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Key to the species of *Megarhyssa* (Hymenoptera, Ichneumonidae, Rhyssinae) in America, north of Mexico

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Abstract

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A dichotomous and an interactive key to the species of *Megarhyssa* (Hymenoptera: Ichneumonidae) in America, north of Mexico are presented. A diagnosis accompanied by images is provided for male and female wasps of each of the four species, *Megarhyssa atrata*, *Megarhyssa greenei*, *Megarhyssa macrurus* and *Megarhyssa nortoni*.

Key Words

parasitoid

identification

giant ichneumon fly

Introduction

The subfamily Rhyssinae Morley, of the ‘pimpliformes’ Ichneumonidae (Order: Hymenoptera), is found worldwide and comprises 234 described species in eight genera (Yu et al. 2012). Though hypothesized to have originated in the northern hemisphere (Wahl and Gauld 1998), the diversity of this subfamily is heavily biased to the tropics with nearly half of the species belonging to the circumtropical genus, *Epirhyssa* Cresson, 1865 (Yu et al. 2012). Rhyssinae are generally large in size and some of the most impressive specimens occur in the cosmopolitan genus *Megarhyssa* Ashmead (Hymenoptera: Ichneumonidae: Rhyssinae). The majority of the 37 described species in this genus occur in the Oriental region and the Eastern Palearctic. A handful of species occur in each of the following regions: Western Palearctic, Nearctic and Australasian; with one record for both the Neotropical (Chiapas) and Afrotropical regions (Yu et al. 2012).

Though only four species of *Megarhyssa* occur in the Nearctic (Yu et al. 2012), they are a common sight in the forests of the United States and Canada. Members of this genus are ectoparasitoid idiobionts of wood-boring siricid larvae (Townes 1969) and one species, *M. nortoni* (Cresson), is an effective biocontrol agent employed by the National *Sirex* Coordination Committee to control the invasive woodwasp, *Sirex noctilio* Fabricius (Hymenoptera: Siricidae). Characteristics such as their bright coloration and large size place these spectacular insects among the ‘charismatic megafauna’ of the arthropod world, often capturing the attention of hobbyists and nature enthusiasts. Given the frequency with which non-specialists encounter and work with species of *Megarhyssa*, image-rich dichotomous and interactive keys will increase the accuracy of identifications.

The four species of *Megarhyssa* found in the United States and Canada are broadly distributed across the region (Townes and Townes 1960; Carlson 1979). The only species native to more southern regions is *Megarhyss-*

sa macrurus (Linnaeus) which is also found in Mexico (Townes and Townes 1960). In addition, *Megarhyssa nortoni* now occurs in Australia, New Zealand and South Africa where it was introduced as a biological control agent (Taylor 1976; Bartlett et al. 1978; Taylor 1978; Haugen and Underdown 1990; Tribe and Cillié 2004; Hurley et al. 2007). Siricid wood wasps native to north America are the common hosts of each of the four species (Beaulne 1939; Carlson 1979; Champlain 1922; Heatwole and Davis 1965; Hopkins 1893; Nénon 1995; Stillwell 1967; Townes 1944; Townes and Townes 1960; Treherne 1916) with *M. nortoni* also parasitizing the invasive wood wasp, *Sirex noctilio* (Carlson 1979; Nuttall 1980; Valentine and Walker 1991; Vincent and King 1995).

A key to the genera of Nearctic Rhyssinae, illustrated with high quality color images, is available online at <http://www.amentinst.org/GIN/Rhyssinae>. Here, we present a key to the four Nearctic species, designed for use by non-specialists. We have adopted some characters

from previous keys (Merill 1915; Townes and Townes 1960) in addition to creating our own when necessary. This key will be linked to the website of the American Entomological Institute where it will complement its generic key. It will also be advertised on the popular website www.bugguide.net to promote its use by the general public.

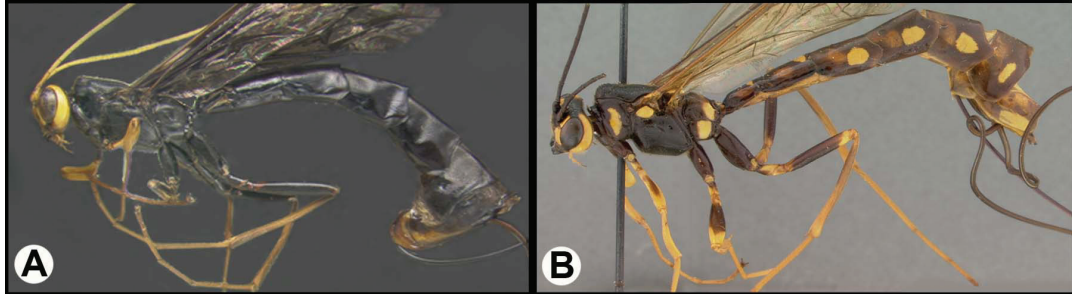
Materials and methods

Type specimens for each species were checked for the diagnostic morphological characters assigned by Merrill (1915) and Townes and Townes (1960). A broad range of specimens from the hundreds of *Megarhyssa* housed in the Kentucky and American Entomological Institute collections were examined. Characters included in the keys were chosen based on the ease with which they could be assessed by a non-specialist.

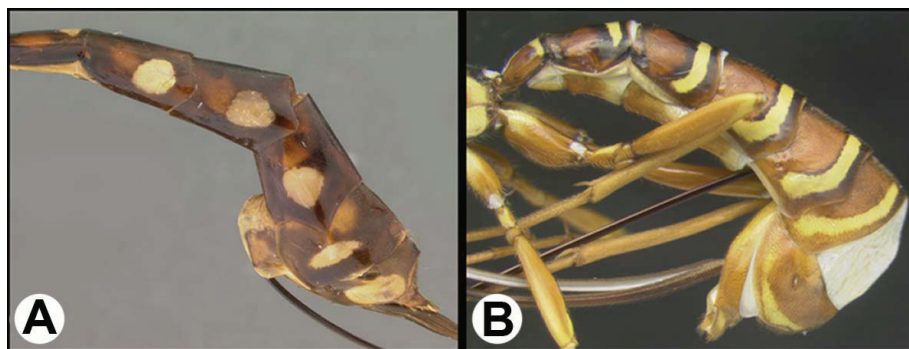
Key to species

Females.

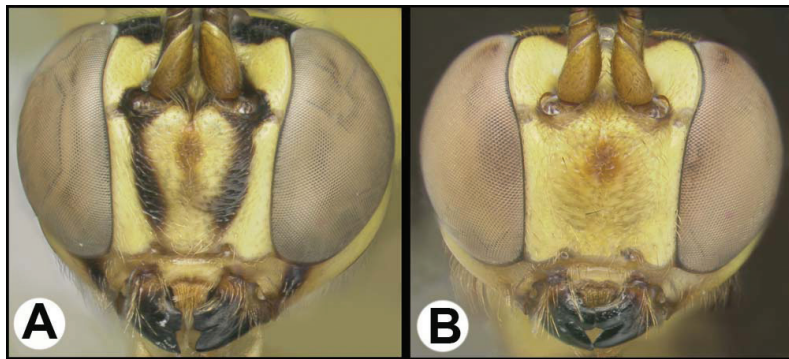
- 1 A. Metasoma melanic (blackish-brown) and lacking yellow markings; ovipositor sheath about 3.7 times as long as fore wing.....*M. atrata* (Fabricius)
- B. Metasoma ranging from brown to reddish-brown with conspicuous bright yellow markings; ovipositor sheath 1.8 to 3 times as long as fore wing..... 2



- 2 A. Well-defined, yellow, roundish spot on each of tergites 4-6..... *M. nortoni* (Cresson)
- B. Angled yellow bands on each of tergites 4-6..... 3

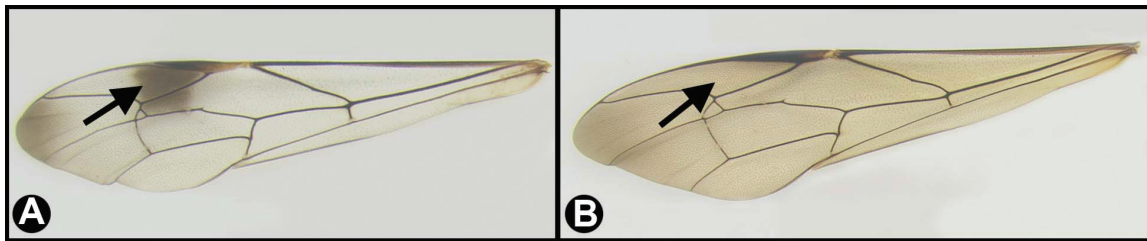


- 3 A. Vertical black stripe on face below each antennal socket; ovipositor sheath about 3 times as long as fore wing
- *M. macrurus* (Linnaeus)
- B. Vertical stripes on face absent; ovipositor sheath about 1.8 times as long as fore wing
- *M. greenei* Viereck

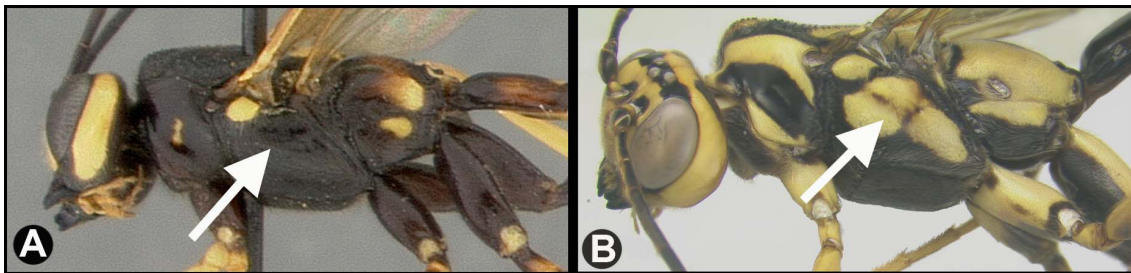


Males.

- 1 A. Fore wing marked with brown patch at base of cell 2R1
- *M. macrurus* (Linnaeus)
- B. Fore wing lacking brown patch at base of cell 2R1
- 2



- 2 A. Mesopleuron blackish brown with yellow spot below wing insertion, no additional yellow markings.....
- *M. nortoni* (Cresson)
- B. Mesopleuron ranging from blackish brown to reddish-brown, yellow spot below wing insertion and additional yellow markings.....
- 3



- 3 A. Mesosoma color reddish-brown and yellow
- *M. greenei* Viereck
- B. Mesosoma color blackish-brown and yellow.....
- *M. atrata* (Fabricius)



Taxonomy

Modified from Merrill 1915; Townes and Townes 1960.

Megarhyssa Ashmead, 1900

Characters diagnostic of *Megarhyssa* include the presence of a petiolate triangular areolet on the fore wing, a longitudinal ridge on the trochantellus of the middle leg and lateral tubercles on the apical margin of the clypeus. In addition, tergites 3–5 of female *Megarhyssa* are smooth to punctate and sternites 2–6 possess a pair of tubercles close to the anterior sternal margin. Male *Megarhyssa* have a strong setiferous groove which is close to and paralleling the apical 0.7 of the ventral interior margin; and tergites 3–6 are strongly concave apically and possess a median apical or subapical longitudinal submembranous area. These male specific characters are not well developed in small specimens and they may key to the genus *Rhyssella* (Townes & Townes, 1960).

Megarhyssa atrata (Fabricius)

Figs 1–2

Ichneumon atratus Fabricius, 1781. Species Insectorum, v. 1, p. 436.

Ichneumon tenebrator Thunberg, 1822; 1824. Acad. Imp. des Sci. St. Petersburg, Mem.8: 266; 9: 322. Unnecessarily proposed n. name for *atratus* Fabricius.

Rhyssa laevigata Brullé, 1846. In Lepeletier, Hist. Nat. Ins. Hym., v. 4, p. 78.

Megarhyssa atrata lineata Porter, 1957. Ent. News 68: 206. Synonymized by Carlson (1979)

Geographic range. Eastern Nearctic to about longitude 100 °W (Townes and Townes 1960).

Hosts. *Tremex columba* (Hopkins 1893; Treherne 1916; Beaulne 1939; Townes 1944; Nénon 1995).

Distinguishing characters. Female: Head and antenna mostly yellow, may or may not have a dark spot above the clypeus. Mesosoma and metasoma black. Mesosoma

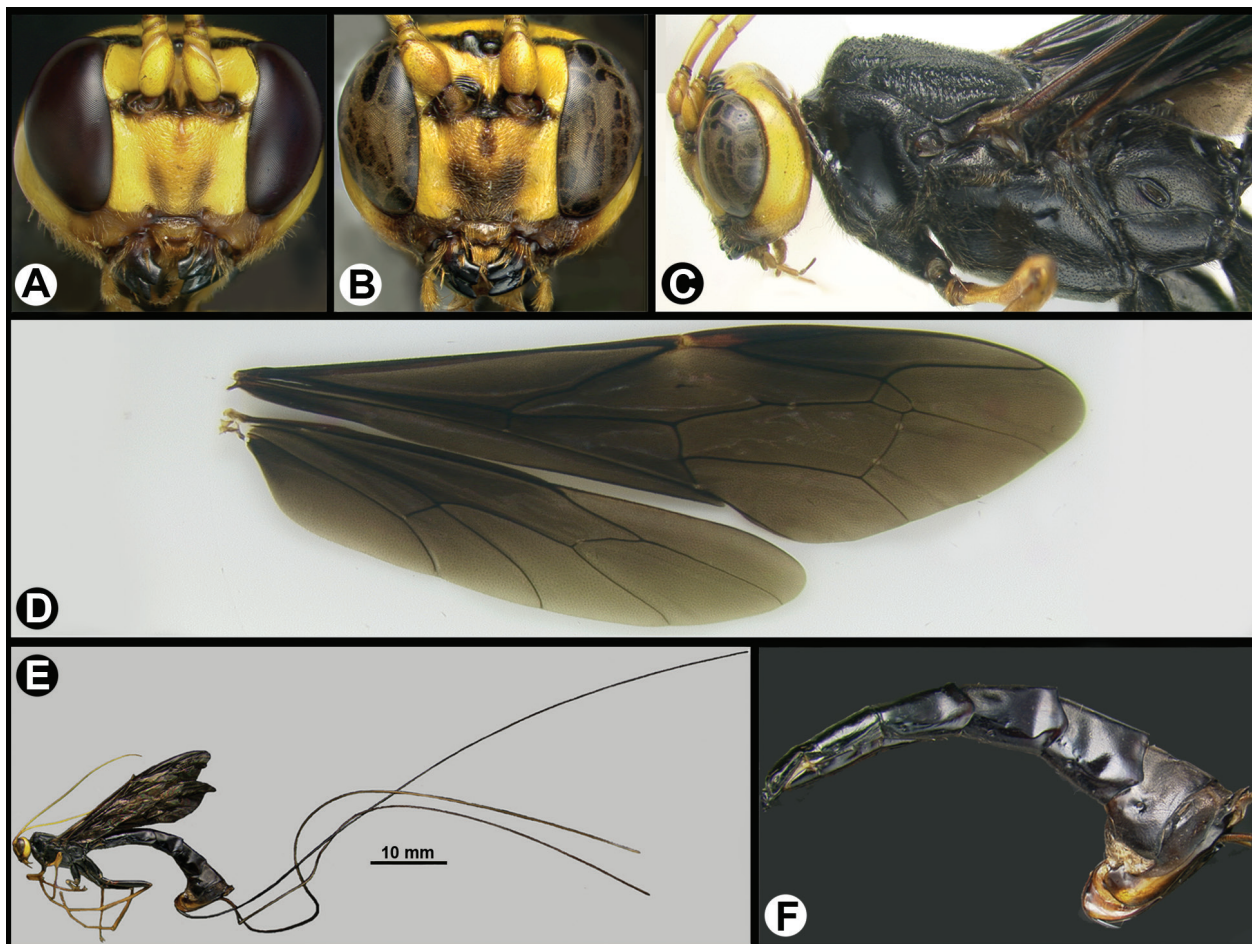


Figure 1. *Megarhyssa atrata* female. A. Anterior head; B. Anterior head showing color variation; C. Lateral head and mesosoma; D. Wings; E. Lateral habitus; F. Lateral metasoma.

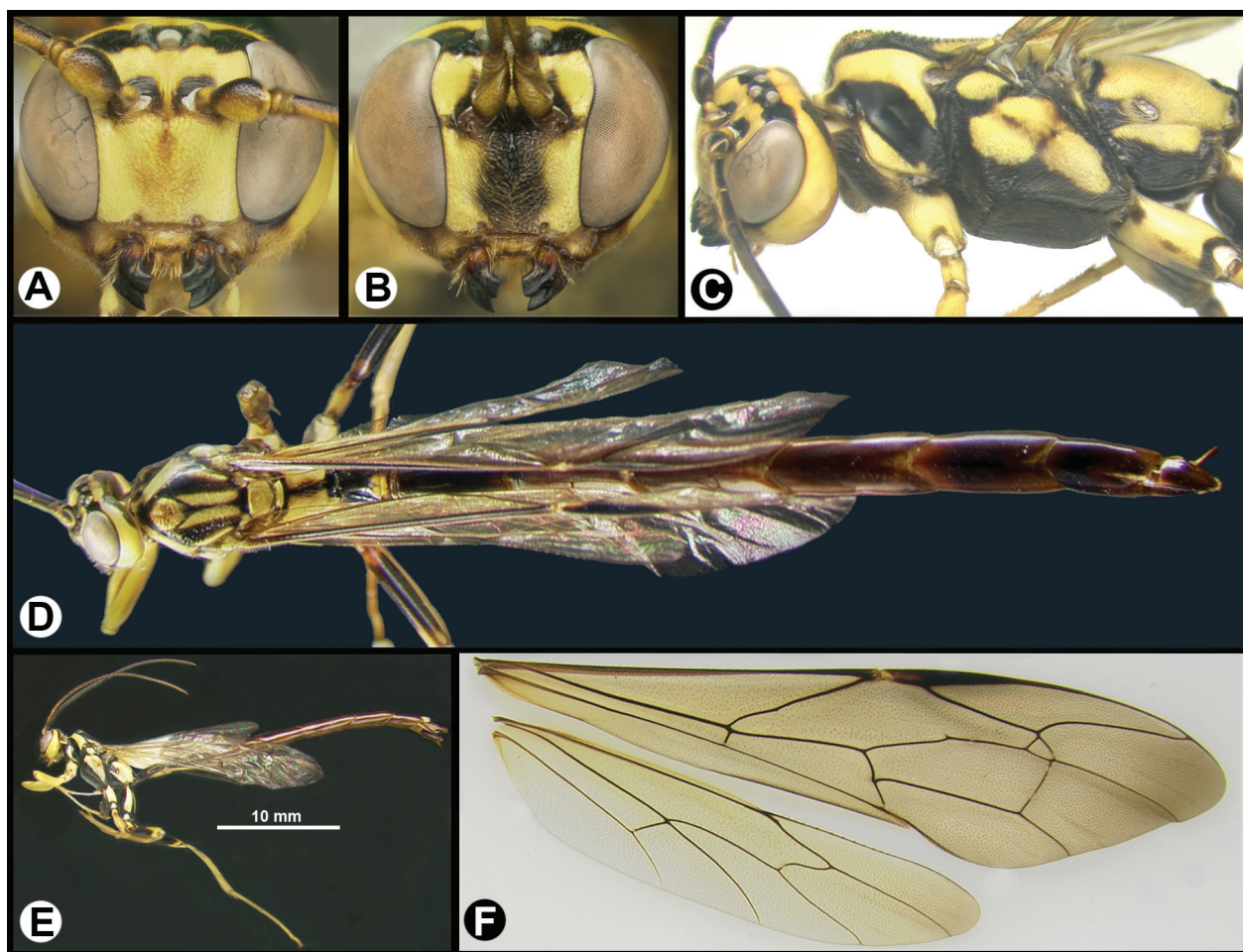


Figure 2. *Megarhyssa atrata* male. **A.** Anterior head; **B.** Anterior head showing color variation; **C.** Lateral head and mesosoma; **D.** Dorsal habitus; **E.** Lateral habitus; **F.** Wings.

sometimes with a small yellow spot on posterodorsal corner of pronotum, rarely with yellow markings. Fore wing 15 to 30 mm long; wings infuscate or entirely black. Ovipositor sheath about 3.7 times as long as forewing.

Females may be distinguished from the other species occurring in the USA and Canada by their body color.

Male. Head yellow, may or may not have a dark spot above the clypeus. Mesosoma yellow and blackish brown; metasoma very dark brown to black with a yellow mark on the hind margin of the first tergite; wings hyaline, fore wing 16 to 22 mm long.

Males may be distinguished from *M. macrurus* by the evenly darkened fore wing and the lack of a brown patch at the base of cell 2R1; from *M. nortoni* by the additional yellow markings on the mesopleuron; and from *M. greenei* by the color of the mesosoma.

Megarhyssa greenei Viereck, 1911

Figs 3–4

Megarhyssa greenei Viereck, 1910. In Smith, N. J. State Mus., Ann. Rpt. for 1909, p. 627. Nomen nudum.

Megarhyssa greenei Viereck, 1911. U. S. Natl. Mus., Proc. 40: 191.

Megarhyssa greenei floridana Townes, 1960. U. S. Natl. Mus. Bul. 216 (pt. 2): 424. Synonymized by Carlson (1979).

Geographic range. Most specimens are found in the eastern Nearctic to about longitude 96 °W, with some found as far west as Wyoming (Townes and Townes 1960).

Hosts. *Tremex columba* (Townes 1944; Townes and Townes 1960; Heatwole and Davis 1965; Stillwell 1967).

Diagnosis. Female: Head mostly yellow; mesosoma reddish-brown and yellow. Metasoma reddish-brown, each tergite with an angled yellow band; bands on the third and following tergites interrupted on the midline. Fore wing 12 to 27 mm long. Wings hyaline and the fore wing usually with a large brown patch at the base of cell 2R1. Ovipositor sheath about 1.8 times as long as fore wing.

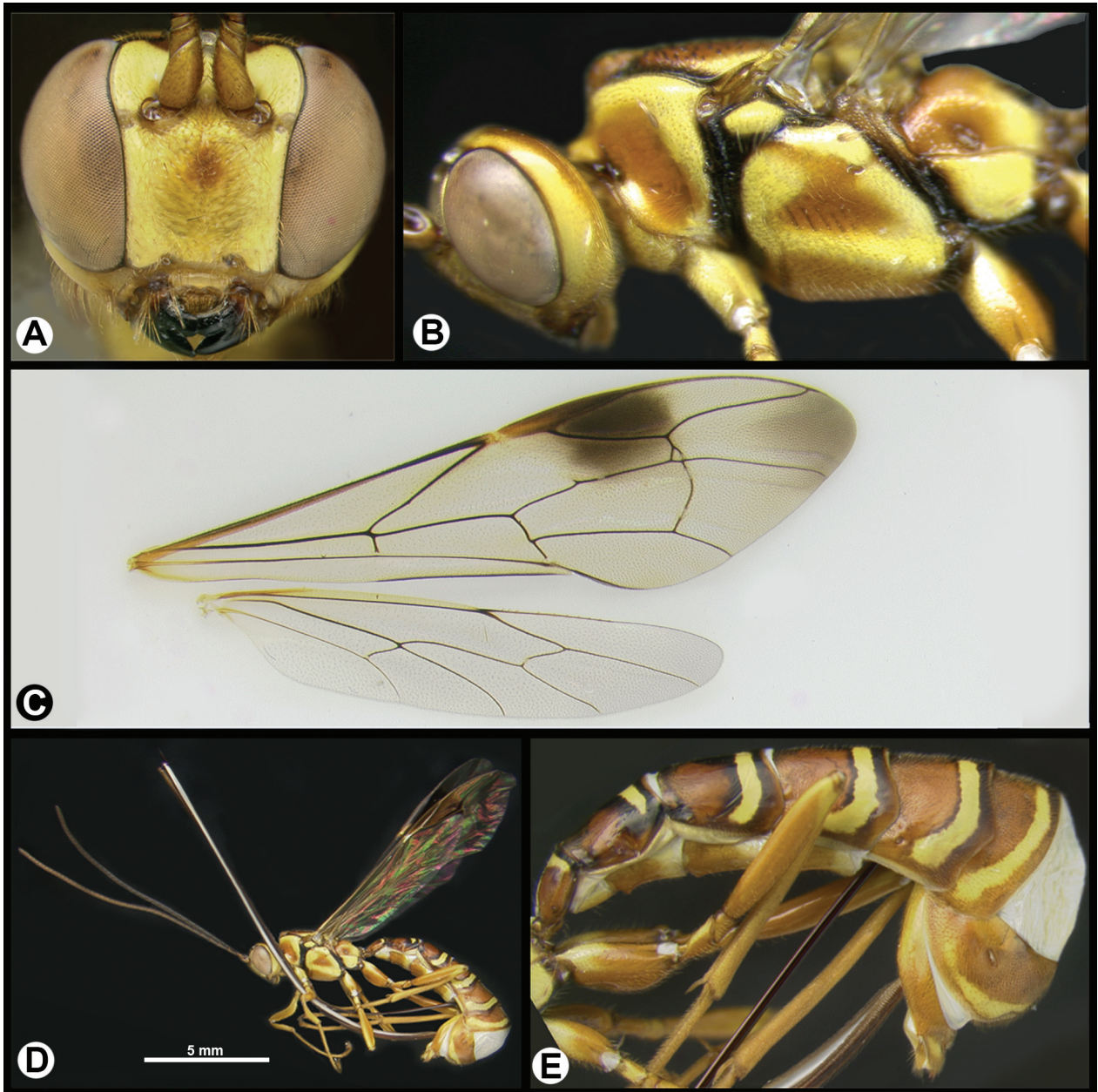


Figure 3. *Megarhyssa greenei* female. **A.** Anterior head; **B.** Lateral head and mesosoma; **C.** Wings; **D.** Lateral habitus; **E.** Lateral metasoma.

Females can be distinguished from *M. atrata* by their reddish-brown and yellow body color; from *M. nortoni* by the angled yellow bands on their metasoma; and from *M. macrurus* by the lack of vertical stripes on the face.

Male: Head mostly yellow; mesosoma reddish-brown and yellow; metasoma reddish-brown with yellow and

black markings on first two or three tergites. Wings hyaline; fore wing 10 to 16 mm long.

Males can be distinguished from *M. atrata* by their mesosoma color; from *M. nortoni* and *M. macrurus* by the lack of vertical stripes on the face.

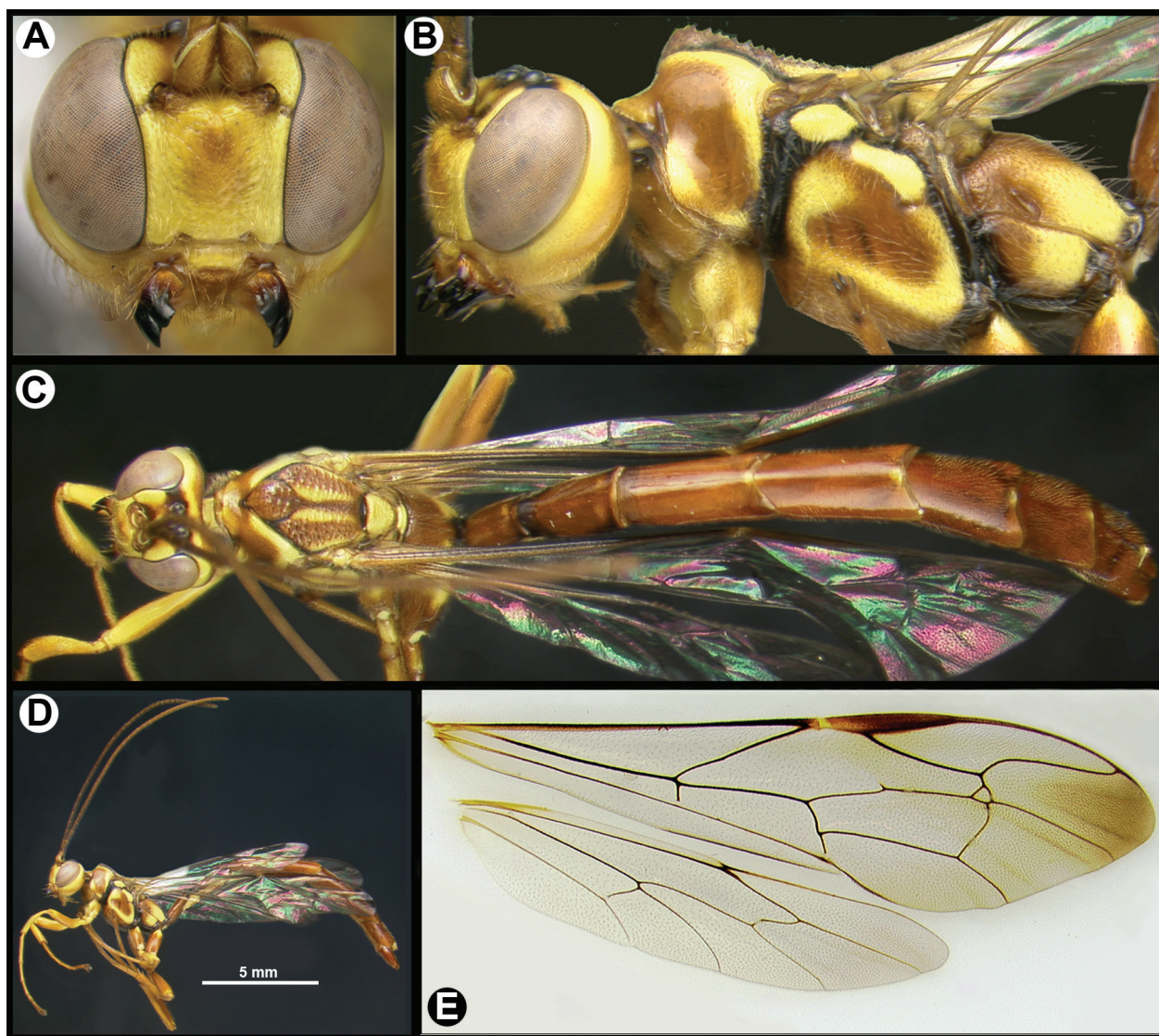


Figure 4. *Megarhyssa greenei* male. **A.** Anterior head; **B.** Lateral head and mesosoma; **C.** Dorsal habitus; **D.** Lateral habitus; **E.** Wings.

Megarhyssa macrurus (Linnaeus, 1771)

Figs 5–6

There are three subspecies:

Megarhyssa macrurus icterosticta Michener

Megarhyssa lunator icterosticta Michener, 1939. Pan-Pacific Ent. 15: 130.

Megarhyssa macrurus lunator (Fabricius)

Ichneumon lunator Fabricius, 1781. Species Insectorum, v. 1, p. 430.

Thalessa? histrio Kriechbaumer, 1890. Wien, Mus. der Naturgesch., Ann. 5: 487. Preocc. in *Megarhyssa* by *Ichneumon histrio* Christ, 1791.

Megarhyssa macrurus macrurus (Linnaeus)

Ichneumon macrurus Linnaeus, 1771. Mantissa Plantarum, v. 2, p. 540.

Ichneumon georgicus Megerle, 1803. Appendix ad Cat. Ins., Quae Mense Novembris 1802 Vienne Austriae Auctionis Lege Vendita Fuere, p. 16.

Megarhyssa lunatrix Schulz, 1906. Spolia Hym., p. 115. Emendation.

Megarhyssa lunator phaeoptila Michener, 1939. Pan-Pacific Ent. 15: 129.

Note. The specific epithet *macrura* is commonly applied to this species, however the name *macrurus* was interpreted by Townes (1944) and Townes and Townes (1960) as a noun and therefore is not required to match the gender of the genus name.

Geographic range. *M. macrurus icterosticta* is found in Arizona, Colorado, New Mexico, and Utah. *M. macrurus lunator* ranges across the eastern Nearctic to the

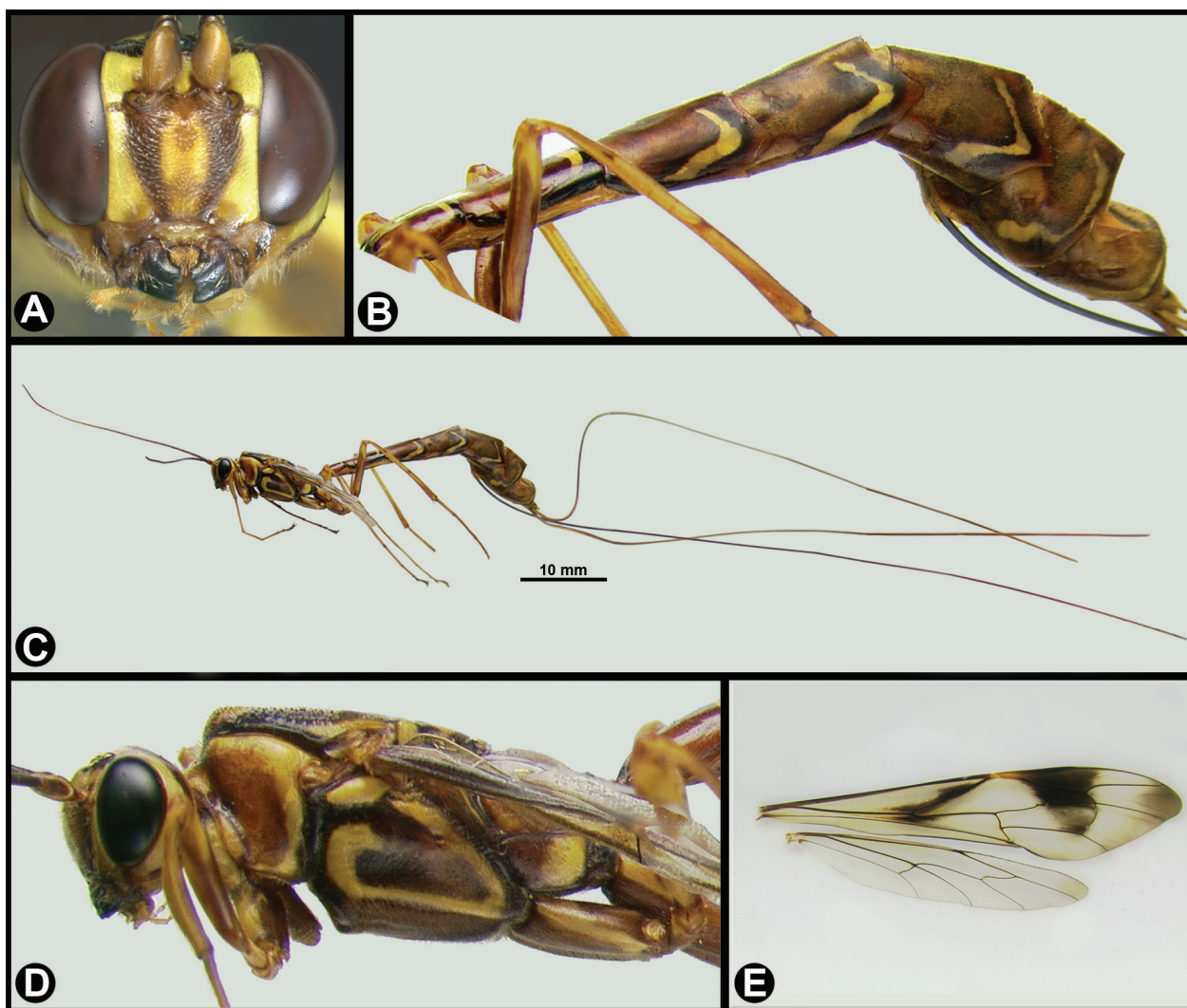


Figure 5. *Megarhyssa macrurus* female. **A.** Anterior head; **B.** Lateral metasoma; **C.** Lateral habitus; **D.** Lateral head and mesosoma; **E.** Wings.

eastern slopes of the Rocky Mountains. *M. macrurus macrurus* extends from Florida to south-western Texas, and has been collected in Mexico (Chihuahua).

Hosts. *Tremex columba* (Carlson, 1979).

Diagnosis. Female. Head yellow and dark brown, with two vertical stripes on face, one below each antennal socket. Mesosoma and metasoma ranging from dark brown to reddish-brown and yellow. Each tergite with an angled yellow band interrupted on the third to sixth tergites. Wings hyaline with brown patches; fore wing 18 to 29 mm long. Ovipositor sheath about 3.0 times as long as fore wing.

Females can be distinguished from *M. atrata* by their body color; from *M. nortoni* by the angled yellow bands

on the tergites; and from *M. greenei* by the vertical stripes on the face.

It should be noted that Carlson (1979) did not separate *M. macrurus lunator* from *M. macrurus macrurus*.

Male. Head yellow and dark brown, with two vertical stripes on face, one below each antennal socket. Mesosoma yellow and blackish brown, metasoma brown, first and second tergites with a short yellow band on hind margin. Wings hyaline, fore wing 7 to 21 mm long with a brown patch at the base of cell 2R1.

Males can be distinguished from the other species occurring in the USA and Canada by the brown patch at the base of cell 2R1 of the fore wing and the presence of two vertical stripes on the face.

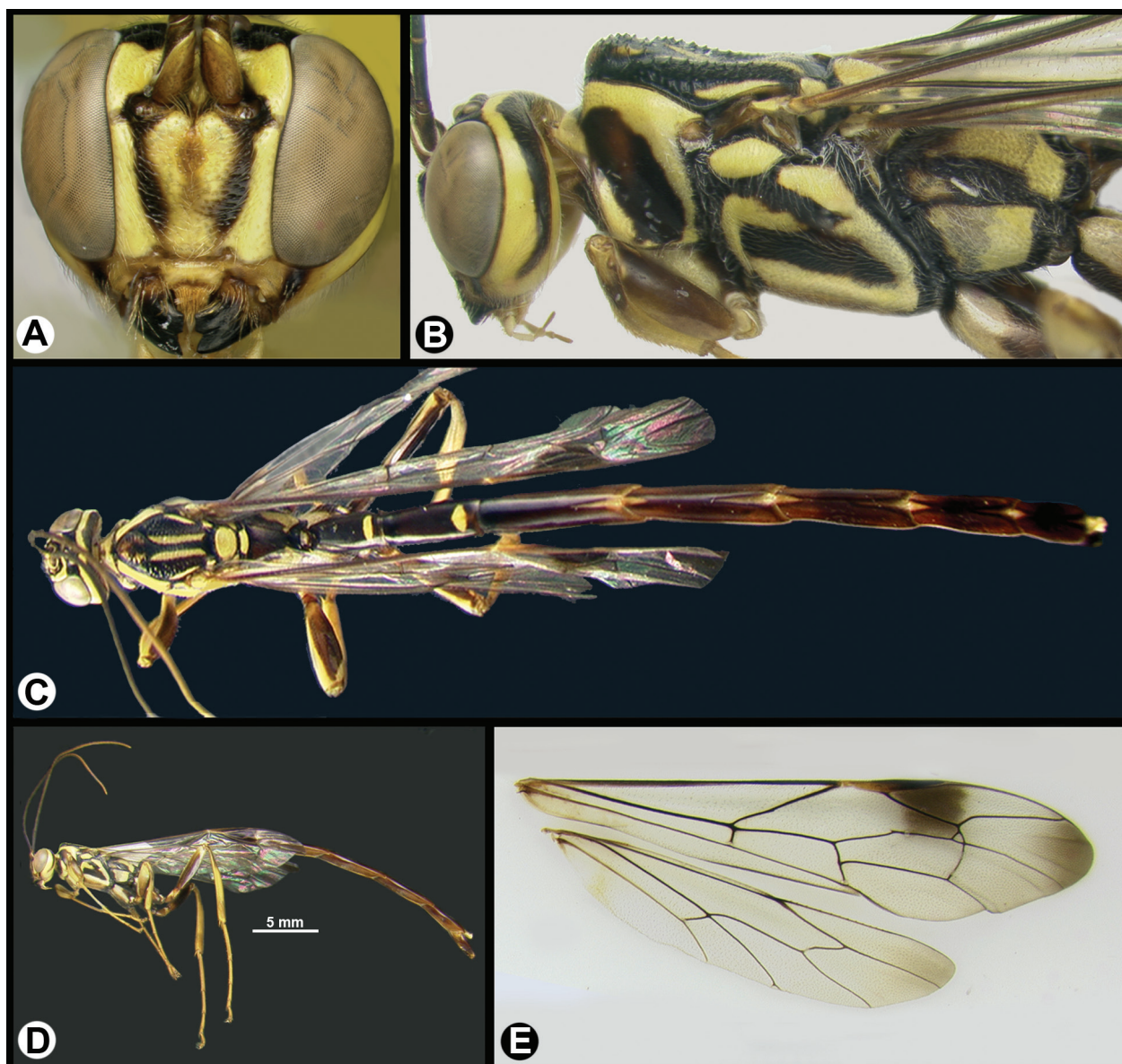


Figure 6. *Megarhyssa macrurus* male. **A.** Anterior head; **B.** Lateral head and mesosoma; **C.** Dorsal habitus; **D.** Lateral habitus; **E.** Wings.

Megarhyssa nortoni (Cresson, 1864)

Figs 7–8

There are two subspecies:

Megarhyssa nortoni nortoni (Cresson).

Rhyssa nortoni Cresson, 1864. Ent. Soc. Phila., Proc. 3: 317.

Megarhyssa nortonii Dalla Torre, 1901. Cat. Hym., v. 3, p. 481. Emendation.

Megarhyssa nortoni quebecensis (Provancher).

Thalessa quebecensis Provancher, 1873. Nat. Canad. 5: 447.

Geographic range. *M. nortoni nortoni* is distributed along the Pacific Coast from south-western Canada to California, and extends eastward to central Colorado. *M.*

nortoni quebecensis is found in the north-eastern U.S. and adjacent parts of Canada. In the late 1960s and early 1970s this species was collected across the United States and Canada, encompassing the ranges of both subspecies, for introduction as a biocontrol agent in Australia (Taylor 1976) and New Zealand (Bartlett et al. 1978). The populations established in Australia were then introduced to South Africa (Tribe and Cillie 2004).

Hosts. *Sirex noctilio* (Carlson 1979; Nuttall 1980; Valentine and Walker 1991; Vincent and King 1995); *Sirex* sp. (Carlson 1979); *Urocerus albicornis* (Champlain 1921; Townes 1944); *Xeris morrisoni* (Townes 1944).

Diagnosis. Female. Head black to blackish brown and yellow; mesosoma black or blackish brown, with yellow spots; metasoma brown and usually a little paler than me-

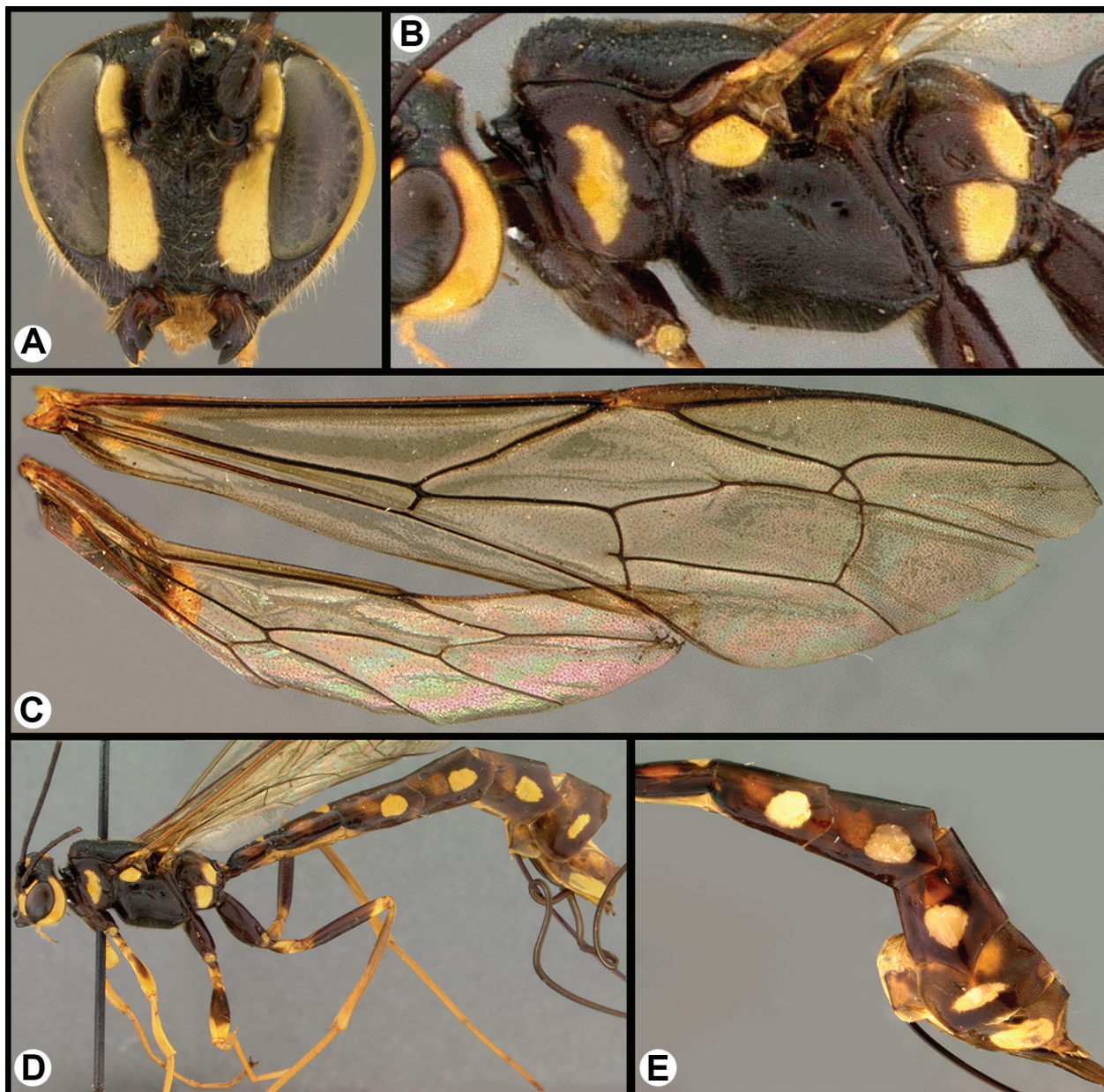


Figure 7. *Megarhyssa nortoni* female. **A.** Anterior head; **B.** Lateral head and mesosoma; **C.** Wings; **D.** Lateral habitus; **E.** Lateral metasoma.

sosoma. Subtriangular median subapical spot on first and second tergites, large round yellow spot on side of tergites 3-5, and vertical yellow blotch on side of sixth and seventh tergites. Fore wing 13 to 29 mm long. Ovipositor sheath about 2.7 times as long as fore wing.

Females can be distinguished from *M. atrata* by the body color; and from *M. macrurus* and *M. greenei* by the yellow spots on the tergites.

It should be noted that Carlson (1979) did not separate *M. nortoni nortoni* from *M. nortoni quebecensis*.

Male. Head black to blackish brown and yellow; mesosoma black to blackish brown, with yellow spots; metasoma brown, the tergites usually darker medially; the first two tergites with a median subapical yellow spot. Fore wing 9.5 to 20 mm long.

Males can be distinguished from *M. macrurus* by the lack of a brown patch at the base of cell 2R1 of the fore wing and from *M. atrata* and *M. greenei* by the single vertical black band on the face and the color of the mesopleuron.

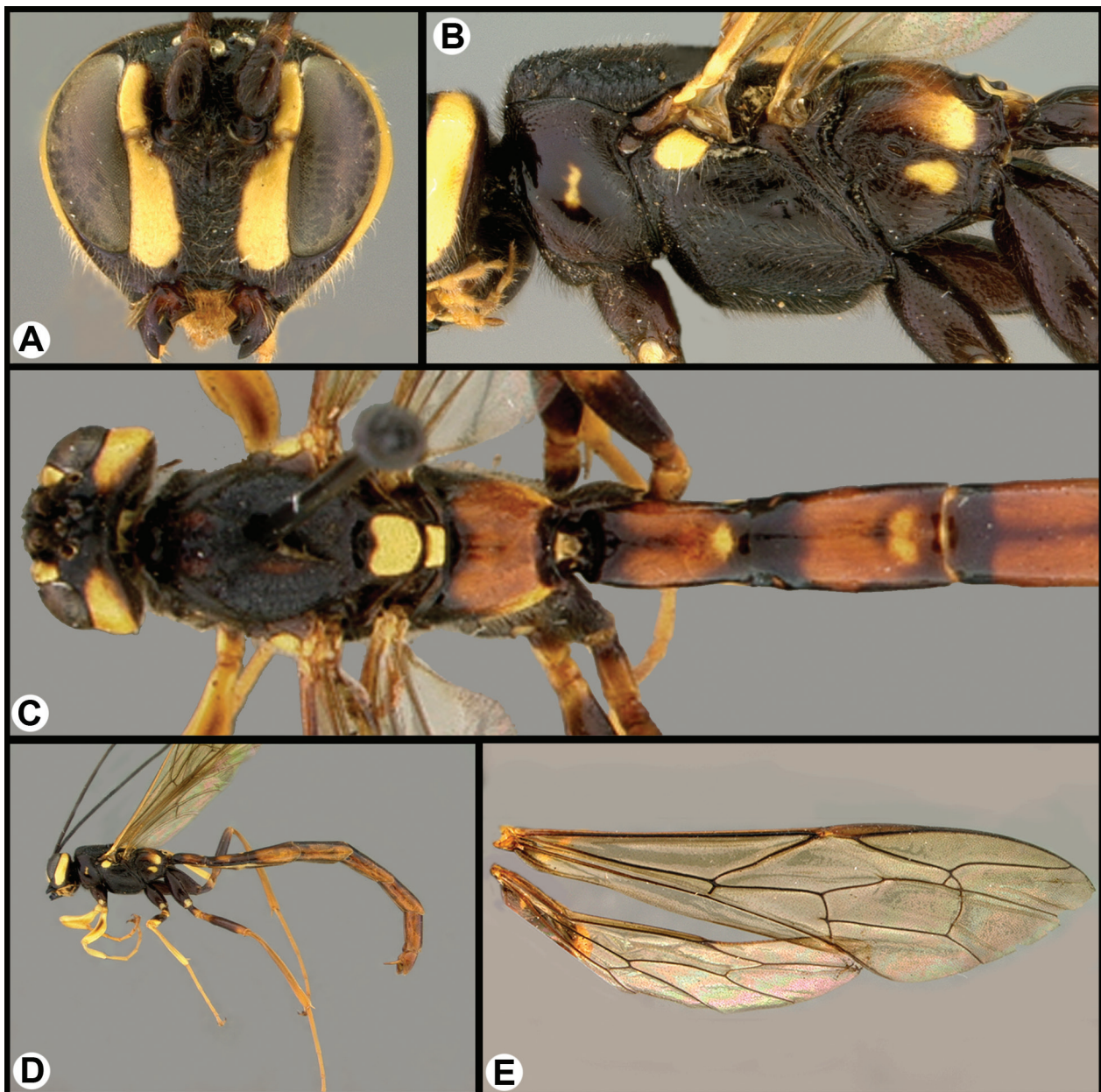


Figure 8. *Megarhyssa nortoni* male. **A.** Anterior head; **B.** Lateral head and mesosoma; **C.** Dorsal habitus; **D.** Lateral habitus; **E.** Wings.

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Supplementary material 1

Delta Editor Character Matrix

Authors: Victoria G. Pook, Michael J. Sharkey, David B. Wahl
Data type: specimens data

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Supplementary material 2

Interactive Key

Authors: Victoria G. Pook, Michael J. Sharkey, David B. Wahl
Data type: species key

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