadridens (Linnaeus, 1763)	+	(+)		(p)	L	ON
Odynerus dilectus de Saussure, 1870				t	C(L)	NB, QC to BC, NT, YT
**Pachodynerus erynnis* (Lepeletier, 1841)	+				L	ON (adventitious)
Parancistrocerus bicornis (Robertson, 1901)	+					–
Parancistrocerus fulvipes (de Saussure, 1855)	+	(+)		(+)	L	–
Parancistrocerus histrio (Lepeletier, 1841)	+				L	–

(Table contd. on next page)

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Table 1 (contd.). Canadian distribution and biology of solitary Vespidae of northeastern North America

Species	Nest				F	Distribution (Canada)
	c	d	m	g		
Eumeninae (contd.)						
Parancistrocerus leionotus (Viereck, 1906)	r				L	ON, MB
Parancistrocerus pedestris (de Saussure, 1855)	+				L	QC, ON
Parancistrocerus pensylvanicus (de Saussure, 1855)	+				L	NF to BC
**Parancistrocerus perennis* (de Saussure, 1857)	+				L	ON
Parancistrocerus salcularis (de Saussure, 1852)	+				L	–
Parancistrocerus vagus (de Saussure, 1857)			v, r		L	ON, SK to BC
**Parazumia symmorpha* (de Saussure, 1855)	r					QC, ON
Pseudodynerus quadrisectus (Say, 1837)	+				L	–
**Stenodynerus ammonia* (de Saussure, 1852)						ON, MB
Stenodynerus anormis (Say, 1824)	+			+	L	ON to BC
**Stenodynerus blepharus* Bohart, 1953						ON
Stenodynerus fundatiformis (Robertson, 1901)				+	C,L	–
Stenodynerus histrionalis (Robertson, 1901)	+				L	–
Stenodynerus kennicottianus (de Saussure, 1870)				+		QC to BC, NT
Stenodynerus krombeini Bohart, 1953	+				L	–
Stenodynerus lineatifrons Bohart, 1948	+				L	–
Stenodynerus lucidus (Rohwer, 1917)						QC to BC
Stenodynerus oculeus (Robertson, 1901)						–
Stenodynerus pulvinatus Bohart, 1953	+				L	–
Symmorphus albomarginatus (de Saussure, 1855)	+				C	all excl. NU
Symmorphus canadensis (de Saussure, 1855)	+				mC,L	NS to BC, NT
Symmorphus cristatus (de Saussure, 1855)	+				C	all excl. NU
Zethus spinipes Say, 1837					L	–
Masarinae						
**, ***Pseudomasaris edwardsii* (Cresson, 1872)			r		P	ON (adventitious)
Total species (nest site unknown for 5 spp.)	**43**	**1**	**9**	**8**		

Note: *Euodynerus pratensis* (de Saussure, 1870) has been doubtfully recorded from Ontario.

Explanations. * – newly recorded from Canada, ** – not recorded from the northeastern U.S.

NEST TYPE: c – nest in cavities above ground (e.g., borings in wood), d – old mud dauber nests, m – self-constructed mud nests, g – ground nests.

NEST LOCATION (of cavity nests and self-constructed mud nests): r – on rocks, walls and other inanimate structures, v – on vegetation (e.g. twigs).

NEST ARCHITECTURE (for ground nests): t – constructs mud turrets over entrance. Renting (for ground nests): p – uses only pre-existing ground burrows.

OTHER INFORMATION: ( ) – secondary or exceptional nest site, [ ] – nesting habits inferred from relationship with other species. Total for species per nest type considers only primary nest site of each species.

F – FOOD OF LARVAE: L – Lepidoptera larvae, C – Coleoptera larvae, m – leaf miners, P – mixture of pollen and nectar.

Table 2. Canadian distribution of social and socially parasitic Vespidae of north-eastern North America

Species	SP	Distribution (Canada)
Polistinae		
Polistes annularis (Linnaeus, 1763)		–
Polistes aurifer de Saussure, 1853		AB, BC (PE: adventitious)
**Polistes bellicosus* Cresson, 1872		(ON: adventitious)†
**Polistes carolina* (Linnaeus, 1767)		(ON: adventitious)†
**Polistes dominicus* (Vallot, 1802)		(ON: adventitious)
Polistes dominula (Christ, 1791)		NS, ON, BC (introduced)
Polistes dorsalis (Fabricius, 1775)		–
**Polistes exclamans* Viereck, 1906		(ON: adventitious)†
Polistes fuscatus (Fabricius, 1793)		NB to MB, SK(?)
**Polistes metricus* Say, 1831		ON
Polistes perplexus Cresson, 1870		–
Polistes sp.n. A		–
Polistes sp.n. B		–
Vespinae		
Dolichovespula adulterina (du Buysson, 1905)	+	all excl. NU
Dolichovespula arenaria (Fabricius, 1775)		all excl. NU
Dolichovespula maculata (Linnaeus, 1763)		all excl. NU
Dolichovespula norvegicoides (Sladen, 1918)		all excl. NU
Dolichovespula norwegica (Fabricius, 1781)		all
Vespa crabro Linnaeus, 1758		ON (introduced)
Vespula acadica (Sladen, 1918)		all excl. NU
Vespula austriaca (Panzer, 1799)	+	all
Vespula consobrina (de Saussure, 1864)		all excl. NU
Vespula flavopilosa Jacobson, 1978		NS, QC to MB
Vespula germanica (Fabricius, 1793)		QC to MB (introduced)
Vespula maculifrons (du Buysson, 1905)		NS, NB, QC to MB
Vespula pensylvanica (de Saussure, 1857)		MB to BC (ON: adventitious)
Vespula rufa (Linnaeus, 1758)		all excl. NU
Vespula squamosa (Drury, 1773)	(+)	(ON: adventitious)†
Vespula vidua (de Saussure, 1854)		NS, NB, QC, ON, MB
Vespula vulgaris (Linnaeus, 1758)		all excl. NU

Explanations. * – newly recorded from Canada.

SP – SOCIAL PARASITE: + obligatory social parasite (no worker caste), (+) facultative social parasite (with worker caste).

DISTRIBUTION: all – recorded from all provinces and territories; †: native in eastern U.S.

FEMALE: Flagellum with 10 flagellomeres, never hooked or coiled apically. Metasoma with 6 externally visible segments.

In the field, male Eumeninae can usually be distinguished from females by their yellow clypeus; females usually have a predominantly black clypeus (in a few species males show substantial black markings [e.g., *Pseudodynerus quadrisectus*], whereas in others females may have an entirely yellow clypeus [e.g., *Ancistrocerus lutonidus*). In most male *Polistes* the clypeus is entirely yellow whereas females have at least some black or ferruginous markings (not applicable to some species from other parts of North America). Sexing

Vespinae in the field is slightly more difficult, though the experienced observer will easily recognize males by their longer antennae and their more elongate metasoma.

New diagnostic characters and morphological observations

Cephalic foveae. Cephalic foveae are unique morphological structures that evolved within the Eumeninae (Carpenter and Cumming 1985). These usually paired pits located behind the ocelli on the vertex (e.g., Fig. 4.2) represent openings of dermal glands of unknown function. So far they have only been recorded from female wasps (Carpenter and Cumming 1985, Cumming and Leggett 1985). During this study cephalic foveae were discovered for the first time in male Eumeninae, in several species of the closely related genera *Parancistrocerus* and *Stenodynerus* (we have also seen cephalic foveae in males of two unidentified species of *Montezumia* from Bolivia). The foveae of male wasps are always smaller and less conspicuous than in females of the same species, and are usually not located in a conspicuous depression as in females. In some cases the functionality of male foveae is evidenced by small amounts of dried gland secretions in and around the foveae, as found in female wasps. In some species the development of male foveae is variable, and they may not be readily detectable in all specimens. A definitive determination of presence/absence is sometimes difficult to make by external examination because the usually very small foveae are hard to detect among the rough surface sculpture of the vertex. In these cases only dissection could yield unambiguous results but this was not attempted here. Cumming and Leggett (1985) report cephalic foveae in male-like intersex specimens without mentioning a taxon. The males examined here all appear to be normal males. Cephalic foveae were found in males of the following species: *Parancistrocerus salcularis* (Figs 4.8, 4.10), *P. bicornis*, *P. fulvipes*, *P. toltecus* (de Saussure), *P. vagus*, *P. leionotus* (distinct only in some specimens), *Stenodynerus fundatiformis* (foveae coalescent in female, separated in male), *S. propinquus* (de Saussure) (as in previous species), *S. toas* (Cresson), *S. ammonia paraensis* (often indistinct), and *S. histrionalis*. More species could probably be added to this list through careful examination. The presence of cephalic foveae in *both* sexes has interesting implications for the possible function of these structures. Their presence in both males and females makes it less likely that they secrete pheromones involved with mating behaviour.

Cephalic foveae have been used in eumenine taxonomy before but not for the species treated in this Atlas. We found them to be crucial for diagnosing species in the difficult *Ancistrocerus catskill* complex (Figs B3.12–13).

Flagellum. The vestiture of the flagellum has to our knowledge not been used in eumenine taxonomy. We found the presence/absence of small, spine-like hairs on the male flagellum a useful diagnostic character for species in the *Euodynerus castigatus*-group (Fig. B5.27). The length of hairs on the basal flagellomeres of *Polistes fuscatus*-group females helped to recognise one undescribed species (Figs B10.18–19).

The flagellum of female Eumeninae offers very few characters of taxonomic value. The relative length of the basal flagellomere was found here to be useful as an additional character to separate females of *Symmorphus*.

Mandible. Some male Eumeninae show conspicuous, sexually dimorphic modifications of the mandible such as a deep notch between mandibular teeth 2 and 3, combined with a deep apical emargination of the clypeus (e.g., *Odynerus dilectus*, *Pseudepipona*; corresponding females have the mandibular teeth evenly spaced and the clypeus at most slightly emarginate). As a very rare aberration this condition is also found in some species of *Ancistrocerus*. We have examined five males of *A. adiabatus* (Fig. 4.11) from Ontario, Quebec and North Carolina (CNCI, DEBU, LEMQ) and one male of *A. antilope* (Fig. 4.12) from Virginia (DEBU) with both mandibles and clypeus modified. Blüthgen (1958) coined the term 'oplomerocephaly' ("Oplomerocephalie") for this condition, which he suspected to be caused by parasitism by Mermithidae (Nematoda). Blüthgen (1944, 1958, 1961, 1966) mentions three Palaearctic *Ancistrocerus* species in which oplomerocephalic specimens have been found: *A. nigricornis* (Curtis), *A. parietinus* (L.), and *A. oviventris* (Wesmael). In males of the Mexican *A. arista* (de Saussure) the mandible is always emarginate (Carpenter and Cumming 1985). To our knowledge oplomerocephalic males have not been recorded previously from any Nearctic species with otherwise normally developed mandibles. It is likely that occasional oplomerocephalic specimens will be found in other Nearctic *Ancistrocerus* species than the ones mentioned here.

The mandible shows less variation within Eumeninae females and has therefore not been used to characterize species treated in this Atlas. We found that the length of mandibular teeth can be diagnostic in the genera *Euodynerus* and *Stenodynerus*. The apical tooth is more elongate in

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two ground-nesting species of *Euodynerus* (Fig. B5.28) and one ground-nesting *Stenodynerus* (Fig. B7.37). The two *Euodynerus* species with elongate teeth (*E. annulatus*, *E. crypticus*) often nest in hard-packed soil (Isely 1914), while another ground-nesting species with shorter teeth (*E. auranus*) nests in sandy soils. Perhaps the elongation of the apical tooth evolved in response to the greater wear by excavating in hard-packed soils.

Costal scale of fore wing. This character is employed here for the first time in eumenine taxonomy. Richards (1978) used the same structure, which he referred to as the "keel beneath base of costa", to key out one species of *Agelaia* (Polistinae: Epiponini). The costal scale is a small scale- or ridge-like ventral elevation at the very base of the costa (Figs B3.10–11). Its shape is of crucial taxonomic importance in the difficult *Ancistrocerus catskill*-complex. Distinct differences between species can also be observed in *Euodynerus* but a significant number of other, more obvious characters renders the costal scale of little importance for the taxonomy of this genus.

Femoral pubescence. The pubescence below the femora has occasionally been used in eumenine taxonomy (e.g., MacLachlan 1980: *Eumenes*). Pubescence below the fore and sometimes the hind femur is often sexually dimorphic, and has proven very useful for separating males in the genera *Euodynerus* and *Stenodynerus* (e.g., Figs B5.12–13, B7.12–13). Differences of pubescence below the hind femur have helped resolve previous problems in identifying certain species of *Symmorphus* (Figs B8.6–7; see discussion under *S. canadensis*).

Fore tarsus. A character that has apparently never been reported before is the presence of rake setae in ground-nesting Eumeninae. Rake setae are commonly found in other ground-nesting aculeate wasps such as Pompilidae, Sphecidae, Crabronidae and Mutillidae (e.g., Evans 1950, Bohart and Menke 1976). Within the area under study only two species of *Euodynerus* have well-developed rake setae on the fore basitarsus (*E. auranus*: Fig. 4.14, *Euodynerus* sp. G). *Euodynerus auranus* nests in dune areas (in Ontario mostly along Lake Huron). The nesting habits of *Euodynerus* sp. G are unrecorded but probably similar to the closely related *E. auranus* (with which it was previously confused). The rake setae apparently represent an adaptation for digging burrows in friable sand (Bohart and Menke 1976). Ground-nesting Eumeninae that nest mostly in hard-packed soils (e.g., *Euodynerus annulatus*, *E. crypticus*) lack rake setae, and use a completely different digging method. Similar to species that use mud for cell construction, they moisten the ground with water from their crop prior to digging. This requires frequent trips to nearby water sources throughout the process (e.g., Isely 1914). Earth is mostly removed by action of the mandibles, shaped into small pellets and discarded during short flights in close proximity to the nest. The digging method of *E. auranus* is similar to other ground-nesting aculeate wasps in that water is not used for moistening the ground (unnecessary for digging into friable sand), and that soil is removed through the action of the legs (see Biology section under that species). Interestingly, another eumenine genus that nests in sandy soils, the mostly western *Pterocheilus*, evolved a different system of soil removal. Here the labial palpi are enlarged and fringed with long bristles forming a basket ('psammophore') which is used to carry sand (Carpenter and Cumming 1985: Fig. 16).

Acarinarium. The 'mite compartment' between terga 1 and 2 of *Parancistrocerus* species, and the homologous non-mite bearing structure in the closely related genus *Stenodynerus* shows important taxonomic features (first used for diagnostic purposes by Bohart 1952). *Parancistrocerus vagus* differs from congeners in having a small median depression of tergum 2 (Fig. B7.29) that appears to serve as an entrance/exit to the acarinarium. Interestingly, this depression shows a previously unrecorded sexual dimorphism. In the male the depression is wide and relatively shallow whereas in the female it is narrower and deeper. Furthermore, the hind margin of the overhanging recurved basal lamella of tergum 2 forms a wider gap with the remainder of the tergum in the male than in the female, so that the acarinarium is more open to the outside.

Sternum 2. Sternum 2 shows several important diagnostic characters (e.g., ridging of the transverse basal groove, Figs B5.38–39; presence/absence of median furrow). Presence vs. partial absence of pubescence on this sternum is also useful to distinguish certain species of *Ancistrocerus* (*A. lutonidus* vs. *A. catskill*; *A. adiabatus* vs. *A. albolacteus*), though in some species this character is variable.

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5. Biology

Solitary wasps (Eumeninae and Masarinae)

REFERENCES. – Hunt 2007, O'Neill 2001, Cowan 1991; Krombein 1979, 1967; Spradbery 1973, Evans and West-Eberhard 1970, Torchio 1970.

The Eumeninae owe the common name 'potter wasps' to the fact that some species build more or less free-standing mud nests (e.g., Figs C6.8, C19.5). However, this habit is neither typical nor part of the groundplan for the subfamily. According to Carpenter and Cumming (1985) the primitive, and also the most common, nesting behaviour is 'renting', i.e., nesting in existing cavities (Table 1). The most commonly used cavities are borings in decaying wood (e.g., Fig. C51.10), but some species use other structures such as hollow twigs and stems, artificial cavities in man-made structures, empty galls, old mud dauber nests, small cavities in rocks, walls or concrete (e.g., Fig. C51.8), old *Polistes* nests, and even abandoned ground burrows of other aculeates (especially when located in vertical banks). One species (*Ancistrocerus unifasciatus*) seems to nest primarily in old mud dauber nests. Several species (in three genera) dig their own ground burrows; of these, two construct a mud tube over the nest entrance. A few species (in five genera) build free-standing mud nests on the surfaces of rocks or vegetation. Some species show a surprising plasticity of nesting habits. The most prominent example of this in our native fauna seems to be *Ancistrocerus catskill*, which, according to the literature, nests in borings in wood or stems, old mud dauber nests and (probably rarely) in abandoned aculeate burrows. Additionally, we found *A. catskill* nesting in a small cavity in a rock, which served as a starting point for a series of mud cells, the latter of which were built fully exposed on top of the cavity above the level of the rock surface (Fig. C6.8). This gradation from cells concealed within a cavity to fully exposed, free-standing mud cells involves a series of behavioural steps equivalent to a putative evolutionary sequence leading from 'renting' ancestors to species that construct free mud nests. Nests of renters and burrowing species are usually multicellular, though some extralimital burrowing species make unicellular nests only (e.g., Evans 1956). Free-standing mud nests may be unicellular or multicellular (Isely 1914, Clark and Sandhouse 1936). Much of the data on nesting behaviour of Eumeninae was gathered through the very efficient trap nest technique (Krombein 1967), which uses artificial borings and stems. Because this method records renting wasps only, it is likely that the plasticity of the nesting behaviour of certain species has been underestimated. At least some 'renting' species are apparently also capable of excavating burrows in soft materials such as the pith in stems or similar artificial substrates like styrofoam (Cooper 1979).

Most Eumeninae provision their nests with caterpillars (usually leaf rollers and tiers). However, four species included in this Atlas exclusively use Coleoptera larvae (Chrysomelidae, Curculionidae, Buprestidae), while three species use both Lepidoptera and Coleoptera larvae. Three species are specialized on leaf miners (either Lepidoptera, or Coleoptera, or both). Records of Eumeninae taking sawfly prey (e.g., Ashmead 1894) are doubtful (Krombein 1967). Each cell within a nest is provisioned with several prey items before the egg hatches ('mass provisioning'). Cells giving rise to females usually receive a greater amount of food than cells containing males, which usually are smaller.

As in all other Vespidae, the egg is suspended from a thin stalk and deposited before the nest is provisioned. Brood cells of the linear nests of renting wasps are separated from each other by plugs (called cell partitions) of mud or agglutinated sand (reflected in the alternate common name 'mason wasps'). Unlike mud daubers in the families Sphecidae and Crabronidae, Eumeninae usually prepare mud from dry earth and water carried in their crops (but see Fig. C64.5: *Symmorphus albomarginatus* as an apparent exception). One genus (*Leptochilus*) uses macerated pith and loose sand for this purpose (Parker 1966). In this case the sand is later incorporated into the cocoon spun by the larva. Sometimes empty intercalary cells are present between provisioned cells. In most species only a small fraction of nests show intercalary cells. A few species, however, seem to include them in the majority of their nests (e.g., *Monobia quadridens*). The empty cell usually present at the outer end of each nest is called vestibular cell. The outer closure (closing plug) is made of the same material as the cell partitions.

Like many other hymenopterans, Vespidae control the sex of their offspring, which is determined through fertilization of the egg (unfertilized eggs give rise to males, fertilized eggs produce females). The smaller males have a shorter larval/pupal development time than the females. In mixed-sex nests of renting wasps, females develop in the inner cells of the nest and emerge after the males, which develop in the outer cells. Deviations from this pattern have to be considered accidental (e.g., failure of sperm to fertilize egg; nest taken over by another wasp of the same species). Many

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species (at least in the southern part of their range) produce more than one generation per year. The overwintering stage is in all known cases the fully grown larva.

An interesting detail of eumenine biology is the close relationship between some genera and mites of the family Saproglyphidae (Krombein 1961, Cooper 1954). Each mite-bearing genus (*Parancistrocerus*, *Ancistrocerus*, *Monobia*) is associated with a different genus of mites. Male and female wasps carry hypopi (resting stage of mites) in a specialized area of the body called the acarinarium. In *Parancistrocerus* and *Monobia* this mite chamber is formed by the transversely depressed base of tergum 2 which is usually covered by the apical portion of tergum 1. In *Ancistrocerus* the mite-bearing body parts are only slightly modified (i.e., ventral surface of free apical portion of posterior terga; in *A. antilope* male and female genital chamber as well as posterior and lateral surfaces of male propodeum). Mites are transferred from males to females during mating. During oviposition up to 20 hypopi transfer from the female wasp into each brood cell. The hypopi develop into adults (through one intermediate stage) within the brood cell while the wasp grows into a fully mature larva. After the cocoon has been completed the adult mites feed heavily on the quiescent wasp larva by piercing its cuticle. Interestingly, the larva does not seem to be adversely affected by this. The mites complete their life cycle (in three stages from egg to hypopus) within the cocoon before the wasp emerges. The new generation of hypopi mounts the adult wasp shortly after eclosion. It is still unclear what benefit the wasps incurs from the association with mites.

In this study new data or inferences on the nesting biology of the following twelve species of Eumeninae are presented (see biology section under each species): *Ancistrocerus albophaleratus*, *A. catskill*, *A. unifasciatus*, *Eumenes verticalis**, *Euodynerus auranus*, *E. castigatus**, *E. planitarsis**, *E.* sp. G*, *Parancistrocerus leionotus**, *Parazumia symmorpha**, *Stenodynerus anormis*, and *S. kennicottianus** (for species marked by asterisks this represents the first published information on nesting biology).

The biology of Masarinae differs from Eumeninae most prominently in that the nests are provisioned with a mixture of pollen and nectar instead of insect larvae. Pollen and nectar destined for nest provisions are temporarily stored in the honey stomach (crop), undergoing very little digestion. The mud nest is attached to inanimate surfaces (rocks, etc.) or vegetation, and consists of one or more cells. After all of the cells of one nest are completed they are usually covered with an additional layer of mud. *Pseudomasaris edwardsii*, the only species recorded from the study area, uses nectar to moisten soil when preparing mud for nest construction (Torchio 1970).

Social wasps (Polistinae and Vespinae)

REFERENCES. – Hunt 2007, Ross and Matthews 1991, Turillazzi and West-Eberhard 1996, Akre *et al*. 1981, Spradbery 1973, West-Eberhard 1969.

With the exception of socially parasitic species that do not have castes, the Vespinae and Polistinae are eusocial insects, with cooperative parental care for offspring, differentiation between reproductive ('queens') and sterile castes ('workers'), and overlapping generations. Eusociality in Vespinae is more advanced than in Polistinae in that castes are more clearly differentiated by size and morphology, and colonies are often much larger. In *Polistes*, worker size range encompasses the size range of queens (though queens are larger on average). Furthermore, reproductive differentiation between queens and workers is not as firmly entrenched as in Vespinae, with some *Polistes* workers usually starting to lay eggs in the reproductive phase of the colony cycle, and supersedure of queens by workers taking place much more frequently.

In the geographic area covered by this Atlas the overwintering stage of most species (including all Vespinae) are the new queens, though in some *Polistes* species (e.g., *P. annularis*) males overwinter as well, and mating takes place in spring. Under more favourable climates (e.g., in the southern U.S., Central America, and a few countries into which species have been introduced by accident) some species have been reported to develop perennial nests. In Vespinae each colony is founded by a single queen, whereas in *Polistes* two or more foundresses often cooperate in nest foundation before one of the females gains dominance over the others. This α-female does not leave the nest in order to forage, lays more eggs and participates less in nest construction than subordinate females. After the first workers emerge the auxiliaries are driven away from the nest. In our area, nests of both Vespinae and Polistinae are made of paper carton prepared from masticated plant fibre (weathered or decayed wood, etc.). In Vespinae the combs of the nest are protected by a multi-layered envelope (e.g., Fig. C84.11; often more or less rudimentary when nest is built in smaller cavities). *Polistes* nests are not protected by such an envelope (e.g., Fig. C78.6). Depending on the species, nests are aerial, built in cavities (hollow logs, etc.) or subterranean (the latter only in Vespinae, and, rarely, in some extralimital species

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of *Polistes*). Some species show considerable flexibility in nesting behaviour. During the founding phase the queen performs all the necessary tasks involved in rearing the offspring and nest building. Soon after the first workers emerge the queen stops foraging, and does not leave the nest any more. At first all new offspring reared in the colony are workers but later in the year sexuals (males and queens) are produced. In Vespinae, queens (and some males) are reared in larger cells than workers. Larvae of *Polistes* are fed mostly with masticated caterpillars (e.g., Fig. C77.14), those of Vespinae are fed with a wide variety of arthropod prey (e.g., Fig. C94.10). Species of the *Vespula vulgaris*-group also use meat scavenged from carcasses and other sources.

The Vespinae include two species of obligatory social parasites (*Dolichovespula adulterina*, *Vespula austriaca*). Females of these species enter nests of their hosts (another species in the same genus) and sooner or later kill the host queen. Invasion takes place either when workers have already emerged (in *Vespula austriaca*) or before that (in *Dolichovespula adulterina*). In the latter case the host queen is not immediately killed so that more workers can be reared. Obligatory social parasites lack the worker caste, and all eggs of the inquiline queen give rise to fertile males and females. One species, *Vespula squamosa*, is a facultative social parasite. Queens either found nests of their own or usurp nests of another yellowjacket species (usually *V. maculifrons*). Interspecific nest usurpation is otherwise uncommon. Intraspecific nest usurpation on the other hand appears to be very common, both in Vespinae and in *Polistes*. Whereas in Vespinae the resident queen is killed by the successful intruder, in *Polistes* she remains at the nest as a subordinate helper.

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B. Keys to subfamilies, genera and species

1. Key to eastern Nearctic Vespidae subfamilies

Note: extralimital taxon in brackets.

1 Apical flagellomeres (from flagellomere III–V onward) consolidated into a club (Figs 1.5, 1.16) which may be flattened. Fore wing with two submarginal cells, first subdiscoidal cell in contact with medial cell (Fig. 1.2) (adventitious; a western group with one record from ON) .....[Masarinae]

one species: 68. *Pseudomasaris edwardsii*

- Apical flagellomeres not club-like but sometimes forming hook or coil in male. Fore wing with three submarginal cells, first subdiscoidal cell not in contact with medial cell (Figs 1.1, 1.3–4) 2

2 Mid tibia with one spur* (Fig. 1.6). Gena tapering to nearly a point ventrally (Fig. 1.9); posterobasal corner of mandible almost contiguous to eye margin (separated by at most 2x ocellar diameter). Tarsal claws cleft (Fig. 1.8). Solitary .....2. **Eumeninae**

- Mid tibia with two spurs (Fig. 1.7). Gena wide throughout, not tapering ventrally (Fig. 1.10); posterobasal corner of mandible separated from ventral eye margin by more than diameter of antennal socket. Tarsal claws simple. Eusocial or socially parasitic 3

*Note: some extralimital species have two spurs.

3 Clypeus with pointed apex (Fig. 1.11; apex minutely truncate in female). Head and body with extremely short, inconspicuous hair (Figs 1.11, 1.17). Metasomal tergum 1 almost straight to gently arched in profile (Fig. 1.13)..... 9. **Polistinae**

- Clypeus with broadly truncate and more or less emarginate apex (Fig. 1.12). Head and body with long hairs (Figs 1.12, 1.18). Metasomal tergum 1 with abrupt anterior declivity (Fig. 1.14)..... 11. **Vespinae**

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2. Key to northeastern Nearctic Eumeninae genera (mason or potter wasps)

1 Metasoma petiolate, segment 1 at least twice as long as wide and only half as wide as segment 2 (Figs 2.1–2) 2

- Metasoma not petiolate, segment 1 at most 1.4x as long as wide, its width at least 0.7x that of segment 2 (e.g., Figs 2.26–27) 3

2 Clypeal margin strongly produced and angulate, extending distinctly below level of lower eye margin (Fig. 2.3). Minimum width of metasomal segment 2 slightly less than width of segment 1 (Fig. 2.1). Vein M nearly straight at base of submarginal cell II (Fig. 2.5) ..... 4. ***Eumenes*** (4 spp.)

- Clypeal margin truncate and more or less straight, not extending below level of lower eye margin (Fig. 2.4). Minimum width of metasomal segment 2 less than half width of segment 1 (Fig. 2.2). Vein M with two distinct kinks at base of submarginal cell II (Fig. 2.6) (U.S.: MA and IL southward) .... ***Zethus***

one species: 67. *Zethus spinipes*

3 Anterior face of pronotum with a pair of pits medially (Fig. 2.12) 4

- Anterior face of pronotum lacking pair of pits medially 5

4 Metasomal tegum 1 with overhanging hind margin long, covering an acarinarium (i.e., a space used to accommodate symbiotic mites; mites may be present or not); base of tergum 2 essentially smooth (Fig. 2.9), sometimes minutely roughened but not pitted ..... 7. ***Parancistrocerus*** (9 spp.)

- Metasomal tergum 1 with short overhang, the space below not serving as acarinarium (mites never present); base of tergum 2 usually with a row of shallow to deep pits (Fig. 2.10), the pits sometimes obsolete medially leaving only 1–2 shallow pits at each end; in one species (*S. krombeini*) completely without pits ..... 7. ***Stenodynerus*** (11 spp.)

Note: due to the difficulties in separating these two genera, the species of *Parancistrocerus* and *Stenodynerus* are treated in a single key.

5 With one or both of the following features: metasomal tergum 1 with transverse carina at summit (Figs 2.11, 2.19); pronotum lacking transverse carina 6

- Pronotum always with transverse carina (e.g., Fig. 2.12), tergum 1 always without transverse carina ... 8

6 Metasomal tergum 1 with shallow median groove posterior to carina (Fig. 2.11). Male antenna simple apically (Fig. 2.7). Omaulus well-defined in both sexes, curved backward ventrally (Fig. 2.13) ..... 8. ***Symmorphus*** (3 spp.)

- Metasomal tergum 1 without median groove. Male antenna hooked (Fig. 2.24) or coiled apically (Fig. 2.8). Female without omaulus 7

7 Tegula rounded posteriorly (Fig. 2.16). Tergum 1 lacking transverse carina. Male: apical six flagellomeres flattened and coiled (Fig. 2.8); mid femur with two deep emarginations ventrally (Fig. 2.18). Female: cephalic foveae as far apart as hind ocelli (Fig. 2.14) ..... ***Odynerus***

one species: 40. *Odynerus dilectus*

- Tegula pointed posteriorly (Fig. 2.17). Tergum 1 with transverse carina (Fig. 2.19), rarely indistinct. Male: apical flagellomeres neither flattened nor coiled; flagellomere XI reflexed (similar to Fig. 2.24; see also 3.5); mid femur simple. Female: cephalic foveae closer together than hind ocelli (Fig. 2.15), sometimes coalescent ..... 3. ***Ancistrocerus*** (14 spp.)

8 Pronotum with complete humeral carina (extending to pronotal hind margin) (Fig. 2.20). Male flagellum with ten flagellomeres, simple apically, flagellomere X minute. Body black, with extensive ferruginous to orange markings (Fig. 2.37); yellow markings absent except for male clypeus (Fig. 2.37) and small male frontal spots ..... ***Pachodynerus***

one species: 41. *Pachodynerus erynnis*

- Pronotum without or rarely with an incomplete humeral carina (ending far from pronotal hind margin, e.g., similar to Fig. 7.3). Male flagellum with eleven flagellomeres, hooked apically (e.g., Fig. 2.24). Body colour variable, with well developed yellow or ivory markings on meso- and metasoma 9

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9 Propodeum with dorsal carina broadly separated from (i.e., distinctly posterior to) hind margin of metanotum; propodeal dorsum in between almost horizontal, shelf-like (Fig. 2.21). [Black, with purplish wings and ivory markings, including propodeal spots and complete apical fasciae on terga 1 and 2; Fig. 2.40] (U.S.: from NJ, PA, OH and IL southward)..... ***Pseudodynerus***

one species: 52. *Pseudodynerus quadrisectus*

- Propodeum with or without dorsal carina, if present the carina almost at level of (not posterior to or at most slightly posterior to) hind margin of metanotum; propodeum without distinct shelf-like area behind metanotum (e.g., Fig. 2.27) 10

10 Flagellomere I approximately as long as II (Fig. 2.23). Vein M with two distinct kinks at base of submarginal cell II (similar to Fig. 2.6). Propodeal valvula large and with free upper, lower and posterior margin (i.e., not fused to submarginal carina); submarginal carina strongly produced posteriorly and pointed (Fig. 2.22). Small wasps, <9 mm.....6. ***Leptochilus*** (2 spp.)

- Flagellomere I at least 1.3x as long as II (Fig. 2.24). Vein M nearly straight or very slightly angled at base of submarginal cell II (similar to Fig. 2.5). Propodeal valvula variably developed but dorsally always fused to submarginal carina (e.g., Fig. 5.31); submarginal carina rarely posteriorly produced (some *Euodynerus*; Fig. 5.22). Larger, usually >9 mm 11

11 Metasomal tergum 1 only 0.70–0.75x as wide as segment 2 (Fig. 2.26). Terga 2 and 3 with thin, translucent, reflexed, apical lamella (Fig. 2.26). Propodeum rounded laterally (Figs 2.26, 2.42) .....***Parazumia***

one species: 51. *Parazumia symmorpha*

- Width of metasomal tergum 1 subequal to segment 2 (e.g., Fig. 2.27). Terga 2 and 3 rarely with translucent, reflexed, apical lamella (*Euodynerus hidalgo*), but then propodeum angled posterolaterally (similar to Fig. 2.27).....12

12 Mandible entirely black; postocular spot absent (Fig. 2.28). Body black with ivory markings; only tergum 1 with apical fascia, metasoma otherwise black (Fig. 2.43). Tegula with truncate hind margin, the truncation nearly perpendicular to main body axis (Fig. 2.25)..... ***Monobia***

one species: 39. *Monobia quadridens*

- Mandible always with at least a small pale spot near base, sometimes extensively ferruginous; postocular spot pale to ferruginous, usually small (Fig. 2.29). Body variably coloured, often with yellow (sometimes also ferruginous) markings (e.g., Fig. 2.44); apical fasciae present at least on terga 1 and 2, if body marked with ivory and only tergum 1 fasciate (*E. bidens*, Fig. 2.45) then tegula pointed posteriorly and with curved oblique posterolateral margin (shape similar to Fig. 2.17), not truncate.....5. ***Euodynerus*** (16 spp.)

3. Key to northeastern Nearctic *Ancistrocerus* species

1 Sternum 2 with median longitudinal furrow behind transverse basal groove (Fig. 3.1).....2

- Sternum 2 lacking median longitudinal furrow.....3

2 Pronotum with transverse carina (Fig. 3.2), except medially. Male: vertex with low, impunctate median swelling just behind level of hind ocelli. Female: scutellum and metasoma beyond segment 2 black (Fig. 3.34; tergum 2 rarely with an evanescent apical fascia) .....11. ***A. unifasciatus*** (de Saussure)

- Pronotum without transverse carina (at most subcarinate near humeral angle). Male: vertex without impunctate median swelling. Female: scutellum with a pair of yellow spots, terga 1–3 fasciate (as in Fig. 3.36; fascia of tergum 2 always broad; tergum 3 rarely black) ..... 5. ***A. campestris*** (de Saussure)

3 Propodeum with ventrolateral ridges very prominent, about as high as ocellus diameter (Figs 3.3–4). Male flagellomere XI short, length along outer surface only about 1/3 length of flagellomere IX along outer surface (Fig. 3.5) 4

- Propodeum with ventrolateral ridges, if present, low. Male flagellomere XI normal, length along outer surface at least half length of flagellomere IX along outer surface (e.g., Fig. 3.16).....5

4 Propodeum with posterior and ventrolateral surfaces shining, impunctate (Fig. 3.3). Wings moderately infuscated in both sexes; female scutellum with a pair of yellow spots, at least terga 1–4 fasciate (Fig. 3.37) .....4. ***A. antilope*** (Panzer)

- Propodeum with posterior and ventrolateral surfaces dull, micropunctate (Fig. 3.4). Female: wings strongly infuscated; scutellum and metasoma beyond segment 3 black (Fig. 3.38)..... ..... 10. ***A. spinolae*** (de Saussure)

5 Sternum 2 behind transverse basal groove slightly concave in profile (Fig. 3.6).....6

- Sternum 2 behind transverse groove convex in profile (e.g., Fig. 3.7).....7

6 Transverse carina of tergum 1 with deep V-shaped medial incision (Fig. 3.8). Metanotum usually black (Fig. 3.39), sometimes with evanescent yellow spots ..... 9. ***A. parietum*** (L.)

- Transverse carina of tergum 1 at most with small median incision (Fig. 3.9). Metanotum with broad transverse yellow band (Fig. 3.40), sometimes missing or interrupted medially in male..... ..... 7. ***A. gazella*** (Panzer)

7 Costal scale (i.e., ventral projection at very base of costa) with convex outline in posterior view and acute edge in lateral view (Fig. 3.10). Female: cephalic foveae usually* fused or contiguous, usually* at most separated by a narrow septum (Fig. 3.12); propodeum usually with pale markings (e.g., Fig. 3.7) 8

- Costal scale less prominent, its outline straight to weakly convex, its edge more rounded (Fig. 3.11). Female: cephalic foveae separated by horizontal plateau-like area of at least fovea diameter (Fig. 3.13); propodeum entirely black.....10

* except in *A. lutonidus* where the foveae are well separated (corrected: 19/03/08).

8 Tergum 2 almost always with a pair of yellow discal spots (Fig. 3.7); tergum 1 with apical fascia on each side extended forward and usually inward (Figs 3.7, 3.41). Pale markings of body bright yellow. Male: middle flagellomeres narrowly and obscurely yellowish beneath. Female: sterna 2–5 with complete apical fasciae (Fig. 3.7); sternum 2 micropubescent throughout; clypeus completely or largely yellow (Fig. C8.4), often with black median spot or with more or less parallel-sided longitudinal stripe in dorsal half (U.S.: ME and WI southward; recorded from Buffalo, NY) ....8. ***A. lutonidus*** Bohart

- Tergum 2 lacking discal spots (small spots present in aberrant females); tergum 1 with apical fascia sometimes more or less extended forward but never inward. Pale markings of body yellow to ivory. Male: flagellum from base to apex with a broad, bright yellow stripe beneath (as in Fig. 3.17). Female: usually only sternum 2, rarely also 3, with complete apical fascia; mid section of sternum 2 without micropubescence; clypeus usually with a pair of dorsal and a pair of ventral pale spots (Fig. C6.6), rarely confluent laterally and ventrally leaving central black mark that is distinctly expanded at apex.... 9

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9 Body with pale markings bright yellow to ivory. Female: scape with broad pale stripe ventrally, neither interrupted nor narrowed near middle (Fig. 3.14); flagellum yellowish beneath from base to apex; propodeum marked with pale laterally (usually less extensive than in Fig. 3.7), the markings often extending to propodeal dorsum; tergum 6 rarely with pale median spot; metanotum almost always with complete pale band (Fig. 3.42); parategula frequently marked with pale..... 6. ***A. catskill*** (de Saussure)

- Body with pale markings ivory (sometimes yellowish on head and scape). Female: scape with pale anterior stripe restricted to basal half (Fig. 3.15), or lacking pale markings; rarely with complete stripe that is interrupted medially or narrowed in distal half; flagellum at most dark reddish below, the basal 1–2 segments sometimes more yellowish; propodeum usually black, rarely with a pair of small ivory spots on and below propodeal angle; tergum 6 with well developed ivory spot (Fig. 3.43); metanotum usually with a pair of ivory spots (Fig. 3.43), rarely with complete ivory band or entirely black; parategula black.....13. ***Ancistrocerus* sp. A**

Note: males of these two species cannot be reliably distinguished.

10 Male (seven metasomal segments).....11

- Female (six metasomal segments).....14

11 Clypeus with deep apical emargination (Fig. 3.16). Scape with black dorsal mark extending posteriorly onto ventral surface. Pedicel black beneath (Fig. 3.16). [Flagellum black beneath except for apical flagellomeres (Fig. 3.16), rarely obscurely dark reddish. Body with pale markings ivory, rarely bright yellow*. Mesosoma very short and stubby (Fig. 3.18).] ..... 12. ***A. waldenii*** (Viereck)

- Clypeus with shallow to moderately deep apical emargination (e.g., Fig. 3.17). Scape with black dorsal mark not extending posteriorly onto ventral surface, but scape rarely with black ventral stripe free from dorsal mark. Pedicel almost always yellowish or reddish beneath.....12

* Note: the yellow colour form is newly recorded here from the eastern U.S. (Virginia).

12 Mesosoma shorter and more stubby (Fig. 3.19). Flagellum usually predominantly black beneath except for apical and sometimes basal flagellomeres (a few specimens with bright yellow body markings have the whole ventral surface of the flagellum more or less yellow). Scutellum often entirely black; metanotum black, rarely with small yellow spots in yellow colour form (in this case spots on scutellum very large and almost confluent medially). Pale markings of body usually ivory or pale yellow (at least on metasoma) except in some specimens from southern part of range. Genitalia as in Fig. 3.33 .... 3. ***A. albophaleratus*** (de Saussure) and 14. **sp. B***

- Mesosoma relatively elongate and slender (Fig. 3.20). Flagellum usually extensively yellow beneath (Fig. 3.17; usually dark in the northern *A. albolacteus* except terminal segments). Scutellum usually with paired yellow spots; metanotum with a pair of yellow spots or black (pale markings absent in *A. albolacteus*). Pale markings of body bright yellow (ivory in *A. albolacteus*). Genitalia as in Fig. 3.32 ... .13

*Note: the male of species B is unrecognised.

13 Sternum 2 without appressed micropubescence medially. Flagellum yellow to orange beneath (Fig. 3.17). At least terga 1–5 with apical fascia. Metasoma with pale markings usually bright yellow, rarely pale yellow .....1. ***A. adiabatus*** (de Saussure)

- Sternum 2 behind basal groove evenly covered in appressed micropubescence. Middle flagellomeres usually black, rarely somewhat reddish beneath. Usually only terga 1–4 with apical fascia. Metasoma with pale markings ivory, rarely yellow..... 2. ***A. albolacteus*** Bequaert

Note: *A. albolacteus* is tentatively recognised as a good species.

14 Mesosoma more elongate, posterior part of scutum and scutellum conspicuously flattened and in one plane (Figs 3.23, 3.25). Pale markings of body usually bright yellow, ivory in some boreal specimens 15

- Mesosoma shorter and more stubby, posterior part of scutum with shorter flattened area and scutellum slightly convex (Figs 3.21–22, 3.24). Pale markings of body usually ivory or pale yellow except in some specimens from southern part of range 16

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15 Pale markings of body bright yellow. Clypeus always at least with a pair of dorsal spots (often confluent with ventral pair). Sternum 4 with yellow markings. Tergum 5 almost always with yellow apical fascia. Scutellum with a pair of yellow spots (Fig. 3.23)..... 1. ***A. adiabatus*** (de Saussure)

- Pale markings of body ivory to pale yellow. Clypeus usually black, sometimes with a pair of pale ventral spots. Sternum 4 and tergum 5 without pale markings. Scutellum usually black, rarely with a pair of small pale spots..... 2. ***A. albolacteus*** Bequaert

  Note: *A. albolacteus* is tentatively recognised as a good species.

16 Tergum 6 with ivory spot* (Fig. 3.45), sternum 5 with apicolateral spots. Scape completely black (Fig. 3.28). Metanotum with short, horizontal, more or less flat anterior area in front of vertical posterior area (Fig. 3.26). Upper ridge of propodeum usually absent or poorly developed, propodeal dorsum rugose laterally but usually without distinct small areolae (Fig. 3.26). Pale markings of body ivory** ..... 12. ***A. waldenii*** (Viereck)

- Tergum 6 and sternum 5 completely black***. Scape almost always at least posteroventrally or ventrodistally with brown, ivory or yellow stripe or spot (Fig. 3.29). Metanotum more rounded, less abruptly declivous posteriorly (Fig. 3.27). Upper ridge of propodeum usually well defined; propodeal dorsum laterally with coarse, areolate sculpture (Fig. 3.27). Pale markings of body sometimes bright yellow in specimens from southern part of range..... 17

  Notes. * Rarely absent according to Bequaert (1944*a*). ** The yellow colour form has not yet been found in females (cf. couplet 10). *** Tergum 6 exceptionally with pale spot but then scape extensively marked with ivory or yellow.

17 Mid and hind tibia with well-developed (rarely small) pale spot, the spot embracing dorsalmost area of tibia (Fig. 3.31); tibiae in yellow colour form largely yellow. Terga 1–4 or 5 with apical fasciae (Figs 3.47–48); sternum 3 usually with complete or interrupted apical fascia but at least with small pale spot(s) near middle. Scutellum with a pair of pale spots* (Figs 3.47–48). Scape usually predominantly black with brown markings ventrally (Fig. 3.29) (but yellow stripe always present in yellow colour form)..... 3. ***A. albophaleratus*** (de Saussure)

- Mid and hind tibia black, rarely in part suffused with amber**; pale spots, if present, small and restricted to anterior surface (also in the yellow colour form), not attaining dorsalmost area of tibia (Fig. 3.30). Terga 1–2 or 3 with apical fasciae*** (Fig. 3.44), sometimes interrupted on tergum 3; sternum 3 with pale apicolateral spots only, rarely completely black. Scutellum black (Fig. 3.44). Scape usually with yellow to dirty yellow stripe beneath, at least distally..... 14. ***Ancistrocerus*** **sp. B**

  Notes. * Scutellar spots sometimes absent in specimens from AB, BC. ** Tibiae of specimens from NT, YT, AK frequently extensively suffused with amber. *** Some specimens from AB, SK, BC with apical fascia on tergum 4.

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4. Key to eastern Nearctic *Eumenes* species

Note: extralimital taxon in brackets.

1 Scape ferruginous (Fig. 4.1); body with more or less extensive ferruginous markings (Figs 4.1–3, 4.13–14) 2

- Scape black, sometimes marked with yellow or ivory (Fig. 2.3); body with yellow or ivory markings only (Figs 4.9–12, 4.15–17) 3

2 Pronotum rounded anteriorly, lacking transverse carina between humeral angles. Metasomal segment 1 with long erect hair (length up to 3x mid ocellar diameter, Fig. 4.3) (western half of U.S. east to MN) ..... 15. ***E. bollii*** Cresson

- Pronotum with fine transverse carina (Fig. 4.1). Segment 1 with short, more or less appressed hair (Fig. 4.2) (eastern U.S.: NC and TN southward) ..... [18. *E. smithii* de Saussure]

3 Fore wing strongly infuscated along anterior margin (Fig. 4.7). Male: pubescence of hind femur ventrally in basal half almost as long as mid ocellar diameter (Fig. 4.4). Female: propodeum dorsolaterally with well-spaced macropunctures, at least some interspaces much larger than one puncture diameter, the interspaces sparsely micropunctate and polished (Fig. 4.9); propodeum with pale dorsolateral spot. [Male flagellomere XI similar to Fig. 4.6.] ..... 17. ***E. fraternus*** Say

- Fore wing slightly infuscated along anterior margin (Fig. 4.8). Male: pubescence below hind femur short, less than half as long as ocellar diameter. Female: propodeum dorsolaterally with close macropunctures, interspaces at most as large as puncture diameter (Fig. 4.10), often dull and rugose; propodeum often completely black or with ventrolateral pale spot 4

4 Mid femur with yellow apex, the yellow area sharply delimited from black remainder of femur (Fig. 4.12). Male: flagellomere XI more slender, externally without carina, on inner surface with fine microtomentum (Fig. 4.5). Female: propodeum usually with ventrolateral pale spot (Fig. 4.12; often with smaller dorsolateral spot as well), rarely completely black ..... 19. ***E. verticalis*** Say

- Mid femur gradually becoming reddish apically, its apex sometimes also with yellow spot* (Fig. 4.11). Male: flagellomere XI stout, outer surface with longitudinal carina, inner surface without microtomentum (Fig. 4.6). Female: propodeum either with a pair of dorsolateral pale spots only (Fig. 4.11) or completely black ..... 16. ***E. crucifera*** Provancher

*Note: specimens from Atlantic Canada show a mid femoral pattern similar to *E. verticalis*. Females of the two species from this area are sometimes difficult to separate.

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5. Key to northeastern Nearctic *Euodynerus* species

Note: extralimital taxon in brackets.

1 Inner orbit completely black (e.g., Fig. 5.2). Metanotum with yellow or ivory band along anterior margin (Figs 5.44–52), scutellum rarely with a pair of small pale spots. Tergum 1 with at least a few long erect hairs (length greater than mid ocellar diameter) behind declivity (Fig. 5.3). Male mid and hind tarsus with darkened last tarsomere (Figs 5.10–11) or tarsus entirely black .... *E. foraminatus*-group 2

- Inner orbit marked with yellow, ivory or ferruginous (e.g., Fig. 5.1). Metanotum often without pale band along anterior margin but scutellum usually with a pair of pale or ferruginous spots (e.g., Figs 5.53–54, 5.56–57, 5.59–61). Tergum 1 usually with short hair (length less than mid ocellar diameter) or bare behind declivity. Male mid and hind tarsus yellow to ferruginous, last tarsomere not darkened 14

2 Body marked with ivory 3

- Body marked with yellow 7

3 Wings dark brown with purplish reflections (Figs 5.44–46). Usually only first one or two terga with apical fasciae (Figs 5.44–46; in male rarely up to five but then posterior fasciae very narrow or interrupted as in Fig. 5.15) 4

- Wings at most slightly tinged with pale brown, lacking purplish reflections (Figs 5.47–48). At least first four terga with well-developed apical fasciae (Figs 5.47–48) 6

4 Tergum 1 largely ivory behind declivity except for narrow median black streak. Tergum 2 black or with evanescent apicolateral spots, its hind margin simple, without translucent border (Fig. 5.5). Propodeum with well-developed lateral angle, dorsal surface ivory on each side of concavity (Fig. 5.5). Fore femur with extremely short hair ventrally (length less than 0.2x mid ocellar diameter). Female: notauli strongly impressed and areolate, very obvious among fine, general scutal punctation (Fig. 5.4) (U.S.: MN and NJ southward) ..... 23. ***E. bidens*** (de Saussure)

- Tergum 1 largely black behind declivity except for apical fascia, which may extend forward laterally (Figs 5.45–46). Tergum 2 with well-developed apical fascia (Figs 5.45–46), its hind margin sometimes thickened and reflexed, with translucent border (Fig. 5.46). Propodeum evenly rounded laterally, without distinct angle, black (Figs 5.45–46), rarely with small ivory spot(s). Fore femur with long, erect hair ventrally (length greater than mid ocellar diameter; as in Fig. 5.12). Female: notauli hardly differentiated, obscured by coarse scutal macropunctation 5

5 Female: tibiae black (Fig. C31.1) or with small ivory spots on outer surface. Male: flagellomere XI (measured along outer surface*) 0.75–0.90x as long as flagellomere I (i.e., its minimum length along anterior surface); smooth ventral area of flagellomere IX straight in profile (Fig. 5.8); aedeagus with small ventromedial lamellae (Fig. 5.40). Both sexes: upper half of propodeal concavity enclosed laterally by relatively high, uninterrupted carina (Fig. 5.6) ..... 31. ***E. megaera*** (Lepeletier)

- Female: outer surface of tibiae largely or entirely ivory (Fig. C34.1). Male: flagellomere XI* 0.95–1.10x as long as flagellomere I; smooth ventral area of flagellomere IX convex in profile (Fig. 5.9); aedeagus with large ventromedial lamellae (Fig. 5.41). Both sexes: upper half of propodeal concavity usually not enclosed by continuous carina laterally, the carinal development varying from absent (except for dorsal tooth-like projection) to low and rim-like (less than 0.5x mid ocellar diameter high) and usually partially interrupted (Fig. 5.7) ..... 34. ***E. schwarzi*** (Krombein)

*Note: for correct measurement flagellomere XI needs to be adducted (i.e., in its natural position).

6 Male: mid tarsomeres 1–4 extremely compressed laterally (Fig. 5.11); fore femur with ventral hairs long (length subequal to mid ocellar diameter; as in Fig. 5.12). Female: sternum 2 with complete apical fascia (rarely with small interruptions) ..... 32. ***E. planitarsis*** (Bohart)

- Male: mid tarsus only moderately compressed (Fig. 5.10); fore femur with ventral hairs unusually short (length ca. 0.3x mid ocellar diameter; Fig. 5.13) (but femur with longer hair posteriorly). Female: sternum 2 with a pair of posterolateral ivory spots ..... 30. ***E. leucomelas*** (de Saussure), in part

7 Male (seven metasomal segments) 8

- Female (six metasomal segments) 11

8 Basal half of fore femur with long, erect hair ventrally and posteriorly (length subequal to mid ocellar diameter; Fig. 5.12). Flagellomere XI stout (Fig. 5.14) 9

- Basal half of fore femur with very short hair ventrally (length at most 0.3x mid ocellar diameter; Fig. 5.13) and sometimes also posteriorly. Flagellomere XI slender (Fig. 5.17) 10

9 Terga 1–4 with complete apical fascia, tergum 5 almost always* and 6 often with complete apical fascia or posteromedial spot (Fig. C28.1), the one or two most posterior fasciae never interrupted medially, if reduced then abbreviated laterally. Parategula almost always yellow. Aedeagus with very short ventromedial lamellae (Fig. 5.42) ..... 28. ***E. foraminatus*** (de Saussure)

- Terga 1 and 2 with complete apical fascia; usually one or more of terga 3–5 with yellow posterolateral spots or, rarely, with more or less complete but narrow apical fascia, in which case the one or two most posterior fasciae are interrupted medially (Fig. 5.15); fasciae never abbreviated laterally. Parategula black, at most very narrowly reddish at apex. Aedeagus with prominent ventromedial lamellae (Fig. 5.43) ..... 35. ***Euodynerus* sp. F**

*Note: only 1–2% of male *E. foraminatus* lack yellow markings on tergum 5.

10 Posterior surface of metanotum and propodeal concavity dull, not shining (Fig. 5.18). Propodeum with at most a small lamellate tooth just behind posterolateral corners of metanotum (U.S.: NJ southwards*) ..... 24. ***E. blakeanus*** (Cameron)

Posterior surface of metanotum and propodeal concavity moderately to highly shining despite ridging and/or punctation (as in Fig. 5.6). Propodeum with prominent lamellate tooth just behind posterolateral corners of metanotum (similar to Fig. 5.6) ..... rare yellow colour form of 30. ***E. leucomelas*** (de Saussure)

*Note: range insufficiently known due to previous confusion with *E. foraminatus*.

11 Terga 3 and 4 without apical fascia. Wings dark brown with strong purplish reflections (Fig. 5.50); scape amber to brown below (Fig. C35.4), rarely brownish yellow. Tegula often without yellow. Parategula black, at most very narrowly reddish at apex ..... 35. ***Euodynerus* sp. F**

- Terga 3 and 4 with complete apical fascia. Wings pale brown, with weak purplish reflections (Fig. 5.51). Scape bright yellow below (as in Fig. 5.2). Tegula always marked with yellow. Parategula marked with yellow 12

12 Clypeus with yellow apical spots (Fig. 5.2) besides paired basal spots or crescent-shaped basal mark. Posterior surface of metanotum and propodeal concavity dull, not shining (Fig. 5.18). Propodeum without or with small lamellate tooth just behind posterolateral corners of metanotum ..... 24. ***E. blakeanus*** (Cameron)

- Clypeus without yellow markings in apical half, basal half with crescent-shaped yellow mark or paired spots. Posterior surface of metanotum and propodeal concavity moderately to highly shining despite ridging and/or punctation (as in Fig. 5.6). Propodeum with prominent lamellate tooth just behind posterolateral corners of metanotum (similar to Fig. 5.6) 13

13 Tergum 2 with apical margin truncate, slightly to considerably thicker than that of tergum 3 in posterior view (apical thickness up to 0.8x mid ocellar diameter); terga 2–4 with punctation in preapical area coarse, deep and usually dense (Figs 5.15, 5.51). Sternum 2 with distinct median longitudinal groove in basal half ..... 28. ***E. foraminatus*** (de Saussure)

- Tergum 2 with apical margin thin and rounded, not noticeably thicker than that of tergum 3; terga 2–4 with punctation in preapical area shallower, finer and usually more widely spaced (Figs 5.16, 5.49). Sternum 2 with median groove often weakly developed ..... rare yellow colour form of 30. ***E. leucomelas*** (de Saussure)

14 Tergum 1 with long erect or semi-erect hairs behind declivity (their length greater than mid ocellar diameter). Male fore femur with small ventrobasal tubercle (Fig. 5.19) (eastern U.S.) 15

- Tergum 1 with extremely short, appressed pubescence behind declivity. Male fore femur not tuberculate 16

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15 Body marked with ivory. Interocellar area not tuberculate. Metanotum black. Tergum 1 virtually impunctate behind declivity (Fig. 5.53) (U.S.: VA southward) ..... 20. ***E. annectens*** (de Saussure)

- Body marked with yellow and sometimes ferruginous (Fig. 5.54). Each hind ocellus bordered medially by low tubercle; the tubercle projecting above level of ocellus in lateral view (similar to Fig. 7.28). Metanotum with yellow band along anterior margin. Tergum 1 distinctly punctate (Fig. 5.54) (U.S.: MD southward) ..... 25. ***E. boscii*** (Lepeletier)

16 Terga 2 and 3 with hind margin thin, reflexed and translucent (Fig. 5.21). [Scutellum black; metanotum with yellow band along anterior margin (Fig. 5.55)]..... 29. ***E. hidalgo*** (de Saussure)

- Tergum 2, at most, with hind margin reflexed, its margin thickened or thin and translucent 17

17 Disc of tergum 2 and tergum 1 impunctate (Fig. 5.56) (western U.S., occurrence in Ontario doubtful) .....[33. *E. pratensis* (de Saussure)]

- Disc of tergum 2 punctate; tergum 1 strongly punctate to impunctate (Figs 5.57–61)..... 18

18 Propodeum with submarginal carina distinctly produced, more or less rectangular with narrowly rounded apex (Fig. 5.22). Metanotum with yellow band along anterior margin and scutellum black (Fig. 5.58; rarely scutellum with a pair of small yellow spots). Male: flagellomere XI conspicuously flattened, obliquely truncate apically (Fig. 5.26); mid femur with anteroventral depression near base (Fig. 5.24); hind femur posterobasally with dense long semi-erect hair (Fig. 5.25). [Female: apical tooth of mandible as long as second and third combined]..... 21. ***E. annulatus*** (Say)

- Propodeum with submarginal carina very low and rim-like, not projecting posteriorly (e.g., Fig. 5.31). Metanotum usually without yellow band along anterior margin (Figs 5.59–61), if present then scutellum largely ferruginous or with a pair of large ferruginous spots (Fig. 5.57). Male: flagellomere XI smaller, neither flattened nor broadly truncate; mid femur without anteroventral depression near base; hind femur with short hairs posterobasally, with a few scattered longer hairs..... 19

19 Tergum 1 practically impunctate (Fig. 5.57). Male: fore trochanter with long, erect hair (Fig. 5.20); flagellomeres III–VII black; hind margin of tergum 2 neither thickened nor double-edged. Female: cephalic foveae in deep depression (Fig. 5.23); mandible with apical tooth at least as long as second and third combined (Fig. 5.28) ..... 27. ***E. crypticus*** (Say)

- Tergum 1 sparsely to densely punctate (Figs 5.59–61). Male: fore trochanter with short, decumbent hair; flagellomeres III–VII yellow to brownish beneath (Fig. C22.3); hind margin of tergum 2 slightly to strongly thickened (0.4–1.3x mid ocellar diameter), double-edged and often reflexed (Fig. 5.33). Female: area around cephalic foveae flattened, at most slightly and very gradually depressed below level of vertex; mandible with apical tooth at most slightly longer than second..... 20

20 Propodeum with lateral ridge dentate below angle (Fig. 5.31). Male: flagellomere XI yellowish to pale brown on outer surface; flagellomeres I–VII with scattered short, bristle-like hairs (spicules) on ventral surface (Fig. 5.27; their length ca. 0.15–0.2x mid ocellar diameter); mandible with second tooth longer than third (Fig. 5.30). Female: fore basitarsus without rake (Fig. 5.34) ..... 26. ***E. castigatus*** (de Saussure)

- Propodeum with lateral ridge not dentate below angle (Fig. 5.32). Male: flagellomere XI black; flagellomeres I–VII without short, bristle-like hairs on ventral surface; mandible with second tooth as long as third (Fig. 5.29). Female: fore basitarsus with distinct rake setae (Fig. 5.35)..... 21

21 Sternum 2 abruptly sloping up from basal groove towards slightly concave, plateau-like middle part (thus forming strongly convex welt just behind transverse basal groove; Fig. 5.36). Transverse basal groove of sternum 2 granulose or with fine longitudinal or oblique ridging (> 25 ridges) (Fig. 5.38). Female: wings very slightly infuscated (Fig. 5.60) (ON and MI westward) ..... 22. ***E. auranus*** (Cameron)

- Sternum 2 rising gradually towards slightly convex middle part which is not plateau-like; median area immediately behind basal groove almost flat, conspicuously inclined towards basal groove (Fig. 5.37). Basal groove of sternum 2 with ca. 16–22 coarse to moderate longitudinal ridges (Fig. 5.39). Female: wings moderately infuscated (Fig. C36.1) (U.S.: MA southward)..... 36. ***Euodynerus* sp. G**

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6. Key to northeastern Nearctic *Leptochilus* species

1 Mouthparts very long, when extended reaching to mid coxae (Fig. 6.2). Interocellar area not tuberculate, with longitudinal groove behind mid ocellus; interantennal prominence not developed (Fig. 6.2). Male: flagellomere XI long and only slightly flattened, its apex reaching base of F IX (Fig. 6.5); mid femur simple ..... 38. ***L. republicanus*** (Dalla Torre)

- Mouthparts short, when extended not reaching beyond fore coxae. Interocellar area distinctly tuberculate; interantennal prominence pointed (Fig. 6.1). Male: flagellomere XI short and extremely flattened, its apex far from reaching base of flagellomere IX (Fig. 6.4); mid femur with broad anteroventral depression in basal half (Fig. 6.3) (U.S.: from NJ southward) .... 37. ***L. acolhuus*** (de Saussure)

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7. Key to northeastern Nearctic species of *Parancistrocerus* and *Stenodynerus*

1 Humeral carina short but well-developed, continuing pronotal carina posteriorly (Fig. 7.3). Omaulus strong and nearly straight ventrally, not or very slightly curving posteriorly (Fig. 7.1). Pronotal hind margin between tegulae completely bordered with yellow (Fig. 7.3, sometimes obscure posteriorly). Male: mid femur with low anteroventral swelling just before middle (Fig. 7.4). [Flagellomere VIII of male with deep apical emargination on inner side. Pronotal carina strong medially (Fig. 7.3). Tergum 3 with complete apical fascia (Fig. 7.57).] (U.S.: NY and MN southward) ..... 56. ***S. fundatiformis*** (Robertson)

- Humeral carina absent. Omaulus in most species distinctly curved posteriorly and becoming weak ventrally (Fig. 7.2). Pronotal hind margin black or brownish. Male: mid femur simple or variously modified but not as above 2

2 Sternum 2 in lateral view bluntly angled behind basal groove (Fig. 7.5), without median longitudinal crease. [Interocellar area without tubercles. Pronotal carina weakly defined. Summit of tergum 1 without transverse carina. Terga 1 and 2 lacking discal yellow spots; metasomal terga almost always entirely black beyond segment 2 (Fig. 7.5). Male: flagellum yellow beneath; mid femur without anteroventral depression near base.] ..... 48. ***P. perennis*** (de Saussure)

- Sternum 2 in lateral view evenly convex behind basal groove (e.g., Fig. 7.6), with median longitudinal crease 3

3 Mid ocellus bordered posteriorly by low and eyelid-like, sometimes conspicuous, swelling (Fig. 7.7, better developed in male than in female), the swelling clearly projecting above level of ocellus in anterior view and usually separated from it by a fine crease 4

- Area immediately behind mid ocellus flat, not projecting above level of ocellus in anteroventral view; mid ocellus not bordered by fine crease posteriorly (e.g., Fig. 7.8) 7

4 Tergum 1 near summit with scattered long hairs that are several times longer than the general pubescence (similar to Fig. 7.6). Pronotal carina strongly developed, including medially (as in Fig. 7.3). Acarinarium present (cf. Key 2, couplet 4) (U.S.: NY and MI southward) ..... 42. ***P. bicornis*** (Robertson)

- Tergum 1 near summit with uniform short pubescence. Pronotal carina interrupted or weak medially. Acarinarium absent (cf. Key 2, couplet 4) 5

5 Vertex with a pair of (sometimes poorly developed) impunctate swellings near summit of eye slightly behind level of hind ocelli (Fig. 7.9). Tergum 2 with pits in basal groove shallow or obsolete medially (Fig. 7.14). Pronotum with punctures well separated (Fig. 7.9; on average by one mid ocellar diameter, in some spots by distinctly more). Size larger, fore wing length 5.5–7.0 (male), 7.0–8.0 mm (female). Male: flagellomere XI slender, its width < 0.25x that of flagellomere IX (Fig. 7.10); flagellum black to orange-yellow ventrally; base of fore femur with scattered longish hairs ventrally (length ≤ 0.4x mid ocellar diameter) among extremely short hairs (Fig. 7.12). (U.S.: MI and MA southward) ..... 63. ***S. pulvinatus*** Bohart

- Vertex without impunctate swellings near summit of eye. Tergum 2 with pits in basal groove deep, including medially (as in Fig. 7.16). Pronotum with punctures denser, usually separated by less than one mid ocellar diameter (Fig. 7.19–20). Size smaller, fore wing length 4.8–5.5 (male), 5.5–6.5 mm (female). Male: flagellomere XI broad, its width ca. 0.35x that of flagellomere IX (Fig. 7.11); flagellum extensively yellow ventrally; base of fore femur with extremely short uniform hairs ventrally, without longer hairs (Fig. 7.13) 6

6 Pronotal carina almost always complete medially (similar to Fig. 2.12). Parategula narrowed near middle, somewhat to strongly incurved along oblique posteromedial margin, and hooked or pointed toward apex (Fig. 7.19). Tergum 1 with or without small round discal spots, if present the spots usually connected to apical fascia (Fig. 7.59). Sternum 2 without yellow discal spots. Clypeus with coarse punctures (Fig. 7.17). Male: flagellomere IX with sharply delimited shining area opposite flagellomere XI (Fig. 7.11); interantennal spot round, not extending ventrally beyond interantennal prominence (Fig. 7.17) ..... 55. ***S. blepharus*** Bohart

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- Pronotal carina briefly interrupted medially by smooth or punctate area. Parategula wide throughout, with convex or at least straight posteromedial margin, usually broadly rounded at apex (Fig. 7.20). Tergum 1 with elongate oblique spots laterally, usually connected to apical fascia; sternum 2 often with yellow discal spots, especially in male (Fig. 7.60). Clypeus with fine punctures (Fig. 7.18, coarser in female). Male: flagellomere IX dull throughout; interantennal spot elongate, extending to base of clypeus ventrally (Fig. 7.18) (U.S.: NY, MI and MN southward)..... 62. ***S. oculeus*** (Robertson)

7 Clypeal apex straight to slightly convex (Fig. 7.21). Male: mid femur laterally compressed in basal half, sometimes conspicuously distorted (Figs 7.23–24); flagellomere XI very broad with shining apex that fits into deep apical emargination of flagellomere VIII (Fig. 7.22). [Acarinarium absent].....8

- Clypeal apex at least slightly emarginate (e.g., Figs 7.27, 7.31, 7.33–34, 7.39; rarely almost straight). Male: mid femur simple or with more or less distinct anteroventral depression in basal third (Fig. 7.36); flagellomere XI narrow to slightly broadened, dull throughout; apex of flagellomere VIII at most shallowly emarginate (depth of emargination < 0.5x mid ocellar diameter).....9

8 Summit of tergum 1 without transverse carina; punctures scattered. Pronotal carina well defined but low medially (similar to Fig. 2.12). Terga with apical fasciae becoming paler on caudal segments; tergum 1 with yellow discal spots (often connected to apical fascia) (Fig. 7.61). Male mid femur strongly distorted, with deep oblique anterior depression in basal half, dorsoventrally flattened in distal half (Fig. 7.24).....54. ***S. anormis*** (Say)

- Summit of tergum 1 with an irregular transverse carina formed by enlarged confluent punctures followed by smooth area (Fig. 7.25). Pronotal carina rounded over medially. Terga with apical fasciae bright yellow; tergum 1 without discal spots (spots present in specimens from southern U.S.) (Fig. 7.62). Male mid femur with moderate anterior depression in basal half, not flattened distally (Fig. 7.23) .....53. ***S. ammonia*** (de Saussure)

9 Horizontal part of tergum 1 with sparse to abundant long hairs near summit (length greater than mid ocellar diameter; Fig. 7.6). [Terga 1 and 2 with yellow discal spots, on former often connected to apical fascia (Fig. 7.6). Acarinarium present.].....10

- Tergum 1 with shorter hairs (length less than mid ocellar diameter) 11

10 Summit of tergum 1 with irregular transverse carina formed by anterior margin of confluent punctures followed by smooth area (Fig. 7.26). Pronotal carina interrupted medially. Interocellar area not tuberculate, with shallow median impression. Tergum 3 with apical fascia usually interrupted medially. Male: ocelli large, mid ocellus usually separated from hind ocelli by its own diameter or less (Fig. 7.27) (U.S.: NJ southward)..... 49. ***P. salcularis*** (de Saussure)

- Summit of tergum 1 without transverse carina. Pronotal carina entire (Fig. 2.12). Each hind ocellus bordered medially by low tubercle; the tubercle in male always, in female usually projecting above level of ocellus in lateral view (Fig. 7.28). Tergum 3 with complete apical fascia (Fig. 7.6). Male: ocelli of usual size, mid ocellus separated from hind ocelli by at least 1.2x its own diameter..... ..... 45. ***P. leionotus*** (Viereck)

11 Tergum 2 with subbasal median depression (sometimes hidden under tergum 1) forming entrance to acarinarium (Fig. 7.29, shallower in male). Male: clypeus with sharp apicolateral teeth bordering deep median emargination (depth greater than mid ocellar diameter; Fig. 7.8). [Summit of tergum 1 without transverse carina. Tergum 1 and almost always tergum 2 with discal spots, on former often connected to apical fascia; tergum 3 with complete apical fascia (Fig. 7.51). Male mid femur slightly depressed anteroventrally near base (as in Fig. 7.36). Tegula and usually mid and hind tibia without yellow, uniformly amber-reddish.]..... 50. ***P. vagus*** (de Saussure)

- Tergum 2 without subbasal median depression (e.g., Figs 7.14–16, 7.40). Male: clypeus with shallow apicomedial emargination (e.g., Fig. 7.31; its depth less than mid ocellar diameter).....12

12 Tergum 1 with posterior, horizontal part convex in lateral view (Fig. 7.30). [Pronotal carina complete. Summit of tergum 1 with conspicuous transverse carina formed by row of confluent coarse punctures followed by posteriorly convex smooth area (similar to Fig. 7.26). Tergum 1 with yellow discal spots (usually connected to apical fascia); tergum 2 without discal spots; the following terga without apical fasciae except in some males (Fig. 7.30).] (U.S.: MI southward) ..... 43. ***P. fulvipes*** (de Saussure)

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- Tergum 1 with posterior, horizontal part straight in lateral view (Figs 7.54, 7.56, 7.63–68). Summit of tergum 1 usually without transverse carina but if present (*S. histrionalis* and *S. lineatifrons*; Figs 7.65–66) the carina less conspicuous and following smooth area not convex. If tergum 1 with yellow spots then tergum 2 also spotted.....13

13 Metasoma without pale markings beyond segment 2 (Figs 7.53, 7.63–66).....14

- Metasoma with yellow or ivory apical fasciae on one or more terga beyond segment 2 (Figs 7.54–56, 7.67–68) 17

Note: *S. histrionalis* keys both ways.

14 Body with pale markings ivory to pale yellow. Eye emargination without pale spot (Fig. 7.31). Tergum 1 with small punctures and no carina at summit (Figs 7.63–64). Male: flagellomere XI unusually small and slender, not extending to base of flagellomere IX (Fig. 7.35). Female: legs almost completely black except anterior surface of fore tibia and apex of fore femur. [Male: mid femur without anteroventral depression near base; flagellum black beneath except sometimes apical flagellomeres.] (Canada) ....61. ***S. lucidus*** (Rohwer)

- Body with pale markings bright yellow to ferruginous; propodeum and tergum 1 often largely ferruginous (Figs 7.53, 7.65). Eye emargination with yellow or reddish spot (Figs 7.33–34). Summit of tergum 1 with an irregular transverse carina formed by coarse, confluent punctures (Figs 7.53, 7.65–66). Male: flagellomere XI larger, extending to base of flagellomere IX. Female: legs largely reddish or yellow to orange-yellow with brown or black (eastern U.S.).....15

15 Tergum 1 with an acarinarium under its apical margin; tergum 2 with basal transverse groove smooth (as in Fig. 7.40). Tergum 2 without pair of spots and sometimes also without apical fascia (Fig. 7.53). Male mid femur without anteroventral depression near base.....44. ***P. histrio*** (Lepeletier)

- Tergum 1 without an acarinarium under its apical margin; tergum 2 with basal transverse groove pitted at least laterally (Fig. 7.15). Tergum 2 often with a pair of yellow spots (Fig. 7.66; small and dark ferruginous in *S. lineatifrons*, if present), apical fascia always developed. Male mid femur with anteroventral depression near base (as in Fig. 7.36).....16

16 Interantennal spot parallel-sided or decreasing in width from interantennal prominence towards upper end (Fig. 7.33). Pronotal carina interrupted or indistinct medially. Tergum 1 largely ferruginous; tergum 2 rarely with a pair of obscure ferruginous discal spots (Fig. 7.65). Yellow markings of body (except male clypeus) more or less suffused with reddish (Fig. 7.33). Male: clypeus coarsely punctate (as in Fig. 7.17). Female: clypeus with crescent-shaped dorsal mark (Fig. 7.33) (U.S.: VA southward) .....60. ***S. lineatifrons*** Bohart

- Interantennal spot increasing in width dorsally (Fig. 7.34). Pronotal carina complete and well defined medially (similar to Fig. 2.12). Tergum 1 without ferruginous markings in specimens from northeastern states; tergum 2 with a pair of yellow spots (Fig. 7.66; always present in male?). Yellow markings of body deep yellow in northeastern specimens. Male: clypeus finely punctate (Fig. C58.3). Female: clypeus with transverse dorsal mark, not or hardly emarginate ventrally (Fig. 7.34) (U.S.: NY southward).....57. ***S. histrionalis*** (Robertson), in part

17 Transverse basal groove of tergum 2 shining, with complete row of deep pits (Fig. 7.16). Tergum 3 with complete or nearly complete apical fascia (Fig. 7.16; rare exceptions). Male: base of fore femur with uniform, extremely short pubescence ventrally (as in Fig. 7.13); base of mid femur not at all depressed anteroventrally. Female: apical tooth of mandible as long as second and third tooth combined* (Fig. 7.37). [Pale markings of body usually pale yellow to ivory (paler in female), at least on posterior terga. Tergum 2 with apical margin scarcely thickened (thickness ≤ 0.6x mid ocellar diameter) (Fig. 7.67). Male flagellum obscure reddish to black beneath.].....58. ***S. kennicottianus*** (de Saussure)

- Basal groove of tergum 2 at least medially without pits (sculpture similar to Fig. 7.14); sometimes strongly pitted laterally but then surface dulled by fine rugosity. Tergum 3 with fascia interrupted medially or absent, very rarely complete. Male: base of fore femur ventrally with scattered longish hairs (length up to 0.4x mid ocellar diameter) among extremely short pubescence (similar to Fig. 7.12); base of mid femur slightly to distinctly depressed anteroventrally (Fig. 7.36). Female: apical tooth of mandible subequal in length to second* (Fig. 7.38).....18

* Note: apical tooth often significantly shortened through wear in older specimens.

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18 Pronotal carina complete and well defined medially (similar to Fig. 2.12). Clypeus with very shallow apical emargination (depth less than 0.3x mid ocellar diameter; Fig. 7.34), finely punctate in male (Fig. C58.3). Basal groove of tergum 2 shallowly pitted laterally (Fig. 7.15). Male: flagellum dark beneath; clypeus yellow; apical margin of tergum 2 scarcely thickened (thickness rarely up to 0.8x mid ocellar diameter; Fig. 7.66); interantennal spot extending to clypeus ventrally, distinctly widening dorsally (as in Fig. 7.18). Female: dorsal half of clypeus with transverse mark, not or hardly emarginate ventrally (Fig. 7.34); femora either with brown or blackish basal areas gradually merging into yellow apical areas or largely ferruginous. [Pale markings of body yellow to orange yellow.] (U.S.: NY southward) ..... 57. ***S. histrionalis*** (Robertson), in part

- Pronotal carina interrupted medially. Clypeus with deeper apical emargination (depth usually over 0.5x mid ocellar diameter; Fig. 7.39), coarsely punctate in male (e.g., Fig. C60.3). Tergum 2 with basal groove finely wrinkled but not pitted (e.g., Fig. 7.40). Male: flagellum often yellowish beneath, if dark then clypeus almost always with black apical or discal markings (Fig. C46.4) and/or apical margin of tergum 2 thickened to at least one mid ocellar diameter (Fig. 7.55); interantennal spot very rarely extending to clypeus or widening dorsally. Female: dorsal half of clypeus with crescent-shaped pale mark (sometimes confluent with ventral spots), with a pair of spots or unmarked; femora black and yellow, without extensive intervening brownish areas (e.g., Fig. 7.54) 19

19 Tergum 2 with basal groove slightly concave immediately before subbasal declivity (Fig. 7.41, lateral view), the declivity with denser punctation than remainder of tergum but punctures only slightly smaller, well defined and not confluent; interspaces as smooth as elsewhere on tergum, not granulose (Fig. 7.43). Male: flagellum extensively yellow below; tergum 2 with a pair of yellow discal spots (Fig. 7.68). Female: apical half of clypeus with a pair of yellow spots (Fig. 7.39), sometimes confluent with yellow basal mark (U.S.: MA southward) ..... 59. ***S. krombeini*** Bohart

- Tergum 2 with basal groove flat anterior to subbasal declivity (Fig. 7.42), the declivity with punctation becoming increasingly dense and small anteriorly; punctures just behind basal groove noticeably small, more or less confluent and not clearly differentiated from finely rugose interspaces (Fig. 7.44). Male: flagellum often black, if extensively yellow below then tergum 2 without discal spots. Female: clypeus very rarely with yellow spots in apical half 20

20 Male (seven metasomal segments) 21

- Female (six metasomal segments) 22

21 Flagellum black or with restricted obscure yellowish areas beneath; free margin of clypeus usually narrowly black (Fig. C46.4), clypeal disc sometimes also marked with black (as in Fig. 7.17). Markings of body bright yellow. Tergum 2 occasionally with a pair of yellow discal spots (Fig. 7.55). Aedeagus conspicuously constricted near middle (Fig. 7.45) ..... 46. ***P. pedestris*** (de Saussure)

- Flagellum yellow beneath; apical margin of clypeus yellow except sometimes laterally; clypeal disc yellow. Markings of body often pale yellow (as in Fig. 7.56). Tergum 2 without pale discal spots. Aedeagus slightly narrowed near middle, not constricted (Fig. 7.46) ..... 47. ***P. pensylvanicus*** (de Saussure)

22 Scutum with yellow posteromedial spot (as in Figs 7.19–20). Clypeus with paired dorsal spots, often confluent and forming a single crescent-shaped mark (exceptionally clypeus entirely black). [Tergum 1 frequently, tergum 2 almost always, with yellow discal spots (Fig. 7.54).] ..... 46. ***P. pedestris*** (de Saussure), in part

- Scutum without pale posteromedial spot. Clypeus with a pair of separate, yellow dorsal spots or entirely black 23

23 Tergum 2 without pale discal spots (Fig. 7.56; or else markings somewhat pale yellow). Markings of body pale to bright yellow (Fig. 7.56) ..... 47. ***P. pensylvanicus*** (de Saussure), in part

- Tergum 2 with a pair of discal yellow spots; markings of body bright yellow (Fig. 7.54)..... 47. ***P. pensylvanicus*** or 46. ***P. pedestris***, in part

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8. Key to eastern Nearctic *Symmorphus* species

1 Metasomal tergum 1 broad (Fig. 8.8), median postcarinal length 0.44–0.55x apical width of tergum. Male: flagellomere XI large, at least as long as broad (Fig. 8.1). Female: flagellomere I longer than maximum width of flagellum; cephalic foveae small, separated by at least four times their own width (Fig. 8.3); hair below base of fore femur long, some hairs at least one mid ocellar diameter long..... ..... 64. ***S. albomarginatus*** (de Saussure)

- Metasomal tergum 1 more elongate, median postcarinal length 0.61–0.83x apical width of tergum(Figs 8.9–10). Male: flagellomere XI smaller, length 0.55–0.94x width (as in Fig. 8.2 or smaller [after Cumming 1989]). Female: flagellomere I shorter than maximum width of flagellum; cephalic foveae separated by at most three times their own width (Figs 8.4–5); hair below base of fore femur shorter (length less than 0.5x mid ocellar diameter but sometimes with a few longer hairs).....2

2 Hair below basal half of hind femur extremely short (length ca. 0.2x mid ocellar diameter), of nearly uniform length and very dense, the brush thus of regular appearance (almost velvet-like) (Fig. 8.6). Cephalic foveae of female very large, separated by at most 1.5x their own diameter (Fig. 8.4)..... ..... 65. ***S. canadensis*** (de Saussure)

- Hair below basal half of hind femur longer (length ca. 0.3x mid ocellar diameter), less dense, usually with some longer hairs admixed between shorter hairs, the brush thus appearing irregular, length of hairs noticeably decreasing distally (Fig. 8.7). Cephalic foveae of female smaller, separated by at least 2.5x their own diameter (Fig. 8.5)..... 66. ***S. cristatus*** (de Saussure)

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9. Key to eastern Nearctic Polistinae genera (Paper Wasps)

Note: extralimital taxon in brackets.

1 Metasoma sessile, the first segment at most slightly longer than wide (Figs 10.6–7). Tarsomere 4 of mid and hind leg symmetrical ..... ***Polistes*** (11 spp.)

- Metasoma petiolate, the first segment more than twice as long as wide. Tarsomere 4 of mid and hind leg strongly asymmetrical (U.S.: SC to TX along Gulf Coast) .....[*Mischocyttarus*]
  Represented in the east by *M. mexicanus* (de Saussure) and *M. phthisicus* (Fabricius)

10. Key to northeastern Nearctic *Polistes* species

Note: two adventitious species, the western *P. aurifer* de Saussure (one record from Prince Edward Island) and the Caribbean *P. dominicus* (Vallot) (one record from Ontario) are not included in the key (for diagnoses see species treatments: 70. *P. aurifer*, 73. *P. dominicus*).

1 Flagellum almost entirely bright orange (excluding black dorsal streak in basal 3/4 of flagellomere I, Fig. 10.4). Scutum black, with a pair of yellow spots in anterior half (Fig. 10.3; the spots exceptionally absent). Centre of mesopleuron with coarse, contiguous punctures; omaulus present, dorsally almost extending to dorsal groove of mesopleuron (Fig. 10.1). Head and body (excluding appendages) entirely black and yellow (Figs 10.3–4, 10.44). Female: scape black above, yellow below; clypeus yellow, with or without black central spot(s) (Fig. 10.4) ..... 74. ***P.* (*Polistes*) *dominula*** (Christ)

- Flagellum usually brownish to black dorsally (Figs 10.18–19), if partly orange then at least middle portion infuscated (Fig. 10.5). Yellow scutal markings rarely present but if so then scutum predominantly ferruginous. Centre of mesopleuron with dense, small punctures, sometimes interspersed with scattered macropunctures; omaulus absent (Fig. 10.2). Head and body usually with well-developed ferruginous markings. Female: scape reddish to ferruginous below; clypeus usually marked with ferruginous areas, if black and yellow, then black spot attaining dorsal margin .... *P.* (*Aphanilopterus*) 2

2 Metasomal segment 1 more slender, tergum 1 at least as long as broad (measured from base of anterior declivity to hind margin; Fig. 10.6), in profile with shallow depression near 2/3 (Fig. 10.8). Apical flagellomeres orange, contrasting with blackish median flagellomeres (Fig. 10.5). Head behind occipital carina with dense fringe of relatively long, erect hairs (length up to one mid ocellar diameter, best seen in anterolateral view; Fig. 10.10) 3

- Metasomal segment 1 stout, tergum 1 broader than long (Fig. 10.7), in profile more evenly rounded (Fig. 10.9). Flagellum more or less darkened on most of dorsal surface, at most becoming gradually paler towards apex, but never with contrasting pattern (Figs 10.18–19). Head behind occipital carina with short fringe of erect hairs (length less than 0.5x mid ocellar diameter, plus a few scattered longer hairs; Fig. 10.11) .....*P. fuscatus*-group 4

3 Mesopleuron without macropunctures. Head, meso- and metasoma conspicuously marked with yellow, notably on mesopleuron and propodeum (Figs 10.10, 10.12, 10.45). Metasoma predominantly ferruginous with apical yellow fasciae on most or all segments, base of terga more or less black (Fig. 10.45) (ON: adventitious; U.S.: from NJ southward)..... 76. ***P. exclamans*** Viereck

- Mesopleuron with small but distinct macropunctures (Fig. 10.13). Yellow markings absent or inconspicuous on head, meso- and metasoma except well-developed apical fascia on tergum 1 (Fig. 10.46). Ground colour of metasoma black except for ferruginous mark on tergum 1 and sometimes a pair of ferruginous spots on tergum 2 (Fig. 10.46) (U.S.: NY and MA southward)..... .....69. ***P. annularis*** (L.)

4 Micropunctures of mesosoma and female clypeus smaller than in other species, the integument therefore more shining, with a 'greasy' lustre (Fig. 10.14). Eye with scattered, minute hairs (visible at 20x magnification). Pronotal fovea of female and most males either absent (Fig. 10.14) or developed as a minute, shallow pit. Propodeal orifice distinctly and fairly abruptly narrowed dorsally (Fig. 10.16). Female: flagellomeres I–VIII or IX with relatively long, bristly hairs posteriorly and dorsally (hairs

becoming sparser and shorter towards apex of flagellum; Fig. 10.18) (U.S.: DE and IL southward; distribution insufficiently known) ..... 80. ***Polistes* sp. A**

- Micropunctures of clypeus and mesosoma coarser, the integument less shining, without 'greasy' lustre (e.g., Fig. 10.15). Eye usually bare; hairs, if present, only visible at high magnification. Pronotal fovea usually well developed, penetrating pronotum (Fig. 10.15); exceptionally minute and shallow. Propodeal orifice at most slightly and gradually narrowed dorsally (Fig. 10.17). Female: only flagellomeres I–II (in *P. perplexus** often I–VI) with bristly hairs posteriorly and dorsally, these hairs shorter (Fig. 10.19) 5

  * Easily separated from species A by the entirely pubescent gena (see couplet 8).

5 Female (six metasomal segments) 6

- Male (seven metasomal segments) 15

6 Metasoma without yellow markings, or only tergum 1 with yellow apical fascia (Figs 10.48–49, 10.52–54, 10.56) 7

- Metasoma with yellow markings on tergum 1 and at least one of segments 2–6 (Figs 10.47, 10.50–51, 10.55, 10.57) 12

7 Mesosoma, metasoma, and legs almost entirely ferruginous (Figs 10.48–49, C72.1, C72.3, C79.1, C79.3), black or dark brown areas, if present, restricted to one or more of the following areas: small spot in front of pronotal carina, certain sutures of mesosoma, margins and sometimes one or three longitudinal stripes on scutum, median groove of propodeum, narrow bases of terga 2 or 3 (rarely), posterior bases of coxae, and apex of hind tibia medially 8

- At least either mesosoma, metasoma or legs with more extensive black areas than above 9

8 Malar space and gena uniformly covered by fine, appressed silvery pubescence arising from minute punctures, interspersed by a few scattered macrosetae arising from larger punctures (Fig. 10.20). Propodeum coarsely ridged (Fig. 10.37) (U.S.: from MD southward) ..... 79. ***P. perplexus*** Cresson

- Malar space and lower gena bare except for a few scattered macrosetae arising from larger punctures; only upper 3/4 of gena with fine, appressed silvery pubescence (Fig. 10.21). Propodeum usually with fine or no ridging (Fig. 10.38) (ON: adventitious; U.S.: from NY southward) ..... 72. ***P. carolina*** (L.)

9 One or more of the following features present: clypeal disc marked with black; mesopleuron with yellow dorsal spot (Fig. 10.28); at least one of metasomal segments 3–6 with ferruginous markings..... ..... 77. ***P. fuscatus*** (Fabricius), in part

- Clypeal disc entirely ferruginous (Fig. 10.24). Mesopleuron lacking yellow dorsal spot. Metasomal segments 3–6 entirely black (Fig. 10.52–54) 10

10 Sternum 2 strongly convex (Fig. 10.22). Black ocellar spot (if present) either separate from (Fig. 10.24), or in rare cases, very narrowly connected to black antennal spot(s) (if present). Mesopleuron and propodeum with ferruginous marks (ON: Pelee I.; eastern U.S.) ..... 78. ***P. metricus*** Say

- Sternum 2 moderately convex (Fig. 10.23). Black ocellar marking usually broadly connected to black antennal marking (Fig. 10.25). Mesopleuron and/or propodeum sometimes entirely black 11

11 Sterna 3–5 with central area densely punctate, the interspaces less than one puncture diameter; punctation mostly fine, with few, regularly spaced, larger punctures (Fig. 10.39). Mesopleuron sometimes entirely black ..... 77. ***P. fuscatus*** (Fabricius), in part

- Sterna 3–5 with central area more coarsely punctate, the punctures rather spaced and in some areas two puncture diameters apart; punctures of sparsely punctate areas either uniform in size or large punctures more numerous than small punctures (Fig. 10.40). Mesopleuron marked with ferruginous (MD, WV, VA; distribution insufficiently known) ..... 81. ***Polistes* sp. B**

12 Hind trochanter beyond basal constriction, and usually hind femur, with more or less developed black or brown markings 13

- Hind trochanter beyond basal constriction (and hind femur) ferruginous, without black or brown markings 14

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13 Small species (fore wing length 10–13 mm). Hind femur with black or brown mark forming a complete ring near base. Clypeal disc not marked with black or dark brown; black frontal markings, if present, not connecting ocelli to antennal bases (Fig. 10.29) (U.S.: southern MA southward) ..... 75. ***P. dorsalis*** (Fabricius)

- Larger species (fore wing length 13–17 mm, exceptionally as short as 11 mm). Hind femur with black or brown mark often interrupted dorsally, if forming a complete ring then clypeal disc marked with black or dark brown, and black frontal marking connecting ocelli to antennal bases (Fig. 10.25) ..... 77. ***P. fuscatus*** (Fabricius), in part

14 Clypeus with at least half of disc yellow (Fig. 1.11) (ON: adventitious; U.S.: NY southward, mainly coastal) .....71. ***P. bellicosus*** Cresson

- Clypeus with yellow markings, if present, occupying less than half of disc (Fig.10.25) ..... 77. ***P. fuscatus*** (Fabricius), in part*

* Note. Only a very small percentage of northeastern *P. fuscatus* key to this couplet. In some cases their separation from *P. bellicosus* is difficult.

15 Sternum 7 with prominent median tubercle, clearly visible in profile (Fig. 10.31). All flagellomeres with tyloids dull orange-yellow; basal 2/5 of flagellomere XI nearly parallel-sided in posterior view (Fig. 10.32). [Anterior and ventral surfaces of flagellum concolorous yellow to orange from base to apex (as in Fig. 10.36)]..... 75. ***P. dorsalis*** (Fabricius)

- Sternum 7 with weak median tubercle, not visible in profile. Apical flagellomeres with tyloids shining black, brown, or orange-yellow; flagellomere XI often more or less strongly tapered apically (Fig. 10.33) 16

16 Flagellomeres VIII–X dark brown to black (Figs 10.33–35), their tyloids at most slightly paler than black dorsal surface.....17

- Flagellomeres VIII–X at least in part yellow to reddish brown (Figs 10.32, 10.36), their tyloids usually much paler than black to dark brown dorsal surface (rarely flagellomeres entirely reddish yellow) 18

17 Flagellomeres I–V with anterior surface dark reddish brown, weakly contrasting with black to slightly darker brown anterior surface of apical flagellomeres (Fig. 10.35). Aedeagal teeth small; each row of teeth stopping well before apex of median expansion of aedeagus (Fig. 10.43). Metasoma largely black, rarely with ferruginous spots on terga 1 or 2, whitish apical fascia usually present on tergum 1 only (rarely also on 2 and 3).....81. ***Polistes* sp. B**

- Flagellomeres I–V with anterior surface yellow to orange, strongly contrasting with black apical flagellomeres (Fig. 10.34). Aedeagal teeth large; each row of teeth extending basally almost to apex of median expansion of aedeagus (Fig. 10.41–42). Metasoma usually with either ferruginous or yellow markings more extensive than above..... 77. ***P. fuscatus*** (Fabricius)

18 Metasoma with ferruginous markings, if present, restricted to terga 1 and 2; yellow apical fascia present at most on tergum 1..... 78. ***P. metricus*** Say

- Metasoma with ferruginous markings on all terga (sometimes very small on terga 1, 3 and 4); sometimes with well-developed yellow apical fasciae on several terga.....19

19 Yellow markings well developed: at least metasomal terga 1–3 with apical fasciae; upper mesopleuron with spot below pronotal lobe (similar to Fig. 10.28). Mesopleuron often without ferruginous markings .....71. ***P. bellicosus*** Cresson

- Yellow markings much more reduced: rarely metasomal tergum 1 with apical fascia; upper mesopleuron almost always without spot, if rarely present, the spot ill-defined. Mesopleuron extensively ferruginous 20

20 Propodeum with coarse transverse ridging (Fig. 10.37).....79. ***P. perplexus*** Cresson

- Propodeum usually smooth or with very fine transverse ridging (Fig.10.38), exceptionally with coarser ridging .....72. ***P. carolina*** (L.)

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11. Key to Nearctic Vespinae genera (Yellowjackets and Hornets)

1 Posterior ocelli separated from hind margin of vertex by several times ocellar diameter (Fig. 11.1; separated by only ca. 2x ocellar diameter in males). Pronotal carina nearly complete (Fig. 11.1). Tyloids of male flagellum prominent (Fig. 11.5). Large wasps (fore wing length 16–24 mm) with ferruginous markings on head and mesosoma..... ***Vespa***

one species: 87. *Vespa crabro*

- Posterior ocelli separated from hind margin of vertex by at most one ocellar diameter (Fig. 11.2). Pronotal carina absent or broadly interrupted medially. Tyloids of male flagellum, if present, not prominent and hardly discernible in profile. Smaller wasps (fore wing length 8–18 mm) without ferruginous markings on head and mesosoma.....2

2 Malar space long (ca. 2x mid ocellar diameter, Fig. 11.3). Pronotal carina present, broadly interrupted medially..... ***Dolichovespula*** (5 spp.)

- Malar space short (at most one mid ocellar diameter, Fig. 11.4). Pronotal carina absent .... ***Vespula*** (10 spp.)

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12. Key to eastern Nearctic *Dolichovespula* species

1 Metasomal terga 1 and 2 with pale apical fasciae well developed and not or hardly incised medially (Figs 12.10–12). Female (queens and workers) either with broadly interrupted pale postocular band (Fig. 12.2) or whole lower gena black (Fig.12.1) 2

- Metasomal terga 1 and 2 either completely black or with apical fasciae interrupted or deeply incised medially (Figs 12.13–18). Female usually with uninterrupted pale postocular band (Fig. 12.3) 3

2 Body with pale markings ivory; tergum 2 of males and workers usually with a pair of ferruginous blotches (Fig. 12.10). Female: lower gena black (Fig. 12.1) or with small pale spot whose (anteroposterior) width is less than 1.5x mid ocellar diameter. Male: at least flagellomeres VII-X with one tyloid (Fig. 12.4). Mostly subarctic and high boreal zones, rarely further south .... 86. ***D. norwegica*** (Fabricius)

- Body with pale markings yellow; tergum 2 never with ferruginous markings (Fig. 12.12). Female: lower gena with larger pale spot whose width is greater than 1.5x mid ocellar diameter (Fig. C85.1). Male: at least flagellomeres VII-X with two tyloids (Fig. 12.5) ..... 85. ***D. norvegicoides*** (Sladen)

3 Pronotum striate in ventral corner (Fig. 12.6). Terga 1–3 essentially black, without pale apical fasciae but tergum 3 usually with pale lateral spots (Figs 12.13–14; exceptionally terga 1 and/or 3 fasciate). Hind tibia black, at most with small pale spots near base and apex (Fig. C84.1). Male: apex of sternum 7 with a pair of pointed teeth (Fig. 12.7). Large species (fore wing length 11–18 mm) with ivory markings ..... 84. ***D. maculata*** (L.)

- Pronotum not striate in ventral corner. Terga 1–3 with pale apical fasciae (Figs 12.15–16, 12.18), in male sometimes evanescent or absent on terga 1 and 2 (Fig. 12.17). Outer surface of hind tibia largely pale. Male: apex of sternum 7 rounded, lacking teeth. Smaller species (fore wing length 9–14 mm) with yellow or ivory markings 4

4 Body with pale markings ivory* (Figs 12.16–18). Ocular sinus predominantly black, the black area extending to lower margin of sinus (Fig. 12.8). Flagellum black; apical flagellomeres of male without tyloids (but flagellomere XI sometimes with one tyloid). No worker caste (social parasite); female fore wing length 13.0–14.0 mm ..... 82. ***D. adulterina*** (du Buysson)

- Body with pale markings yellow (Fig. 12.15). Ocular sinus predominantly pale (Fig. 12.9) except in some subarctic specimens. Flagellum yellow ventrally; apical flagellomeres of male with two tyloids each (similar to Fig. 12.5). Worker caste present; female fore wing length usually 9.0–12.0 mm .... 83. ***D. arenaria*** (Fabricius)

*Note. In *D. adulterina* (especially queens) a yellow form occurs very rarely (this form is more common in western North America). The other characters given in this couplet will distinguish such specimens from *D. arenaria*.

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13. Key to eastern Nearctic *Vespula* species

Notes. Species groups according to Carpenter (1987). Extralimital taxon in brackets.

1 Body with pale markings ivory ..... *V. rufa*-group, in part 2

\- Body with pale markings yellow 3

2 Black markings more or less extensively replaced with ferruginous on terga 1 and 2 (Figs 13.33–34, 13.57, 13.68; ferruginous areas sometimes small in queens); tergum 1 with a pair of enclosed ivory basal spots and a broad, uninterrupted, apical fascia. Mostly in subarctic and high boreal zones, extremely rare further south ..... 95. ***V. rufa*** (L.)

\- Black markings not replaced with ferruginous; tergum 1 without pale basal spots, its pale apical fascia narrow and interrupted medially, or absent (Figs 13.35, 13.58, 13.69) ..... 90. ***V. consobrina*** (de Saussure)

3 Scutum with a pair of paramedian longitudinal yellow stripes extending along almost its whole length (Fig. 13.1). Metasomal pattern distinctive: queens with extremely reduced black markings (Fig. 13.56); tergum 2 of workers and males with an additional, discal yellow fascia (interrupted medially) in addition to apical fascia (Figs 13.32, 13.67) (ON: adventitious; eastern U.S.) ..... *V. squamosa*-group: 96. ***V. squamosa*** (Drury)

\- Scutum black, sometimes with a pair of small yellow spots in posterior half (Fig. C91.4). Metasoma always with well developed black pattern, tergum 2 lacking additional discal fascia 4

4 Female (queens and workers): occipital carina absent ventrally; black band between corona and ocular sinus broad (at least 2x mid ocellar diameter), parallel-sided or widening dorsally (Figs 13.3, 13.8–9); black base of tergum 1 with a pair of well defined yellow spots broadly removed from apical fascia (Figs 13.36–38). Male: dorsal surface of tergum 7 straight in profile, not depressed apically (Fig. 13.4); flagellum moderately long, flagellomere II 1.4–1.5x as long as broad ..... *V. rufa*-group, in part 5

\- Female: occipital carina continuous to base of mandible (Fig. 13.2); black band between corona and ocular sinus usually narrow dorsally (Figs 13.12, 13.14; width at most one mid ocellar diameter) or interrupted, if broad (*V. vulgaris*, Fig. 13.13) then black mark of tergum 1 not (or barely) enclosing yellow spots (Figs 13.40–43, 13 62). Male: tergum 7 with apical depression behind median slope, step or overhang (Figs 13.27–29); flagellum very long, flagellomere II 1.9–2.1x as long as broad ..... *V. vulgaris*-group 7

5 Metasomal terga beyond tergum 1 very sparsely haired and hairs short, often virtually bare (Fig. 13.6). Worker: black discal spot(s) of clypeus small, not connected to subantennal spot (Fig. 13.3). Queen: yellow apical fascia of tergum 2 narrow, evenly concave anteriorly; terga 4 and 5 with free black lateral spots; the spots at most medially close to black basal mark (Fig. 13.59). Male: clypeal disc entirely yellow or with three small black spots ..... 97. ***V. vidua*** (de Saussure)

\- Metasomal terga conspicuously haired, the hairs longer and more numerous (Fig. 13.7). Worker: black clypeal spot large, connected to subantennal spot (Fig. 13.9). Queen: either yellow apical fascia of tergum 2 very wide laterally and abruptly narrowed medially (Fig. 13.60), or terga 4 and 5 lacking free black lateral spots (Fig. 13.61; rarely with free lateral spots only narrowly separated from black basal mark on both sides: Fig. C88.2). Male: clypeal disc with one elongate irregular spot usually extending to dorsal and/or ventral margin of clypeus 6

6 Hind tibia with long erect black hairs on at least upper half of outer surface (Fig. 13.5). Queen: tergum 2 with yellow apical fascia very wide laterally, abruptly narrowed medially; terga 3–5 with free or almost free black lateral spots (Fig. 13.60); clypeal apex with teeth strongly produced and slightly curved outward (Fig. 13.8). Male: digitus with long, black, anteriorly directed lobe ventrally (Fig. 13.10). No worker caste (social parasite); female fore wing length 12–13 mm ..... 89. ***V. austriaca*** (Panzer)

\- Hind tibia usually without long erect black hairs, rarely with a few hairs dorsally near base. Queen: tergum 2 with yellow apical fascia narrow throughout; terga 2–5 usually with more or less enclosed yellow spots in black area (Fig. 13.61); clypeal apex with teeth less produced (Fig. 13.9). Male: digitus with short, brown, anteriorly directed lobe ventrally (Fig. 13.11); Worker caste present; female fore wing length usually 8.5–10 mm ..... 88. ***V. acadica*** (Sladen)

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7 Female (queens and workers; six metasomal segments) 8

- Male (seven metasomal segments) 12

8 Eye margined with yellow dorsally (Fig. 13.12), yellow eye loop rarely narrowly interrupted (ON: adventitious; western Nearctic) ..... [94. *V. pensylvanica* (de Saussure)]

- Eye margined with black dorsally; yellow eye loop absent (e.g., Figs 13.13–14) 9

9 Black band between corona and ocular sinus broad (at least 2x mid ocellar diameter), its outer margin convex to almost straight (Fig. 13.13). Yellow postocular band either interrupted (Fig. 13.15), distinctly narrowed near middle or enclosing black spot. Propodeum entirely black* ..... 98. ***V. vulgaris*** (L.)

- Black band between corona and ocular sinus narrow (at most 1.5x mid ocellar diameter, exceptionally up to 2x mid ocellar diameter), sometimes interrupted, its outer margin almost always concave or indented (Fig. 13.14). Yellow postocular band complete, neither distinctly narrowed nor with black spot near middle (Fig. 13.16). Worker: propodeum with yellow lateral spots (e.g., Figs 13.16, 13.19) except in some *V. maculifrons* 10

  * Note. According to Eck (1996) all three characters mentioned here may be absent in extreme xanthic forms of *V. vulgaris*. Such specimens appear to occur mostly in the western part of its range and not in the area covered by this key (nevertheless, Eck mentions one aberrant series from Erie, PA). All specimens examined by us key properly through this couplet.

10 Tergum 1 with anchor-shaped black medial mark or sometimes with black basal mark enclosing a pair of transverse yellow spots (Figs 13.44–46, 13.66); the anchor-shaped mark at least twice as wide as long, very narrow at base (width ca. one mid ocellar diameter, rarely up to 2x mid ocellar diameter)..... 93. ***V. maculifrons*** (du Buysson)

- Tergum 1 with either diamond-shaped, arrow-shaped, or pentagonal black basal mark (Figs 13.47–51, 13.54–55, 13.64–65) or with zigzagged basal area (Figs 13.52–53, 13.63); black basal mark less than twice as wide as long and/or wider at base (width over 3x mid ocellar diameter) 11

11 Worker: tergum 1 with black medial mark diamond-shaped to arrow-shaped (Figs 13.48–51), always narrowed at base with basal width less than 3x mid ocellar diameter; pronotal lobes, scutum, upper mesopleuron behind scrobal furrow and lower mesopleuron never marked with yellow (as in Fig. 13.16). Queen: tergum 1 with yellow apical fascia broadly attaining summit (Fig. 13.65). Worker and queen: third mandibular tooth* with margin distinctly concave (Fig. 13.17)..... 92. ***V. germanica*** (Fabricius)

- Worker: tergum 1 with black medial mark arrow-shaped to broadly pentagonal, rarely merely zigzagged (Figs 13.52–55), its base varying from not narrowed at all to strongly narrowed; if base of black mark narrowed then yellow spots present on one or more of the following (Fig. 13.19): pronotal lobes, scutum, upper mesopleuron behind scrobal furrow or lower mesopleuron. Queen: tergum 1 with yellow apical fascia not attaining summit (Fig. 13.63). Worker and queen: third mandibular tooth with margin nearly straight* (Fig. 13.18) ..... 91. ***V. flavopilosa*** Jacobson

  * Note. The difference between the two states is subtle and may prove difficult for the inexperienced user. In worn specimens the original shape of the mandible is difficult to assess.

12 Aedeagus with apical portion inflated and strongly convex ventrally (posterior view), its apical margin with distinct dorsomedial emargination (Fig. 13.20). Tergum 1 with diamond-shaped black mark slightly constricted at base (Figs 13.75–76) 13

- Aedeagus with apical portion simple, more or less flat ventrally, its dorsoapical margin not emarginate (Fig. 13.21). Tergum 1 without diamond-shaped black mark, sometimes with pentagonal mark (not constricted at base) or with anchor-shaped mark strongly constricted at base (Figs 13.73–74, 13.77–78) 14

13 Eye margined with black dorsally, never with yellow spot near eye margin (Fig. 13.22). Black subantennal mark lacking deep dorsal emarginations or pair of yellow spots (rarely with single median spot, Fig. 13.22). Tergum 7 with sparse short, semi-erect pubescence below apical margin (Fig. 13.20). Aedeagus with small expansion just basal to apical inflated part (Fig. 13.24)..... 92. ***V. germanica*** (Fabricius)

- Eye usually margined with yellow dorsally (similar to Fig. 13.12); yellow eye loop present but usually more or less broadly interrupted; eye sometimes margined with black dorsally, but then often with small yellow spot near eye margin. Black subantennal mark almost always with deep dorsal emarginations (sometimes coalescent ventrally) or pair of yellow spots (Fig. 13.23). Tergum 7 with dense, relatively long, semi-erect pubescence below apical margin (Fig. 13.26). Aedeagus slender basal to apical inflated portion (Fig. 13.25) (western Nearctic, adventitious ON) ....[94. *V. pensylvanica* (de Saussure)]

14 Tergum 7 with an abrupt, step-like apical depression (Figs 13.28–29, showing extremes); apical emargination of sternum 7 with bevelled margin and small median projection (Fig. 13.30). Tergum 1 usually either with an anchor-shaped black mark (Fig. 13.77) or black basal area with more or less enclosed yellow spots (similar to Fig. 13.44), rarely with plain black basal area (Fig. 13.78)..... .....93. ***V. maculifrons*** (du Buysson)

- Tergum 7 gradually sloping towards apical depression (Fig. 13.27); apical emargination of sternum 7 at most minutely bevelled and lacking medial projection (Fig. 13.31). Tergum 1 neither with anchor-shaped black basal mark nor with black basal area enclosing yellow spots (Figs 13.73–74).....15

15 Black band between corona and ocular sinus broad (at least 2x mid ocellar diameter), its outer margin convex to almost straight (as in Fig. 13.13) .....98. ***V. vulgaris*** (L.)

- Black band between corona and ocular sinus narrow (at most one mid ocellar diameter), its outer margin concave or indented (as in Fig. 13.14) .....91. ***V. flavopilosa*** Jacobson

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C. Taxonomic treatment

Family Vespidae

Five of the six recognised subfamilies occur in the Nearctic (the social Stenogastrinae are Oriental). The Euparagiinae and Masarinae (pollen wasps) have a western distribution (the single record of Masarinae from Ontario is probably due to accidental introduction). The three subfamilies that are indigenous to the northeast are the Eumeninae (mason or potter wasps), Polistinae (paper wasps) and Vespinae (yellowjackets and hornets).

REFERENCES. – Brothers and Finnamore, 1993 (key to Vespoidea families and subfamilies); Carpenter, 1981 (key to Vespidae subfamilies and tribes); van der Vecht and Carpenter, 1990 (World catalogue of genera); Krombein, 1979 (catalogue of North American species).

Subfamily Eumeninae (mason or potter wasps)

The subfamily includes 29 genera in America north of Mexico (Carpenter 2004*a*), 13 of which occur in the northeast.

REFERENCES. – Carpenter, 2004*a* (key to Nearctic genera), 1986*a* (checklist of World genera); Menke and Stange, 1986 (update to Carpenter and Cumming's, 1985 key); Carpenter and Cumming, 1985 (key to Nearctic genera); Parker, 1966 (key to Nearctic genera).

Ancistrocerus Wesmael

This genus has a primarily Holarctic distribution. Previous authors recognised 20 species in the Nearctic region (Krombein 1979, Rodríguez-Palafox 1996, Buck *et al*. 2006). The taxonomy of the genus is difficult, with some species still undescribed and others currently inappropriately treated at the subspecies level. We recognise 14 species from the northeast.

REFERENCES. – Bequaert, 1944*a* (revision of Nearctic species, key); Gusenleitner, 1995 (key to *A. parietum*-group).

TAXONOMY OF *ANCISTROCERUS CATSKILL* AND RELATED SPECIES. The most recent edition of the Nearctic Hymenoptera catalogue (Krombein 1979) recognizes three subspecies of *A. catskill*: *A. c. albophaleratus*, *A. c. halophilus* and the nominate subspecies. The three forms show distinct differences in colouration but are morphologically nearly identical. The range of the nominate subspecies broadly overlaps with both of the other subspecies (*A. c. halophilus* is western and will not be considered here). The two eastern subspecies are traditionally separated on the colour of their pale markings (ivory in *A. c. albophaleratus*, bright yellow in the nominate subspecies). Originally, the three subspecies were described as different species (still recognized by Bequaert 1925) but later they were reduced to subspecies (Bequaert 1944*a*). Krombein (1967) first observed that both yellow and ivory specimens emerged from the same nests and proposed the synonymy of *albophaleratus* with *catskill* (synonymy not followed by Krombein 1979).

A careful examination of the *A. catskill* complex shows that it is comprised of at least four species in the eastern Nearctic (plus one additional species from western Canada). Further species will likely be recognised from other areas of the wide range of "*A. catskill*". Based on two new characters (cephalic foveae and wing scale at the base of the costa), which have not previously been used to diagnose species in the genus, the eastern species of the *A. catskill* complex can be divided into two groups. Each group includes forms that are marked with either bright yellow or ivory. In typical *A. catskill*, in *Ancistrocerus* sp. A, and in the western *A. spilogaster* the cephalic foveae are very closely approximated and more or less fused (Fig. B3.12; a thin median septum between the foveae is usually visible; rarely the septum is thick). In contrast, the cephalic foveae of most Eumeninae are paired and clearly separated by a plateau-like, horizontal area of variable width (e.g., Figs A4.2, A4.7–10, B8.3–5). This is also true for *A. albophaleratus*, *Ancistrocerus* sp. B, and the remainder of the eastern Nearctic species of the genus (Fig. B3.13). Secondly, in *A. catskill*, *Ancistrocerus* sp. A. and *A. spilogaster* the costal scale (i.e., the scale-like elevation at the base of the costa of the fore wing) is more produced than in other species (its outline is strongly convex in anterolateral view; its rim is acute in lateral view; its medial process is more salient in posterolateral view; Fig. B3.10). In *A. albophaleratus* and *Ancistrocerus* sp. B this scale is slightly convex in anteroventral view, its rim is more rounded and its medial process not salient (Fig. B3.11). Another species with separated cephalic foveae occurs in western Canada, but differs from similar eastern species by having a convex wing scale. The species pairs *A. catskill*/sp. A and *A. albophaleratus*/sp. B differ from each other by the extent of pale markings in the female (see key; at present no characters are known that will separate males). With the exception of *Ancistrocerus* sp. A (marked with ivory), all species occur in a bright yellow and in an ivory colour form.

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1. *Ancistrocerus adiabatus* (de Saussure, 1852)

Figs A4.11; B3.17, 20, 23, 25, 32, 49, 50; C1.1–7.

SPECIES RECOGNITION. This species and *A. albolacteus* are distinguished from the species of the *A. catskill*-complex by the more slender mesosoma with scutum and scutellum distinctly flattened dorsally in females. Differences between *A. adiabatus* and *A. albolacteus* are discussed under the latter. *Ancistrocerus adiabatus* has relatively extensive yellow markings including a complete yellow metanotal band (usually absent in males) and a yellow ventral surface of the flagellum in both sexes (sometimes obscure in females), but it lacks pale markings on the propodeum (present in females of *A. catskill* and *A. lutonidus*) on the parategula (often present in females of *A. catskill*), and on female tergum 6 (present in *Ancistrocerus* sp. A).

VARIATION. Fore wing length 5.0–7.0 mm (♂♂), 6.5–9.5 mm (♀♀). Pale markings usually bright yellow, in some northern males slightly pale. Female clypeus usually with a pair of dorsal and a pair of ventral spots (very rarely ventral ones absent), the spots usually confluent laterally and often ventrally as well; one xanthic female from St. John, NB (CNCI) was examined with clypeus almost entirely yellow except for the edges and a narrow black median line extending from base to middle of disc. Interantennal spot of male rarely extended to clypeal margin along interantennal carina. Yellow spot along inner orbit of male rarely interrupted opposite antenna. Yellow spot between inner orbit and antennal socket of female rarely absent. Spot on upper mesopleuron well developed in female, usually present (small or large) in male, rarely absent. Tegula exceptionally without pale markings in male. Pair of pale scutellar spots well developed in female; usually small in male, exceptionally absent. Metanotal band rarely interrupted medially in female (most of these specimens are intermediate with regard to the yellow colour form of *A. albophaleratus* and are tentatively identified as *A. adiabatus*); metanotum usually completely black or with irregular yellow markings in male, rarely with a complete band. Metasomal terga 1–(4)5 (female) or 1–(5)6 (male) fasciate (the more melanic colour frequently induced by stylopization). Female sternum 1 with more or less developed apical fascia, sternum 2 and usually 3 with complete apical fascia, the latter usually interrupted laterally, rarely reduced to lateral spots; sternum 4 usually with apicolateral spots, sometimes with laterally interrupted fascia, rarely with complete fascia; sternum 5 usually with apicolateral spots and/or median spot, rarely lacking yellow markings. In the male sterna 1–6 often with more or less complete apical fascia, often obscure on sternum 1 and sometimes on posterior sterna. In melanic specimens at least sternum 2 with complete yellow fascia and sterna 3 and 4 with apicolateral spots.

DISTRIBUTION. Transcontinental in Canada and the U.S. (Krombein 1979). We have examined specimens from every Canadian province except NF/LB and AB. The western ssp. *cytainus* (Cameron, 1906) ranges from CO to OR and CA. The former ssp. *albolacteus* is tentatively treated as a species here (see below).

BIOLOGY. Breeds in borings in twigs, stems and wood, empty insect galls and sawfly cocoons, old mud-dauber nests, and rubber tubing. Cell partitions and closing plugs are made of mud. Prey consists of caterpillars of Amphisbatidae, Oecophoridae, Gelechiidae, Tortricidae and Coleophoridae (Krombein 1967, 1979).

2. *Ancistrocerus albolacteus* Bequaert, 1944 **stat. n.**

Figs B3.51; C2.1–5.

TAXONOMY. *Ancistrocerus albolacteus* was described as a variety or subspecies of *A. adiabatus*. Morphologically the two species are almost identical except for the evenly micropubescent sternum 2 of the male (devoid of micropubescence medially in *A. adiabatus*). The sympatric occurrence of these taxa argues for species status for *A. albolacteus*. Both species occur in BC, AB, QC and NB but only in one case have we seen specimens from one and the same locality (6 ♂♂ *A. adiabatus*, 1 ♂, *A. albolacteus*, NB, Kouchibouguac Natl. Pk., Jul/Aug 1977, CNCI).

SPECIES RECOGNITION. This species has more restricted pale markings than *A. adiabatus* (especially the female), and the markings are usually paler (ivory instead of bright yellow). However some males of *A. albolacteus* from British Columbia have quite extensive pale markings similar to *A. adiabatus* and in rare cases the markings can be yellow. However, the pubescence of male sternum 2 and the extent and colour of female markings are reliable diagnostic characters (see key).

VARIATION. Fore wing length 5.0–7.5 mm (♂♂), 6.0–8.5 mm (♀♀). Pale markings of body usually ivory, yellow in some males from British Columbia (e.g., 1 ♂, BC, Saanich Distr., CNCI). Female clypeus usually black, sometimes with a pair of small ventral spots. Male clypeus sometimes black dorsally, in one aberrant specimen mostly black except for a pair of confluent apical spots (1 ♂, BC, Kaslo; CNCI). Yellow spot along inner

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orbit of male usually interrupted opposite antenna, sometimes entire or restricted to level below antenna. Yellow spot between inner orbit and antennal socket of female sometimes absent. Spot on upper mesopleuron small or absent in female, sometimes present in males of yellow colour form. Tegula of male usually with restricted pale markings, sometimes more extensively marked or entirely black. Pair of pale scutellar spots absent or minute in female; rarely present in male (mostly in yellow colour form). Metanotum black or with small irregular pale spots, rarely with a pair of large spots or complete transverse band; metanotum exceptionally with pale spots in male. Metasomal terga 1–4 (female) or 1–(3)4(6) (male) fasciate, in female fascia of tergum 4 sometimes evanescent. Female sternum 2 with complete apical fascia; sternum 3 with pale apicolateral spots, rarely more or less connected by evanescent fascia. In male usually at least sternum 2 with apical fascia (rarely evanescent medially) and sternum 3 with apicolateral spots, in xanthic specimens sterna 1–6 with more or less complete apical fasciae (usually obscure on sternum 1 and on posterior sterna).

DISTRIBUTION. Canada: QC to BC (Krombein 1979) newly recorded from NB, LB and NT. We have not seen specimens or published records from ON, MB and SK but it must be assumed that the species occurs there. Western U.S.: AK, WA, OR, ID, MT, SD, CO and UT (Krombein 1979).

BIOLOGY. Unknown.

3. *Ancistrocerus albophaleratus* (de Saussure, 1855) **sp. restit.**

Figs A4.12; B2.15, 38; B3.11, 13, 19, 22, 24, 27, 29, 31, 33, 47, 48; C1.1–11.

SPECIES RECOGNITION. Females of most other species of the *A. adiabatus*-group differ from *A. albophaleratus* females by the presence of pale markings on the propodeum (*A. catskill*, *A. lutonidus*, rarely *Ancistrocerus* sp. A) or tergum 6 (*A. lutonidus*, *A. waldenii*, *Ancistrocerus* sp. A; exceptionally absent in all three species). Furthermore, females of *A. catskill*, *A. adiabatus* and *Ancistrocerus* sp. A very rarely lack the pair of ventral spots of the clypeus (absent in most *A. albophaleratus*, especially more northern specimens; dorsal spots often absent as well and then clypeus completely black). Both male and female of *A. adiabatus* have a more slender mesosoma and the female has a more flattened scutum and scutellum. Additionally the flagellum of *A. adiabatus* is usually extensively yellow beneath (usually dark except apically in *A. albophaleratus*). However, some males of *A. albophaleratus* with yellow body markings and yellow lower surface of the flagellum can only be separated from *A. adiabatus* by genitalic characters (see key). Males of other species differ by the deeply emarginate clypeus (*A. waldenii*) or the prominent costal scale (*A. lutonidus*, *A. catskill*, *Ancistrocerus* sp. A).

VARIATION. Fore wing length 5.0–8.0 mm (♂♂), 6.0–10.0 mm (♀♀). Pale markings of body ivory to bright yellow. In Canada the bright yellow colour form is restricted to southern Ontario and British Columbia; in the eastern U.S. it is common. Intermediate, pale yellow specimens are commonly found among males; markings of the metasoma are usually paler than those of the head. Female clypeus usually with a pair of pale dorsal spots, sometimes ventral spots also present (lateral and ventral spots very rarely confluent in ivory-marked specimens, more commonly so in yellow-marked specimens); in northern specimens clypeus frequently completely black, in rare cases only small ventral spots present. Pale spot along inner orbit of male sometimes interrupted opposite antenna or reduced to a small spot just above clypeus. Pale spot between inner orbit and antennal socket of female usually absent in ivory colour form, usually present in yellow colour form. Female scape very variably coloured: usually predominantly black with brown ventral stripe that is often reduced to a narrow posterior line or a small distal spot; in yellow-marked and a few ivory-marked specimens scape with broad yellow or ivory ventral stripe. Pedicel of male usually yellow beneath, rarely dark. Male flagellum usually only yellowish beneath on apical and basal segments, rarely dusky yellow on middle segments, in yellow colour form sometimes lower surface distinctly yellow as in *A. adiabatus*. Pronotal band narrow, in male the lateral portions exceptionally absent. Spot on upper mesopleuron varying from well-developed to absent in female, always absent in male. Tegula rarely without pale markings in male. Parategula black even in the most xanthic forms. Pale scutellar spots large to small in female (absent in some western specimens); present or absent and usually small in male. Metanotum almost always black, in ivory-marked females rarely, in yellow marked ones occasionally with a pair of pale spots, never with a complete transverse band. Propodeum without trace of pale markings, even in yellow colour form. Mid and hind tibiae always marked with pale; pale spot embracing dorsal midline (absent on hind tibia and attaining it only on mid tibia in 1 ♀, QC, Laniel, CNCI), in xanthic specimens of ivory colour form often entire base of tibia pale, in yellow-marked specimens tibia largely to completely yellow. Metasomal terga 1–4

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or 5 fasciate in female (fascia of tergum 5 often usually abbreviated laterally; tergum 6 with pale spot in 1 ♀, ON, St. Lawrence Is. Natl. Pk., CNCI); terga 1–(4)6 fasciate in male. Female sterna 1 and 2 usually with complete apical fascia (fascia of sternum 1 often obscure or absent); fascia of sternum 2 complete (rarely interrupted in western specimens); sternum 3 usually with laterally interrupted fascia but at least lateral and small median spots present (only lateral ones present in some western specimens and 1 stylopized female from ON, Thunder Bay Distr., 25 km W jct. Hwys 11 and 802S, ROME), fascia very rarely complete in ivory colour form, usually complete or to subinterrupted laterally in yellow colour form); sternum 4 with apicolateral spots (rarely absent in western specimens), yellow-marked specimens sometimes also with more or less developed median spot; sternum 5 exceptionally with apicolateral spots in ivory colour form (1 ♀, QC, Laniel, CNCI), rarely with laterally interrupted fascia in yellow colour form. Male sternum 1 usually with more or less developed apical fascia, sternum 2 always with complete fascia; sternum 3 with complete or rarely laterally interrupted fascia; sternum 4 with apicolateral spots or interrupted fascia, rarely with complete fascia; sternum 5 black, sometimes with apicolateral and/or median spots or, rarely, apical fascia; sternum 6 black, rarely with apical fascia; pale markings of sterna 4–6 often evanescent.

DISTRIBUTION. Canada: transcontinental; we have seen material from all provinces and territories except NU. Northern U.S. including AK, in mountains south to NC, NM, AZ (Krombein 1979). The distribution of *A. albophaleratus* in the U.S. needs to be re-examined due to confusion with related species.

BIOLOGY. Previous biological data need to be treated with caution because of confusion with other species. *Ancistrocerus albophaleratus* has been recorded to nest in borings in wood, hollow stems and abandoned galls using mud for nest partitions and closing plugs (Krombein 1967, 1979). Fye (1965) reared the species from trap nests; his identifications are confirmed here (material examined in CNCI). Further specimens reared from trap nests were examined by the authors (2 ♀♀, ON, Wellington Co., Morriston, DEBU). One of us (S.A.M.) observed a female at a mud nest made in the crevice of a rock near Wiarton, Bruce or Grey Co., Ontario (Figs 3.10–11). Fye (1965) recorded Tortricidae, Gelechiidae, "Noctuidae" (in the traditional sense) and Geometridae as prey. Other prey records given in Krombein (1979) (Oecophoridae, Pyralidae (Phycitinae), Pterophoridae) need to be revisited due to confusion with *A. catskill*.

4. *Ancistrocerus antilope* (Panzer, 1798)

Figs B3.3, 5, 37; C4.1–7.

SPECIES RECOGNITION. Similar to the rare *A. spinolae*, from which it can be separated by the characters used in the key (see also under that species). *Ancistrocerus antilope* and *A. spinolae* are the only species in the genus with a strongly developed ventrolateral ridge on the propodeum.

VARIATION. Fore wing length 7–10 mm (♂♂), 8–12.5 mm (♀♀). Female clypeus black with a pair of dorsal and almost always with a pair of smaller ventral yellow spots. Interantennal spot of male sometimes divided, rarely absent. Mesopleuron with a yellow dorsal spot, rarely absent in male. Scutellum with a pair of yellow spots, sometimes absent in male. Terga 1–4 in female and 1–6 in male fasciate; tergum 5 in female often with a transverse apicomedial spot; fascia of tergum 6 in male not always extending to lateral margin. Sternum 2 and 3 fasciate in female, sometimes more or less interrupted on sternum 3; sternum 4 and rarely 5 with posterolateral spots; male sterna 2–6 fasciate.

DISTRIBUTION. Canada: all provinces. Entire continental U.S. excluding AK, AL, FL. Palaearctic region from Europe to Siberia (Krombein 1979). Three subspecies have been described from the western Nearctic: ssp. *allegrus* Bequaert, 1943 (CO, OR, CA), ssp. *navajo* Bequaert, 1925 (MT to NM, CA), and ssp. *spenceri* Bequaert, 1943 (BC).

BIOLOGY. Nests in borings in wood, in stems of sumac and elder, and in abandoned mud-dauber nests. Closing plugs and cell partitions are made of mud. Preys on caterpillars of Oecophoridae, Amphisbatidae, Gelechiidae, Tortricidae, Pyralidae and "Noctuidae" (in the traditional sense) (Krombein 1967, 1979).

5. *Ancistrocerus campestris* (de Saussure, 1852)

Figs B3.1, 36; C5.1–5.

SPECIES RECOGNITION. *Ancistrocerus campestris* is easily recognised by the combination of two characters: sternum 2 with median furrow near base and pronotum without distinct carina.

VARIATION. Fore wing length 6.5–9 mm (♂♂), 9–11 mm (♀♀). Hind margin of tergum 2 slightly thickened in female, not reflexed; in male moderately to very strongly thickened and reflexed. Punctation in preapical area of tergum 2 moderate to coarse in female, in male coarse to extremely coarse with aciculate interspaces. Female clypeus yellow with a black discal spot that is usually

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connected by a narrow stripe to the dorsal margin of the clypeus; ventrolateral corners of discal spot rarely extending to clypeal margin. Postocular spot sometimes very small in male. Scutellum with a pair of well-developed yellow spots, sometimes small in male. Metanotal band complete, in male exceptionally narrowly interrupted at middle. Terga 1–3 fasciate; fascia of tergum 3 rarely absent in female; in male tergum 4 often fasciate as well. Lateral forward extension of apical fascia of tergum 1 usually broad, sometimes strongly extended towards middle. Tergum 2 in two examined males with a pair of small yellow discal spots. Sternum 2 fasciate; sternum 3 usually with posterolateral yellow spots, these sometimes missing, rarely with interrupted or complete fascia.

DISTRIBUTION. Canada: ON. Eastern U.S.: NH south to FL, west to MN, SD, KS, TX (Bequaert 1944*a*, Krombein 1979).

BIOLOGY. Nests in borings in wood, sumac stems and old mud dauber nests. Nest partitions and closing plugs are made of mud. Prey consists of caterpillars of Amphisbatidae, and Gelechiidae (Krombein 1967, 1979).

6. *Ancistrocerus catskill* (de Saussure, 1853)

Figs B3.10, 12, 14, 42; C6.1–9.

SPECIES RECOGNITION. This species is similar to *Ancistrocerus* sp. A and *A. lutonidus* (diagnostic characters discussed under the latter two species). The male of *A. catskill* resembles *A. adiabatus* in having the flagellum extensively yellow beneath but differs from that species by the stockier build (i.e., mesosoma less elongate).

VARIATION. Fore wing length 5.5–7.5 mm (♂♂), 7.5–10.0 mm (♀♀). Pale markings of body bright yellow to ivory. In pale forms head markings, especially clypeus, usually more yellowish than metasomal markings. The ivory colour form occurs mostly in northern localities; in Ontario it is usually found from about 45°N latitude northward. Female clypeus usually with a pair of dorsal and a pair of ventral spots (very rarely ventral or dorsal ones absent); spots often coalescent laterally or ventrally, rarely both laterally and ventrally. Pale spot of mandible rarely absent in female. Yellow spot along inner orbit of male sometimes interrupted opposite antenna or reduced to a small spot just above clypeus. Pronotal band sometimes interrupted laterally, in male rarely lateral portions absent. Spot on upper mesopleuron present in female, usually absent or very small in male. Parategula often marked with yellow in female, rarely in male. Pair of pale scutellar spots well developed in female; often small in male, sometimes absent. Metanotal band rarely interrupted medially in female, very rarely reduced to small, irregular evanescent spots; metanotum usually completely black in male, sometimes with small, irregular evanescent spots, rarely with a complete band. Propodeum in female with a pair of more or less extensive, elongate, pale, lateral spots (sometimes interrupted near pronotal angle); exceptionally absent in yellow colour form (1 ♀, ON, Ottawa area, CNCI); male propodeum black, rarely with minute evanescent spot near pronotal angle. Metasomal terga 1–(4)5 (female) or 1–(4)6 (male) fasciate, tergum 6 of female rarely with a pale spot that is usually small and evanescent. Tergum 2 in female exceptionally with a pair of small discal spots (1 ♀, Quebec: Cap Rouge, CNCI; 1 ♀, New York, AMNH; 1 ♀, North Carolina, CNCI). Female sterna 1 and 2 usually with complete apical fascia; fascia of sternum 1 sometimes obscure or completely absent (especially in ivory colour form), fascia of sternum 2 sometimes reduced to lateral spots; sternum 3 usually with apicolateral spots, sometimes with laterally interrupted fascia, very rarely with complete fascia; sternum 4 usually with apicolateral spots, rarely absent. Male sternum 1 usually with more or less developed apical fascia, sternum 2 always with complete fascia; sternum 3 with complete or, rarely, laterally interrupted fascia; sterna 4 and 5 with or without complete fascia; sternum 6 black or with apicomedial pale spot.

DISTRIBUTION. Canada: all provinces. Transcontinental in U.S. in Transition and Austral Zones (Bequaert 1944*a*, Krombein 1979). The taxonomic status of populations from British Columbia and the western U.S. requires further investigation. The western ssp. *halophila* Viereck, 1903 occurs west of the Rocky Mts. The former ssp. *albophaleratus* is here reinstated as a good species (see above).

BIOLOGY. Nests in pre-existing borings in wood and twigs, in abandoned mud-dauber nests and deserted burrows of ground-nesting bees (Krombein 1979). Krombein's (1967) trap nest data are apparently based on mixture of *A. catskill* and *A. albophaleratus*. Due to possible confusion with other species in this complex all previous rearing data have to be treated with caution. Data from specimens examined confirm that the species nests in cavities: 6 ♀♀ from Guelph, ON (DEBU) reared from trap nests; 1 ♀ from Fairfield, CT (AMNH) is labelled "wasp makes nest holes in hard cement mortar between bricks". Besides that the species also constructs mud cells that are attached to rocks (1 ♀, "bred from mud cell on stone"; 1 ♂, "from mud cell under stone"; both from W.H. Harrington

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collection, i.e., likely from the Ottawa area; CNCI). In 2005 we collected a multicellular mud nest on a rock at the edge of a river from which 1 ♂ and 5 ♀♀ emerged (Ontario, Fergus; DEBU) (Figs 6.8–9). The lower cells of this nest were located within a small natural cavity of the rock and were completely hidden by other cells on the surface. The outer cells were fully exposed and thus creating the impression that the whole nest was attached to more or less flat rock surface. Fye's (1965) prey records apparently pertain to *A. antilope* (Krombein 1967: 109). Krombein (1967, 1979) mentions Oecophoridae, Pterophoridae, Pyralidae, Tortricidae and Gelechiidae as prey, but his prey records need to be revisited due to confusion with A. *albophaleratus*.

7. *Ancistrocerus gazella* (Panzer, 1798)

Figs B1.15; B2.17; B3.6, 9, 40; C7.1–5.

SPECIES RECOGNITION. This species is very similar to *A. parietum*, with which it shares the extensive yellow markings and somewhat concave sternum 2. Besides characters given in the key *A. gazella* differs from *A. parietum* by the somewhat shorter hairs of the head and mesosoma, the more produced humeral angle, and the minutely roughened and therefore slightly duller longitudinal ridges of the female clypeus (completely polished and glossy in *A. parietum*).

VARIATION. Fore wing length 6–7 mm (♂♂), 6.5–8 mm (♀♀). Humeral angle of pronotum more or less produced; in female usually, in male always produced at least slightly beyond level of anterior margin of pronotum, and in female usually, in male always at least slightly curved outward. Female clypeus usually yellow with a central black spot extending to dorsal margin of clypeus and sometimes ventral margin as well; rarely reduced to just a more or less parallel-sided streak; in dark specimens clypeus black with a pair of large yellow dorsal spots and a smaller pair of ventral spots; ventral spots sometimes absent. Yellow spot along inner orbit elongate or reduced to small spot in male, in female a small spot usually present. Yellow pronotal band occupying approximately anterior 1/3–1/2 of pronotum. Parategula black, often marked with yellow. Pair of yellow scutellar spots usually better developed in female than in male; in female the spots usually very narrowly separated, rarely confluent or more broadly separated from each other. Metanotal band usually very broad in female; narrower in male, sometimes interrupted medially or absent. Metasomal terga 1–5 fasciate, the fascia of tergum 5 usually abbreviated laterally, rarely absent; tergum 6 rarely with a small yellow preapical spot (probably more often present in male). Usually sterna 1–4 or 1–5 fasciate; fascia of sternum 1 sometimes obscure medially; fasciae on sterna 2–5 emarginate or interrupted laterally; fascia of sternum 2 (and 3 in male) always complete, fascia of sternum 3 in female (4 in male) rarely interrupted laterally; fascia of sternum 4 in female (5 in male), if present, usually interrupted laterally; sternum 5 of female, 6 of male sometimes with a small posteromedial yellow spot.

DISTRIBUTION. Canada: Ontario. Eastern U.S.: MA, NY, NJ, DE (Buck *et al*. 2006), newly recorded from MI (photographic record, Bugguide), RI (photographic record, Bugguide), and MD (photographic record, Bugguide). Native to the Palaearctic: Europe to Afghanistan; Northwest Africa, Canary Islands and Madeira; introduced in New Zealand (Dvořák and Castro 2007). *Ancistrocerus gazella* was introduced to the U.S. before 1961 when the first specimen was collected in New York. In Ontario the species was collected for the first time in 1983. Due to confusion with another introduced species, *A. parietum*, the species was not noticed by Nearctic workers before 2005 (Buck *et al*. 2006).

BIOLOGY. The biology of this species is similar to that of *A. parietum* in that it nests in a great variety of natural and man-made cavities such as hollow stems, borings in wood, and holes in brick-and-mortar walls or metal rails (Blüthgen 1961).

8. *Ancistrocerus lutonidus* Bohart, 1974

Figs B3.7, 41; C8.1–4.

SPECIES RECOGNITION. Similar to *A. catskill* but with more extensive yellow markings and body larger in size. The female is unique within the genus in having all of sternum 2 behind the basal groove covered in short, appressed pubescence (absent medially on a larger or smaller patch in other species) and in possessing an evenly and fairly densely haired penultimate segment of the labial palpus (this segment almost bare or with scattered hairs in other species). Furthermore, the cephalic foveae of the female are paired with a distinct horizontal area between them (coalescent in *A. catskill* or, at most, divided by a narrow septum). The male is distinguished from all other species in possessing discal spots on tergum 2 (rarely the spots absent). Besides characters provided in the key the male differs from *A. catskill* by the slightly longer flagellomere XI, the more rounded pronotal angle (distinctly angulate in *A. catskill*) and the more extensive yellow markings on the hind femur (at least in some areas covering more than apical

half; in *A. catskill* usually at most apical fourth yellow, rarely with a dull yellow streak extending to middle of femur).

VARIATION. Fore wing length 7.0–8.0 mm (♂♂), 9.0–10.5 mm (♀♀). Female clypeus entirely yellow, sometimes with a central black spot or a black stripe in basal half extending to dorsal margin of clypeus. Yellow spot of mandible sometimes absent in female. Parategula marked with yellow in female, usually black in male. Pair of yellow scutellar spots very narrowly separated, often fused in female, rarely in male. Propodeum in female with a pair of lateral elongate yellow spots from dorsum to ventral margin, interrupted at level of pronotal angle in some specimens. Metasomal terga 1–5 (female) or 1–6 (male) fasciate, tergum 6 of female almost always with a yellow preapical spot. Fascia of tergum 1 angulately produced forward and often also inward behind transverse suture. Discal spots of tergum 2 rarely connected to apical fascia, rarely missing. Sterna 1–5 (female) or 1–(5)6 (male) with entire apical fasciae. Sternum 2 of male sometimes with a pair of obscure, amber, discal spots.

DISTRIBUTION. Not yet recorded from Canada but due to its occurrence in Buffalo, NY (Bequaert 1944*a*) it is to be expected in southern Ontario. Eastern U.S.: MA to SC, west to WI, IN and TX (Krombein 1979), also recorded from ME and GA by Bequaert (1944*a*).

BIOLOGY. The nest is attached to twigs of low bushes and consists of hardened clay with 6 to over 20 more or less radially arranged brood cells (Krombein 1979).

9. *Ancistrocerus parietum* (Linnaeus, 1758)

Figs B2.19; B3.8, 39; C9.1–5.

SPECIES RECOGNITION. This species is similar to *A. gazella* (diagnostic characters given under that species).

VARIATION. Fore wing length 6.5–8.0 mm (♂♂), 7.5–10.0 mm (♀♀). Humeral angle of pronotum hardly produced in female; in male sometimes produced slightly beyond level of anterior margin of pronotum and more or less curved outward. Female clypeus usually yellow with a central black spot extending to dorsal margin of clypeus, sometimes also extending to ventrolateral margin of each side; rarely clypeus black with a pair of large yellow dorsal spots and a smaller pair of ventral spots. Yellow spot along inner orbit elongate or reduced to small spot in male, in female a small spot usually present. Yellow pronotal band occupying approximately anterior 1/3–2/5 of pronotum. Spot on upper mesopleuron large, small or absent in female; usually absent in male, if present small. Parategula black. Pair of yellow scutellar spots large and usually narrowly separated in female; large, small or absent in male. Metanotum with two or more, irregular, often evanescent spots or completely black. Metasomal terga 1–5 fasciate, tergum 6 of female almost always with a yellow preapical spot. Sterna 1–5 in female 1–(5)6 in male fasciate; fascia of sternum 1 sometimes obscure; fasciae emarginate; fascia of sternum 5 interrupted laterally in female, usually interrupted on 6 and sometimes on 5 in male.

DISTRIBUTION. Canada: ON, QC, newly recorded from NF (photographic record, Bugguide), NS, MB and SK. Eastern U.S.: MA to DC, west to OH and MI (Krombein 1979). Native to Palaearctic: from Europe and Northwest Africa to Manchuria, also Madeira (Gusenleitner 1995). This Palaearctic species was found for the first time in North America in 1916 (NY: Ithaca; cf. Bequaert 1925). The oldest Canadian specimen examined by us was collected in 1917 (QC: 1 ♂, Outremont; LEMQ), a decade earlier than the oldest previously published records from 1928 (QC: "Kamour Co." [= Kamouraska?] and Montreal; cf. Bequaert 1944*a*).

BIOLOGY. Nests in crevices in mortar or rock, tree stumps, and burrows in clay banks. Preys on caterpillars (Tortricidae recorded from Ontario), in Europe rarely also on *Melasoma* (Chrysomelidae) larvae (Krombein 1979).

10. *Ancistrocerus spinolae* (de Saussure, 1855)

Figs B3.4, 38; C10.1–3.

SPECIES RECOGNITION. Structurally this species is very similar to the common and widespread *A. antilope*. The female is easily distinguished from *A. antilope* by the reduced yellow markings (absent from clypeus, mesopleuron, tegula, scutellum, terga 3–5), and strongly infuscated wings. The male is more similar to *A. antilope* in having the wings only moderately infuscated and metasomal terga 3–6 fasciate (after Bequaert 1925; the male of this rare species was not available for examination). Both sexes can be separated from *A. antilope* by the duller surface of the propodeum (see key).

VARIATION. Fore wing length ca. 12.5 mm (♀♀). Apical fascia of tergum 2 sometimes reduced or absent in female (Bequaert 1944*a*). The number of specimens available for study was insufficient to study variation.

DISTRIBUTION. Canada: newly recorded from ON. Eastern U.S.: CT south to FL, west to MI, IL, MO, TX (Krombein 1979).

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BIOLOGY. Nests in borings in wood and old mud-dauber nests. Nest partitions and closing plugs are made of agglutinated sand. Prey consists of caterpillars (Krombein 1967, 1979).

11. *Ancistrocerus unifasciatus* (de Saussure, 1852)

Figs B2.39; B3.2, 34, 35; C11.1–7.

SPECIES RECOGNITION. *Ancistrocerus unifasciatus* is easily recognisable in both sexes. It is the only species of *Ancistrocerus* in the area covered by this Atlas with the following characters: male vertex with a low, impunctate swelling behind the ocelli (vertex strongly punctate in other species); female metasoma black except for yellow apical fascia of tergum 1 (tergum 2 exceptionally with a narrow, irregular apical fascia; in other species at least tergum 2 has a well-developed apical fascia).

VARIATION. Fore wing length 6.5–9 mm (♂♂), 9.5–12 mm (♀♀). Markings of female head orange-yellow to ferruginous. Interantennal spot exceptionally absent in female. Inner orbit often with narrow yellow stripe above clypeus in male, in female often with reddish spot. Female clypeus with a pair of reddish dorsal spots, rarely missing; male clypeus yellow, rarely with a narrow black median stripe extending from base to middle of clypeus, the lower end exceptionally widened to form a black spot. Female mandible black to extensively reddish. Postocular spot sometimes almost completely reduced in male. Pronotal band usually restricted to median 2/5 of pronotum, in female rarely, in male sometimes extending to humeral angle. Mesopleuron rarely with a small orange-yellow dorsal spot in female, exceptionally present in male. Metanotal band usually complete, in male rarely interrupted medially or completely absent. Tergum 1 sometimes more or less reddish along inner margin of lateral forward extension of apical fascia. Tergum 2 rarely with narrow apical fascia in female, in this case preapical area sometimes with yellow interspaces between black punctures. Tergum 3 usually with narrow fascia in male, often also tergum 4. Sternum 1 with more or less yellowish apical margin, sternum 2 with well developed fascia in male, rarely with narrow fascia in female; male sternum 3 with posteroapical yellow spots, rarely absent or with complete fascia, male sternum 4 rarely with small posteroapical spots, as well.

One exceptional male from Point Pelee, Ontario has the clypeus black with a pair of large yellow spots on its dorsal half and pair of small, ill-defined reddish-yellow spots near clypeal apex. The specimen is not stylopized.

DISTRIBUTION. Canada: ON and QC, newly recorded from PE (photographic record: http://bugguide.net/node/view/168543). Eastern U.S. west to IA, KS, TX (Bequaert 1944*a*, Krombein 1979). The ssp. *seminole* Bequaert, 1943 occurs in Florida.

BIOLOGY. Nests in old mud dauber nests (Krombein 1979). While there are several species of Eumeninae (especially in the genus *Ancistrocerus*) that occasionally nest in abandoned mud-dauber nests *A. unifasciatus* appears to have a strong preference for this type of nest site. We recently found the species to be exceptionally abundant around an open barn with an extremely high density of mud-dauber nests (both *Sceliphron* and *Trypoxylon*) attached to the underside of the roof. However, the species also nests occasionally in other cavities. One female was collected while provisioning a nest in a sign made from corrugated plastic with rectangular cells (inner width 4 x 5 mm) near Oakville (Ontario) (S.M. Paiero, University of Guelph). The sign was located in a barn, i.e., in a place where mud dauber nests, the primary nest site of the species, are typically found.

12. *Ancistrocerus waldenii* (Viereck, 1906)

Figs B3.16, 18, 21, 26, 28, 45, 46; C12.1–7.

SPECIES RECOGNITION. The male is unique among the species of the study area for its deeply emarginate clypeal apex (otherwise only found in one Mexican species). The female is very similar to females of *A. albophaleratus* and *Ancistrocerus* sp. A. Additional distinguishing characters include: pale spot between eye margin and antennal socket almost never present (spot present or absent in *A. albophaleratus*, always present in sp. A); clypeus with relatively large dorsal spots (almost always more closely approximated medially than antennal sockets, rarely confluent) and usually without ventral spots; the latter, if present, small, never confluent, and then dorsal spots very large (in sp. A dorsal spots more widely separated medially than antennal sockets; ventral spots always present and sometimes confluent; spots variable in *A. albophaleratus*); scape completely black (in other species at least ventrally or posteriorly with yellow to brown stripe); sternum 5 almost always with pale apical markings (absent in some western specimens; present or absent in sp. A; absent in *A. albophaleratus*); tergum 6 with pale apicomedian spot (according to Bequaert, 1944*a*, rarely absent; absent in *A. albophaleratus*).

VARIATION. Fore wing length 6.0–9.0 mm (♂♂), 8.0–10.0 mm (♀♀). Pale markings of body usually ivory. Two males from Virginia (the only

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specimens from this state examined by the authors) have bright yellow markings (1 ♂, Giles Co., Cascades Recreation Area; 1 ♂, Giles Co., White Rock Recreation Area; both DEBU). Previously, yellow-marked specimens were only known from British Columbia and the western U.S. (ssp. *excavatus* and ssp. *flavidulus*, see below). Female clypeus usually with a pair of dorsal spots only (often absent in western specimens), in xanthic specimens the spots rarely confluent. Yellow spot along inner orbit almost always absent in female (exception: 1 ♀, QC, Luskville, CNCI) present or absent in male, never with spot between inner orbit and antennal socket. Male scape black on posterior portion of ventral surface except rarely in yellow or yellowish specimens where yellow/brown area may extend to posterior margin of scape (1 ♂, VA, Montgomery Co., Pandapas Pond, DEBU). Spot on upper mesopleuron present in female (often absent in western specimens), rarely present and then small in male. Parategula black. Pair of pale scutellar spots almost always confluent or separated by a hair line (in western specimens usually well separated, rarely absent); in male well-developed to absent. Metanotum almost always black, exceptionally (1 ♀, ON, Vineland, DEBU) with a pair of well-developed pale spots. Metasomal terga 1–5 (female) or 1–(5)6 (male) fasciate, tergum 6 of female with pale spot. Female sterna 1–3, sometimes also 4, very rarely 5 with complete apical fascia (on sternum 1 sometimes obscure or completely absent); at least laterally interrupted fascia present on sternum 4 (apicolateral spots only in some western specimens); at least apicolateral spots present on sternum 5 (absent in some western specimens). Male sternum 1 sometimes with more or less developed apical fascia, sterna 2 and 3 with complete fascia; sternum 4 sometimes and 5 very rarely with complete fascia; sternum 6 black or with apicolateral pale spots.

DISTRIBUTION. Transcontinental in Canada (Krombein 1979), recorded from LB by Bequaert (1944*a*) and from YT by Finnamore (1997). We have examined specimens of the typical subspecies from every province and territory in Canada except LB and NU. Northern U.S. including AK, south to VA, MI, IL, SD, CO and NM; the western ssp. *excavatus* Bequaert, 1944, and ssp. *flavidulus* Bequaert, 1944 occur from BC to CA and east to MT, WY, CO, AZ (Krombein 1979).

BIOLOGY. Builds mud nests on walls or rocks or in cavities in mortar. Tortricidae have been recorded as prey of ssp. *flavidulus* (Krombein 1979).

13. *Ancistrocerus* sp. A

Figs B3.15, 43; C13.1–5.

TAXONOMY. See notes on the taxonomy of *A. catskill* and related species on page 106.

SPECIES RECOGNITION. At present the males of this species cannot be separated with confidence from *A. catskill*. The female is similar to *A. albophaleratus* and *A. catskill*. From the former it differs by the following characters (besides those mentioned in the key): pale spot on tergum 6 present (tergum 6 and often 5 completely black in *A. albophaleratus*), sternum 5 often with a pair of apicolateral pale spots (absent in *A. albophaleratus*), clypeus with a pair of spots in ventral half (usually absent in *A. albophaleratus*).

VARIATION (females only). Fore wing length 7.5–10.0 mm. Pale markings of body ivory, those of head and scape rarely distinctly yellowish. Clypeus with a pair of dorsal and a pair of ventral spots, the spots fairly often coalescent ventrally less commonly laterally, rarely both laterally and ventrally. Scape usually with an anterobasal and/or a ventrodistal spot (often confluent), when confluent and well-developed, always with a fairly abrupt narrowing near middle; sometimes scape nearly completely black. Pedicel usually dark beneath, sometimes more or less yellowish. Pronotal band rarely interrupted laterally, in western specimens lateral portions rarely absent. Spot on upper mesopleuron rarely absent. Pair of pale scutellar spots usually large, rarely small (especially in western specimens). Metanotal band usually at least narrowly interrupted medially, sometimes reduced to small, irregular evanescent spots or completely black (the latter only seen in western specimens). Propodeum usually black, rarely with a pair of small, pale spots at (and sometimes below) propodeal angle. Metasomal terga 1–5 fasciate, tergum 6 with a well-developed pale spot. Sternum 1 usually without fascia, if present often indistinct; fascia of sternum 2 usually complete; sternum 3 with apicolateral spots, sometimes with incomplete fascia, rarely with complete fascia; sternum 4 always and 5 sometimes with apicolateral spots, sternum 4 rarely also with apicomedian markings. A rare melanic variety lacks the spot on tergum 6 (1 ♀, QC, Kazabazua, CNCI) and sometimes also pale markings of tergum 5 and sternum 4 (1 ♀, ON, Pukaskwa Natl. Pk., DEBU). It is not clear whether these specimens are conspecific with *Ancistrocerus* sp. A.

DISTRIBUTION. Canada: all provinces and territories except LB, NU. Eastern and northern U.S.: NY, AK, ID and CO (identification of specimens from CO tentative).

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BIOLOGY. A series of specimens from Nyack, NY (AMNH) is labelled "ex *Amphibolips confluentus*". This Cynipidae species causes oak apple galls from which the specimens were apparently reared. One female (NS[?], "N Sawler East", CNCI) is pinned with an unidentified caterpillar.

14. *Ancistrocerus* sp. B

Figs B3.30, 44; C14.1–3.

TAXONOMY. See notes on the taxonomy of *A. catskill* and related species on page 106.

SPECIES RECOGNITION. Males of this species cannot be separated with confidence from *A. albophaleratus*. The female of this species is easily distinguished from other species in the *A. catskill* complex by the dark legs and reduced number of apical fasciae of the metasoma (though a similar melanic colour form of *Ancistrocerus* cf. sp. A rarely occurs in northern Ontario, see above).

VARIATION (females only). Fore wing length 7.5–9.0 mm. Pale markings of body usually ivory, rarely yellow. Clypeus black, often with a pair of (usually small) dorsal and sometimes also a pair of pale ventral spots, rarely with ventral spots only, the spots never confluent. Pale spot between inner orbit and antennal socket almost always absent (present in 1 ♀, NT, Fort McPherson, CNCI). Scape with an amber, or less commonly clear ivory of yellow stripe beneath, often more brown in basal half. Pronotal band narrow, in western specimens rarely lateral portions absent. Spot on upper mesopleuron usually absent, if present very small and often evanescent except in some western specimens. Tegula black or black and brown, with or without pale markings. Pale scutellar spots almost always absent (moderately developed in 1 ♀, AB, Drumheller, CNCI). Parategula, metanotum and propodeum black. Mid and hind tibiae black, the black areas sometimes suffused with amber in specimens from NT, YT; pale markings absent or small, restricted to anterior surface of tibia and not extending to dorsal midline. Metasomal terga 1–3 fasciate; the fascia of tergum 3 often interrupted medially, rarely completely absent (1 ♀, ON, Manitoulin I., Carter Bay, DEBU; 1 ♀, ON, Trenton, CNCI; 1 ♀, AB, McMurray, CNCI; 1 ♀, NT, Fort Wrigley, CNCI); some specimens from SK, AB, BC with fasciate tergum 4 but fascia usually abbreviated laterally. Sternum 1 with or without fascia, if present often indistinct; fascia of sternum 2 usually complete, rarely reduced to a pair of lateral spots; sternum 3 with apicolateral spots; sternum 4 rarely with apicolateral spots.

DISTRIBUTION. Canada: ON to BC, NT, YT. Northern U.S.: AK.

BIOLOGY. Unknown.

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***Eumenes* Latreille**

The genus *Eumenes* has a worldwide distribution, and is represented in the Nearctic by twelve species north of the Isthmus of Tehuantepec (Krombein 1979, Rodríguez-Palafox 1996). Four species occur in northeastern North America.

REFERENCES. – MacLachlan, 1980 (key to Nearctic species); Bequaert, 1938 (revision of Canadian species, key), 1944*b* (key to Canadian species).

15. *Eumenes bollii* Cresson, 1872

Figs B4.3, 13; C15.1–3.

SPECIES RECOGNITION. This species is easily distinguished from all other northeastern *Eumenes* by the ferruginous markings on the scape and mesosoma. The extralimital *E. smithii* (known from North Carolina, Tennessee, Missouri) is similar but has a fine transverse pronotal carina and has only very short hair on segment 1 of the metasoma.

VARIATION. Fore wing length not studied (♂♂), 11–13 mm (♀♀). Variation otherwise not studied.

DISTRIBUTION. Canada: AB, newly recorded for BC. Western half of U.S. east to MN, IA, MO (Krombein 1979). Mexico: Tamaulipas, Baja California (Rodríguez-Palafox 1996). The western ssp. *oregonensis* Bequaert, 1938 occurs in ID, WA, OR and NV.

BIOLOGY. Builds mud nests that are attached to vegetation (Isely 1914).

16. *Eumenes crucifera* Provancher, 1888

Figs B2.3; B4.6, 11, 16; C16.1–4.

NOMENCLATURAL NOTE. J.M. Carpenter (*in litt*.) kindly pointed out to us that "*crucifera*" is the correct spelling of the species name despite Steyskal's (1980) suggestion that the name should be emended to "*crucifer*". The original spelling "*crucifera*" should be maintained because it is a latinization of the French word "crucifère", which can be either an adjective or a noun. As Provancher (1888) did not specify whether the name represented either of the two, it must be treated as a noun in accordance with Article 31.2.2 of the ICZN. The original spelling therefore remains unchanged.

SPECIES RECOGNITION. See key and notes under *E. fraternus* and *E. crucifera*.

VARIATION. Fore wing length 7.5–9 mm (♂♂), 9.5–10.5 mm (♀♀). The colour of pale markings varies from yellow to ivory. Inner eye margin in male black, sometimes with pale spot. Female clypeus usually with an arched dorsal mark, rarely interrupted medially, exceptionally just with two small spots, xanthic specimens also with a ventral spot, or clypeus mostly yellow with black central spot and black apical margin. Female scape sometimes with pale basal spot. Postocular spot rarely absent. Pronotal band sometimes with interruption or indentation halfway between median line and pronotal angle. Mesopleuron rarely with a dorsal spot in female. Propodeum in female often with a pair of dorsal pale spots. Apices of femora at most with small pale spot. Tergum 1 rarely with a pair of pale spots. Spots of tergum 2 rarely small or absent in male. Preapical fasciae usually present on terga 1–(5)6 in male and 1–5 in female, in the latter tergum 6 sometimes with a pale spot. Fasciae on corresponding sterna more variable, often only partially developed.

DISTRIBUTION. Canada: Transcontinental north to 63°N latitude, recorded from YT by Finnamore (1997). We have not seen specimens from NU. Northern and western U.S. south to NJ, KY, NM, CA. Mexico (Krombein 1979). Krombein (1979) recognises five different subspecies, with the ssp. *nearcticus* Bequaert, 1944 occurring in the northeast.

BIOLOGY. Unknown. Other species of *Eumenes* build jug-like mud nests that are usually attached to twigs and provisioned with caterpillars (Krombein 1979).

17. *Eumenes fraternus* Say, 1824

Figs B2.1, 30; B4.4, 7, 9, 17; C17.1–5.

SPECIES RECOGNITION. Besides characters provided in the key *E. fraternus* can be distinguished from *E. fraternus* and *E. crucifera* by the shorter pubescence of the scape (hair length less than 0.8x mid ocellar diameter). In *E. crucifera* and especially *E. verticalis* at least some hairs are as longs as mid ocellar diameter.

VARIATION. Fore wing length 8–10.5 mm (♂♂), 10–12.5 mm (♀♀). Colour of pale markings always ivory. Female clypeus with an arched dorsal mark, sometimes interrupted medially. Female scape black, sometimes with pale basal spot. Mesopleuron rarely with a dorsal spot in female. Propodeum in male rarely with a pair of dorsal pale spots. Apices of femora at most with small pale spot. Tergum 1 exceptionally with a pair of pale spots. Spots of tergum 2 rarely small or absent in male. Preapical fasciae usually present on terga 1–4 or 5 in male and 1–4(5) in female. Fasciae on sterna highly variable, more or less developed or absent on sterna 3–6 in male; female usually with a pair of lateral spots on sterna 3 and sometimes 4.

DISTRIBUTION. Canada: ON. Eastern U.S.: NH and MA south to FL, west to MN, NE, KS, OK, TX (Krombein 1979, Bequaert 1938).

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BIOLOGY. Builds jug-like mud nests that are usually attached to twigs. Prey are caterpillars (Krombein 1979).

18. *Eumenes smithii* de Saussure, 1852

Figs B4.1, 2, 14; C18.1–5.

This extralimital species was included in the key because it occurs close to the area covered by the Atlas, and might be found there in future.

SPECIES RECOGNITION. Similar to *E. bollii*. For distinguishing characters see under that species.

VARIATION. Fore wing length 10.0–10.5 mm (♂♂, n = 3), female not examined. Variation not studied otherwise.

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: TN (new state record, CNCI) and NC south to FL, west to MS. The ssp. *belfragei* Cresson, 1872 (= ssp. *americanus* of authors, not de Saussure, 1852) from NE to AR and TX, also in Mexico (Tamaulipas, Nuevo León, Jalisco, and Michoacán) (Krombein 1979, Rodríguez-Palafox 1996).

BIOLOGY. The jug-like mud nests are attached to leaves, blades of grass (Isely 1917), or rocks (Fig. 18.5). Preys on caterpillars of Geometridae (Isely 1917).

19. *Eumenes verticalis* Say, 1824

Figs B1.1; B2.5; B4.5, 8, 10, 12, 15; C19.1–5.

SPECIES RECOGNITION. MacLachlan (1980) commented on the difficulties in separating females of *E. verticalis* and *E. crucifera*. Both species are very variable in colouration across their largely overlapping ranges. However, a careful comparison of sympatric material of both species often reveals useful colour characters, which are only applicable to specimens from certain geographic areas (MacLachlan 1980). No reliable diagnostic colour characters have been mentioned for northeastern Nearctic populations in previous works (Bequaert 1938, 1944*b*; MacLachlan 1980). A highly reliable character that is developed in ca. 95% of *E. verticalis* females is the pair of ventrolateral spots on the propodeum (always absent in *E. crucifera*). Another character is the colouration of the femoral apex (see key); this character holds up for material from Ontario and Quebec but not the Atlantic provinces. MacLachlan (1980) suggested that clypeal punctation was also diagnostic but this could not be confirmed on the examined material. We were able to find only one reliable structural difference between females of both species, the development of the costal scale, which is more produced and sharp-edged in *E. verticalis* than in either *E. crucifera* or *E. fraternus*.

VARIATION. Fore wing length 7–8.5 mm (♂♂), 8–9.5 mm (♀♀). The colour of pale markings varies from yellow to ivory. Female clypeus with a pair of more or less elongate dorsal spots, which are often fused dorsally, rarely clypeus mostly yellow with black apical margin and black central spot extending to dorsal and/or ventral margin. Pronotal band sometimes with interruption or indentation halfway between median line and pronotal angle. Mesopleuron rarely with small dorsal spot in female. Propodeum usually with a pair of ventral spots, sometimes also with smaller dorsal spots, rarely completely black; ventral spots exceptionally present in male. Apices of fore and mid femora with pale spot, which may be fairly large. Tergum 1 in female often, in male rarely, with a pair of pale spots. Preapical fasciae usually present on terga 1–5 in male and 1–4 or 5 in female. Fasciae on corresponding sterna often only partially developed.

DISTRIBUTION. Canada: QC to BC, YT (Finnamore 1997). Eastern U.S. south to NC, MO; western U.S. (Krombein 1979). Mexico: Tamaulipas, Nuevo León, Baja California (Rodríguez-Palafox 1996). Based on the colour of the pale markings northeastern populations have been divided into two (probably unjustified) subspecies (Bequaert 1944*b*): the nominate subspecies (yellow markings) and ssp. *neoboreus* Bequaert, 1944 (ivory markings). Two other subspecies, ssp. *coloradensis* Cresson, 1875, and ssp. *tricinctus* Isely, 1917 occur in the west.

BIOLOGY. The nest of *E. verticalis* is recorded here for the first time (Fig. 19.5). Unlike other species of *Eumenes* it is attached to rocks and is hemispherical (rather than spherical). Even though we have examined only one nest we assume rocks are the usual choice of substrate because of the habitat preferences of this species. Unlike the common *E. fraternus* and *E. crucifera*, the rarely collected *E. verticalis* prefers sparsely vegetated habitats like empty lots, gravel pits and rocky shorelines. Prey are probably caterpillars, as in other species.

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***Euodynerus* Dalla Torre**

A primarily Holarctic genus with several species in Central America, the Caribbean, as well as the Afrotropical and Oriental regions. The Nearctic fauna (north of the Isthmus of Tehuantepec) includes 31 species. Twenty-four described species occur north of Mexico (Krombein 1979, Bohart 1982, Rodríguez-Palafox 1996), thirteen of which are found in the northeast. In addition, two undescribed species were newly discovered during this project.

REFERENCES. – Bohart, 1939*a* (key to *E. auranus* [= *E. boscii* auctt.] and related species), 1945 (description of *E. planitarsis*), 1948*a* (key to *E. foraminatus* subspecies and related species); Bequaert, 1937 (key to subspecies of *E. hidalgo*), 1939 (key to *E. annectens* and related species); Krombein, 1962 (description of *E. schwarzi*).

20. *Euodynerus annectens* (de Saussure, 1870)

Figs B5.53; C20.1–4.

SPECIES RECOGNITION. This species is easily recognisable because of the ivory markings combined with a black metanotum and virtually impunctate tergum 1 (other ivory-marked *Euodynerus* species have a pale-banded metanotum and punctate tergum 1). The only other large, stout-bodied, pale-marked Eumeninae with strongly infuscate wings (*E. bidens*, *Monobia quadridens*, *Pseudodynerus quadrisectus*) also lack the apical fascia of tergum 2.

VARIATION (mostly after Bequaert 1936). Fore wing length 10–13.5 mm (♂♂), 13.5–14 mm (♀♀). Female clypeus with a pair of widely separated ivory dorsal spots, sometimes also with a pair of preapical spots. Interantennal spot usually absent in female, present in male and sometimes extending to clypeus. Pairs of ivory spots of scutellum and propodeal dorsum sometimes absent in male. Apical fascia of tergum 3 complete, reduced to lateral spots or absent.

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: VA to FL (Krombein 1979).

BIOLOGY. The only described nest had a diameter of about 6 cm, was made of coarse sandy clay with a few larger grains of up to 2.5 mm diameter, contained 21 radially oriented cells and was attached to the fork of a twig. Prey has not been recorded (Clark and Sandhouse 1936).

21. *Euodynerus annulatus* (Say, 1824)

Figs B5.22, 24–26, 58; C21.1–4.

SPECIES RECOGNITION. The male of *E. annulatus* is distinguished from all other species in the genus by the large, apically flattened, slightly expanded and obliquely truncate flagellomere XI, the slightly depressed anteroventral base of the mid femur, and the combination of a densely long-haired posteroventral surface of the hind femur and contrastingly short-haired ventral surfaces of fore and mid femur (other species with ventrally long-haired hind femur possess long hair on fore and mid femora, as well). Furthermore, the distal sterna of the male metasoma bear very dense, short erect hair (absent in most other species, present but less dense in the extralimital *E. pratensis*). The female is distinguished by the very long apical mandibular tooth (see key; character shared with *E. crypticus*). The outer margin of the tegula is more strongly angled posterolaterally than in any other species, so that the margin is almost perpendicular to the main body axis posteriorly. *Euodynerus annulatus* is one of five species, in which a very sparsely punctate tergum 1 contrasts with a strongly punctate tergum 2 (including discal area). It is distinguished from the other four species with smooth tergum 1 (*E. hidalgo*, *E. crypticus*, *E. auranus*, *Euodynerus* sp. G; punctation variable in latter two) by the angularly produced submarginal carina.

VARIATION. Fore wing length 8–9.5 mm (♂♂), 8.5–10.5 mm (♀♀). Yellow markings of head in female more or less suffused with ferruginous; female clypeus sometimes yellow and ferruginous, without black. Yellow pronotal band narrow or broad, with a ferruginous posterior border that can vary from linear to very broad (extending to posterior corners of pronotum). Spot on upper mesopleuron usually absent. Scutellum rarely with a pair of tiny yellow or ferruginous spots. Markings on propodeum yellow with narrow ferruginous border to entirely ferruginous. Metasomal terga 1–4 with yellow fasciae, in male often also terga 5 and 6; apical fasciae of sterna 2 and 3 usually reduced to lateral spots in female, complete at least on sternum 2 in male, sometimes also on following sterna up to sternum 6, but then becoming more ferruginous posteriorly. Lateral third of tergum 1 with variable amounts of yellow and ferruginous. Tergum 2 in male often, in female rarely, with a pair of ferruginous discal spots; ferruginous spots sometimes also present on male sternum 2. Legs largely ferruginous, with variable amounts of yellow.

DISTRIBUTION. Canada: AB and BC, newly recorded from ON and SK. Transcontinental in U.S. (Krombein 1979). Mexico: northern Mexico, including Baja California, south to Durango (Rodríguez-Palafox 1996). Northeastern populations belong to the ssp. *arvensis* (de Saussure, 1870). The nominate subspecies and three other subspecies have a western distribution. *Euodynerus*

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annulatus has apparently become very rare or extirpated in Ontario with no specimens having been collected after 1954 (Essex Co., Point Pelee, CNCI).

BIOLOGY. *Euodynerus annulatus* is one of only two ground-nesting species of Eumeninae in the northeast that builds a chimney-like mud tube over the nest entrance (see also *Odynerus dilectus*). The mud tube is ca. one inch long, thick-walled and usually curved. There seems to be no particular preference for a certain soil type; nests are built in both hard and soft soils (Isely 1914). Isely found nests always in close proximity to water (usually not farther than 27m, exceptionally 91m away). While digging, females make frequent trips to water sources in order to take up water for moistening and softening the soil. Excavated soil is used for the building of mud tubes. There is also one record of the species nesting in an abandoned mud dauber nest (Isely 1914). Broods cells are provisioned with caterpillars of Crambidae, Pyralidae and "Noctuidae" (in the traditional sense) (Evans 1956, Krombein 1979).

22. *Euodynerus auranus* (Cameron, 1906)

Figs A4.4, 14; B5.1, 29, 32, 35, 36, 38, 60; C22.1–4.

TAXONOMY. Northeastern populations of *E. auranus* have been referred to under the name *E. auranus aquilus* Bohart, 1974 in the literature. Bohart and Menke (1974) stated that "*E. auranus aquilus* occurs over most of the eastern United States". However, most of the eastern populations, except those from Michigan and Minnesota, actually belong to a closely related, undescribed species (see comments under *Euodynerus* sp. G). Specimens from the type locality of *E. auranus aquilus* in southwestern Texas show a different colour pattern than northeastern populations (ON, MI, MN), and the subspecies name should therefore not be applied to the latter. Western *E. auranus* have been classified into four different subspecies: *E. a. auranus*, *E. a. albivestis* (Bohart, 1939), *E. a. azotopus* (Bohart, 1939), and *E. a. aquilus* (see Krombein 1979). Currently, there is no available subspecies name for the colourationally distinct northeastern populations.

SPECIES RECOGNITION. *Euodynerus auranus* and sp. G are the only eastern Nearctic species of the genus with well-developed rake setae on the female fore basitarsus. Males of both species are easily recognised by the extensively yellow lower surface of flagellomeres I(–VI)–VII and black flagellomere XI (in most other species the lower surface of flagellomeres I–VII is black, except in *E. castigatus*, which has a partially yellowish flagellomere XI), and a relatively longer male clypeus (least interocular distance / clypeal length 0.88–0.93; in *E. castigatus* 0.98–1.09). *Euodynerus auranus* and sp. G can be separated by the characters provided in the key.

VARIATION. Fore wing length 7–9 mm (♂♂), 7–10.5 mm (♀♀). Punctation of tergum 1 extremely variable, very sparse and inconspicuous to almost as strong and dense as on tergum 2. Apical reflex and punctation of apical fascia of tergum 2 also very variable, on average stronger in male than in female; punctation within apical fascia coarse or very coarse, the punctures deep and separate or confluent with strongly projecting aciculate interspaces. Female clypeus usually with a pair of basal yellow spots, sometimes absent. Interantennal spot in female usually more or less divided medially, rarely missing, in male almost always extending all the way to clypeus. Yellow stripe along inner eye margin exceptionally absent in female. Mandible black to reddish in female, always with yellow basal spot. Ferruginous markings usually not developed on head, occasionally present in postocular spot of female (exceptionally in male), very rarely in female clypeal spots. Yellow pronotal band sometimes linear laterally, a ferruginous posterior border very rarely present in male, present or absent in female but usually very narrow and incomplete, exceptionally broad and extending to middle of pronotum posteriorly. Spot on upper mesopleuron small or absent (usually absent in male), almost always yellow, very rarely ferruginous. Scutellum with a pair of yellow spots (rarely absent in male), sometimes bordered with ferruginous, very rarely entirely ferruginous. Metanotum with or without a pair of small yellow spots (less commonly in male), posteriorly sometimes with a narrow, transverse, ferruginous band. Yellow propodeal spots large, very rarely small or bordered with ferruginous. Metasomal terga 1(–3)–4(5) with yellow apical fasciae in female, in male terga 1(–4)–5(6) fasciate. Tergum 1 with or without narrow ferruginous area bordering lateral forward extension of yellow apical fascia, tergum 2 exceptionally with a pair of small yellow discal spots. Sterna usually without complete apical fasciae in female, in male fasciae usually complete on sternum 2 and often 3.

DISTRIBUTION. Canada: ON to BC, newly recorded for ON, MB, SK, and BC. Northeastern U.S.: MI (Bohart 1939*a*; misidentified as *E. boscii boscii*), MN (new state record: 1 ♀, Pelican Lake, Nisswa, UCDC); western U.S. east to ND, KS, western TX. Mexico: Coahuila, Chihuahua, Baja California, Durango (Krombein 1979, Rodríguez-Palafox 1996). In Ontario the species is almost

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entirely restricted to dune systems along Lake Huron. This peculiar distribution pattern is similar to that of other western aculeate species that reach the eastern limit of their range on dune systems in Ontario (e.g., *Mellinus abdominalis* Cresson, *Diploplectron peglowi* Krombein, both Crabronidae; Buck 2004). The newly discovered Ontario populations mark the eastern limit of the species distribution.

BIOLOGY. Evans (1978) found this species nesting in an apparently abandoned, incipient burrow of *Bembix pruinosa* Fox (Crabronidae) in a large blow-out dune area in Weld Co. Colorado. The nest had a single mud cell 15 cm from the entrance of the burrow and 5.5 cm below the soil surface. The cell had very thin walls (thickness 0.3 mm), and was filled with 25 caterpillars of two different genera of Gelechiidae. In Ontario the species is also restricted to dune habitats, mostly along Lake Huron (except for two old records from Strathroy, Middlesex Co. and "E Ont."). Apparently the species is also capable of digging its own burrows. In July 2003 the senior author observed one female starting to dig into slightly sloped, friable sand contiguous to an *Arctostaphylos* twig on a dune at Carter Bay, Manitoulin Island (Ontario). The observation was interrupted after the female had dug about 1 cm into the sand. Females are well equipped for digging burrows by the presence of rake setae on the fore basitarsus, a hitherto unreported morphological adaptation in Eumeninae (see General Part – Morphology). *Euodynerus auranus* and sp. G are the only Eumeninae species in Ontario with rake setae, even though several other species in the genus (e.g., *E. crypticus*, *E. annulatus*) also nest in the ground. On various occasions females were observed investigating spun-together leaves of *Arctostaphylos* and an unidentified dune Asteraceae for the presence of prey (Buck, pers. obs.).

CONSERVATION. Because of its local occurrence along Lake Huron and its specific preference for lakeshore dunes this species is one of the most vulnerable vespids in Ontario. Its survival depends on the preservation of intact dune habitats, which are threatened by excessive use or destruction through development, off-road vehicles, vacationers, etc.

23. *Euodynerus bidens* (de Saussure, 1870)

Figs B2.27, 45; B5.4, 5, 44; C23.1–5.

SPECIES RECOGNITION. *Euodynerus bidens* is the only species of the genus which has the pale markings restricted to tergum 1 (small evanescent ivory spots sometimes occur on male tergum and sternum 2). The species thus more resembles *Monobia quadridens* than any other species of *Euodynerus* (differential diagnosis under that species). Other diagnostic characters besides those mentioned in the key include: female vertex very long, the distance between hind ocelli and occipital carina three times the distance between hind ocelli (at most two times in other species); cephalic foveae small and widely separated, area around them neither depressed nor with conspicuously different surface texture (in other species located in shallow depression bordered by posterior carina and area around them often more densely punctured than remainder of vertex); female pronotum, scutum and scutellum with unusually fine punctures; dorsal surface of propodeum largely ivory (black in other ivory-marked species except *E. annectens*); male fore trochanter and fore femur short-haired below (long-haired in other ivory-marked species, male of *E. annectens* not examined).

VARIATION. Fore wing length 11.5–13 mm (♂♂), 14–17 mm (♀♀). Interantennal spot present or absent in female. Apex of male clypeus sometimes with narrow black band. Scape black, sometimes brownish or with ivory spot near base in male. Mesopleuron black, sometimes with small ivory dorsal spot. Scutellum completely black or with a pair of small ivory spots. Male mid coxa usually with small ivory spot, sometimes largely ivory or completely black; male mid femur sometimes with ivory anteroapical spot. Tergum 1 largely ivory behind declivity, the ivory fascia anteromedially sometimes indented by a narrow longitudinal black stripe. Male tergum 2 sometimes with tiny discal or posterolateral ivory spots; male sternum 2 sometimes with small ivory posterolateral spots.

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: MN and NJ south to FL (Krombein 1979).

BIOLOGY. Unknown. The strongly compressed mid tarsus of the male indicates affinities with species in the *E. foraminatus*-group, all of which nest in borings in wood.

24. *Euodynerus blakeanus* (Cameron, 1909) **sp. restit.**

Figs B5.2, 18, 52; C24.1–4.

TAXONOMIC NOTE. *Euodynerus blakeanus* was previously considered a subspecies of *E. foraminatus* even though it is structurally very similar to *E. leucomelas*. Like several other presumed subspecies of *E. foraminatus* (e.g., *E. apopkensis* (Robertson), *E. parvirudis* (Bohart)) it

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represents a good species and is well-differentiated morphologically from *E. foraminatus*. Previously, *E. blakeanus* was only recorded from Central Texas (Cameron 1909). During this study we identified additional material from six additional states (see below), indicating that the species is widely distributed in the eastern U.S. Its (insufficiently) known range appears to overlap entirely with the more widespread *E. foraminatus* (we have examined typical *E. foraminatus* from the type locality of *E. blakeanus*: Lee Co., Texas; BMNH and USNM). See also taxonomic note under *E. leucomelas*.

SPECIES RECOGNITION. The species differs from both *E. foraminatus* and the yellow colour form of *E. leucomelas* by the dull (vs. shining) propodeal concavity and posterior surface of the metanotum, and the yellow apical spots of the female clypeus (absent in other species). It differs furthermore from *E. foraminatus* by the simple (not thickened) apical margin of tergum 2 and the shallower and finer punctation of preapical areas of terga 2–5.

VARIATION. Fore wing length ca. 6.5–8.0 mm (♂♂), 8.5–9.5 mm (♀♀). The original description is based on specimens from Texas, which have more extensive yellow markings than specimens from other states: Female clypeus with a pair of yellow dorsal and a pair of yellow apical spots (the former usually, the latter often confluent; clypeal disc of females from TX largely or rarely completely yellow with black central spot or pair of spots); mandible sometimes with large yellow to reddish yellow medial spot besides triangular basal spot (mandible, excluding margins, sometimes largely yellow in females from TX); scutum entirely black (sometimes with small yellow spot adjacent to tegula in females from TX); scutellum entirely black or with pair of small yellow spots (often present in specimens from TX); propodeum entirely black (yellow dorsal and/or posterolateral spots often present in specimens from TX); apical fascia of tergum 1 moderately widened laterally (as in *E. foraminatus*; greatly widened in specimens from TX, especially in females which sometimes have most of the dorsal surface yellow); tergum 2 without yellow discal spots (sometimes present in specimens from TX). Apical fasciae present on terga 1–4 or 5 (female) or 1–5 or 6 (male). Female sternum 2 with more or less interrupted apical fascia, following sterna up to sternum 5 usually with yellow apicolateral spots. Male sterna 2–5 or 6 with apical fasciae, posterior ones sometimes more or less interrupted.

DISTRIBUTION. Insufficiently known due to confusion with *E. foraminatus*. Not recorded from Canada. Previously known in eastern U.S. only from TX (1 ♀, Brazos Co., College Station, DEBU; Lee Co., Cameron 1909), newly recorded from NJ (1 ♀, Camden Co.; 1 ♀, Lakehurst; 1 ♀, New Gretna; all USNM), MD (1 ♂, 1 ♀, Plummers I.; USNM), WV (1 ♀, Hampshire Co.; DEBU, presented by S. Droege), NC (1 ♀, Great Smoky Mts. Natl. Pk.; CNCI), MO (1 ♀, Williamsville; CNCI) and KS (4 ♂♂, Douglas Co., 15 mi SE Lawrence; USNM).

BIOLOGY. Unknown. Probably nesting in cavities like other members of the *E. foraminatus*-group.

25. *Euodynerus boscii* (Lepeletier, 1841)

Figs B5.19, 54; C25.1–4.

SPECIES RECOGNITION. *Euodynerus boscii* is readily recognised by the well developed submarginal carina of the propodeum in combination with a conspicuously haired metasomal tergum 1. In other species with well developed submarginal carina the posterior horizontal portion of tergum 1 is bare. The male of *E. boscii* is furthermore characterized by the presence of a low ventral swelling on the basal half of the fore femur (a similar but less developed swelling is present in males of the extralimital *E. pratensis*).

VARIATION. Fore wing length ca. 8.5 mm (♂♂), ca. 10 mm (♀♀). Variation not studied.

DISTRIBUTION. Not recorded from Canada. Eastern U.S. west to KS, OK, TX (Krombein 1979). The northern limit of the distribution of *E. boscii* is not explicitly mentioned in the literature. Bohart and Menke (1974) mention it from MD, which appears to be the northernmost record. The northeastern subspecies is *molestus* (de Saussure, 1870). The nominate subspecies occurs from NC to northern FL; ssp. *boharti* (Krombein, 1959) is restricted to Florida.

BIOLOGY. Nests in borings in wood including structural lumber. Cell partitions and terminal plug are made of firmly agglutinated sand. Prey are caterpillars of Crambidae (Pyraustinae) and Pyralidae (Epipaschiinae) (Krombein 1967, 1979).

26. *Euodynerus castigatus* (de Saussure, 1853)

Figs A4.13; B5.27, 30, 31, 33, 34, 59; C20.1–4.

SPECIES RECOGNITION. This species is distinguished from similar species by the presence of 1–3 small, irregular teeth on the lateral ridge of the propodeum below the propodeal angle (teeth absent in the closely related *E. auranus* and *E.* sp. G), a strongly punctate tergum 1 (very sparsely punctate in other species except in few specimens of *E. auranus*), black metanotum (marked with

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yellow and/or ferruginous in other species except a few females and many males of *E. auranus*), posterior half of male sternum 7 with moderately dense erect hair (hairing either semi-erect, i.e., more or less inclined posteriorly, or erect and very dense, brush-like), and other characters mentioned in the key. *Euodynerus castigatus* is the only yellow-marked species in the genus with the lower surface of male flagellomeres I–VII distinctly spiculate.

VARIATION. Fore wing length 8–9 mm (♂♂), 9–11 mm (♀♀). Apical reflex and punctation of apical fascia of tergum 2 somewhat variable, on average stronger in male than in female. Female clypeus usually with an arched basal yellow spot, sometimes medially divided, rarely absent; clypeal apex rarely with a ferruginous spot sometimes connected to the yellow basal spot. Interantennal spot in female usually more or less divided medially, rarely missing, in male extending to clypeus or separated from it. Yellow stripe along lower inner orbit exceptionally absent in female, sometimes interrupted hallway between ocular sinus and clypeus. Yellow markings of head sometimes slightly suffused with reddish, especially postocular spot, which is usually completely ferruginous. Yellow pronotal band usually with narrow ferruginous posterior border, sometimes practically absent in male, rarely broad and extending to middle of pronotum posteriorly. Spot on upper mesopleuron usually small to moderately developed, rarely absent in female (usually absent in male), almost always yellow, rarely ferruginous. Scutellum with a pair of yellow spots, almost always with at least very narrow ferruginous inner border, the spots rarely almost meeting at middle. Yellow propodeal spots large, sometimes narrowly bordered with ferruginous, rarely almost completely ferruginous. Metasomal terga 1(–2)–3(4) with yellow apical fasciae in female, in male terga 1(–3)–4(5) fasciate. Tergum 1 with at least a narrow ferruginous area bordering lateral forward extension of yellow apical fascia. Sternum 2 and very rarely 3 with posterolateral yellow spots in female; sternum 2 of male with complete fascia or posterolateral spots, sterna 3–5 sometimes also with spots.

DISTRIBUTION. Canada: newly recorded for ON and BC. Transcontinental in the U.S. (Krombein 1979). Mexico: Morelos, Jalisco (Rodríguez-Palafox 1996). Subspecies *rubrivestis* (Bohart, 1948) occurs in GA and FL (Fig. 26.5), ssp. *sanneovestis* (Bohart, 1948) in California. The distribution of *E. castigatus* in Ontario is mostly allopatric with regard to the closely related *E. auranus*, which occurs on dunes along Lake Huron. *Euodynerus castigatus* prefers inland dunes or other sandy areas, but both species occur together on Lake Huron dunes at Inverhuron Provincial Park (Bruce Co.).

BIOLOGY. Unrecorded. *Euodynerus castigatus* is associated with sandy areas in Ontario. On three occasions the senior author observed females on sandy soil, where they apparently were gathering sand. None of the females showed digging behaviour so we assume that sand was gathered for nest construction (most likely in a cavity). Even though the closely related *E. auranus* nests in the ground, this is apparently is not the case for *E. castigatus*.

27. *Euodynerus crypticus* (Say, 1823)

Figs B5.23, 28, 57; C27.1–7.

SPECIES RECOGNITION. *Euodynerus crypticus* can easily be recognised by colour characters alone. It is the only *Euodynerus* in the northeast lacking black markings on the scape and pedicel (in other species upper surface with a black streak, rarely very reduced in *E. annulatus* and *E. castigatus*), largely ferruginous pronotum, with ferruginous area extending to pronotal hind corner (in other species pronotum black posteriorly except, very rarely, in *E. annulatus*), largely ferruginous scutellum, ferruginous spot rarely interrupted medially (in other species scutellum black, or black with yellow spots, or black, yellow and ferruginous; very rarely with two ferruginous spots in *E. auranus* and *E. castigatus*) and lacking distinct apical fascia on female tergum 2, i.e., apical fascia ill-defined, brown or amber, sometimes yellowish brown (in other species yellow apical fascia always well developed). Structurally, *E. crypticus* is distinguished from other species by the ventrally long-haired male fore trochanter (hair length over one mid ocellar diameter; hairs erect with bent tips), contrasting with short-haired ventral surface of fore femur (in other species hairs of ventral surface of fore trochanter and fore femur uniform, either both short- or both long-haired), by the deeply depressed vertex around the female cephalic foveae (area around cephalic foveae flattened in other species, at most slightly and gradually depressed below level of vertex), and the very long apical tooth of the female mandible (see key, character shared by *E. annulatus*).

VARIATION. Fore wing length 9.5–11.5 mm (♂♂), 13.5–15 mm (♀♀). Pale markings of head mostly yellow in male (excluding ferruginous postocular spot), mostly ferruginous in female (excluding small yellow spot at base of mandible). Female clypeus usually ferruginous with black

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dorsal and lateral margin, sometimes black with ferruginous apex and a pair of large dorsal ferruginous spots. Postocular spot extending to at least level of middle of eye, in female often extending across whole gena from level of upper eye margin to base of mandible. Female vertex often with additional small to large ferruginous spot between cephalic foveae and upper eye margin, often confluent with postocular spot. Scape ferruginous, with yellow lower surface in male. Dorsal surface of pronotum largely ferruginous; yellow pronotal band usually restricted to middle third, in male often better developed and extending to humeral angle; black markings usually restricted to anterior and lateral surfaces, rarely occupying lateral third or fourth of dorsal surface. Mesopleuron with or without ferruginous dorsal spot. Female scutum sometimes with a pair of small, closely approximated ferruginous spots in posterior half. Scutellum usually ferruginous with black margin, sometimes black with a pair of large ferruginous spots. Metanotum with transverse yellow band, sometimes interrupted medially or suffused with ferruginous. Propodeum with a pair of ferruginous dorsal spots, in female usually extending to propodeal angle or extending along propodeal ridge ventrally, rarely completely absent or with a small yellow spot within (male only). Apical fascia of tergum 1 usually with broad ferruginous border along inner margin of lateral forward extension, rarely without ferruginous markings. Apical fasciae practically absent on following terga in female, at most yellowish brown and ill-defined, present on tergum 2 and usually 3 in male. Male sternum 2 usually with posterolateral yellow spots or apical fascia, spots sometimes also present on sternum 3. More or less extensive ferruginous areas often developed on segment 2 and following in specimens from eastern U.S., absent from the few known Canadian specimens.

DISTRIBUTION. Canada: ON, AB. Eastern U.S.: CT and NY south to GA, west to WY, UT, AZ (Bequaert 1940*b*, Krombein 1979). Mexico: south to Oaxaca (Rodríguez-Palafox 1996). Based on the extent of ferruginous markings northeastern populations were divided into two (probably unjustified) subspecies (Bequaert 1940*b*): the nominate subspecies (extensive ferruginous markings) and ssp. *balteatus* (Say, 1837). Subspecies *stricklandi* (Bequaert, 1940) ranges from AB to SD and CO.

BIOLOGY. Nests in small colonies in the ground. Burrows are vertical and brood cells are separated by clay partitions. Females make frequent trips to water sources while digging. As in many other ground-nesting Eumeninae the water is used for softening the hard-packed soil in which the nest is built (Isely 1914). Prey consists of caterpillars of Hesperiidae (Krombein 1979).

28. *Euodynerus foraminatus* (de Saussure, 1853)

Figs B2.24, 44; B5.12, 14, 42, 51; C28.1–5.

SPECIES RECOGNITION. This species is most similar to *Euodynerus* sp. F, *E. blakeanus* and the rare yellow form of *E. leucomelas,* from which it can be separated by the characters mentioned in the key. *Euodynerus boscii* is also similar but has conspicuous long hair (hair length over 1.5x mid ocellar diameter) on all metasomal terga (shorter and much sparser in *E. foraminatus*), posterolaterally subangulate tegulae (perfectly rounded in *E. foraminatus*-group), and lacks long hair on the ventral surface of the male fore femur.

VARIATION. Fore wing length 6–9 mm (♂♂), 7–10.5 mm (♀♀). The punctation of the apical fasciate part of tergum 2 and following terga varies from moderately to coarsely punctate. In coarsely punctate specimens the apical margin of tergum 2 is more or less reflexed, lamellate and translucent. Female clypeus usually with arcuate yellow dorsal spot, sometimes narrowly to broadly divided, exceptionally all black. Female mesopleuron usually with large yellow dorsal spot, sometimes small, rarely missing; male mesopleuron often black, sometimes with small yellow dorsal spot. Female occasionally with a pair of small yellow spots on scutellum. Tegula with yellow anteriorly and posteriorly, the yellow areas more reduced in male but rarely absent. Parategula yellow, in male often only tip and then sometimes more amber, very rarely completely black. Propodeum very rarely with yellow spots on dorsal surface and on ventral half of lateral ridge. Metasomal terga 1–4 always fasciate, in female sometimes also tergum 5 medially, in male usually tergum 5 and sometimes middle of 6. Female sterna 2–4 with posteroapical yellow spots, rarely absent on 4; male sternum 2 usually with apical fascia, rarely reduced to lateral spots, sterna 3, 4, usually 5 and often 6 with posterolateral yellow spots, rarely one or more with more or less developed apical fascia; male sternum 2 rarely with a pair of discal yellow spots.

One aberrant female from Killbear Provincial Park, Ontario has yellowish ivory markings. The pale markings are very extensive and include a pair of large ivory spots on the dorsal surface of the propodeum, a complete apical fascia to tergum 5, and a broadly interrupted apical fascia to sternum 2. The specimen is recognisable as *E. foraminatus* based on the slightly thickened hind margin of

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tergum 2 and the relatively strong punctation of preapical areas of terga 2–4.

DISTRIBUTION. Canada: all provinces. U.S.: transcontinental (Krombein 1979). Mexico: Tamaulipas (Rodríguez-Palafox 1996). Probably all of the currently recognised subspecies of *E. foraminatus* (see Krombein 1979) represent different species. *Euodynerus foraminatus* is the most common species of the genus in most of the eastern Nearctic region, except at northern localities.

BIOLOGY. Nests in borings in wood, hollow twigs, and other suitable cavities like old *Polistes* cells, corrugated cardboard, etc. Uses mud or firmly agglutinated sand for cell partitions and closing plugs. Prey are caterpillars of Oecophoridae, Tortricidae, Gelechiidae, Pyralidae, Crambidae (Pyraustinae) and Thyrididae (Krombein 1967, 1979).

29. *Euodynerus hidalgo* (de Saussure, 1857)

Figs B5.21, 55; C29.1–5.

SPECIES RECOGNITION. This distinctive species is immediately recognised by the reflexed, lamellate, translucent apical margins of terga 2 and 3. In other species the margin of tergum 3 is never reflexed. Tergum 2 has a reflexed apical margin in a few other species, where it can be either thickened (*E. auranus*, *E.* sp. G, *E. castigatus*) or thin and more or less translucent (some species of *E. foraminatus*-group).

VARIATION. Fore wing length 8–9 mm (♂♂), 8.5–10.5 mm (♀♀). Interantennal spot in male extending to clypeus, sometimes interrupted at middle by transverse black stripe. Yellow stripe along lower inner orbit ending at level of antennae in female, usually continued to clypeus in male but often interrupted at level of antennae. Yellow markings of head sometimes slightly suffused with reddish in female, postocular spot usually completely ferruginous, sometimes (more often in male) with yellow centre. Yellow pronotal band usually extending to humeral angle, rarely restricted to middle third of pronotum (laterally replaced by ferruginous), with or without narrow ferruginous posterior border, ferruginous area rarely broad and extending to middle of pronotum posteriorly. Dorsal spot of mesopleuron small, rarely absent in female (often absent in male), rarely suffused with ferruginous. Scutellum rarely with a pair of small ferruginous spots near lateral margins. Metanotum with transverse yellow band usually well developed, rarely obscure. Ferruginous propodeal spots present or absent on upper surface, occasionally large, especially in male. Metasomal terga 1–3 with yellow apical fasciae, in male medial remnant of fascia often present on tergum 4. Tergum 1 with an often very narrow ferruginous area bordering yellow apical fascia, more conspicuous laterally. Sternum 2 with posterolateral yellow spots in female (rarely with complete but obscure fascia); sterna 2(–4) of male with complete fascia or posterolateral spots, gradually less developed on more posterior segments, sometimes brownish and ill-defined.

DISTRIBUTION. Canada: newly recorded for ON and BC. Transcontinental in U.S., in the east north to MA, NY, PA, OH (Bequaert 1937, Krombein 1979). Mexico: south to Morelos and Jalisco (Rodríguez-Palafox 1996). The northeastern subspecies is *boreoorientalis* (Bequaert, 1937). The nominate subspecies and spp. *viereckii* (Cameron, 1909) occur in the west.

BIOLOGY. Nests in borings in wood and uses firmly agglutinated sand as cell partitions and closing plugs. Specimens from the western part of its range (which have been attributed to different subspecies) were found to nest in mud cells (probably of an anthophorine bee) within a burrow in a clay bank, in old *Sceliphron* (Sphecidae) nests, or in mud nests built in an abandoned *Polistes* nest. Prey are Pyralidae (Phycitinae) caterpillars (Krombein 1967, 1979).

30. *Euodynerus leucomelas* (de Saussure, 1855)

Figs B5.10, 13, 16, 17, 44, 49; C30.1–6.

TAXONOMIC NOTE. The specimens treated here as the 'yellow colour form' of *E. leucomelas* present a difficult taxonomic problem. Specimens with these characteristics are rare in collections (ca. 30 specimens examined), and have so far been found only in Ontario and the following states: NH, OH, NJ, MD, WV, NC, and FL. Morphologically they are not clearly separable from *Euodynerus fedoris* (Bohart, 1945) **stat. n.**, a taxon described and recorded only from Texas. *Euodynerus fedoris* is currently treated as a synonym of "*Euodynerus foraminatus blakeanus*" (Krombein 1979) but actually represents a species different from both *E. foraminatus* and *E. blakeanus* (species status see above). All three species occur sympatrically in Lee Co., Texas (material at USNM and BMNH) where they can be separated without difficulty based on structural and colour characters. Typical *E. fedoris* from Texas are similar to *E. blakeanus* but differ from the latter in the same way as *E. leucomelas* (see couplets 7–13 of *Euodynerus* key), except for the fact that some females show small yellow apical clypeal spots. In addition, females and most males of *E. fedoris* lack black markings on the femora and

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on the scape (present in *E. blakeanus*). Yellow markings of *E. fedoris* from Texas are even more extensive than in *E. blakeanus* from Texas. The only characters that distinguish *E. fedoris* from the 'yellow colour form' of *E. leucomelas* are the greater extent of yellow markings and replacement of black markings on legs and scape by reddish markings. This might be due merely to geographic variation as more extensive yellow markings are also observed in Texan populations of *E. blakeanus* (but not in Texan *E. foraminatus* s. str!). Due to the scarcity of material in collections and insufficient sampling in Gulf Coast states we are presently unable to determine with certainty whether *E. fedoris* is a good species or merely a southern geographic race of *E. leucomelas*. If the former is true then what is interpreted here as the 'yellow colour form' of *E. leucomelas* might in fact be a northern race of *E. fedoris*.

SPECIES RECOGNITION. This species is most similar to *E. planitarsis*, with which it shares the ivory colour of its pale markings and the presence of well-developed apical fasciae on at least terga 1–4. The yellow colour form, which is rare in the northeastern Nearctic closely resembles *E. blakeanus* and *E. foraminatus*. *Euodynerus leucomelas* differs from these three species by the characters given in the key. *Euodynerus leucomelas* and *E. blakeanus* are the only eastern Nearctic species in the *foraminatus*-group with relatively small flagellomere XI and short-haired ventral surface of the fore femur.

VARIATION. Fore wing length 6–8 mm (♂♂), 8–9.5 mm (♀♀). Pale markings usually ivory, sometimes pale yellow (especially in male), rarely bright yellow as in *E. foraminatus*. The yellow form of *E. leucomelas* was previously unrecognised and has been confused with *E. blakeanus* and *E. foraminatus*. Only four specimens (3 ♂♂, 1 ♀) of the bright yellow form are known from eastern Canada. The percentage of yellow specimens seems to increase southward, but one bright yellow male was collected as far north as Sudbury, Ontario. Towards the southern limit of its range the yellow form might be only form that occurs. In bright yellow specimens the pale markings are much more extensive, which is especially obvious in the female.

Female clypeus usually black, sometimes with a pair of dorsal spots, rarely confluent (usually with arcuate dorsal spot yellow colour form). Scape black, with pale stripe below in yellow colour form. Female mesopleuron with small or large pale dorsal spot. Female rarely with a pair of small pale spots on scutellum. Female tegula almost always marked with pale posteriorly and often anteriorly, in male pale markings often very reduced, sometimes absent. Parategula usually marked with pale in female, usually black in male (usually marked with pale in yellow colour form). Propodeum sometimes with pale spots on dorsal surface and on ventral half of lateral ridge in yellow colour form. Metasomal terga 1–4 always fasciate, in female sometimes also tergum 5 medially, in male tergum 5 usually and middle of 6 sometimes. Apical fascia of tergum 2 hardly extended forward on sides, except in yellow colour, where the apical fascia typically forms a subtriangular anteromedially directed extension from both sides. Female sterna 2, 3 and rarely 4 with posteroapical pale spots, rarely absent on 3 (in yellow colour form sterna 2–4 with spots); male sterna 2–4 and sometimes 5 with posterolateral pale spots, on sternum 2 usually extended towards middle and sometimes forming complete fascia; apical fascia complete on male sternum 2 in yellow colour form and sometimes also on one or more of the following sterna (present on sterna 2–6 in extreme cases). Female tibiae usually black, sometimes more or less extensively marked with pale on outer surface (especially hind and mid tibia), but tibiae almost completely yellow in yellow colour form. Female tarsi predominantly black; yellow to reddish in yellow colour form.

DISTRIBUTION. Canada: all provinces (not recorded from LB), YT. Northern and western U.S., south to NC, TN in the east and NM, AZ in the west (Krombein 1979). The western ssp. *oregonensis* (Bohart, 1948) ranges from WY to WA and south to OR and NV.

BIOLOGY. Nests in cavities in sumac twigs. Nest partitions and closing plugs are made of mud. Caterpillars of Crambidae (Pyraustinae), Pyralidae, Pterophoridae, Tortricidae, Gelechiidae, Geometridae, Nolidae and Erebidae (Herminiinae, formerly Noctuidae) are used as prey (Fye 1965, Krombein 1979). All prey records stem from trap nest experiments conducted by Fye (1965). Because Fye did not separate *E. leucomelas* from the closely related *E. planitarsis* (material examined in CNCI), there remains some doubt about the correct prey associations.

31. *Euodynerus megaera* (Lepeletier, 1841)

Figs B5.3, 6, 8, 40, 45; C31.1–5.

SPECIES RECOGNITION. *Euodynerus megaera* is very similar to *E. schwarzi*, from which it can be separated by the characters given in the key. Krombein (1962) separated both species based on colouration of the tibiae, development of the propodeal carina and male genitalia. The first two characters are quite variable and do not always

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allow separation of the two species. Many males of *E. megaera* have the outer surface of the tibiae as extensively pale-marked as *E. schwarzi*. Development of the propodeal carina is difficult to quantify, and specimens of *E. megaera* with weakly developed carina are hardly distinguishable from *E. schwarzi* with well-developed carina. Unless the genitalia are examined reliable identification of males is only possible through the newly discovered characters of the flagellum.

VARIATION. Fore wing length 8–10 mm (♂♂), 9.5–12.0 mm (♀♀). The hind margin of tergum 2 varies from being slightly thicker than that of tergum 3 to considerably thickened, especially in the male (thickness of hind margin up to 0.6x mid ocellar diameter). Female clypeus with a pair of ivory dorsal spots, often confluent, sometimes absent; male clypeus ivory, usually with narrow black or brownish apical margin, sometimes black margin wider, rarely apical third with irregular black mark. Female scape black, sometimes with obscure reddish white stripe below. Mesopleuron of both sexes with well-developed ivory dorsal spot. Tegula mainly black, frequently with ivory spots anteriorly and/or posteriorly. Parategula usually marked with ivory, sometimes suffused with reddish or completely black. Scutellum sometimes with a pair of small ivory spots. Terga 1 and 2 with apical fasciae; in male terga 3 and 4 often with posterolateral spots, rarely with complete fasciae, tergum 5 rarely with apicomedial spot. Apical fascia of tergum 1 expanded forward to a variable degree near lateral margin. Sternum 2 with a pair of ivory spots in posterolateral corners, rarely absent in female; in male sometimes one or more of the following sterna (up to sternum 5) with posterolateral spots. Female femora and tibiae black, in male highly variable, completely black to extensively ivory-marked including posteroapical spot and (postero-)ventral stripe on apical 2/3 of fore femur, anterior stripe on apical third of mid femur, dorsoapical spot on hind femur, and entire anterior surface of all tibiae (occasionally suffused with reddish).

DISTRIBUTION. Canada: newly recorded from ON. Eastern U.S.: NY, PA and IL south to FL, west to OK and eastern TX (Krombein 1979).

BIOLOGY. Nests in borings in wood and uses agglutinated sand or less commonly mud for closing plugs and cell partitions. Preys on caterpillars of Tortricidae, Crambidae (Pyraustinae), Pyralidae (Epipaschiinae, Phycitinae), Amphisbatidae, and Erebidae (Herminiinae, formerly in Noctuidae) (Krombein 1967, 1979).

32. *Euodynerus planitarsis* (Bohart, 1945)

Figs B5.11, 47; C32.1–4.

SPECIES RECOGNITION. This species is very similar to *E. leucomelas*, from which it can be distinguished by the characters given in the key. An additional character, which is especially useful for identifying females, is the development of the costal scale. It is better developed, i.e., more convex in anteroventral view and with more acute edge in *E. planitarsis* than in *E. leucomelas*. The difference between the two species is very subtle, and requires comparative material.

VARIATION. Fore wing length 7–9.5 mm (♂♂), 9.5–10.5 mm (♀♀). Hind margin of tergum 2 usually at least slightly thicker than that of tergum 3 (thickening more pronounced in males than in females), width of thickening in some males up to 0.3x mid ocellar diameter. Female clypeus usually with a pair of dorsal spots, rarely confluent or absent. Scape black, usually with more or less extensive ill-defined pale mark beneath near apex, the mark usually dusky or somewhat reddish. Mesopleuron in female usually, in male sometimes with small or large pale dorsal spot. Female rarely with a pair of small pale spots on scutellum. Tegula marked with pale posteriorly and often anteriorly, the pale markings usually more reduced in male. Parategula marked with pale, the markings more reduced but rarely absent in male. At least metasomal terga 1–4 fasciate, in female usually also tergum 5 medially, in male tergum 5 always and middle of 6 frequently. Apical fascia of tergum 2 usually not extended forward on sides, the forward extension, if present, small and oblique. Female sternum 2 with complete apical fascia, sometimes with small interruption(s); sterna 3, 4 and rarely 5 with posteroapical pale spots; male sterna 2 and 3 with complete apical fascia, and sterna 4–6 with posteroapical pale spots, sometimes confluent and forming complete fascia on 4 and 5. Female mid and hind tibia with a dorsal ivory stripe extending over most of its length (rarely only half length); fore tibia with or without pale marking, if present often obscure or suffused with reddish.

One aberrant male from Dyers Bay, Bruce Co., Ontario, has large pale discal spots on sternum 2, which are connected to the apical fascia posterolaterally.

DISTRIBUTION. Canada: NS to BC, newly recorded for SK, NT. Mostly northern U.S.: ME, NH, MI, WI, MN, CO (Bohart 1945, Krombein 1979).

BIOLOGY. Unrecorded. Fye (1965) described the biology of the closely related *E. leucomelas* (see above). Examination of his material (deposited at CNCI) revealed that his observations were actually based on a mixture of both *E. leucomelas* and *E.*

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planitarsis. Both species appear to have a very similar biology.

33. *Euodynerus pratensis* (de Saussure, 1870)

Figs B5.56; C33.1–4.

SPECIES RECOGNITION. *Euodynerus pratensis* stands out among all Nearctic *Euodynerus* because of its largely impunctate tergum 2 (excluding the coarsely punctate apical fascia). Further diagnostic characters include: scutellum and apical portions of terga 2–6(7) with long, erect hairs (hair length distinctly greater than one mid ocellar diameter; long hairs also present in *E. boscii* but covering terga completely including tergum 1); submarginal carina of propodeum angularly produced (character shared with *E. boscii* and *E. annulatus*); male fore femur with a weak, inconspicuous swelling ventrally in basal half (similar but better developed in *E. boscii*); male flagellomere XI relatively small and slender, neither flattened nor apically expanded (larger and slightly flattened in *E. boscii*; distinctly larger, apically expanded and conspicuously flattened in *E. annulatus*).

VARIATION. Fore wing length 8.5–11.5 mm (♂♂), 10.5–12 mm (♀♀) (Bequaert 1936, and own observation). Specimens from the northwestern part of the range (WA and ID south to northeastern CA, NV) are mainly black and yellow with very limited amounts of ferruginous. Elsewhere the species is mostly ferruginous and yellow with very restricted black markings. The latter form is the one that has been recorded from Ontario.

DISTRIBUTION. Canada: recorded from ON by Bohart (1951). Western U.S.: WA and ID to CA, east to KS, TX (Krombein 1979). Mexico: Tamaulipas, Nuevo León, Baja California (Rodríguez-Palafox 1996). The ssp. *brumalis* (Bequaert, 1936) ranges from ID and WA to CA and NV. Bohart (1951) published neither a specimen depository nor further locality data for his record from Ontario. During this study no eastern Nearctic material of *E. pratensis* was found. The occurrence of this western species in Ontario appears highly unlikely. It seems possible that Bohart's record is based on misinterpreted or wrong label data.

BIOLOGY. Nests in borings in wood and *Sambucus* stems. Cell partitions and closing plugs are made out of mud. Caterpillars serve as prey (Krombein 1967, 1979).

34. *Euodynerus schwarzi* (Krombein, 1962)

Figs B5.7, 9, 41, 46; C34.1–4.

SPECIES RECOGNITION. *Euodynerus schwarzi* is very similar to *E. megaera*, from which it can be separated by the characters given in the key. The differences between the two species are discussed under *E. megaera*.

VARIATION. Fore wing length 8–9.5 mm (♂♂), 9.5–12.0 mm (♀♀). The hind margin of tergum 2 varies from being slightly thicker than that of tergum 3 to considerably thickened, especially in the male (thickness of hind margin up to 0.7x mid ocellar diameter). Female clypeus with an arched ivory dorsal spot; male clypeus ivory, usually with narrow black or brownish apical margin, often dilated to form a small black mark between apical teeth. Female scape obscure reddish white below (at least in distal half), rarely in part clear ivory. Mesopleuron with small to large ivory dorsal spot, usually smaller in male than in female. Tegula mainly black, usually with ivory spots anteriorly and/or posteriorly. Parategula with or without ivory mark, sometimes suffused with reddish or completely black. Scutellum sometimes with a pair of small ivory spots. Terga 1 and 2 with apical fasciae; in male terga 3 and 4 often with posterolateral spots, tergum 5 rarely with apicomedial spot. Apical fascia of tergum 1 with more or less straight anterior margin, sometimes with moderate forward extension at extreme sides. Sternum 2 with a pair of ivory spots in posterolateral corners; in male sternum 3 and sometimes 4 and 5 with posterolateral spots, as well. Femora black, often marked with ivory in male: fore femur with posteroapical spot and (postero-)ventral stripe in apical half, mid femur with anterior stripe in apical third. Anterior surface of all tibiae largely to completely ivory.

DISTRIBUTION. Canada: newly recorded from ON. Eastern U.S.: NJ and PA south to SC, west to OK and eastern TX (Krombein 1979; newly recorded from SC and TX based on material in DEBU).

BIOLOGY. Nests in borings in wood and uses mud for cell partitions and closing plugs. At Rondeau Provincial Park, Ontario, one female was observed scraping dry clay from the disturbed ground of a rarely frequented woodland trail. Prey consists of caterpillars of Tortricidae, Crambidae (Pyraustinae) and Amphisbatidae (Krombein 1967, 1979).

35. *Euodynerus* sp. F

Figs B2.29; B5.15, 43, 50; C35.1–7.

SPECIES RECOGNITION. This species is similar to the common and widespread *E. foraminatus*, from which it can be separated by the characters given in the key.

VARIATION. Fore wing length 8.0–9.0 mm (♂♂), 9.0–11.0 mm (♀♀). Female clypeus with a pair of yellow dorsal spots, completely black in

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about one third of specimens; male clypeus yellow, with narrow black or brownish apical margin, sometimes with a small black apical spot, or with a pair of irregular discal spots. Female scape below more or less ferruginous, brownish, or dirty yellow, sometimes partially bright yellow. Mesopleuron usually completely black, in some females with a small yellow dorsal spot. Tegula translucent reddish except black basal section, rarely with small and often obscure yellow spots anteriorly and/or posteriorly. Hind margin of parategula often narrowly obscure reddish. Terga 1 and 2 with apical fasciae, in male sometimes also with narrow, subinterrupted fasciae on terga 3 and 4, in female rarely with a pair of spots in posterolateral corners. Apical fascia of tergum 1 usually expanded forward near lateral margin. Sternum 2 with a pair of yellow spots in posterolateral corners, posterolateral spots on sternum 3 often present in male, rarely in female, the following sterna up to sternum 6 rarely spotted as well in male.

DISTRIBUTION. Apparently widely distributed in the eastern Nearctic but rare. Canada: southwestern Ontario (Kent, Essex, and Lambton Cos.). Eastern and midwestern U.S.: MI (1 ♀, Wayne Co., Dearborn; photographic record: Bugguide), IL (1 ♀, Lake Co., Reed Turner Woodland; Fig. 35.6, see also Bugguide), MD (1 ♀, Baltimore Co., USNM), DC (1 ♀, USNM), VA (2 ♂♂, Black Pond and Alexandria, USNM), NE (1 ♀, Sarpy Co., Bellevue; Fig. 35.7, see also Bugguide) and AR (1 ♀, Fulton Co., Mammoth Spring; FSCA).

BIOLOGY. Unknown. Probably nests in borings in wood like other members of the *E. foraminatus*-group. Most of the females collected by the senior author were scraping dry clay from the disturbed ground of a rarely frequented woodland trail.

36. *Euodynerus* sp. G

Figs B5.37, 39, 61; C36.1–4.

Rygchium boscii boscii sensu Bohart, 1939*a*, nec (Lepeletier, 1841) (partim)

Euodynerus auranus aquilus Bohart in Bohart & Menke, 1974 (partim, excluding type material)

TAXONOMY. This undescribed species has previously been confused with its western sibling species *E. auranus*. Bohart (1939*a*) included in his concept of "*E. boscii boscii*" (misidentification) both *Euodynerus* sp. G as well as northeastern, southeastern and Mexican fringe populations of *E. auranus* (specimens from MI, TX and Coahuila, Mexico). After recognising the true identity of *E. boscii* (a valid species, see above) Bohart (in Bohart and Menke 1974) described the nameless entity as *E. auranus aquilus* Bohart. His concept of the subspecies remained more or less unchanged, i.e., he continued to include both eastern/southern *E. auranus* and *Euodynerus* sp. G under the new name. However, the holotype (examined, UCDC) and all 17 paratypes (8 examined, UCDC) pertain to southeastern populations of *E. auranus*, still leaving the eastern sibling species of *E. auranus*, *Euodynerus* sp. G, without a name.

Except in the south, the two species appear to be well separated geographically. There are no records of either of the two species between southwestern Ontario and Long Island, New York, or between the Appalachians and the Mississippi River. In Texas, however, both species occur in very close proximity even though a range overlap has not yet been detected.

Separate species status for the two species appears not only justified because of the subtle yet reliable morphological differences but also because of the strikingly different colour patterns in the southern contact zone. *E. auranus* occurs in a multitude of very divergent geographic colour forms throughout its extensive range, some of which (i.e., the northeastern form that occurs in Ontario and Michigan) are practically identical to the typical colour form of *Euodynerus* sp. G. The latter shows little variation except for a more extensively red-marked form from peninsular Florida. In Texas, where the ranges of the two species meet, *E. auranus* occurs in a form with abundant yellow and ferruginous markings (e.g., 1 ♂, Austin, UCDC), whereas *Euodynerus* sp. G maintains its largely black colour with restricted yellow and ferruginous markings (1 ♂, Lee Co., located just east of Austin; UCDC) that is typical for most of its range. The close proximity of such divergent colour forms can probably be taken as a good indicator for the genetic isolation between the two species.

SPECIES RECOGNITION. See under *E. auranus*.

VARIATION. Fore wing length 7.5–8.5 mm (♂♂), 8.5–11.0 mm (♀♀). Punctation of tergum 1 somewhat variable, quite sparse. Apical reflex and punctation of apical fascia of tergum 2 also variable, on average stronger in male than in female. Female clypeus either with a pair of more or less separated basal yellow spots or a large basal crescent-shaped mark; apex narrowly reddish to yellowish, sometimes with small yellow spot(s). Interantennal spot of female entire, in male extending to clypeus but either narrowed or interrupted below prominence. Mandible largely reddish in female, with yellow basal spot. Spot on upper mesopleuron sometimes absent in male. Scutellum with a pair of yellow spots (sometimes suffused with ferruginous), occasionally absent in male. Metanotum black in specimens examined by

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us. Yellow propodeal spots usually large, sometimes smaller in male. Metasomal terga 1–3 with yellow apical fasciae in female; in male terga 1(–3)–4 fasciate. Tergum 1 usually with very restricted ferruginous markings, sometimes better developed on lateral forward extension of apical fascia. Sternum 2 with yellow apicolateral spots in female, other sterna black; in male fasciae usually complete on sternum 2 and sometimes 3.

DISTRIBUTION. Not recorded from Canada. We have examined material from the following states in the U.S.: MA, NY (Long Island), NJ, VA, WV, GA, FL and TX (Lee Co.). Bohart's (1939*a*) records (as *E*. "*boscii boscii*", misidentification) pertain in part to *E. auranus* (records from MI, Austin, TX and Mexico), in part to this new species (NJ and MA).

BIOLOGY. Unrecorded. Based on the presence of rake setae on the female fore basitarsus and the close relationship with *E. auranus* (see above) there is little doubt that this species is ground-nesting. Very likely the nest is built in sandy soils as is the case in *E. auranus* (see also General Part – Morphology).

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***Leptochilus* de Saussure**

A primarily Holarctic genus with 55 Nearctic species (north of the Isthmus of Tehuantepec) and 38 species north of Mexico (Parker 1966). Most species have a southwestern distribution, and only five species occur in the eastern Nearctic, two of which reach the northeast and one eastern Canada.

REFERENCE. – Parker, 1966 (revision of Nearctic species, key).

37. *Leptochilus acolhuus* (de Saussure, 1857)

Figs B2.22; B6.1, 3, 4, 7; C37.1–4.

SPECIES RECOGNITION. See key, and notes under the following species.

VARIATION. Fore wing length ca. 5 mm. The colouration of this species varies greatly across its range, and Parker (1966) distinguished five different colour forms. Specimens from the eastern Nearctic (excluding Florida) have black bodies with orange-yellow markings.

DISTRIBUTION. Not recorded from Canada. U.S. from MA and NJ in Atlantic coast states south to FL, also TX, AZ. Mexico, Guatemala, Costa Rica (Parker 1966).

BIOLOGY. Has been observed once to prey upon a leaf-mining caterpillar of Gracillariidae (Krombein 1964). Nest site unknown. Another species of the same species group from southern Mexico was seen entering beetle burrows in a fallen log (Parker 1966).

38. *Leptochilus republicanus* (Dalla Torre, 1889)

Figs B2.23, 41; B6.2, 5, 6; C38.1–7.

SPECIES RECOGNITION. Besides characters given in the key *L. republicanus* differs from *L. acolhuus* as follows: Clypeus strongly convex, its free apical margin hardly produced (weakly convex, with strongly produced apical margin); tergum 1 not overlapping sternum 1 on petiolate base, i.e., lateral margins of tergum 1 separated from each other by 2x mid ocellar diameter (overlapping sternum 1 on petiolate base, lateral margins separated by one mid ocellar diameter).

VARIATION. Fore wing length 5.5–6.5 mm. The body of northeastern specimens is black with yellow markings. Southern specimens also have red markings, especially replacing black areas of tergum 1. The extent of yellow markings in northeastern specimens is relatively constant: In females, the yellow clypeal spot varies from very small to covering more than half of the clypeus; the apical fascia of tergum 3 is usually more or less developed but sometimes absent.

DISTRIBUTION. Canada: newly recorded from southern Ontario. Eastern U.S.: MA and NY in Atlantic coast states south to FL, also NE, CO, KS, TX (Parker 1966). The new Ontario records represent a significant range extension with the closest previously known localities in extreme southeastern parts of NY and PA. The species has not been recorded from either OH or MI.

BIOLOGY. Nests in hollow twigs of *Rhus* and *Sambucus*. Nest partitions are made from an inner plug of macerated pith and an outer plug of sand; closing plugs are made of sand (Parker 1966). Prey are leaf-mining larvae of Chrysomelidae, Buprestidae and Curculionidae (Krombein 1979).

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***Monobia* de Saussure**

This primarily Neotropical genus includes seven Nearctic species (north of the Isthmus of Tehuantepec) and three species north of the Mexican border, two of which are restricted to southern Texas (Porter 1981).

REFERENCE. – Porter, 1981 (key to species north of Mexico).

39. *Monobia quadridens* (Linnaeus, 1763)

Figs B1.6; B2.25, 28, 43; C39.1–5.

SPECIES RECOGNITION. *Monobia quadridens* is the only eumenine wasp in eastern Canada with a single, broad, apical fascia on tergum 1 but otherwise black metasoma. *Euodynerus bidens*, which occurs in the eastern U.S. as far north as Minnesota and New Jersey, strongly resembles *M. quadridens* in size and colouration but can be distinguished by the evenly rounded posterolateral margin of the tegula (bluntly angled in *M. quadridens*), truncate clypeal apex without distinct lateral teeth (shallowly emarginate with distinctly projecting lateral teeth) and evenly rounded base of sternum 2 (abruptly angled).

VARIATION. Fore wing length 11.0–14.5 mm (♂♂), 14–18 mm (♀♀). The following ivory markings are sometimes present: a small spot on male scape, a pair of lateral (rarely paramedian) spots on scutellum (rarely an almost complete transverse band), small spots on dorsal surface of propodeum (especially in males), traces of apical fascia on male tergum 2, and a small spot near base of fore tibia dorsally.

DISTRIBUTION. Canada: southern Ontario. Eastern U.S.: NH to FL, west to WI, KS, NM (Krombein 1979). Northern Mexico: Tamaulipas, Nuevo León (Porter 1981, Rodríguez-Palafox 1996). The occurrence of this species in Canada was apparently never mentioned in the literature, but identified material has been present in Canadian collections for a long time.

BIOLOGY. Nests in various types of cavities like abandoned carpenter bee tunnels, hollow stems, old mud dauber nests and rarely in old burrows of ground-nesting bees. Nest partitions and closing plugs are made of mud or agglutinated sand (Krombein 1967). Prey consists of Micro-lepidoptera caterpillars of Pyralidae (Phycitinae, Epipaschiinae), Crambidae (Pyraustinae), Elachis-tidae (Stenomatinae), Amphisbatidae, Gelechiidae and Tortricidae (Krombein 1967, 1979).

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***Odynerus* Latreille**

The North American fauna includes four species, three of which are restricted to the western U.S. (Krombein 1979).

REFERENCE. – Bohart, 1939*b* (key to Nearctic species).

40. *Odynerus dilectus* de Saussure, 1870

Figs A4.2; B2.8, 14, 16, 18, 36; C40.1–6.

SPECIES RECOGNITION. *Odynerus dilectus* superficially resembles certain pale-marked species of *Euodynerus* and *Ancistrocerus*. The former differs from *O. dilectus* by the presence of a sharply defined and continuous pronotal carina (at most very vaguely indicated in *O. dilectus*), the latter by the presence of a transverse carina of tergum 2 (absent). The male of *O. dilectus* is highly distinctive by its deeply emarginate clypeal apex, deep emargination between second and third mandibular tooth, coiled apical four flagellomeres, ventrally depressed fore femur, two deep, ventral emarginations of mid femur, clavate mid tibia and sternum 2 with a low, sparsely punctate, median swelling. The female has widely separated cephalic foveae each of which is bordered by a fine carina posteriorly. The propodeum of *O. dilectus* is evenly rounded laterally without a clearly defined posterior concavity.

VARIATION. Fore wing length 6.0–8.0 mm (♂♂), 6.0–9.0 mm (♀♀). Female clypeus entirely black, very rarely with a pair of small lateral spots, in one specimen from NT connected by an evanescent, interrupted, crescent-shaped mark along dorsal margin. Narrow pale spot along inner orbit extending to from ventral margin of eye emargination to clypeus, sometimes interrupted at level of antenna or restricted to ventral margin of eye emargination. Interantennal spot transverse in male, usually medially divided and small in female. Pronotal band usually somewhat expanded posteriorly on each side, sometimes almost linear, almost always entire but medially divided in one female. Scutellum very variable, completely black to marked with a well-developed transverse, usually anteriorly emarginate, pale band, often with a pair of pale lateral spots or an irregularly interrupted band. Metanotum usually black, sometimes with a pair of lateral pale spots (very rarely almost coalescent); markings of scutellum and metanotum on average better developed in male than in female. Mesopleuron sometimes with a pale dorsal spot in male (rarely in female and then usually evanescent). Male tegula marked with pale posteriorly and usually anteriorly, rarely completely pale except hyaline spot; female tegula darker on average, never completely pale, in some specimens dark brown and lacking pale markings. Terga 1–(3)4 or 5 (female) or 1–(5)6 (male) with apical fasciae. Sternum 2 with interrupted or sometimes entire apical fascia, sternum 3 (and rarely 4) with pale apicolateral spots.

DISTRIBUTION. Canada: AB (Krombein 1979) and YT (Finnamore 1997), newly recorded for NB, QC, ON, MB, SK, BC, NT. Northern and western U.S.: NY, MN, AK; WA and MT to CA and NM in Canadian life zone (Krombein 1979).

BIOLOGY. This species nests gregariously in the ground and constructs mud turrets over the nest entrance. The turrets are usually straight (curved in ca. 20% of cases), and vary in length from 1.2–3.0 cm. Each nest contains 3–7 cells. Prey are alfalfa and clover weevil larvae (*Hypera postica* (Gyll.), *H. punctata* F.; Curculionidae), exceptionally caterpillars (Bohart *et al*. 1982, Schaber 1985).

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***Pachodynerus* de Saussure**

This primarily Neotropical genus is represented in North America by five species, four of which occur only in the southern United States (FL, TX to CA) (Carpenter 1986*b*). One species is endemic to eastern North America.

REFERENCES. – Willink and Roig-Alsina, 1998 (revision, key); Carpenter, 1986*b* (key to Nearctic species).

41. *Pachodynerus erynnis* (Lepeletier, 1841)

Figs A4.1, 3; B2.20, 37; C41.1–5.

SPECIES RECOGNITION. Habitus similar to *Euodynerus* but easily distinguished from that genus both by structure and by colour. *Pachodynerus erynnis* differs from other eastern Canadian Eumeninae by the presence of a complete humeral carina that reaches the hind margin of the pronotum, the strongly developed and sharp-edged propodeal carina, which curves anteriorly about midway between the propodeal angle and the submarginal carina, and the simple, 10-segmented male flagellum. The colouration is unique in completely lacking pale (yellow or ivory) markings on the meso- and metasoma (*Leptochilus acolhuus* from the southeastern U.S. are similarly coloured but structurally very different). Yellow markings are only present in the male and restricted to the clypeus, labrum, interantennal spot, and inner orbits above clypeus. Both male and female are extensively marked with ferruginous, including scape, pedicel and basal three flagellomeres, most of mandible, pronotum, metanotum and metasomal segment 1 (excluding anterior vertical surface of tergum 1), tegula, legs (excluding most or all of coxae), upper surface of propodeum, and apical fasciae on tergum and sternum 2.

VARIATION. Fore wing length ca. 9 mm (♂♂), 10.5–11 mm (♀♀). The ferruginous markings sometimes have a yellowish tinge, especially the lower surface of the scape, the metanotum, apical fasciae of tergum and sternum 2. Fascia of sternum 2 sometimes interrupted medially. Apical segments of metasoma sometimes marked ferruginous.

DISTRIBUTION. The core range of this species includes the Atlantic and Gulf coast states from NC to FL and west to LA (Willink and Roig-Alsina 1998). Outside this range the species has only been found three times: in DC (Bohart 1951), MA (Krombein 1979) and southern Ontario (new record). The record from Washington D.C. was considered an introduction by Bohart (1951), the specimen from Massachusetts was collected after a storm (Krombein 1979). Even though the collection of the specimen from Rondeau Prov. Pk., Ontario, was not preceded by any major tropical storms its occurrence in the province is probably adventitious.

BIOLOGY. Nests in pre-existing cavities such as borings in dead wood and old cynipid galls. In Florida the species also uses old mud nests of the introduced Neotropical eumenine *Zeta argillaceum* (L.) (Matthews and González 2004). Nest partitions and closing plugs consist of firmly agglutinated sand. Prey are caterpillars of Erebidae (Herminiinae, formerly in Noctuidae), Pyralidae (Phycitinae, Chrysauginae), Oecophoridae, Amphisbatidae, Elachistidae (Stenomatinae), Coleophoridae and Tortricidae (Krombein 1967, 1979).

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***Parancistrocerus* Bequaert**

Parancistrocerus is primarily a New World and Oriental genus with one species in the Palaearctic. The North American fauna consists of 25 species (updated from Krombein 1979; see taxonomic note under *P. fulvipes*), nine of which occur in the northeast. Five species are recorded from eastern Canada.

REFERENCES. – Bohart, 1952 (key to Nearctic species), 1948*b* (key to Florida species of *Parancistrocerus* and *Stenodynerus*).

42. *Parancistrocerus bicornis* (Robertson, 1901)

Figs B7.7, 48; C42.1–5.

SPECIES RECOGNITION. This is the only species of the genus in the area covered by the key with an eye-lid like swelling behind the mid ocellus. The character is shared by several species of *Stenodynerus* (including *S. blepharus* which occurs in Ontario). From these species *P. bicornis* is distinguished by the strongly developed and medially uninterrupted pronotal carina, and the scattered long hairs on the summit and dorsal surface of tergum 1 (the only other species with long hairs are *P. salcularis* and *P. leionotus*). Further diagnostic characters include: interocellar tubercles between hind ocelli well-developed, especially in male; weak, impunctate, ocular swellings at summit of eyes just behind level of hind ocelli (as in *Stenodynerus pulvinatus* and often *P. salcularis*); male flagellum yellowish to obscure reddish beneath (especially basal segments); pronotum with relatively large, smooth interspaces, appearing more polished than in most other species; scutum with yellow posteromedial spot (often absent in male); male mid femur without anteroventral depression near base; terga 1 and 2 with discal spots (often absent on tergum 2 or both terga in male); summit of tergum 1 with an irregular transverse carina formed by enlarged confluent punctures followed by smooth area; hind margin of tergum 2 distinctly thickened (often very strongly in male).

VARIATION. Fore wing length 5.5–7.0 mm (♂♂), 6.5–7.5 mm (♀♀). Variation otherwise not studied.

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: MI and NY south to FL and AR, west to AZ (Krombein 1979). The bright yellow-marked form that occurs across most of the range of the species is ssp. *ceanothi* (Rohwer, 1912). The nominate subspecies from Florida has reddish markings; ssp. *cushmani* (Bohart, 1949) from western TX to AZ has pale yellow markings (Fig. 42.5).

BIOLOGY. Subspecies *cushmani* nests in borings in wood and uses mud for nest partitions and closing plugs. The prey has not been recorded (Krombein 1967, 1979).

43. *Parancistrocerus fulvipes* (de Saussure, 1855)

Figs B7.30, 52; C43.1–4.

Stenodynerus (*Parancistrocerus*) *vogti* Krombein, 1962, **new synonymy**

TAXONOMIC NOTE. *Parancistrocerus vogti* was described from a single, malformed female (wings deformed) reared from a trap nest from Plummers I., Maryland (holotype at USNM) and has apparently never collected since. Examination of the holotype suggests that it represents a stunted, abnormally developed specimen of *P. fulvipes*, a common species in Maryland. The specimen agrees with all the diagnostic characters of *P. fulvipes* mentioned in the key and following paragraph. It furthermore possesses a very deep acarinarium, another character typical for *P. fulvipes*. We interpret the differences between the holotype of *P. vogti* and normal *P. fulvipes* females (i.e., size only about 0.6x the normal size; transverse basal groove of sternum 2 with numerous longitudinal ridges; disc of sternum 2 not sloping down towards basal groove, more or less straight in profile and more or less at same level with groove; tergum 1 shortened) as developmental abnormalities, possibly as a consequence of malnourishment.

SPECIES RECOGNITION. This species can only be recognized by a combination of characters. Tergum 1 with well-developed discal spots, but discal spots completely absent from tergum 2. This colour pattern is otherwise only found in a few specimens of *P. bicornis* and *P. vagus* (both species usually have yellow spots on tergum 2). *Parancistrocerus fulvipes* differs from the former by the absence of a small, eye-lid like swelling behind the mid ocellus, and the presence of an anteroventral depression near the base of the male mid femur. It can be distinguished from *P. vagus* by the presence of a strongly developed transverse carina near the summit of tergum 1 followed by a smooth area, and the absence of several characters unique to *P. vagus* (see under that species). Further diagnostic characters of *P. fulvipes* are: male flagellum dark beneath except sometimes basal segment(s), which can be obscure reddish; interocellar tubercles between hind ocelli well-developed, especially in male; pronotal carina developed medially but low; posterior half of tergum 1 convex in lateral view (shared to a lesser degree by *P. vagus*, *P. bicornis*, *P. salcularis*); terga without apical fasciae beyond tergum 2 except

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sometimes in male; hind margin of tergum 2 slightly (female) to moderately (male) thickened.

VARIATION. Fore wing length 5.5–8.0 mm (♂♂), 7.5–8.5 mm (♀♀). Variation otherwise not studied.

DISTRIBUTION. Not recorded from Canada. Eastern U.S. west to MI, IL, KS, OK, TX (Krombein 1979). Mexico: Tamaulipas (Rodríguez-Palafox 1996). The reddish form that occurs from SC to FL was named ssp. *rufovestis* (Bohart, 1948).

BIOLOGY. This species uses a variety of pre-existing nest sites such as borings in wood, old mud dauber and *Polistes* nests, and abandoned burrows of ground-nesting bees, but it may also construct its own burrows in the ground. Mud or agglutinated sand is used for closing plugs and nest partitions. Prey are caterpillars of Tortricidae, Nolidae (Chloephorinae; formerly in Noctuidae), Crambidae (Pyraustinae) and Gelechiidae (Krombein 1967, 1979; Nelson 1968).

44. *Parancistrocerus histrio* (Lepeletier, 1841)

Figs B2.33; B7.32, 53; C44.1–5.

SPECIES RECOGNITION. Other *Parancistrocerus* and *Stenodynerus* with entirely black metasomal segments 3–6 differ as follows: *P. perennis* has a bluntly angulate sternum 2 (evenly convex in *P. histrio*), *S. histrionalis* has an uninterrupted pronotal carina (broadly rounded over medially in *P. histrio*), *P. fulvipes* has large yellow discal spots on tergum 1 (absent in *P. histrio* but sometimes with small ferruginous spots instead, or else disc of tergum 2 largely ferruginous), and *S. lineatifrons* and *S. histrionalis* have a pitted basal groove of tergum 2 (i.e., acarinarium absent; basal groove smooth and acarinarium present in *P. histrio*). Further diagnostic characters of *P. histrio* are: dorsal surface of pronotum very coarsely punctate and with small interspaces; propodeum very coarsely rugose with a distinct horizontal shelf-like area behind metanotum; male mid femur without distinct anteroventral depression near base; wings strongly infuscated at least in female; summit of tergum 1 with irregular, transverse carina formed by enlarged, confluent punctures; dorsal surface of tergum 1 essentially flat; hind margin of tergum 2 not thickened.

VARIATION. Fore wing length 6.0–7.0 mm (♂♂), 8.0–9.0 mm (♀♀). Variation otherwise not studied.

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: newly recorded from DE (1 ♀, Augustine Beach, 1 ♀, Fenwick I., both DEBU) and MD (1 ♀, Port Republic, CNCI; 2 ♂♂, 1 ♀, Assateague I., DEBU); DC to FL and LA (Krombein 1979).

BIOLOGY. Nests in borings in wood. Closing plugs and nest partitions are made from firmly agglutinated sand. Prey consists of caterpillars (Krombein 1967, 1979).

45. *Parancistrocerus leionotus* (Viereck, 1906)

Figs B2.12; B7.6, 28, 50; C45.1–5.

SPECIES RECOGNITION. This relatively large species is similar to *P. vagus*, but these species rarely occur together (distinction see under that species). The male of the similar *P. pedestris* lacks distinct ocellar tubercles and discal spots of tergum 1; both sexes have a medially interrupted pronotal carina (entire in *P. leionotus*) and tergum 3 usually lacks the apical fascia (if present, it is almost always interrupted).

VARIATION. Fore wing length 5.5–7.5 mm (♂♂), 6.0–8.0 mm (♀♀). Ocellar tubercles more strongly developed in male than in female, in the latter often not projecting above level of hind ocellus in lateral view. Long hairs near summit of tergum 1 sometimes quite sparse. Thickening of apical margin of tergum 2 variable, its thickness 0.4–1.1x mid ocellar diameter (male) or 0.2–0.7x mid ocellar diameter (female). Body with pale markings usually bright yellow but one male from Walpole I. with somewhat pale yellow markings. The only known female from Manitoba is marked with ivory and has a scarcely thickened apical margin of tergum 2, as described for the ssp. *yumus* (see below). Female clypeus with a pair of yellow dorsal spots, sometimes coalescent to form a crescent-shaped mark, rarely completely black or with an additional, smaller pair of ventral spots. Interantennal spot usually extending almost to clypeus in male, in female and some males restricted to area above interantennal tubercle. In male yellow spot along inner eye margin often extending to clypeus ventrally, sometimes interrupted at level of antenna. Postocular spot rarely absent in male. Transverse pronotal band sometimes more or less emarginate on each side. Scutum with a small to minute posteromedian spot in ca. one third of females. Propodeum in female with a pair of elongate spots from dorsum along lateral ridge to just above submarginal carina, sometimes interrupted near middle or rarely reduced to a dorsal or ventral spot, exceptionally almost completely black; male propodeum entirely black or with a pair of dorsal spots, very rarely with small ventrolateral spots as well. Terga 1–(4)5 (female) or 1–(5)6 (male) with apical fasciae, the one on tergum 3 not interrupted medially (except in

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one female). Discal spots of terga 1 and 2 always present in both sexes, the former often connected to apical fascia. Female sternum 2 with apical fascia (rarely interrupted near middle), sides of sternum 3 with apical spots; male sterna 2–3(4) with apical fascia, the one on sternum 3 sometimes interrupted or laterally abbreviated, evanescent fascia sometimes also present on sternum 1, discal spots sometimes present on sternum 2.

DISTRIBUTION. Canada: ON, newly recorded for MB (?ssp. *yumus*). U.S.: widely distributed excluding Pacific Coast states (Krombein 1979). The ssp. *yumus* (Viereck, 1908) has whitish markings and an only slightly thickened apical margin of tergum 2; it ranges from CO south to AZ and western TX (Krombein 1979).

BIOLOGY. The biology of *P. leionotus* was previously unknown. The species differs markedly from related species by using small cavities in rocks or concrete as nest sites. At Oakville, 16 Mile Creek the species was very common around a steep storm drainage gully that was laid out with mid-size limestone boulders. Both males and females were frequently seen flying over the rock surface, occasionally landing on the rocks. Apparently, the limestone provided abundant nesting opportunities because of the prevalence of small cavities in this type of rock. On 25 June, 2005, a female was seen entering a small cavity on the lower surface of a rock. The opening of the cavity had already been narrowed with mud. The female did not carry any prey but three other females were collected while carrying small caterpillars. A similar, already closed nest was discovered at the same locality and brought back to the lab, but nothing emerged. Unlike its relatives *P. vagus*, *P. pedestris* and *P. pensylvanicus,* which inhabit open woodlands, *P. leionotus* occurs in more sparsely vegetated, usually disturbed areas such as wastelands, roadsides, or industrial properties.

46. *Parancistrocerus pedestris* (de Saussure, 1855)

Figs B7.42, 45, 54, 55; C46.1–7.

SPECIES RECOGNITION. This species is very similar to *P. pensylvanicus* from which it can be separated by the colour characters given in the key. Females that lack the scutal spot and discal spots of tergum 1 cannot be separated from *P. pensylvanicus*. The only reliable structural character that separates both species is the shape of the aedeagus, whose middle portion is abruptly constricted in dorsoventral view in *P. pedestris* (hardly constricted in *P. pensylvanicus*). Another species that is strikingly similar is *Stenodynerus krombeini* (see discussion under that species), which has not yet been recorded from Canada.

VARIATION. Fore wing length 5.0–6.5 mm (♂♂), 6.0–7.5 mm (♀♀). Thickening of apical margin of tergum 2 variable, its thickness 0.6–1.4x mid ocellar diameter (male) or 0.4–1.0x mid ocellar diameter (female). Body with pale markings always bright yellow. Female clypeus with a yellow crescent-shaped dorsal mark or a pair of dorsal spots, very rarely and only in specimens from eastern U.S. with yellow in apical half of clypeus; male clypeus highly variable, usually with narrow or wide black apical margin, sometimes also with irregular black median blotch(es) on disc, rarely predominantly black and coloured as in female or nearly completely yellow including apical margin between teeth. Interantennal spot restricted to area above interantennal prominence, rarely extending almost to clypeus in male. Male flagellum black beneath or partly obscure yellowish, very rarely yellow as in *P. pensylvanicus* (1 ♂, ON, Waterloo Reg., Blair; this male has the clypeal margin yellow as in *P. pensylvanicus* but has a pair of yellow discal spots on tergum 2, and genitalia with the characters of *P. pedestris*). Transverse pronotal band of variable width and shape, in male sometimes abbreviated laterally, exceptionally interrupted or subinterrupted laterally. Scutum usually with a small to minute posteromedian spot in female (very rarely present in male). Mesopleuron with dorsal spot exceptionally absent in male. Propodeum in female usually with a pair of small to large ventrolateral spots, sometimes also with a pair of small dorsolateral spots, very rarely (in specimens from eastern U.S.) the spots connected and forming two complete vertical bands from dorsum to submarginal carina, rarely propodeum completely black; male propodeum usually entirely black, very rarely with small dorsal and/or ventral spots. Female terga 1–(4)5 and male terga 1–5 or 6 with apical fasciae, the fascia of tergum 3 usually absent, interrupted or reduced to lateral spots, very rarely complete; one aberrant male has all terga beyond tergum 2 completely black. Discal spots of tergum 1 present or absent in female, absent in male, in Canadian specimens not connected to apical fascia; discal spot of tergum 2 present in female, present or absent in male. Sternum 2 with apical fascia, sides of sternum 3 in male more often than in female with apical spots; in male sometimes with interrupted apical fascia.

DISTRIBUTION. Canada: QC, newly recorded from ON. Eastern U.S. west to MN, KS and NM (Krombein 1979). In Ontario this species is common in appropriate habitats within the Carolinian life zone. Outside this area the species

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occurs very locally and in much smaller numbers. The reddish form from Florida and Georgia is ssp. *bifurcus* (Robertson, 1901).

BIOLOGY. Nests in borings in wood, sumac and elder and provisions with caterpillars of Gelechiidae. Nest partitions and closing plugs are made from mud (nominate subspecies) or agglutinated sand (ssp. *bifurcus*) (Krombein 1967, 1979).

47. *Parancistrocerus pensylvanicus* (de Saussure, 1855)

Figs B2.9; B7.36, 38, 40, 44, 46, 56; C47.1–5.

TAXONOMIC NOTE. We are not convinced that the ivory colour form, which was described as ssp. *ignotatus* (Bohart, 1952) (see below) merits formal recognition.

SPECIES RECOGNITION. Similar to *P. pedestris* with which it often occurs together in Carolinian parts of Ontario (differences discussed under that species). The pale colour form is also very similar to the rare *Stenodynerus lucidus*. The male of that species differs from *P. pensylvanicus* by the small flagellomere XI (i.e., not extending to base of F X), the dark flagellum (yellowish ventrally in *P. pensylvanicus*), and the absence of an anteroventral depression near base of mid femur. Both sexes of *S. lucidus* lack apical fasciae on segments 3 and onward.

VARIATION. Fore wing length 5.0–6.5 mm (♂♂), 5.0–7.0 mm (♀♀). Thickening of apical margin of tergum 2 variable, its thickness 0.3–1.0x mid ocellar diameter (male) or 0.2–0.5x mid ocellar diameter (female). Pale markings of body bright yellow to ivory. The pale yellow form is the predominant form in central and northern Ontario. Ivory specimens are very rare in the east and have only been found in the northernmost part of the range. The ivory form is more common in the west and was described as ssp. *ignotatus* (see below). Female clypeus usually black, in bright yellow specimens often with a pair of yellow dorsal spots; male clypeus in aberrant specimens sometimes with an irregular black discal mark. Interantennal spot restricted to area above interantennal prominence in female, sometimes extending almost to clypeus in male. Transverse pronotal band usually narrow, sometimes interrupted or subinterrupted laterally, in pale females often abbreviated laterally. Parategula marked with yellow, or occasionally with obscure brownish; parategula in small, dark specimens sometimes completely black. Female terga 1–(4)5 and male terga 1–5 or 6 with apical fasciae, fascia of tergum 3 usually absent, interrupted or reduced to lateral spots, very rarely complete. Discal spots of tergum 2 sometimes present in female (these specimens are difficult to separate from *P. pedestris*); also present in one exceptional male. Sternum 2 with apical fascia, in female often, in male rarely interrupted, sides of sternum 3 rarely with apical spots.

DISTRIBUTION. Transcontinental in Canada and the northern U.S., south to NC, MO, TX, NM, CO and OR (Krombein 1979). The ivory-marked ssp. *ignotatus* has been recorded from NB and the northern and western U.S. (MI, MN, ID, WA to CA), and is recorded here for the first time from Ontario.

BIOLOGY. Nests in borings in twigs. Prey are caterpillars of Tortricidae (Krombein 1979).

48. *Parancistrocerus perennis* (de Saussure, 1857)

Figs B7.5, 47; C48.1–5.

SPECIES RECOGNITION. This species is separated from all other species in the area by the bluntly angulate base of sternum 2 (moderately convex in other species). The female clypeus is marked with a single, slightly arched yellow dorsal spot.

VARIATION. Fore wing length 6.0–7.0 mm (♂♂), 6.5–8.0 mm (♀♀). Colour showing very little variation. Interantennal spot sometimes extending to clypeus in male, in female sometimes slightly extending below level of interantennal prominence. Transverse pronotal band entire or interrupted medially, relatively broad. Terga and sterna 1–2 with apical fasciae, in male sometimes sternum 3 with median remnant of fascia; in both sexes terga 3 and 4 rarely have thin, evanescent apical fasciae. Some specimens from the eastern U.S. show reddish lateral areas on tergum 1 (transitional to ssp. *anacardivora*).

DISTRIBUTION. Canada: newly recorded for southern Ontario. Eastern U.S. west to Mississippi River, also KS (Krombein 1979). The southern form (NC to FL and LA) with predominantly red tergum 1 is ssp. *anacardivora* (Rohwer, 1915).

BIOLOGY. Nests in hollow twigs, especially sumac. Nest partitions and closing plugs of the ssp. *anacardivora* consist of agglutinated sand. Prey are caterpillars of Coleophoridae (ssp. *perennis*), Tortricidae (Olethreutinae) and Gelechiidae (ssp. *anacardivora*) (Krombein 1967, 1979).

49. *Parancistrocerus salcularis* (de Saussure, 1852)

Figs A4.7–10; B7.26, 27, 49; C49.1–4.

SPECIES RECOGNITION. This species is readily separated from other species by the combination of long hairs on tergum 1 (otherwise only present in *P. leionotus*, *P. bicornis*), a distinct transverse carina on tergum 1 followed by a smooth area (absent in

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P. leionotus), and the absence of interocellar tubercles (present in *P. bicornis*). Furthermore, *P. salcularis* has longer hair on the pronotum than other species (length of longest hairs equals basal diameter of flagellomere 1; rarely appearing shorter when large distal portion of hairs is curved posteriorly). Further diagnostic character not mentioned in the key: male flagellum dark beneath; male mid femur without or with a faint anteroventral depression near base; terga 1 and 2 with yellow discal spots; apical margin of tergum 2 very slightly to moderately thickened; apical fascia of tergum 3 usually interrupted.

VARIATION. Fore wing length 6.0–8.0 mm (♂♂), 8.0–8.5 mm (♀♀). Variation otherwise not studied.

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: NJ south to FL, west to TX (Krombein 1979). The reddish form from Florida has been named ssp. *rufulus* (Bohart, 1948).

BIOLOGY. All observations are on ssp. *rufulus*: nests in borings in wood and old galls from scrub oak; nest partitions and closing plugs are made from firmly agglutinated sand. Prey consists of caterpillars of Gelechiidae, Tortricidae, Crambidae (Pyraustinae) and Pyralidae (Phycitinae, Epipaschiinae) (Krombein 1967).

50. *Parancistrocerus vagus* (de Saussure, 1857)

Figs B2.32; B7.8, 29, 51; C50.1–4.

SPECIES RECOGNITION. This species is uniquely characterized by a small median depression on tergum 2 just below the hind margin of tergum 1 that serves as entrance to the acarinarium. Furthermore, the male has a deeply emarginate clypeal apex, unusually large mandibular teeth 2–4, and the pubescence of sterna 3–7 is conspicuously erect (but not particularly long) and somewhat brush-like (especially on sternum 7). In colouration and size the species closely resembles *P. leionotus* but it lacks the longish hairs on the summit of tergum 1, and the tegula, mid and hind tibiae are conspicuously tinged with amber-reddish, lacking clear yellow areas (except rarely the tibiae).

VARIATION. Fore wing length 6.5–8.0 mm (♂♂), 7.5–9.0 mm (♀♀). Interestingly, the median depression at the base of tergum 2 (entrance to the acarinarium) is sexually dimorphic: It is broad and shallow in the male, narrow and deep in the female. Overall, the size of the aperture is much larger in the male than in the female. If mites are transferred during copulation one might speculate that the larger opening allows the mites to leave the acarinarium more quickly in order to move over to the female. Thickening of apical margin of tergum 2 varies between 0.3–0.8x mid ocellar diameter (male) or 0.25–0.5x mid ocellar diameter (female). Female clypeus with a pair of yellow dorsal spots, often coalescent and forming a crescent-shaped mark; male clypeus sometimes with small to medium-sized, irregular black discal blotch. Interantennal spot sometimes extending almost to clypeus in male. Transverse pronotal band usually interrupted medially and very rarely laterally, sometimes more or less emarginate on each side. Spot on upper mesopleuron sometimes small or absent in male. Parategula usually marked with yellow, or sometimes with reddish-brown. Propodeum black in eastern Canadian specimens; specimens from more western or southern localities sometimes with a pair of more or less elongate lateral spots. Terga 1–(3)4 (female) or 1–(4)5(6) (male) with apical fasciae, the one on tergum 3 rarely interrupted medially but then fascia on tergum 4 reduced to a few spots or absent. Terga 1 and 2 with discal spots in both sexes, the former usually connected to apical fascia, the latter sometimes very small or absent, especially in small specimens. Female sternum 2 with usually more or less medially interrupted apical fascia, sternum 3 rarely with apicolateral spots; male sterna 2(–3) with apical fascia, the one on 2 often interrupted in eastern Canadian specimens (3 is then absent), evanescent fascia sometimes also present on sternum 1; small, blurred discal spots sometimes present on sternum 2 (observed in extralimital material from BC, VA, GA).

DISTRIBUTION. Canada: ON, BC, newly recorded from SK and AB. Entire U.S. except Pacific Coast states (Krombein 1979). Mexico (Rodríguez-Palafox 1996). The reddish Floridian form was named ssp. *slossonae* (Bohart, 1948).

BIOLOGY. Builds free mud nests. Two described nests were attached to branches 0.6 and 1 m above the ground, had a size of ca. 2.5 cm (diameter) and 1.9 x 3.4 cm, and one contained 6 cells (Evans 1956, 1978). Eickwort (1973) describes a 5-celled mud nest in a crevice of a rock. The surface of the nest was perfectly flush with the rock surface. The identity of prey caterpillars has not been recorded.

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***Parazumia* de Saussure**

This New World genus includes 10 species (Carpenter and Garcete-Barrett 2005). Two species occur north of Mexico, one of which is restricted to CO, AZ and TX.

REFERENCE. – Carpenter and Garcete-Barrett, 2005 (revision, key).

51. *Parazumia symmorpha* (de Saussure, 1855)

Figs B1.8; B2.26, 42; C51.1–11.

SPECIES RECOGNITION. This is the only north eastern Nearctic eumenine species with a somewhat narrowed (but not petiolate) metasomal segment 1 and reflexed, lamellate, apical margins of terga 2 and 3. The spiracles of metasomal segment 1 are borne on small but distinct tubercles and the wings are strongly infuscated with a purple tinge.

VARIATION. Fore wing length 8–11.5 mm (♂♂), 11–15.5 mm (♀♀). Yellow interantennal spot often absent in female, postocular spot sometimes absent in male. Male clypeus yellow, its apical margin more or less bordered with black, laterally sometimes extending significantly onto clypeal disc, its base sometimes narrowly black and disc with a more or less complete black median stripe. Mandible sometimes marked with yellow and/or amber (more often in male). Mesopleuron rarely with yellow dorsal spot (one female). Scutellum sometimes with a pair of small yellow spots, rarely large. Metanotum completely black or more frequently with a pair of small yellow spots, sometimes large, rarely with a complete band. Propodeum rarely with a pair of small yellow ventral spots. Female metasoma black beyond segment 2, rarely with remnants of an apical fascia on tergum 3. Male terga 1, 2 and usually 3 with apical fascia (incomplete on 3), tergum 4 sometimes with a medial remnant of an apical fascia.

DISTRIBUTION. Canada: newly recorded from ON and QC. Eastern U.S. west to IA, eastern NE (Cass and Sarpy Cos., new state record, see next paragraph), KS, CO, AZ (Krombein 1979).

BIOLOGY. Previously unrecorded. On July 3, 2006, a female of this species was observed by naturalists L. and B. Padelford entering a hole in riprap concrete on the south bank of the Platte River near the Louisville Lakes State Recreation Area in Cass Co., Nebraska (Figs 51.6–8; see also Bugguide). In one of the images (Fig. 51.6) the wasp can be seen carrying a small spherical mass, apparently a mixture of mud and small pieces of gravel. Another female of the same species was observed on July 28–29, 2007 at a hole in the upper surface of a boardwalk in Fontenelle Forest, Sarpy Co., Nebraska by the same observers (Figs 51.9–11; see also Bugguide). Its behaviour was described to us as follows (L. and B. Padelford, *in litt*.): "[The wasp] was exhibiting the same behaviour today, i.e., exploring these holes in the boardwalk made by countersunk screws. The hole [shown] in the photos seemed to be favored by the wasp because each time it flew it came back to the same hole. The hole was 11 mm in diameter and 14 mm deep. It was entering the hole repeatedly and extracting material that it left around the hole. Both photos show some of the debris removed by the wasp." The behaviour shown on both series of images leaves no doubt that holes in both concrete and lumber were being used as nest sites. These observations are significant as there is no other published information on the nesting habits of the genus *Parazumia*.

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***Pseudodynerus* de Saussure**

This is a primarily Neotropical genus with one species in eastern North America.

REFERENCES. – Hermes and Melo, in press (revision of New World species, key); Bequaert, 1941 (revision of New World species, key).

52. *Pseudodynerus quadrisectus* (Say, 1837)

Figs B2.21, 40; C52.1–5.

SPECIES RECOGNITION. The habitus of this species is reminiscent of *Euodynerus* but the body shape is more elongate. *Pseudodynerus quadrisectus* can be distinguished from other ivory-marked Eumeninae with strongly infuscated wings by the following characters: Male clypeus usually predominantly black. Propodeum with a distinct shelf-like horizontal area behind metanotum, posteriorly delimited by a sharp, serrate carina that is narrowly interrupted medially. Propodeal carina short, only defined dorsally, not developed laterally. Tergum 1 completely smooth and very shining between well-spaced punctures, conspicuously long-haired (hair length up to 3x mid ocellar diameter or more) but hairs sparse.

VARIATION (in part after Bequaert 1941). Fore wing length 10.5–13 mm (♂♂), 12–16 mm (♀♀). Extent of ivory markings quite variable: Inner orbit of female sometimes with ivory mark below ocular sinus. Clypeus with paired dorsal spots, sometimes confluent and forming a crescent-shaped mark, rarely completely black; in male also often with paired ventral spots (sometimes only with ventral spots), rarely completely ivory except apical and ventrolateral margins. Mandible with ivory basal mark in female, small or absent in male. Pronotum with broad anterior ivory band, sometimes almost completely ivory except posterolateral margin and ventral portion. Scutum rarely with a pair of tiny anterolateral ivory spots adjacent to pronotum. Scutellum sometimes with a pair of ivory spots, rarely confluent. Dorsal surface of propodeum with a pair of ivory spots, sometimes broken up into two or three spots, sometimes almost completely ivory extending down below level of propodeal angle. Tegula and hind coxa occasionally marked with ivory. Mesopleuron besides the usual large dorsal spot sometimes with additional small ivory spots behind scrobal furrow and on lower mesopleuron. Tergum 1 with apical fascia sometimes covering most of dorsal surface except median black spot. In male tergum 2 rarely with small ivory lateral spots near base and tergum 3 rarely with small lateral spots near apical margin; exceptionally tergum 3 with complete and tergum 4 with interrupted apical fascia. Mid and hind coxa usually with ivory spot. Fore and mid tibia usually with ivory stripe or spot, better developed on former, sometimes absent.

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: northern NJ (Bergen Co.), eastern PA (Pittsburgh area), northern OH (Ashland Co.) and central IL south to FL and west to eastern parts of KS, OK and TX (Bequaert 1941). The ssp. *aztecus* (de Saussure, 1857) occurs in Mexico and Costa Rica (West-Eberhard *et al*. 1995, Rodríguez-Palafox 1996).

BIOLOGY. Nests in cavities in wood and makes mud partitions between brood cells. Prey are caterpillars (Krombein 1979).

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***Stenodynerus* de Saussure**

This genus is widely distributed in the New World, as well as the Palaearctic and Oriental regions. With 48 described species it is the largest vespid genus in America north of Mexico (Krombein 1979). The northeastern fauna is comprised of 11 species, five of which occur in Canada. Up to the present only partial keys to the eastern Nearctic fauna existed, which rendered the identification of northeastern material extremely difficult. The present key in conjunction with Bohart's (1948*b*) key to red-marked southeastern species covers almost the entire eastern fauna (exception: *S. propinquus*, which occurs from NC and AL westward, see diagnosis under *S. fundatiformis*; note that the red-marked Floridian forms of *S. blepharus* and *S. krombeini* are not included in Bohart's key and that '*S. ammonia*' sensu Bohart, nec (de Saussure) = *S. histrionalis rufustus*).

REFERENCES. – Bohart, 1953 (key to *S. blepharus* and related species), 1948*b* (key to Florida species of *Stenodynerus* and *Parancistrocerus*), 1944 (review of *S. propinquus*-group, key), 1943 (review of *S. anormis*-group, key).

53. *Stenodynerus ammonia* (de Saussure, 1852)

Figs B2.34; B7.21–23, 25, 62; C53.1–5.

SPECIES RECOGNITION. This species and *S. anormis* are the only representatives of the *S. anormis*-group in our area. The group is characterized by the apically truncate (not emarginate) clypeus and the deformed male mid femur (the latter occurs also in *S. fundatiformis*). The two species can be separated by the characters given in the key. The clypeus of female *S. oculeus* is often truncate as well but this species possesses distinct interocellar tubercles (including an eyelid-like swelling behind mid ocellus), lacks the irregular transverse carina of near the summit of tergum 1 and the discal spots of tergum 1 (present only in *S. ammonia* specimens from southeastern U.S.).

VARIATION. Fore wing length 5.0–6.0 mm (♂♂), 5.5–7.0 mm (♀♀). Female clypeus with a yellow crescent-shaped dorsal mark often interrupted medially, rarely reduced to a pair of small spots. Interantennal spot usually restricted to area above interantennal prominence, sometimes extending to clypeus in male. Postocular spot sometimes small, rarely completely absent. Pronotal spots usually less than twice as wide as long, occasionally about three times as wide as long. Parategula usually black, occasionally marked with yellow, rarely completely yellow. Propodeum in female sometimes with a pair of small ventrolateral spots, rarely extending further up and extending to propodeal angle. Female terga 1–4 and male terga 1–6 with apical fasciae, the fascia of tergum 3 complete or interrupted medially, rarely reduced to small spots. Sternum 2 with apical fascia, sometimes interrupted medially and/or laterally (more often in female than in male); sternum 3 usually with apicolateral spots, rarely missing in female, sometimes with a complete fascia in male and then sternum 4 with apicolateral spots as well.

DISTRIBUTION. Canada: newly recorded for ON and MB. Eastern U.S. west to MN, KS and TX (Krombein 1979). Reddish-marked populations from SC to FL represent the nominate subspecies. The widespread yellow form is ssp. *paraensis* (de Saussure, 1855).

BIOLOGY. Unknown. The biological information provided for *S. ammonia ammonia* by Krombein (1967) is probably based on a misidentification and was not included in Krombein (1979). The taxon Krombein (1967) referred to as *S. ammonia histrionalis* is in fact *S. histrionalis* (see Krombein 1979).

54. *Stenodynerus anormis* (Say, 1824)

Figs B7.24, 61; C54.1–4.

SPECIES RECOGNITION. This species shows the characteristics of the *S. anormis*-group (apically truncate clypeus and deformed male mid femur). Diagnostic characters separating *S. anormis* from *S. ammonia* (the only other species of the *S. anormis*-group occurring in the northeastern Nearctic) are mentioned under that species. The female of *S. oculeus*, which sometimes also has an apically truncate clypeus, can easily be distinguished by the interocellar tubercles (absent in *S. anormis*), the medially interrupted pronotal carina (entire in *S. anormis*), medially interrupted fascia of tergum 3 (entire in *S. anormis*) and bright yellow metasomal markings (becoming paler on posterior segments in *S. anormis*). Further diagnostic characters not mentioned in the key include short bristly hairs on posterior surface of male flagellomeres I–VIII (becoming longer on more apical segments), and a yellow frons between antennal socket and upper margin of clypeus in male (black in all other species except *S. fundatiformis*).

VARIATION. Fore wing length 4.5–6.0 mm (♂♂), 6.0–7.5 mm (♀♀). Female clypeus with a yellow crescent-shaped dorsal mark, rarely thin and (sub-)interrupted laterally and/or medially or reduced to small median spot(s). Interantennal spot restricted to area above interantennal prominence in female, always extending to clypeus in male.

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Posteromedial spot of scutum rarely missing in female, absent in males from east, but sometimes present and minute in western specimens, very rarely of moderate size. Propodeum in female with a pair of yellow stripes on each side on propodeal concavity, sometimes extending to propodeal dorsum; propodeum similarly marked in male, sometimes propodeal stripes interrupted at level of propodeal angle, rarely propodeum almost completely black. Female terga 1–5 and male terga 1–6 with apical fasciae, fascia of tergum 3 complete. Discal spots of tergum 1 separate or connected to apical fascia. Female sternum 2 usually with broadly interrupted apical fascia, sometimes interrupted narrowly and rarely almost complete; sternum 3 and sometimes 4 with apicolateral pale spots. Male sterna 2–4 with apical fascia, frequently interrupted medially and/or laterally on sterna 3 and 4; sternum 5 with pale with apicolateral spots. Male sternum 2 usually with a pair of pale discal spots.

DISTRIBUTION. Transcontinental and widespread in Canada and the U.S. (Krombein 1979). Mexico: Baja California (Rodríguez-Palafox 1996). We have seen Canadian specimens from ON, MB, SK, AB and BC.

BIOLOGY. The species has been reared from cells in a pithy stem, the cells being separated by mud partitions. Prey are caterpillars (Krombein 1979). We suspect that the species also nests in the ground. In 2004 the senior author observed females entering ground burrows at two different occasions in Guelph, ON. In neither case did the female carry any prey or engage in burrowing activity that was visible to the observer. Both burrows were in very hard-packed soil, had clean-cut exit holes and completely lacked tumuli or loose earth in the perimeter that could be attributed to recent burrowing activity. The burrows were found on a sparsely vegetated, empty lot that had been bulldozed probably a decade earlier. It is unclear whether the burrows were made by the wasps themselves.

55. *Stenodynerus blepharus* Bohart, 1953

Figs B7.11, 13, 17, 19, 59; C55.1–4.

SPECIES RECOGNITION. *Stenodynerus blepharus* belongs to a group of species that is characterized by an eyelid-like, transverse swelling behind the mid ocellus. The male is unique for its subshining, black area of flagellomere IX (opposite flagellomere XI), that is clearly delimited from the surrounding dull surface of the flagellum. In other species the same area is dull as the remainder of the flagellum. The female differs from other species by the absence of elongate, oblique, lateral, yellow spots on tergum 1 (the spots are either absent or small, roughly circular or short-triangular and almost always connected to the apical fascia).

VARIATION. Fore wing length 4.8–5.5 mm (♂♂), 5.5–6.3 mm (♀♀). Thickening of apical margin of tergum 2 0.7–1.0x mid ocellar diameter (male) or 0.4–0.8x mid ocellar diameter (female). Female clypeus with a pair of small to large yellow dorsal spots that sometimes coalesce to form a crescent-shaped mark; rarely clypeus almost completely black; male clypeus yellow with black apicolateral margins and in most cases a small to large, more or less irregularly shaped, central black spot, that is sometimes connected to the black margin ventrolaterally or ventrally. Transverse pronotal band entire or briefly interrupted medially, hind margin on each side straight and oblique to strongly outwardly arcuate. Yellow posteromedian spot of scutum rarely absent in male. Female propodeum often with a pair of yellow lateral spots, better developed dorsally than ventrally, sometimes extending to all the way from dorsum to submarginal carina, but often with multiple interruptions; male propodeum completely black. Female terga 1–4 or 5 and male terga 1–5 or 6 with apical fasciae (in male often completely absent or weakly developed on terga 3–6), fascia of tergum 3 usually represented by small lateral spots, rarely better developed but always broadly separated. Lateral spots of tergum 1 present or absent in female, absent in male, if present almost always connected to apical fascia or else very small; discal spots of tergum 2 very small to evanescent in one male. Sternum 2 with apical fascia; sides of sternum 3 with apical spots; in male sometimes with laterally interrupted or nearly complete apical fascia, these sometimes completely absent.

DISTRIBUTION. Canada: newly recorded from Carolinian region in ON. Eastern U.S.: NY (new state record: 3 ♂♂ 1 ♀, det. R.M. Bohart, from Huntington, L.I., AMNH), and MD south to FL and west to WV, KS and TX (Krombein 1979). A Floridian form with predominantly red tergum 1 has not been formally named, and is not included in Bohart's (1948*b*) key.

BIOLOGY. Unknown.

56. *Stenodynerus fundatiformis* (Robertson, 1901)

Figs B1.9; B7.1, 3, 4, 57; C56.1–6.

SPECIES RECOGNITION. This species is part of the *S. propinquus*-group, which is distinguished from all other *Stenodynerus* (and *Parancistrocerus*) by the presence of a short humeral carina that curves posteriorly at the humeral angle. The only

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representative of this group in our area is *S. fundatiformis*. A second species, *S. propinquus*, occurs from NC and AL westward and is distinguished from *S. fundatiformis* by the angulate outer surface of male flagellomere XI (evenly and gently curved in *S. fundatiformis*) and the medially distinctly angled transverse carina of sternum 1 (forming a small, medial, rounded or slightly angled projection in *S. fundatiformis*).

VARIATION. Fore wing length 6.5–8.0 mm (♂♂), 7.0–8.0 mm (♀♀). Variation otherwise not studied.

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: NY to FL , west to MN, MO, AR and TX (Bohart 1944, Krombein 1979). The reddish-marked southern form (SC to FL, west to MO, AR, TX) is the nominate subspecies. The yellow marked northern form has been named ssp. *gonosceles* Bohart, 1944.

BIOLOGY. The nominate subspecies nests in both sandy and hard-packed soil. Prey consists of case-bearing leaf beetle larvae (Chlamisinae) and leaf-rolling or case-bearing caterpillars of Pyralidae, Gelechiidae, Tortricidae (Olethreutinae), Geometridae and Psychidae (Evans 1956, Krombein 1964).

57. *Stenodynerus histrionalis* (Robertson, 1901)

Figs B7.15, 34, 66; C57.1–4.

SPECIES RECOGNITION. A combination of characters is required to diagnose this species: clypeal apex emarginate (not truncate as in *S. anormis*-group), no eyelid-like swelling behind mid ocellus (present in *S. blepharus* and related species), pronotal carina entire but sometimes low medially (interrupted medially in several species), humeral carina absent (present in *S. fundatiformis*). *Stenodynerus histrionalis* is one of four species in the genus in which the row of pits in the transverse basal groove of tergum 2 (below overhang of tergum 1) is obsolete medially (i.e., there are only ca. 2 pits on each side). A similar condition is found in *S. krombeini* (pits even more reduced), *S. lineatifrons* (pits slightly better developed than in *S. histrionalis*) and *S. pulvinatus* (only median pits obsolete).

VARIATION. Fore wing length 5.5–6.0 mm (♂♂), 6.0–7.5 mm (♀♀). Variation otherwise not studied.

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: NY to FL, west to CO and TX (Krombein 1967). The reddish Floridian form has been described as ssp. *rufustus* Bohart, 1974; ssp. *paenevagus* (Viereck, 1906) occurs in KS, CO and TX.

BIOLOGY. Nests in borings in wood. Nest partitions and closing plugs are made of firmly agglutinated sand. Prey consists of caterpillars of Tortricidae and Gelechiidae (Krombein 1967, 1979).

58. *Stenodynerus kennicottianus* (de Saussure, 1870)

Figs B2.10; B7.16, 37, 67; C58.1–5.

SPECIES RECOGNITION. A combination of characters is required to diagnose this species: clypeal apex emarginate (not truncate as in *S. anormis*-group), interocellar area at most weakly tuberculate (moderately to strongly tuberculate in *S. blepharus* and related species), pronotal carina interrupted medially (entire in several other species), tergum 3 with complete apical fascia (absent or interrupted in several other species).

VARIATION. Fore wing length 4.5–6.0 mm (♂♂), 5.0–6.5 mm (♀♀). Thickening of apical margin of tergum 2 up to 0.6x mid ocellar diameter (male) or up to 0.5x mid ocellar diameter (female). Pale markings of body varying from pale to bright yellow in male (usually paler on posterior metasomal segments), always pale yellow in female. Female clypeus usually black, rarely with a small, pale, dorsomedian spot, in western specimens sometimes with three spots (dorsomedian and -lateral), rarely connected to form a crescent-shaped dorsal mark; male clypeus sometimes with black apical margin and small, black, evanescent discal spot(s), which is rarely large and connected to black ventral margin. Interantennal spot restricted to area above interantennal prominence in female, in western males rarely narrowly extending to clypeus. Pale spot along inner orbit restricted to eye emargination or extending ventrally to clypeus in male, in the latter case almost always interrupted at level of antennal socket. Postocular spot often small, rarely absent in male. Scutum with posteromedial spot present in some specimens from western Canada (more frequently in females), but usually small and evanescent. Spot on upper mesopleuron sometimes small, rarely absent in male. Propodeal dorsum often with a pair of pale spots in female, rarely present in male. Female terga 1–5 and male terga 1–(5)6 with apical fasciae, the fascia of tergum almost always 3 complete, very rarely narrowly interrupted at middle. One aberrant male with bright yellow markings from Rondeau Prov. Pk., ON, has terga 3–7 almost completely black except for evanescent median remnant of fascia on tergum 4. Tergum 2 with discal spots of sometimes present (more often in female) but usually small. Sternum 2

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with complete apical fascia; sternum 3 with apicolateral spots in female, in male varying from completely black (very rare) to fasciate but then fascia usually interrupted laterally; sternum 4 in male sometimes with median or lateral remnant(s) of apical fascia.

DISTRIBUTION. Transcontinental in Canada and the U.S., except the southwest; the western ssp. *antheus* (Cameron, 1908) occurs east to WY, UT and NM (Krombein 1979). We have examined Canadian specimens from QC, ON, MB, SK, AB, BC and NT.

BIOLOGY. Not recorded previously. On September, 3rd 2004 one of us (S.A.M.) observed several specimens (males, see Fig. 58.5, and probably females) at the vertical sandy banks of a small river at Michael's Bay, Manitoulin I., ON. Some specimens (supposedly females) were seen entering small holes in the sandy bank. The absence of rearing records from trap nests etc. and this new observation seems to indicate that *S. kennicottianus* is a ground-nesting species.

59. *Stenodynerus krombeini* Bohart, 1953

Figs B7.39, 41, 43, 68; C59.1–4.

SPECIES RECOGNITION. This species is strikingly similar to *Parancistrocerus pedestris*. The reduction of pits in the basal groove of tergum 2 (below overhang of tergum 1) has progressed so far in *S. krombeini* that it hardly differs from species of *Parancistrocerus*. In *Parancistrocerus* the dorsobasal lamella of tergum 2, which forms the roof of the acarinarium and is firmly appressed to the overhang of tergum 1, is longer than in *Stenodynerus* where the same space does not serve as an acarinarium. Further differences between terga 2 of *S. krombeini* and *P. pedestris* are mentioned in the key.

VARIATION. Fore wing length 5.0–6.5 mm (♂♂), 6.5–7.0 mm (♀♀). Variation otherwise not studied.

DISTRIBUTION. The distribution of *S. krombeini* is insufficiently known, probably due to confusion with *Parancistrocerus pedestris*. Krombein (1979) lists *S. krombeini* only from the type locality in NC. We have seen specimens from nine states: MA, North Falmouth (1 ♂, CNCI), Wellfleet (1 ♀, AMNH); VA, Falls Church (2 ♂♂, AMNH); TN, Great Smoky Mts Natl. Pk., Indian Gap, 5200 ft (1 ♂, CNCI), Highlands (1 ♂ 1 ♀, CNCI); NC Raleigh (1 ♂, DEBU), Singletary Lake St. Pk. (2 ♂♂, DEBU); SC, Georgetown Co., Hobcaw Barony (1 ♂ 1 ♀, DEBU); GA, Reed-Bingham St. Pk (1 ♂, AMNH); FL, Gainesville (1 ♂, CNCI), Palatka (1 ♀, AMNH); MS, 3 mi N Wesson (1 ♀, CNCI); TX Fredericksburg (1 ♀, CNCI). Floridian specimens have the yellow markings suffused with orange (male) or red (female), tergum 1 is predominantly red, and the apical margin of tergum 2 is less thickened than in specimens from other areas.

BIOLOGY. Nests in borings in wood and makes nest partitions and closing plugs of firmly agglutinated sand. Prey are caterpillars of Gelechiidae and Tortricidae (Olethreutinae) (Krombein 1967, 1979).

60. *Stenodynerus lineatifrons* Bohart, 1948

Figs B7.33, 65; C60.1–5.

SPECIES RECOGNITION. This is one of only two orange- or red-marked species (excluding legs) that occur in the extreme southern portion of the area covered by our key (reddish forms of other species occur only in the southeastern U.S.). The other species is *Parancistrocerus histrio*, which possesses an acarinarium at the base of tergum 2 (for further diagnostic characters see key).

VARIATION. Fore wing length 5.5–7.0 mm (♂♂), 6.5–7.5 mm (♀♀). Variation otherwise not studied.

DISTRIBUTION. Not recorded from Canada. Mainly southeastern U.S.: NC, SC and FL (Krombein 1979); newly recorded from VA (1 ♀, Norfolk, DEBU).

BIOLOGY. Nests in borings in wood and uses firmly agglutinated sand for closing plugs and nest partitions. Caterpillars of Tortricidae and Gelechiidae serve as prey (Krombein 1967, 1979).

61. *Stenodynerus lucidus* (Rohwer, 1917)

Figs B7.31, 35, 63, 64; C61.1–4.

SPECIES RECOGNITION. This is the only species in *Stenodynerus* (and *Parancistrocerus*) with ivory markings and completely black metasomal segments 3–6(7). The male is furthermore characterized by the unusually small flagellomere XI (which does not reach the base of flagellomere IX).

VARIATION. Fore wing length 4.5–5.0 mm (♂♂), 5.5–6.0 mm (♀♀). Pale markings ivory; markings of male head and legs pale yellow. Female clypeus black; male clypeus sometimes with black apical margin. Scape pale yellow below in male, completely black in female. Pronotal spots small to minute and closely approximated, occasionally absent in both sexes. Mesopleuron with dorsal spot present or absent in female, absent in male. Tegula black or brown with black inner margin; parategula black. Pale metanotal band in male sometimes (sub-)interrupted medially, rarely

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absent. Metasomal terga 1 and 2 with apical fasciae; sternum 2 usually with complete apical fascia, sometimes interrupted laterally, in female rarely reduced to a pair of lateral spots.

DISTRIBUTION. Canada: QC, ON and BC, newly recorded from PE, MB, SK, AB, and NT. Northern and western U.S.: MN; MT and WA south to CO, UT and CA (Krombein 1979).

BIOLOGY. Unknown.

62. *Stenodynerus oculeus* (Robertson, 1901)

Figs B7.18, 20, 60; C62.1–4.

SPECIES RECOGNITION. This is one of three species in the genus with an eyelid-like swelling behind the mid ocellus. It differs from the other two species (*S. pulvinatus* and *S. blepharus*) as follows: clypeus finely punctate (not coarsely punctate); interantennal spot of male elongate, extending to clypeus ventrally (not about as long as wide and restricted to area above interantennal prominence); sternum 2 with punctures of anterolateral corners distinctly smaller than posteromedian ones (not subequal in size); sternum 2 often with a pair of discal spots in male and sometimes in female (always absent in the other two species). Further diagnostic characters are given in the key.

VARIATION. Fore wing length 5.0–5.5 mm (♂♂), 5.5–6.5 mm (♀♀). Variation otherwise not studied.

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: NY south to FL, west to MN and TX (Krombein 1979). The reddish form from GA and FL is the nominate subspecies; the more widespread yellowish form is ssp. *illinoensis* (Robertson, 1901).

BIOLOGY. Unknown.

63. *Stenodynerus pulvinatus* Bohart, 1953

Figs B7.2, 9, 10, 12, 14, 58; C63.1–4.

SPECIES RECOGNITION. This is one of three *Stenodynerus* with an eyelid-like swelling behind the mid ocellus. It can be separated from the other two species, *S. blepharus* and *S. oculeus*, by characters provided in the key.

VARIATION. Fore wing length 5.5–7.0 mm (♂♂), 7.0–8.0 mm (♀♀). Variation otherwise not studied.

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: MA south to FL, west to MI and KS (Krombein 1979). The reddish Floridian form was named ssp. *surrufus* Krombein, 1959.

BIOLOGY. The biology of the nominate subspecies has not been studied. Subspecies *surrufus* nests in borings in wood and makes closing plugs and nest partitions from firmly agglutinated sand. Caterpillars of Gelechiidae, Tortricidae (Olethreutinae) and Pyralidae (Phycitinae) serve as prey (Krombein 1967, 1979).

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***Symmorphus* Wesmael**

The genus *Symmorphus* is mainly Holarctic and Oriental but reaches northern parts of the Neotropical region. Four species occur in North America, one of which is restricted to British Columbia and the western United States (Cumming 1989).

REFERENCE. – Cumming, 1989 (World revision, key).

64. *Symmorphus albomarginatus* (de Saussure, 1855)

Figs B2.11, 13, 35; B8.1, 3, 8; C64.1–5.

SPECIES RECOGNITION. *Symmorphus albomarginatus* is similar to *S. cristatus*, from which it can be separated by the characters given in the key. The following characters are also helpful: size larger than the other two species in the genus; flagellomere XI of male black except for tyloid (more extensively reddish in other species); hairs of ventral surface of hind femur as in *S. cristatus*, longer than in *S. canadensis*; tergum 3 almost always with apical fascia in northeastern specimens (usually absent in *S. cristatus*), but often absent in specimens from eastern U.S. (Cumming 1989).

VARIATION. Fore wing length 7–7.5 mm (♂♂), 8.5–9.5 mm (♀♀). Pale markings usually ivory in Canadian populations except most specimens from Carolinian life zone, yellow in specimens from Pennsylvania and southern New York southward (Cumming 1989). Female clypeus with basal pale spot narrow to wide, rarely absent. Interantennal spot rarely absent. Scape with anteroventral surface black or pale-marked in female, pale mark always present in male, usually extending more than halfway to apex. Pronotum with a pair of pale spots of variable size, very small in some males. Pale spot on mesopleuron and pair of spots on scutellum sometimes absent in male. Tegula black or brown marked with pale or completely black. Female tibiae with pale markings usually restricted to outer surface, rarely almost absent. Metasoma with apical fasciae developed on terga 1–4 and sometimes 5 (rarely in female), exceptionally absent on tergum 3 (see above). Sterna 2–5 with posterolateral pale spots or more or less complete fascia; the fascia usually narrowly interrupted on sternum 2, reduced to small spots on following sterna.

DISTRIBUTION. Transcontinental in Canada (not recorded from NU) and U.S., absent from desert areas of southwestern U.S. and southern Great Plains. The ssp. *midas* Cumming, 1989 ranges from southeastern TX through Mexico to northern Nicaragua (Cumming 1989).

BIOLOGY. Nests in borings in wood, sumac and elderberry stems, and uses mud for cell partitions and closing plugs. Prey are *Chrysomela* larvae (Krombein 1967, 1979).

65. *Symmorphus canadensis* (de Saussure, 1855)

Figs B2.7; B8.2, 4, 6, 10; C65.1–5.

SPECIES RECOGNITION. This species is easily confused with *S. cristatus*. Some diagnostic characters used by previous authors proved to be unreliable. The width/length ratio of tergum 1, which is one of the main diagnostic characters in Cumming's (1989) key, shows significant allometric variation. Small specimens of *S. cristatus* have a more slender tergum 1 (medial postcarinal length up to 0.78x apical width) than larger specimens (medial postcarinal length 0.61–0.69x apical width; Cumming 1989), and cannot be separated from *S. canadensis* (medial postcarinal length 0.71–0.81x apical width; Cumming 1989) based on this character. However, both males and females of the two species can be reliably distinguished based on the newly discovered character of the pubescence of the ventral surface of the hind femur and other characters mentioned in the key.

VARIATION. Fore wing length 5.0–6.8 mm (♂♂), 4.5–7.3 mm (♀♀). Body with pale markings usually deep yellow, ivory only in northern specimens. Female clypeus with pale basal spot narrow to wide, often absent. Interantennal spot rarely absent in male. Anteroventral surface of scape usually black in female, sometimes with more or less extensive pale basal mark. Pronotum with a pair of pale spots of variable size, very small in some males. Pair of pale spots on scutellum sometimes absent in male. Tegula black or brownish, sometimes marked with pale. Apical fasciae typically developed on terga 1, 2 and 4 (exceptionally missing on 4), almost always absent on 3 and 5 in female, more often present in male. Sternum 2 with posterolateral pale spots or an interrupted fascia; occasionally sternum 4 and more rarely 3 with posterolateral spots, especially in male.

DISTRIBUTION. Distributed throughout Canada and the U.S., except arctic, high boreal and southwestern desert regions; not recorded from NF, LB, YT, NU and AK (Cumming 1989).

BIOLOGY. Nests in borings in wood and twigs, and uses mud for cell partitions and closing plugs. Preys on leaf-mining Coleoptera and Lepidoptera larvae, predominantly Chrysomelidae (especially *Chalepus* spp.), more rarely on Gracillariidae,

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Cosmopterigidae and Curculionidae (*Apion*, *Prionomerus*) (Krombein 1967, 1979).

66. *Symmorphus cristatus* (de Saussure, 1855)

Figs B8.5, 7, 9; C66.1–5.

SPECIES RECOGNITION. In many ways this species is morphologically intermediate between *S. albomarginatus* and *S. canadensis*. Differences are listed in the key and discussed under the other two species. Male flagellomere XI is shorter than in other species (length 0.55–0.71x width; 0.75–0.94x in *S. canadensis*, 1.00–1.20 in *S. albomarginatus*; Cumming 1989).

VARIATION. Fore wing length 5.0–7.0 mm (♂♂), 5.5–9.0 mm (♀♀). Body with pale markings usually ivory or pale yellow, bright yellow only in specimens from Carolinian Life Zone and further south. Female clypeus with pale basal spot usually small, often absent; male clypeus rarely with a narrow preapical black band. Interantennal spot rarely absent in male. Female with anteroventral surface of scape black (exceptionally so in male), rarely with small pale basal mark. Pronotum with a pair of pale spots of variable size, very small to absent in some males. Male sometimes without pair of pale spots on scutellum. Tegula black to amber. Apical fasciae typically developed on terga 1, 2 and 4, in male sometimes also on 3 and 5. Sternum 2 with posterolateral pale spots or an interrupted fascia; occasionally sternum 4 and more rarely 3 with posterolateral spots, in male sometimes also 5 and 6.

DISTRIBUTION. Transcontinental in Canada and northern U.S., south to NC, NE, NM and CA (Cumming 1989).

BIOLOGY. Nests in borings in wood and sumac stems, and provisions with free-living Chrysomelinae larvae (Krombein 1967, 1979).

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***Zethus* Fabricius**

This is a very speciose Neotropical genus with numerous species in the Nearctic, Afrotropical and Oriental regions (Carpenter and Garcete-Barrett 2002). There are 30 Nearctic species (north of the Isthmus of Tehuantepec), and six species in America north of Mexico, five of which are restricted to the southernmost United States (Krombein 1979, Rodríguez-Palafox 1996).

REFERENCES. – Porter, 1978 (key to North American species); Bohart and Stange, 1965 (revision of New World species, key).

67. *Zethus spinipes* Say, 1837

Figs A4.5–6; B2.2, 4, 6, 31; C67.1–7.

SPECIES RECOGNITION. *Zethus* and *Eumenes* are the only eumenine genera with a petiolate metasoma in the northeastern Nearctic. Besides characters already mentioned in the generic key *Z. spinipes* differs from the eastern Nearctic species of *Eumenes* as follows: distance between hind ocelli and occipital carina more than twice the distance between hind ocelli (distance between hind ocelli subequal to distance between ocelli and occipital carina in *Eumenes*); notauli present and almost extending to middle of scutum (absent in *Eumenes*); tegula elongate, ca. twice as long as broad (short, less ca. 1.5x as long as broad in *Eumenes*); omaulus present (absent in *Eumenes*); valvula of propodeum largely free dorsally (fused dorsally along its whole length to submarginal carina in *Eumenes*); outer surface of female mid and hind tibia with short, blunt, flattened spines (absent in *Eumenes*); male hind basitarsus wider than tarsomere 2 and with a dense brush of short hair on ventral surface (unmodified, its width subequal to tarsomere 2 in *Eumenes*).

VARIATION (partly after Bohart and Stange 1965). Fore wing length 9.5–11 mm (♂♂), 12–14 mm (♀♀). The extent of pale markings varies considerably. Southern populations (ssp. *variegatus*) have more extensive pale markings. Females of the nominate subspecies vary from being almost completely black (except a narrow apical fascia on tergum 1) to possessing small ivory markings on frons (a pair of interantennal spots), mandible, pronotum, upper mesopleuron, scutellum, metanotum, propodeum, tergum and sternum 2 (apical fascia). In the male, pale markings may or may not occur on the legs and one or more terga beyond tergum 2.

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: MA, NY (Westchester Co.), PA (Pike Co.), OH (Hocking Co.), IL and WI (new state record; 1 specimen, Cross Plains, Dane Co.; photographic record: Bugguide) south to FL, west to KS, OK and TX (Bohart and Stange 1965, Krombein 1979). The ssp. *variegatus* de Saussure, 1852 occurs from MD southward.

BIOLOGY. Poorly known. According to Ashmead (1894) the cells of *Z. spinipes* are attached to twigs. This observation is very likely due to confusion with *Eumenes* (see Grissell 1975). Other species build their nests in twigs and borings in wood. One species of Tortricidae (Olethreutinae) has been recorded as prey of ssp. *variegatus* (Krombein 1979).

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Subfamily Masarinae (Pollen Wasps)

The subfamily includes five genera in the New World, four of which are restricted to South America, and one occurs in the Nearctic region (Carpenter 2001).

REFERENCE. – Carpenter, 2001 (World catalogue, species distributions).

***Pseudomasaris* Ashmead**

This genus includes 15 species and is restricted to the western Nearctic region (Carpenter 2001). Three species occur in Canada (*P. vespoides* (Cresson) is recorded for the first time: 1 ♂, 2 ♀♀, AB, Waterton; 1 ♂, BC, Chilcotin; all CNCI); a fourth species has been collected once in southern Ontario.

REFERENCES. – Richards, 1966 (key), 1963 (revision).

68. *Pseudomasaris edwardsii* (Cresson, 1872)

Figs B1.16; C68.1–5.

SPECIES RECOGNITION (after Richards 1966). The female can be distinguished from other species in the genus by the following combination of characters: frons simple above antennal sockets (with sharp transverse ridge in other spp.), mid femur flattened beneath (rounded in other spp.), mid tibia almost always with a distinct anterior prominence near middle. The male is diagnosed as follows: fore basitarsus without posterior fringe, flagellomeres 4–5 wider than the antennal club (narrower in other spp.).

VARIATION. Fore wing length ca. 8.5 mm (both sexes). Variation otherwise not studied.

DISTRIBUTION. Western U.S.: WA to CA, east to ID, WY, CO, UT and AZ. Mexico: Baja California Norte (Carpenter 2001). The single occurrence at Forks of the Credit in southern Ontario (6 ♂♂ from a malaise trap; PYU, AMNH) is clearly adventitious. Apparently, the species has not become established.

BIOLOGY. Mud nests consist of 1–10 cells attached to rocks or vegetation. Provisions with pollen and nectar from plants of ten genera of Hydrophyllaceae, Rhamnaceae, Tamaricaceae, Onagraceae, Lamiaceae, Boraginaceae, Caprifoliaceae, Asteraceae (Krombein 1979, Torchio 1970).

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Subfamily Polistinae (Paper Wasps)

This diverse subfamily is represented in the New World by 21 genera (Carpenter 2004*b*), most of which are restricted to tropical areas. Only four genera occur in America north of Mexico, two of which are found in the east.

REFERENCES. – Carpenter, 2004*b* (key to New World genera), Richards, 1978 (revision of New World species, key to genera and species).

***Polistes* Latreille**

The genus *Polistes* occurs in all biogeographic regions and includes 203 described species (Carpenter 1996*a*, Carpenter *in litt*.). The Nearctic fauna consists of 24 native or naturalized species, 11 of which occur in the northeast. Two species were newly discovered during this project and will be formally described elsewhere. Two adventitious species have each been recorded once from the area, one of western Nearctic and one of Neotropical origin. The northeastern species fall in two subgenera. The nominate subgenus is represented by the single, introduced Palaearctic species *P. dominula*. Formerly, the native Nearctic species were classified into five subgenera, two of which, *Aphanilopterus* and *Fuscopolistes*, are represented in the northeast (Richards 1973, 1978). Carpenter (1996*a*, 1996*b*) synonymized *Fuscopolistes* and three other subgenera with *Aphanilopterus*, but a recent study provided renewed support for the validity of the former (Pickett *et al*. 2006). Below, we refer to the species formerly placed in *Fuscopolistes* as the *P. fuscatus*-group (comprised of *P. bellicosus*, *P. carolina*, *P. dorsalis*, *P. fuscatus*, *P. metricus*, *P. perplexus*, *Polistes* sp. A and sp. B).

REFERENCES. – Carpenter, 1996*a* (catalogue of World species, distribution), 1996*b* (phylogeny of subgenera); Pickett *et al*., 2006 (phylogeny of subgenera); Bequaert, 1940*a* (taxonomy of Canadian and U.S. species, key).

69. *Polistes annularis* (Linnaeus, 1763)

Figs B10.2, 5, 13, 46; C69.1–6.

SPECIES RECOGNITION. Similar in colouration to *P. metricus* from which it can be distinguished by the more slender metasomal segment 1, the punctate mesopleuron, often orange flagellomeres VI–X (black above in *P. metricus*) and yellow apical fascia of tergum 1 (rarely present in *P. metricus*). The male of *P. annularis* is unique among northeastern *Polistes* in showing practically the same colouration as the female, by lacking yellow markings on the clypeus and mesopleuron.

VARIATION (partly after Richards 1978). Fore wing length 18.5–23.5 mm (♀♀), 17.5–19.5 mm (♂♂). Dark specimens from northern localities have a largely black mesosoma with ferruginous areas on pronotum, margins of scutellum, ferruginous pair of stripes on scutum and spot on upper mesopleuron. Southern specimens have a largely ferruginous mesosoma with black area in front of pronotal carina, black hind margin of scutum, pleural sutures and black central groove of propodeum. Metasoma mainly black, tergum 1 partly to mostly ferruginous, tergum 2 sometimes with pair of ferruginous spots. Yellow markings very restricted, in male usually present along inner eye margin below eye emargination and, rarely, very narrow clypeal margin, both sexes on propodeal valvula, sometimes also on pronotal keel and metanotum along anterior margin, rarely with traces of propodeal stripes (well developed in two males examined). The legs vary from largely black to largely ferruginous (excluding yellow apices of femora, bases of tibiae and tarsi).

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: MA (probably adventive), NY, PA, OH south to FL, west to SD, NE, KS, OK and TX (Richards 1978).

BIOLOGY. Nests attached to twigs and branches of shrubs and trees, also in sheltered places on buildings. Preys on a great variety of caterpillars with records from the following families: Arctiidae, Saturniidae, Geometridae, Limacodidae, Lymantriidae, Notodontidae, Nymphalidae, Sphingidae, Erebidae, Noctuidae, Amphisbatidae and Elachistidae (Krombein 1979).

70. *Polistes aurifer* de Saussure, 1853

Figs B10.58; C70.1–5.

SPECIES RECOGNITION. This western Nearctic species is closely related to *P. fuscatus* and has until recently been treated as a subspecies of the latter (Richards 1978). In both sexes it is distinguished from *P. fuscatus* by the ferruginous dorsal surface of flagellomere 1 and sometimes also the following flagellomeres (more or less darkened in *P. fuscatus*), by the more yellowish wings, and by the presence of yellow discal spots on tergum 2 (often confluent with apical fascia; the spots rarely present in *P. fuscatus* females, uncommon in *P. fuscatus* males).

VARIATION. Size as in *P. fuscatus*. Specimens from the northern part of the range are usually black, marked richly with yellow, and have very restricted ferruginous markings; some southwestern forms possess a largely yellow metasoma. Specimens from certain areas of the southern U.S.

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and northwestern Mexico are largely ferruginous with almost no black markings and moderately to well developed yellow markings.

DISTRIBUTION. Canada: AB and BC; according to Starr (1991) possibly also in MB and SK (records not clearly distinguished from *P. fuscatus*; see Distribution under that species); adventitious in PE (1 ♀, Summerside, November 1973; CNCI). Western U.S.: WA and MT south to western TX and CA. Northeastern Mexico: Baja California, Sonora, Chihuahua, and Coahuila. Introduced in Hawaii and Society Is. (Carpenter 1996*a*).

BIOLOGY. Nests in sheltered situations (Krombein 1979).

71. *Polistes bellicosus* Cresson, 1872

Figs B1.11; B10.51; C71.1–8.

TAXONOMIC NOTE. Previously published keys (e.g., Bequaert 1940*a*, Richards 1978) fail to separate this species from *P. fuscatus*. While the typical, extensively ferruginous, colour form from the southeast is easily distinguished from *P. fuscatus*, northern specimens (which are much darker) are extremely similar to certain sympatric colour forms of *P. fuscatus*. We have examined females of *P. fuscatus* with strikingly *bellicosus*-like colour patterns from as far north as Ontario. Based on the newly discovered character of male flagellum colour (see below) males of both species can now be separated without difficulty.

DISCUSSION. The present definition of *P. bellicosus* significantly expands the previous concept of the species (e.g., Richards 1978) by including forms with predominantly black mesosoma, which were usually misidentified as *P. fuscatus*. The original description of *P. bellicosus* (based on specimens from Texas, see Cresson 1872) mentions a black median stripe of the propodeum as the only black colour element, and black markings are not mentioned at all in Richards' (1978) subsequent diagnosis. Separation of dark males of *P. bellicosus* from *P. fuscatus* was possible through the discovery that all-dark apical flagellomeres are diagnostic for *P. fuscatus*. Cresson (1872) noted that the flagellum of male *P. bellicosus* was "pale beneath, dark above", but subsequent authors did not realize the importance of this character.

SPECIES RECOGNITION. Males of *P. bellicosus* and *P. metricus* can be distinguished from *P. fuscatus* males by the concolorous orange to ferruginous tyloids (in *P. fuscatus* tyloids of apical flagellomeres are considerably darker than the basal ones) and the yellowish to ferruginous anterior surface of apical flagellomeres (dark brown to black in *P. fuscatus*). The male of *P. bellicosus* possesses a yellow dorsal mesopleural spot (absent in *P. metricus*) and yellow apical fasciae on at least terga 1–3 (on tergum 1 at most in *P. metricus*). Females differ from most *P. fuscatus* females by the ferruginous hind trochanter and femur (lacking black or brown markings; see key), and the well-developed yellow markings (especially on clypeus). *Polistes bellicosus* can be distinguished from the largely ferruginous *P. carolina* and *P. perplexus* by its well-developed yellow markings.

REDESCRIPTION. Fore wing length 13.0–17.5 mm (♀♀), 14.5–17.0 mm (♂♂). *Female*. Head ferruginous, with the following black markings: rectangular ocellar spot, in southern specimens often reduced to narrow area around ocelli, sometimes completely absent; small spots frequently above and below antennal sockets, the former rarely connected to ocellar spot. Dorsal surface of antenna including apex of scape usually more or less darkened. Mesosoma of northeastern specimens black, with the following ferruginous markings: at least dorsal half of pronotum, usually lateral areas in front of pronotal carina, usually small stripe bordering yellow dorsal mesopleural spot anteriorly, sometimes ventral mesopleural spot, usually stripes on scutum (often coalescent posteriorly), most of scutellum and metanotum, more or less extensive areas of propodeum, varying from small margins around yellow stripes to most of propodeum (propodeum rarely entirely black marked with yellow). Mesosoma of southern specimens (i.e., typical form) largely ferruginous with black markings reduced to sutures and median stripes of scutum and propodeum. Metasoma largely ferruginous, often with incomplete median stripe on tergum 1 and narrow basal bands on terga 2–4, often triangularly produced on tergum 2; sterna (especially 1 and 2) also often with black basal areas. Legs largely ferruginous; coxae usually with small to moderate-sized black spots on posterior surface, rarely with small spots on anterior surface (largest on fore coxa); fore and mid femora sometimes with small black posterobasal spots; hind tibia almost always with black or brownish posterodorsal apical spot, sometimes dorsal surface more or less brownish. Yellow markings usually well developed including at least half of surface of clypeal disc, mandibles, inner orbits, sometimes transverse supra-antennal stripes (if present often more or less suffused with ferruginous); gena along posterior eye margin at least in ventral half and usually most of malar space (rarely gena almost completely ferruginous); pronotal carina and pronotal hind margin; scutellum and metanotum anteriorly; upper mesopleural spot (exceptionally

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evanescent), often small subalar area of metanotum; paramedian propodeal stripes (exceptionally absent), rarely also lateral stripes (more common in specimens from southwestern part of range); coxae almost always with yellow markings; femora, tibiae and tarsi also marked with yellow; apical fasciae on metasomal terga 1 to 3, 4 or 5 (rarely well developed on terga 1 and 2 only and evanescent on 3), exceptionally discal spots on tergum 2; apical fasciae of sterna 2–(3)4, usually more or less broadly interrupted medially; exceptionally sterna without yellow markings. *Male* differs from female as follows: yellow markings better developed including most of face below top of ocular sinuses; ventral and anterior surface of mesopleuron, most of fore and mid coxa, and larger areas on femora and tibiae; often subbasal spot on sternum 2; yellow propodeal stripes sometimes absent. Black markings often better developed than in female, sometimes including entire propodeum; metasoma with black basal marks of terga 1–3 sometimes (almost) extending to yellow apical fascia.

DISTRIBUTION. Canada: first recorded from Ontario, apparently adventitious (1 ♀, Chatham; CNCI). Eastern U.S.: newly recorded from NY, Long I. (1 ♂, USNM); NJ, Island Beach (3 ♀♀, USNM); DE, New Castle Co., Cedar Swamp Wildlife Area (1 ♀, DEBU); MD, Anne Arundel, Calvert, Talbot and Worcester Cos. (17 ♂♂, 21 ♀♀; DEBU, USNM); DC (1 ♂, 1 ♀, USNM); VA (all USNM), Tangier I. (1 ♂), Dyke (1 ♀), Cole's Point (1 ♀), Cape Charles (2 ♀♀), and Norfolk (1 ♀); previously known from NC to FL and Gulf Coast states west to TX (Richards 1978). All new records are from coastal areas, except for the specimen from Dyke, VA.

BIOLOGY. Undescribed. One of us (S.A.M.) observed and photographed three different nests of this species on a pine branch, on a bare twig of a shrub and under an eave (Fig. 71.6) in Charleston Co., South Carolina.

72. *Polistes carolina* (Linnaeus, 1767)

Figs B10.9, 15, 21, 38, 49; C72.1–7.

SPECIES RECOGNITION. This species and *P. perplexus* are the only species in the east with almost completely ferruginous body. Females of *P. carolina* differ from *P. perplexus* by the largely bare malar space and lower gena, which contrasts with the finely silvery pubescent upper gena (in *P. perplexus* both malar space and gena are silvery pubescent). Previously, males of both species could not be separated. In material examined by us both sexes of *P. perplexus* show consistently coarser transverse ridging of the propodeum than *P. carolina*.

VARIATION. Fore wing length 15.0–20.5 mm (both sexes). *Female*. Body almost entirely ferruginous, sometimes with the following black markings: spot(s) around ocelli (typically one minute spot around each ocellus, rarely confluent and forming a single rectangular or irregular mark); distal half of dorsal surface of scape (rarely), medial spot in front of pronotal carina, incomplete central stripe and rarely margins and incomplete lateral stripes on scutum, mesosoma behind fore coxae, some mesosomal sutures, median stripe of propodeum (usually incomplete), and narrow anterior bands on sternum 2 and terga 3 and 4. Flagellum more or less darkened along entire dorsal surface except sometimes parts of flagellomere 1. Yellow markings also very restricted, sometimes present on mandibles, clypeus, inner orbit, propodeal valvula, propodeal stripes (exceptional), tergum 1 (apical fascia), outer surface of tibiae and tarsi. *Male* differs from female as follows: Black or dark brown markings often better developed, including sometimes small spots on posterior surface of fore and mid femur, and spots on sterna 3–6. Yellow markings very variable: in xanthic specimens including entire face up to upper limit of eye emargination, malar space and lower gena, pronotal carina, lateral surfaces of pronotum, anterior and ventral areas of mesopleuron, indistinct upper mesopleural spot (suffused with ferruginous), small spot on upper metapleuron, anterior surfaces of all coxae, trochanters and femora, sternum 1 more or less yellowish, large yellow basal spot on sternum 2 and partially developed apical fasciae of sterna 3 and 4. Most specimens have the median portion of the face as well as the median part of the dorsal 2/3 of the clypeus somewhat suffused with ferruginous. The most ferruginous specimens lack most of the yellow markings of the mesosoma, metasoma, coxae and femora except small mesopleural spots behind the fore coxae.

DISTRIBUTION. Canada: recorded for the first time from ON as an adventitious species (not established). Eastern U.S.: NY, PA, OH south to FL, west to IL, KS, AR and eastern TX. Introduced to Bermuda (Richards 1978, Carpenter 1996*a*).

BIOLOGY. Nests in more or less exposed areas such as under roofs of buildings or in old tires. The species has often been reported to nest in protected sites (e.g., hollow trees) but these reports are apparently due to confusion with *P. perplexus* (Wade and Nelson 1978). Prey consists of caterpillars and Chrysomelidae larvae. One report describes an attack on a cicada (*Tibicen auletes* Germar) (Richards 1978). Due to confusion with

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the very similar *P. perplexus* some of the biological information published might actually refer to that species.

73. *Polistes dominicus* (Vallot, 1802)

Figs B10.59; C73.1–3.

SPECIES RECOGNITION. This Caribbean species is easily distinguished from native northeastern Nearctic *Polistes* by its colouration. The single specimen from Toronto belongs to the light colour form that occurs on most islands within its range except Barbados. The body of these wasps is nearly entirely ferruginous except for a wide yellow apical fascia of tergum 1. Structurally the species is similar to *P. annularis* with which it shares the slender metasomal segment 1 and the punctate mesopleuron.

VARIATION. Fore wing length 14.0–18.0 mm (♀♀), male not available for examination. Nearly entirely ferruginous excluding brown flagellomeres II–V and femora, and yellowish tibiae and tarsi. In specimens from Barbados the mesosoma is marked to a variable extent with dark brown.

DISTRIBUTION. Not native to the Nearctic region. We have examined one female from ON (Toronto, 19 May 1981, L. Coote; DEBU), obviously an accidental introduction or perhaps a mislabelled specimen. Lesser Antilles: St. Kitts, Montserrat, Martinique, St. Lucia, St. Vincent (including Mustique I.), Grenada (Carriacou I.), Trinidad and Barbados (Carpenter 1996*a*).

BIOLOGY. One nest has been reported from under an earthen overhang of a roadside bank. Prey consists of caterpillars (Richards 1978).

74. *Polistes dominula* (Christ, 1791)

Figs B10.1, 3, 4, 44; C74.1–8.

NOMENCLATURAL NOTE. J.M. Carpenter (pers. comm.) kindly pointed out to us that the correct gender ending for this species is *dominula*. "*Dominula*" is the diminutive form of the Latin noun *domina* (= mistress) and therefore indeclinable (the original combination is *Vespa dominula* Christ).

SPECIES RECOGNITION. This recently introduced species, the only species of the nominate subgenus in North America, is easily recognisable by its colouration (see key), the dense punctation of its mesopleuron and the strong ridging of the propodeum (the latter also present in *P. perplexus* and sometimes *P. metricus*, both of which have extremely reduced yellow markings). *Polistes dominula* is very similar to several Palaearctic species from which it can be separated using the key by Dvořák and Roberts (2006).

VARIATION. Fore wing length 9.5–13.0 mm (♀♀), 8.5–12.0 (♂♂). This species shows relatively little variation. Female clypeal disc with well developed black central spot, with two smaller spots or entirely yellow. Female mandible black, sometimes with yellow spot. Black subantennal mark of female rarely with a pair of small, yellow spots. Female vertex sometimes with a pair of minute yellow spots behind hind ocelli. Yellow postocular stripe usually broadly interrupted near middle, rarely complete but narrowed. In male yellow spots of posteroventral corner of pronotum sometimes confluent with yellow transverse stripe across pronotal carina. In female yellow stripes along pronotal hind margins rarely confluent with stripe of pronotal carina. Female rarely lacking yellow, comma-shaped scutal spots. Yellow spots of metanotum confluent or separate. Mesopleuron in female sometimes, in male usually with small to medium-sized spot below scrobe. Male with ventral surface of mesopleuron yellow, exceptionally black as in female (1 ♂, ON: Sault Ste. Marie, DEBU). Female metapleuron rarely, male metapleuron usually with upper and lower yellow spots (lower spot less frequently present). Yellow discal spots of tergum 1 confluent with apical fascia or separate, always (?) confluent in male. Yellow discal spots of tergum 2 always present, in male sometimes very large and confluent with apical fascia and then often enclosing small black spot. Male with yellow spot at base of sternum 2 very variable, in extreme cases confluent with apical fascia or represented by a swarm of small, evanescent spots. Reddish-orange areas very restricted, limited to flagellum, femora (between black and yellow markings) and inner surface of tibiae. Male with ventral surface of fore coxa always, mid coxa almost always and hind coxa sometimes marked with yellow.

DISTRIBUTION. Canada: NS (first record 2003), ON (first record 1997) and BC (first record 2003) (Borkent and Cannings 2004, Hoebeke and Wheeler 2005). U.S.: ME to WI, MI, OH and VA, also MO, CO, UT and WA to CA (Arduser and Stevens 1999, Landolt and Antonelli 1999, Cervo *et al*. 2000, Hoebeke and Wheeler 2005). Palaearctic and Oriental: central and southern Europe to Mongolia and China, south to northern Africa, Israel, Iran, Afghanistan, Pakistan and northern India. Introduced in Western Australia, Chile (Carpenter 1996*a*) and Argentina (Sackmann *et al*. 2003). According to K.M. Picket (*in litt*.) the species is widespread in the U.S. Midwest and is now expanding its range into the southwestern states (AZ, NV). The species was introduced first into Massachusetts in the 1970's, and was first recorded from Michigan in 1995 (Judd and

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Carpenter 1996). The first Canadian records from Ontario (Windsor, Guelph, Niagara Falls; see material examined and Hoebeke and Wheeler 2005) indicate that the species was already widespread in southwestern Ontario in 1997. The northernmost records in Ontario are from Pancake Bay Prov. Pk. (2007; collected by K.N. Barber, DEBU), Sault Ste. Marie (2005; collected by K.N. Barber, DEBU), Manitoulin I. (2005; H. Goulet, pers. comm.) and Ottawa (2006; H. Goulet, pers. comm.). The species is still spreading rapidly, should already be present in Quebec, and will soon be found in New Brunswick and Prince Edward Island. According to R. Roughley and T.D. Galloway (in litt., December 2007) the species has not yet been found in Manitoba.

BIOLOGY. The introduction and rapid spread of *P. dominula* in North America has spawned a series of investigations on its biology, especially in comparison with the native North American *P. fuscatus*, with which it is sympatric throughout the eastern portion of its range. *Polistes dominula* builds its nests in sheltered places like *P. fuscatus* but it shows a much greater propensity to use manmade structures (eaves, etc.) (Silagi *et al*. 2003). This may account for the fact that *P. dominula* has become much more abundant in urban and suburban areas than *P. fuscatus*. According to Gamboa *et al*. (2002) *P. dominula* has completely replaced *P. fuscatus* in certain areas of Michigan. This is not the case in Ontario where the two species have coexisted almost as long as in Michigan, even though *P. dominula* is now much more common in heavily disturbed habitats. Further biological differences between the two species include a much broader prey spectrum (including insects from many other orders besides caterpillars; Cervo *et al*. 2000), greater tendency to store nectar (Silagi *et al*. 2003), higher productivity (e.g., due to lesser body mass in *P. dominula*; Armstrong and Stamp 2003), shorter larval and pupal development times, lesser incidence of parasitism by Strepsiptera (we have not seen any stylopized *P. dominula* so far), and higher winter mortality (in Rochester, MI) for *P. dominula* (Gamboa *et al*. 2004).

75. *Polistes dorsalis* (Fabricius, 1775)

Figs B10.29–32, 50; C75.1–8.

SPECIES RECOGNITION. This is the smallest species of the genus in our area. Its colour pattern is similar to ferruginous forms of *P. fuscatus* and dark forms of *P. bellicosus*. Females of *P. dorsalis* can be separated from *P. bellicosus* by the presence of black or brown markings on the femora (completely ferruginous in *P. bellicosus*) and from lighter forms of *P. fuscatus* by the black or brown hind femoral mark forming a complete ring (dorsally interrupted by ferruginous in *P. fuscatus*). The latter character varies geographically and is only reliable in eastern populations (we have seen *P. d. dorsalis* females from Mississippi and Texas in which the femoral ring is interrupted). Dark forms of *P. fuscatus* often possess a complete black femoral ring as well but show black markings in areas where they are always absent in *P. dorsalis* (e.g., on clypeal disc) and/or lack ferruginous marks where they are always present in *P. dorsalis* (e.g., on pronotum and tergum 2). *Polistes dorsalis* occasionally shows colour patterns that are unique and immediately distinguish it from other species of the *P. fuscatus*-group: females sometimes possess a yellow mesopleural spot just below the end of the scrobal furrow (rarely present in extralimital *P. bellicosus*), and xanthic specimens of both sexes never show four discrete yellow propodeal stripes as do certain xanthic forms of *P. fuscatus* and *P. bellicosus*. In the latter two species the lateral propodeal stripes are always closer to the metapleural suture than to the paramedian stripes, whereas in *P. dorsalis* the lateral and paramedian stripes are either confluent (sometimes rendering most of the propodeum yellow) or the lateral stripes are irregular in shape and closer to the paramedian stripes than to the metapleural suture. The male of *P. dorsalis* shows two unique morphological characters that immediately separate it from other species in the *P. fuscatus*-group: an unusually prominent median tubercle of sternum 7 (visible in profile) and dull (as opposed to shining) tyloids on the apical flagellomeres.

VARIATION. Fore wing length 10.0–13.0 mm (both sexes). *Female*. Yellow markings of head always present, typically forming a V-shaped apical mark on clypeus, sometimes reduced to a small apical spot; supra-antennal stripes absent, rarely present but then strongly suffused with ferruginous; stripes on inner orbit always present, usually not dipping into ocular sinus; postocular stripe on gena, if present, rarely extending to base of mandible; mandible usually more or less yellowish, its base rarely clear yellow. Black markings usually quite restricted; ocellar mark large and rectangular to extremely reduced, leaving only narrow rings around each ocellus, never connected to black spot (if present) above antennal socket; supraclypeal area and sutures between antennal socket and clypeus sometimes marked with black; occiput completely black to largely ferruginous. Antenna with dorsal surface including scape often black or brown but in specimens from southern U.S. scape, pedicel and flagellomeres I, IX and X often entirely

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ferruginous, and dorsal surface of remainder of flagellomeres only slightly darker. Mesosoma usually largely black, ferruginous markings at least present on dorsal half of pronotum and posterior 2/3 of scutellum (on latter rarely largely replaced with black). The most ferruginous specimens lacking black on entire dorsal surface of mesosoma (excluding suture between scutum and scutellum), but median furrow of propodeum at least in part black; pleuron with substantial black or brown markings including lower parts of mesopleuron (above mid coxa, and around metapleural and midventral sutures) and metapleuron except centre of lower plate (pleuron almost entirely ferruginous in some specimens from southwestern localities, e.g., Mississippi). Yellow markings of mesosoma quite constant and well developed; small yellow spot below ventral end of scrobal furrow sometimes present; propodeal stripes never abbreviated, of normal width to very wide, sometimes with irregular confluent or separate lateral spots, which are always closer to the paramedian stripes than to the metapleural suture (unlike other species), never with regular lateral stripes as in *P. fuscatus* or *P. bellicosus*, in extreme cases most of propodeum yellow (the latter typical for ssp. *neotropicus* and *maritimus*). Coxae almost always largely black to dark brown, occasionally with more or less developed ferruginous spots, rarely with very small yellow spots. Femora always with black or dark brown basal markings, increasing in size from fore to hind femur, forming ring on hind femur. Yellow markings usually well developed on femora and tibiae. Metasoma usually largely ferruginous with more or less developed black basal bands on terga and sterna. The darkest specimens have ferruginous markings restricted to a pair of large spots on tergum 2, posterior part of tergum 5 and segment 6. The most ferruginous specimens lack black tergal markings and possess very restricted black sternal markings (e.g., base of sternum 2). Yellow fasciae well developed, typically present on terga 1–4, occasionally 1–5, rarely 1–3 (some stylopized specimens only 1–2); sterna typically with complete fascia on sternum 2 and more or less interrupted ones on 3 and 4; occasionally fasciae completely absent. *Male* similar to female, differing as follows: face yellow up to level of ocular sinuses (rarely entire mid section of frons and dorsomedial 2/3 of clypeus ferruginous), anteroventral part of mesopleuron yellow (rarely reduced to a pair of small spots); anterior surfaces of fore and mid coxae more or less entirely yellow, sometimes spots on anterior surface of hind coxa (rarely up to 2/3); anterior yellow stripes on fore and mid femora, sometimes also on hind femora; sternum 1 often and base of 2 usually with yellow spot; sterna 2–(5)6 with yellow apical fasciae. Ferruginous areas of mesosoma on average smaller than in female, usually absent or minute on pleuron and propodeum.

DISTRIBUTION. Not recorded from Canada. The nominate subspecies occurs in the eastern and southern U.S. from southwestern MA, southeastern NY, NJ, MD, and WV (Hampshire Co., new state record, DEBU, presented by S. Droege) south to FL and west to TX and AZ (Bohart and Bechtel 1957), Mexico south to Guerrero, and Jamaica (Carpenter 1996*a*). Richards (1978) and Carpenter (1996*a*) gave Virginia as the northern limit of its distribution. The subspecies *neotropicus* Bequaert, 1940 ranges from CO, NM and TX south to Costa Rica, and subspecies *californicus* Bohart, 1949 from AZ and CA to northwestern Mexico (Chihuahua and Baja California to Sinaloa); ssp. *maritimus* Bequaert, 1940 occurs on the Bahamas (Andros I.) and ssp. *clarionensis* Bohart, 1949 on Clarion I. and the Revillagigedo group off the Pacific coast of Mexico.

BIOLOGY. Nests in shrubbery and beneath eaves (Krombein 1979).

76. *Polistes exclamans* Viereck, 1906

Figs B1.13, 17; B10.6, 8, 10, 12, 45; C76.1–8.

SPECIES RECOGNITION. This species is unlikely to be confused with other species. It is the only species in the area covered by this work with a yellow spot on the lower mesopleuron (in front of the metapleural suture). All metasomal segments (except sternum 1 and rarely apical segments) have well-developed yellow apical fasciae and the propodeum has four yellow stripes. Both characters occur usually in *P. dominula* and very rarely in *P. fuscatus*, but the former lacks ferruginous markings on the body (present and usually extensive in *P. exclamans*), while in the latter the flagellum is more or less unicolorous dorsally (contrastingly coloured with dark median and bright orange apical flagellomeres in *P. exclamans*).

VARIATION. Fore wing length 13.0–16.5 mm (♀♀), 12.0–15.0 (♂♂). The extent of ferruginous markings is variable. They are present at least on the centre of the clypeus (female), most of frons (female, excluding black area around ocelli and yellow inner orbits), pronotal disc except ventrally, most of scutum, median portion of all terga (in male sometimes very reduced). In very light specimens black markings are largely replaced by ferruginous except for the following: part of occiput, some mesosomal sutures, limited areas of mesopleuron (behind scrobal furrow) and metapleuron (above

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pit), central groove of propodeum, narrow bases of terga 1–3, part of hind femur, mid and hind tibiae. Yellow markings are variable in size but quite constant in presence/absence. They may be present or absent on metapleuron and on terga 5 and 6 (female, according to Richards 1978).

DISTRIBUTION. Canada: one record from ON (adventitious; 1 ♂, Weston, DEBU). Eastern U.S.: NJ, IN, IL south to FL, west to NE, CO, OK and TX, recently (by accidental introduction?) also in NM (Dona Ana Co., photographic record: Bugguide), AZ (1 ♀ from a nest, Bisbee, USNM) and CA (Orange Co., photographic record: Bugguide); introduced to HI. Mexico: Chihuahua to Jalisco, Hidalgo (Richards 1978, Carpenter 1996*a*).

BIOLOGY. Nests usually in sheltered places (e.g., eaves under roofs), also in trees. Males show territorial behaviour, a very unusual trait in social wasps (Richards 1978). Prey consists of caterpillars of various families including Arctiidae, Saturniidae, Hesperiidae, Notodontidae, Noctuidae, Erebidae, Pieridae, Crambidae (Pyraustinae) and Sphingidae (Krombein 1979).

77. *Polistes fuscatus* (Fabricius, 1793)

Figs B1.3, 7; B10.7, 11, 23, 25, 26, 28, 33, 34, 39, 41, 42, 54–57; C77.1–15.

TAXONOMIC NOTE. The separation of the hypervariable *P. fuscatus* from related species remains the greatest taxonomic problem of the northeastern Vespidae fauna. Colour patterns of *P. fuscatus* are strongly influenced geographically, as in many other Vespidae, and have resulted in the description of many questionable subspecies. Besides geographic variation individual variation is also extremely pronounced. What makes the recognition of *P. fuscatus* especially challenging is the fact that different parts of the body can follow different colour trends, e.g., the extent of yellow markings can vary independently on head, meso- and metasoma (in most other Vespidae xanthic or melanic tendencies affect all parts of the body in the same direction). The individual distinctiveness of colour patterns in *P. fuscatus* facilitates recognition of nestmates, and apparently reduces aggressive interactions between individuals (Tibbetts 2002). There is evidence that the social structure of *Polistes* colonies selects for individual distinctiveness and phenotypic diversity (Tibbetts 2004).

Females of *P. fuscatus* intergrade with both *P. metricus* and *P. bellicosus*, two very differently patterned species. Even though males of these species can be identified without problem there seem to be no reliable morphological characters that separate females. Their identification using colour patterns is not always possible, and it appears that extreme forms of *P. fuscatus* can show patterns that are indistinguishable from extreme forms of the other two species. The boundaries between the three species as drawn here are therefore tentative.

SPECIES RECOGNITION. The male is easily distinguished from other members of the *P. fuscatus*-group by the complete darkening of the (3–)4–5 apical flagellomeres (including ventral and anterior surface, apex of flagellomere XI sometimes paler). In other species only the dorsal surface of the apical flagellomeres is darkened whereas tyloids and the anterior surfaces are essentially the same light colour (yellow-orange) as the basal flagellomeres. Females from northern localities (including the vast majority of Canadian specimens) are easily identified by the largely black colouration of the whole body (with or without well-developed yellow markings). Problematic are many specimens from the southern half of the range, where the extent of ferruginous markings is often much increased. Females with ferruginous head and mesosoma, dark metasoma and reduced yellow markings resemble *P. metricus*, whereas females with largely ferruginous body and well developed yellow markings resemble *P. bellicosus*. The differences are discussed under these species.

VARIATION. Fore wing length 11.5–17.0 mm, usually above 13.0 mm (♀♀), 11.0–17.0 (♂♂). *Female*. Extent of ferruginous areas extremely variable, generally increasing from northern to southern latitudes. Largely black northern forms have at least the following body parts ferruginous: small areas on mandible, postocular spot, scape ventrobasally and ventrodistally, flagellum ventrally, small areas on fore and mid femora, most of fore tibia, mid tibia and tarsi. Extremely ferruginous specimens (occurring rarely in the area covered by the Atlas but more commonly further south) are nearly entirely ferruginous, excluding the following black areas: mark around ocelli, dorsoapical spot on scape, upper surface of flagellum, median stripe of scutum, scrobal furrow and dorsal groove of mesopleuron, narrow stripes along some sutures of mesosoma (e.g., scutum – scutellum; metapleuron – propodeum); spot in central groove of propodeum ventrally, small medial spots on metasomal terga 1–3, spots on all coxae. The extent of yellow areas is also very variable. Yellow markings are often well-developed in Canadian specimens but sometimes also in extensively ferruginous-marked specimens from southern localities. Richly marked specimens show the following yellow markings: most of mandible, clypeus ventrally and laterally, lower inner orbits,

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transverse spot(s) above antennae, postocular spot(s), pronotum along carina and posterior margin, dorsal mesopleural spot and small ventral spot just above mid coxa, anterior fasciae on scutellum and metanotum, metapleural ridge and narrow adjacent areas, pair of longitudinal stripes on propodeum, rarely additional pair of longitudinal stripes or spots on lateral portions of propodeum, propodeal valvula, apical fasciae on terga 1–5 and sterna 2–5, small lateral spots on tergum 1, sometimes discal spots on tergum 2, markings on mid and hind coxae, small areas on all femora and tibiae, dorsal surface of basal segments of tarsi. When very restricted, yellow markings are at least present on the following: pronotal hind margin (often obscure), propodeal valvula, knees of legs, basal segments of tarsi. *Male*: Variation similar to female but the following always yellow: mandible except apical margin, clypeus, frons up to level of upper margin of ocular sinus, lower gena, ventral surface of antenna from scape to about flagellomere 6 (often suffused with orange), ventral surface of mesopleuron, anterior surface of all coxae (sometimes only small spot on hind coxa), ventral surface of fore femur, anterior surface of mid and hind femur, apical fasciae of sterna 2–5 (sometimes incomplete on 2 or 5), and basal spot on sternum 2. In addition to the yellow markings present in the female the following may be present: ventral corners of pronotum behind carina (almost always); metapleuron ventrally, very rarely also tiny spots on terga 3 and 4, and sternum 1.

DISTRIBUTION. Canada: NS, PE, QC and ON (Richards 1978, Starr 1991), apparently newly recorded for NB (photographic record, Bugguide); according to Starr (1991) probably also in MB and SK (records not clearly distinguished from *P. aurifer*, see below). Eastern U.S.: south to FL, west to NE and TX; Bermuda, Jamaica, Barbados, introduced to Cape Verde Is. and Ascension I. (Carpenter 1996*a*). According to Starr (1991) the ranges of *P. fuscatus* and *P. aurifer* (formerly considered a subspecies of *P. fuscatus*) overlap in MB and SK. As some of the characters previously used to separate the two species (such as the presence of yellow spots on tergum 2) are variable in *P. fuscatus* the western limit of the distribution of *P. fuscatus* and the eastern limit of *P. aurifer* need to be re-examined. Borkent and Cannings (2004) erroneously mentioned *P. fuscatus* as "native to British Columbia" based on misinterpreted distributional information provided by Carpenter (1996*a*).

BIOLOGY. Nests in sheltered areas above or near the ground such as eaves or roofs or below rocks. Prey are mostly caterpillars but also Orthoptera (Krombein 1979). A detailed study of the social biology of this species was done by West-Eberhard (1969).

78. *Polistes metricus* Say, 1831

Figs B10.17, 22, 24, 27, 36, 52; C78.1–8.

SPECIES RECOGNITION. Female very similar to some ferruginous colour forms of *P. fuscatus*. *Polistes metricus* has very restricted yellow markings (as in some *P. fuscatus*), but the mesosoma is more extensively ferruginous while the metasoma is mostly black (see key). Unlike *P. metricus*, ferruginous specimens of *P. fuscatus* often show ferruginous markings beyond metasomal segment 2. The convexity of sternum 2 (more pronounced in *P. metricus*) provides an additional morphological character, but the difference is sometimes quite subtle.

VARIATION. Fore wing length 14.0–21.5 mm (♀♀), 14.5–18.0 mm (♂♂). *Female* on one extreme with almost entirely ferruginous head and mesosoma (excluding black dorsal surface of flagellum, pedicel and distal third of scape, narrow ocellar rings, some mesosomal sutures), on the other extreme ferruginous marked with considerable black as follows: large spot around ocelli extending from eye to eye, marks below and above each antennal socket, spot on interantennal prominence, occiput, most of pronotum in front of pronotal carina, scutum except a pair of ferruginous, posteriorly convergent or connected stripes and a pair of spots opposite tegula, mesopleuron except spots behind and in front of scrobal furrow and on lower mesopleuron, metapleuron around edges and upper pit, pair of propodeal stripes (very rarely so; propodeum usually ferruginous with more or less developed black median stripe). The metasoma is largely black and shows ferruginous markings as follows: apical fascia and lateral margins of tergum 1 usually, pair of discal spots and lateral margins of tergum 2 often, base of sternum 2 rarely. Femora usually with black to dark brown markings, sometimes absent on fore and mid femur, always present at least ventrally on hid femur. At least hind tibia with dorsal surface largely black to dark brown (excluding yellow base). Yellow markings restricted to propodeal valvula (sometimes ferruginous) and rarely tergum 1 (apical fascia). *Male* similar to female but black markings sometimes more extensive, e.g., 1 ♂ from IN: Lafayette (CNCI), with entirely black scutum, black posterior half of mesopleuron (except ferruginous dorsal spot), black metapleuron (except ferruginous dorsal spot) and black propodeum with wide lateral and narrow paramedian ferruginous stripes. Yellow

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markings include (in addition to those present in female): entire face to level of upper eye emargination (in some specimens median portion of clypeus and area between and below antennal sockets more or less ferruginous), pronotal carina sometimes, extreme ventrolateral corners of pronotum usually, anteroventral area of mesopleuron to level of ventromedial suture (very variable, from very large area to completely absent), usually large basal spot on sternum 2, apical fasciae on sterna 2–4 (often absent on 2 and 4, sometimes sterna 2–4 completely dark). Extent of yellow markings on legs also extremely variable: some yellow present at least on mid coxa (always?, sometimes suffused with ferruginous), base of mid and hind tibiae and all tarsi; xanthic specimens with anterior surface of all coxae, trochanters, femora and tibiae yellow.

DISTRIBUTION. Canada: newly recorded from extreme southwestern ON (2 ♀♀, Pelee I., DEBU). Eastern U.S.: ME (1 ♀, Dryden, CNCI; new state record, probably adventitious), NY, PA, southern OH south to FL, west to NE, KS, OK and eastern TX (Richards 1978).

BIOLOGY. Nests are built in both sheltered and exposed places (eaves of roofs, trees, shrubs). Prey consists mostly of caterpillars (Isely 1922).

79. *Polistes perplexus* Cresson, 1870

Figs B10.19, 20, 37, 48; C79.1–6.

SPECIES RECOGNITION. This species is extremely similar to *P. carolina* with which it has been confused until fairly recently (Richards 1978, lists *P. perplexus* as a synonym of *P. carolina*). For characters distinguishing the two species see under *P. carolina*. Remarkably, the female of *P. perplexus* differs from all other species of the *P. fuscatus*-group by the entirely silvery pubescent malar space and gena (lower gena and malar space bare except for a few scattered setulae in other species). Overall, black markings seem to be better developed and yellow markings less developed than in *P. carolina*.

VARIATION. Fore wing length 18.0–21.5 mm (♀♀), 17.0–18.0 mm (♂♂, n = 3). *Female*. Body almost entirely ferruginous, with the following black to dark brown markings: spot around ocelli usually well developed, rarely divided into individual spots around each ocellus, spot in front of pronotal carina (often), scutum rarely largely black with posteriorly confluent ferruginous median and ferruginous lateral stripes, large anteroventral area of mesopleuron in two specimens, some mesosomal sutures and central stripe of propodeum. Yellow markings absent except sometimes on propodeal valves and tarsi. *Male* differs from female as follows: yellow markings better developed including face up to ocular sinus, anterior surface of pronotal carina, small anteroventral spots of mesopleuron, anterior corners of metanotum, coxae (hind coxae only with small spots), anterior surface of femora and tibiae (usually more or less suffused with ferruginous); yellow areas of metasomal sterna not observed due to poor condition of specimens. Black areas of scutum, mesopleuron and metapleuron more extensive than ferruginous areas in all three males examined (one male has the scutum nearly entirely black).

DISTRIBUTION. Not recorded from Canada. Eastern U.S.: PA (new state record: 1 ♂, locality not given, DEBU) and MD to GA, west to southern IL, KS, OK and TX (Krombein 1979).

BIOLOGY. Nests in sheltered areas such as hollow trees, under wooden platforms and inside storage buildings (Wade and Nelson 1978). Biology otherwise poorly known due to confusion with *P. carolina*. Some biological references for that species likely pertain to *P. perplexus*.

80. *Polistes* sp. A

Figs B10.14, 16, 18, 35, 47; C80.1–7.

TAXONOMY. This newly discovered, undescribed species belongs in the *P. fuscatus*-group and was previously confused with *P. fuscatus*, *P. metricus*, *P. bellicosus* and *P. carolina* (depending on the colour pattern of the individual). Northeastern females key to *P. metricus* in Richards' (1978) key, which does not properly separate *P. fuscatus* from *P. metricus*. The most remarkable diagnostic character of sp. A is the (usual) absence of the pronotal fovea, a structure that occurs in every other species of the *P. fuscatus*-group. Otherwise, species without a pronotal fovea occur only in some Neotropical species of the subgenera *Aphanilopterus* and *Epicnemius* as well as the Old World/Australasian subgenus *Polistella*.

SPECIES RECOGNITION. No other northeastern species of the *P. fuscatus*-group is better characterized by morphology than sp. A (some other species can only be separated on colouration). These characters include (see key): pronotal fovea usually absent or minute (see below); propodeal orifice narrowed dorsally; female flagellum more extensively hairy than in other species; micropunctures of mesosoma and clypeus smaller than usual, the integument therefore more shining ('greasy' in appearance); eyes with sparse, minute hairs, and tergum 1 evenly and quite strongly convex (less convex in some males).

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DESCRIPTION. Fore wing length 13.5–15.5 mm (♀♀), 12.5–15.5 mm (♂♂). Pronotal fovea variable, on average better developed in males than in females (Table 3).

Female head largely ferruginous; black are large but deeply incised ocellar spot, some facial sutures, sometimes narrow band connecting antennal bases, occiput above foramen (except for latter black markings absent in one specimen each from Virginia and Florida); yellow markings vary from absent to well-developed (some specimens from Illinois and Missouri) and then include: chevron-shaped spot along clypeal margin, part of mandibles, transverse stripes above antennal bases (sometimes fused medially), and inner orbits from level of antennal bases to clypeal margin; facial markings often suffused with orange. Antenna ferruginous with black to dark brown dorsal surface (basal half of scape sometimes ferruginous). Mesosoma largely ferruginous; black as follows: spot in front of pronotal carina (sometimes covering most of anterior face of pronotum), sometimes dorsal surface of pronotum, scutum except usually two pairs of ferruginous stripes (in southern specimens scutum largely ferruginous), sometimes spot(s) in centre of scutellum (one specimen), pleural sutures, rarely most of metapleuron, sutures between scutum and propodeum, more or less extensive ventral areas of mesosoma, central stripe and sometimes lateral stripes of propodeum (stripes narrow to very broad); yellow are pronotal carina and ventral pronotal spots (usually poorly developed, sometimes connected), dorsal mesopleural spot (usually absent), small spots immediately above mid and hind coxae, small posterodorsal spot of metapleuron (usually absent), small paired scutellar spots (usually absent), paired metanotal spots (sometimes absent), relatively short and narrow propodeal stripes (usually absent), propodeal valvula. Metasoma predominantly black to dark brown, with ferruginous spots at least on terga 1 and 2 (one specimen each from Virginia and Florida with entirely ferruginous metasoma); dark colour of posterior segments often becoming gradually paler posteriorly; yellow are apical fascia of tergum 1 (usually narrow and inconspicuous, often widely interrupted medially, rarely absent) and in midwestern specimens usually more or less interrupted fasciae on terga 2 and 3, lateral spots on tergum 4 and sterna 2–4. Legs largely ferruginous, with the following black to dark brown: parts of coxae (especially mid and hind coxa), fore femur sometimes posteriorly, mid and hind femur usually ventrally, dorsal surface of tibia (often absent on fore tibia, most extensive on hind tibia); legs nearly entirely ferruginous in one specimen from Virginia; yellow are lateral to posterolateral stripes on all coxae (only midwestern and southern specimens), apex of femora and base of tibiae (sometimes inconspicuous; sometimes basal 2/5 of mid and hind tibiae dorsally), tarsi more or less yellowish, especially basitarsi. *Males* known only from specimens collected in Maryland (expected to be darker and with less developed yellow markings than specimens from western or southern part of range). Face largely yellow up to eye emargination; eye emargination, central part of frons between and below antennae, and dorsomedial part of clypeus slightly to strongly suffused with ferruginous, black markings include interantennal tubercle, often vertical stripes between antennal bases and dorsal margin of clypeus, and sometimes dorsomedial spot on clypeus. Antennae ferruginous with black dorsal surface. Mesosoma usually largely black with the following ferruginous markings: spot on lateral surface of pronotum frequently, stripes on scutum and propodeum rarely, margins of scutellum and metanotum, rarely their disks as well, dorsal mesopleural spot often, spots on lower mesopleuron and metapleuron rarely; yellow mesosomal markings unusually restricted, similar to female and sometimes completely absent; venter of mesopleuron often with small yellow spots behind fore coxae. Metasoma largely black; ferruginous spots usually present on tergum 2 (rarely covering most of tergum), sometimes also present on terga 1 and 3 and/or sterna 1 and 2, rarely posterior metasomal segments in part more or less dark ferruginous; yellow markings very restricted: apical fascia of tergum 1 usually present but often indistinct and reduced to small lateral spots; terga 2 and 3 rarely with interrupted fasciae as well; apical fascia usually present but usually interrupted on sternum 3, often on 4, rarely on 2. Leg colouration as in female but with the following additional yellow markings: pale yellow spot on fore coxa (sometimes restricted to medial surface) and almost always on mid coxa; yellow anterior stripes on fore femur, almost always on mid femur and usually on hind femur, size of spot decreasing from former to latter, on hind femur often only a small spot near base; dorsal surface of tibiae with yellow stripe (sometimes restricted to basal half on hind tibia);

Table 3. Development of pronotal fovea in *Polistes* sp. A

	absent	minute, shallow	fairly large and deep	Total
Females	13 (57%)	10 (43%)	-	23
Males	4 (18%)	10 (46%)	8 (36%)	22
Total	17 (38%)	20 (44%)	8 (18%)	45

Note: One female could not be scored due to heavy greasy/oily deposit on cuticle.

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yellow markings of femora and tibiae often ± suffused with orange, especially towards the edges.

DISTRIBUTION. Not known from Canada. Apparently widespread but rare in eastern U.S.; so far recorded (22 ♂♂, 24 ♀♀) from DE, MD, VA, NC, SC, FL, IL, and MO.

BIOLOGY. Unknown.

81. *Polistes* sp. B

Figs B10.40, 43, 53; C81.1–6.

TAXONOMY. This newly discovered species is very similar to, and has been confused with the closely related *P. fuscatus* and *P. metricus*. Females key to either *P. fuscatus pallipes* (dark specimens) or *P. metricus* (couplet 15; specimens with well-developed ferruginous markings) in Richards' (1978) key.

SPECIES RECOGNITION. Females differ from all other species of the *P. fuscatus*-group by the sparser punctation of central areas of sterna 3–5. Females of *P. metricus*, which rarely also show somewhat sparser punctation on these sterna differ from sp. B. by the more bulging sternum 2. Males differ from other species by the following characters: anterior surface of flagellum dark reddish brown, usually becoming gradually darker brown to black on distal flagellomeres (neither uniformly yellowish as in *P. metricus* nor yellow with contrasting black apical flagellomeres as in *P. fuscatus*); rows of ventral teeth of aedeagus not extending basally almost to apex of median expansion of aedeagus (as in *P. fuscatus*), aedeagal teeth distinctly smaller than in *P. fuscatus*, slightly smaller than in *P. metricus*. The colour pattern of females differs from dark varieties of *P. fuscatus* ("*pallipes*") by the entirely ferruginous clypeal disk (lacking black or yellow markings), the presence of a ferruginous dorsal mesopleural spot (spot yellow or absent in "*pallipes*"), absence of yellow propodeal stripes (often present in "*pallipes*"). Females (with few exceptions) differ from *P. metricus* in possessing a large black frontal spot which broadly connects the ocellar area to the antennal bases (interrupted by transverse ferruginous band in *P. metricus*).

DESCRIPTION. Fore wing length 14.0–17.0 mm (♀♀), 14.0–16.0 mm (♂♂). *Female* head ferruginous with the following black areas: large frontal spot extending to from ocellar area to antennal bases, sometimes including small ferruginous spots dorsomedially of antennal base (rarely interrupted above antennal bases by transverse ferruginous band), spots connecting antennal base to dorsal margin of clypeus, most of occiput, dorsal surface of antenna; head without yellow markings. Mesosoma black with the following ferruginous markings: pronotal carina often, small to very large spots on pronotum behind carina, dorsal and often ventral mesopleural spot, small ventral metapleural spot rarely, scutal stripes frequently, scutellum and metanotum partly to entirely (scutellum rarely all black), propodeal stripes usually (one or two pairs, rarely stripes on each side coalescent); pale yellow markings very restricted, usually present pronotal carina medially and propodeal valves. Metasoma largely black, ferruginous markings sometimes present on tergum and sternum 1, rarely baso-laterally on tergum 2; pale yellow apical fascia usually present on tergum 1, usually interrupted, sometimes evanescent. Legs with coxae black, often marked with ferruginous; femora black, fore femur with ferruginous anterior surface, mid and hind femur with ferruginous dorsal stripes; fore tibia ferruginous, sometimes with black dorsal stripe, mid tibia ferruginous and black, sometimes with yellow base, hind tibia often largely black, usually with more or less yellow base; tarsi yellow to reddish yellow. *Male* similar to female except following: face yellow, sometimes partly suffused with reddish between and below antennal bases including dorsobasal part of clypeus; small black spots often present above and below antennal bases and on median part of frontoclypeal suture. Mesosoma with ferruginous markings on average less developed: dorsal mesopleural spot sometimes, ventral spot usually absent, scutal and propodeal markings rarely present; yellow mesosomal markings present on venter of mesopleuron (pair of spots behind fore coxae, sometimes coalescent); one specimen with evanescent yellow spots on propodeum. Metasoma usually lacking ferruginous markings; if present including small spot on tergum 1 and in one specimen small discal spots on tergum 2; whitish apical fascia present and well-developed on tergum 1, rarely also on terga 2 and 3 (evanescent on latter); metasomal venter with pale yellow spot at base of sternum 2 (size small to moderate, rarely absent) and pale yellow apical fasciae of sterna 2–5 (often wide on sternum 3; darkest specimens with sternal fasciae absent except for tiny apical spots on sternum 3). Pale yellow spots on fore and mid coxae well developed, small or absent on hind coxa; yellow anterior stripes present on fore and mid femur (sometimes reduced to apical half on latter), usually absent or represented by small basal spot on hind femur; anterior surface of fore, mid and basal half of hind tibiae sometimes yellow, often more or less suffused with ferruginous.

DISTRIBUTION. Insufficiently known. Not known from Canada. We have examined 9 ♂♂ and 10 ♀♀ from MD, VA and WV.

BIOLOGY. Unknown.

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Subfamily Vespinae (Yellowjackets and Hornets)

This predominantly Old World group is represented in the Nearctic (and the northeast) by three genera with mainly Holarctic or Palaearctic/Oriental distribution. The genus *Vespa* was accidentally introduced to the New World.

REFERENCES. – Carpenter and Kojima, 1997 (catalogue of World species, distribution); Carpenter, 1987 (phylogeny of World genera, subgenera and species groups); Akre *et al*., 1981 (key to Nearctic genera); Bequaert, 1932 (taxonomy of Nearctic species, key).

***Dolichovespula* Rohwer**

This genus includes 18 species and is distributed through the Holarctic and Oriental region. Six species occur in North America including five species in the northeast (Carpenter and Kojima 1997, Archer 1999).

REFERENCES. – Archer, 1989 (key to World species); Akre *et al*., 1981 (key to Nearctic workers); Wagner, 1978 (key to Nearctic species); Miller, 1961 (key to Nearctic species).

82. *Dolichovespula adulterina* (du Buysson, 1905)

Figs B12.2, 8, 16–18; C82.1–10.

SPECIES RECOGNITION. Other ivory-marked *Dolichovespula* species differ from *D. adulterina* in that either the hind tibia is black or almost completely black (*D. maculata*) or the apical fasciae of terga 1–5 are neither interrupted nor narrowed (*D. norwegica*, worker, queen) or terga 1 and 2 possess ferruginous markings (*D. norwegica*, male, worker).

VARIATION. Fore wing length 13.0–14.0 mm (♀♀), 10.0–12.0 mm (♂♂). Pale markings of body ivory, rarely pale yellow. The yellow colour form occurs mostly in the western Nearctic and in the Palaearctic portion of its range (specimens from the latter can be marked with pure yellow). Bequaert (1932) and Miller (1961) mention yellow-marked specimens only from the western Nearctic but very rarely they also occur in the east (1 ♂, PA, Scranton, AMNH; J.M. Carpenter, pers. comm.). Clypeus with usually elongate, rarely small and round, black discal spot, in female almost always, in male often extending to ventral margin of clypeus, in melanic specimens sometimes extending to dorsal margin as well. Ivory postocular band interrupted or narrowed near middle, in male often hardly narrowed at all. Ivory posterior band of pronotum usually more or less broadened at pronotal carina (on average more pronounced in female); pronotum laterally behind pronotal fovea sometimes with small ivory spot (rarely present in female). Metanotum sometimes lacking pair of ivory spots (more often in male than in female). Apical fascia of tergum 1 and in male also of tergum 2 often strongly reduced, rarely completely absent. Female with pairs of black discal spots almost always present at least on tergum 5, at most on terga 3–5; one xanthic female with a pair of enclosed ivory spots in black band of tergum 2. Apical fasciae interrupted at least on terga 1 and 2, interrupted or medially incised on following terga. Male tergum 6 usually with less developed fascia than previous terga, in some cases entirely black; male tergum 7 usually black, rarely with a pair of ivory spots.

DISTRIBUTION. Canada: all provinces and territories except NU. Northern and western U.S.: AK, south to GA, KY, IL, WI, MN, ND, NM, AZ and CA. Palaearctic (and adjacent parts of Oriental) from northern and western Europe to Sakhalin, Japan, northern China and Taiwan, south to Turkey, Georgia and Mongolia (Carpenter and Kojima 1997, Archer 1999).

BIOLOGY. This is the only obligate social parasite (lacking worker caste) of the genus *Dolichovespula* in North America. Nearctic hosts are *D. arenaria* and the western *D. alpicola* (as *D. saxonica* (Fabricius) in Wagner, 1978, mis-identification; incorrectly cited as *D. norvegicoides* in Akre *et al*. 1981); in the Palaearctic *D. saxonica* and *D. norwegica* are the only confirmed hosts (Carpenter and Perera 2006, Dvořák 2007). The parasite queen invades the host nest early in the season before workers have emerged. The foundress is ultimately killed but later in the season males of the host species may still be produced by host workers laying unfertilized eggs (Akre *et al*. 1981).

83. *Dolichovespula arenaria* (Fabricius, 1775)
Aerial Yellowjacket

Figs B1.12, 18; B11.2, 3; B12.3, 9, 15; C83.1–11.

SPECIES RECOGNITION. The very common aerial yellowjacket differs from *D. norvegicoides*, the only other yellow-marked *Dolichovespula* of the east, by the medially interrupted or incised apical fasciae of terga 1 and 2 (not narrowed medially in *D. norvegicoides*). The very rare, mainly western, yellow-marked colour form of *D. adulterina* can be separated from *D. arenaria* by the more extensive black markings in the ocular sinus (see key).

VARIATION. Fore wing length 9.0–12.0 mm (workers), 12.5–13.5 mm (♀♀), 9.5–12.0 mm (♂♂). Black clypeal spot usually elongate (often with a pair of small spots on each side), rarely small

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and round or anchor-shaped (females), or absent (male), rarely narrowly extending to ventral margin of clypeus (females). Black medial subantennal mark rarely with yellow spots in male (usually connected to corona). Ocular sinus predominantly yellow except in melanic males from northern localities, in which black area broadly reaches lower margin of sinus. Yellow postocular band wide throughout or narrowed (rarely in male) or with enclosed black spot near middle. Pronotal carina almost always more or less marked with yellow. Scutum rarely with a pair of yellow spots in posterior half. Metapleuron and propodeum rarely with small yellow spots in female; spots exceptionally present on propodeum in male (1 ♂, ON, Guelph, DEBU). Males from subarctic localities may have the mesosoma entirely black (e.g., 1 ♂, MB, Churchill, Akudlik, EDUM). Pairs of black discal spots often absent in worker, sometimes present on tergum 5 rarely on 4; spots better developed in queen and always present on terga 4 and 5, usually on 3 and sometimes on 2; spots usually attached to basal band in male and then most frequently so on terga 4 and 5, more rarely on terga 2, 3 or 6.

DISTRIBUTION. Canada: all provinces and territories except NU. Northern and western U.S.: AK, south to GA, KY, IL, IA, NE, NM, AZ and CA (Carpenter and Kojima 1997). This is one of the most common yellowjacket species in eastern North America.

BIOLOGY. Nests are usually aerial and attached to herbage, shrubs or trees from near the ground to canopy level. In urban situations they are often found on manmade structures. More rarely nests are constructed under rocks or even in ground burrows where workers may excavate soil to allow for nest expansion, as in *Vespula* species. Females usually forage for live arthropods and rarely visit carrion. Because of its tendency to use manmade structures as nest locations and because of its abundance this species can be a nuisance. Individuals from smaller colonies are usually not very aggressive but large colonies (which are relatively rare) can react strongly and very aggressively to disturbance (Akre *et al*. 1981).

84. *Dolichovespula maculata* (Linnaeus, 1763)
Baldfaced Hornet

Figs B12.6, 7, 13, 14; C84.1–11.

SPECIES RECOGNITION. The baldfaced hornet is the largest of our native yellowjackets. It is easily distinguished from other *Dolichovespula* species by the largely to completely black hind tibia (marked with pale on most or all of outer surface in other species) and other characters provided in the key.

VARIATION. Fore wing length 11.0 – ca. 15.0 mm (workers), ca. 15.0–18.0 mm (♀♀), 13.5–16.0 mm (♂♂); there appears to be no distinct size gap between workers and queens, which makes it difficult to separate the castes based on measurements alone. Black clypeal mark extending from dorsal margin ventrally, usually just stopping short of ventral margin, occasionally attaining it, rarely dorsally and ventrally free in female. Ivory postocular band wide, in female slightly narrowed near middle or even in width. Pronotal carina always marked with ivory; pronotum with ivory posterior band sometimes more or less broadened in female, in some cases covering nearly whole upper surface; pronotal lobes sometimes with small ivory spot in female; pronotum laterally below pronotal fovea often with small ivory spot on carina (less common in male). Metanotum sometimes lacking pair of ivory spots (more often in male than in female). Apical fascia of tergum 1 absent in female but often present and sometimes well developed in male. Tergum 3 with enclosed lateral ivory spots in female, often extending to margin of tergum in male (rarely absent); exceptionally tergum with a well-developed, medially interrupted apical fascia (1 ♂, ON, Wellington Co., Arkell, DEBU). Free black discal spots rarely present on tergum 5 or on terga 4 and 5 of female. Apical fasciae of terga 4 and 5 almost always interrupted in female, rarely only deeply incised; in male sometimes terga 4–6 only deeply incised. Hind tibia entirely black or with small ivory spot(s) near base, less often near apex as well.

DISTRIBUTION. Canada: all provinces and territories except NU. U.S. except most of Great Plains, AK, south to central FL, west to eastern ND, SD, NE, KS, OK and TX, south in western mountain ranges to NM, AZ and CA (Carpenter and Kojima 1997; Akre *et al*. 1981).

BIOLOGY. The nests of this species are almost always aerial and usually higher above the ground than in other species (from ground level up to > 20 m). Nests are built in vegetation, on rocks and on manmade structures such as houses, sheds, power poles, etc. Exceptionally, nests may be subterranean or in hollow trees. Females prey on live arthropods, sometimes preferentially on other yellowjacket species; occasionally carrion is visited as an additional protein source. The baldfaced hornet occurs both in natural and populated areas. It usually causes relatively little nuisance because nests are often located high above the ground. The species often causes alarm due its impressive size but it actually appears to be less aggressive than

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some of the common smaller yellowjacket species (Akre *et al*. 1981).

85. *Dolichovespula norvegicoides* (Sladen, 1918)

Figs B12.5, 12; C85.1–10.

TAXONOMIC NOTE. Before 1984 the western *D. alpicola* Eck, 1984 was confused with *D. norvegicoides*.

SPECIES RECOGNITION. The diagnostic characters that distinguish this species from *D. arenaria* are discussed under the latter.

VARIATION. Fore wing length 9.0–11.0 mm (workers), 12.0–13.0 mm (♀♀), 10.0–12.0 mm (♂♂). Black clypeal spot almost always extending to both dorsal and ventral margins of clypeus, rarely stopping short of either dorsal or ventral margin; in male clypeal spot rarely free dorsally and ventrally. Black medial subantennal mark rarely with deep dorsal emarginations in male or worker. Yellow postocular band broadly interrupted near middle, in male rarely entire and only narrowed medially. Flagellum yellow to orange beneath in females, dark except spots on basal 1–4 flagellomeres in male. Pronotal carina exceptionally marked with yellow stripe (1 ♂, ON, Bruce Co., Tobermory, DEBU). Metanotum usually lacking pair of yellow spots. Metasomal terga never with free black discal spots.

DISTRIBUTION. Canada: all provinces and territories except NU. Northern and western U.S.: AK, south to SC, TN, KY, WV, PA, MI, WI, MN, ND, WY, ID and CA (Carpenter and Kojima 1997).

BIOLOGY. The biology of this mostly northern species is poorly known. All recorded nests were aerial and located in low shrubs (Akre *et al*. 1981).

86. *Dolichovespula norwegica* (Fabricius, 1781)

Figs B12.1, 4, 10, 11; C86.1–9.

SPECIES RECOGNITION. This is the only ivory-marked species of *Dolichovespula* in which the apical fasciae of terga 1 and 2 are neither interrupted nor incised. Except for the colour of its pale markings the species is very similar to *D. norvegicoides*, from which it can be separated by the characters provided in the key.

VARIATION. Fore wing length 9.0–10.0 mm (workers), 12.5–13.0 mm (♀♀), 10.5–12.5 mm (♂♂). Black clypeal spot usually extending to both dorsal and ventral margins of clypeus, rarely not attaining dorsal margin. Lower gena black, with or without small ivory spot. Female flagellum usually with more or less developed orange ventral spots on each flagellomere, sometimes entirely dark. Mesopleuron with ivory spot small, often absent. Scutellum in female rarely, in male often without ivory spots; metanotum almost always lacking ivory spots. Metasomal terga 1 and 2 with ferruginous blotches laterally in worker and male, these occasionally absent, especially on tergum 1. Tergum 5 rarely with almost with free black discal spots.

DISTRIBUTION. Canada: all provinces and territories. Northern U.S.: AK and ME. Palaearctic: northern and western Europe east to Kamchatka and northern China, south to Turkey and Kirghizia (Carpenter and Kojima 1997, Archer 1999).

BIOLOGY. Poorly known in the Nearctic. Recorded nests were subterranean or partially subterranean and small (Akre *et al*. 1981). In Europe nests are often found in low shrubbery, less commonly in trees (sometimes more than 10 m above ground), haystacks, beehives, old bird nests, and window frames (Spradbery 1973).

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***Vespa* Linnaeus**

The 22 species in this genus occur naturally in the Palaearctic, Oriental and northeastern Afrotropical regions (Carpenter and Kojima 1997, Nguyen *et al*. 2006). Three species have been accidentally introduced to the New World: the Palaearctic *Vespa crabro* to the eastern Nearctic, the eastern Palaearctic *V. simillima* Smith to British Columbia, and the Oriental *V. orientalis* Linnaeus to Cozumel I., Quintana Roo, Mexico (Carpenter and Kojima 1997, Dvořák 2006).

REFERENCE. – Archer, 1989 (key to World species).

87. *Vespa crabro* Linnaeus, 1758
European Hornet
Figs B11.1, 5; C87.1–10.

SPECIES RECOGNITION. The European hornet is easily recognised by its large size, head shape and colouration.

VARIATION. Fore wing length 16–20 mm (workers), ca. 22–24 mm (♀♀, n = 5), ca. 22 mm (♂♂, n = 3). The colour pattern of this species is fairly constant. Males (always?) have black markings in and in front of the ocellar area and extending laterally to the antennal bases. In females these markings are rarely present. The male flagellum has strongly developed tyloids (two on each flagellomere except flagellomere I which has only one). The extent of ferruginous markings is slightly variable; ferruginous markings are (nearly) absent in specimens from eastern Europe and the eastern Palaearctic region.

DISTRIBUTION. Canada: ON and QC (new record; sighted in Aylmer in 2004/5 by H. Goulet, pers. comm.). Eastern U.S.: MA to GA, AL, and MI, west to ND, SD, IN, KY and TN. Widespread in Palaearctic region from Europe to Sakhalin, Japan, northern China, and Taiwan (Carpenter and Kojima 1997). First introduced to the Nearctic region in the New York area between 1840 and 1860 (Akre *et al* 1981).

BIOLOGY. Nests are usually built in hollow trees and other cavities such as hollow walls, attics, barns, and abandoned bee hives; very rarely they are below ground. The nest is surrounded by an envelope of wood fibres when built in more exposed situations; nests in confined spaces have only a rudimentary envelope. Various kinds of insects (including honey bees and yellowjackets) serve as prey. Unlike other North American Vespinae the adults are also active at night and are attracted to light. Workers girdle twigs and branches of various trees and shrubs in order to feed on sap. The European hornet occurs mostly in woodlands and is rarely a nuisance (Akre *et al*. 1981).

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***Vespula* Thomson**

This primarily Holarctic and Oriental genus is comprised of 26 species (Carpenter and Kojima 1997, Eck 1998; Dong *et al*. 2002, 2004; Dong *et al*. 2005), 13 of which occur in North America (11 in the northeast). Three synanthropic species have been introduced to temperate parts of the southern hemisphere and Hawaii (Carpenter and Kojima 1997) where they are now serious pests.

REFERENCES. – Eck, 1996 (key to Nearctic species of *V. vulgaris*-group); Archer, 1989 (key to World species); Akre *et al*., 1981 (key to Nearctic workers); Jacobson *et al*., 1978 (key to Nearctic species of *V. vulgaris*-group); Miller, 1961 (key to Nearctic species excluding *V. germanica* and *V. flavopilosa*).

88. *Vespula acadica* (Sladen, 1918)

Figs B1.14; B13.7, 9, 11, 37–39, 61, 72; C88.1–13.

SPECIES RECOGNITION. About 50% of workers and males and nearly all queens possess a pair of yellow to obscure brown spots enclosed within the black fascia of sternum 2 (absent in other *Vespula* species except rarely in males of *V. austriaca*, a very rarely collected social parasite). Further differences between *V. acadica* and similar species of the *V. rufa*-group (*V. vidua*, *V. austriaca*) are discussed under these species.

VARIATION. Fore wing length 8.5–10.0 mm (workers), 12.0–13.0 mm (♀♀, n = 7), ca. 11.0–13.0 mm (♂♂, n = 9). Black clypeal mark of female extending to dorsal margin of clypeus, in worker rarely to ventral margin of clypeus, in males clypeal mark usually free or extending to both dorsal and ventral margins. Yellow stripe along inner orbit ending near apex of ocular sinus, in males often extending far along upper margin of sinus. Female with lower gena black, often enclosing a small to medium-sized yellow spot ventrally; male with a yellow postocular band that is sometimes interrupted near middle. Metanotum with or without a pair of yellow spots in female, absent in male (always?). Propodeum in worker rarely with a pair of evanescent yellow spots. Pair of enclosed yellow spots near summit of tergum 1 almost always present (absent in one aberrant male from ON, Bruce Co., Inverhuron Prov. Pk., DEBU). Enclosed yellow spots present in about half of workers and males, and almost all queens; the spots sometimes more or less suffused with brown and evanescent. Queen generally with enclosed yellow spots on terga 3–5 as well; in xanthic specimens sometimes narrowly connected to apical fascia. One aberrant worker (ON, Bruce Co., Dorcas Bay, DEBU; Fig. 88.12) shows brownish suffusions to tergum 2 of similar extent as in *V. rufa* (which is marked with ivory instead of yellow).

DISTRIBUTION. Canada: all provinces and territories except NU. Northern U.S. including AK, south to NC, TN, WV, MI, WI, MN, NE, NM, AZ and CA (Carpenter and Kojima 1997).

BIOLOGY. Nests are usually built in rotten logs, under logs or in the soil; aerial nests are uncommon. Females prey on live arthropods only. Due to its silvicolous habitat preferences and primarily boreo-montane distribution *V. acadica* rarely comes into contact with man and is therefore not a nuisance species (Akre *et al*. 1981).

89. *Vespula austriaca* (Panzer, 1799)

Figs B13.5, 8, 10, 60, 71; C89.1–6.

SPECIES RECOGNITION. The queen of this rarely collected social parasite is easily recognised by its distinctive metasomal pattern that includes a pair of enclosed yellow spots on tergum 1, a black median mark with 'ear'-like processes on tergum 2, and pairs of free to narrowly connected black spots on following terga. The male is most similar to *V. acadica* but possesses outstanding black hairs on at least the basal half of the hind tibia (absent in other species, but a few black hairs near base of tibia may be present in *V. acadica*). Further diagnostic characters are mentioned in the key.

VARIATION. Fore wing length 12.0–13.0 mm (♀♀, n = 4), ca. 10.0–11.5 mm (♂♂, n = 3). Female clypeus with three black discal spots, sometimes more or less confluent; male with a central black mark that reaches apical margin of clypeus. Female with lower gena black, enclosing a small to medium-sized yellow spot ventrally; male with a yellow postocular band interrupted near middle, or lower gena entirely black. Scape with or without a yellow anterior mark. Tergum 2 of one aberrant male (AB, Beaverlodge, DEBU) with a pair enclosed yellow discal spots similar to *V. acadica*. Pairs of black discal spots on female terga 3–5 usually free, rarely narrowly connected to black basal band.

DISTRIBUTION. Canada: all provinces and territories. Northern U.S. including AK, south to NJ, MI, WI, ND, NM, AZ and CA. Widespread in Palaearctic region from Europe to Kamchatka, Japan and northwest China, south to Turkey, northern Pakistan and northern India (Miller 1961, Carpenter and Kojima 1997).

BIOLOGY. This species is an obligate social parasite in nests of other *Vespula* species and lacks the worker caste. Recorded hosts are *V. acadica* in North America and *V. rufa* in Europe (Akre *et al*. 1981).

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90. *Vespula consobrina* (de Saussure, 1864) Blackjacket

Figs B13.35, 58, 69; C90.1–10.

SPECIES RECOGNITION. The blackjacket is easily recognised by the ivory colour of its pale markings (shared with *V. rufa*) and the absence of ferruginous markings on terga 1 and 2 (present in *V. rufa*). Queens of *V. consobrina* are sometimes confused with the baldfaced hornet (*Dolichovespula maculata*) or with *D. adulterina* but both of the latter species have the fasciae of terga 4 and 5 interrupted or deeply incised medially (straight in *V. consobrina*).

VARIATION. Fore wing length 9.5–11.0 mm (workers), 13.0–14.0 mm (♀♀), ca. 10.5–12.5 mm (♂♂, n = 9). Black clypeal mark of female usually either free or extending to dorsal margin of clypeus, rarely extending to ventral margin, or both dorsal and ventral margins, or divided into three small spots; in male clypeal mark usually extending to ventral margin, sometimes also to dorsal margin, rarely free (in some cases reduced to three or one small spot(s)). Ivory stripe along inner orbit ending near apex of ocular sinus, in male often extending far along upper margin of sinus. Female with lower gena black, usually enclosing a small to medium-sized ivory spot ventrally; male with a ivory postocular band that is rarely interrupted near middle. Scape sometimes (often in male) with pale anterior mark. Apical fascia of tergum 1 in queen often, in worker and male occasionally, evanescent or absent. Xanthic queens sometimes with free black discal spots on terga 4 and 5 and narrowly connected spots on tergum 2.

DISTRIBUTION. Canada: all provinces and territories except NU. Northern U.S. south to GA, KY, IL, WI, ND, CO, UT and CA (Carpenter and Kojima 1997).

BIOLOGY. Usually nests in abandoned rodent borrows in the ground but also in rotten logs, rock cavities or hollow walls. Live arthropods serve as prey. This species inhabits mainly forested areas and therefore infrequently comes into contact with man (Akre *et al*. 1981).

91. *Vespula flavopilosa* Jacobson, 1978

Figs B13.18, 19, 27, 31, 52–55, 63, 74; C91.1–14.

SPECIES RECOGNITION. This species was described less than three decades ago and had previously been confused with *V. vulgaris* and *V. maculifrons*. Queens are relatively easy to distinguish from other species in the *V. vulgaris*-group by the apical fascia of tergum 1 not extending to the summit of the tergum (shared with *V. vulgaris*) in combination with a narrow black band (width at most 1.5x mid ocellar diameter) between the corona and the ocular sinus (at least 2x mid ocellar diameter in *V. vulgaris*). Xanthic workers (with basally narrowed black medial mark of tergum 1) similar to *V. germanica* but show better developed yellow markings on the pronotal lobes, scutum and mesopleuron (see key).

VARIATION. Fore wing length 8.0–11.0 mm (workers), 12.5–14.5 mm (♀♀), ca. 11.0–12.5 mm (♂♂, n = 5). Black clypeal mark of queen extending to dorsal and sometimes ventral margin of clypeus; in worker clypeal mark usually more or less parallel-sided and extending to dorsal margin with isolated dot(s) near middle, sometimes the markings very reduced, with small discal spots only or disc entirely yellow and clypeal mark reduced to small basal remnant; male clypeus with yellow disc, sometimes with small black spot(s). Black band between corona and ocular sinus sometimes interrupted in worker. Black subantennal mark usually with enclosed yellow spots (sometimes confluent with corona), missing in about 10% of females; subantennal mark of male very reduced, often reduced to isolated black spot at interantennal prominence. Scape black, in male with yellow anterior mark (always?). Xanthic workers often with very broad pronotal stripes. Over 95% of workers with yellow spots on at least one of the following: posterior half of scutum, pronotal lobes, upper mesopleuron behind scrobal furrow, lower mesopleuron. Upper metapleuron usually marked with yellow. Propodeum with a pair of yellow spots in worker and exceptionally in queen, absent in male. Black basomedial mark of tergum 1 usually with very broad base (in queen extending across whole width of tergum), in extremely xanthic workers width of basal attachment sometimes only slightly more than 2x mid ocellar diameter. Tergum 2 in worker rarely, in queen usually with free black discal spots; terga 3–5 in worker rarely, in queen always with free discal spots.

DISTRIBUTION. Canada: NS, QC to MB. Eastern U.S. west to ND, SD, IA, MO, and along Appalachians south to GA and TN (Carpenter and Kojima 1997).

BIOLOGY. Nests are subterranean. Females prey on live arthropods and scavenge on carrion, like other species of the *V. vulgaris*-group. This species is less common around human dwellings than *V. germanica* and *V. maculifrons* but can still be pestiferous at times (Akre *et al*. 1981).

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92. *Vespula germanica* (Fabricius, 1793)
German Yellowjacket
Figs B13.17, 20, 22, 24, 48–51, 65, 76; C92.1–14.

SPECIES RECOGNITION. This species typically has a diamond-shaped basomedial black mark on tergum 1. The adventitious *V. pensylvanica* is very similar in this respect but has yellow eye loops. The basomedial mark is narrower (at most twice as wide as long) than in *V. maculifrons* and usually has a narrower basal attachment than in *V. flavopilosa*. Melanic workers of *V. germanica* are similar to some xanthic *V. maculifrons*, and normal workers are difficult to separate from very xanthic *V. flavopilosa*. In both cases the absence of yellow spots or deep dorsal emarginations in the black subantennal mark is diagnostic. The males of *V. germanica* and the western *V. pensylvanica* are the only species in the genus with dorsoventrally inflated apical portion of the aedeagus (see key for diagnostic differences).

VARIATION. Fore wing length 7.5–12.0 mm (workers), 13.0–15.0 mm (♀♀), ca. 12.0–13.0 mm (♂♂, n = 7). Clypeus of queen usually with three small black spots, sometimes with two spots and a more or less parallel-sided mark connected to the dorsal margin of the clypeus; worker similar to queen but sometimes only with one small median spot; male clypeus with 0–4 small black spots. Black band between corona and ocular sinus rarely interrupted in worker, often in queen and male. Black subantennal mark lacking yellow spots or deep dorsal emarginations in worker, 2(–3) spots rarely present in queen, one median spot present in one male. Scape black, in male always, in workers very rarely with yellow anterior mark. Xanthic workers sometimes with broad pronotal stripes and small yellow spot on upper metapleuron. Propodeum with a pair of yellow spots in worker and rarely in queen, absent in male. Black basomedial mark of tergum 1 diamond-shaped to arrow-shaped, its width ranging from shorter than length up to (rarely) twice its length; width of basal attachment 1.2 to nearly 3x mid ocellar diameter. Discal spots of tergum 2 in worker often connected in a characteristic cross-bar manner to median extension of black basal band (not found in any other species). Terga 2–5 with or without paired, free, black, discal spots.

DISTRIBUTION. Introduced in Nearctic region. Canada: QC, ON and MB. U.S.: VT to MD, west to WI, MI, IN, OH and PA, also in WA and CA. Europe and North Africa to eastern Siberia, China, Korea, south to Israel, Iran, Afghanistan, Pakistan and northern India. Introduced in Iceland, New Zealand, Australia, Ascension Island, South Africa, Chile and Argentina (Carpenter and Kojima 1997). In North America this species was first collected in 1891 at Ithaca, New York (Menke and Snelling 1975). It remained rare and did not spread significantly until the late 1960s, when it entered a period of rapid range expansion. *Vespula germanica* was collected for the first time in Ontario in June 1971 (4 workers, Harrow, DEBU). Within only a few years it became widespread in the southern part of the province. The first record from Manitoba is from September 1976 (Galloway and Preston 1982).

BIOLOGY. Nest are usually subterranean but are also built in hollow walls, in roofs, attics, etc. Prey consists of a wide variety of arthropods; in addition females scavenge on carrion and meat. *Vespula germanica* and *V. maculifrons* are the most common pest yellowjackets in the northeast (Akre *et al*. 1981).

93. *Vespula maculifrons* (du Buysson, 1905)
Eastern Yellowjacket
Figs B1.4, 10; B11.4; B13.14, 16, 21, 28–30, 44–46, 66, 77, 78; C93.1–18.

SPECIES RECOGNITION. This species is distinguished from other species in the *V. vulgaris*-group by the broad, anchor-shaped basomedial mark of tergum 1 (width at least 2x length; width of basal attachment ca. one mid ocellar diameter, rarely up to 2x mid ocellar diameter). In melanic specimens the lateral extremes of this mark become fused with the basal band which then encloses a pair of transverse yellow spots (in male the spots sometimes disappear completely). Such specimens are similar to certain species in the *V. rufa*-group (*V. acadica*, *V. vidua*, *V. austriaca*) from which they can be separated by the characters in couplet 4 of the key. The male of *V. maculifrons* is unique in having an abruptly declivous tergum 7 and a bevelled apical emargination of sternum 7 with minute median projection.

VARIATION. Fore wing length 7.0–11.0 mm (workers), 12.0–13.5 mm (♀♀), (9.0–)11.0–13.0 mm (♂♂). Clypeus of queen usually with ventrally expanded black central mark connected to dorsal margin, or with two black spots and a more or less parallel-sided mark connected to dorsal margin, rarely just with three small spots; worker clypeus with one, two or three black discal spots (rarely none), and with parallel-sided mark that is long, short or absent; male clypeus usually unmarked, rarely with 1–2 black spots. Black band between corona and ocular sinus rarely interrupted in worker and male, more often in queen. Black subantennal mark with deep dorsal emarginations, rarely with enclosed yellow spots; in xanthic workers and males the mark sometimes restricted to

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interantennal prominence. Scape black, in male with yellow anterior mark. Pronotal lobes and upper metapleuron rarely with small yellow spots in worker. Posterior half of scutum rarely with pair of yellow spots in queen. Yellow spots of metanotum often very small in male, rarely absent. Propodeum usually with yellow marks in worker, rarely in queen, never in male. Black basomedial mark of tergum 1 usually anchor-shaped, at least twice as wide as long; width of basal attachment usually ca. one mid ocellar diameter, rarely up to 2x mid ocellar diameter. Melanic specimens with black basal band enclosing a pair of transverse yellow spots, the spots sometimes absent in male. Free discal spots present on terga 2–5 of queen only.

DISTRIBUTION. Canada: NS to MB (not recorded from PE). Eastern half of U.S. west to MT, WY, CO and NM. Northeastern Mexico south to Hidalgo (Carpenter and Kojima 1997).

BIOLOGY. Under natural conditions nests are almost always subterranean (rarely in decaying stumps). However, in urban environments nests are often built in hollow walls, attics and other artificial cavities. Besides preying on arthropods females also scavenge on carrion. This is one of the most common and most pestiferous yellowjackets in the northeast (Akre *et al*. 1981).

94. *Vespula pensylvanica* (de Saussure, 1857) Western Yellowjacket

Figs B13.12, 23, 25, 26, 47, 64, 75; C94.1–10.

SPECIES RECOGNITION. The metasomal pattern of *V. pensylvanica* is very similar to *V. germanica*, but it is the only species in the *V. vulgaris*-group that possesses a yellow eye-loop. Occasionally, in males the eye loop is completely absent (it can be more or less broadly interrupted in both sexes but rarely so in females). Males without a yellow eye loop can be distinguished from *V. germanica* by the deeply emarginate or spotted subantennal mark on the frons, the slender preapical portion of the aedeagus, and the much more densely pubescent apical margin of tergum 7 (see key). A narrow eye loop is also present in most females of *V. squamosa* (*squamosa* species group) but this species shows a radically different metasomal pattern.

VARIATION. Fore wing length 8.5–10.5 mm (workers), 12.5–14.5 mm (♀♀; Jacobson *et al*. 1978), 12.5–14.0 mm (♂♂). Variation otherwise not studied.

DISTRIBUTION. Canada: MB to BC, firstly recorded as an adventitious species for ON. Western U.S. east to WI, NE, CO and TX. Mexico: Baja California Norte, México and Michoacán. Introduced to Hawaii (Carpenter and Kojima 1997). According to Akre *et al*. (1981) occurrence east of the 105th meridian is scattered. The single Ontario record is the easternmost known for *V. pensylvanica*, but the species has apparently not become established in the province.

BIOLOGY. Nest are usually subterranean but are also built in other dark cavities like hollow walls and attics. Females prey on a wide variety of arthropods (occasionally even on slugs) besides scavenging on carrion. This is the most significant pest yellowjacket in western North America (Akre *et al*. 1981).

95. *Vespula rufa* (Linnaeus, 1758)

Figs B13.33, 34, 57, 68; C95.1–9.

TAXONOMY. This species has usually been referred to as *V. intermedia* (du Buysson, 1905) in the North American literature (e.g., Miller 1961, Akre *et al*. 1981, Carpenter 1987). It differs from typical *V. rufa* (from Europe and western Asia) in possessing ivory instead of yellow markings. Eastern Palaearctic populations are also marked with ivory but in most areas they show more reduced ferruginous suffusions of terga 1 and 2 (Archer 1981). This form has been called *V. rufa schrenckii* (Radoszkowski, 1861). Due to the variability of ferruginous markings, which can be observed in both Palaearctic and Nearctic specimens, Archer (1997) synonymized *intermedia* with *rufa schrenckii*. However, pale-marked populations also occur within the range of the nominate subspecies (i.e., in Sweden, Turkmenistan, southern Kazakhstan; see Archer 1997. Note that Archer considered the 'subspecies' of *V. rufa* more as colour forms rather than formal taxa.).

SPECIES RECOGNITION. This rarely collected subarctic species can immediately be separated from other *Vespula* species by the presence of ferruginous markings on terga 1 and 2. Pale markings are ivory as in *V. consobrina*. Workers and males of the largely sympatric *Dolichovespula norwegica* show a similar colouration but they lack enclosed ivory spots near the summit of tergum 1 and sometimes also lack ferruginous markings on the same tergum.

VARIATION. Fore wing length 10.0–11.0 mm (workers), 12.5–13.0 mm (♀♀, n = 5), 11.0–12.0 mm (♂♂, n = 5). Black clypeal spot usually extending to both dorsal and ventral margins of clypeus, sometimes only narrowly so, occasionally not attaining ventral margin. Lower gena of female black, sometimes with small ivory spot; male with complete, medially narrowed or interrupted pale band, but sometimes lower gena black except for a small pale spot. Metanotum with or without pair of

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ivory spots; the spots usually small. Ferruginous markings of metasoma on average more extensive in worker than in queen or male. Tergum 1 of worker largely ferruginous with ivory markings, black area usually restricted to relatively small spot on anterior, vertical surface, occasionally also with small median spot between pair of basal ivory spots. Tergum 1 of queen sometimes largely black on anterior surface and with large median and small lateral black spots on posterior, horizontal surface. Tergum 2 with large, ferruginous, lateral spots, sometimes confluent posteriorly in worker; often very reduced to nearly absent in queen. Sternum 2 largely ferruginous, sterna 3 and 4 sometimes with ferruginous spots as well. Posterior margin of black basal area of terga nearly straight in worker, with slightly prominent, paired, lateral convexities in queen; terga never with free black discal spots.

DISTRIBUTION. Canada: transcontinental in the north with records from all provinces and territories except NU. Northern U.S.: AK, VT and NY. Palaearctic (and adjacent Oriental): from western, northern and central Europe to Kamchatka, Japan, China, Taiwan, south to Turkey, Uzbekistan and Nepal (Carpenter and Kojima 1997).

BIOLOGY. The biology of Nearctic populations has not been studied (Akre *et al*. 1981). In the Palaearctic the species nests usually below ground (often very close to the surface), more rarely in cavities above ground (hollow stumps. wall cavities, bird boxes), under moss, in dense bushes, under eaves of houses or in attics (Archer 1997). Like other species in this group *V. rufa* preys on live arthropods only and does not scavenge on carrion.

96. *Vespula squamosa* (Drury, 1773) – Southern Yellowjacket

Figs B13.1, 32, 56, 67; C96.1–10.

SPECIES RECOGNITION. This is the most distinctive yellowjacket species in the east. All castes show a pair of long longitudinal stripes on the scutum, unique among eastern species. The queen is characterized by a strong reduction of black markings on the metasoma, leaving only pairs of discal spots (often indistinct) and black basal areas on tergum 1 (restricted to vertical, anterior surface) and tergum 2. The metasomal pattern of the very dissimilar worker and male is also unique: it includes an additional, medially interrupted, discal fascia on tergum 2.

VARIATION. Fore wing length 9.5–11.0 mm (workers), 15.0–16.5 mm (♀♀), ca. 12.5 mm (♂♂, n = 2). Yellow markings of queen slightly suffused with orange, especially on metasoma. Clypeus with or without a small black central spot in queen, rarely more elongate and somewhat extended dorsally; clypeal mark more or less parallel-sided and extending to dorsal margin of clypeus in worker; black markings absent in male. Black band between corona and ocular sinus often interrupted in queen, narrow in worker, broad in male. Yellow eye-loop broadly interrupted at summit of eye in male, sometimes narrowly interrupted in worker. Elongate spots of scutum sometimes more or less connected to each other just before middle and/or posteriorly in queen. Pronotal lobes usually more or less marked with yellow in female. Queen with yellow scutal spots opposite tegula; rarely present in worker. Yellow band of metanotum complete, sometimes narrowly interrupted in male. Mesopleuron with an elongate yellow spot from pronotal lobe to mid coxa; in male reduced to dorsal and ventral spots. Propodeum with large yellow markings in female, with or without small markings in male. Pattern of metasoma fairly uniform; in queen pairs of discal spots on terga 2–5 and medial spot of tergum 2 usually more or less evanescent.

DISTRIBUTION. Canada: adventitious in southern ON (one record). Eastern U.S.: NY to FL, west to WI, IA, NE, KS, OK and TX. Mexico: Tamaulipas south to Michoacán and Chiapas. Also in Guatemala and Honduras (Carpenter and Kojima 1997).

BIOLOGY. This species shows facultative social parasitism of other yellowjackets, especially *V. maculifrons* and rarely *V. vidua*. In the United States up to 80% of *V. squamosa* nests result from nest usurpations of other species. Like those of its preferred host, the nests of *V. squamosa* are mostly subterranean but aerial nests are not uncommon in urban settings where they are usually found in hollow walls. Workers prey on live arthropods and scavenge on carrion. In the southeastern U.S. *V. squamosa* is an important nuisance species because of its preference for disturbed areas, resulting in frequent contact with humans (Akre *et al*. 1981).

97. *Vespula vidua* (de Saussure, 1854)

Figs B13.3, 4, 6, 36, 59, 70; C97.1–10.

SPECIES RECOGNITION. The queen of this species is easily recognisable by the presence of enclosed yellow spots on tergum 1, largely black tergum 2, median black mark with 'ear'-like processes on tergum 3 (the processes becoming separate spots in xanthic specimens), and largely yellow terga 4 and 5 with free, black, discal spots. Workers and males can be separated from similar species (*V. acadica*, *V. austriaca*) by the very short

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and sparse pubescence on discs of terga 2–6 and other characters mentioned in the key.

VARIATION. Fore wing length 9.5–12.0 mm (workers), 14.0–15.0 mm (♀♀), ca. 11.0–14.0 mm (♂♂). Clypeus with three small black discal spots, in worker rarely confluent and forming single, anchor-shaped mark; in male often obliterated or reduced to one medial spot. Yellow stripe along inner orbit usually ending on upper margin of sinus, rarely abbreviated and ending near apex of ocular sinus in male and worker. Yellow postocular band usually interrupted near middle, rarely complete but then significantly narrowed (exceptionally hardly narrowed) or enclosing black spot; postocular band entire and not narrowed near middle in male. Metanotum black, worker exceptionally (1 specimen, ON, Dundas, DEBU) with tiny, evanescent yellow spots. 'Ear'-shaped processes of black medial mark of tergum 3 of females sometimes forming separate spots in xanthic specimens; in worker usually, in queen the 'ear'-shaped processes very rarely completely merging with black basal band. Enclosed yellow spots rarely present on tergum 3 (in female, very rarely in queen) or 4 (male). Queen always, worker usually, and male sometimes with pairs of black discal spots on terga 4 and 5.

DISTRIBUTION. Canada: NS to ON (not recorded from PE), MB (Galloway and Preston 1982). Eastern U.S. south to GA along Appalachians, west to ND, SD, IA, IL and KY (Carpenter and Kojima 1997).

BIOLOGY. Nests are usually subterranean; they rarely are built in decaying logs or manmade structures. Females prey on live arthropods and are rarely a nuisance to man (Akre *et al*. 1981).

98. *Vespula vulgaris* (Linnaeus, 1758)

Figs B13.2, 13, 15, 40–43, 62, 73; C98.1–14.

SPECIES RECOGNITION. This species can be diagnosed by the relatively broad black band (width at least 2x mid ocellar diameter) between the corona and the ocular sinus. Species of the *V. rufa*-group are similar in this regard but possess a pair of well-defined, enclosed, yellow spots within the black basal band of tergum 1, these spots are well separated from the yellow apical fascia. Exceptionally, enclosed yellow spots are developed in *V. vulgaris*, but in this case they are of irregular shape and only narrowly separated from the apical fascia.

VARIATION. Fore wing length 8.0–10.5 mm (workers), 12.5–14.0 mm (♀♀), 11.5–13.5 mm (♂♂). Clypeus of female usually with black central mark extending to dorsal margin and widened ventrally (rarely with two spots separate from mark), the mark in worker frequently, in queen sometimes also connected to ventral margin; male clypeus with an elongate vertical mark that is usually interrupted one or more times, in extreme cases forming complete stripe that reaches both dorsal and ventral margins, or mark reduced to two spots. Black subantennal mark sometimes with enclosed yellow spots (rarely deep dorsal emarginations) in females; spots or deep dorsal emarginations almost always present in male. Yellow postocular band interrupted, abruptly narrowed or with enclosed black spot near middle, continuous in male. Scape black, in male with yellow anterior mark. Pronotal lobes and propodeum of worker exceptionally with small yellow spots (1 spm., ON, Manitouwadge, DEBU). Yellow spots of metanotum small in male, rarely absent. Black basomedial mark of tergum 1 very variable in worker: most commonly basal band produced backward in from of a wide triangle medially, very rarely with enclosed irregular yellow spots near summit; sometimes with anchor- or arrow-shaped medial mark, the minimum width of mark twice its length; minimum width of basal attachment 2x mid ocellar diameter. Xanthic workers rarely with evanescent enclosed yellow spots on tergum 2. Free black discal spots rarely present on tergum 2 (worker) or terga 3–5 (queen).

DISTRIBUTION. Canada: every province and territory except NU. Northern and western U.S.: AK, south to GA, KY, IL, IA, NE, NM, AZ and CA. Mexico: Durango, México, Michoacán and Oaxaca. Palaearctic (and adjacent parts of Oriental): Europe to Sakhalin, Japan, northern China, south to Turkey, Iran, northern India. Introduced to Hawaii, Iceland, New Zealand and Australia (Victoria, Tasmania) (Rodríguez-Palafox 1996, Carpenter and Kojima 1997).

BIOLOGY. Nests are usually subterranean but are sometimes also built in rotten logs or stumps, forest duff, hollow walls or even aerial locations. Females prey on a wide variety of arthropods in addition to scavenging on carrion. *Vespula vulgaris* is one of the major pest yellowjackets in the west but in the east it presents a much lesser problem than *V. maculifrons* and *V. germanica* (Akre *et al*. 1981).

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F. Appendices

Appendix 1. Glossary of scientific terms

Note: for abbreviations of Canadian provinces/ territories and American States, and for acronyms of specimen depositories see the pertinent sections under Material and Methods.

acarinarium: space between base of tergum 2 and posterior overhang of tergum 1 used to accommodate symbiontic mites by all species of the genus *Parancistrocerus*. Compared to other genera (especially the closely related *Stenodynerus*, which lacks the acarinarium), the space between the two terga is enlarged and less sculptured in *Parancistrocerus*.

aculeate: the Aculeata include the stinging members within the order Hymenoptera (bees, ants and wasps).

aedeagus: intromittent organ ('penis') of male insects.

Afrotropical: biogeographic region that includes sub-Saharan Africa.

allometric: size-related variation of shape.

allopatric: possessing geographic ranges that do not overlap.

areola, pl. areolae (adj.: areolate): cuticular surface structure in which smaller or larger smooth areas are separated from each other by narrow ridges or wrinkles.

auctt.: abbreviation for "*auctorum*" (Lat. for "of authors"). After a species name it indicates misidentifications. For instance, "*Euodynerus auranus* (= *E. boscii* auctt.)" means that *E. auranus* was misidentified as *E. boscii* by some authors.

basitarsus: basal segment of tarsus.

carina: linear, crest-like elevation.

caste: a class of morphologically distinct individuals within a colony of social insects, adapted to performing different tasks within the colony.

cephalic foveae: pair of paramedian pits, unique to Eumeninae, situated behind hind ocelli on the vertex. In some species the foveae are coalescent, forming a single median pit. The foveae represent external openings of dermal glands.

clypeus: sclerite below frons.

coalescent: fused or merged.

confluent: fused or merged.

corona: in Vespinae the pale median frontal spot between and above the antennae.

costa: wing vein at leading edge of fore wing, extending from base of wing almost to apex.

costal scale: scale- or ridge-like elevation ventrally at very base of costa. This term is newly introduced here.

coxa: small basal joint of insect leg.

dorsal groove (of mesopleuron): longitudinal groove in centre of mesopleuron, posteriorly ending in scrobal furrow.

digitus: inner lobe of paramere of male genitalia.

discal: on disc (as opposed to marginal area) of sclerite (e.g., discal spots).

discoidal cell: see Fig. A4.5.

eusocial: reproductive strategy that entails sterile castes ('workers'), cooperative parental care and overlapping generations.

extralimital: occurring outside a certain, defined geographic area; used here to refer to taxa that occur outside the area covered by this Atlas.

fascia, pl. fasciae: transverse band (used here only for pale markings on metasoma).

femur: part of insect leg between tibia and trochanter.

ferruginous: of a rustlike red colour.

flagellum: elongate apical portion of antenna beyond the two basal joints (scape and pedicel).

flagellomere: one article of flagellum.

frontal: pertaining to frons.

gena: cheek, lateral part of head behind compound eye and in front of occipital carina.

groundplan: a phylogenetic term that refers to the set of character states possessed by the hypothetical ancestor of a given taxonomic group (e.g., a genus or family).

Holarctic: biogeographic region that includes Nearctic and Palaearctic.

humeral angle: anterior, dorsolateral corner of pronotum.

humeral carina: carina that extends posteriorly from humeral angle, originating anteriorly from pronotal carina.

impunctate: without punctures.

inquiline: a species that lives with social species in their nest.

interantennal prominence: median frontal prominence between antennal sockets.

interantennal spot: pale spot between (and slightly above) antennae, ventrally sometimes extending to clypeal suture.

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interocular distance: distance between the compound eyes measured across the frons.

jugal lobe: posterobasal lobe of hind wing (absent in Vespinae).

malar space: area between compound eye and base of mandible.

marginal cell: see Fig. A4.5.

medial cell: see Fig. A4.5.

melanic: colour form with black markings more developed than average.

mesopleuron: largest sclerite laterally on mesosoma; in Hymenoptera extending all the way to midventral suture. Pertains to segment 2 of insect thorax.

mesosoma: middle portion of body of Hymenoptera Apocrita between head and metasoma; composed of thorax plus abdominal segment 1 (= propodeum).

metanotum: posteriormost dorsal sclerite of thorax in front of propodeum. Pertains to segment 3 of insect thorax.

metapleuron: posteriormost lateral sclerite of thorax in front of propodeum. Pertains to segment 3 of insect thorax.

metasoma: posterior portion of body of Hymenoptera Apocrita; composed of all abdominal segments except segment 1, which is fused to thorax. Synonym: gaster.

microtomentum: dense, extremely short pubescence, giving matt appearance to cuticular surfaces.

Nearctic: biogeographic region that includes North America (Canada, United States, northern portions of Mexico).

nominate: the nominate subspecies of a species is the one with the same name as the species, e.g., *Ancistrocerus antilope* ssp. *antilope*.

notauli: inner pair of grooves on scutum.

occipital carina: U-shaped carina separating posterior from lateral and dorsal surfaces of head; if fully developed extending to base of mandibles ventrally.

ocellar: pertaining to ocelli.

ocellus: simple (as opposed to compound) eye on vertex, occurring in set of three (single median, anterior; paired lateral, posterior).

ocular sinus: emargination of median margin of compound eye.

oplomerocephaly (adj. oplomerocephalic): rare, abnormal condition in some *Ancistrocerus* species where male mandible between teeth 2 and 3 and apex of male clypeus is deeply emarginate.

omaulus: carina on anterior portion of mesopleuron extending from near pronotum (when fully developed) posteroventrally.

orbit: imaginary border around compound eye (only inner orbits are referred to here).

Oriental: biogeographic region that includes southern part of Asia.

Palaearctic: biogeographic region that includes Europe, Africa north of Sahara, and northern part of Asia.

paramere: large, paired lateral lobes of male genitalia, terminating in long posterior spine in Eumeninae.

parategula: small lobe-like, sometimes hooked, posterolateral projection of (meso-)scutum, situated next to posteromedial margin of tegula.

pedicel: small second joint of antenna, between scape and flagellum.

petiolate: stalked; used for metasoma when basal portion is conspicuously narrowed over a distance.

postocular band/spot: pale band/spot on gena.

pronotal carina: transverse anterior carina of pronotum separating anterior declivity from posterior horizontal portion.

pronotal fovea: small anterolateral pit of pronotum.

pronotal lobe: small, lobe-like posterolateral projection of pronotum covering mesothoracic spiracle.

pronotum: anteriormost dorsal sclerite of thorax in front of scutum. Pertains to segment 1 of insect thorax.

propodeal concavity: large, more or less concave, medial area of propodeum usually defined by dorsal and lateral ridges.

propodeal valvula: triangular, rounded or subrectangular, ventrolateral posterior projection of propodeum, usually thin and somewhat translucent; not to be confused with submarginal carina of propodeum which, if present, is situated above valvula.

propodeum: first abdominal segment of Hymenoptera Apocrita, broadly fused to thorax and sharply delimited from rest of abdomen ('metasoma') by extreme constriction.

rake setae: enlarged setae on outer margin of fore tarsus (in Vespidae only developed on basitarsus) that help ground nesting species in removing dirt from their burrows.

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rugose: with wrinkled cuticular surface structure (noun: rugosity).

scape: large basal joint of antenna (note that the small, spherical basal portion through which the scape is articulated to the head capsule is not a separate joint).

sclerite: a plate-like, hardened, largely inflexible portion of the cuticle, separated from other plate-like areas by sutures or membranes.

scrobal furrow: furrow on upper mesopleuron that extends dorsally and posteroventrally from scrobe; gives rise anteriorly to dorsal groove.

scrobe: small pit behind centre of upper mesopleuron.

scutum (= mesoscutum): largest dorsal sclerite of mesosoma. Pertains to segment 2 of insect thorax.

scutellum: small dorsal sclerite of mesosoma behind scutum. Pertains to segment 2 of insect thorax.

septum: thin dividing wall.

sessile: without a stalk-like base (used for base of metasoma, opposite of petiolate).

seta: hair or bristle.

silvicolous: inhabiting wooded areas.

sp. restit.: abbreviation for Latin *species restituta*; referring to a species that was synonymized with another species or reduced to subspecies rank after its description, and later reinstated as a valid species.

spicules: minute, spine-like hairs.

stat. n.: abbreviation for new status; used in taxonomy to denote a new rank for a species-group name (e.g., when a subspecies is elevated to species rank or a species is demoted to subspecies rank).

sternum, pl. sterna: ventral sclerite of metasoma.

stylopized: parasitized by Strepsiptera.

subantennal spot: black median spot of frons just above clypeus; used in Vespinae and Polistinae.

subdiscoidal cell: see Fig. A4.5.

subequal: approximately equal.

submarginal carina: more or less projecting carina near ventral, posterolateral extreme of propodeum, situated just above propodeal valvula.

submarginal cell: see Fig. A4.5.

supersedure: a nest of a solitary species taken over by another species.

sympatric: sharing same geographic range.

tarsomere: one segment of tarsus.

tarsus: distal part of insect leg, consisting of five joints.

taxon, pl. taxa: a unit in biological classification of unspecified rank. For instance, a species, a genus and a family are taxa at different ranks.

tegula: small, shield-like plate above base of fore wing.

tibia: part of insect leg between tarsus and femur.

trochanter: small second joint of insect leg from basal.

tyloid: welt or swelling on male flagellomere.

vertex: top of head between compound eyes including ocellar area.

xanthic: colour form with yellow or ivory markings more developed than average.

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Appendix 2: Image data

Unless stated otherwise the depository of all museum specimens photographed is the University of Guelph Insect Collection (DEBU). All imaged museum specimens are labelled with a blue label ("*Photo on file*").

FRONTISPIECE. *Polistes bellicosus* ♀, SC: Charleston Co., Hobcaw Barony, Belle Baruch Marine Field Lab.

A. General

4. Morphology

A4.1. *Pachodynerus erynnis* ♂, ON: Kent Co., Rondeau Prov. Pk.
A4.2. *Odynerus dilectus* ♀, SK: Snowden (CNCI).
A4.3. *Pachodynerus erynnis* ♂, ON: Kent Co., Rondeau Prov. Pk.
A4.4. *Euodynerus auranus* ♀, ON: Bruce Co., Inverhuron Prov. Pk.
A4.5–6. *Zethus spinipes* ♂, MD: Calvert Co., Port Republic.
A4.7. *Parancistrocerus salcularis* ♀, NC: Bladen Co., Singletary Lk. St. Pk.
A4.8. *Parancistrocerus salcularis* ♂, GA: Colquitt Co., Reed-Bingham St. Pk. (AMNH).
A4.9. *Parancistrocerus salcularis* ♀, NC: Bladen Co., Singletary Lk. St. Pk.
A4.10. *Parancistrocerus salcularis* ♂, GA: Colquitt Co., Reed-Bingham St. Pk. (AMNH).
A4.11. *Ancistrocerus adiabatus* ♂, ON: Haldimand-Norfolk Reg., Normandale Fish Culture Station.
A4.12. *Ancistrocerus antilope* ♂, VA: Montgomery Co., Pandapas Pond.
A4.13. *Euodynerus castigatus* ♀, ON: Dufferin Co., Mono Cliffs Prov. Pk.
A4.14. *Euodynerus auranus* ♀, ON: Bruce Co., Bruce Peninsula Natl. Pk., Singing Sands.

B. Keys to subfamilies, genera and species

1. Key to Vespidae subfamilies

B1.1. *Eumenes verticalis* ♀, ON: Lincoln Co., Grimsby.
B1.2. *Pseudomasaris zonalis* ♂, CA: Kern Co., Mt. Abel, 2500m.
B1.3. *Polistes fuscatus* ♂, ON: Sudbury Distr., Sudbury.
B1.4. *Vespula maculifrons* ♀, ON: Middlesex Co., London.
B1.5. *Pseudomasaris vespoides* ♀, AB: Waterton Lakes Natl. Pk. (CNCI).
B1.6. *Monobia quadridens* ♂, ON: Essex Co., Point Pelee Natl. Pk.
B1.7. *Polistes fuscatus* ♀, ON: York Reg., Woodbridge, Boyd Conservation Area.
B1.8. *Parazumia symmorpha* ♀, ON: Essex Co., Point Pelee.
B1.9. *Stenodynerus fundatiformis* ♀, NC: Macon Co., Highlands, Horse Cove, 3000 ft (CNCI).
B1.10. *Vespula maculifrons* worker, ON: Bruce Co., Inverhuron Prov. Pk.
B1.11. *Polistes bellicosus* ♀, SC: Charleston Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B1.12. *Dolichovespula arenaria* worker, ON: Kent Co., Rondeau Prov. Pk.
B1.13. *Polistes exclamans* ♀, NC: Wake Co., Raleigh.
B1.14. *Vespula acadica* ♀, ON: Bruce Co., Dorcas Bay.

Habitus plate

B1.15. *Ancistrocerus gazella* ♀, ON: Wellington Co., Guelph.
B1.16. *Pseudomasaris edwardsii* ♂, CA: Inyo Co., Panamint Mts.
B1.17. *Polistes exclamans* ♀, NC: Wake Co., Raleigh.
B1.18. *Dolichovespula arenaria* ♀, ON: Manitoulin Distr., Manitoulin I., Carter Bay Dunes.

Eumeninae

2. Key to Eumeninae genera

B2.1. *Eumenes fraternus* ♀, SC: Charleston Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B2.2. *Zethus spinipes* ♂, NC: New Hanover Co., Fort Fisher.
B2.3. *Eumenes crucifera* ♂, ON: Hamilton-Wentworth Reg., Flamborough.
B2.4. *Zethus spinipes* ♂, NC: New Hanover Co., Fort Fisher.

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B2.5. *Eumenes verticalis* ♀, ON: Lincoln Co., Grimsby.
B2.6. *Zethus spinipes* ♂, MD: Calvert Co., Port Republic.
B2.7. *Symmorphus canadensis* ♂, ON: Halton Reg., Oakville nr. Hwy 25 and Burnhamthorpe Rd.
B2.8. *Odynerus dilectus* ♂, ON: Hamilton-Wentworth Reg., Ancaster (CNCI).

B2.9. *Parancistrocerus pensylvanicus* ♂, ON: Kent Co., Rondeau Prov. Pk.
B2.10. *Stenodynerus kennicottianus* ♀, SK: Saskatchewan Landing (CNCI).
B2.11. *Symmorphus albomarginatus* ♂, ON: Manitoulin Distr., Manitoulin I., Providence Bay.
B2.12. *Parancistrocerus leionotus* ♀, ON: Wellington Co., Guelph.
B2.13. *Symmorphus albomarginatus* ♀, ON: Manitoulin Distr., Manitoulin I., Square Bay.
B2.14. *Odynerus dilectus* ♀, SK: Snowden (CNCI).
B2.15. *Ancistrocerus albophaleratus* ♀, ON: Thunder Bay Distr., Black Sturgeon Lake (CNCI).

B2.16. *Odynerus dilectus* ♀, ON: Lincoln Co., Vineland.
B2.17. *Ancistrocerus gazella* ♀, ON: Wellington Co., Guelph.
B2.18. *Odynerus dilectus* ♂, AB: Edmonton (CNCI).
B2.19. *Ancistrocerus parietum* ♀, ON: Bruce Co.: Inverhuron Prov. Pk.
B2.20. *Pachodynerus erynnis* ♂, ON: Kent Co., Rondeau Prov. Pk.
B2.21. *Pseudodynerus quadrisectus* ♂, IN: Brown Co., 12 mi SW Columbus, State Fishing Area.
B2.22. *Leptochilus acolhuus* ♂, FL: Alachua Co., Gainesville.

B2.23. *Leptochilus republicanus* ♂, NC: Wake Co., Raleigh.
B2.24. *Euodynerus foraminatus* ♂, ON: Grey Co., Hepworth dunes.
B2.25. *Monobia quadridens* ♂, ON: Bruce Co., Inverhuron Prov. Pk.
B2.26. *Parazumia symmorpha* ♀, ON: Wellington Co., Rockwood.
B2.27. *Euodynerus bidens* ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B2.28. *Monobia quadridens* ♂, ON: Bruce Co., Inverhuron Prov. Pk.
B2.29. *Euodynerus* sp. F ♀, ON: Essex Co., Point Pelee Natl. Pk.

Habitus plates

B2.30. *Eumenes fraternus* ♂, ON: Kent Co., Rondeau Prov. Pk.
B2.31. *Zethus spinipes* ♀, NC: Gates Co., no precise locality.
B2.32. *Parancistrocerus vagus* ♂, ON: Bruce Co., Inverhuron Prov. Pk.
B2.33. *Parancistrocerus histrio* ♀, MD: Calvert Co., Port Republic (CNCI).
B2.34. *Stenodynerus ammonia* ♂, ON: Kent Co., Rondeau Prov. Pk.
B2.35. *Symmorphus albomarginatus* ♂, ID: Custer Co., Hwy 21, 25 mi W of Stanley.
B2.36. *Odynerus dilectus* ♀, ON: Lincoln Co., Vineland.
B2.37. *Pachodynerus erynnis* ♂, ON: Kent Co., Rondeau Prov. Pk.

B2.38. *Ancistrocerus albophaleratus* ♂, ON: Waterloo Reg., Erbsville.
B2.39. *Ancistrocerus unifasciatus* ♀, ON: Hamilton Wentworth Reg., Borer's Falls.
B2.40. *Pseudodynerus quadrisectus* ♀, MD: Calvert Co., Port Republic.
B2.41. *Leptochilus republicanus* ♀, ON: Essex Co., Windsor, Ojibway Prairie.
B2.42. *Parazumia symmorpha* ♂, ON: Wellington Co., Rockwood.
B2.43. *Monobia quadridens* ♂, ON: Bruce Co., Inverhuron Prov. Pk.
B2.44. *Euodynerus foraminatus* ♂, ON: Kent Co., Rondeau Prov. Pk.
B2.45. *Euodynerus bidens* ♀, FL: Highlands Co., Archbold Biol. Stn.

3. Key to *Ancistrocerus* species

B3.1. *A. campestris* ♂, ON: Kent Co., Rondeau Prov. Pk.
B3.2. *A. unifasciatus* ♀, ON: Wellington Co., Rockwood.
B3.3. *A. antilope* ♀, ON: Manitoulin Distr., Manitoulin I., Providence Bay.
B3.4. *A. spinolae* ♀, ON: Lambton Co., Pinery Prov. Pk.
B3.5. *A. antilope* ♂, ON: Bruce Co., Johnston Harbour.
B3.6. *A. gazella* ♀, ON: Wellington Co., Guelph.
B3.7. *A. lutonidus* ♀, SC: Oconee Co., Mountain Rest, 1300 ft (CNCI).

B3.8. *A. parietum* ♀, ON: Bruce Co.: Inverhuron Prov. Pk.
B3.9. *A. gazella* ♀, ON: Wellington Co., Guelph.

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B3.10. *A. catskill* ♀, ON: Sudbury Distr., Sudbury.
B3.11. *A. albophaleratus* ♀, ON: Essex Co., Kingsville.
B3.12. *A. catskill* ♀, ON: Wellington Co., Fergus.
B3.13. *A. albophaleratus* ♀, ON: Thunder Bay Distr., Black Sturgeon Lake (CNCI).
B3.14. *A. catskill* ♀, ON: Haldimand-Norfolk Reg., Normandale Fish Culture Station.
B3.15. *Ancistrocerus* sp. A ♀, ON: Nipissing Distr., Algonquin Prov. Pk., Lake Travers road.
B3.16. *A. waldenii* ♂, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
B3.17. *A. adiabatus* ♂, ON: Nipissing Distr., Algonquin Prov. Pk., Arowhon Rd.
B3.18. *A. waldenii* ♂, ON: Sudbury Distr., Chapleau, Racine Lk.
B3.19. *A. albophaleratus* ♂, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
B3.20. *A. adiabatus* ♂, ON: Kent Co., Rondeau Prov. Pk.
B3.21. *A. waldenii* ♀, ON: Thunder Bay Distr., Terrace Bay.
B3.22. *A. albophaleratus* ♀, ON: Bruce Co., Inverhuron Prov. Pk.
B3.23. *A. adiabatus* ♀, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
B3.24. *A. albophaleratus* ♀, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
B3.25. *A. adiabatus* ♀, ON: Essex Co., Pelee I., Lighthouse Point Prov. Nat. Res.
B3.26. *A. waldenii* ♀, QC: Cité Vaudreuil, Mt. Rigaud summit, 220 m (CNCI).
B3.27. *A. albophaleratus* ♀, ON: Thunder Bay Distr., Black Sturgeon Lake (CNCI).
B3.28. *A. waldenii* ♀, ON: Thunder Bay Distr., Terrace Bay.
B3.29. *A. albophaleratus* ♀, ON: Thunder Bay Distr., Black Sturgeon Lake (CNCI).
B3.30. *Ancistrocerus* sp. B ♀, ON: Carleton Reg., Ottawa (CNCI).
B3.31. *A. albophaleratus* ♀, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
B3.32. *A. adiabatus* ♂, ON: Peel Reg., Forks of the Credit.
B3.33. *A. albophaleratus* ♂, ON: Northumberland Co., Healey Falls.

Metasoma plates

B3.34. *A. unifasciatus* ♀, ON: Wellington Co., Guelph.
B3.35. *A. unifasciatus* ♂, ON: Waterloo Reg., Blair.
B3.36. *A. campestris* ♂, ON: Haldimand-Norfolk Reg., Normandale Fish Culture Station.
B3.37. *A. antilope* ♀, ON: Nipissing Distr., Algonquin Prov. Pk., Smoke Lk.
B3.38. *A. spinolae* ♀, ON: Lambton Co., Pinery Prov. Pk.
B3.39. *A. parietum* ♀, ON: York Reg., Toronto.
B3.40. *A. gazella* ♀, ON: Wellington Co., Guelph.
B3.41. *A. lutonidus* ♀, SC: Oconee Co., Mountain Rest, 1300 ft (CNCI).
B3.42. *A. catskill* ♀, ON: Haldimand-Norfolk Reg., Normandale Fish Culture Station.
B3.43. *Ancistrocerus* sp. A ♀, ON: Manitoulin Distr., Killarney.
B3.44. *Ancistrocerus* sp. B ♀, YT: Whitehorse, Copper Haul Road.
B3.45. *A. waldenii* ♀, ON: Thunder Bay Distr., Terrace Bay.
B3.46. *A. waldenii* ♂, ON: Sudbury Distr., Chapleau, Racine Lk.
B3.47. *A. albophaleratus* ♀, ON: Bruce Co., Inverhuron Prov. Pk.
B3.48. *A. albophaleratus* ♀, NY: Suffolk Co., Great Gull Island (AMNH).
B3.49. *A. adiabatus* ♀, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
B3.50. *A. adiabatus* ♂, ON: Kent Co., Rondeau Prov. Pk.
B3.51. *A. albolacteus* ♀, LB: Goose Bay (CNCI).

4. Key to *Eumenes* species

B4.1. *E. smithii* ♂, MS: Lafayette Co., no precise locality (CNCI).
B4.1 (inset). *E. smithii* ♂, TN: locality not given (CNCI).
B4.2. *E. smithii* ♂, MS: Lafayette Co., no precise locality (CNCI).
B4.3. *E. bollii* ♀, BC: Oliver (CNCI).
B4.4. *E. fraternus* ♂, ON: Haldimand-Norfolk Reg., Manestar Tract.
B4.5. *E. verticalis* ♂, ON: Wellington Co., Guelph.
B4.6. *E. crucifera* ♂, ON: Dufferin Co., Mono Cliffs Prov. Pk.
B4.7. *E. fraternus* ♀, SC: Charleston Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B4.8. *E. verticalis* ♂, ON: Halton Reg., Oakville, 16 Mile Creek nr. Hwy 407.

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B4.9. *E. fraternus* ♀, ON: Kent Co., Rondeau Prov. Pk.
B4.10. *E. verticalis* ♀, ON: Halton Reg., Oakville.
B4.11. *E. crucifera* ♀, ON: Thunder Bay Distr., Neys Prov. Pk.
B4.12. *E. verticalis* ♀, ON: Peel Reg., Forks of the Credit.

Metasoma plate

B4.13. *E. bollii* ♀, BC: Oliver (CNCI).
B4.14. *E. smithii* ♂, MS: Lafayette Co., no precise locality (CNCI).
B4.15. *E. verticalis* ♀, ON: Peel Reg., Forks of the Credit.
B4.16. *E. crucifera* ♀, ON: Thunder Bay Distr., Neys Prov. Pk.
B4.17. *E. fraternus* ♂, ON: Kent Co., Rondeau Prov. Pk.

5. Key to *Euodynerus* species

B5.1. *E. auranus* ♀, ON: Manitoulin Distr., Manitoulin I., Sand Bay.
B5.2. *E. blakeanus* ♀, WV: Hampshire Co., 4 km N Capon Bridge.
B5.3. *E. megaera* ♀, SC: Charleston Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B5.4. *E. bidens* ♀, FL: Highlands Co., Archbold Biol. Stn.
B5.5. *E. bidens* ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B5.6. *E. megaera* ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B5.7. *E. schwarzi* ♀, TX: Angelina Co., Bouton Lk., Campground SE of Zavalla.

B5.8. *E. megaera* ♂, SC: Charleston Co., Cape Romain N.W.R., Bull Island.
B5.9. *E. schwarzi* ♂, ON: Kent Co., Rondeau Prov. Pk.
B5.10. *E. leucomelas* ♂, ON: Thunder Bay Distr., Sleeping Giant Prov. Pk., Marie Louise Lake Campground.
B5.11. *E. planitarsis* ♂, MB: Gillam (CNCI).
B5.12. *E. foraminatus* ♂, ON: Hamilton-Wentworth Reg., Flamborough.
B5.13. *E. leucomelas* ♂, ON: Elgin Co., Orwell.
B5.14. *E. foraminatus* ♂, ON: Grey Co., Hepworth dunes.
B5.15. *Euodynerus* sp. F ♂, ON: Kent Co., Rondeau Prov. Pk.
B5.16. *E. leucomelas* ♀, ON: Thunder Bay Distr., Pukaskwa Natl. Pk., SW of Administration Bldg.
B5.17. *E. leucomelas* ♂, ON: Bruce Co., Inverhuron Prov. Pk.

B5.18. *E. blakeanus* ♀, TX: Brazos Co., College Station.
B5.19. *E. boscii* ♂, SC: Aiken Co., Aiken (CNCI).
B5.20. *E. crypticus* ♂, ON: Kent Co., Rondeau Prov. Pk.
B5.21. *E. hidalgo* ♂, ON: Haldimand-Norfolk Reg., Normandale Fish Culture Station.
B5.22. *E. annulatus* ♀, ON: Essex Co., Point Pelee (CNCI).
B5.23. *E. crypticus* ♀, GA: Rabun Co., Pine Mountain, 1400 ft (CNCI).
B5.24. *E. annulatus* ♂, ON: Essex Co., Point Pelee (CNCI).
B5.25. *E. annulatus* ♂, LA: Rapides Parish, Alexandria (FSCA).

B5.26. *E. annulatus* ♂, ON: Essex Co., Point Pelee (CNCI).
B5.27. *E. castigatus* ♂, ON: Nipissing Distr., Algonquin Prov. Pk., McManus Lake Rd.
B5.28. *E. crypticus* ♀, GA: Rabun Co., Pine Mountain, 1400 ft (CNCI).
B5.29. *E. auranus* ♂, ON: Bruce Co., Inverhuron Prov. Pk.
B5.30. *E. castigatus* ♂, ON: Bruce Co., Inverhuron Prov. Pk.
B5.31. *E. castigatus* ♀, ON: Bruce Co., Inverhuron Prov. Pk.
B5.32. *E. auranus* ♀, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
B5.33. *E. castigatus* ♂, NC: Pender Co., Holly Shelter (CNCI).
B5.34. *E. castigatus* ♀, ON: Dufferin Co., Mono Cliffs Prov. Pk.
B5.35. *E. auranus* ♀, ON: Bruce Co., Bruce Peninsula Natl. Pk., Singing Sands.

B5.36. *E. auranus* ♀, ON: Bruce Co., Inverhuron Prov. Pk.
B5.37. *Euodynerus* sp. G ♀, WV: Nicholas Co., Camp Woodbine (AMNH).
B5.38. *E. auranus* ♀, ON: Bruce Co., Inverhuron Prov. Pk.
B5.39. *Euodynerus* sp. G ♀, GA: Rabun Co., Satolah (CNCI).
B5.40. *E. megaera* ♂, ON: Essex Co., Point Pelee Natl. Pk.
B5.41. *E. schwarzi* ♂, ON: Kent Co., Rondeau Prov. Pk.

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B5.42. *E. foraminatus* ♂, ON: Halton Reg., Oakville nr. Hwy 25 and Burnhamthorpe Rd.
B5.43. *Euodynerus* sp. F ♂, ON: Kent Co., Rondeau Prov. Pk.

Metasoma plates

B5.44. *E. bidens* ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B5.45. *E. megaera* ♀, MS: Washington Co., Stoneville (CNCI).
B5.46. *E. schwarzi* ♂, ON: Kent Co., Rondeau Prov. Pk.
B5.47. *E. planitarsis* ♀, ON: Manitoulin Distr., Manitoulin I., Union Rd. nr. Portage Lk.
B5.48. *E. leucomelas* ♀, ON: Thunder Bay Distr., Mouth of Pic River, N side.
B5.49. *E. leucomelas* ♀, ON: Halton Reg. Burlington.
B5.50. *Euodynerus* sp. F ♀, ON: Kent Co., Rondeau Prov. Pk.
B5.51. *E. foraminatus* ♀, ON: Kent Co., Rondeau Prov. Pk.
B5.52. *E. blakeanus* ♀, WV: Hampshire Co., 4 km N Capon Bridge.
B5.53. *E. annectens* ♂, GA: Tift Co., Tifton (AMNH).
B5.54. *E. boscii* ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B5.55. *E. hidalgo* ♀, ON: Kent Co., Rondeau Prov. Pk.
B5.56. *E. pratensis* ♀, AZ: Santa Cruz Co., Santa Rita Mts., outside Madera Canyon.
B5.57. *E. crypticus* ♂, TX: Edwards Co., Rocksprings (CNCI).
B5.58. *E. annulatus* ♀, ON: Essex Co., Point Pelee (CNCI).
B5.59. *E. castigatus* ♀, ON: Bruce Co., Inverhuron Prov. Pk.
B5.60. *E. auranus* ♀, ON: Bruce Co., Inverhuron Prov. Pk.
B5.61. *Euodynerus* sp. G ♂, NJ: Bergen Co., Ramsey (AMNH).

6. Key to *Leptochilus* species

B6.1. *L. acolhuus* ♂, FL: Alachua Co., Gainesville.
B6.2. *L. republicanus* ♀, ON: Essex Co., Windsor, Ojibway Prairie.
B6.3. *L. acolhuus* ♂, FL: Miami-Dade Co., Homestead (CNCI).
B6.4. *L. acolhuus* ♂, FL: Alachua Co., Gainesville.
B6.5. *L. republicanus* ♂, NC: Wake Co., Raleigh.
B6.6. *L. republicanus* ♀, ON: Essex Co., Windsor, Ojibway Prairie.
B6.7. *L. acolhuus* ♀, GA: Lumpkin Co., Dahlonega (CNCI).

7. Key to *Parancistrocerus* and *Stenodynerus* species

B7.1. *S. fundatiformis* ♀, NC: Macon Co., Highlands, Horse Cove, 3000 ft (CNCI).
B7.2. *S. pulvinatus* ♂, VA: Fairfax Co., Great Falls (AMNH).
B7.3. *S. fundatiformis* ♀, NC: Moore Co., no precise locality.
B7.4. *S. fundatiformis* ♂, SC: Aiken Co., Aiken (CNCI).
B7.5. *P. perennis* ♂, ON: Welland Co., Welland, Wainfleet Bog.
B7.6. *P. leionotus* ♂, ON: Halton Reg., Oakville, 16 Mile Creek nr. Hwy 407.
B7.7. *P. bicornis* ♀, NC: Bladen Co., Singletary Lake St. Pk.
B7.8. *P. vagus* ♂, ON: Northumberland Co., Alderville First Nations Prairie.
B7.9. *S. pulvinatus* ♀, VA: Falls Church (AMNH).
B7.10. *S. pulvinatus* ♂, VA: Falls Church (AMNH).
B7.11. *S. blepharus* ♂, ON: Halton Reg., Oakville nr. Hwy 25 and Burnhamthorpe Rd.
B7.12. *S. pulvinatus* ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B7.13. *S. blepharus* ♂, ON: Essex Co., Windsor, Ojibway Prairie.
B7.14. *S. pulvinatus* ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B7.15. *S. histrionalis* ♂, NY: Kings Co., Long I., Flatbush (AMNH).
B7.16. *S. kennicottianus* ♀, SK: Saskatchewan Landing (CNCI).
B7.17. *S. blepharus* ♂, ON: Halton Reg., Oakville, Hwy 25 & Burnhamthorpe Rd.
B7.18. *S. oculeus* ♂, VA: Falls Church (AMNH).
B7.19. *S. blepharus* ♂, NY: Suffolk Co., Huntington, Kalbfleisch Field Res. Stn. (AMNH).
B7.20. *S. oculeus* ♀, SC: Bamberg Co., Denmark (AMNH).
B7.21. *S. ammonia* ♂, ON: Kent Co., Rondeau Prov. Pk.

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B7.22. *S. ammonia* ♂, ON: Essex Co., Point Pelee.
B7.23. *S. ammonia* ♂, ON: Essex Co., Pelee I., Stone Road Alvar.
B7.24. *S. anormis* ♂, ON: Kent Co., Rondeau Prov. Pk.
B7.25. *S. ammonia* ♀, ON: Essex Co., Point Pelee Natl. Pk.
B7.26. *P. salcularis* ♀, GA: Colquitt Co., Reed-Bingham St. Pk. (AMNH).

B7.27. *P. salcularis* ♂, NC: Wake Co., Raleigh.
B7.28. *P. leionotus* ♂, ON: Halton Reg., Oakville 16 Mile Creek nr. Hwy 407.
B7.29. *P. vagus* ♀, ON: Hamilton-Wentworth Reg., Flamborough.
B7.30. *P. fulvipes* ♂, NC: Hew Hanover Co., Fort Fisher.
B7.31. *S. lucidus* ♂, BC: Squamish, Diamond Head Trail, 3200 ft (CNCI).
B7.32. *P. histrio* ♂, SC: Charleston Co., Cape Romain N.W.R., Bull Island.

B7.33. *S. lineatifrons* ♀, FL: Highlands Co., Archbold Biol. Stn., Lake Placid (AMNH).
B7.34. *S. histrionalis* ♀, VA: Falls Church (AMNH).
B7.35. *S. lucidus* ♂, MB: 2 mi W Stockton (CNCI).
B7.36. *P. pensylvanicus* ♂, ON: Halton Reg., Oakville, 16 Mile Creek nr. Hwy 407.
B7.37. *S. kennicottianus* ♀, SK: Prince Albert (CNCI).
B7.38. *P. pensylvanicus* ♀, ON: Bruce Co., Inverhuron Prov. Pk.
B7.39. *S. krombeini* ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B7.40. *P. pensylvanicus* ♂, ON: Kent Co., Rondeau Prov. Pk.

B7.41. *S. krombeini* ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B7.42. *P. pedestris* ♀, ON: Kent Co., Rondeau Prov. Pk.
B7.43. *S. krombeini* ♀, GA: Colquitt Co., Reed-Bingham St. Pk. (AMNH).
B7.44. *P. pensylvanicus* ♀, ON: Kent Co., Rondeau Prov. Pk.
B7.45. *P. pedestris* ♀, ON: Kent Co., Rondeau Prov. Pk.
B7.46. *P. pensylvanicus* ♀, ON: Kent Co., Rondeau Prov. Pk.

Parancistrocerus metasoma plates

B7.47. *P. perennis* ♂, ON: Welland Co., Welland, Wainfleet Bog.
B7.48. *P. bicornis* ♂, SC: Horry Co., Cherry Grove Beach (CNCI).
B7.49. *P. salcularis* ♂, GA: Colquitt Co., Reed-Bingham St. Pk. (AMNH).
B7.50. *P. leionotus* ♂, ON: Halton Reg., Oakville, 16 Mile Creek nr. Hwy 407.
B7.51. *P. vagus* ♂, ON: Bruce Co., Inverhuron Prov. Pk.
B7.52. *P. fulvipes* ♂, NC: Hew Hanover Co., Fort Fisher.
B7.53. *P. histrio* ♀, MD: Calvert Co., Port Republic (CNCI).
B7.54. *P. pedestris* ♀, ON: Kent Co., Rondeau Prov. Pk.

B7.55. *P. pedestris* ♂, ON: Essex Co., Windsor, Ojibway Prairie.
B7.56. *P. pensylvanicus* ♀, ON: Bruce Co., Inverhuron Prov. Pk.

Stenodynerus metasoma plates

B7.57. *S. fundatiformis* ♀, NC: Macon Co., Highlands, Horse Cove, 3000 ft (CNCI).
B7.58. *S. pulvinatus* ♂, VA: Fairfax Co., Great Falls (AMNH).
B7.59. *S. blepharus* ♀, VA: Arlington Co., Glencarlyn (AMNH).
B7.60. *S. oculeus* ♂, IL: Piatt Co., White Heath (AMNH).

B7.61. *S. anormis* ♂, ON: Kent Co., Rondeau Prov. Pk.
B7.62. *S. ammonia* ♂, ON: Kent Co., Rondeau Prov. Pk.
B7.63. *S. lucidus* ♀, ON: Manitoulin Distr., Manitoulin I., Providence Bay.
B7.64. *S. lucidus* ♂, ON: Rainy River Distr., Rainy Lake (CNCI).
B7.65. *S. lineatifrons* ♂, FL: Highlands Co. (?), Lake Placid (AMNH).
B7.66. *S. histrionalis* ♂, SC: Horry Co., Myrtle Beach (AMNH).
B7.67. *S. kennicottianus* ♂, ON: Brant Co., Brantford Railway Prairie.
B7.68. *S. krombeini* ♂, VA: Falls Church (AMNH).

8. Key to *Symmorphus* species

B8.1. *S. albomarginatus* ♂, ID: Custer Co., Hwy 21, 25 mi W of Stanley.
B8.2. *S. canadensis* ♂, ON: Halton Reg., Oakville nr. Hwy 25 and Burnhamthorpe Rd.

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B8.3. *S. albomarginatus* ♀, ON: Manitoulin Distr., Manitoulin I., Sand Bay.
B8.4. *S. canadensis* ♀, ON: Welland Co., Niagara Falls.
B8.5. *S. cristatus* ♀, ON: Welland Co., Niagara Falls.
B8.6. *S. canadensis* ♂, ON: Welland Co., Niagara Falls.
B8.7. *S. cristatus* ♂, ON: Dufferin Co., Mono Cliffs Prov. Pk.

Metasoma plates

B8.8. *S. albomarginatus* ♀, ON: Parry Sound Distr., Killbear Prov. Pk.
B8.9. *S. cristatus* ♀, ON: Halton Reg., Oakville.
B8.10. *S. canadensis* ♀, ON: Waterloo Reg., Blair.

Polistinae

10. Key to *Polistes* species

B10.1. *P. dominula* ♀, ON: Wellington Co., Guelph.
B10.2. *P. annularis* ♀, TX: San Augustine Co., Texas A&M Forestry Stn. nr. Sam Rayburn Res.
B10.3. *P. dominula* ♂, ON: Essex Co., Windsor, Ojibway Prairie.
B10.4. *P. dominula* ♀, ON: Wellington Co., Guelph.
B10.5. *P. annularis* ♀, LA: St. Tammany Parish, Pearl River Wildlife Area.
B10.6. *P. exclamans* ♀, NC: Wake Co., Raleigh.
B10.7. *P. fuscatus* ♀, ON: York Reg., Etobicoke.
B10.8. *P. exclamans* ♀, NC: Wake Co., Raleigh.
B10.9. *P. carolina* ♀, TX: Angelina Co., Angelina Natl. For. E of Zavalla, Boykin Springs.
B10.10. *P. exclamans* ♀, NC: Wake Co., Raleigh.
B10.11. *P. fuscatus* ♀, ON: Middlesex Co., Melbourne.
B10.12. *P. exclamans* ♀, NC: Wake Co., Raleigh.
B10.13. *P. annularis* ♀, TX: San Augustine Co., Texas A&M Forestry Stn. nr. Sam Rayburn Res.
B10.14. *Polistes* sp. A ♀, SC: Pickens Co., Clemson (CNCI).
B10.15. *P. carolina* ♀, TX: Angelina Co., Angelina Natl. For. E of Zavalla, Boykin Springs.
B10.16. *Polistes* sp. A ♀, IL: Champaign Co., Champaign (CNCI).
B10.17. *P. metricus* ♀, SC: Georgetown Co., Brookgreen Gardens (CNCI).
B10.18. *Polistes* sp. A ♀, IL: Champaign Co., Champaign (CNCI).
B10.19. *P. perplexus* ♀, AR: Logan Co., Ozark Natl. Forest, 6.6 km E Hwy 309 (ROME).
B10.20. *P. perplexus* ♀, TX: Angelina Co., Boykin Springs in Angelina Natl. For. E of Zavalla.
B10.21. *P. carolina* ♀, TX: Angelina Co., Boykin Springs in Angelina Natl. For. E of Zavalla.
B10.22. *P. metricus* ♀, TX: Brazos Co., College Station.
B10.23. *P. fuscatus* ♀, ON: Lambton Co., Pinery Prov. Pk.
B10.24. *P. metricus* ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B10.25. *P. fuscatus* ♀, NC: Gates Co., no precise locality.
B10.26. *P. fuscatus* ♀, ON: Wellington Co., Arkell.
B10.27. *P. metricus* ♀, FL: Highlands Co., Archbold Biol. Stn., Lake Annie.
B10.28. *P. fuscatus* ♀, ON: Halton Reg., Oakville.
B10.29. *P. dorsalis* ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
B10.30. *P. dorsalis* ♀, FL: Miami-Dade Co., Homestead.
B10.31. *P. dorsalis* ♂, FL: Miami-Dade Co., Homestead.
B10.32. *P. dorsalis* ♂, FL: Miami-Dade Co., Homestead.
B10.33. *P. fuscatus* ♂, ON: York Reg., Leaside.
B10.34. *P. fuscatus* ♂, ON: Halton Reg., Oakville.
B10.35. *Polistes* sp. A ♂, MD: Prince George's Co., Largo, Hwy 214 & Church Rd.
B10.36. *P. metricus* ♂, MD: Prince George's Co., Patuxent Wildlife Res. Refuge, Visitor Center.
B10.37. *P. perplexus* ♀, TX: Montgomery Co., Sam Houston Natl. For.
B10.38. *P. carolina* ♀, GA: Fulton Co., Atlanta (CNCI).
B10.39. *P. fuscatus* ♀, MD: Anne Arundel Co., Milt's Pit 4 mi SW Davidsonville.
B10.40. *Polistes* sp. B ♀, MD: Prince George's Co., Patuxent Wildlife Res. Refuge, Visitor Center.

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B10.41. *P. fuscatus* ♂, ON: Wellington Co., Guelph.
B10.42. *P. fuscatus* ♂, MD: Anne Arundel Co., Milt's Pit 4 mi SW Davidsonville.
B10.43. *Polistes* sp. B ♂, MD: Prince George's Co., Patuxent Wildlife Res. Refuge 1 mi E Montpelier.

Metasoma plates

B10.44. *P. dominula* ♂, ON: Essex Co., Ojibway Prairie.
B10.45. *P. exclamans* ♀, NC: Wake Co., Raleigh.
B10.46. *P. annularis* ♀, NC: Gates Co., no precise locality.
B10.47. *Polistes* sp. A ♀, IL: Champaign Co., Champaign (CNCI).
B10.48. *P. perplexus* ♀, TX: Angelina Co., Boykin Springs in Angelina Natl. For. E of Zavalla.
B10.49. *P. carolina* ♀, TX: Angelina Co., Angelina Natl. For. E of Zavalla, Boykin Springs.
B10.50. *P. dorsalis* ♀, FL: Miami-Dade Co., Homestead.
B10.51. *P. bellicosus* ♀, SC: Charleston Co., Cape Romain N.W.R., Bull Island.
B10.52. *P. metricus* ♀, FL: Highlands Co., Archbold Biol. Stn., Lake Annie.
B10.53. *Polistes* sp. B ♀, MD: Prince George's Co., Greenbelt, Beltsville Agricultural Res. Center.
B10.54. *P. fuscatus* ♀, VA: Giles Co., Bald Knob, 1 km S Mountain Lake.
B10.55. *P. fuscatus* ♀, ON: Simcoe Co., Midland
B10.56. *P. fuscatus* ♀, DE: New Castle Co., Augustine Beach.
B10.57. *P. fuscatus* ♀, ON: Halton Reg., Oakville.
B10.58. *P. aurifer* ♂, AB: Ralston.
B10.59. *P. dominicus* ♀, Barbados: Sayes Court Agricultural Stn.

Vespinae

11. Key to Vespinae genera

B11.1. *Vespa crabro*, worker, ON: Frontenac Co., Sharbot Lake.
B11.2. *Dolichovespula arenaria* worker, ON: Wellington Co., Fergus.
B11.3. *Dolichovespula arenaria* ♀, VA: Montgomery Co., Poverty Creek Trail.
B11.4. *Vespula maculifrons* ♀, ON: Haldimand-Norfolk Reg., Manestar Tract.
B11.5. *Vespa crabro*, ♂, NY: Tompkins Co., Ithaca.

12. Key to *Dolichovespula* species

B12.1. *D. norwegica* worker, YT: Dempster Hwy km 466.
B12.2. *D. adulterina* ♀, VA: Giles Co., Bald Knob.
B12.3. *D. arenaria* ♀, ON: Manitoulin Distr., Manitoulin I., Carter Bay Dunes.
B12.4. *D. norwegica* ♂, YT: Dempster, Hwy. km 450, 67°00'N 136°12'W (ROME).
B12.5. *D. norvegicoides* ♂, ON: Sudbury Distr., Chapleau.
B12.6. *D. maculata* ♀, ON: Bruce Co., Inverhuron Prov. Pk.
B12.7. *D. maculata* ♂, ON: Manitoulin Distr., Killarney Prov. Pk.
B12.8. *D. adulterina* ♀, VA: Giles Co., Bald Knob.
B12.9. *D. arenaria* ♀, VA: Montgomery Co., Poverty Creek Trail.

Metasoma plate

B12.10. *D. norwegica* worker, YT: Dempster Hwy km 466.
B12.11. *D. norwegica* ♀, YT: Klondike Hwy at McCabe Cr., 62°32'N 136°46'W (ROME).
B12.12. *D. norvegicoides* Worker, ON: Sudbury Distr., Chapleau, Racine Lk.
B12.13. *D. maculata* ♀, ON: Algoma Distr., Thessalon.
B12.14. *D. maculata* ♂, ON: Manitoulin Distr., Killarney Prov. Pk.
B12.15. *D. arenaria* worker, ON: Manitoulin Distr., Manitoulin I., Sand Bay.
B12.16. *D. adulterina* ♀, VA: Giles Co., Bald Knob.
B12.17. *D. adulterina* ♂, ON: Waterloo Reg., Erbsville.
B12.18. *D. adulterina* ♂, ON: Nipissing Distr. or Haliburton Co., Algonquin Prov. Pk., Old Railway Bike Trail, S trail head.

13. Key to *Vespula* species

B13.1. *V. squamosa* worker, NC: Wake Co., Raleigh.

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B13.2. *V. vulgaris* ♀, ON: Wellington Co., Guelph.
B13.3. *V. vidua* worker, ON: Northumberland Co., Murray Hills.
B13.4. *V. vidua* ♂, ON: Hamilton-Wentworth Reg., Flamborough.
B13.5. *V. austriaca* ♀, ON: Thunder Bay Distr., Sleeping Giant Prov. Pk., Sifting Lk. Trail.
B13.6. *V. vidua* worker, ON: Haldimand-Norfolk Reg., 4 km N Cayuga.
B13.7. *V. acadica* worker, ON: Bruce Co., Inverhuron Prov. Pk.

B13.8. *V. austriaca* ♀, ON: Thunder Bay Distr., Sleeping Giant Prov. Pk., Sifting Lk. Trail.
B13.9. *V. acadica* ♀, ON: Dufferin Co., Primrose.
B13.10. *V. austriaca* ♂, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
B13.11. *V. acadica* ♂, ON: Bruce Co., Inverhuron Prov. Pk.
B13.12. *V. pensylvanica* ♀, CA: Alpine Co., Hope Valley.
B13.13. *V. vulgaris* ♀, ON: Sudbury or Algoma Distr., 60 km N Espanola.
B13.14. *V. maculifrons* ♀, ON: Haldimand-Norfolk Reg., Manestar Tract.

B13.15. *V. vulgaris* worker, ON: Wellington Co., Guelph.
B13.16. *V. maculifrons* worker, ON: Bruce Co., Inverhuron Prov. Pk.
B13.17. *V. germanica* ♀, ON: Essex Co., Kingsville.
B13.18. *V. flavopilosa* ♀, ON: Simcoe Co., Washago.
B13.19. *V. flavopilosa* worker, ON: Halton Reg., Oakville nr. Hwy 25 and Burnhamthorpe Rd.
B13.20. *V. germanica* ♂, ON: Wellington Co., Guelph.
B13.21. *V. maculifrons* ♂, ON: Wellington Co., Guelph.

B13.22. *V. germanica* ♂, ON: Wellington Co., Guelph.
B13.23. *V. pensylvanica* ♂, BC: Vancouver.
B13.24. *V. germanica* ♂, no data (unlabelled specimen).
B13.25. *V. pensylvanica* ♂, BC: Kamloops (CNCI).
B13.26. *V. pensylvanica* ♂, BC: Kamloops (CNCI).
B13.27. *V. flavopilosa* ♂, ON: Haldimand-Norfolk Reg., St. Williams Forestry Stn.

B13.28. *V. maculifrons* ♂, ON: Wellington Co., Guelph.
B13.29. *V. maculifrons* ♂, ON: Haldimand-Norfolk Reg., Manestar Tract.
B13.30. *V. maculifrons* ♂, ON: Hamilton-Wentworth Reg., Greensville.
B13.31. *V. flavopilosa* ♂, ON: Wellington Co., Guelph.

Metasoma plates (workers)

B13.32. *V. squamosa*, NC: Wake Co., Raleigh.
B13.33. *V. rufa*, MB, Churchill, 58.3706°N 93.4944°W.
B13.34. *V. rufa*, MB, Churchill, 58.3706°N 93.4944°W.
B13.35. *V. consobrina*, ON: Manitoulin Distr., Manitoulin I., Portage Bay.
B13.36. *V. vidua*, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
B13.37. *V. acadica*, ON: Sudbury Distr., Chapleau, Racine Lk.
B13.38. *V. acadica*, PA: Clearfield Co., Lanse, 1600 ft.
B13.39. *V. acadica*, ON: Bruce Co., Dorcas Bay.
B13.40. *V. vulgaris*, ON: Wellington Co., Guelph.
B13.41. *V. vulgaris*, ON: Grey Co., Owen Sound.
B13.42. *V. vulgaris*, ON: Dufferin Co., Primrose.
B13.43. *V. vulgaris*, ON: Wellington Co., Guelph.

B13.44. *V. maculifrons*, NC: Wake Co., Raleigh.
B13.45. *V. maculifrons*, ON: Wellington Co., Guelph.
B13.46. *V. maculifrons*, ON: Wellington Co., Fergus.
B13.47. *V. pensylvanica*, CA: Marin Co., Marin City.
B13.48. *V. germanica*, ON: Peel Reg., Mississauga, Erindale Park.
B13.49. *V. germanica*, ON: Waterloo Reg., Kitchener, Doon Heritage Crossroads.
B13.50. *V. germanica*, ON: Wellington Co., Guelph.
B13.51. *V. germanica*, ON: Wellington Co., Guelph.
B13.52. *V. flavopilosa*, ON: Wellington Co., Guelph.
B13.53. *V. flavopilosa*, ON: Wellington Co., Guelph.
B13.54. *V. flavopilosa*, ON: County/District unknown, Gold Lake.

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B13.55. *V. flavopilosa*, ON: Halton Reg., Oakville.

Metasoma plate (queens)

B13.56. *V. squamosa*, MS: Scott Co., Forest, Harrell Hill Prairie.
B13.57. *V. rufa*, YT: Klondike Hwy at McCabe Creek, 62°32'N 136°46'W (ROME).
B13.58. *V. consobrina*, ON: Sudbury Distr., Chapleau, Racine Lk.
B13.59. *V. vidua*, ON: Haldimand-Norfolk Reg., Manestar Tract.
B13.60. *V. austriaca*, ON: Thunder Bay Distr., Sleeping Giant Prov. Pk., Sifting Lk. Trail.
B13.61. *V. acadica*, ON: Kenora Distr., Ignace.
B13.62. *V. vulgaris*, ON: Dufferin Co., Mono Cliffs Prov. Pk.
B13.63. *V. flavopilosa*, VA: Montgomery Co., Pandapas Pond.
B13.64. *V. pensylvanica*, CA: Alpine Co., Hope Valley.
B13.65. *V. germanica*, ON: Haldimand-Norfolk Reg., Manestar Tract.
B13.66. *V. maculifrons*, ON: Haldimand-Norfolk Reg., Manestar Tract.

Metasoma plate (males)

B13.67. *V. squamosa*, FL: Sarasota Co., 10 km E Sarasota.
B13.68. *V. rufa*, MB: Churchill, 58.3706°N 93.4944°W.
B13.69. *V. consobrina*, ON: Bruce Co., Inverhuron Prov. Pk.
B13.70. *V. vidua*, ON: Kent Co., Rondeau Prov. Pk.
B13.71. *V. austriaca*, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
B13.72. *V. acadica*, ON: Bruce Co., Inverhuron Prov. Pk.
B13.73. *V. vulgaris*, ON: Wellington Co., Guelph.
B13.74. *V. flavopilosa*, ON: Wellington Co., Guelph.
B13.75. *V. pensylvanica*, BC: Vancouver.
B13.76. *V. germanica*, ON: Wellington Co., Guelph.
B13.77. *V. maculifrons*, ON: Haldimand-Norfolk Reg., Manestar Tract.
B13.78. *V. maculifrons*, ON: Waterloo Reg., Blair.

C. Taxonomic treatment

Eumeninae

Ancistrocerus

1. *Ancistrocerus adiabatus*

C1.1. ♂, ON: Essex Co., Pelee I., Lighthouse Point Prov. Nat. Res.
C1.2. ♀, ON: Essex Co., Pelee I., Lighthouse Point Prov. Nat. Res.
C1.3. ♂, ON: Kent Co., Rondeau Prov. Pk.
C1.4. ♀, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
C1.5. ♂, ON: Nipissing Distr., Algonquin Prov. Pk., Arowhon Rd.
C1.6. ♀, ON: Kent Co., Rondeau Prov. Pk.
C1.7. ♀ live, ON: Bruce Co., Dunks Bay.

2. *Ancistrocerus albolacteus*

C2.1. ♂, CO: Doolittle Ranch, Mt. Evans (CNCI).
C2.2. ♀, LB: Goose Bay (CNCI).
C2.3. ♂, CO: Clear Creek Co., Mt. Evans, Echo Lk., 10,600 ft (CNCI).
C2.4. ♀, BC: Lakelse Lake Bog S of Terrace (CNCI).
C2.5. ♀ live, AB, Banff Natl. Pk., nr. Bow River (© S. Luk, see also Bugguide).

3. *Ancistrocerus albophaleratus*

C3.1. ♂, ON: Waterloo Reg., Erbsville.
C3.2. ♀, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
C3.3. ♀, CT: Fairfield Co., New Canaan (AMNH).
C3.4. ♂, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
C3.5. ♀, ON: Bruce Co., Inverhuron Prov. Pk.
C3.6. ♂, ON: Waterloo Reg., Erbsville.
C3.7. ♀, ON: Manitoulin Distr., Manitoulin I., Carter Bay.

C3.8. ♀, NY: Westchester Co., Lewisboro (ANMH).
C3.9. ♀ live, ON: Simcoe Co., Midland.
C3.10–11. ♀ live, ON: Bruce or Grey Co., Wiarton.

4. *Ancistrocerus antilope*

C4.1. ♂, ON: Algoma Distr. Sault Ste. Marie.
C4.2. ♀, ON: Haldimand-Norfolk Reg., Manestar Tract.
C4.3. ♂, ON: Kent Co., Rondeau Prov. Pk.
C4.4. ♀, ON: Nipissing Distr., Algonquin Prov. Pk., Smoke Lk.
C4.5. ♂, ON: Dufferin Co., Mono Cliffs Prov. Pk.
C4.6. ♀, ON: Manitoulin Distr., Manitoulin I., Shrigley Bay.
C4.7. ♀ live, ON: Essex Co., Point Pelee.

5. *Ancistrocerus campestris*

C5.1. ♀, ON: Kent Co., Rondeau Prov. Pk.
C5.2. ♂, ON: Haldimand-Norfolk Reg., Normandale Fish Culture Station.
C5.3. ♂, ON: Kent Co., Rondeau Prov. Pk.
C5.4. ♀, ON: Kent Co., Rondeau Prov. Pk.
C5.5. ♂ live, ON: Wellington Co., Fergus.

6. *Ancistrocerus catskill*

C6.1. ♂, ON: Manitoulin Distr., Manitoulin I., Shrigley Bay.
C6.2. ♀, ON: Hamilton-Wentworth Reg., Dundas.
C6.3. ♂, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
C6.4. ♀, ON: Haldimand-Norfolk Reg., Normandale Fish Culture Station.
C6.5. ♂, ON: Dufferin Co., Mono Cliffs Prov. Pk.
C6.6. ♀, ON: Haldimand-Norfolk Reg., Normandale Fish Culture Station.
C6.7. ♀ live, MA: Worcester Co., Harvard (© T. Murray, see also Bugguide).
C6.8. ♀ live, ON: Wellington Co., Fergus.
C6.9. ♂ live, ON: Wellington Co., Fergus.

7. *Ancistrocerus gazella*

C7.1. ♂, ON: Wellington Co., Guelph.
C7.2. ♀, ON: Wellington Co., Guelph.
C7.3. ♀, ON: Wellington Co., Guelph.
C7.4. ♂, ON: Wellington Co., Guelph.
C7.5. ♀, ON: York Reg., Etobicoke.

8. *Ancistrocerus lutonidus*

C8.1. ♀, SC: Oconee Co., Mountain Rest, 1300 ft (CNCI).
C8.2. ♀, SC: Oconee Co., Mountain Rest, 1300 ft (CNCI).
C8.3. ♂, NY: locality not given (AMNH).
C8.4. ♀, SC: Oconee Co., Mountain Rest, 1300 ft (CNCI).

9. *Ancistrocerus parietum*

C9.1. ♂, ON: Wellington Co., Guelph.
C9.2. ♀, ON: York Reg., Toronto.
C9.3. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
C9.4. ♀, ON: Bruce Co., Inverhuron Prov. Pk.
C9.5. ♀ live, ON: Grey Co., Owen Sound.

10. *Ancistrocerus spinolae*

C10.1–3. ♀, ON: Lambton Co., Pinery Prov. Pk.

11. *Ancistrocerus unifasciatus*

C11.1. ♂, ON: Haldimand-Norfolk Reg., Manestar Tract.
C11.2. ♀, ON: Hamilton Wentworth Reg., Borer's Falls.
C11.3. ♀, ON: Wellington Co., Guelph.
C11.4. ♂, ON: Wellington Co., Aberfoyle.
C11.5. ♀, ON: Wellington Co., Rockwood.

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C11.6. ♂ live, ON: Wellington Co., Fergus.
C11.7. ♀ live, ON: Wellington Co., Fergus.

12. *Ancistrocerus waldenii*
C12.1. ♀, QC: Vaudreuil Co., Summit of Mt. Rigaud.
C12.2. ♂, ON: Sudbury Distr., Chapleau, Racine Lk.
C12.3. ♀, ON: Thunder Bay Distr., Terrace Bay.
C12.4. ♂, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
C12.5. ♀, ON: Thunder Bay Distr., Terrace Bay.
C12.6. ♂ live, VA: Giles Co., Ripplemead.
C12.7. ♀ live, MA: Hampshire Co., Amherst (© T. DiTerlizzi, see also Bugguide: main, inset).

13. *Ancistrocerus* sp. A
C13.1. ♀, ON: Nipissing Distr., Algonquin Prov. Pk., Lake Travers road.
C13.2. ♀, ON: Manitoulin Distr., Killarney.
C13.3. ♀, ON: Nipissing Distr., Algonquin Prov. Pk., Lake Travers road.
C13.4. gynandromorph, QC: James Bay Rte km 542, Lac Yasinski rest area.
C13.5. ♀, NB: Moncton (CNCI).

14. *Ancistrocerus* sp. B
C14.1. ♀, ON: Carleton Reg., Ottawa (CNCI).
C14.2. ♀, YT: Whitehorse, Copper Haul Road.
C14.3. ♀, YT: Whitehorse, Copper Haul Road.

Eumenes

15. *Eumenes bollii*
C15.1–3. ♀, BC: Oliver (CNCI).

16. *Eumenes crucifera*
C16.1. ♀, ON: Thunder Bay Distr., Neys Prov. Pk.
C16.2. ♂, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
C16.3. ♂, ON: Hamilton-Wentworth Reg., Flamborough.
C16.4. ♀, ON: Lanark Co., Patterson Lake.

17. *Eumenes fraternus*
C17.1. ♂, ON: Kent Co., Rondeau Prov. Pk.
C17.2. ♀, SC: Charleston Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C17.3. ♂, ON: Essex Co., Point Pelee.
C17.4. ♀, ON: Kent Co., Rondeau Prov. Pk.
C17.5. ♀ live, ON: Durham Reg., Whitby.

18. *Eumenes smithii*
C18.1–2. ♂, MS: Lafayette Co., no precise locality (CNCI).
C18.3. ♂, TN: locality not given (CNCI).
C18.4. ♀ live, FL: Lake Co., Lady Lake (© M. White, see also Bugguide)
C18.5. ♀ live, FL: Lake Co., Lady Lake (© M. White, see also Bugguide)

19. *Eumenes verticalis*
C19.1. ♀, ON: Peel Reg., Forks of the Credit.
C19.2. ♂, ON: Halton Reg., Oakville, 16 Mile Creek nr. Hwy 407.
C19.3. ♂, ON: Halton Reg., Oakville, 16 Mile Creek nr. Hwy 407.
C19.4. ♀, ON: Halton Reg., Oakville, 16 Mile Creek nr. Hwy 407.
C19.5. ♂ live, ON: Wellington Co., Guelph.

Euodynerus

20. *Euodynerus annectens*
C20.1–3. ♂, VA: Mouth of Tobacco Creek, 25 mi from Fredericksburg (paratype, USNM).
C20.4. ♀, VA: Mouth of Tobacco Creek, 25 mi from Fredericksburg (holotype, USNM).

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21. *Euodynerus annulatus*
    C21.1. ♂, ON: Essex Co., Point Pelee (CNCI).
    C21.2. ♀, ON: Essex Co., Point Pelee (CNCI).
    C21.3. ♂, ON: Essex Co., Point Pelee (CNCI).
    C21.4. ♀, ON: Essex Co., Point Pelee (CNCI).
22. *Euodynerus auranus*
    C22.1. ♂, ON: Manitoulin Distr., Manitoulin I., Carter Bay Dunes.
    C22.2. ♀, ON: Bruce Co., Inverhuron Prov. Pk.
    C22.3. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
    C22.4. ♀, ON: Manitoulin Distr., Manitoulin I., Sand Bay.
23. *Euodynerus bidens*
    C23.1. ♀, FL: Highlands Co., Archbold Biol. Stn.
    C23.2. ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
    C23.3. ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
    C23.4. ♀, FL: Highlands Co., Archbold Biol. Stn.
    C23.5. ♀ live, SC: Charleston Co., Cape Romain N.W.R., Bull Island.
24. *Euodynerus blakeanus*
    C24.1. ♀, TX: Brazos Co., College Station.
    C24.2. ♀, WV: Hampshire Co., 4 km N Capon Bridge.
    C24.3. ♂, TX: Bastrop Co., Lost Pines Pk. (CNCI).
    C24.4. ♀, WV: Hampshire Co., 4 km N Capon Bridge.
25. *Euodynerus boscii*
    C25.1. ♂, SC: Aiken Co., Aiken (CNCI).
    C25.2. ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
    C25.3. ♂, SC: Aiken Co., Aiken (CNCI).
    C25.4. ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
26. *Euodynerus castigatus*
    C26.1. ♂, NC: Pender Co., Holly Shelter (CNCI).
    C26.2. ♀, ON: Bruce Co., Inverhuron Prov. Pk.
    C26.3. ♂, ON: Haldimand-Norfolk Reg., Normandale Fish Culture Station.
    C26.4. ♀, ON: Bruce Co., Inverhuron Prov. Pk.
    C26.5. ♀ live (ssp. *rubrivestis*), FL: St. Lucie Co., Fort Pierce (© S. McCann, see also Bugguide).
27. *Euodynerus crypticus*
    C27.1. ♂, ON: Kent Co., Rondeau Prov. Pk.
    C27.2. ♀, ON: Lincoln Co., Vineland Station.
    C27.3. ♂, TX: Edwards Co., Rocksprings (CNCI).
    C27.4. ♂, ON: Kent Co., Rondeau Prov. Pk.
    C27.5. ♀, GA: Rabun Co., Pine Mountain, 1400 ft (CNCI).
    C27.6. ♀ live, AR: Washington Co., Fayetteville (© E. Trammel).
    C27.7. ♀ live, AR: Washington Co., Fayetteville (© E. Trammel, see also Bugguide).
28. *Euodynerus foraminatus*
    C28.1. ♂, ON: Kent Co., Rondeau Prov. Pk.
    C28.2. ♀, ON: Kent Co., Rondeau Prov. Pk.
    C28.3. ♂, ON: Dufferin Co., Mono Cliffs Prov. Pk.
    C28.4. ♀, ON: Wellington Co., Guelph.
    C28.5. ♂ live, ON: locality not given.
29. *Euodynerus hidalgo*
    C29.1. ♂, ON: Haldimand-Norfolk Reg., Normandale Fish Culture Station.
    C29.2. ♀, ON: Kent Co., Rondeau Prov. Pk.
    C29.3. ♂, ON: Haldimand-Norfolk Reg., Normandale Fish Culture Station.
    C29.4. ♀, ON: Kent Co., Rondeau Prov. Pk.
    C29.5. ♀ live, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.

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30. *Euodynerus leucomelas*
    C30.1. ♂, ON: Kent Co., Wheatley Prov. Pk.
    C30.2. ♂, ON: Lambton Co., Port Franks, Watson Property nr. L-lake.
    C30.3. ♀, ON: Thunder Bay Distr., Mouth of Pic River, N side.
    C30.4. ♂, ON: Kent Co., Rondeau Prov. Pk.
    C30.5. ♀, ON: Haldimand-Norfolk Reg., Manestar Tract.
    C30.6. ♂ live, ON: Wellington Co., Fergus.
31. *Euodynerus megaera*
    C31.1. ♀, TX: Jasper Co., Forest route 335 near Ebenezer.
    C31.2. ♀, MS: Washington Co., Stoneville (CNCI).
    C31.3. ♂, SC: Aiken Co., Aiken (CNCI).
    C31.4. ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
    C31.5. ♀ live, FL: Indian River Co., Vero Beach (© S. McCann, see also Bugguide).
32. *Euodynerus planitarsis*
    C32.1. ♂, MB: Gillam (CNCI).
    C32.2. ♀, ON: Manitoulin Distr., Manitoulin I., Union Rd. nr. Portage Lk.
    C32.3. ♂, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
    C32.4. ♀, ON: Manitoulin Distr., Manitoulin I., Union Rd. nr. Portage Lk.
33. *Euodynerus pratensis*
    C33.1. ♂, TX: Val Verde Co., Val Verde, Devil's River, Dolan Falls (CNCI).
    C33.2. ♀, AZ: Santa Cruz Co., Santa Rita Mts., outside Madera Canyon.
    C33.3. ♂, TX: Val Verde Co., Val Verde, Devil's River, Dolan Falls (CNCI).
    C33.4. ♀, AZ: Santa Cruz Co., Santa Rita Mts., outside Madera Canyon.
34. *Euodynerus schwarzi*
    C34.1. ♀, TX: Angelina Co., Bouton Lk., Campground SE of Zavalla.
    C34.2. ♂, ON: Kent Co., Rondeau Prov. Pk.
    C34.3. ♂, ON: Kent Co., Rondeau Prov. Pk.
    C34.4. ♀, ON: Kent Co., Rondeau Prov. Pk.
35. *Euodynerus* sp. F
    C35.1. ♀, ON: Essex Co., Point Pelee Natl. Pk.
    C35.2. ♀, ON: Kent Co., Rondeau Prov. Pk.
    C35.3. ♂, ON: Kent Co., Rondeau Prov. Pk.
    C35.4. ♀, ON: Kent Co., Rondeau Prov. Pk.
    C35.5. ♂, ON: Kent Co., Rondeau Prov. Pk.
    C35.6. ♀ live, IL: Lake Co., Reed Turner Woodland (© T. Bentley, see also Bugguide).
    C35.7. ♀ live, NE: Sarpy Co., Bellevue (© L. and B. Padelford, see also Bugguide: main, inset).
36. *Euodynerus* sp. G
    C36.1. ♀, GA: Rabun Co., Pine Mountain, 1400' (CNCI).
    C36.2. ♂, NJ: Bergen Co., Ramsey (AMNH).
    C36.3. ♂, NJ: Ocean Co., Lakehurst (AMNH).
    C36.4. ♀, NC: County unknown, Franklin (CNCI).

Leptochilus

37. *Leptochilus acolhuus*
    C37.1. ♂, FL: Alachua Co., Gainesville.
    C37.2. ♀, GA: Lumpkin Co., Dahlonega (CNCI).
    C37.3. ♂, FL: Alachua Co., Gainesville.
    C37.4. ♀, FL: Pasco Co., Withlacoochee St. For., Croom Reservation.
38. *Leptochilus republicanus*
    C38.1. ♀, ON: Essex Co., Windsor, Ojibway Prairie.
    C38.2. ♀, ON: Essex Co., Windsor, Ojibway Prairie.

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C38.3. ♂, NC: Wake Co., Raleigh.
C38.4. ♀, ON: Essex Co., Windsor, Ojibway Prairie.
C38.5–7. ♀ live, NJ: Atlantic Co., Port Republic (© J. Connor, see also Bugguide: middle, bottom).

Monobia

39. *Monobia quadridens*

C39.1–2. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
C39.3. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
C39.4. ♀, ON: Essex Co., Windsor, Ojibway Prairie.
C39.5. ♂ live, SC: Charleston Co., Cape Romain N.W.R., Bull Island.

Odynerus

40. *Odynerus dilectus*

C40.1. ♀, ON: Lincoln Co., Vineland.
C40.2. ♂, ON: Hamilton-Wentworth Reg., Ancaster (CNCI).
C40.3. ♀, ON: Lincoln Co., Vineland.
C40.4. ♂, MB: Carberry (CNCI).
C40.5. ♀, ON: Lincoln Co., Vineland.
C40.6. ♀ live, MT: Glacier Co., Duck Lake (© L. Schimming, see also Bugguide).

Pachodynerus

41. *Pachodynerus erynnis*

C41.1–3. ♂, ON: Kent Co., Rondeau Prov. Pk.
C41.4. ♀, FL: Miami-Dade Co., Everglades Natl. Pk., Anhinga Trail.
C41.5. ♂ live, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.

Parancistrocerus

42. *Parancistrocerus bicornis*

C42.1. ♂, SC: Horry Co., Cherry Grove Beach (CNCI).
C42.2. ♀, VA: Falls Church (AMNH).
C42.3. ♂, VA: Falls Church (AMNH).
C42.4. ♀, NC: Bladen Co., Singletary Lk. State Pk.
C42.5. ♀ live (ssp. *cushmani*), AZ: Cochise Co., Portal.

43. *Parancistrocerus fulvipes*

C43.1. ♂, NC: Hew Hanover Co., Fort Fisher.
C43.2. ♀, VA: Falls Church (AMNH).
C43.3. ♂, VA: Fairfax Co., Great Falls (AMNH).
C43.4. ♀, VA: Falls Church (AMNH).

44. *Parancistrocerus histrio*

C44.1. ♀, MD: Calvert Co., Port Republic (CNCI).
C44.2. ♂, GA: Lumpkin Co., Dahlonega (AMNH).
C44.3. ♂, NC: New Hanover Co., Fort Fisher.
C44.4. ♀, MD: Calvert Co., Port Republic (CNCI).
C44.5. ♀, live, FL: Indian River Co., Vero Beach (© S. McCann, see also Bugguide).

45. *Parancistrocerus leionotus*

C45.1. ♂, ON: Halton Reg., Oakville, 16 Mile Creek nr. Hwy 407.
C45.2. ♀, ON: Wellington Co., Guelph.
C45.3. ♂, ON: Halton Reg., Oakville, 16 Mile Creek.
C45.4. ♀, ON: Halton Reg., Oakville, 16 Mile Creek.
C45.5. ♀ live, ON: Wellington Co., Guelph.

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46. *Parancistrocerus pedestris*
C46.1. ♂, ON: Essex Co., Windsor, Ojibway Prairie.
C46.2. ♀, ON: Kent Co., Rondeau Prov. Pk.
C46.3. ♀, ON: Essex Co., Point Pelee Natl. Pk.
C46.4. ♂, ON: Kent Co., Rondeau Prov. Pk.
C46.5. ♀, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
C46.6. ♀ live, ON: Essex Co., Point Pelee.
C46.7. ♀ live, NY: New York, Central Park (© C. Matson, see also Bugguide).

47. *Parancistrocerus pensylvanicus*
C47.1. ♀, ON: Bruce Co., Inverhuron Prov. Pk.
C47.2. ♂, ON: Kent Co., Rondeau Prov. Pk.
C47.3. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
C47.4. ♀, ON: Bruce Co., Inverhuron Prov. Pk.
C47.5. ♂ live, ON: Wellington Co., Fergus.

48. *Parancistrocerus perennis*
C48.1. ♂♀, ON: Welland Co., Welland, Wainfleet Bog.
C48.2. ♂, ON: Welland Co., Niagara Whirlpool.
C48.3. ♂, ON: Kent Co., Rondeau Prov. Pk.
C48.4. ♀, ON: Kent Co., Rondeau Prov. Pk.
C48.5. ♀ live, GA: Fulton Co., Atlanta (© B. DuPree, see also Bugguide).

49. *Parancistrocerus salcularis*
C49.1. ♂, GA: Colquitt Co., Reed-Bingham St. Pk. (AMNH).
C49.2. ♀, SC: Aiken Co., Aiken (CNCI).
C49.3. ♂, NC: Wake Co., Raleigh.
C49.4. ♀, SC: Aiken Co., Aiken (CNCI).

50. *Parancistrocerus vagus*
C50.1. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
C50.2. ♀, ON: Hamilton-Wentworth Reg., Flamborough.
C50.3. ♂, ON: Northumberland Co., Alderville First Nations Prairie.
C50.4. ♀, ON: Hamilton-Wentworth Reg., Flamborough.

Parazumia

51. *Parazumia symmorpha*
C51.1. ♂, ON: Wellington Co., Rockwood.
C51.2–3. ♀, ON: Wellington Co., Rockwood.
C51.4. ♂, ON: Halton Reg., Oakville, 16 Mile Creek nr. Hwy 407.
C51.5. ♀, ON: Essex Co., Point Pelee.
C51.6–8. ♀ live, NE: Cass Co., Louisville Lakes State Recreation Area (© L. and B. Padelford, see also Bugguide).
C51.9–11. ♀ live, NE: Sarpy Co., Fontenelle Forest (© L. and B. Padelford, see also Bugguide).

Pseudodynerus

52. *Pseudodynerus quadrisectus*
C52.1. ♀, MD: Calvert Co., Port Republic.
C52.2. ♂, GA: Rabun Co., Satolah (CNCI).
C52.3. ♂, IN: Brown Co., 12 mi SW Columbus, State Fishing Area.
C52.4. ♀, MD: Calvert Co., Port Republic.
C52.5. ♂ live, NC: Durham Co., Snowhill Road north of Cabin Branch Creek, Treyburn area (© P. Coin, see also Bugguide).

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Stenodynerus

53. *Stenodynerus ammonia*
    C53.1. ♂, ON: Kent Co., Rondeau Prov. Pk.
    C53.2. ♀, ON: Essex Co., Point Pelee Natl Pk.
    C53.3. ♂, ON: Kent Co., Rondeau Prov. Pk.
    C53.4. ♀, ON: Essex Co., Point Pelee Natl. Pk.
    C53.5. ♀ live, SC: Charleston Co., Cape Romain N.W.R., Bull Island.

54. *Stenodynerus anormis*
    C54.1. ♂, ON: Kent Co., Rondeau Prov. Pk.
    C54.2. ♀, ON: Essex Co., Point Pelee Natl. Pk.
    C54.3. ♂, ON: Wellington Co., Guelph.
    C54.4. ♀, ON: Wellington Co., 2 km N Shiloh.

55. *Stenodynerus blepharus*
    C55.1. ♀, VA: Arlington Co., Glencarlyn (AMNH).
    C55.2. ♂, ON: Essex Co., Windsor, Ojibway Prairie.
    C55.3. ♂, ON: Halton Reg., Oakville, Hwy 25 & Burnhamthorpe Rd.
    C55.4. ♀, ON: Essex Co., Windsor, Ojibway Prairie.

56. *Stenodynerus fundatiformis*
    C56.1. ♀, NC: Macon Co., Highlands, Horse Cove, 3000 ft (CNCI).
    C56.2. ♂, VA: Falls Church (AMNH).
    C56.3. ♂, NC: Macon Co., Highlands, Blue Valley Lookout, 3500 ft (CNCI).
    C56.4. ♀, NC: Moore Co., no precise locality.
    C56.5–6. ♂♀ live, AR: Washington Co., Fayetteville (© E. Trammel, see also Bugguide: top, inset, bottom).

57. *Stenodynerus histrionalis*
    C57.1. ♂, SC: Horry Co., Myrtle Beach (AMNH).
    C57.2. ♀, NY: Queens Co., Far Rockaway (AMNH).
    C57.3. ♂, NC: Moore Co., Southern Pines (AMNH).
    C57.4. ♀, VA: Falls Church (AMNH).

58. *Stenodynerus kennicottianus*
    C58.1. ♂, ON: Brant Co., Brantford Railway Prairie.
    C58.2. ♀, ON: Bruce Co., Inverhuron Prov. Pk.
    C58.3. ♂, ON: Bruce Co., Tobermory Bog.
    C58.4. ♀, ON: Wellington Co., Guelph.
    C58.5. ♂ live, ON: Manitoulin Distr., Manitoulin I., Michael's Bay.

59. *Stenodynerus krombeini*
    C59.1. ♂, VA: Falls Church (AMNH).
    C59.2. ♀, MA: Barnstable Co., Wellfleet (AMNH).
    C59.3. ♂, VA: Falls Church (AMNH).
    C59.4. ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.

60. *Stenodynerus lineatifrons*
    C60.1. ♂, FL: Highlands Co. (?), Lake Placid (AMNH).
    C60.2. ♂, FL: Clay Co., Gold Head Branch St. Pk. (CNCI).
    C60.3. ♂, SC: Charleston Co., Cape Romain N.W.R., Bull Island.
    C60.4. ♀, FL: Highlands Co., Archbold Biol. Stn., Lake Placid (AMNH).
    C60.5. ♀ live, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.

61. *Stenodynerus lucidus*
    C61.1. ♂, ON: Rainy River Distr., Rainy Lake (CNCI).
    C61.2. ♀, QC: James Bay Rte. km 603.1, 54°43'28"N, 77°43'10"W.
    C61.3. ♂, BC: Squamish, Diamond Head Trail, 3200 ft. (CNCI).
    C61.4. ♀, ON: Manitoulin Distr., Manitoulin I., Providence Bay.

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62. *Stenodynerus oculeus*
    C62.1. ♂, IL: Piatt Co., White Heath (AMNH).
    C62.2. ♀, SC: Aiken Co., Aiken (CNCI).
    C62.3. ♂, VA: Falls Church (AMNH).
    C62.4. ♀, NC: Wake Co., Raleigh.

63. *Stenodynerus pulvinatus*
    C63.1. ♂, VA: Fairfax Co., Great Falls (AMNH).
    C63.2. ♀, VA: Falls Church (AMNH).
    C63.3. ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
    C63.4. ♀, VA: Falls Church (AMNH).

Symmorphus

64. *Symmorphus albomarginatus*
    C64.1. ♂, ID: Custer Co., Hwy 21, 25 mi W of Stanley.
    C64.2. ♀, ON: Parry Sound Distr., Killbear Prov. Pk.
    C64.3. ♂, ON: Manitoulin Distr., Manitoulin I., Sand Bay.
    C64.4. ♀, ON: Manitoulin Distr., Manitoulin I., Sand Bay.
    C64.5. ♀ live, IL: Wayne Co., Fairfield (© S. Scott, see also Bugguide).

65. *Symmorphus canadensis*
    C65.1. ♂, ON: Thunder Bay Distr., Sleeping Giant Prov. Pk., Sawyer Bay Trail.
    C65.2. ♀, ON: Wellington Co., Guelph.
    C65.3. ♂, ON: Halton Reg., Oakville nr. Hwy 25 and Burnhamthorpe Rd.
    C65.4. ♀, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
    C65.5. ♀ live, ON: locality not given.

66. *Symmorphus cristatus*
    C66.1. ♀, ON: Bruce Co., Dorcas Bay.
    C66.2. ♂, ON: Wellington Co., Ariss.
    C66.3. ♂, ON: Dufferin Co., Mono Cliffs Prov. Pk.
    C66.4. ♀, ON: Welland Co., Niagara Whirlpool.
    C66.5. ♀ live, ON: Bruce Co., Dunks Bay.

Zethus

67. *Zethus spinipes*
    C67.1. ♀, VA: Giles Co., Ripplemead.
    C67.2. ♀ (ssp. *variegatus*), NC: Gates Co., no precise locality.
    C67.3. ♀, VA: Giles Co., Ripplemead.
    C67.4–5. ♂ (ssp. *variegatus*), NC: New Hanover Co., Fort Fisher.
    C67.6. ♀, VA: Giles Co., Ripplemead.
    C67.7. ♀ live (ssp. *variegatus*), SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.

Masarinae

Pseudomasaris

68. *Pseudomasaris edwardsii*
    C68.1. ♂, CA: Inyo Co., Panamint Mts.
    C68.2. ♀, UT: Tooele Co., Loop Camp 13 mi SW Grantsville, 7400 ft.
    C68.3. ♂, CA: Inyo Co., Panamint Mts.
    C68.4. ♀, UT: Tooele Co., Loop Camp 13 mi SW Grantsville, 7400 ft.
    C68.5. ♂ live, CA: Los Angeles Co., Eaton Canyon Natural Area (© H. Wisch, see also Bugguide).

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Polistinae

Polistes

69. *Polistes annularis*
C69.1. ♀, NC: Gates Co., no precise locality.
C69.2. ♂, TN: Hamilton Co., East Ridge, [Elise] Chapin Sanctuary (CNCI).
C69.3. ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C69.4. ♀, LA: St. Tammany Parish, Pearl River Wildlife Area.
C69.5. ♂, MD: Montgomery Co., Glen Echo (ROME).
C69.6. ♀ live, FL: Alachua Co., Payne's Prairie St. Pk. (© S. McCann, see also Bugguide).

70. *Polistes aurifer*
C70.1. ♂, AB: Ralston.
C70.2. ♀, UT: Salt Lake Co., Red Butte Canyon (ROME).
C70.3. ♀, BC: Okanagan Valley, Osoyoos.
C70.4. ♂, AB: Ralston.
C70.5. ♀ live, MT: Sanders Co., Thompson Falls (© L. Schimming, see also Bugguide).

71. *Polistes bellicosus*
C71.1. ♀, MD: Anne Arundel Co., Milt's Pit 4 mi SW Davidsonville.
C71.2. ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C71.3. ♀, MD: Wicomico Co., 5 mi SE Salisbury, Bear Swamp Rd.
C71.4. ♀, MD: Anne Arundel Co., Milt's Pit 4 mi SW Davidsonville.
C71.5. ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C71.6. ♀ live, SC: Charleston Co., Cape Romain N.W.R., Bull Island.
C71.7. ♀ live, SC: Charleston Co., Cape Romain N.W.R., Bull Island.
C71.8. ♂ live, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.

72. *Polistes carolina*
C72.1. ♀, TX: Angelina Co., Angelina Natl. For. E of Zavalla, Boykin Springs.
C72.2. ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C72.3. ♀, NC: Gates Co., no precise locality.
C72.4. ♀, NC: Bladen Co., Singletary Lk.
C72.5. ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C72.6–7. ♀ live, GA: Ware Co., no precise locality (© J.N. Dell, see also left, right).

73. *Polistes dominicus*
C73.1. ♀, Barbados: Sayes Court Agricultural Stn.
C73.2. ♀, Montserrat: Plymouth.
C73.3. ♀, St. Lucia, no precise locality.

74. *Polistes dominula*
C74.1. ♀, ON: Kent Co., Wheatley Prov. Pk.
C74.2. ♂, ON: Essex Co., Ojibway Prairie.
C74.3. ♀, ON: Kent Co., Wheatley Prov. Pk.
C74.4. ♂, ON: Essex Co., Windsor, Ojibway Prairie.
C74.5. ♀, ON: Wellington Co., Guelph.
C74.6. ♂, ON: Waterloo Co., Blair.
C74.7. ♀ live, ON: Hamilton-Wentworth Reg., Copetown.
C74.8. ♀ live, ON: Wellington Co., Fergus.

75. *Polistes dorsalis*
C75.1. ♀, FL: Miami-Dade Co., Homestead.
C75.2. ♂, FL: Miami-Dade Co., Homestead.
C75.3. ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C75.4. ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C75.5. ♂, FL: Miami-Dade Co., Homestead.
C75.6. ♀ live, FL: St. Lucie Co., no precise locality (© J. Hollenbeck, see also Bugguide).
C75.7. ♀ live, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.

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C75.8. ♂ live, FL: Ft. Lauderdale Co., no precise locality (© C. Weber, see also Bugguide).

76. *Polistes exclamans*

C76.1. ♀, NC: Wake Co., Raleigh.
C76.2. ♂, ON: York Reg., Weston.
C76.3. ♀, TX: Cameron Co., Brownsville.
C76.4. ♂, ON: York Reg., Weston.
C76.5. ♀, TX: Val Verde Co., Seminole Canyon State Hist. Pk. (ROME).
C76.6. ♂, NC: Wake Co., Raleigh.
C76.7. ♀ live, MD: Worcester Co., Assateague I. (© R. Orr).
C76.8. ♀ live, TX: Travis Co., Austin (© B. Malow, see also Bugguide).

77. *Polistes fuscatus*

C77.1. ♀, ON: Simcoe Co., Midland.
C77.2. ♀, VA: Giles Co., Bald Knob, 1 km S Mountain Lake.
C77.3. ♀, DE: New Castle Co., Augustine Beach.
C77.4. ♀, ON: Halton Reg., Oakville.
C77.5. ♂, ON: Guelph.
C77.6. ♂, MD: Worcester Co., Mt. Olive Church Rd. S Colbourne.
C77.7. ♀, ON: Bruce Co., Inverhuron Prov. Pk.
C77.8. ♂, ON: Essex Co., Point Pelee.
C77.9. ♀, ON: Wellington Co., Arkell.
C77.10. ♀, ON: Essex Co., Point Pelee Natl Pk.
C77.11. ♀, NC: Gates Co., no precise locality.
C77.12. ♂, ON: Guelph.
C77.13. ♂♀ live, FL: Marion Co., Sunnyhill (© J. Hollenbeck, see also Bugguide).
C77.14. ♀ live, ON: Grey Co., Owen Sound.
C77.15. ♂ live, ON: Wellington Co., Fergus.

78. *Polistes metricus*

C78.1. ♀, FL: Highlands Co., Archbold Biol. Stn., Lake Annie.
C78.2. ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C78.3. ♀, NC: Bladen Co., Bladen St. Forest.
C78.4. ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C78.5. ♂, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C78.6. ♂♀ live, LA: Ascension Parish, no precise locality (© P. Babin, see also Bugguide).
C78.7. ♀ live, SC: Charleston Co., Cape Romain N.W.R., Bull Island.
C78.8. ♂ live, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.

79. *Polistes perplexus*

C79.1. ♀, TX: Angelina Co., Boykin Springs in Angelina Natl. For. E of Zavalla.
C79.2. ♂, KY: Rowan Co., Morehead (CNCI).
C79.3. ♀, TX: Angelina Co., Boykin Springs in Angelina Natl. For. E of Zavalla.
C79.4. ♀, AR: Logan Co., Ozark Natl. Forest, 6.6 km E Hwy 309 (ROME).
C79.5. ♂, KY: Rowan Co., Moorehead (CNCI).
C79.6. ♀ live, TX: Travis Co., Austin (© B. Grizzard, see also Bugguide).

80. *Polistes* sp. A

C80.1. ♀, IL: Champaign Co., Champaign (CNCI).
C80.2. ♂, MD: Anne Arundel Co., Milt's Pit 4 mi SW Davidsonville.
C80.3. ♀, SC: Pickens Co., Clemson (CNCI).
C80.4. ♂, MD: Anne Arundel Co., Milt's Pit 4 mi SW Davidsonville.
C80.5. ♀, IL: Champaign Co., Champaign (CNCI).
C80.6. ♂, MD: Anne Arundel Co., Milt's Pit 4 mi SW Davidsonville.
C80.7. ♀, SC: Pickens Co., Clemson (CNCI).

81. *Polistes* sp. B

C81.1. ♀, MD: Prince George's Co., Greenbelt, Beltsville Agricultural Res. Center.
C81.2. ♂, MD: Prince George's Co., Patuxent Wildlife Res. Refuge, Visitor Center.

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C81.3. ♀, MD: Prince George's Co., Greenbelt, Beltsville Agricultural Res. Center.
C81.4. ♂, MD: Prince George's Co., Largo, Hwy 214 & Church Rd.
C81.5. ♀, MD: Prince George's Co., Greenbelt, Beltsville Agricultural Res. Center.
C81.6. ♂, MD: Prince George's Co., Patuxent Wildlife Res. Refuge, Visitor Center.

Vespinae

Dolichovespula

82. *Dolichovespula adulterina*

C82.1. ♀, VA: Giles Co., Bald Knob.
C82.2. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
C82.3. ♀, VA: Giles Co., Bald Knob.
C82.4. ♂, ON: Carleton Reg., Richmond fen.
C82.5. ♀, VA: Giles Co., Bald Knob.
C82.6. ♂, ON: Carleton Reg., Richmond fen.
C82.7. ♀, VA: Giles Co., Bald Knob.
C82.8. ♂, ON: Waterloo Reg., Erbsville.
C82.9. ♂, ON: Nipissing Distr. or Haliburton Co., Algonquin Prov. Pk., Old Railway Bike Trail, S trail head.
C82.10. ♂ live, ON: locality not given.

83. *Dolichovespula arenaria*

C83.1. Worker, ON: Halton Reg., Oakville.
C83.2. ♀, ON: Manitoulin Distr., Manitoulin I., Carter Bay Dunes.
C83.3. ♂, ON: Grey Co., Hepworth, Grey Sauble Authority forests.
C83.4. Worker, ON: Manitoulin Distr., Manitoulin I., Sand Bay.
C83.5. ♀, ON: Wellington Co., Arthur.
C83.6. ♂, ON: Grey Co., Hepworth, Grey Sauble Authority Forests.
C83.7. Worker, ON: Kent Co., Rondeau Prov. Pk.
C83.8. ♀, VA: Montgomery Co., Poverty Creek Trail.
C83.9. ♂, ON: Haldimand-Norfolk Reg., Turkey Point.
C83.10. Nest, ON: Wellington Co., Fergus.
C83.11. Worker live, ON: Bruce Co., Dunks Bay.

84. *Dolichovespula maculata*

C84.1. Worker, ON: Waterloo Reg., Cambridge, Sudden Tract.
C84.2. ♀, ON: Essex Co., Windsor.
C84.3. ♂, ON: Lambton Co., Sarnia, Clearwater Nature Trail.
C84.4. Worker, ON: Hastings Co., Purdy.
C84.5. ♀, ON: Algoma Distr., Thessalon.
C84.6. ♂, ON: Manitoulin Distr., Killarney Prov. Pk.
C84.7. Worker, ON: Wellington Co., Wylde Lk. Bog 8 km E. Arthur.
C84.8. ♀, ON: Bruce Co., Inverhuron Prov. Pk.
C84.9. ♂, ON: Wellington Co., Guelph.
C84.10. Workers live, ON: Lambton Co., Pinery Prov. Pk.
C84.11. Nest, ON: Wellington Co., Fergus.

85. *Dolichovespula norvegicoides*

C85.1. Worker, ON: Nipissing Distr., Algonquin Prov. Pk., Arowhon Rd.
C85.2. ♀, ON: Thunder Bay Distr., Neys Prov. Pk.
C85.3. ♂, ON: Nipissing Distr., Algonquin Prov. Pk., Lake Travers Rd.
C85.4. Worker, ON: Sudbury Distr., Chapleau, Racine Lk.
C85.5. ♀, ON: Sudbury Distr., Chapleau, Racine Lk.
C85.6. ♂, ON: Bruce Co., Tobermory, Dunks Bay.
C85.7. Worker, ON: Nipissing Distr., Algonquin Prov. Pk., Arowhon Rd.
C85.8. ♀, ON: Sudbury Distr., Chapleau, Racine Lk., Lowbush.
C85.9. ♂, ON: Muskoka Distr., Dwight.

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C85.10. Worker live, ON: Bruce Co., Dunks Bay.

86. *Dolichovespula norwegica*

C86.1. Worker, YT: Dempster Hwy km 466.
C86.2. ♀, YK: Richardson Mts, 5 km SSW Mount Hare, 800 m.
C86.3. ♂, YT: Dempster Hwy km 450, 67°0'N 136°12'W (ROME).
C86.4. Worker, YT: Dempster Hwy km 466.
C86.5. ♀, YT: Klondike Hwy at McCabe Cr., 62°32'N 136°46'W (ROME).
C86.6. ♂, YT: Dempster Hwy km 450, 67°0'N 136°12'W (ROME).
C86.7. Worker, YT: "Erebia Ck.", 67°58'N, 136°29'W.
C86.8. ♀, YT: Dempster Hwy. km 72 at Tombstone Campground, North Klondike R., 63°31'N 138°13'W (ROME).
C86.9. ♂, YT: Dempster, Hwy. km 450; 67°00'N 36°12'W (ROME).

Vespa

87. *Vespa crabro*

C87.1. Worker, ON: Haldimand-Norfolk Reg., 4 km S of Canfield.
C87.2. ♀, VA: Montgomery Co., Pandapas Pond.
C87.3. ♂, ON: Haldimand-Norfolk Reg., Canfield.
C87.4. Worker, ON: Frontenac Co., Sharbot Lake.
C87.5. ♀, VA: Montgomery Co., Pandapas Pond.
C87.6. ♂, NY: Tompkins Co., Ithaca.
C87.7. Worker, ON: Haldimand-Norfolk Reg., 4 km S of Canfield.
C87.8. ♀, VA: Montgomery Co., Pandapas Pond.
C87.9. ♂, NY: Tompkins Co., Ithaca.
C87.10. ♀ live, VA: Montgomery Co., Pandapas Pond.

Vespula

88. *Vespula acadica*

C88.1. Worker, ON: Bruce Co., Inverhuron Prov. Pk.
C88.2. ♀, ON: Bruce Co., Dorcas Bay.
C88.3. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
C88.4. Worker, ON: Sudbury Distr., Chapleau, Racine Lk.
C88.5. ♀, ON: Kenora Distr., Ignace.
C88.6. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
C88.7. Worker, ON: Manitoulin Distr., Manitoulin I., Square Bay.
C88.8. ♀, ON: Dufferin Co., Primrose.
C88.9. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
C88.10. Worker, ON: Sudbury Distr., Chapleau, Racine Lk.
C88.11. Worker, PA: Clearfield Co., Lanse, 1600 ft.
C88.12. Worker, ON: Bruce Co., Dorcas Bay.
C88.13. Worker live, MA: Worcester Co., Petersham (© T. Murray, see also Bugguide).

89. *Vespula austriaca*

C89.1. ♀, ON: Thunder Bay Distr., Sleeping Giant Prov. Pk., Sifting Lk. Trail.
C89.2. ♂, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
C89.3. ♀, ON: Thunder Bay Distr., Sleeping Giant Prov. Pk., Sifting Lk. Trail.
C89.4. ♂, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
C89.5. ♀, ON: Thunder Bay Distr., Sleeping Giant Prov. Pk., Sifting Lk. Trail.
C89.6. ♂, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.

90. *Vespula consobrina*

C90.1. Worker, ON: Manitoulin Distr., Manitoulin I., Portage Bay.
C90.2. ♀, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
C90.3. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
C90.4. Worker, ON: Manitoulin Distr., Manitoulin I., Portage Bay.

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C90.5. ♀, ON: Sudbury Distr., Chapleau, Racine Lk.
C90.6. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
C90.7. Worker, ON: Manitoulin Distr., Manitoulin I., Portage Bay.
C90.8. ♀, ON: Manitoulin Distr., Manitoulin I., Carter Bay.
C90.9. ♂, ON: Bruce Co., Inverhuron Prov. Pk.
C90.10. Worker live, ON: Bruce Co., Dunks Bay.

91. *Vespula flavopilosa*

C91.1. Worker, ON: Wellington Co., Guelph.
C91.2. ♀, ON: Hamilton-Wentworth Reg., Dundas.
C91.3. ♂, ON: Wellington Co., Guelph.
C91.4. Worker, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
C91.5. ♀, VA: Montgomery Co., Pandapas Pond.
C91.6. ♂, ON: Wellington Co., Guelph.
C91.7. Worker, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
C91.8. ♀, ON: Haldimand-Norfolk Reg., Turkey Point.
C91.9. ♂, ON: Haldimand-Norfolk Reg., St. Williams Forestry Stn.
C91.10. Worker, ON: Wellington Co., Guelph.
C91.11. Worker, ON: Wellington Co., Guelph.
C91.12. Worker, ON: County/District unknown, Gold Lake.
C91.13. Worker, ON: Halton Reg., Oakville.
C91.14. Worker live, ON: Bruce Co., Dunks Bay.

92. *Vespula germanica*

C92.1. Worker, ON: Brant Co., Brantford Railway Prairie.
C92.2. ♀, ON: Essex Co., Windsor, Ojibway Prairie.
C92.3. ♂, ON: Wellington Co., Guelph.
C92.4. Worker, ON: Wellington Co., Guelph.
C92.5. ♀, ON: Haldimand-Norfolk Reg., Manestar Tract.
C92.6. ♂, ON: Wellington Co., Guelph.
C92.7. Worker, ON: Wellington Co., Guelph.
C92.8. ♀, ON: Elgin Co., St. Thomas.
C92.9. ♂, ON: Wellington Co., Guelph.
C92.10. Worker, ON: Peel Reg., Mississauga, Erindale Park.
C92.11. Worker, ON: Waterloo Reg., Kitchener, Doon Heritage Crossroads.
C92.12. Worker, ON: Wellington Co., Guelph.
C92.13. Worker, ON: Wellington Co., Guelph.
C92.14. ♀ live, ON: Wellington Co., Fergus.

93. *Vespula maculifrons*

C93.1. Worker, ON: Bruce Co., Inverhuron Prov. Pk.
C93.2. ♀, ON: Lambton Co., Port Franks, Watson Property nr. L-lake.
C93.3. ♂, ON: Wellington Co., Guelph.
C93.4. Worker, ON: Wellington Co., Guelph.
C93.5. ♀, ON: Haldimand-Norfolk Reg., Manestar Tract.
C93.6. ♂, ON: Haldimand-Norfolk Reg., Manestar Tract.
C93.7. Worker, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
C93.8. ♀, ON: Haldimand-Norfolk Reg., Manestar Tract.
C93.9. ♂, ON: Haldimand-Norfolk Reg., Manestar Tract.
C93.10. Worker, NC: Wake Co., Raleigh.
C93.11. Worker, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
C93.12. Worker, ON: Wellington Co., Guelph.
C93.13. Worker, ON: Wellington Co., Fergus.
C93.14. ♂, ON: Waterloo Reg., Blair.
C93.15. ♂, NC: Wake Co., Raleigh.
C93.16. ♂, ON: Hamilton-Wentworth Reg., Flamborough.
C93.17. ♂, ON: Haldimand-Norfolk Reg., Manestar Tract.

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C93.18. Workers live, ON: Wellington Co., Fergus.

94. *Vespula pensylvanica*

C94.1. Worker, CA: Marin Co., Marin City.
C94.2. ♀, CA: Alpine Co., Hope Valley.
C94.3. ♂, BC: Vancouver.
C94.4. Worker, CA: Marin Co., Marin City.
C94.5. ♀, CA: Alpine Co., Hope Valley.
C94.6. ♂, BC: Vancouver.
C94.7. Worker, CA: Marin Co., Marin City.
C94.8. ♀, CA: Alpine Co., Hope Valley.
C94.9. ♂, BC: Vancouver.
C94.10. Worker live, AZ: Pima Co., Mt. Lemmon.

95. *Vespula rufa*

C95.1. Worker, MB: Churchill, Ramsay Creek, 58.7307°N 93.7796°W.
C95.2. ♂, MB: Churchill, Ramsay Creek, 58.7307°N 93.7796°W.
C95.3. Worker, MB, Churchill, 58°22'14"N, 93°29'40"W.
C95.4. ♀, YT: Klondike Hwy at McCabe Creek, 62°32'N 136°46'W (ROME).
C95.5. ♂, MB: Churchill, 58.3706°N 93.4944°W.
C95.6. Worker, MB, Churchill, 58.3706°N 93.4944°W.
C95.7. Worker, MB, Churchill, 58.3706°N 93.4944°W.
C95.8. Worker, MB: Churchill, 58.3706°N 93.4944°W.
C95.9. ♂, MB: Churchill, 58.3706°N 93.4944°W.

96. *Vespula squamosa*

C96.1. Worker, FL: Marion Co., Silver Springs Woods, Ocala Natl. For.
C96.2. ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C96.3. ♂, FL: Sarasota Co., 10 km E Sarasota.
C96.4. Worker, NC: Wake Co., Raleigh.
C96.5. ♀, MS: Scott Co., Forest, Harrell Hill Prairie.
C96.6. ♂, FL: Sarasota Co., 10 km E Sarasota.
C96.7. Worker, FL: Pasco Co., Withlacoochee St. For., Croom Reserve.
C96.8. ♀, SC: Georgetown Co., Hobcaw Barony, Belle Baruch Marine Field Lab.
C96.9. ♂, FL: Sarasota Co., 10 km E Sarasota.
C96.10. ♂ live, FL: Sarasota Co., Myakka River St. Pk.

97. *Vespula vidua*

C97.1. Worker, ON: Wellington Co., Guelph.
C97.2. ♀, VA: Giles Co., Cascades Rec. Area.
C97.3. ♂, ON: Hamilton-Wentworth Reg., Flamborough.
C97.4. Worker, ON: Haldimand-Norfolk Reg., Turkey Point Prov. Pk.
C97.5. ♀, ON: Haldimand-Norfolk Reg., Manestar Tract.
C97.6. ♂, ON: Kent Co., Rondeau Prov. Pk.
C97.7. Worker, ON: Northumberland Co., Murray Hills.
C97.8. ♀, ON: Lambton Co., Port Franks, Watson Property Near L-lake.
C97.9. ♂, ON: Hamilton-Wentworth Reg., Flamborough.
C97.10. ♂ live, ON: Wellington Co., Rockwood.

98. *Vespula vulgaris*

C98.1. Worker, ON: Wellington Co., Guelph.
C98.2. ♀, ON: Sudbury or Algoma Distr., 60 km N Espanola.
C98.3. ♂, ON: Wellington Co., Guelph.
C98.4. Worker, ON: Wellington Co., Guelph.
C98.5. ♀, ON: Dufferin Co., Mono Cliffs Prov. Pk.
C98.6. ♂, ON: Wellington Co., Guelph.
C98.7. Worker, ON: Bruce Co., Inverhuron Prov. Pk.
C98.8. ♀, ON: Sudbury or Algoma Distr., 60 km N Espanola.

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C98.9. ♂, ON: Halton Reg., Georgetown.
C98.10. Worker, ON: Wellington Co., Guelph.
C98.11. Worker, ON: Grey Co., Owen Sound.
C98.12. Worker, ON: Dufferin Co., Primrose.
C98.13. Worker, ON: Wellington Co., Guelph.
C98.14. Worker live, ON: Bruce Co., Dunks Bay.

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