



C3.1: *S. nitidus* ♀ with pale femora

3. Genus *Sirex* Linnaeus

Fig. C3.1 (live female, habitus)

Sirex Linnaeus, 1760 [1761]: 396. Type species: *Sirex juvencus* Linnaeus designated by Curtis (1829: plate 253).

Sirex subg. *Paururus* Konow, 1896: 41, 43. Type species: *Sirex juvencus* Linnaeus designated by Rohwer, 1911. Objective synonymy by Bradley (1913: 9).

Diagnostic combination

Both sexes of *Sirex* are recognized by presence of the fore wing vein Cu1, the dark areas of the body with dark blue or green metallic reflections, the gena without ridge behind eye, and without a white spot dorsally. **Females** also have the cornus in dorsal view not constricted near the middle.

Description

Color. Black portions of body with dark blue or green metallic reflections, remaining pale surfaces, if present, light reddish brown to reddish brown.

Head. Antennal sockets with distance between their inner edges 1.5–2.0 times distance between inner edge of eye and outer edge of socket (Fig. C3.2). Distance between inner edges of lateral ocelli about as long as distance between outer edge of lateral ocellus and nearest edge of eye (Fig. C3.3). Maximum distance between outer edges of eyes clearly less than maximum width of head (thus, in frontal view, genal edge completely visible and not intersected by outer edge of eye) (Fig. C3.2). Minimum distance between inner edges of eyes about 1.5 times maximum eye height (Fig. C3.2). Gena without ridge behind eye and without white spot (at most

with brown spot in males of one species) (Fig. C3.4), with large pits, each with posterior edge not elevated as low tooth. Head with setae sharp at apex. Antenna with 12 or more flagellomeres (the smallest specimens have the lowest number), and middle flagellomeres in dorsal view 1.5–3.0 times as long as wide; middle and apical flagellomeres with sensory pits over all except outer surface, apical 5–10 flagellomeres each with sensory oval impression on inner dorsal and inner ventral surfaces.

Thorax. Pronotum smooth or pitted over less than 0.5 of anterior surface. Mesoscutum densely pitted over median 0.5–0.7 only. Mesotarsomere 1 in lateral view not enlarged, its dorsal and ventral edges almost parallel and base of tarsomere at most 0.7 times its maximum width. Metatibia with two apical spurs, in **male** metatibia in lateral view 3.5–5.6 times as long as maximum width. In **female**, metatarsomere 2 in lateral view 1.5–5.0 times as long as maximum height. Metatarsomere 5 shorter than metatarsomere 2 or metatarsomeres 2 + 3. Fore wing with apex acutely and angularly rounded, with vein 2r–m joined to cell 2M (as in Fig. B1.71), with vein 2r–m present, with cell 1Rs2 clearly wider than long, with cell 3R1 3.0–3.8 times as wide as long, with cell 2R1 about 0.5 times as wide as cell 3R1, with vein 2r–rs joining stigma near middle, with stigma gradually attenuated even distal to junction with vein 2r–rs (Fig. A3.30), with vein Cu1 almost always fully developed, with vein 1cu–a joining vein Cu about mid way between veins 1m–cu and M, with vein 2A adjacent to posterior edge of wing for 0.25 times length of cell 1A length (Fig. A3.30), and with vein 3A absent or present but short. Hind wing with anal cell 1A (as in Fig. 1.44); hamuli clearly present both basal and apical to junction of veins R1 and C (Fig. B1.11).

Abdomen Female. Cornus in dorsal view short or long, lateral edges markedly to slightly convergent, but not constricted (Figs. B2.87 & B2.88). Tergum 9 with lateral

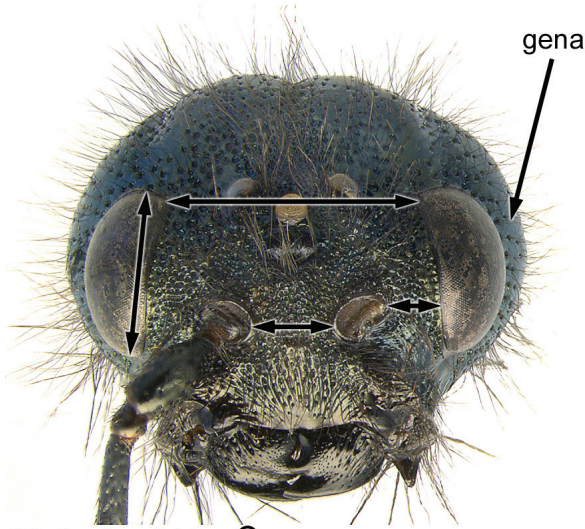
edges of median basin slightly divergent, straight or almost so, and sharply outlined for less than 0.3 times median length of basin (Figs. B2.87 & B2.88), and with basin base (outlined by black furrows laterally) 0.85–1.5 times as wide as median length of basin. Cercus present but very small and wart-like. **Sheath.** Length of basal section 0.4–1.4 times as long as apical section; apical section without longitudinal lateral ridge, and with teeth in apical third of dorsal margin and each tooth usually with small seta at base (as in Fig. B1.48). **Ovipositor.** Lancet with any of annuli 10–17 aligned with the junction of basal and apical sections of sheath; first two or three annuli anterior to teeth annuli each with clearly outlined, open ended pit extending along most of annulus and most pits with ventral edge ridged; pits anterior to first annulus before teeth annuli large to very large and edge of annulus below pit sharply and acutely produced and clearly outlined to ventral edge of lancet (Fig. C3.5).

Diversity and distribution

Sirex is diverse in the Northern Hemisphere with 28 extant species (15 known from the Palaearctic region) (Taeger and Blank 2011, Taeger *et al.* 2010). This is the most diverse genus in the New World with 14 species, one of which, *S. noctilio*, was introduced from the Old World. The genus is widespread across North America. More species are expected from the Mexican highlands and perhaps the large Caribbean islands. We studied six Palaearctic species in addition to the Nearctic ones.

References

References provided here mostly emphasize the taxonomic literature. Slippers and Haugen (2009) maintain an extensive bibliography (about 430 papers) on all aspect of *Sirex*, and their links to other information.



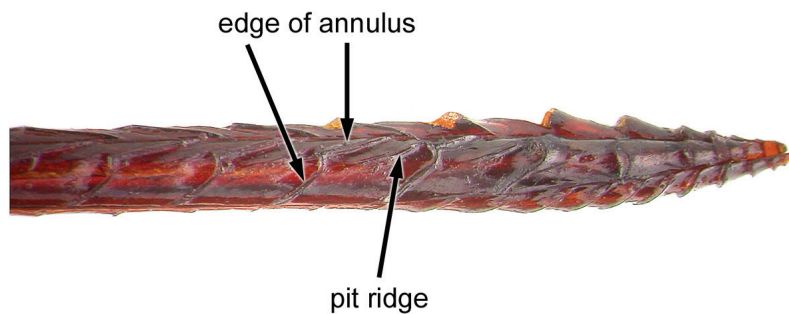
C3.2: *S. nitidus* ♀



C3.3: *S. nitidus* ♀



C3.4: *S. nitidus* ♂



C3.5: *S. abietinus* ♀

4. *Sirex abietinus* Goulet, n. sp.

Fig. C4.1 (female habitus)

Fig. C4.2 (male habitus)

Fig. C4.4 (map)

Sirex juvenescens race *cyaneus* Bradley, 1913: 14 (not *S. cyaneus* Fabricius, 1781: 419); accepted as subspecies by Ries 1951: 83, Middlekauff 1960: 65, Smith 1979: 126. This synonymy applies only to females from the Rocky Mountains and westward.

Sirex cyaneus Ries, 1951: 83 (not Fabricius, 1781: 419); Middlekauff 1960: 64, Smith 1979: 127. This synonymy applies only to females from the Rocky Mountains and westward.

Diagnostic combination

Among **females** with a completely light reddish brown metafemur, short metatarsomere 2 (tarsomere 1.5–3.0 times as long as high), and long tarsal pad (pad 0.7–0.8 times as long as ventral length of tarsomere) [*cyaneus*, *hispaniola*, and *nitidus*], those of *S. abietinus* are recognized by the very small pits at the middle of the lancet (length 0.0–0.13 times as long as length of annulus), length of annulus 10 1.76–2.37 times as long as height of ovipositor (lance + lancet), and the lack of pits in basal 6–9 annuli of the ovipositor. Among **males** with a reddish brown metafemur and mainly black metatibia [*cyaneus*, *nitidus*, *noctilio* and *varipes*] those of *S. abietinus* are recognized by the completely light reddish brown mesotibia and mesotarsus, the generally larger pits on the gena and vertex (pit diameter 0.25–0.4 times lateral ocellus diameter), and the narrow pale spot at the base of the metatibia (spot extending slightly beyond minimum constricted portion and as long as or slightly longer than wide).

Adults of this species are extremely similar to those of *S. cyaneus*, but the range of *S. abietinus* is from the Rocky Mountains and westward.

FEMALE. Description

Color. Body, antenna and palps black with dark blue metallic reflections. Coxae black, femora, tibiae and tarsi light reddish brown (apical half of tarsomeres 5 occasionally darker but not dark brown or black, and femora black in one specimen from southern Yukon). Fore wing mainly clear, at most tinted light brown in apical third.

Head. Gena with pits 0.0–4.0 pit diameters apart; vertex especially on postocellar area with pits 0.0–2.0 pit diameters apart, and each pit diameter 0.15–0.25 times lateral ocellus diameter.

Thorax. Mesoscutum with coarse, net-like pits in median

area. Metatarsomere 2 in lateral view 2.1–3.2 times as long as high, and its length about 1.0–1.2 times length of tarsomeres 3 + 4; tarsal pad 0.8–0.9 times as long as ventral length of tarsomere. Fore wing vein 3A absent.

Abdomen. Median basin of tergum 9 with basal width 0.65–1.2 times as long as median length, maximum width 1.1–1.4 times as long as median length, and median length 0.55–0.65 times cornus length (Fig. B2.87). Cornus in dorsal view usually long and thick, with edges straight and curved apically, its median length 1.2–1.4 as long as maximum width of abdomen at junction of terga 9 and 10 (Fig. B2.87). **Sheath.** Length 0.75–0.95 times fore wing length, basal section 0.75–1.0 times as long as apical section. **Ovipositor.** Lancet with 31–37 annuli (basal annuli weakly outlined); junction of basal and apical section of sheath aligned between 9th and 10th or 10th and 11th annuli, with 26–29 pits beginning with annuli 4–11 (Fig. C4.3). Pits near middle annuli or area at base of apical section of sheath 0.03–0.14 times as long as an annulus (pits gradually and markedly decreasing in size toward base), 0.15–0.4 times as high as lancet height in lateral view, and 1.0–1.7 times as long as high; annulus 10 length/ovipositor diameter (lance + lancet) 1.76–2.37 (based on 26 specimens) (Fig. B2.85). Last 4–6 annuli before teeth annuli as well as first tooth annulus with ridge on ventral edge of pit (Fig. C3.5). Edge of apical 6–8 annuli before teeth annuli extending as ridge to ventral edge of lancet (Fig. C3.5).

MALE. Description

Color. Head thorax and coxae black with dark blue metallic reflections. Coxae, metatibia (except extreme base), and metatarsomeres 1–3 black; femora, and tibiae and tarsus of fore and middle legs light reddish brown. Fore wing tinted light yellow. Abdomen with segments 1–3 (basomedian region from tergum 4 to as many as terga 4–7) black, segments 3–7 (excluding black median spot when present) light reddish brown, and sternum 9 light reddish brown rarely with some black at side.

Thorax. Metatibia 3.9–5.5 times as long as maximum width. Metatarsomere 1 in lateral view 3.1–3.4 times as long as maximum height.

Type material

Holotype female (CNC), in perfect condition, labeled “Clearwater BC 20–VI–67” “66–6076–03 Abies lasiocarpa R’rd [reared] logs Coll [struck out]” [White label], “HOLOTYPE *Sirex abietinus* Goulet CNC No. 23907” [Red label]. Type locality: Canada, British Columbia, Clearwater.

Paratypes. 50 females and 10 males. **CANADA.** Alberta: Banff, 10.IX.1924 (1F, MTEC); Banff, 11.IX.1924 (1

F, MTEC). **British Columbia:** Atlin 22.VIII.1955 (1 F, CNC); Clearwater, 2.VIII, 3.VIII.1966, 31.V, 5.VI, 20.VI, 22.VI.1967, reared from *Abies lasiocarpa* (8F, 1M allotype [20.V], CNC); Forest Insect Survey 272, 6.VIII.1938 (1 F, CNC); Forest Insect Survey 393, 15.IX.1939 (1 F, CNC); Hope Mountains, 20.VIII.1931 (1 F, CNC); Lower Hazel Cr., 10.VIII (1 F, CNC); Lumberton 3.VIII.1935 (1 F, CNC); Mount Revelstoke, 6000', 12.VIII.1923 (11 F, CNC); Quam Lake (1 F, CNC); Sarita River 2.VIII. 1946, 22.VII, 30.VII, 5.VIII.1948 (3 F, 3 M, CNC); Uslika Lake 5.VII, 20.VII.1967, reared from *Abies lasiocarpa* (2 M, CNC); Uslika Lake 20.VII.1966, reared from *Abies lasiocarpa* (2 M, CNC); Mi 41, Uslika Lake Rd. 18.VI.1966, reared from *Abies lasiocarpa* (1 M, CNC); Vancouver, 18.VIII.1914 (1 F, CNC); Vancouver Island (1 F, CNC); Vernon, 30.VI, 5.VII.1965, reared from *Abies lasiocarpa* (3 F, CNC); White Pine Cr., 26.V, 3.VII.1967, reared from *Abies lasiocarpa* (2 M, CNC). **Yukon Territory:** Lake Laberge, 1929 (1 F, CNC); Whitehorse 27.VIII.1959 (1 F, CNC). **USA. California:** Napa Co., Angwin, 20.IX.1968 (1 F, USNM). **Colorado:** no data (1 F, USNM). **Montana:** Gallatin Co., Bozeman, 19.VIII.1984 (1F, MTEC); Rivali Co., Nezperce Mountain, VII.1923 (1F, MTEC). **Nevada:** Elko Co., Jarbidge, Hopk. U.S. 18677, 15.VIII.1929 (1 F, USNM). **Oregon:** Klamath Co., Crater Lake Nat. Park, Crater Springs (1 F, USNM); Sisters, 15.VIII.1938, reared from *Abies lasiocarpa*, R. L. Furniss, Hopk. U. S. 31,766–S, barcode 00105829 (1 F, OSAC). **Utah:** Tabionia, 25.IX.1941, R. L. Furniss, barcode 00110916 (1 F, OSAC). **Washington:** Clear Lake, 24.II.1955, reared from *Abies amabilis*, cage 26, barcode 00105775 (1 F, OSAC); Mount Rainier Nat. Park, Paradise Valley, Hopk. U.S. 4245a (1 F, USNM). **Wyoming:** Teton Co., Yellowstone Nat. Park, Old Faithful, 26.VIII.1925 (1 F, 2 M, USNM).

Taxonomic notes

Sirex abietinus is a Nearctic species. Adults of this species are very similar to those of *S. cyaneus*, a Nearctic species. *Sirex cyaneus* should not be confused with the European “*S. cyaneus*”, a name incorrectly used in Europe for two European species that should be called *S. torvus* M. Harris (see chapter D, Additional Notes) and *S. juvenus*. The ovipositor of *S. abietinus* has no pits in basal 0.4, a character state that does not occur in either European species. *Sirex abietinus* is the western equivalent of the more eastern *S. cyaneus*. *Sirex abietinus* females have relatively long ovipositor annuli (value calculated only for annulus between pits 9 and 10) and, commonly, a thick and long cornus, and males have completely light reddish brown apical abdominal segments. *Sirex cyaneus* females have relatively short

ovipositor annuli (value calculated only for annulus between pits 9 and 10) and a short cornus, and males (except in Alberta and perhaps Saskatchewan) have at least sterna 8 and 9 black (in most specimens, tergum 8 is completely black). The information from morphology and DNA barcoding shows a difference of 10.6% in the base pair number between *S. abietinus* and *S. cyaneus*. Clearly, the western populations (i.e., *S. abietinus*) are specifically distinct from *S. cyaneus*. The ranges of both species are allopatric. The two species have no known close relatives in Eurasia.

In western North America, this species is sympatric with *S. nitidus* and the pale femora form of *S. californicus*. In *S. abietinus* females, the pit size on the middle annuli of the ovipositor and the proportion of the length of the annulus between pits the 9 and 10 relative to the ovipositor diameter distinguish them from females of *S. nitidus*. In *S. abietinus* males (except specimens from Alberta and perhaps Saskatchewan) the middle leg color patterns distinguish them from *S. nitidus* males. *Sirex abietinus* females are easily distinguished from *S. californicus* females with pale femora by the long tarsal pad of metatarsomere 2, and the ovipositor pit size and shape at middle and base.

Though not yet within the range of *S. noctilio*, both sexes of *S. abietinus* are easily distinguished from *S. noctilio* by puncture size on the vertex, and pit development on the mesoscutum; females are easily separated by the long tarsal pad of metatarsomere 2 and the pit development near the middle of the ovipositor, and males by the reduced pale spot at the base of the metatibia.

Origin of specific epithet

This is an adjective derived from the genus name for the host tree, *Abies*, and *abietinus* means “of fir” because most specimens have been reared from fir.

Hosts and phenology

Sirex abietinus was reared mainly (83%) from *Abies* spp. (Pinaceae) (Morris 1967 [as *S. cyaneus* from *Abies lasiocarpa*]). Kirk (1975) reared 453 specimens from *Abies concolor* and *Picea engelmannii*, but we suspect that most of the specimens reared from firs are *S. abietinus* and most of the specimens reared from spruce are *S. nitidus*. Based on 68 reared and confirmed specimens, other hosts are: *Abies amabilis* (2), *A. lasiocarpa* (56) (reported by Morris (1967) under the names *S. cyaneus* and *S. juvenus*), *Picea engelmannii* (4), *P. glauca* (may not have been reared) (1), *P. sitchensis* (may not have been reared) (1), and *Tsuga heterophylla* (4). We have only one record from *Cupressus macrocarpa* (Cupressaceae).

Based on 30 field-collected specimens, the earliest and latest capture dates are July 20 and September 15. The main flight period is from late July to mid September with a peak in August.

Range

CANADA: AB, BC, YT. **USA:** CA, CO, MT, NV, OR, UT, WA, WY. *Sirex abietinus*, a western North American species, is known from southern Yukon and British Columbia south to California and Colorado (Fig. C4.4). *Sirex abietinus* has been intercepted in England (Saunt 1924). We have seen one male from New Zealand

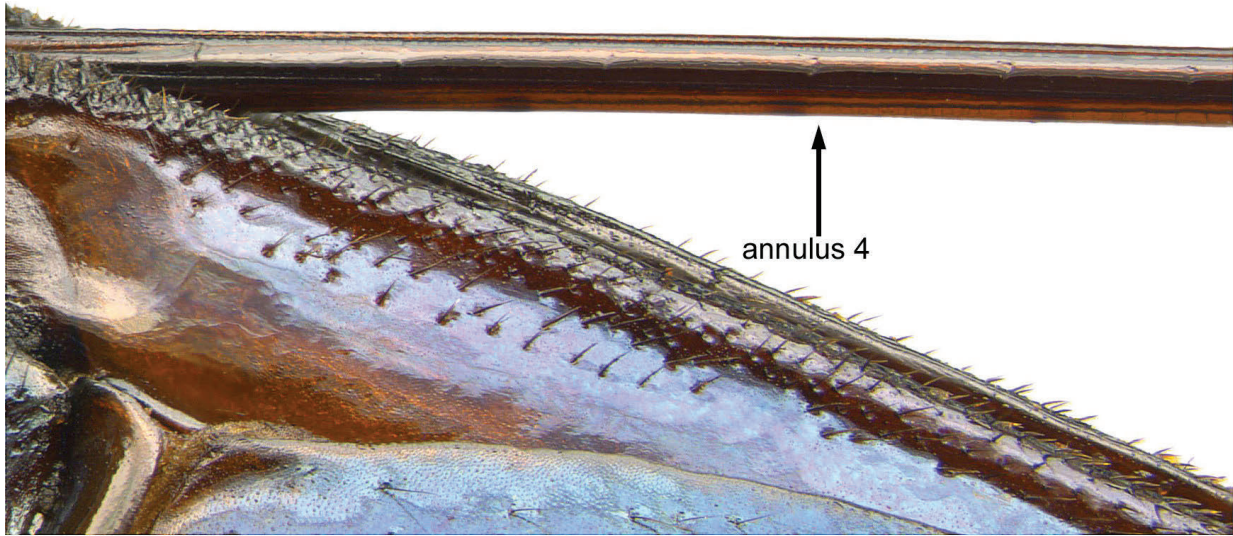
(FRNZ).

Specimens studied and included for range map: 111 females and 44 males from BYUC, CNC, DEBU, EDUM, MTEC, OSAC, PFRC, USFS–GA, and USNM.

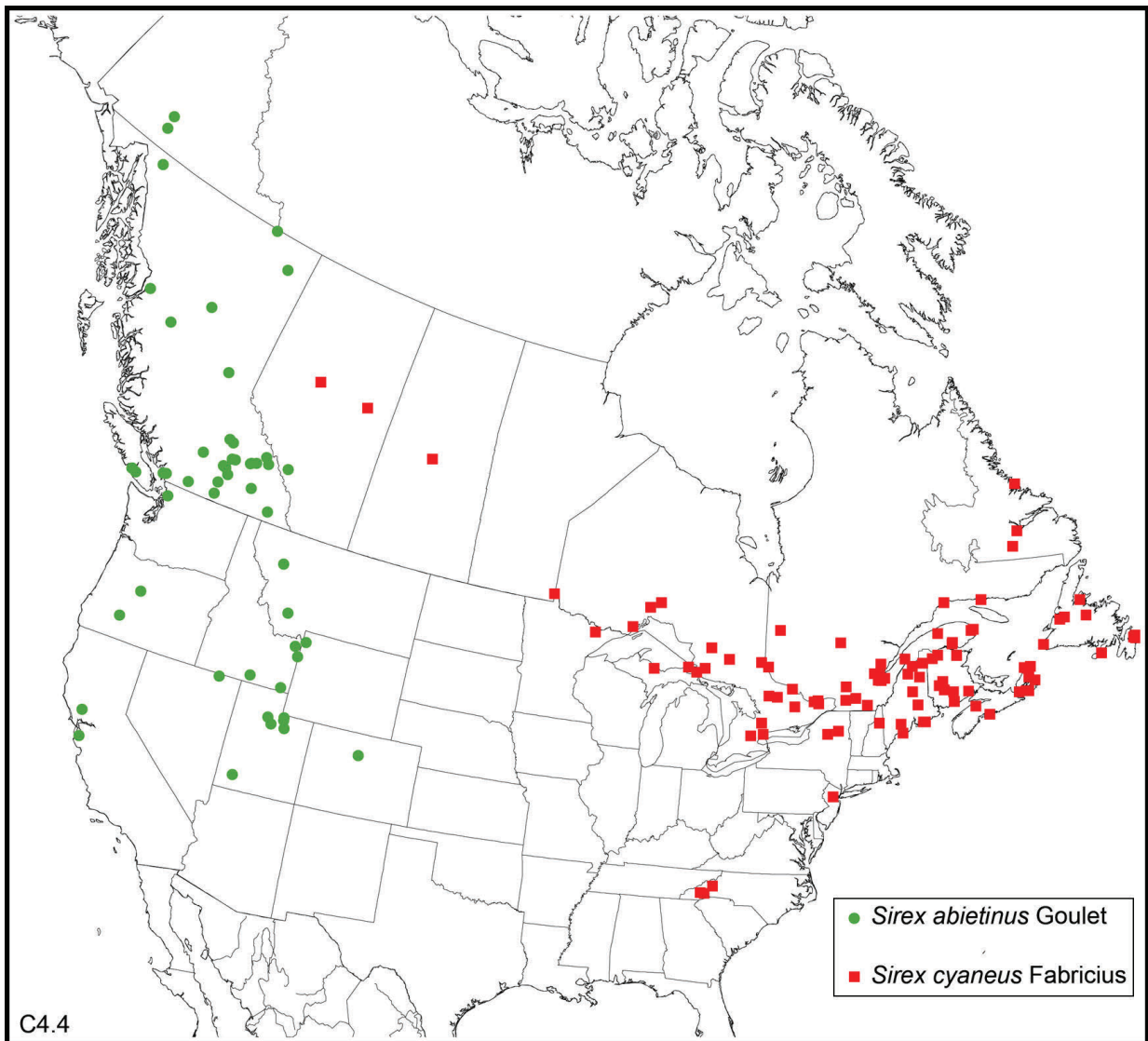
Specimens for molecular studies: 5 specimens. See Fig. E2.5e.

CANADA. British Columbia: 2008, *CNCS 1029*, 601; 2000, *SIRCA 053*, 612; 1969, *SIRCA 064*, 583; 2000, *SIRCA 069*, 553. **USA. California:** 1999, *CBHR 103*, 658.





C4.3: *S. abietinus* ♀



C4.4

5. *Sirex areolatus* (Cresson)

Fig. C5.1, Schiff *et al.* 2006: 20, 21 (female habitus)

Fig. C5.2, Schiff *et al.* 2006: 19 (male habitus)

Fig. C5.3 (map)

Urocerus areolatus Cresson, 1868: 375. Holotype female (ANSP), examined by DRS; Cresson 1916: 9. Type locality: "New Mexico".

Sirex gracilis Westwood, 1874: 114, pl. XXI, fig. 4. Holotype female (OXUM), images prepared by James E. Hogan and sent to HG for study. Synonym by Konow 1898: 81; accepted by Bradley 1913: 14, Ries 1951: 83, Smith 1979: 126. Type locality: "America Septentrionalis".

Urocerus caeruleus Cresson, 1880: 34. Holotype female (ANSP), examined by DRS; Cresson, 1916: 10. Synonym by Konow 1898: 81; accepted by Ries 1951: 83, Smith 1979: 126. Type locality: "Vancouver's Island".

Urocerus gracilis; Cresson, 1880: 51 (change in combination).

Sirex apicalis Kirby, 1882: 377, pl. XV, fig. 11. Holotype male (BMNH), not examined.. Synonym by Konow 1898: 81; accepted by Baumberger 1915: 34, Ries 1951: 83, Smith 1979: 126. Type locality: "Vancouver's Island".

Paururus areolatus; Konow, 1898: 90 (change in combination).

Sirex areolatus; Kirby, 1882: 377 (change in combination); accepted by Bradley 1913: 13, Ries 1951: 83, Middlekauff 1960: 62, Smith 1979: 126.

Sirex areolatus race *areolatus*; Bradley, 1913: 14 (change in rank). Synonym by Ries 1951: 83; accepted by Smith 1979: 126.

Sirex areolatus race *caeruleus*; Bradley, 1913: 14 (change in rank). Synonym by Ries 1951: 83; accepted by Smith 1979: 126.

Diagnostic combination

Among **females** with longer tarsi (metatarsomere 2 about 5.0 times as long as high) [*longicauda*] those of *S. areolatus* are recognized by their completely black legs. **Males** are recognized by their completely black legs.

FEMALE. Description

Color. Body, legs, palps and antenna black with dark blue metallic reflections. Fore wing darkly to lightly tinted.

Head. Gena with pits 1.0–5.0 pit diameters apart; vertex with pits 1.0–2.0 pit diameters apart, and each pit diameter about 0.25 times lateral ocellus.

Thorax. Mesoscutum with quite dense pits and numerous transverse ridges in median area. Metatarsomere 2 in

lateral view about 5.0 times as long as high (Fig. B2.3); tarsal pad 0.35–0.5 times as long as ventral length of tarsomere. Fore wing vein 3A present and extending along posterior margin of wing.

Abdomen. Median basin of tergum 9 with basal width 0.6–1.1 times as long as median length, maximum width about 0.9–1.3 times as long as median length, and median length about 0.55–0.7 times cornus length. Cornus in dorsal view long, attenuated in apical 0.25–0.3, and edges not angular midway; median length 1.2–1.5 times as long as maximum width of abdomen at junction of terga 9 and 10. **Sheath.** Length 0.95–1.2 times fore wing length; basal section 0.5–0.8 times as long as apical section (Fig. B2.5). **Ovipositor.** Lancet with 39–46 annuli (basal annuli clearly outlined); junction of basal and apical sections of sheath aligned between 10th and 11th to 12th and 13th ovipositor annuli, with 35–41 pits beginning with annulus 2 (Fig. B2.12). Pits near middle annuli or area at base of apical section of sheath about 0.15 times as long as an annulus (pits gradually decreasing in size toward base), about 0.3 times as high as lancet height in lateral view, and 1.0–1.2 times as long as high; annulus 10 length/ovipositor diameter (lance + lancet) not measured. Last two annuli before teeth annuli with ridge on ventral edge of pit. Edge of apical 5–7 annuli before teeth annuli extending as ridge to ventral edge of lancet (Fig. B2.10).

MALE. Description

Color. Head, thorax, antenna, palps, abdominal segments 1, 2, 8, sterna 2 and 3 at side, and 8 black with dark blue metallic reflections; abdominal segments 3–7 mostly light reddish brown. Coxae and femora black (Fig. B2.93). Fore wing clear.

Thorax. Metatibia in lateral view 3.9–4.2 times as long as maximum width. Metatarsomere 1 2.8–3.1 times as long as maximum height.

Taxonomic notes

Sirex apicalis Kirby was not examined, but the description, especially the leg color pattern, perfectly matches this species.

Biological notes

Essig (1926) described adults and pupa as well as the microhabitats of the larvae and pupae. Chamberlin (1949) described pupae both in a stump and in adjacent soil.

Hosts and phenology

The host range of *S. areolatus* is very wide (Flanders 1925, Essig 1926, Middlekauff 1960, Cameron 1965, Westcott 1971). Based on 76 reared and confirmed specimens, the main hosts are Cupressaceae: *Cupressus macrocarpa* (49), *Juniperus occidentalis* (20) (from scorched trees (Westcott 1998)), *Calocedrus decurrens* (2), *Sequoia sempervirens* (first recorded by Baumberger (1915), and also from fresh cut burnt trees by De Leon (1952)), and *Taxodium distichum* (5). They are less often recorded from Pinaceae: *Pinus contorta*, *P. jeffreyi*, *P. lambertiana*, *P. radiata*, and *Pseudotsuga menziesii* (Chamberlin 1949).

Based on 44 field-collected specimens, the earliest and latest capture dates are late June and late November. The main flight period is from early September to early October.

Range

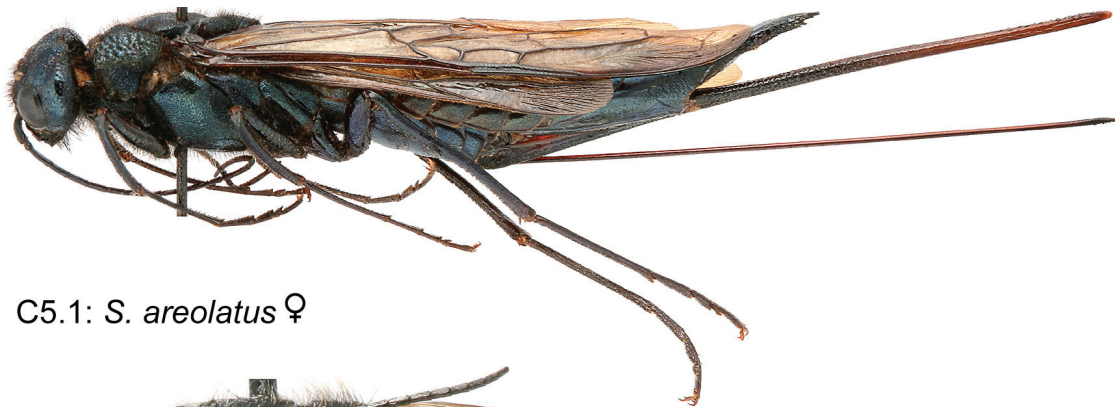
CANADA: BC, NS. **USA:** AR, AL, AZ, CA (Middlekauff 1960), CO, ID, FL, HA, NM, OR, UT, VA, WA. *Sirex areolatus* is mainly a western North American

species known from British Columbia to California and New Mexico (Fig. C5.3). It is adventive in eastern North America (FL, AR, AL, NS, VA) and Hawaii (Burks, 1967) and is probably not established. The species was also intercepted in England (Benson 1940), and we have seen one female from New Zealand (PANZ). However, Smith and Schiff (2002) think that the Virginia record may suggest an establishment in wild habitats.

Specimens studied and included for range map: 50 females and 84 males from BYUC, CNC, FSCA, OSAC, PFRC, UAIC, UCRC, and USNM.

Specimens for molecular studies: 15 specimens. See Fig. E2.5a.

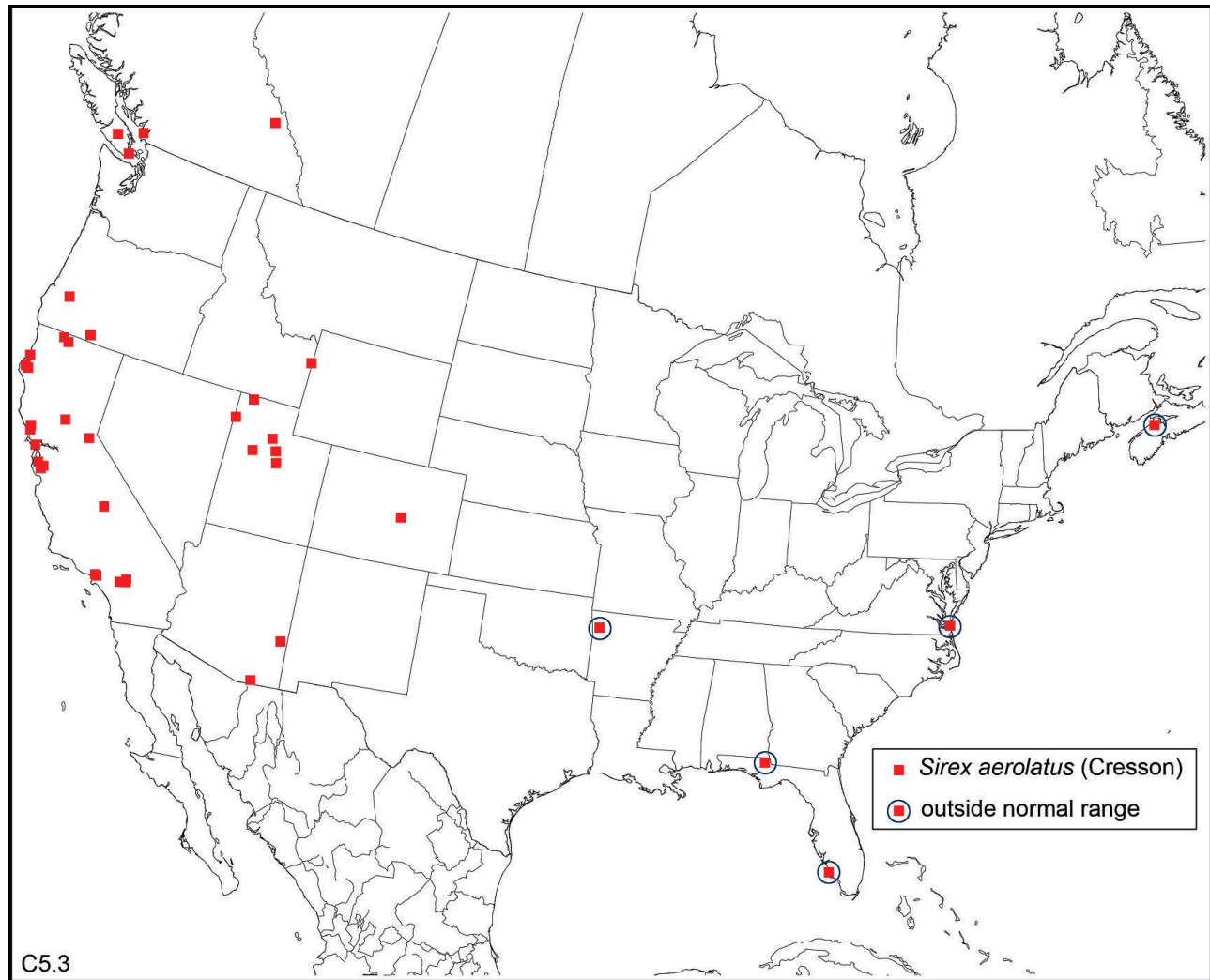
CANADA. British Columbia: 2008, *CNCS 1042*, 601; 2007, *CNCS 1043*, 532; 2007, *CNCS 1044*, 601; 2007, *CNCS 1045*, 607. **USA. California:** 1997, *CBHR 6*, 658; 1999, *CBHR 101*, 658; 2006, *CBHR 377*, 658; 2006, *CBHR 657*, 658; 2006, *CBHR 658*, 658; 2006, *CBHR 659*, 658; 2006, *CBHR 660*, 658; 2006, *CBHR 661*, 658; 2006, *CBHR 662*, 658; 2006, *CBHR 663*, 658; 2006, *CBHR 668*, 658.



C5.1: *S. areolatus* ♀



C5.2: *S. areolatus* ♂



6. *Sirex behrensii* (Cresson)

Fig. C6.1, Schiff *et al.* 2006: 24, 25 (female habitus)

Fig. C6.2, Schiff *et al.* 2006 : 23 (male habitus)

Fig. C6.4 (map)

Urocerus Behrensii Cresson, 1880: 35. Holotype female (ANSP), examined by DRS; Cresson 1916: 9. Type locality: California.

Sirex behrensii; Kirby, 1882: 379 (change in combination); accepted by Bradley 1913: 16, Ries 1951: 83, Middlekauff 1960, Smith 1979: 126.

Diagnostic combination

Among **females** with a black metafemur and metatibia and short metatarsomere 2 (less than 3.0 as long as high) [*californicus*, *mexicanus*, *nigricornis*, *obesus* and *xerophilus*] those of *S. behrensii* are recognized by the reddish brown tarsi and the mainly reddish brown abdomen. **Males** are recognized by the metafemur with a

reddish brown ventral half and a black dorsal half, and by the brown spot on the gena behind the eye and occipital margin.

FEMALE. Description

Color. Head, antenna, palps, thorax, abdominal segments 1 and 2, lateral surface of terga 3–9 or 3–10, and lateral surface of sterna 3–7 or 4–7 black with dark blue metallic reflections; most of terga 3–9, or all of tergum 9 and 10, and most of sterna 3–7 or 4–7 reddish brown (Fig. B2.13). Coxae, femora, most of tibiae, and most of or part of tarsomere 1 of fore leg or fore and middle legs black; apex and ventral half of tibiae, tarsomeres 2–5 of fore leg, 1–5 or 2–5 of middle leg, and metatarsus reddish brown. Fore wing in apical third and basal to stigma with darkly tinted bands (Fig. C6.3).

Head. Gena with pits 4.0–8.0 diameters apart between eye and posterior head margin; very dense on vertex and postocellar area, and each pit diameter about 0.25 times

lateral ocellus. Gena with central surface with a round ridge between eye and occiput (Fig. B2.16).

Thorax. Mesoscutum with dense pits in median area; pits round, and transverse ridges moderately numerous. Metatarsomere 2 in lateral view 2.4–3.0 times as long as high; tarsal pad 0.4–0.5 times as long as ventral length of tarsomere. Fore wing vein 3A present and extending to posterior wing margin (Fig. C6.3).

Abdomen. Median basin of tergum 9 with basal width 0.8–1.0 times as long as median length, maximum width 1.1–1.7 times as long as median length, and median length 1.0–1.2 times as long as cornus length. Cornus in dorsal view short, with edges straight or slightly angular midway; its median length 1.0–1.2 times as long as maximum width of abdomen at junction of terga 9 and 10. **Sheath.** Length 0.68–0.82 times fore wing length, basal section 0.93–1.17 times as long as apical section.

Ovipositor. Lancet with 31–36 annuli (basal annuli clearly outlined); junction of basal and apical section of sheath aligned between 12th and 13th annuli, with 28–32 pits beginning with annulus 2. Pits near middle annuli or area at base of apical section of sheath, about 0.2 times as long as an annulus (pits gradually decreasing in size and very small toward base), about 0.3 times as high as lancet height in lateral view, and about 1.5 times as long as high (Fig. B2.18); annulus 10 length/ovipositor diameter (lance + lancet) not measured. Last 2–3 annuli before teeth annuli as well as first tooth annulus with ridge on ventral edge of pit. Edge of apical 5–7 annuli before teeth annuli extending as ridge to ventral edge of lancet.

MALE. Description

Color. Head (except behind eye), thorax, antenna beyond flagellomere 6, palps, and abdominal segments 1 and 2 black with dark blue metallic reflections; smooth surface on gena between eye and posterior margin of occiput brown (Fig. B2.106); antennomeres 1–5, and abdominal segments 3–9 light reddish brown. Coxae, striated surface of femora of fore and middle legs, and dorsal 0.5 of metafemur black (Fig. B2.104); metatibia (except extreme base), apical 0.3–0.5 of mesotibia and mesotarsomeres 1–2, and metatarsomeres 1–3 and 5 brown to dark brown (Fig. B2.104); most of femora of fore and middle legs, ventral half of metafemur, tibiae and tarsi of fore leg, basal 0.3–0.7 of mesotibia, mesotarsomeres 3–5, metatarsomeres 4, and extreme base (spot about 0.5 times as long as minimum width of tibia at base) of metatibia light reddish brown. Fore wing clear.

Thorax. Metatibia 3.5–4.0 times as long as maximum width (Fig. B2.104). Metatarsomere 1 in lateral view

2.7–3.5 times as long as maximum height.

Taxonomic notes

Females of *S. behrensii* may be confused with the pale abdomen females of *S. nigricornis*. The clearly outlined banded wing pattern, the broad black longitudinal band along the side of the abdomen and completely reddish brown segment 10, and the presence of fore wing vein 3A should distinguish them from *S. nigricornis females*. Males are easily distinguished among New World *Sirex* by antenna and hind leg color patterns. Daly (1963) used specimens of *S. behrensii* for thoracic muscle studies.

Hosts and phenology

The host range of *S. behrensii* is moderately wide (Flanders, 1925, Essig 1926, Middlekauff 1960, Cameron 1965). All but one hosts, based on 50 reared and confirmed specimens, are Pinaceae: *Pinus jeffreyi* (2), *P. lambertiana* (1), *P. ponderosa* (46), *P. radiata*, and *Pseudotsuga menziesii* (1). One record is on *Cupressus macrocarpa* (Cupressaceae).

Based on 30 field-collected specimens, the earliest and latest capture dates are from early June to late November. The main flight period is from late July to late October with a peak in late September.

Range

CANADA: BC. **USA:** CA (Middlekauff 1960), ID, NV, OH (probably not established), OR, WA, WV (probably not established). *Sirex behrensii*, a western North American species, is recorded from southernmost British Columbia to California and Nevada (Fig. C6.4). The specimen from Ohio was on imported lumber and is probably not established (Smith and Schiff 2002).

Specimens studied and included for range map: 32 females and 38 males from CNC, OSAC, PFRC, UCRC, and USNM.

Specimens for molecular studies: 13 specimens. See Fig. E2.5a.

CANADA. British Columbia: 2002, *SIRCA 048*, 416; 2002, *SIRCA 050*, 407; 2002, *SIRCA 051*, 575; 2002, *SIRCA 052*, 407. **USA. California:** 2006, *CBHR 664*, 658; 2006, *CBHR 665*, 499; 2006, *CBHR 666*, 658; 2006, *CBHR 667*, 658; 2006, *CBHR 669*, 658. **Oregon:** 2006, *CBHR 1075*, 658; 2006, *CBHR 1076*, 658; 2006, *CBHR 1077*, 658. **Unknown State:** unknown year, *CBHR 171*, 658.



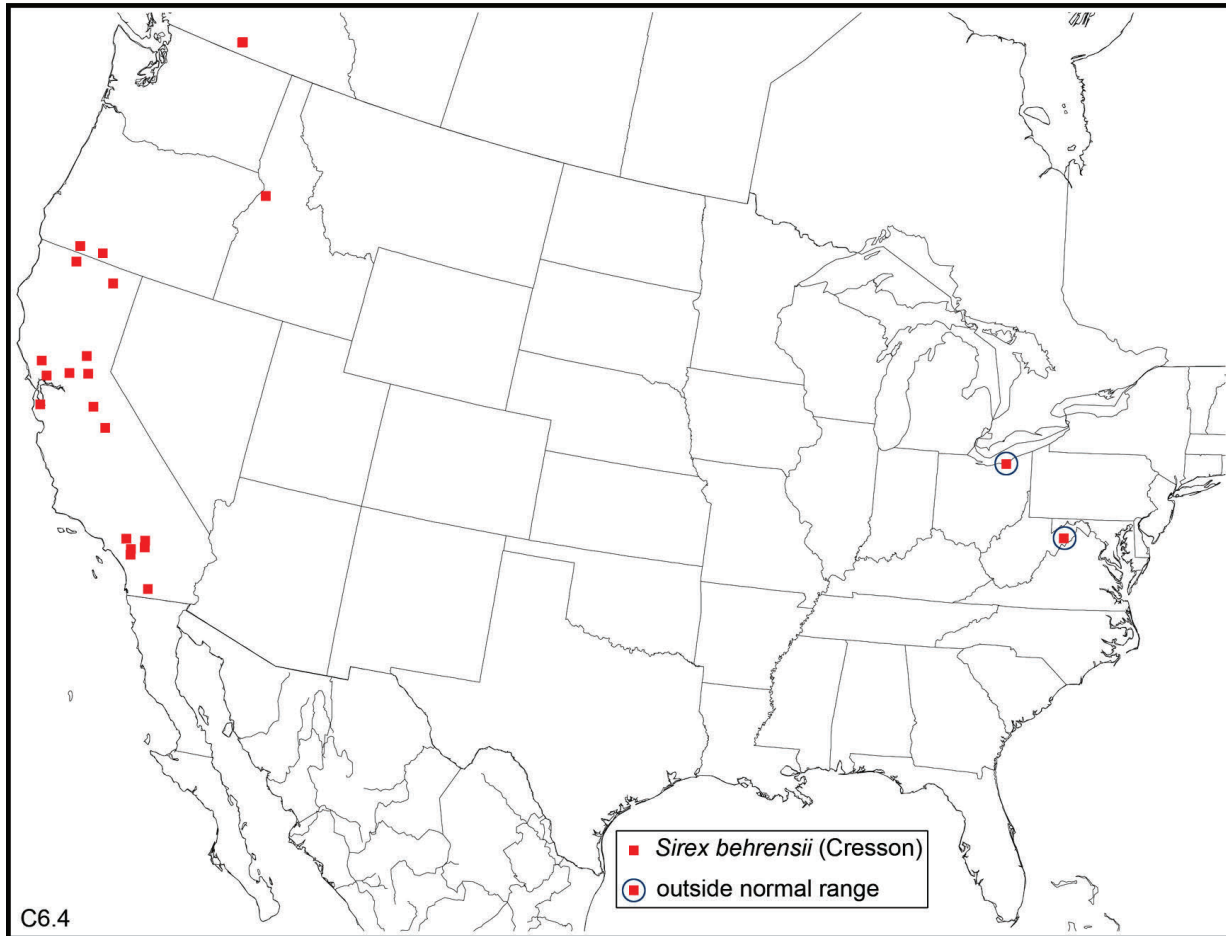
C6.1: *S. behrensii* ♀



C6.2: *S. behrensii* ♂



C6.3: *S. behrensii* ♀



7. *Sirex californicus* (Ashmead), n. stat.

Fig. C7.1, Schiff *et al.* 2006: 36, 37 (female with dark legs, habitus)

Fig. C7.2 (female with pale legs, habitus)

Fig. C7.3, Schiff *et al.* 2006: 35 (male, habitus)

Fig. C7.4 (live female with dark legs)

Fig. C7.5 (live female with pale legs)

Fig. C7.6 (live male)

Fig. C7.7 (map)

Paururus Californicus Ashmead, 1904: 64. Lectotype female (USNM), here designated; labeled “Sept.” “Placer Co., Cal.” “female Type No. 7683 U.S.N.M.”, “*Paururus californicus* Ashm, female [handwritten] Female, type [handwritten]”. Paralectotype female, here designated, from “Hoquiam, Wash.”; Middlekauff 1960: 63. Type locality: California, Placer Co.

Sirex californicus; Bradley, 1913: 11 (change in combination); accepted by Ries 1951: 83.

Sirex obesus Cameron, 1967: 19 (not Bradley, 1913: 12); accepted by Smith 1979: 127.

Sirex juvenis race *cyaneus* Bradley, 1913: 14 (not *S. cyaneus* Fabricius, 1781: 419); accepted as a subspecies by Ries 1951: 83, Middlekauff 1960: 65, Smith 1979: 126. This synonymy applies only to females with light reddish brown femora.

Sirex cyaneus Middlekauff, 1960: 64 (not Fabricius, 1781: 419); accepted by Smith 1979: 127. This applies to the pale legged females of *S. californicus*.

Sirex juvenis californicus; Benson, 1963: 252 (change in rank); accepted by Cameron 1967, Morris 1967: 60, Smith 1979: 127.

Diagnostic combination

Among **females** with the completely black legs, a moderately short metatarsomere 2 (about 2 times as long as high), and a completely or partly darkly tinted (dark bands behind stigma and apical third) fore wing [*obesus* and *nigricornis*], those of *S. californicus* are recognized by the scattered pits on the gena and part of the vertex (pits 2.0–4.0 pit diameters apart). Among **females** with completely pale legs beyond the coxae, a moderately short metatarsomere 2 (about 2.0 times as long as high), and a short tarsal pad on metatarsomere 2 (about 0.5 times as long as ventral tarsal length) [*noctilio*], those of *S. californicus* are recognized by the well developed pits on the vertex and the widespread net-like pits on the median 0.7 of mesoscutum. Among **males** with reddish brown femora, tibiae and tarsi [*mexicanus* and *xerophilus*], those of *S. californicus* are recognized by the light reddish brown basal five or six antennomeres.

FEMALE. Description

Color. In **dark form**, body, legs, palps, and antenna black with dark blue metallic reflections, or in **pale form**, black with dark blue metallic reflections but femora, tibiae and tarsomeres 1–4 light reddish brown. Fore wing darkly tinted (southern part of range) to clear with dark bands basal to stigma and in apical third (Fig. B2.74).

Head. Gena with pits 2.0–4.0 pit diameters apart (Fig. B2.17), vertex and postocellar area with pits 0.1–2.0 pit diameters apart, and each pit diameter about 0.15–0.2 that of lateral ocellus (Fig. B2.36).

Thorax. Mesoscutum with coarse net-like pits restricted to posterior 0.6 of median area, with transverse and longitudinal ridges in coarsely pitted area. Metatarsomere 2 in lateral view more than 2.0 times as long as high, and its length about 1.2 times length of tarsomeres 3 + 4; tarsal pad about 0.5 times as long as ventral length of tarsomere. Fore wing vein 3A absent (Fig. B2.74).

Abdomen. Median basin of tergum 9 with basal width 1.1–1.4 times as long as median length, maximum width 1.3–1.7 times as long as median length, and median length 0.6–0.8 times cornus length. Cornus in dorsal view short, either with edges straight in large specimens or clearly angular midway in small specimens, its median length 0.8–1.1 times as long as maximum width of abdomen at junction of terga 9 and 10. **Sheath.** Length 0.7–0.8 times as long as fore wing length, basal section 1.05–1.35 times as long as apical section. **Ovipositor.** Lancet with 28–38 annuli (edge of basal annuli difficult to see); junction of basal and apical section of sheath aligned between 12th and 13th to 15th and 16th annuli, with 24–34 pits beginning with annulus 2; pit of annulus 2 only extending to edge of annulus 1 (Fig. B2.25). Pits near middle annuli (Fig. B2.19) or area at base of apical section of sheath 0.3–0.35 times as long as an annulus (pits clearly decreased at base to about 0.2), about 0.4–0.6 times as high as lancet height in lateral view, and about 1.6–2.2 times as long as high (Fig. B2.38, middle); length of lancet annulus/ovipositor diameter (lance + lancet) for annulus 2 1.43–2.07, for annulus 5 1.46–2.14, for annulus 10 1.3–1.8, and for annulus 13 1.40–1.66 (7 specimens). Last 4 or 5 annuli before teeth annuli and as well as first tooth annulus with ridge on ventral edge of pit (Fig. C1.15). Edge of apical 4–5 annuli before teeth annuli extending as ridge to ventral edge of lancet.

MALE. Description

Color. Head. Head, apical 0.7 of antenna, palps, thorax, abdominal segments 1, median area of tergum 2 or 1 and 2, and median area of tergum 3 black with dark blue metallic reflections; abdominal segments 3–10, and antennomeres 1–5 light reddish brown (Fig. B2.113). Legs reddish brown, but black on coxae (Fig. B2.107).

Fore wing clear with a very light yellow tint in some specimens (Fig. B2.115).

Thorax. Metatibia 3.8–4.3 times as long as maximum width. Metatarsomere 1 in lateral view 2.7–3.1 times as long as maximum height (Fig. B2.107).

Taxonomic notes

Benson (1963) ranked *S. californicus* as a subspecies of the European *S. juvencus*. The two populations differ in color pattern in both sexes (the color pattern of males was unknown to Benson at the time); in females of *S. californicus*, the tarsal pad of metatarsomere 2 is short (long in *S. juvencus*) and the ovipositor pits are long and large medially and about twice as long as high (short and small medially and a little longer than high in *S. juvencus*). The main hosts of *S. californicus* are various species of *Pinus*; for *S. juvencus* they are various species of *Picea*. The range of *S. californicus* extends from southernmost British Columbia and southwestern Alberta to California, Colorado and South Dakota; a Holarctic species would not have such a range in the Nearctic region. Therefore, *S. californicus* is clearly and specifically distinct from *S. juvencus*.

Females of *S. californicus* exist in two discrete color forms. The legs are either all black or they are light reddish brown beyond the coxae. Dark-legged females are the most common form seen over the range. Pale-legged females are known from southern British Columbia and the northern half of western United States as far east as the Black Hills of South Dakota.

Females of *S. californicus* with black legs are similar to three other western species: *S. obesus*, *S. mexicanus*, and *S. xerophilus*. They are distinguished from them by the less dense pits on the vertex. They are also distinguished from *S. mexicanus* and *S. xerophilus* by the partial or complete dark tinted wings and differences in the pit development on the ovipositor, and from the very similar *S. obesus* by the more slender metatarsomere 2. Females of *S. californicus* may also be confused with females of the black abdomen form of *S. nigricornis* (if the British Columbia record for this species is correct). The ovipositor pits are longer and the pit density on the vertex is clearly less in *S. californicus* than in *S. nigricornis*.

Females of *S. californicus* with pale legs may be confused with similarly colored species associated with firs and spruces (e.g., *S. abietinus*, *S. cyaneus*, *S. nitidus*, and very few specimens of *S. varipes*). Pits on the head of *S. californicus* are clearly larger and the tarsal pad on metatarsomere 2 shorter than in the above four species. Females of the pale form of *S. californicus* may be confused with those of *S. noctilio* with short tarsal pads on metatarsomere 2, but they are easily distinguished by

the much larger and denser pits on the vertex.

Males of *S. californicus* from westernmost Nevada were first associated with females and described by Cameron (1967), and are easily distinguished from males of the three other species with a reddish brown metafemur.

Biological notes

Cameron (1967) reported 216–804 eggs in female ovaries of *S. californicus*, with the highest number of eggs associated with the largest females. Eggs that are going through the ovipositor become 2.5 times as long as those within the ovaries (Cameron 1967). *Megarhyssa nortoni nortoni* (Cresson), an important parasitoid, was often observed ovipositing in logs of *Pinus jeffreyi* containing larvae of *S. californicus* (Cameron, 1967).

Hosts and phenology

The host range of *S. californicus* is wide (Essig 1926, Middlekauff 1960, Cameron 1965, Cameron 1967, Morris 1967, Kirk 1975 [some of the reared specimens could be *S. obesus*]). The most commonly seen hosts belong to *Pinus* (99% of reared specimens). Based on 128 reared and confirmed specimens, all hosts are Pinaceae: *Larix occidentalis* (1), *Pinus albicaulis* (1), *P. contorta* (107) (pale legged females reported as *S. juvencus* by Morris (1967)), *P. coulteri* (1), *P. jeffreyi* (3), *P. lambertiana* (11), *P. monticola* (1), *P. ponderosa* (336) (large emergence reported by Cameron (1968) and Kirk (1975)), *P. sylvestris* (2), and *Pseudotsuga menziesii* (1). We have only one record from *Cupressus macrocarpa* (Cupressaceae).

Based on 74 field-collected specimens, the earliest and latest capture dates are July 17 and September 11. The main flight period is from second half of July to second half of September with a peak in late August (Cameron 1967).

Range

CANADA: AB, BC. **Mexico:** Intercepted specimen from Mexico at United States border in southern California. **USA:** CA (Middlekauff 1960), CO, ID, MT, NV, OR, SD, UT, WA, WY. *Sirex californicus* is found from the Rocky Mountains of southern British Columbia to California, Colorado and South Dakota (Fig. C7.7). We have seen one intercepted female from New Zealand.

Specimens studied and included for range map: 384 females and 91 males from BDUC, BYUC, CFIA, CNC, MTEC, NFRC, OSAC, PFRC, USFS–GA, and USNM.

Specimens of *S. californicus* for molecular studies: 52 specimens. See Fig. E2.5f.

CANADA. British Columbia: 2006, *CBHR 415*, 658; 2006, *CBHR 416*, 658; 2006, *CBHR 417*, 658; 2006, *CBHR 421*, 601; 2006, *CBHR 422*, 624; 2006, *CBHR 424*, 658; 2006, *CBHR 426*, 621; 2006, *CBHR 427*, 658; 2006, *CBHR 428*, 658; 2006, *CBHR 429*, 658; 2006, *CBHR 430*, 658; 2006, *CBHR 431*, 658; 2006, *CBHR 432*, 658; 2006, *CBHR 434*, 617; 2006, *CBHR 435*, 658; 2006, *CBHR 436*, 658; 2006, *CBHR 437*, 658; 2006, *CBHR 447*, 658; 2006, *CBHR 473*, 658; 2000, *SIRCA 075*, 587; 2000, *SIRCA 077*, 636. **USA. California:** 2007, *CNCS 1020*, 590. **Colorado:** 2005, *CBHR 191*, 658; 2006, *CBHR 407*, 607. **Idaho:** 2008, *CBHR 1355*, 624; 2008, *CBHR 1359*, 658. **Montana:** 2004, *CBHR 207*, 658; 2007, *CNCS 1001*, 609; 2007, *CNCS 1002*, 603; 2007, *CNCS 1003*, 557; 2007, *CNCS 1004*, 610; 2007, *CNCS 1009*, 604; 2007, *CNCS 1010*, 611. **Oregon:** 2004, *CBHR 521*, 658. **Washington:** 2005, *CBHR 233*, 602; 2007, *CBHR 1184*,

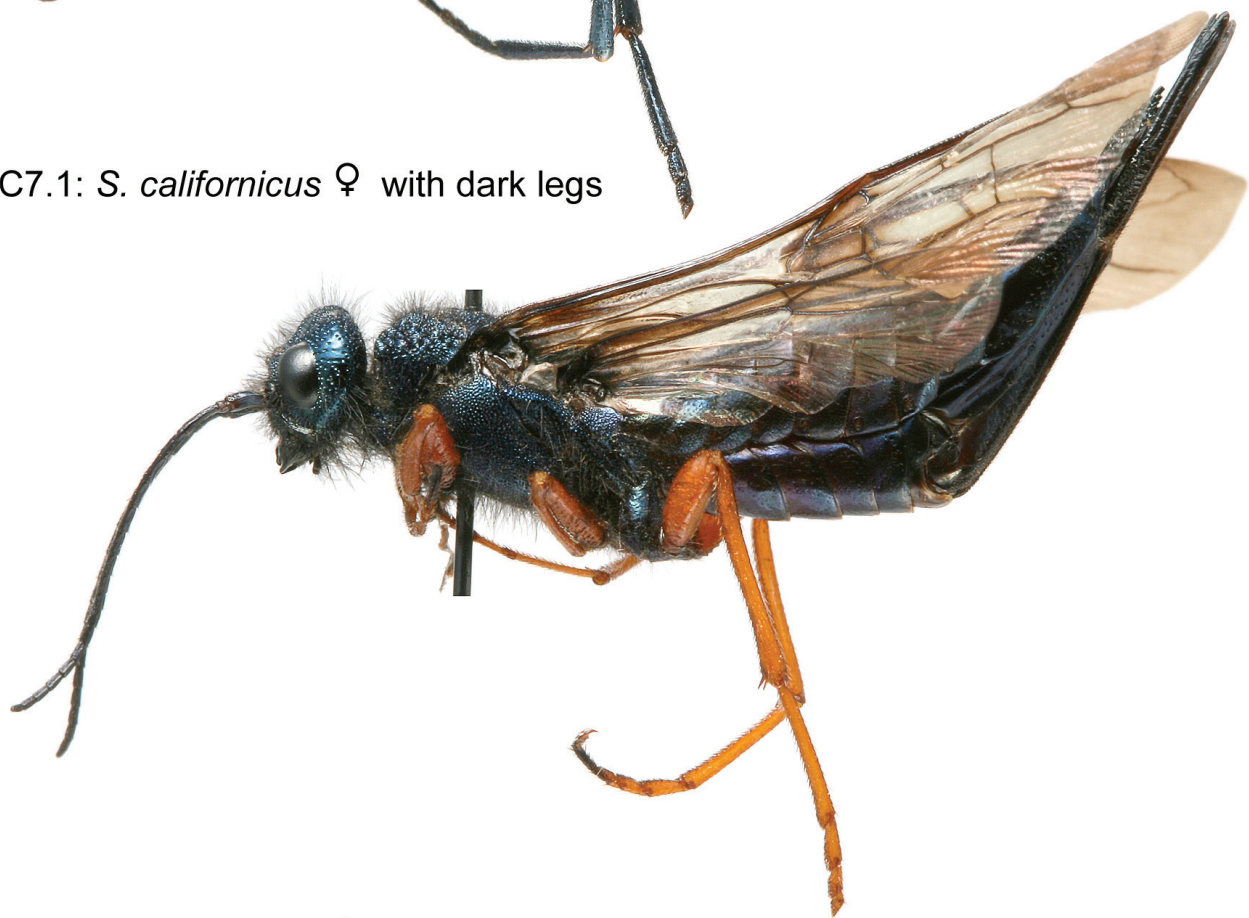
658; 2007, *CBHR 1185*, 658; 2007, *CBHR 1186*, 658; 2007, *CBHR 1187*, 658; 2007, *CBHR 1243*, 658; 2008, *CBHR 1330*, 580; 2008, *CBHR 1341*, 643; 2008, *CBHR 1343*, 658; 2008, *CBHR 1344*, 624; 2008, *CBHR 1347*, 630; 2008, *CBHR 1349*, 514; 2008, *CBHR 1350*, 658; 2008, *CBHR 1970*, 658. **Unknown state:** 2006, *CBHR 402*, 658; 2006, *CBHR 403*, 658; 2006, *CBHR 404*, 601; 2006, *CBHR 405*, 630; 2006, *CBHR 406*, 658.

Specimens of *S. sp.* near *californicus* for molecular studies: 9 specimens. See Fig. E2.5f.

USA. Colorado: 2007, *CNCS 1006*, 585; 2007, *CNCS 1007*, 605; 2007, *CNCS 1008*, 609; 2007, *CNCS 1013*, 588; 2007, *CNCS 1014*, 619; 2007, *CNCS 1015*, 603; 2007, *CNCS 1016*, 584; 2007, *CNCS 1018*, 608; 2007, *CNCS 1019*, 608.



C7.1: *S. californicus* ♀ with dark legs



C7.2: *S. californicus* ♀ with pale legs



C7.3: *S. californicus* ♂



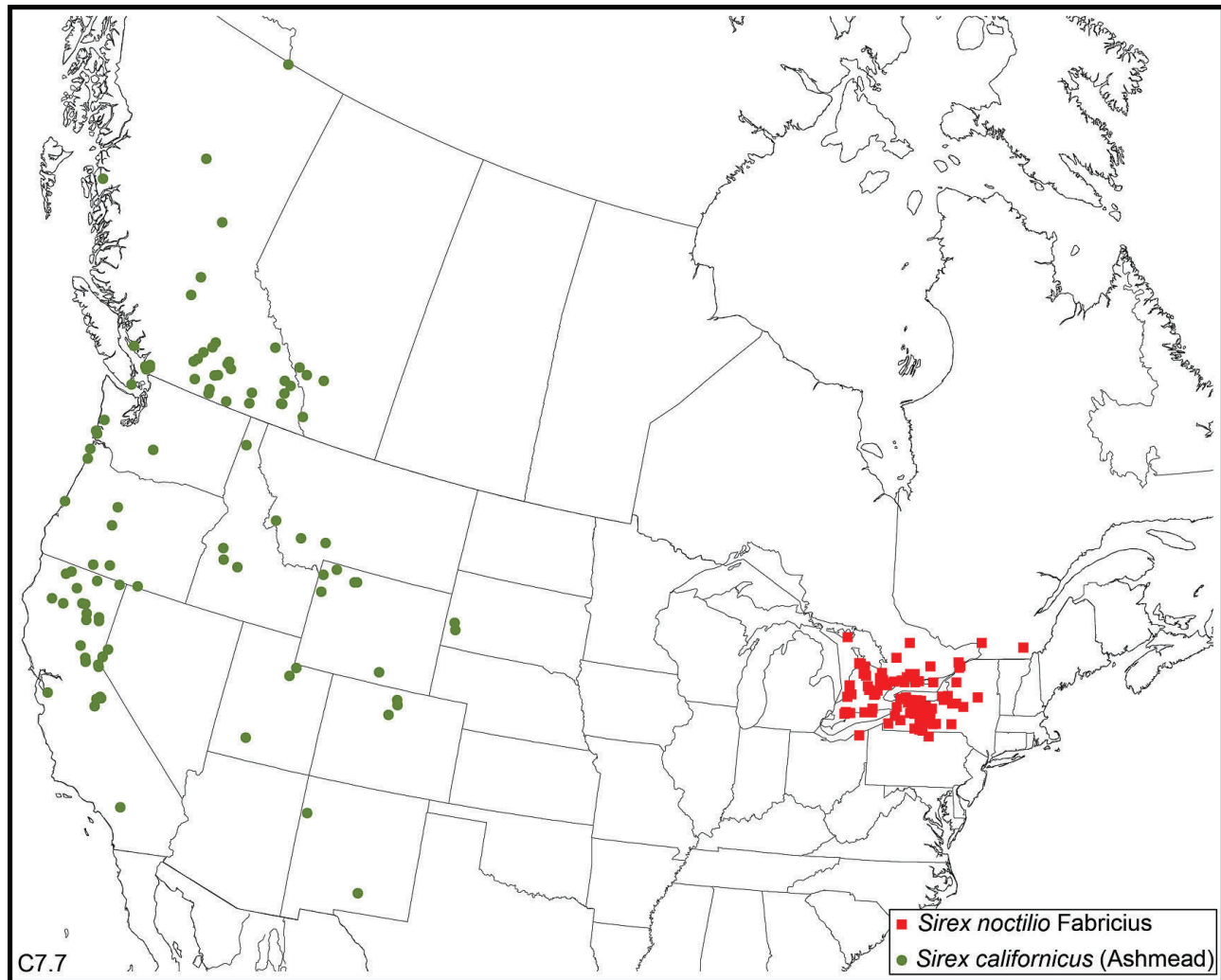
C7.4: *S. californicus* ♀ with dark legs



C7.5: *S. californicus* ♀ with pale legs



C7.6: *S. californicus* ♂



8. *Sirex cyaneus* Fabricius

Fig. C8.1 (female habitus)

Fig. C8.2 (male habitus)

Fig. C4.4 (map)

Sirex cyaneus Fabricius, 1781: 419. Type female (HMUG), dissection and images of ovipositor prepared by Geoff Hancock and sent to HG for study. Type locality: “America boreali”.

Urocerus cyaneus; Norton, 1869: 357 (change in combination); accepted by Provancher 1879: 230 and 1883: 241.

Sirex abbotii Kirby, 1882: 378, pl. XV, fig. 8. Holotype male (BMNH), examined by HG. Synonym by Bradley 1913: 14; accepted by Smith 1979: 126. Until recently, no one knew the whereabouts of the *S. cyaneus* type. The synonymy by Bradley 1913: 14 was thus applied correctly by chance. Type locality: Georgia.

Sirex hirsutus Bradley, 1913: 14 (not Kirby, 1882: 380); accepted by Ries 1951: 83, Smith 1979: 126. See

“Additional notes”

Sirex juvenicus cyaneus; Bradley, 1913: 14 (change in rank); accepted by Hedicke 1938: 19.

Diagnostic combination

Among **females** with a completely light reddish brown metafemur, short metatarsomere 2 (tarsomere 1.5–3.0 times as long as high), black abdomen, and long tarsal pad (length of pad 0.7–0.8 as long as ventral length of tarsomere) [*abietinus*, *nitidus*, and *varipes*], those of *S. cyaneus* are recognized by the much very small pits at the middle of the lancet (pit length 0.0–0.13 times as long as length of annulus), length of annulus 10 1.33–1.82 as long as height of ovipositor (lance + lancet) at this annulus, and the lack of pits in basal 6–9 annuli of the ovipositor. Among **males** with a reddish brown metafemur and mainly black metatibia [*abietinus*, *nitidus*, *noctilio* and *varipes*], those of *S. cyaneus* are recognized by the completely light reddish brown mesotibia and

mesotarsus, the moderately large pits on the gena and the vertex (diameter of pit 0.25–0.4 that of lateral ocellus), and the narrow pale base of the metatibia (spot extending slightly beyond minimum constricted portion and as long as or slightly longer than wide).

Adults of *S. cyaneus* are extremely similar to those of *S. abietinus*. If the male is from east of the Rocky Mountains within the range of *Abies balsamea*, it is likely this species, but outside this range it will likely be those of *S. nitidus*.

FEMALE. Description

Color. Body, antenna (less than 3% of specimens with flagellomeres 1 or 1 and 2 brown; only one specimen with flagellomeres 1–4 light reddish brown), and palps black with dark blue metallic reflections. Coxae black; femora (except brown base), tibiae, and tarsi (apical half of tarsomere 5 usually darker but not dark brown or black (as in Fig. B2.60)) light reddish brown. Fore wing mainly clear, at most light yellowish brown behind stigma.

Head. Gena with pits 2.0–6.0 pit diameters apart and mainly absent centrally behind eye; vertex and postocellar area with pits 0.0–2.0 pit diameters apart (as in Fig. B2.62), and each pit diameter 0.15–0.2 that of lateral ocellus.

Thorax. Mesoscutum with coarse, net like–pits in posterior 0.6 of median area (as in Fig. B2.65). Metatarsomere 2 in lateral view 2.3–2.8 times as long as high, and length 1.1–1.2 times length of tarsomeres 3 + 4; tarsal pad 0.8–0.9 times as long as ventral length of tarsomere (as in Fig. B2.67). Fore wing vein 3A absent.

Abdomen. Median basin of tergum 9 with basal width 0.9–1.3 times as long as median length, maximum width 1.1–1.5 times as long as median length, and median length 0.55–0.65 times as long as cornus length (Fig. B2.88). Cornus in dorsal view short, with edges straight to slightly angular midway; its median length 1.05–1.3 times as long as maximum width of abdomen at junction of terga 9 and 10 (Fig. B2.88). **Sheath.** Length 0.7–0.87 times fore wing length, basal section 0.87–1.12 times as long as apical section. **Ovipositor.** Lancet with 29–33 annuli (basal annuli hardly outlined and very difficult to see); junction of basal and apical section of sheath aligned between 9th and 10th or 10th and 11th annuli, with 16–20 pits beginning with annuli 8–10 (Fig. B2.84, base). Pits near middle annuli or area at base of apical section of sheath 0.0–0.12 times as long as an annulus (pits gradually and markedly decreasing in size toward base and disappearing before any of annuli 7–11), 0.07–0.25 times as high as lancet height in lateral view, and about 1.0–1.6 times as long as high (Fig. B2.86); annulus 10 length/ovipositor diameter (lance + lancet) 1.33–1.82 (based on 29 specimens) (Fig. B2.86). Last 3–4 annuli

before teeth annuli as well as first tooth annulus with ridge on ventral edge of pit. Edge of apical 5–7 annuli before teeth annuli extending as ridge to ventral edge of lancet.

MALE. Description

Color. Head and thorax black with dark blue metallic reflections. Coxae, metatibia (except extreme base), and metatarsomeres 1–3 black; femora, tibiae, and tarsus of fore and middle legs light reddish brown (Fig. B2.132). Fore wing clear. Abdomen with segments 1 and 2 or 1–3 black, segments 3–7 or 4–7 light reddish brown, and segment 8 black, rarely light reddish brown (Fig. B2.133); sternum 8 and 9 black or completely reddish brown (only specimens from Alberta).

Thorax. Metatibia 4.2–4.6 times as long as maximum width. Metatarsomere 1 in lateral view 3.2–3.6 times as long as maximum height.

Taxonomic notes

Much of the North American literature under *S. cyaneus* or *S. juvencus* is very confusing because up to five species fall under these traditional names (Slosson 1895, Blackman and Stage 1918, Essig 1926, Rohwer 1928, Middlekauff 1960, Benson 1963, Cameron 1965, Okutani 1965, Smith and Schiff 2002, Schiff *et al.* 2006).

Females of *S. cyaneus* have commonly been confused with females of the European “*S. cyaneus*” (identified here as *S. torvus* M. Harris, see Chapter D. Additional Notes) and *S. juvencus* because the whereabouts of the Fabricius type of *S. cyaneus* was unknown. Its discovery in HMUG clarifies the name used for several European and American species. *Sirex cyaneus* is distinguished from all European species (*S. juvencus*, *S. torvus*, and *S. atricornis*) by the absence of pits and annuli in the basal 0.4 of the ovipositor. The following character states also distinguish *S. cyaneus* from *S. torvus*: in both sexes of *S. cyaneus* the pits on the gena and vertex are moderate in size (smaller in *S. torvus*); in females of *S. cyaneus* there are no pits in the basal annuli of the ovipositor (pits start on ovipositor annulus 2 in *S. torvus*) and, on average, the apical section the sheath is equal to the basal section (apical section longer than basal section in *S. torvus*); in males of *S. cyaneus* (except in Alberta) the abdominal apex is black (reddish brown in *S. torvus*) and (except in a very few specimens from Alberta) the mesotibia and mesotarsus are completely light reddish brown (widely black mesotibia, except at base, and mesotarsomeres 1–3 in *S. torvus*). *Sirex cyaneus* has even been considered as a subspecies of *S. juvencus*. Adults of *S. juvencus* are easily distinguished from those of *S. cyaneus* by antennal color pattern and ovipositor pit development.

Sirex abbotii and *S. hirsutus* have been assigned traditionally to *S. cyaneus*. The holotype male (from coastal Georgia or southeastern USA) of *S. abbotii* matches males of *S. cyaneus* in color pattern. In the southern Appalachian Mountains, *Abies fraseri* is the only host for *S. cyaneus*. *Abies fraseri* grows only at high elevations. The holotype could have arrived in coastal Georgia (where *A. fraseri* is absent) with logs harvested in the Appalachian Mountains in westernmost Georgia or South Carolina. The holotype of *S. hirsutus* is not a Nearctic species as it is a typical specimen of *S. juvencus* (see Chapter D. Additional Notes about its synonymy). So the holotype is probably an intercepted specimen from Europe.

Where the ranges overlap, females of *S. cyaneus* could be confused only with *S. nitidus* and *S. noctilio* females. Ovipositor pit development distinguishes *S. cyaneus* from these two species. In addition, both sexes of *S. cyaneus* are easily distinguished from those of *S. noctilio* on puncture size on the vertex and pit development on the mesoscutum, and females of *S. cyaneus* are distinguished by the long tarsal pad of metatarsomere 2 and very small pits near the middle of the ovipositor.

Outside its range *S. cyaneus* could be confused with *S. abietinus*, a species found from the Rocky Mountains and westward. The *S. cyaneus* range extends as far as west of Lesser Slave Lake, Alberta. The two species are probably allopatric like their main hosts, various species of *Abies*. There is a gap between *A. balsamea*, an eastern species, and *A. lasiocarpa*, a western species, in western Alberta. In *S. cyaneus*, females have annulus 10 relatively short compared to ovipositor diameter, and, commonly, a relatively thin, short cornus (relatively long annulus and a thick cornus in *S. abietinus*); males (only those at least from Manitoba and eastward) have black sterna 8 and 9 (in most specimens tergum 8 is completely black) (completely light reddish brown apical abdominal segments in *S. abietinus*). The information from morphology and DNA barcoding shows a difference of 10.6% in base pairs between *S. cyaneus* and *S. abietinus*. Despite their great similarity, the two taxa are considered as specifically distinct.

Biological notes

Stillwell (1966) published a fine study on the biology *S. cyaneus* (under the name *S. juvencus* – 800 specimens of this study are in CNC and all are *S. cyaneus*). Adults were reared from weakened *Abies balsamea* collected throughout New Brunswick and Nova Scotia.

Females oviposit in dead and dying firs, but they could be induced to oviposit in healthy logs. Males emerge first, but continue to emerge throughout the summer. On the day of emergence, females start to oviposit. Oviposition

lasts from 4–20 minutes (most last 8–10 minutes). The ovipositor penetrates at about right angle to the surface to a depth of 2–10 mm. Generally, each female lays one to three eggs as the ovipositor is withdrawn. The eggs are about 1 mm long and usually overwinter or hatch in late summer. Larvae overwinter in the first or second instar. The first instar is usually within the oviposition hole, but the second instar larva bores at about a right angle to the oviposition hole. Larvae molt 5–11 times, based on exuviae that are packed in the frass at intervals within each gallery. Most larvae stay within the first 4 cm of the log surface and the length of the galleries vary from 5–15 cm. The pupae are in a chamber usually 2 cm below the surface. The prepupa lasts 4–6 weeks and the pupal stage 2–3 weeks. Most life cycles last two years, but some may last three years. Unmated females produce males only, mated females produce both sexes.

A mycangium is a special organ that carries oidia (a kind of fungal conidia). Two mycangia are found at the base of the ovipositor. In most instances oidia are carried in them. Several kinds of fungi grow in a log, but only one, *Amylostereum chailletii* (in Stillwell's paper, this species is under the genus *Stereum*) is carried by females of *S. cyaneus*. The oidia are deposited on the end of each egg at oviposition time and are also found along the oviposition hole. The larva at hatching time has plenty of this fungus to eat. Without the fungus the larva dies at the first instar. Female larvae carry the fungus in a paired organ called the hypopleural organ. This organ is found in the fold between the first and the second abdominal segments. Following a molt, the fungal oidia remain in the exuvia and the female larvae must pick the fungus again to fill the new hypopleural organ. The female prepupae enclose the fungal oidia in wax-like plates.

Hosts and phenology

The host range of *S. cyaneus* is mainly restricted to species of *Abies* (99% of the reared specimens). Based on 1103 reared and confirmed specimens, all recorded hosts are Pinaceae: *Abies* sp. (38), *Abies balsamea* (932), *A. fraseri* (16, Kirk 1974), *Larix* sp. (5), *Picea glauca* (10), *P. mariana* (1), and *Pinus strobus* (1). *P. elliotii* (Kirk (1974) under *S. abbotii* (see *S. cyaneus* synonymy) is record of a specimen taken outside the range of *S. cyaneus*. Verified published records: (Stillwell 1960, Stillwell 1966, Amman 1969, Kirk 1974); unverified published records: Belyea (1952).

Based on 675 field-collected and reared (under natural conditions) specimens, the earliest and latest capture dates are July 2 and October 3. The main flight period is from the second half of July to the first half of September with a peak in second half of August.

Range

CANADA: AB, MB, NB, NL, NS, ON, QC, SK.
USA: ME, MI, MN, NC, NH, WV. *Sirex cyaneus* is recorded from western Alberta to Newfoundland south to the Great Smoky Mountains (Fig. C4.4). We have seen many intercepted specimens from New Zealand (FRNZ).

Specimens studied and included for range map: 484 females and 933 males from CASS, CNC, CUIC, DEBU, FRLC, GLFC, LECQ, LEMQ, NFRC, NFRN, and USNM.

Specimens for molecular studies: 11 specimens. See Fig. E2.5d.

CANADA. Alberta: 2008, *CNCS 1030*, 598; 2008, *CNCS 1031*, 575; 2008, *CNCS 1032*, 575; 2008, *CNCS 1033*, 580; 2008, *CNCS 1034*, 580; 2008, *CNCS 1035*, 577; 2008, *CNCS 1036*, 587. **New Brunswick:** year unknown, *SIRCA 043*, 594; 2007, *SIRCA 044*, 613. **USA. New York:** 2006, CBHR 610, 658. **Washington:** 2007, CBHR 1327, 628.



C8.1: *S. cyaneus* ♀



C8.2: *S. cyaneus* ♂

9. *Sirex hispaniola* Goulet, n. sp.

Fig. C9.1 (female habitus).

Fig. C9.2 (female dorsal habitus).

Fig. C9.6 (map)

Diagnostic combination

Among **females** with completely reddish brown abdomen beyond the 2nd segment [pale form of *nigricornis*], that of *S. hispaniola* is recognized by the short metatarsomere 2 in lateral view (1.7 times as long as high), the long tarsal pad on metatarsomere 2 (0.8 times as long as ventral length of tarsomere). **Both sexes** probably (male unknown) are recognized by crater-like pits on most of median half of the mesoscutum, and the very dense pits on the gena and most of the vertex (pits on gena 0.0–1.0 and on the vertex 0.0–0.5 pit diameters apart).

FEMALE. Description

Color. Head, thorax, antenna, palps, coxae, apical section of sheath, margin of tergum 9, ventral surface of tergum 10 at base and in anterior half, and all of tarsomeres 5 black with dark blue metallic reflections. Legs after coxae (except tarsomere 5), legs reddish brown. Both wings darkly tinted. Abdomen basal segments 1 and 2 and side of tergum 3 black, remaining terga including cornus light reddish brown.

Head. Gena with pits 0.0–0.5 pit diameters apart (Fig. B2.55); vertex and postocellar area with pits 0.0–0.5 pit diameters apart (Fig. B2.57), and each pit diameter about 0.3–0.4 that of lateral ocellus.

Thorax. Mesoscutum with coarsely, net-like pits over most of median area. Metatarsomere 2 in lateral view 1.7 times as long as high and as long as length of tarsomeres 3 + 4 (Fig. 2.59); tarsal pad 0.8 times as long as ventral length of tarsomere (Fig. C9.3). Fore wing vein 3A absent.

Abdomen. Median basin of tergum 9 with basal width 1.3 times as long as median length, maximum width 1.7 times as long as median length, and median length 0.75 times as long as cornus length. Cornus in dorsal view short, with edges clearly angular midway, its median length 0.7 times as long as maximum width of abdomen at junction of terga 9 and 10. **Sheath.** Length 0.57 times fore wing length, basal section 1.4 times as long as length of apical section (Fig. B2.53). **Ovipositor.** Lancet with 32 annuli (basal annuli not clearly outlined); junction of basal and apical section of sheath aligned between 15th and 16th annuli, with 29 pits beginning with annulus 2; pit of annulus 2 only extending to edge of annulus 1 (Fig. C9.4). Pits near middle annuli (see A, B, C & D in Fig. C9.5) or area at base of apical section of sheath, 0.5 times as long as an annulus (pits scarcely decreasing in

size toward base) (A), about 0.65 times as high as lancet height in lateral view (B), and about 1.5 times as long as high (2.0 times as long on annulus 3) (C); annulus 10 length/ovipositor diameter (lance + lancet) 1.25 (D) (Fig. C9.5). Last 4–5 annuli before teeth annuli as well as first tooth annulus with ridge on ventral edge of pit. Edge of apical 4–5 annuli before teeth annuli extending as ridge to ventral edge of lancet.

MALE. Unknown.

Type material.

Holotype female (MHND), in good condition except right metatarsus missing and left metatarsus glued on a point; labeled [white label] “REP. DOM.: Prov. La Vega, La Sal, Res. Ebano Verde (19°4’101”N 70°34’89”W), 1043 m, 11–12 July 2002, coll. D. Perez, B. Hiero, R. Bastardo” [red label] “HOLOTYPE *Sirex hispaniola* Goulet”. Type locality: Dominican Republic, La Vega, Reserva Ebano Verde.

Taxonomic notes

This is the first species of *Sirex* recorded from the Greater Antilles. The female was captured at high elevation (1040 m, at the lower reaches of pine forests). Hispaniola has three isolated, high mountain ranges. Each could have different species of Siricidae. The same could be said of the three isolated mountain ranges of Cuba. *Sirex hispaniola* is found in the Cordillera Central in the Dominican Republic. It is most similar to the eastern North American *S. nigricornis*. Both have very dense pits on the head and mesoscutum, a short angular cornus, and the unusual basal black transversal band on the ventral surface of segment 10. These two species differ in several characters: the proportions in lateral view and the relative length of the tarsal pad of metatarsomere 2, ovipositor annulus number at the junction of the apical and basal sheath sections, and the long and deep second annulus pit. These differences suggest a rather long period of isolation between the species from continental North America and Hispaniola.

Origin of specific epithet

The name, *hispaniola*, is a noun in apposition and refers to the island that includes Haiti and the Dominican Republic. Julio A. Genaro found an unexpected specimen of *Sirex* while examining the insect collection in Santo Domingo. The discovery is significant and similar discoveries in coniferous forests of other high mountain ranges of Hispaniola and Cuba may be expected. Julio

proposed most appropriately that we use the name *hispaniola* for the new species to emphasize its origin.

Hosts and phenology

Hosts are unknown, but are most likely *Pinus* spp. This is supported by the short apical section of the sheath and the trough development of the pit on annulus 2, a character shared by all New World species of *Sirex*

associated with pines. The single female was captured in mid July.

Range

Sirex hispaniola is known from a single female captured in the Cordillera Central of Hispaniola (Fig. C9.6).



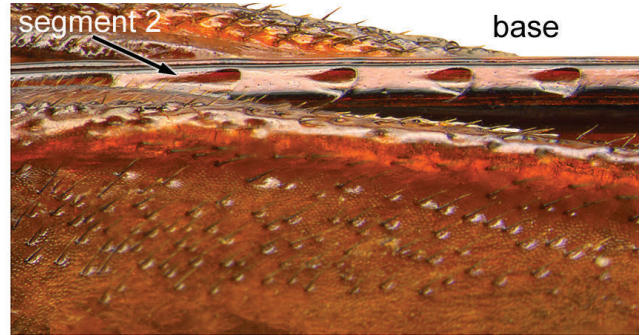
C9.1: *S. hispaniola* ♀



C9.2: *S. hispaniola* ♀

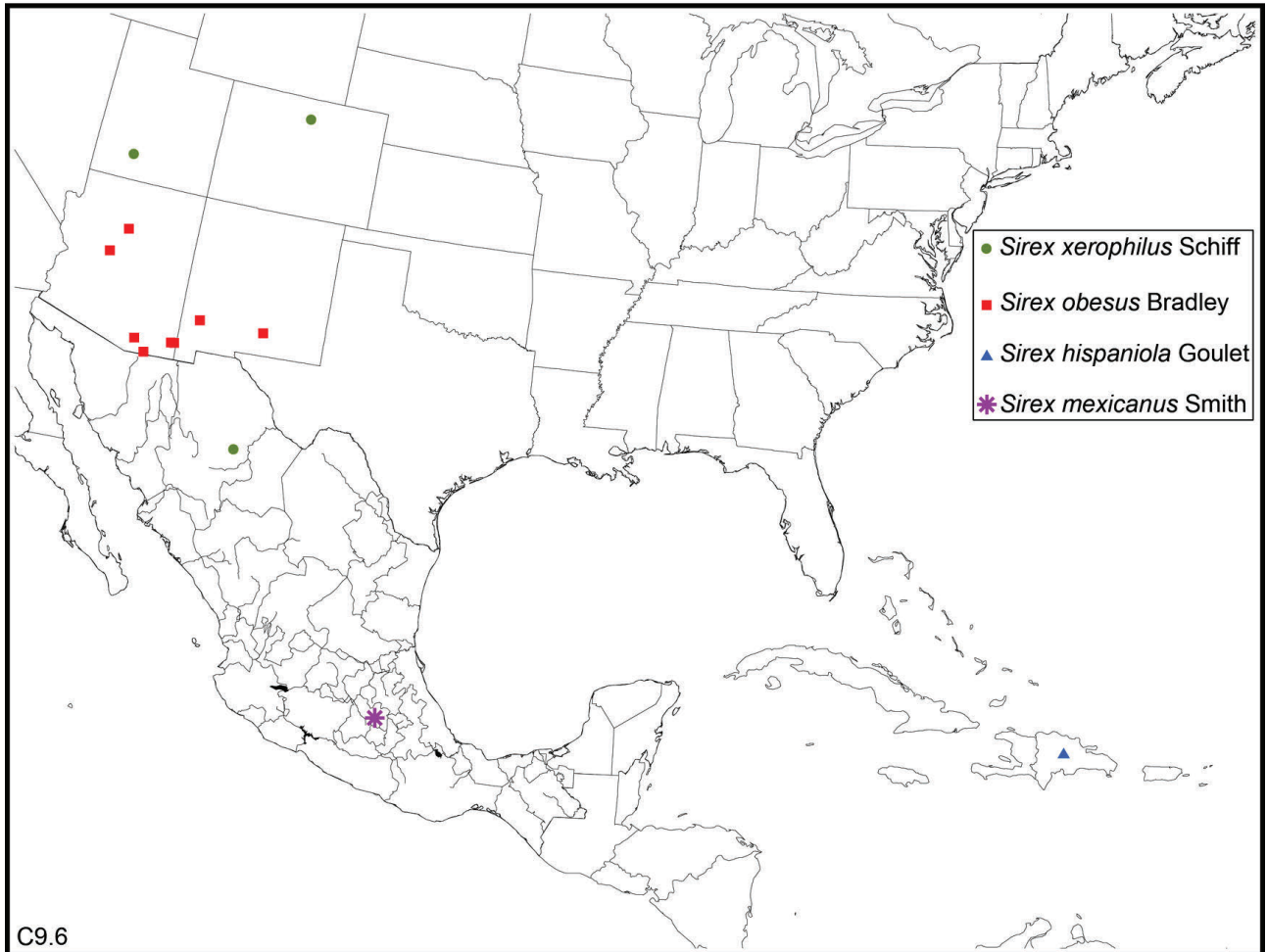


C9.3: *S. hispaniola* ♀



C9.5: *S. hispaniola* ♀

C9.4: *S. hispaniola* ♀



10. *Sirex longicauda* Middlekauff

Fig. C10.1, Schiff *et al.* 2006 : 44 (female habitus)

Fig. C10.2, Schiff *et al.* 2006 : 43 (male habitus)

Fig. C10.4 (map)

Sirex longicauda Middlekauff, 1948: 189. Holotype, female (CASC), not examined; Middlekauff 1960: 65, Middlekauff 1962: 31 (male), Burks 1958: 16, Burks 1967: 26, Smith 1979: 127. Type locality: Berkeley, California.

Diagnostic combination

Among **females** with long (4.0–6.0 times as long as high) metatarsomere 2 [*areolatus*], those of *S. longicauda* are recognized by the reddish brown tibiae and tarsi. Among **males** with black metafemur and gena [*areolatus*, dark form of *S. nigricornis*, and dark legged form of *nitidus*], those of *S. longicauda* are recognized by the reddish brown protibia and protarsus, the finely pitted vertex, and the widely reddish brown base of the metatibia (brown area about 2.0 times as long as minimum width at base).

FEMALE. Description

Color. Body, antenna, and palps black with dark blue or green metallic reflections. Coxae and femora (except apex) black; tibiae and tarsi reddish brown (Fig. B2.7). Fore wing clear.

Head. Gena with pits 2.0–8.0 pit diameters apart, vertex with pits 2.0–4.0 pit diameters apart, and each pit diameter about 0.16 times lateral ocellus.

Thorax. Mesoscutum with dense pits, each pit round but in median area with numerous transverse ridges. Metatarsomere 2 in lateral view 4.0–5.0 times as long as high; tarsal pad about 0.4 times as long as ventral length of tarsomere. Fore wing vein 3A present and clearly extending along posterior margin of wing.

Abdomen. Median basin of tergum 9 with basal width about 0.72 times as long as median length, maximum width about 0.86 times as long as median length, and median length about 0.63 times as long as cornus length. Cornus in dorsal view long, attenuated in apical 0.25–0.3, and edges not angular midway, its median length 1.42 times as long as maximum width of abdomen at junction of terga 9 and 10. **Sheath.** Length 1.1–1.4 times fore wing length, basal section 0.4–0.6 times as long as length of apical section. **Ovipositor.** Lancelet with 40–47 annuli (outline of edge of basal annuli difficult to see (Fig. B2.11)); junction of basal and apical section of sheath aligned between 7th and 8th, or 8th and 9th annuli, with about 22 pits beginning near annulus 18. Pits near middle annuli or area at base of apical section of sheath

about 0.25 times as long as an annulus (pits gradually decreasing in size toward base), about 0.5 times as high as lancet height in lateral view, and about 1.2 times as long as high; annulus 10 length/ovipositor diameter (lance + lancet) not measured. Last annulus before teeth annuli as well as first tooth annulus with ridge on ventral edge of pit (Fig. C10.3). Edge of apical 9–16 annuli before teeth annuli extending as ridge to ventral edge of lancet (Fig. B2.9).

MALE. Description

Color. Head, thorax, antenna, palps, abdominal segments 1, 2, 8, sterna 2, 3 and 4 laterally, and 8 black with dark blue metallic reflections; abdominal segments 3–7 (except for black spot laterally on segments 3 and 4) light reddish brown. Coxae, femora, metatibia (except base), and metatarsomeres 1–3 black (Fig. B2.99); tibiae, and tarsi of fore and middle legs, and metatarsomeres 4 and 5 reddish brown (Fig. B2.101); reddish brown spot at base of metatibia large (spot about 2.0 times as long as minimum width of tibia at base) (Fig. B2.99). Fore wing clear.

Thorax. Metatibia 5.5 times as long as maximum width. Metatarsomere in lateral view 1.44 times as long as maximum height.

Taxonomic notes

The type of *Sirex longicauda* was not examined, but the female description and especially the length of the ovipositor sheath and the long and narrow cornus fits our concept of this species perfectly.

Hosts and phenology

The host range of *Sirex longicauda* is moderately wide (Middlekauff 1960, Wickman 1964b, Cameron 1965). The most preferred hosts (96%) are various species of *Abies*. Based on 134 reared and confirmed specimens all hosts are Pinaceae: *Abies* sp. (2), *Abies concolor* (127) (most records from Kirk (1975)), *A. magnifica* (1), *A. balsamea* (1), *Pinus* sp. (1), *P. albicaulis*, *P. ponderosa*, *P. strobus* (1), and *Pseudotsuga menziesii* (1).

Based on 29 field-collected and reared (under natural conditions) specimens, the earliest and latest capture dates are from early June to mid October. The main flight period is in late September.

Range

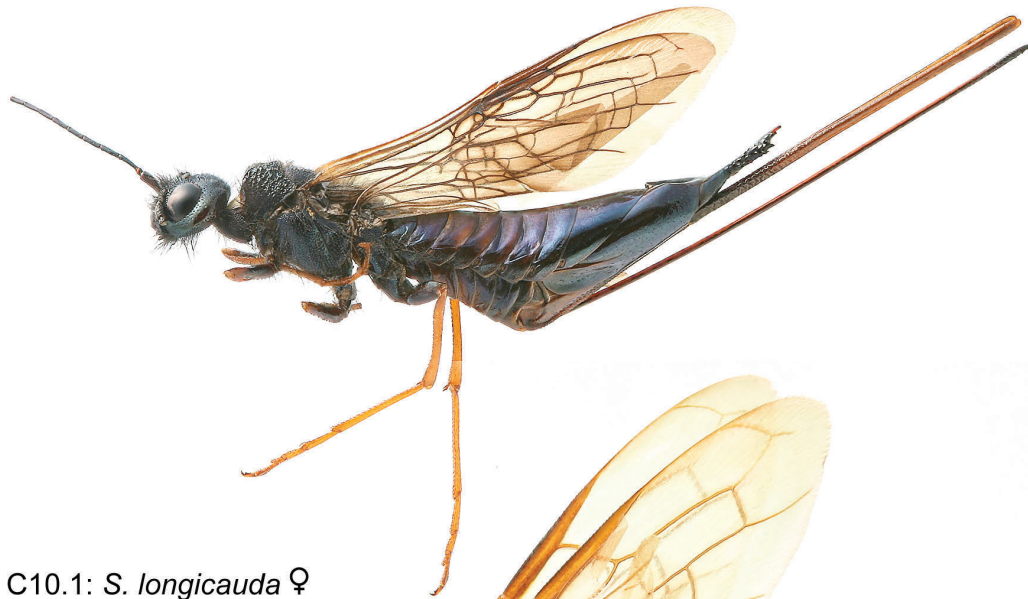
CANADA: BC. **USA:** CA (Middlekauff 1960), CO, ID, GA, HI, KS (from west coast lumber), NE, NM, OH (from *Pinus strobus*), OR, UT, VA, WA.

Sirex longicauda, a western species, is recorded from southwestern British Columbia to forested regions of California and New Mexico (Fig. C10.4). The four eastern specimens (GA, KS, NE and OH) are probably adventive (Burks 1967, Smith and Schiff 2002).

Specimens studied and included for range map: 46 females and 16 males from BYUC, CNC, OSAC, PFRC, UAIC, UCRC, and USNM.

Specimens for molecular studies: 6 specimens. See Fig. E2.5a.

CANADA. British Columbia: 1982, *SIRCA 066*, 307. **USA. Colorado:** 2006, *CBHR 914*, 658; 2006, *CBHR 915*, 658; 2006, *CBHR 916*, 658; 2006, *CBHR 917*, 658; 2006, *CBHR 918*, 658.



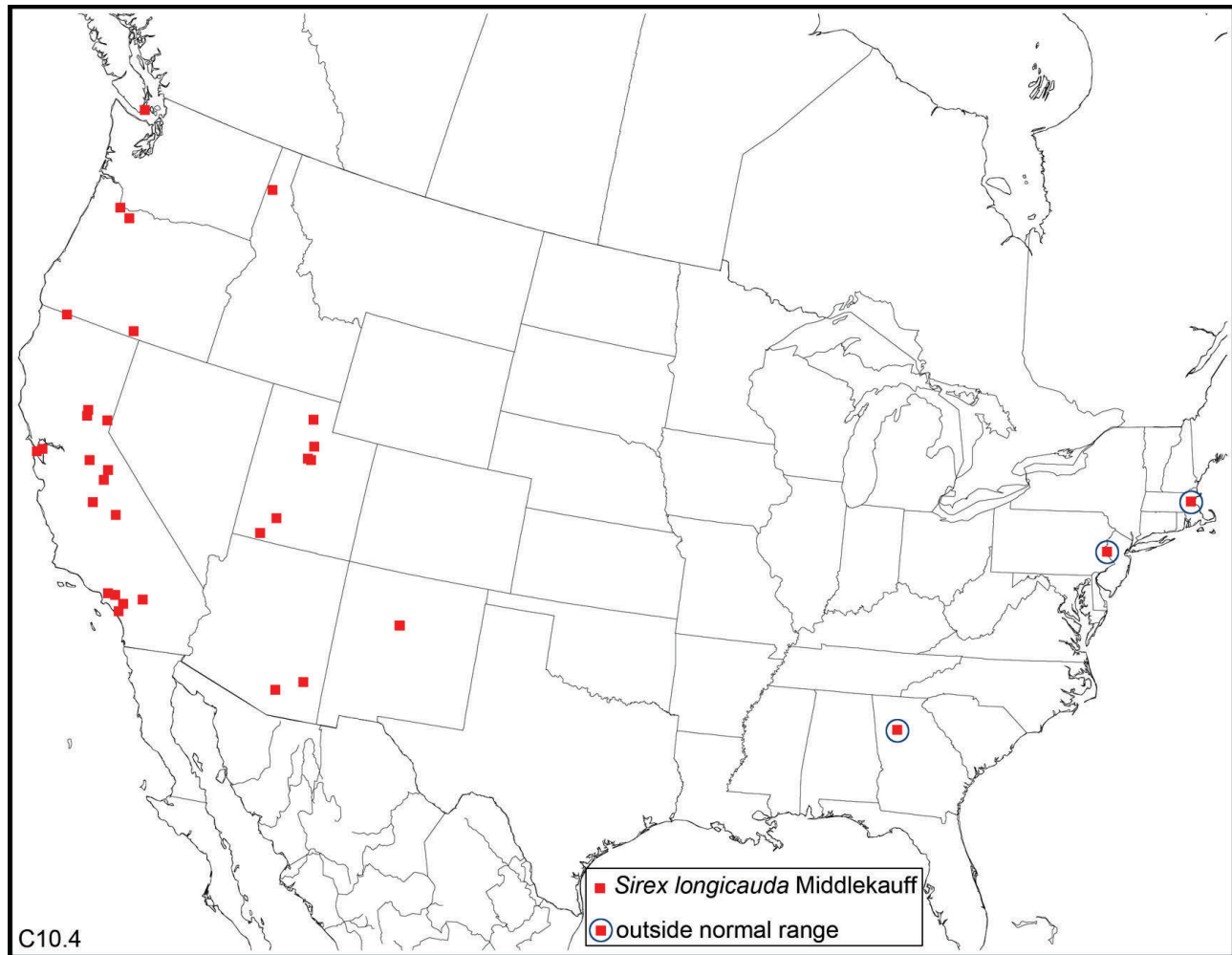
C10.1: *S. longicauda* ♀



C10.2: *S. longicauda* ♂



C10.3: *S. longicauda* ♀



11. *Sirex mexicanus* Smith, n. sp.

Fig. C11.1 (female habitus)

Fig. C11.2 (male habitus)

Fig. C9.6 (map)

Diagnostic combination

Among **females** with metatarsomere 2, 2.0–3.0 times as long as high, and completely black body, legs and a clear fore wing [*xerophilus*], those of *S. mexicanus* are recognized by the few transverse ridges on the posterior half of the mesoscutum. Among **males** with brown femora, tibiae, and tarsi [*californicus*, *obesus*, and *xerophilus*], those of *S. mexicanus* are recognized by light reddish brown antenna (apical antennomeres may be a little darker) and coxae, and the clear fore wing.

FEMALE. Description

Color. Body, legs, palps, and antenna black with dark blue metallic reflections. Fore wing clear.

Head. Gena with pits 0.0–0.5 pit diameters apart (Fig. C11.3), vertex and postocellar area with pits 0.0–0.5 pit diameters apart (Fig. B2.119), and each pit diameter about 0.25–0.3 that of lateral ocellus.

Thorax. Mesoscutum with few transverse ridges in posterior half of median area; pits large but not net-like (Fig. B2.46). Metatarsomere 2 in lateral view 3.0 times as long as high, and its length about 1.2 times as long as tarsomeres 3 + 4; tarsal pad 0.3 times as long as ventral length of tarsomere. Fore wing vein 3A present and clearly outlined (Fig. B2.48).

Abdomen. Median basin of tergum 9 with basal width as long as median length, maximum width 1.2 times as long as median length, and median length 0.8 times as long as cornus length. Cornus in dorsal view short, with edges straight, its median length 0.88 times as long as maximum width of abdomen at junction of terga 9 and 10. **Sheath.** Length 0.65 times fore wing length, and basal section 1.25 times as long as length of apical section. **Ovipositor.** Lancet with 32 annuli (basal annuli clearly outlined (Fig. B2.52)); junction of basal and

apical section of sheath aligned between 15th and 16th annuli, with 28 pits beginning with annulus 2; pit present from annulus 2; pit of annulus 2 only extending to edge of annulus 1 (Fig. B2.52, base). Pits near middle annuli (Fig. B2.50) or area at base of apical section of sheath 0.5 times as long as an annulus (pits slightly decreasing in size toward base), 0.5 times as high as lancet height in lateral view, and 1.4 times as long as high (Fig. B2.52, middle); annulus 2 length/ovipositor diameter 1.35, for annulus 5 1.18, and for annulus 13 1.12 (1 specimen). Last 4 annuli before teeth annuli as well as first tooth annulus with ridge on ventral edge of pit. Edge of apical 5 annuli before teeth annuli extending as ridge to ventral edge of lancet.

MALE. Description

Color. Body, head, palps, thorax, and abdominal segments 1 or 1 and 2 black with dark blue metallic reflections; remaining abdominal segments and antenna (a little darker apically) (Fig. B2.117) light reddish brown. Legs and coxae reddish brown (Fig. B2.121). Fore wing clear.

Thorax. Metatibia 3.4–3.8 times as long as maximum width (Fig. B2.121). Metatarsomere 1 in lateral view 2.7–3.2 times as long as maximum height.

Type material

Holotype female (FSCA), in perfect condition; labeled [White] “Mexico, D.F. 22 June 1980 Woodpile: Garage D. J. Pletsch” [White with red frame] “HOLOTYPE

Sirex mexicanus Smith”. Type locality: Mexico, Distrito Federal.

Paratypes. 1 female and 4 males. **MEXICO.** Distrito Federal: 22.VI.1980, woodpile, garage D. J. Pletsch (3M, 1M allotype, FSCA). USA. Texas: Brownsville (Port of Entry), pallets, 20.VI.2005, M. A. Garcia (1 F, USNM).

Origin of specific epithet

The name *mexicanus* is an adjective derived from the country and capital name – most specimens were collected in the vicinity of Mexico City. This species may be the first of many to be discovered in Mexico.

Hosts and phenology

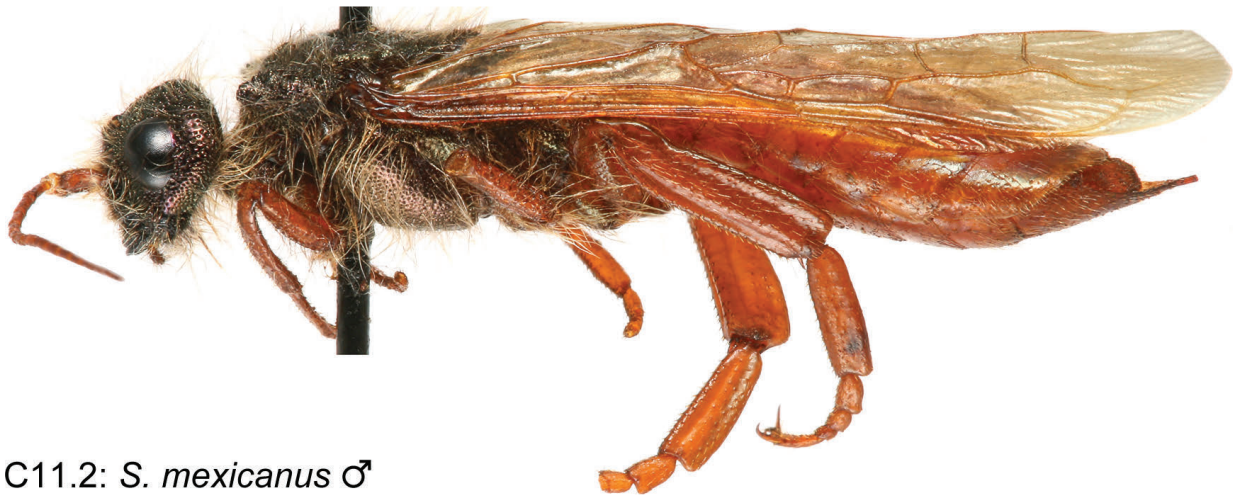
The host of *S. mexicanus* is unknown; it may be on various species of *Pinus* because *S. mexicanus* is related to *S. californicus*, with a short apical sheath section, and annulus 2 with a trough. The type specimens were captured on June 20 and July 22.

Range

Mexico: Distrito Federal, and northern Mexico intercepted at Brownsville, TX. *Sirex mexicanus* is probably widespread as it is found from the vicinity of Mexico City to the port of entry at Brownsville in, southern Texas (Fig. C9.6).



C11.1: *S. mexicanus* ♀



C11.2: *S. mexicanus* ♂



C11.3: *S. mexicanus* ♂

12. *Sirex nigricornis* Fabricius

Fig. C12.1, Schiff *et al.* 2006: 32, 33 (female with black abdomen, habitus)

Fig. C12.2, Schiff *et al.* 2006: 46, 47 (female with mainly reddish brown abdomen, habitus)

Fig. C12.3, Schiff *et al.* 2006: 31 (male with dark abdomen, habitus)

Fig. C12.4, Schiff *et al.* 2006: 45 (male with pale abdomen, habitus)

Fig. C12.5 (live female with mainly reddish brown abdomen)

Fig. C12.6 (live male with dark abdomen)

Fig. C12.7 (live male with pale abdomen)

Fig. C12.10 (map)

Sirex nigricornis Fabricius, 1781: 418. Type, female (HUMG) not examined; Bradley 1913: 16, Ries 1951: 83, Smith 1979: 127. Type locality: “America boreali”.

Urocerus Edwardsii Brullé, 1846: 645, pl. 45, fig. 1. Holotype, female (probably MNHN), not examined; Bradley 1913: 11, Ries 1951: 83, Smith 1979: 126. NEW SYNONYM. Type locality: “l'Amérique septentrionale”.

Urocerus zonatus Norton, 1869: 357. Lectotype male (ANSP) designated by Cresson (1928), examined by DRS; Cresson 1928: 11. Previously synonymized under *S. edwardsii* by Konow 1898: 81; accepted by Bradley 1913: 11, Ries 1951: 83, Smith 1979: 126. NEW SYNONYM. Type locality: “New York”.

Sirex (Urocerus) Edwardsii, Brullé, 1846: 15 (combination in figure legend).

Sirex Edwardsii, Brullé, 1846: pl. 45, fig. 1 (combination engraved on plate).

Urocerus nigricornis; Norton, 1869: 359 (change in combination).

Sirex fulvocinctus Westwood, 1874: 114, pl. XXI, fig. 1. Holotype female (OXUM), images prepared by James E. Hogan and sent to HG for study. Previously synonymized under *S. edwardsii* by Konow 1898: 81; accepted by Cresson 1880: 67, Bradley 1913: 11, Ries 1951: 83, Smith 1979: 126. NEW SYNONYM. Type locality: “America Septentrionalis”.

Sirex abaddon Westwood, 1874: 115, pl. XXI, fig. 7. Syntype females (all in OXUM), images of one female prepared by James E. Hogan and sent to HG for study. Species described from “2 larger and 2 smaller specimens”. Previously synonymized under *S. edwardsii* by Cresson 1880: 67; accepted by Bradley 1913: 11, Ries 1951: 83, Smith 1979: 126. NEW SYNONYM. Type locality: “America Septentrionalis”.

Sirex morio Westwood, 1874: 115, pl. XXI, fig. 6. Holotype female (OXUM), images prepared by James E. Hogan and sent to HG for study. Synonym by Cresson 1880: 67; accepted by Bradley 1913: 11, Ries

1951: 83, Smith 1979: 126. Type locality: “America Septentrionalis”.

Paururus pinicolus Ashmead, 1898: 179. Lectotype female (USNM), here designated and labeled “Washington, D.C.”, “*Paururus pinicolus* Ashm. Female, type [handwritten]”. Number of specimens not stated, but described from “Jacksonville, Fla.; Washington, D.C., and Morgantown W. Va.”. A specimen labeled “Kanawha Sta., W.V.” is labeled “type”, but this was not mentioned in the original description. Synonym by Konow 1898: 270; accepted by Ries 1951: 83, Smith 1979: 126. Type locality: “Washington, D.C.”.

Paururus Hopkinsi Ashmead, 1904: 64. Lectotype female (USNM), here designated and labeled “Fiske Colr., Oct. 8, Tryon, N.C.”, “Pinus,” “Female Type No. 7684 U.S.N.M.,” “*Paururus Hopkinsi*, Ash. [handwritten]”. Described from “many specimens” reared from dead pines from “Tryon, N.C. and Kanawha, W. Va.”. Although “many specimens” are from this locality, only three have red type labels. Konow 1905a: 7. Previously synonymized under *S. edwardsii* by Bradley 1913: 11; accepted by Ries 1951: 83, Smith 1979: 126. NEW SYNONYM. Type locality: “Tryon, N.C.”.

Sirex nigricornis pinicola; Bradley 1913: 16 (change in rank).

Diagnostic combination

Among **females** with a completely black body and legs and fore wing either darkly tinted or with dark bands near middle and apex [*californicus* and *obesus*], those of *S. nigricornis* are recognized by the long metatarsomere 2 (2.7–3.3 times as long as high, and dorsal length clearly longer than metatarsomeres 3 + 4), the crater-like pits on most of median half of the mesoscutum, and the very dense pits on the gena and most of the vertex (pits on gena 0.0–1.0 and on the vertex 0.0–0.5 pit diameters apart). Among **females** with mainly reddish brown abdomen [*behrensii*], those of *S. nigricornis* are recognized by the black edge of the cornus. Among **males** with black metafemur and reddish brown tibiae and tarsi of the fore and mid legs [*longicauda* and *nitidus*], those of *S. nigricornis* are recognized by the very dense pits on the gena and most of the vertex (pits on the gena 0.0–1.0 and on the vertex 0.0–0.5 pit diameters apart).

FEMALE. Description

Color. Head thorax, antenna, palps, coxae, and femora (except apex in some specimens) black with dark blue metallic reflections. Legs in **black form** completely black, in **pale form** as follows: coxae and femora black, and tibiae and tarsi completely black to completely reddish brown (Figs. B2.28 & as in B2.27). Both wings

lightly to darkly tinted (northern localities) (Fig. B2.31b) to darkly tinted (southern localities) (Fig. B2.31a). Abdomen in **dark form** completely black, in **pale form** as follows: basal segments 1 and 2 to as many as 1–4 black, remaining terga light reddish brown (except laterally in some specimens), remaining sterna completely reddish brown to black, basal section of sheath light reddish brown, apical section black at least in basal half (Fig. B2.15), lateral surface of tergum 9 broadly black, ventral surface of tergum 10 black at base and in anterior half (Fig. B2.15), and cornus dorsally at apex and laterally and widely ventrally black.

Head. Gena with pits 0.0–1.0 pit diameters apart (Fig. B2.33), vertex and postocellar area with pits 0.0–0.5 pit diameters apart (Fig. B2.35), and each pit diameter about 0.3–0.4 that of lateral ocellus.

Thorax. Mesoscutum with coarse, net-like pits over most of median area (Figs. B2.42, close-up C12.8). Metatarsomere 2 in lateral view 2.7–3.3 times as long as high, and its length 1.1–1.3 times length of tarsomeres 3 + 4 (Fig. B2.28); tarsal pad 0.3–0.4 times as long as ventral length of tarsomere. Fore wing vein 3A absent (Fig. B2.31b).

Abdomen. Median basin of tergum 9 with basal width 0.9–1.2 times as long as median length, maximum width 1.1–1.4 times as long as median length, and median length 0.7–0.9 times as long as cornus length. Cornus in dorsal view short, with edges clearly angular midway, its median length 0.8–0.9 times as long as maximum width of abdomen at junction of terga 9 and 10. **Sheath.** Length 0.57–0.69 times fore wing length, basal section 1.08–1.45 times as long as apical section. **Ovipositor.** Lancet with 30–35 annuli (basal annuli not clearly outlined); junction of basal and apical section of sheath aligned between 10th and 11th to 13th and 14th annuli, with 26–31 pits beginning with annulus 2; pit of annulus 2 only extending to edge of annulus 1 (Fig. B2.37, base). Pits near middle annuli (Fig. B2.44) or area at base of apical section of sheath 0.35–0.45 times as long as an annulus (pits scarcely decreasing in size toward base), 0.55–0.65 times as high as lancet height in lateral view, and 1.3–1.5 times as long as high (Fig. B2.37, middle); annulus 10 length/ovipositor diameter (lance + lancet) not measured. Last 4–5 annuli before teeth annuli as well as first tooth annulus with ridge on ventral edge of pit. Edge of apical 5–6 annuli before teeth annuli extending as ridge to ventral edge of lancet.

MALE. Description

Color. Head, thorax, antenna (flagellomeres 1 and 2 black to light reddish brown), palps, coxae, and femora (except apex on fore and middle legs in many specimens) black with dark blue metallic reflections. Tibiae, and

tarsi of fore and middle legs light reddish brown (except for brown or black spot on tibia and tarsomeres 1 or 1 and 2 of middle leg in many specimens (Fig. B2.94)); Metatibia and metatarsus black (except metatarsomere 4 usually reddish brown); reddish brown spot at base of metatibia narrow, about as long as minimum width of tibia at base (Fig. C12.9). Fore wing light yellow tinted. Abdomen in **pale form** black on segments 1 and 2 to as many as 1–4, light reddish brown on terga 3–8 or 5–8, and black on sterna 3–9 or 6–9; in **dark form** abdomen black on segments 1–4 and on segments 7 and 8 (including sternum 9).

Thorax. Metatibia 4.3–4.6 times as long as maximum width (Fig. C12.9). Metatarsomere 1 in lateral view 3.2–3.5 times as long as maximum height.

Taxonomic notes

Until this study, pale specimens of *S. nigricornis* were assigned to *S. nigricornis* whereas dark specimens were assigned to *S. edwardsii*. The two color forms have an unusually similar flight period (two periods, clearly separated), the same range, and adults may emerge from the same pine trunk. In addition, the proportions between the length of lancet annuli 2, 5 and 10 relative to the diameter of the ovipositor are similar for both color forms (based on 10 specimens for each color form). For both color forms combined (20 specimens), the annulus length/ovipositor diameter (lance + lancet) for annulus 2 1.6–2.1 (mean = 1.8), for annulus 5 1.1–1.6 (mean = 1.4), annulus 10 1.1–1.5 (mean = 1.3). Finally, the information from morphology and DNA barcoding confirms that the two populations are the same. Therefore, we regard these as two discrete color forms of a single species.

Two types were not examined: *S. nigricornis* Fabricius (pale form) and *S. edwardsii* Brullé (dark form), but the original description and illustration for both species were adequate to allow us to match them with our concept of *S. nigricornis*, the oldest name.

Females of *S. nigricornis* with a pale abdomen could be confused with those of *S. behrensii*. In **both sexes** of *S. nigricornis* the banded pattern is absent in the fore wing, and fore wing vein 3A is absent (banded pattern clearly present in the fore wing, and fore wing vein 3A present in *S. behrensii*). Females of *S. nigricornis* lack the broad black longitudinal band along the side of the abdomen, the ventral surface of tergum 10 is black basally and at the side in anterior half, and the cornus is partly black (broad black longitudinal band along the side of the abdomen present, dorsal and ventral surfaces of tergum 10 without black spots, and cornus completely reddish brown in *S. behrensii*). Males of the two species are easily distinguished on antennal and hind leg color patterns.

Geographical variation

The two color forms are not equally distributed. For instance in Ontario only 23% of trapped adults are the dark body form. The next significant sample is from Indian Head, Saskatchewan, and there 60% of 47 specimens belong to the dark body form. Further west at Lac La Biche in eastern Alberta, all eight specimens are black. So, a gradual increase westward occurs in the proportion of the dark body form.

Hosts and phenology

Sirex nigricornis has a wide host range. Most rearing records are from various species of *Pinus* (94%) (Johnson 1928, Cameron 1965, Kirk 1974). Based on 229 reared and confirmed specimens all hosts are Pinaceae: *Picea* sp. (12), *P. abies* (1), *Pinus* sp. (16), *P. banksiana* (58), *P. clausa*, *P. echinata* (68), *P. elliotii*, *P. palustris*, *P. resinosa* (21), *P. rigida*, *P. strobus* (42), *P. sylvestris* (8), *P. taeda* (1), and *P. virginiana* (2). Records from the *Populus* sp. (Salicaceae) (4) and *Quercus* sp. (Fagaceae) (1) are most likely incorrect.

Based on 893 field-collected specimens, the earliest and latest capture dates are from late July to early October. There are two flight periods, a small one in the second half of July and a major one from mid August to late September with a peak in the second half of September.

Range

CANADA: AB, BC (probably mislabeled), ON, QC, SK. **USA:** AL, AR, DC, FL, GA, LA, MD, MS, NC, NY, OH, PA, TN, TX, VA, WI, WV. If the possibly mislabeled record from British Columbia and one specimen (probably *S. obesus*) from Arizona reported by Cameron (1965) are ignored, *S. nigricornis* has an eastern range

extending from Alberta to Quebec south to Louisiana and northern Florida (Webster 1895, Johnson 1928, Rohwer 1928, Ries 1951, Burks 1958, Burks 1967, Smith 1979, Chapin and Oliver 1986) (Fig. C12.10).

Specimens studied and included for range map: 1406 females and 1561 males from BYUC, CASS, CNC, CUCC, CUIC, DEBU, EDUM, FSCA, GLFC, MRNQ, NFRN, USFS–GA, and USNM.

Specimens for molecular studies: 53 specimens. See Fig. E2.5b.

CANADA. Ontario: 2007, *SIRCA 002*, 658; 2007, *SIRCA 003*, 557; 2007, *SIRCA 004*, 632; 2007, *SIRCA 005*, 619; 2007, *SIRCA 014*, 617; 2007, *SIRCA 015*, 629; 2007, *SIRCA 016*, 628; 2007, *SIRCA 017*, 624; 2006, *CBHR 597*, 658; 2006, *CBHR 598*, 658. **USA. Georgia:** 2006, *CBHR 513*, 658; 2006, *CBHR 514*, 658; 2006, *CBHR 516*, 658; 2006, *CBHR 518*, 658; 2006, *CBHR 519*, 658; 2006, *CBHR 520*, 658; 2006, *CBHR 571*, 658; 2006, *CBHR 572*, 658; 2006, *CBHR 574*, 658; 2006, *CBHR 575*, 658; 2006, *CBHR 576*, 658; 2006, *CBHR 577*, 658; 2006, *CBHR 587*, 658; 2006, *CBHR 588*, 658; 2006. **Illinois:** 2006, *CBHR 170*, 658. **Indiana:** 2005, *CBHR 172*, 658; 2005, *CBHR 173*, 658; 2005, *CBHR 174*, 658; 2005, *CBHR 175*, 658; 2005, *CBHR 177*, 658; 2005, *CBHR 178*, 658; 2005, *CBHR 179*, 658; 2005, *CBHR 180*, 658; 2005, *CBHR 181*, 658; 2005, *CBHR 182*, 658. **Louisiana:** 2005, *CBHR 243*, 658; 2005, *CBHR 256*, 658. **Minnesota:** 2008, *CBHR 1384*, 658; 2008, *CBHR 1460*, 658. **Mississippi:** 2001, *CBHR 30*, 658; 2001, *CBHR 32*, 658; 2001, *CBHR 152*, 658; 2001, *CBHR 153*, 658; 2001, *CBHR 154*, 658; 2001, *CBHR 155*, 658; 2001, *CBHR 156*, 658. **New York:** 2005, *CBHR 205*, 658; 2005, *CBHR 206*, 658. **South Carolina:** 2006, *CBHR 512*, 658; 2006, *CBHR 894*, 658. **Unknown state:** 2005, *CBHR 120*, 658; 2005, *CBHR 121*, 658.



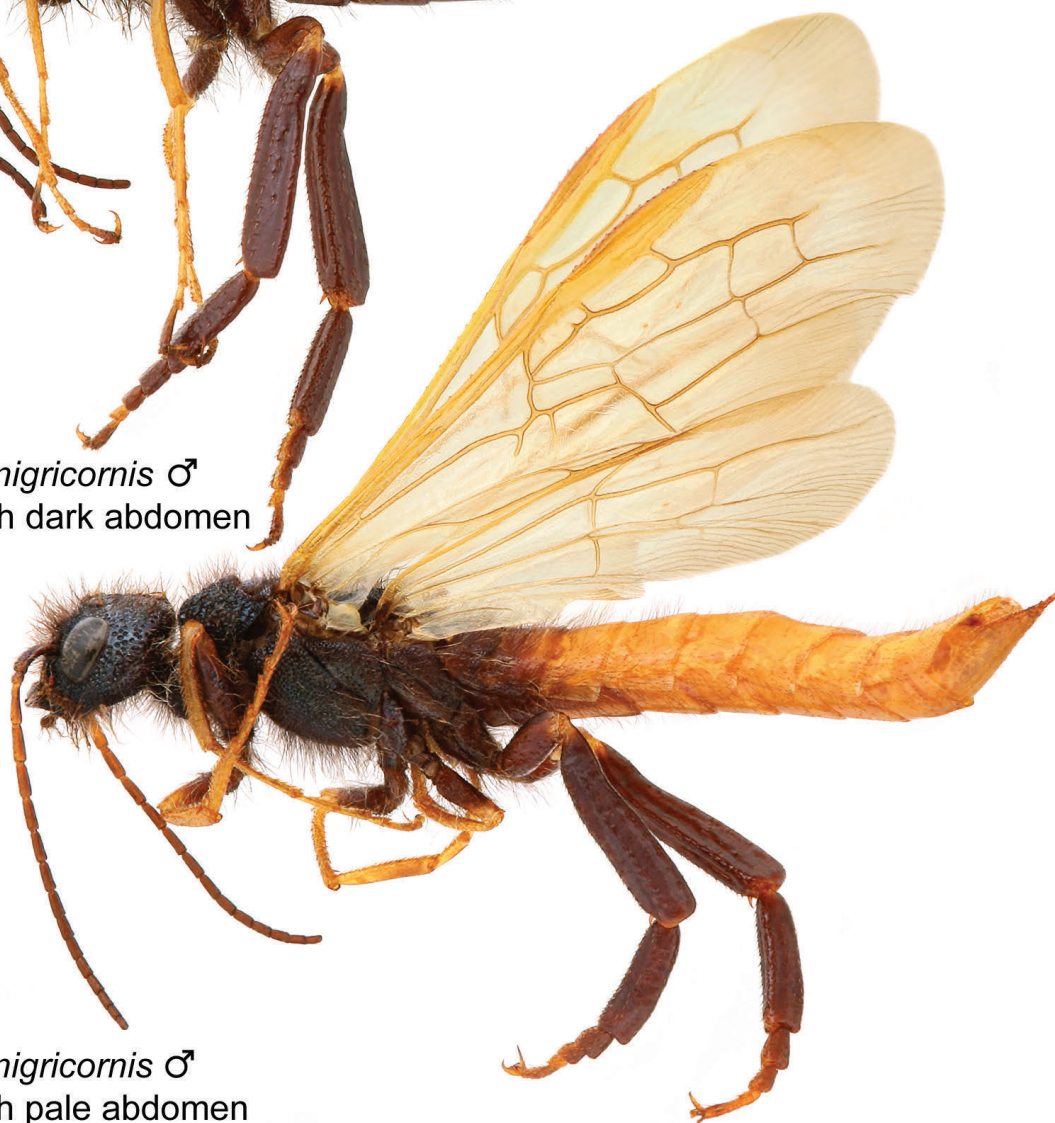
C12.1: *S. nigricornis* ♀
with dark abdomen



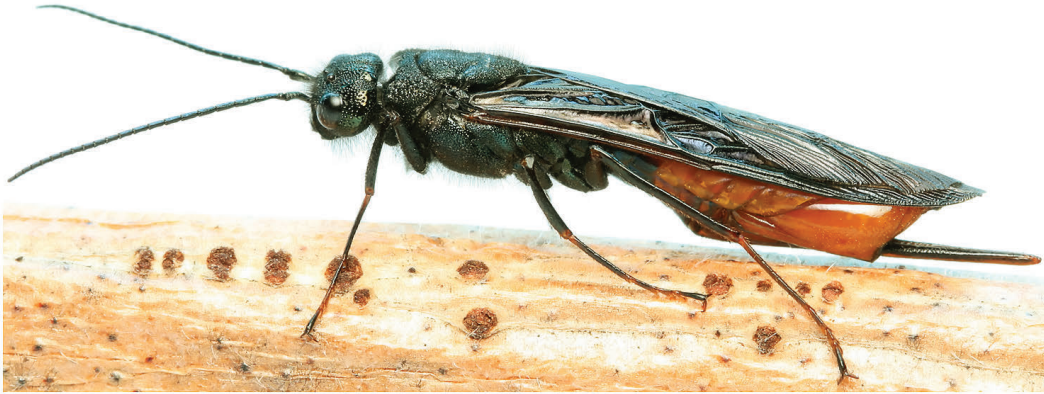
C12.2: *S. nigricornis* ♀
with reddish brown abdomen



C12.3: *S. nigricornis* ♂
with dark abdomen



C12.4: *S. nigricornis* ♂
with pale abdomen



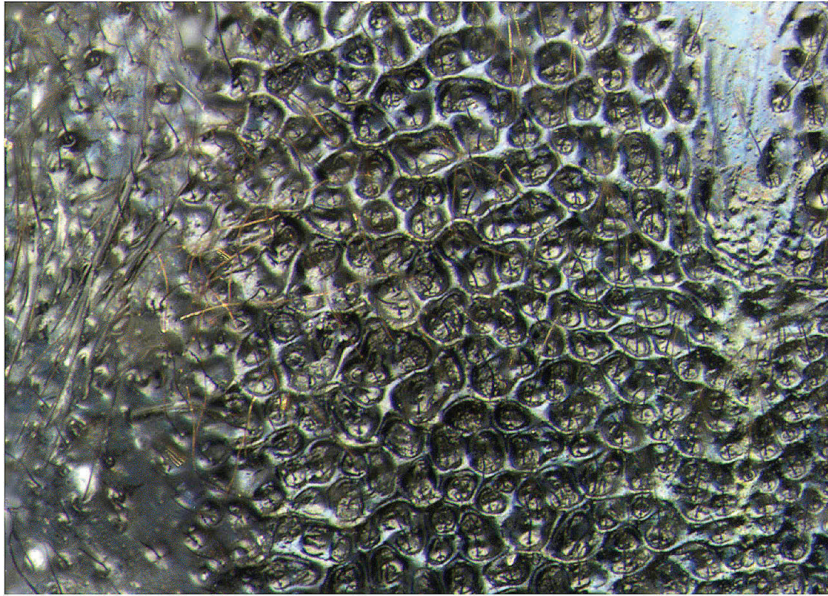
C12.5: *S. nigricornis* ♀ with reddish brown abdomen



C12.6: *S. nigricornis* ♂ with dark abdomen



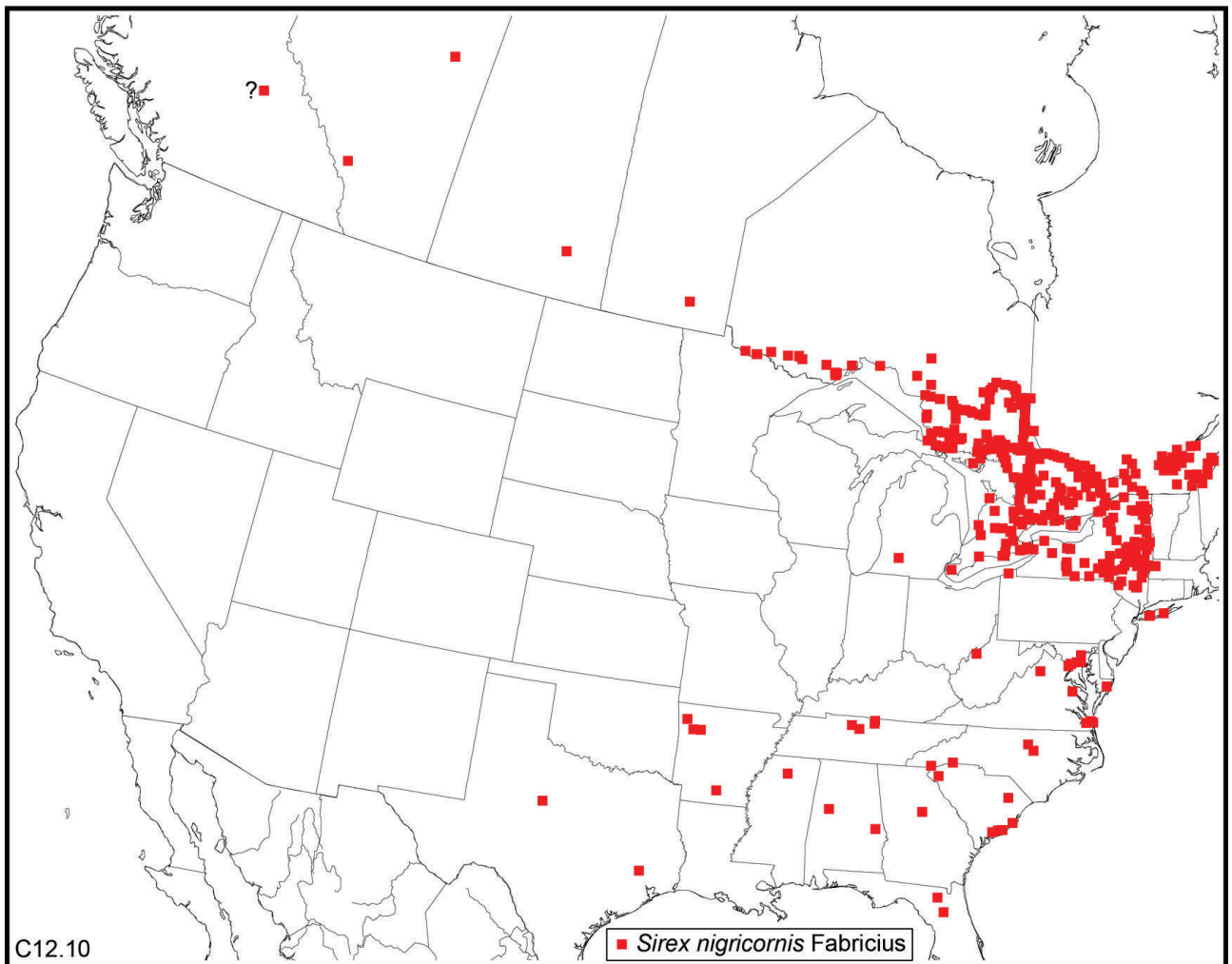
C12.7: *S. nigricornis* ♂ with pale abdomen



C12.8: *S. nigricornis* ♀



C12.9: *S. nigricornis* ♂



13. *Sirex nitidus* (T. W. Harris), comb n. and sp. rev.

Fig. C13.1 (female with pale femora, habitus)

Fig. C13.2 (females with dark femora, habitus)

Fig. C13.3 (male with pale femora and dark abdominal apex, habitus)

Fig. C13.4 (male with pale femora and light abdominal apex, habitus)

Fig. C13.5 (male with black femora and light abdominal apex, habitus)

Fig. C13.6 (male with black femora and black abdomen, habitus)

Fig. C3.1 (live female with pale femora)

Fig. C13.8 (map)

Urocerus nitidus T. W. Harris, 1841: 391. Holotype female (MCZC) with abdomen missing, examined by DRS and image examined by HG. Type locality: Massachusetts.

Sirex juvenicus juvenicus Smith, 1979: 127 (not Linnaeus, 1758: 560).

Sirex juvenicus cyaneus Bradley, 1913: 14 (not Fabricius, 1781: 419).

Sirex cyaneus Ries, 1951: 83 (not Fabricius 1781: 419); Smith 1979: 126.

Sirex californicus Bradley, 1913: 14 (not Ashmead, 1904: 64); Ries 1951: 83, Middlekauff 1960: 62. This misidentification applies only to pale legged females of *S. californicus*.

Diagnostic combination

Specimens with reddish brown femora. Among **females** with black abdomen, completely light reddish brown tibiae, and a long tarsal pad (pad length 0.7–0.8 as long as ventral length of tarsomere) [*cyaneus*, *abietinus*], those of *S. nitidus* are recognized by the larger pits at the middle of the lancet (length 0.18–0.25 times as long as length of annulus). Among **males** with mainly black metatibia and with net-like pits on median 0.5–0.7 of mesoscutum [*abietinus*, *cyaneus*, and *varipes*], those of *S. nitidus* are recognized by the black or brown spot on at least part of the dorsal surface of the mesotibia and mesotarsomere 1 (it may include mesotarsomeres 2 and 3), the generally fine pits on the gena and vertex (diameter of pit 0.1–0.2 that of lateral ocellus), and the narrow pale base of the metatibia (only the area of minimum constriction reddish brown).

Specimens with black or mainly black femora (AK, YT, northern BC and northern half of AB). **Females** of *S. nitidus* are recognized by the long tarsal pad (length 0.7–0.8 times ventral length of tarsomere), short metatarsomere 2 (2.0–3.0 times as long as high), dark blue abdomen, and larger pits at the middle of the

lancet (length 0.18–0.25 times length of annulus). **Males** of *S. nitidus* are recognized by the light reddish brown protibia and protarsus, moderately fine pits on the head, and narrow light reddish brown transverse band at the base of the metatibia.

FEMALE. Description

Color. Body, antenna (less than 1% of specimens with flagellomeres 1 or 1 and 2 brown; only one specimen with flagellomeres 1–4 light reddish brown), and palps black with dark blue metallic reflections. Coxae black, femora (except brown base), tibiae and tarsi (apical half of metatarsomeres 5 usually darker but not dark brown or black) light reddish brown (Fig. B2.2), or in Alaska, Yukon, and northern British Columbia and northern Alberta some specimens with metafemur black (usually pro- and mesofemur also, and in some specimens the dorsal surface of the metatibia black as in *S. varipes* and in one specimen the tibiae and tarsi are completely black). Fore wing mainly clear, at most light yellowish brown behind stigma (Fig. B2.75).

Head. Gena with pits 2.0–4.0 pit diameters apart and mainly absent centrally behind eye (Fig. B2.56), vertex and postocellar area with pits 2.0–4.0 pit diameters apart (Fig. B2.62), and each pit diameter about 0.1–0.2 that of lateral ocellus.

Thorax. Mesoscutum with coarse, net-like pits over most of median surface (Fig. B2.65). Metatarsomere 2 in lateral view 2.0–2.2 times as long as high, and its length about 1.0–1.1 times length of tarsomeres 3 + 4 (Fig. B2.60); tarsal pad 0.7–0.9 times as long as ventral length of tarsomere (Fig. B2.67). Fore wing vein 3A absent (Fig. B2.75).

Abdomen. Median basin of tergum 9 with basal width 0.9–1.1 times as long as median length, maximum width 1.3–1.4 times as long as median length, and median length 0.5–0.6 times as long as cornus length (as in Fig. B2.88). Cornus in dorsal view quite short, with edges straight, its median length 1.0–1.2 times as long as maximum width of abdomen at junction of terga 9 and 10 (as in Fig. B2.88). **Sheath.** Length 0.65–0.8 times fore wing length, basal section 0.91–1.17 times as long as length of apical section (Fig. A3.26). **Ovipositor.** Lancet with 29–35 annuli (basal annuli clearly outlined); junction of basal and apical section of sheath aligned between 10th and 11th or 11th and 12th annuli, with 25–30 pits beginning with annulus 2. Pits near middle annuli or area at base of apical section of sheath, 0.18–0.3 times as long as an annulus (pits gradually and markedly decreasing in size toward base (Fig. B2.83)), 0.4–0.6 times as high as lancet height in lateral view, and about 1.1–1.4 times as long as high (Fig. B2.83); annulus 10 length/ovipositor diameter (lance + lancet) 1.29–1.81 (based on 32 specimens).

Last three annuli before teeth annuli as well as first tooth annulus with ridge on ventral edge of pit (Fig. C13.7). Edge of apical 5–6 annuli before teeth annuli extending as ridge to ventral edge of lancet.

MALE. Description

Color. Head, thorax and coxae black with dark blue metallic reflections. **Pale form** with coxae, mesotibia (part of dorsal surface), mesotarsomere 1 (often mesotarsomere 2) (Fig. B2.135), metatibia (except extreme base), and metatarsomeres 1–3 black; femora, protibia and protarsus, most of mesotibia, mesotarsomeres 2–5, base of metatibia (spot extended slightly beyond minimum constricted portion and about as long as wide (Fig. B2.91)), ventral and part of dorsal surfaces of mesotarsomere 1, and metatarsomeres 4 and 5 light reddish brown (Fig. B2.135). **Black form** (from Alaska commonly, and Yukon to Newfoundland occasionally) with at least metafemur (pro- and mesofemur ranging from partly to completely black) black. Fore wing clear, lightly yellowish brown in apical 0.25. Abdomen segments 1 and 2 or 1–3 black (rarely abdomen completely black, and a few specimens with intermediate pattern seen); segments 3–9 or 4–9 light reddish brown (dominant pattern in the Prairies and western regions) (Fig. B2.140), or segments 3–7 or 4–7 light reddish brown and segment 8 (including sternum 9) black (common pattern east of the Prairie region) (Fig. B2.139).

Thorax. Metatibia 3.8–4.3 times as long as maximum width (Fig. B2.91). Metatarsomere 1 in lateral view 2.7–3.4 times as long as maximum height.

Taxonomic notes

One type female of *Urocerus nitidus* exists, but the abdomen (and, therefore, the ovipositor, which has the only diagnostic characters) is missing so this type specimen cannot be assigned unequivocally to this species. The type is from a region in eastern North America where both *Picea* and *Abies* occur. Therefore, based on the type locality, the holotype could be either the species associated with *Picea*, or the species associated with *Abies*, namely *S. cyaneus*. We decided to assign the T. W. Harris name, *S. nitidus*, to the species associated with *Picea*, rather than describing it as new.

Specimens of *S. nitidus*, as well as those of *S. varipes*, *S. abietinus*, *S. cyaneus*, and pale specimens of *S. californicus* and *S. varipes* have been variously assigned to *S. juvencus* or *S. cyaneus* (Essig 1926, Bedard 1938, Middlekauff 1960, Cameron 1965, Morris 1967). Published information is not meaningful without voucher specimens.

Both sexes of *S. nitidus* differ from those of the

European *S. juvencus*. Females of *S. nitidus* have the five basal flagellomeres almost always (99%) black or brown (light reddish brown in *S. juvencus*), the most basal annuli (2 or 3) of the ovipositor have very small pits relative to those near the middle (quite similar in size at the base and the middle in *S. juvencus*), and the junction of the basal and apical sections of the sheath is aligned between the 10th and 11th annuli of the ovipositor (between the 12th and 13th annuli in *S. juvencus*) (Viitasaari 1984, Viitasaari and Midtgaard 1989). Almost all males of *S. nitidus* have a brown or black spot on the dorsal surface of the mesotibia, and/or a brown spot on mesotarsomere 1 or 1 and 2 (completely light reddish brown in *S. juvencus*). Therefore, *S. nitidus* is specifically distinct from *S. juvencus*. *Sirex juvencus* is only known from interceptions at American and Canadian ports but has not established in North America because in most ports its host plants, *Picea* spp., are absent.

Sirex nitidus is very similar to the European *S. torvus* M. Harris, known as *S. cyaneus* in Europe (see “taxonomic notes” under *S. cyaneus* and Chapter D. Additional Notes). *Sirex torvus* is found in central Europe. Females share the same type of ovipositor and color pattern and are almost undistinguishable from *S. nitidus*. However, in *S. nitidus*, the gena is clearly pitted and the pits are scattered, but in *S. torvus* the pits are few and very fine. In addition, we compared the distances between lancet annuli 2, 5 and 10 relative to the ovipositor diameter of *S. nitidus* (32 females from Laniel, Quebec) against the same measurements taken from Viitasaari and Midtgaard (1989) based on 5 females of *S. torvus*. In **females** of *S. nitidus* the annulus length/ovipositor diameter (lance + lancet) for annulus 2 is 2.0–2.7 (mean = 2.3) [2.6–2.7 (mean = 2.65) in *S. torvus*], for annulus 5 1.5–2.2 (mean = 1.9) [2.25–2.35 (mean = 2.3) in *S. torvus*], and for annulus 10 1.3–1.8 (mean = 1.5) [values not available in Viitasaari and Midtgaard, (1989) for *S. torvus*]. We measured 26 specimens of *S. torvus* for the above parameters of annulus 10, and the values vary from 1.39–1.90. Except for a small difference in annulus 5 between the two species there were no differences in the other proportions. Males of *S. nitidus* have the mid leg (except for males from Alaska) usually less darkly colored (mesotibia and/or mesotarsomere 1 each with a brown or black spot on the dorsal surface) [more darkly colored in *S. torvus*: most of the mesotibia dorsal, lateral and most or all of ventral surface and almost all of mesotarsomere 1 black]. In eastern North America, the apex of the abdomen of most specimens of *S. nitidus* is black whereas the apex is reddish brown westward (apex of abdomen is completely reddish brown in *S. torvus*). *Sirex nitidus* is close to *S. torvus*, but is not exactly the same. The main hosts of *S. torvus* are *Abies* spp., but for *S. nitidus* are *Picea* spp. The differences in

color pattern of the middle leg, the geographical change in color of the apex of the abdomen, and the differences in host preferences preclude an accidental introduction of *S. torvus* into North America. Because of differences in genital pits size and density, color pattern in males and host preferences, we recognize *S. nitidus* as specifically distinct from the *S. torvus*.

Sirex nitidus is also very similar to the little known European species, *S. atricornis* Kjellander. The species is subarctic in northern Scandinavia, Finland and Russia. It may extend to eastern Russia. In Scandinavia, the larvae of this species probably develop only on *Pinus* spp. as no other conifers are recorded from that region of northern Europe. The only difference seen in the two females (DABH) of *S. atricornis* studied by Viitasaari (1984) is the shape of the second annulus before the apical teeth annuli. The ridge of this annulus is straight in *S. atricornis* (very slightly curved in *S. nitidus*). This very subtle difference may vary geographically. Females of *S. nitidus* have wings that are lightly darkened near middle and apical 0.25 (completely clear in *S. atricornis*). In addition, we compared the distances between lancet annuli 2, 5 and 10 relative to the ovipositor diameter of each annulus (32 females from Laniel, Quebec) of *S. nitidus* against the same measurements based on 15 females of *S. atricornis* studied by Viitasaari and Midtgaard (1989). In females of *S. nitidus* the annulus length/ovipositor diameter (lance + lancet) for annulus 2 is 2.0–2.7 (mean = 2.3) [2.5–2.6 (mean = 2.55) in *S. torvus*], for annulus 5 1.5–2.2 (mean = 1.9) [2.1–2.2 (mean = 2.15) in *S. atricornis*], and for annulus 10 1.3–1.8 (mean = 1.5) [values not available for *S. atricornis*]. The *S. atricornis* proportions are within the range of the *S. nitidus* proportions, but the means for *S. nitidus* are clearly lower than those for *S. atricornis*. It seems that the coefficient of variation is much lower for *S. atricornis* than for *S. nitidus* (8% and 9% in the latter). At this point, we do not see any difference between *S. nitidus* and *S. atricornis*. As pointed out by Viitasaari and Midtgaard (1989), *S. atricornis* may be part of a species complex in the Palearctic. We think that *S. torvus* and *S. nitidus* are also part of this complex.

In North America, females of *S. nitidus* may be confused with North American *S. cyaneus* and *S. abietinus* females. They are distinguished from the latter two species by a pit on annulus 2. Females of *S. nitidus* may be confused with *S. noctilio* and the pale legged form of *S. californicus*. They are distinguished from the latter two species by the length of the tarsal pad on metatarsomere 2, and pit development on the vertex and ovipositor.

Geographical variation

Adults of *S. nitidus* show great variation in color

pattern. The patterns are not random but change along geographical lines. Specimens with intermediate color patterns have been seen. Therefore, the color forms are not discrete. The most striking variation is in femur color. Femora may be black or light reddish brown. The pale femora pattern is seen in all regions, but females with black femora are centered in Alaska and are recorded from northernmost British Columbia, Yukon, and as far south as central Alberta. In males the pattern is similar but a few males with black femora have been recorded across Canada as far as Newfoundland in the boreal zones. The black femora form is not recorded in the southern boreal zone and further south. The next significant character in males is the color pattern at the apex of the abdomen. The apical segments may vary from black to reddish brown. From Manitoba and westward the apex is completely reddish brown. From Manitoba and eastward, most specimens have a black abdominal apex. A rare color variation is recorded in males with completely black abdomen in southern Yukon, and northernmost and southern British Columbia. All the above color variation patterns change gradually and subspecific segregation is not justifiable.

Hosts and phenology

Long series of carefully reared and identified specimens of *S. nitidus* are mainly from *Picea* spp. (88%). A few specimens were associated with *Abies*, *Larix*, *Pseudotsuga*, *Tsuga*, *Pinus*, and *Thuja*. Based on 253 reared and confirmed specimens all but one hosts are Pinaceae: *Abies balsamea* (14) (Johnson 1930 – no voucher specimens seen, they could be *S. cyaneus*), *A. lasiocarpa* (2), *Larix laricina* (7), *Picea* sp. (2), *P. engelmannii* (34), *P. glauca* (107) (reported as *S. cyaneus* by Morris (1967)), *P. mariana* (63), *P. rubens* (6), *Pinus contorta* (1), *P. ponderosa* (6), *Pseudotsuga menziesii* (7), and *Tsuga heterophylla* (2). We have only two records from *Thuja plicata* (2), a Cupressaceae. The record on *Populus* (1) is probably incorrect.

Based on 244 field-collected specimens, the earliest and latest capture dates are July 10 and September 25. The main flight period is from the first half of July to early October with a peak in September. Harrington (1882a) reported later capture dates, up to October 18.

Range

CANADA: AB, BC, MB, NB, NF, NS, NT, NU, QC, ON, SK, YT. **USA:** AK, CO, ID, MT, NH, NY, OR, UT, WA, WY. *Sirex nitidus* is a widespread species that occurs transcontinentally from Newfoundland to Alaska anywhere spruces grow in boreal, cold temperate, and mountain zones (Fig. C13.8). We have seen several

intercepted specimens from New Zealand (FRNZ and PANZ).

Specimens studied and included for distribution map: 658 females and 203 males from BDUC, BYUC, CASS, CNC, CUCC, CUIC, DEBU, EDUM, FRLC, GLFC, LECQ, LEMQ, MNRQ, MTEC, NFRC, NFRN, OSAC, PFRC, UAIC, UAM, UASM, USFS-AK, and USNM.

Specimens of *S. nitidus* for molecular studies: 47 specimens. See Fig. E2.5d.

CANADA. British Columbia: 2002, *SIRCA 056*, 393; 2002, *SIRCA 057*, 605; 2001, *SIRCA 058*, 613; 1999, *SIRCA 059*, 612; 2002, *SIRCA 060*, 604; 2001, *SIRCA 067*, 604; 2004, *SIRCA 090*, 639. **Nova Scotia:** 2005, *CBHR 292*, 658; 2005, *CBHR 293*, 658. **Ontario :** 2006, *CBHR 1096*, 658; 2006, *CBHR 1097*, 658; 2006, *CBHR 1098*, 658; 2006, *CBHR 1099*, 611; 2006, *CBHR 1101*, 658; 2006, *CBHR 1192*, 658; 2006, *CBHR 1193*, 658; 2006, *CBHR 1195*, 658; 2006, *CBHR 1196*, 658; 2006, *CBHR 1198*, 658; 2007, *SIRCA 006*, 630; 2007,

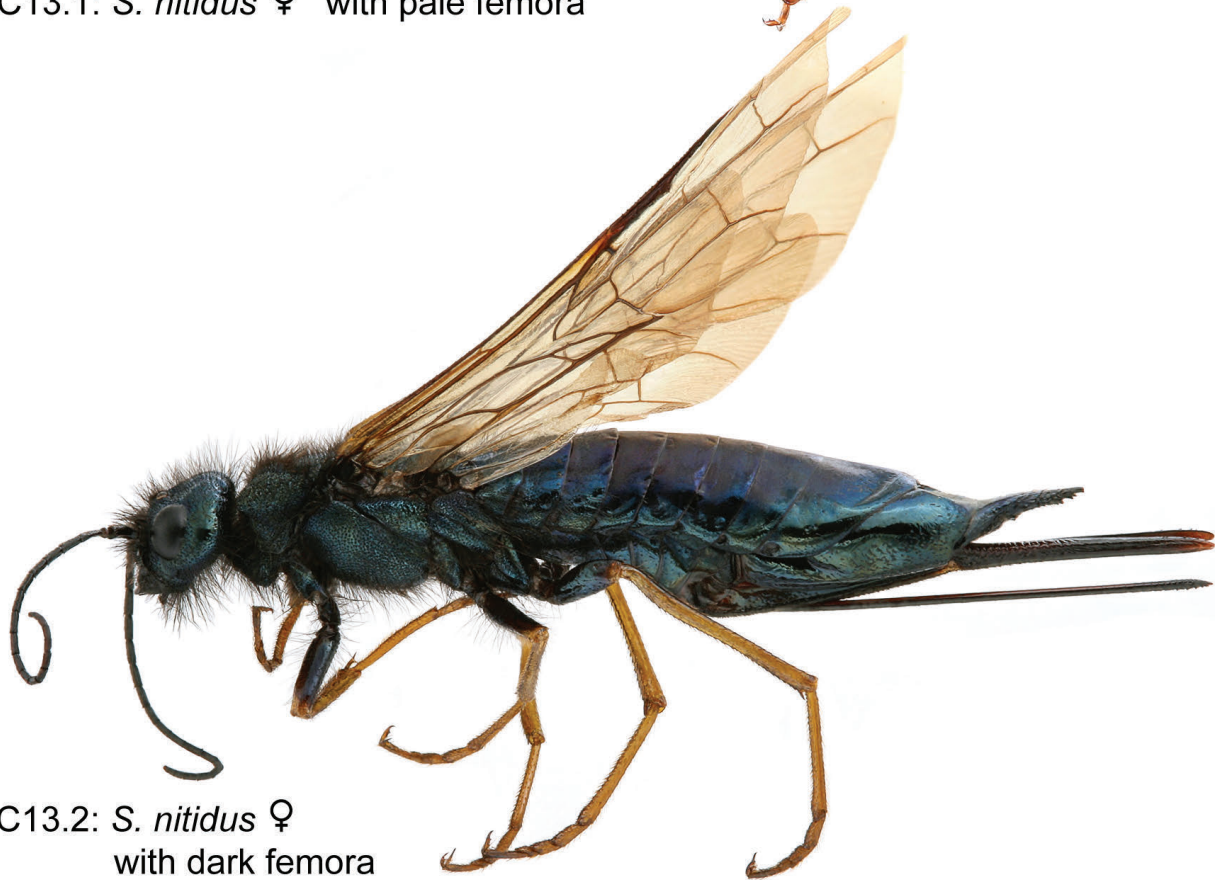
SIRCA 007, 595; 2007, *SIRCA 008*, 612; 2007, *SIRCA 009*, 604; 2007, *SIRCA 010*, 613; 2007, *SIRCA 011*, 613. **USA. Minnesota:** 2008, *CBHR 1378*, 658. **Montana:** 2004, *CBHR 255*, 658; 2006, *CBHR 331*, 658; 2006, *CBHR 368*, 658. **New York:** 2006, *CBHR 599*, 658; 2006, *CBHR 608*, 658; 2006, *CBHR 615*, 658; 2006, *CBHR 636*, 658; 2006, *CBHR 640*, 658; 2006, *CBHR 644*, 658; 2006, *CBHR 740*, 658. **Oregon:** 2005, *CBHR 1057*, 658; 2006, *CBHR 1079*, 658; 2006, *CBHR 1083*, 658; 2006, *CBHR 1088*, 658. **Washington:** 2005, *CBHR 248*, 658; 2005, *CBHR 1056*, 658; 2007, *CBHR 1276*, 658; 2007, *CBHR 1277*, 658; 2008, *CBHR 1964*, 658; 2008, *CBHR 1967*, 658; 2008, *CBHR 1968*, 658.

Specimens of *S. sp.* near *nitidus* for molecular studies: 6 specimens. See Fig. E2.5d.

USA. Colorado: 2005, *CBHR 194*, 658; 2005, *CBHR 554*, 658; 2005, *CBHR 555*, 658; 2005, *CBHR 556*, 658; 2005, *CBHR 557*, 658; 2005, *CBHR 558*, 658.



C13.1: *S. nitidus* ♀ with pale femora



C13.2: *S. nitidus* ♀
with dark femora



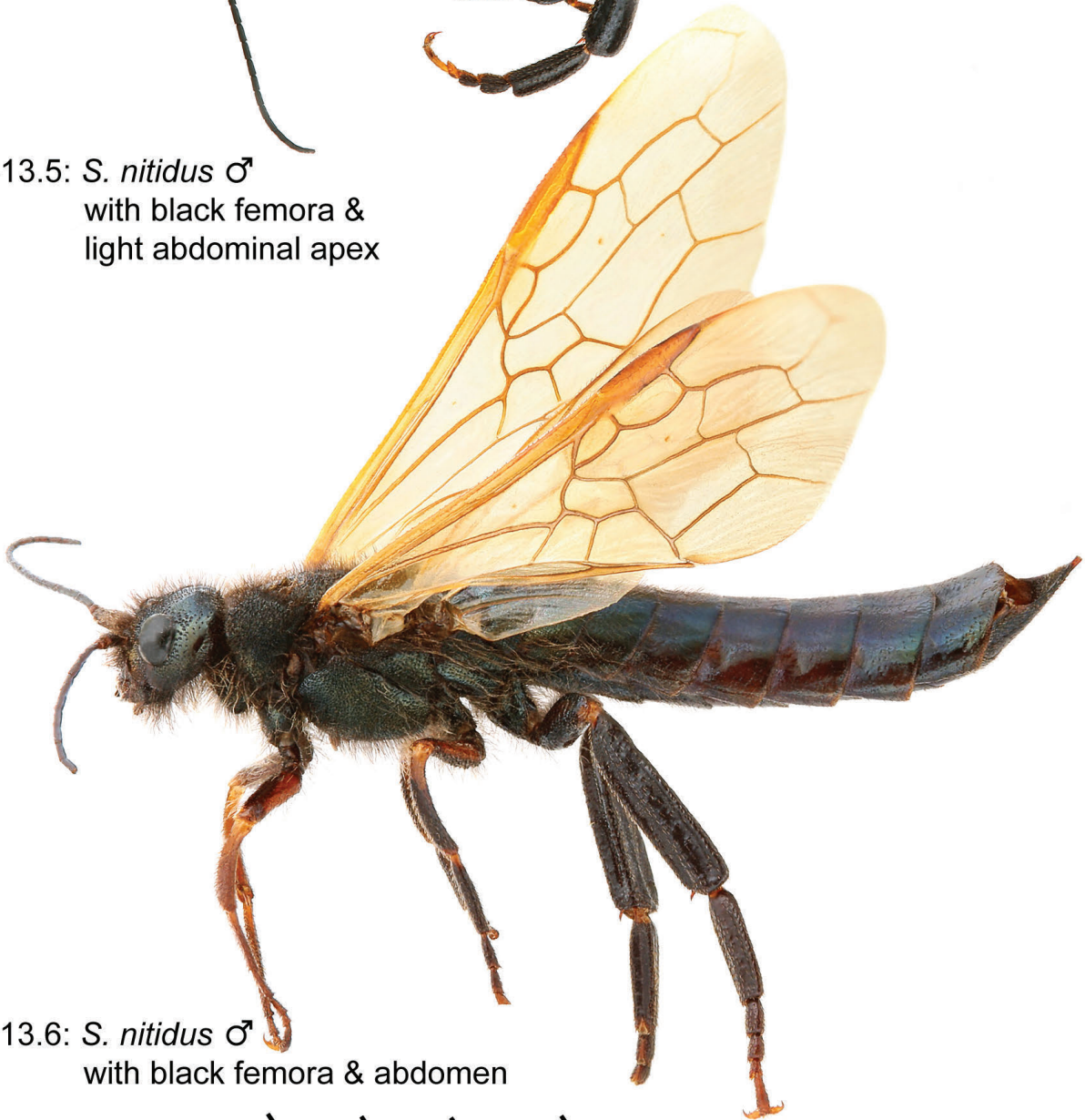
C13.3: *S. nitidus* ♂
with pale femora &
dark abdominal apex



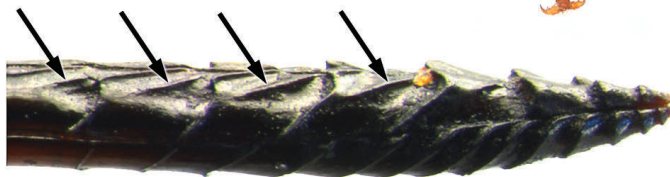
C13.4: *S. nitidus* ♂
with pale femora &
light abdominal apex



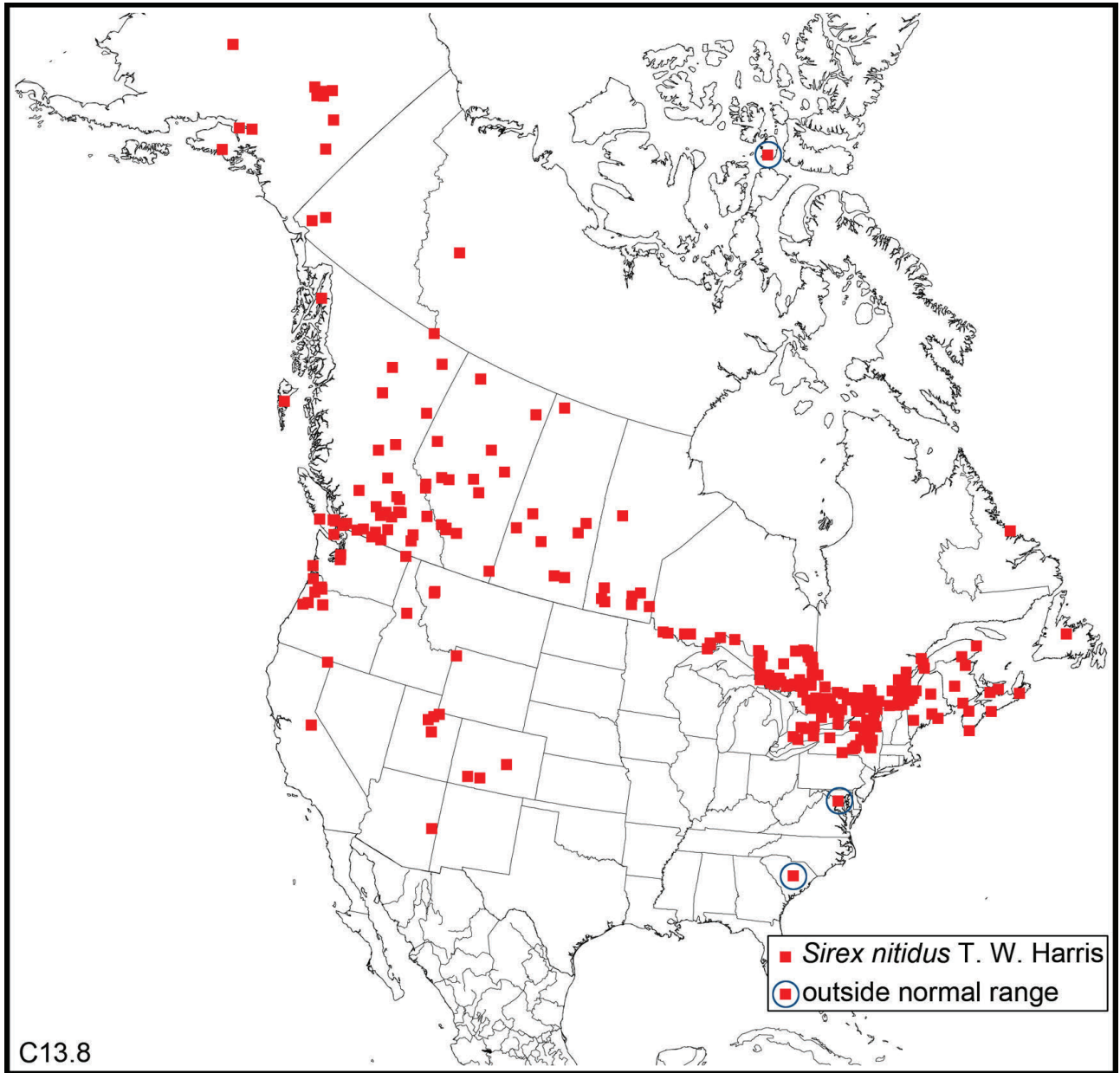
C13.5: *S. nitidus* ♂
with black femora &
light abdominal apex



C13.6: *S. nitidus* ♂
with black femora & abdomen



C13.7: *S. nitidus* ♀



14. *Sirex noctilio* Fabricius

- Fig. C14.1, Schiff *et al.* 2006: 50, 51 (female habitus)
 Fig. C14.2, Schiff *et al.* 2006: 49 (male habitus)
 Fig. C14.3 (live female)
 Fig. C14.4 (live male)
 Fig. C14.5 (live male checking a female)
 Fig. C14.6 (live mating pair)
 Fig. C14.7 (male moving away)
 Fig. C7.7 (map)

Sirex noctilio Fabricius, 1793: 130. Holotype, male, not examined. Type depository unknown (Viitasaari and Midtgaard 1989); but supposedly in the “Sehested” collection, ZMUC; Benson 1943: 36, Burks 1958: 16, Smith 1979: 127. Type locality: “Germania”.

Sirex melanocerus Thomson, 1871: 328. Taeger *et al.* 2010.

Paururus atlantidis Ghiji, 1909: 163-170. Taeger *et al.* 2010.

Diagnostic combination

Among **females** with a light reddish brown metafemur and black abdomen [*abietinus*, pale legged form of *californicus*, *cyaneus*, *nitidus*, and *varipes*], those of *S. noctilio* are recognized by the large median pits on the lancet of the ovipositor (pit 0.5–0.75 times as long as annulus) and the short tarsal pads (tarsal pad of metatarsomere 2 0.2–0.4 times as long as ventral length of tarsomere 2). Among **males** with a reddish brown metafemur and a mainly black metatibia and metatarsomere 1 [*abietinus*, *cyaneus*, *nitidus* and *varipes*], those of *S. noctilio* are recognized by the wide reddish brown base of the metatibia (reddish brown area 2.0–3.0 times as long as minimum width of tibia at base).

FEMALE. Description

Color. Body, antenna and palps black with dark blue metallic reflections. Coxae and apical tarsomeres black (Fig. B2.66); femora (except brown base), tibiae and tarsi light reddish brown (some specimens from the Mediterranean region have black femora, but this color pattern has not been seen in North America). Fore wing basically clear except for brownish yellow spot behind stigma (spot black with dark purple reflections on live specimens).

Head. Gena with pits very fine and 4.0–10.0 pit diameters apart, vertex and postocellar area with pits 2.0–8.0 pit diameters apart (maybe much denser in some specimens) (Fig. B2.61), and each pit diameter about 0.1–0.2 times

lateral ocellus diameter.

Thorax. Mesoscutum mostly with round pits in median area (Figs. B2.63 & B2.64), pits commonly with tooth-like process behind, and teeth rarely fused transversally (Fig. B2.64). Metatarsomere 2 in lateral view 2.9–3.5 times as long as high, and its length about 1.1–1.4 times tarsomeres 3 + 4 (Fig. C14.8); tarsal pad 0.3–0.4 times as long as ventral length of tarsomere (Fig. B2.66). Fore wing vein 3A absent.

Abdomen. Median basin of tergum 9 with basal width 0.9–1.1 times as long as median length, maximum width 1.1–1.3 times as long as median length, and median length 0.5–0.7 times as long as cornus length. Cornus in dorsal view short, with edges straight, its median length 1.0–1.2 times as long as maximum width of abdomen at junction of terga 9 and 10. **Sheath.** Length 0.6–0.75 times fore wing length, basal section 1.05–1.28 times as long as length of apical section. **Ovipositor.** Lancet with 33–37 annuli (basal annuli clearly outlined); junction of basal and apical section of sheath aligned between 14th and 15th to 16th and 17th annuli, with 29–33 pits beginning with annulus 2; pit of annulus 2 only extending to edge of annulus 1. Pits near middle annuli (Fig. B2.68) or area at base of apical section of sheath 0.55–0.75 times as long as an annulus (pits at base a little smaller: about 0.7 times as high as middle pits), about 0.6–0.75 times as high as lancet height in lateral view, and about 1.4–2.0 times as long as high; annulus 10 length/ovipositor diameter (lance + lancet) not measured. Last 4–5 annuli before teeth annuli as well as first tooth annulus with ridge on ventral edge of pit. Edge of apical 3–5 annuli before teeth annuli extending as ridge to ventral edge of lancet.

MALE. Description

Color. Head, thorax, antenna (flagellomeres 1 and 2 sometimes brown), palps, and coxae black with dark blue metallic reflections. Femora (except brown base), tibiae and tarsi of fore and middle legs light reddish brown; metatibia and metatarsus black (except metatarsomere 4 and at least base of 5 reddish brown); reddish brown spot at base of metatibia 2.0–3.0 times as long as minimum width of tibia at base (Fig. B2.124). Fore wing light yellowish brown. Abdomen black on segments 1–2 and on segment 8 (including sternum 9).

Thorax. Metatibia 3.8–4.2 times as long as maximum width (Fig. B2.124). Metatarsomere 1 in lateral view 2.7–3.8 times as long as maximum height.

Taxonomic notes

Viitasaari and Midtgaard (1989) mentioned that there were no type specimens of *S. noctilio* in the Fabricius collection (ZMUC). We were also able to confirm

that the type is not in ZMUC (Vilhelmsen, personal communication). However, in the Linnean Collection (LSUK), there are 3 males of *S. noctilio*. One of the specimens, labelled “*S. noctilio* Fab.,” was collected by “Cromer Mrs Kett.” four years after Fabricius’ description and matches it perfectly. Though this specimen is not the type, it gives us a good idea that Linnaeus considered his *Ichneumon juvenicus* (images of lectotypes in the Linnean Collection seen by HG) distinct from *Sirex noctilio*.

The original description is rather informative. First, Fabricius (1793) had a male (number of specimens not indicated) because both in his brief and long descriptions he clearly stated that the abdomen was reddish brown on the middle segments and blue on the basal and apical segments. Second, he wrote that the antennae are black, and the legs other than the hind legs (coxa, tibia and tarsus) are reddish brown. In Germany, only three species of *Sirex* are known: *S. noctilio*, *S. juvenicus* and *S. torvus*. It is not *S. juvenicus* based on antennal and abdominal color patterns. It is not the European *S. torvus* based on abdominal and mid leg color patterns. So, the present day concept of *S. noctilio* seems to fit perfectly with Fabricius’ description.

Geographical variation

Most specimens of *S. noctilio* have light reddish brown femora and in **females** clear wings. However, we discovered 20 specimens (USNM, all intercepted at American ports) with black femora and in **females** dark tinted wings. Pale legged specimens are found all over Europe, but dark legged ones are recorded from southern Europe only. Moreover, it seems that there are no specimens with intermediate color patterns (Figs. C14.9 & C14.10). All structures and color patterns other than the femoral and wing color patterns are the same between the two color forms. Therefore, the dark legged color form is considered as a discrete color form of the common and widespread pale legged *S. noctilio*. Specimens with dark femora are recorded from the Azores (see Ghigi 1909: 163 under *Paururus atlantidis*), Portugal, Spain, Italy, and Turkey. The pale form is seen everywhere in Europe. In North and South America only the form with light reddish brown femora is recorded.

Biological notes.

Hoebeker *et al.* (2005) briefly summarized the biology of *S. noctilio*. Females attack *Pinus* spp. in Europe as well as in North America. Development requires one or two years. Adults live one or two weeks and do not feed. Females lay one to three eggs at each oviposition hole. During oviposition, they introduce a toxic mucus with the spores (oidia) of *Amylostereum areolatum* (Fries:

Fries). Larvae can develop only on this fungus. A female can use the same oviposition hole to drill one or more lateral holes to oviposit (Viitasaari 1984). Females may lay 75–400 eggs. The largest batch of eggs comes from the largest females (Chrystal 1928, Rawlings 1953, Coutts 1965). Adults dig themselves out and leave exit holes from 3–7 mm in diameter (dependant on adults size (9–35 mm). Adults are able to fly several kilometers.

Hosts and phenology

Based on over 100 reared and confirmed specimens in North America, the hosts of *S. noctilio* are various *Pinus* spp. (Pinaceae). We have seen specimens reared from *P. resinosa*, *P. sylvestris*, and *P. strobus*. In addition *S. noctilio* has been recorded from *P. caribaea*, *P. contorta*, *P. echinata*, *P. elliotii*, *P. kesiya*, *P. nigra*, *P. palustris*, *P. patula*, *P. pinaster*, *P. pinea*, *P. radiata*, and *P. taeda*. In Europe, *S. noctilio* has been reared from *Pseudotsuga menziesii* and in New Zealand and Australia on *Pinus radiata*. The wider host range recorded from Europe may be due to accumulated information from misidentified specimens of other species of *Sirex*.

Based on 66 field-collected specimens, the main flight period is from early July to first half of October with a peak in the second half of July and the first half of August.

Range

ARGENTINA: Rio Negro, Entre Rios, Corrientes, Misiones, Buenos Aires, Cordoba Jujuy (Allard 2008a). **BRAZIL:** Paraná, General Carniero. **CANADA:** MB, ON, QC. **CHILE:** IX and X regions (Allard 2008b), Patagonia, Dina Huapi (Villacide 2010). **USA:** MI, NY, OH, PA, VT. **URUGUAY:** Though the range of *S. noctilio* is originally from Europe to Siberia, it became accidentally established in Australia (Gilbert and Miller 1952), New Zealand (Gourlay 1951, Rawlings 1955), and South Africa (Taylor 1962, Tribe 1995, Tribe 1997). The species was also introduced into South America (Haugen and Hoebeker 2005) and recently into the Great Lake region of North America (Fig. C7.7). The earliest record in North America is a specimen (BMNH) from the Albany River, Ontario, Canada, which ends at James Bay (Benson 1943). It was collected in the early 1800s. Despite some collecting in northern Ontario and intensive collecting in northern Manitoba, no other specimen has been found. It may be an intercepted specimen if it was originally collected near Fort Albany. *Sirex noctilio* became established around Lake Ontario (Ontario and New York) in early 2000 (Hoebeker *et al.* 2005).

Specimens studied and included for distribution map: 313 females and 114 males from CFIA, CNC, CUI, FRNZ, GLFC, ICCM, NZAC, PANZ, USFS-GA, and

USNM.

Specimens for molecular studies: 127 specimens. See Fig. E2.5c.

ARGENTINA: 2005, *CBHR 48*, 658; 2005, *CBHR 49*, 658; 2005, *CBHR 52*, 658; 2005, *CBHR 53*, 658;

AUSTRALIA: year unknown, *CBHR 15*, 658; year unknown, *CBHR 16*, 658; year unknown, *CBHR 17*, 658; year unknown, *CBHR 39*, 658.

CANADA. Ontario: year unknown, *CBHR 286*, 658; 2007, *SIRCA 18*, 615; 2007, *SIRCA 19*, 616; 2007, *SIRCA 20*, 620; 2007, *SIRCA 21*, 628; 2007, *SIRCA 22*, 606; 2007, *SIRCA 45*, 612; 2007, *SIRCA 46*, 658; 2007, *SIRCA 47*, 620.

SOUTH AFRICA: 2007, 2007, *CBHR 1085*, 658.

USA. New York: 2005, *CBHR 20*, 658; 2005, *CBHR 21*, 658; 2005, *CBHR 22*, 658; 2005, *CBHR 23*, 658; 2005, *CBHR 24*, 658; 2005, *CBHR 25*, 658; 2005, *CBHR 26*, 658; 2005, *CBHR 27*, 658; 2007, *CBHR 805*, 658; 2007, *CBHR 807*, 658; 2007, *CBHR 810*, 658; 2007, *CBHR 811*, 658; 2007, *CBHR 814*, 658; 2007, *CBHR 815*, 658; 2007, *CBHR 817*, 658; 2007, *CBHR 819*, 658; 2007, *CBHR 824*, 658; 2007, *CBHR 826*, 658; 2007, *CBHR 827*, 658; 2007, *CBHR 828*, 595; 2007, *CBHR 829*, 658; 2007, *CBHR 834*, 658; 2007, *CBHR 836*, 658; 2007, *CBHR 837*, 611; 2007, *CBHR 1011*, 658; 2007, *CBHR 1012*, 658; 2007, *CBHR 1013*, 658; 2007, *CBHR 1014*, 658; 2007, *CBHR 1015*, 658; 2007, *CBHR 1016*, 658; 2007, *CBHR 1017*, 658; 2007, *CBHR 1018*, 658; 2007, *CBHR 1019*, 658; 2007, *CBHR 1020*, 658; 2007, *CBHR 1021*, 658; 2007, *CBHR 1103*, 658; 2007, *CBHR 1104*, 658; 2007, *CBHR 1105*, 658; 2007, *CBHR 1106*, 658; 2007, *CBHR 1107*, 658; 2007, *CBHR 1108*, 658;

2007, *CBHR 1109*, 658; 2007, *CBHR 1110*, 658; 2007, *CBHR 1111*, 658; 2007, *CBHR 1112*, 658; 2007, *CBHR 1113*, 658; 2007, *CBHR 1114*, 658; 2007, *CBHR 1115*, 658; 2007, *CBHR 1116*, 658; 2007, *CBHR 1117*, 658; 2007, *CBHR 1118*, 658; 2007, *CBHR 1119*, 658; 2007, *CBHR 1124*, 658; 2007, *CBHR 1125*, 658; 2007, *CBHR 1126*, 658; 2007, *CBHR 1127*, 658; 2007, *CBHR 1128*, 658; 2007, *CBHR 1129*, 658; 2007, *CBHR 1130*, 658; 2007, *CBHR 1131*, 658; 2007, *CBHR 1132*, 658; 2007, *CBHR 1133*, 658; 2007, *CBHR 1134*, 658; 2007, *CBHR 1135*, 658; 2007, *CBHR 1136*, 658; 2007, *CBHR 1137*, 658; 2007, *CBHR 1138*, 658; 2007, *CBHR 1139*, 658; 2007, *CBHR 1140*, 658; 2007, *CBHR 1141*, 658; 2007, *CBHR 1142*, 658; 2007, *CBHR 1143*, 658; 2007, *CBHR 1144*, 658; 2007, *CBHR 1145*, 658; 2007, *CBHR 1146*, 658; 2007, *CBHR 1147*, 658; 2007, *CBHR 1148*, 658; 2007, *CBHR 1149*, 658; 2007, *CBHR 1150*, 658; 2007, *CBHR 1151*, 658; 2007, *CBHR 1152*, 658; 2007, *CBHR 1153*, 658; 2007, *CBHR 1154*, 658; 2007, *CBHR 1155*, 658; 2007, *CBHR 1156*, 658; 2007, *CBHR 1158*, 658; 2007, *CBHR 1159*, 658; 2007, *CBHR 1160*, 658; 2007, *CBHR 1161*, 658; 2007, *CBHR 1162*, 658; 2007, *CBHR 1163*, 658; 2007, *CBHR 1164*, 658; 2007, *CBHR 1165*, 658; 2007, *CBHR 1166*, 658; 2007, *CBHR 1167*, 658; 2007, *CBHR 1168*, 658; 2007, *CBHR 1169*, 658; 2007, *CBHR 1170*, 658; 2007, *CBHR 1171*, 658; 2007, *CBHR 1172*, 658; 2007, *CBHR 1173*, 658; 2007, *CBHR 1174*, 658; 2007, *CBHR 1175*, 658; 2007, *CBHR 1176*, 658; 2007, *CBHR 1177*, 658. **Pennsylvania:** 2007, *CBHR 992*, 658; 2007, *CBHR 993*, 658; 2007, *CBHR 994*, 658; 2007, *CBHR 995*, 658.



C14.1: *S. noctilio* ♀ with reddish brown femora & lightly tinted wings



C14.2: *S. noctilio* ♂ reddish with brown femora



C14.3: *S. noctilio* ♀



C14.4: *S. noctilio* ♂



C14.5: *S. noctilio* ♂ checking mated ♀



C14.6: *S. noctilio* ♂ mating with virgin ♀



C14.7: *S. noctilio* ♂ bypassing mated ♀



C14.8: *S. noctilio* ♀



C14.9: *S. noctilio* ♀
with black femora &
darkly tinted wings



C14.10: *S. noctilio* ♂
with black femora

15. *Sirex obesus* Bradley, sp. rev.

Fig. C15.1 (female habitus)

Fig. C15.2 (male habitus)

Fig. C9.6 (map)

Sirex obesus Bradley, 1913: 12. Holotype female (ANSP), examined by HG and DRS. Cresson 1928: 11. Middlekauff 1960: 65. Type locality: Arizona.

Sirex juvenescens californicus; Cameron, 1967: 19 (not Ashmead, 1904: 64); accepted by Smith 1979: 127.

Diagnostic combination

Among **females** with completely black legs and darkly tinted fore wing [*areolatus* and dark legged form of *californicus*], those of *S. obesus* are recognized by the short metatarsomere 2 (1.5 times as long as high) in lateral view and the dense pits on the gena and on most of the vertex (pits 0.0–1.0 pit diameter apart). Among **males** with reddish brown femora, tibiae and tarsi [*californicus*, *mexicanus* and *xerophilus*], those of *S. obesus* are recognized by the black antenna (flagellomeres 1 or 1 and 2 may be reddish brown) and the yellow tinted fore wing.

FEMALE. Description

Color. Body, legs, palps, and antenna black with dark blue metallic reflections. Fore wing darkly tinted.

Head. Gena, vertex and postocellar area with pits 0.0–0.5 pit diameter apart (Fig. C15.3), and each pit diameter about 0.3–0.4 times lateral ocellus diameter.

Thorax. Mesoscutum with some transverse ridges in median area; pits quite large but not coarse or net-like (Fig. B2.41). Metatarsomere 2 in lateral view 1.5 times as long as high, and its length as long as or shorter than length of metatarsomeres 3 + 4 (Fig. B2.39); tarsal pad 0.6 times as long as ventral length of tarsomere. Fore wing vein 3A absent.

Abdomen. Median basin of tergum 9 with basal width 1.1 times as long as median length, maximum width 1.4 times as long as median length, and median length 0.6 times as long as cornus length. Cornus in dorsal view short, with edges slightly angular midway, its median length 0.95 as long as maximum width of abdomen at junction of terga 9 and 10. **Sheath.** Length 0.7 times fore wing length, basal section 1.15 times as long as length of apical section. **Ovipositor.** Lancet with 32 annuli (basal annuli clearly outlined); junction of basal and apical section of sheath aligned between 12th and 13th annuli, with 28 pits beginning with annulus 2; pit of annulus 2 only extending to edge of annulus 1 (as in Fig. B2.52, base). Pits near middle annuli (Fig. B2.43) or area at base of apical section of sheath 0.35 times as long as an annulus (pits not or hardly decreasing in size toward

base), about 0.6–0.7 times as high as lancet height in lateral view, and about 1.3 times as long as high (as in Fig. B2.52, middle); length/ovipositor diameter (lance + lancet) for annulus 2 1.76, for annulus 5 1.53, for annulus 10 1.4, and for annulus 13 1.37 (based on one specimen). Last four annuli before teeth annuli as well as first tooth annulus with ridge on ventral edge of pit. Edge of apical five annuli before teeth annuli extending as ridge to ventral edge of lancet.

MALE. Description

Color. Head, thorax, antenna (flagellomere 1 or 1 and 2 may be reddish brown) (Fig. B2.112), palps, thorax, and abdominal segments 1 or 1 and 2 black with dark blue metallic reflections; remaining abdominal segments light reddish brown. Reddish brown, but black on coxae. Fore wing clearly yellow tinted (B2.114).

Thorax. Metatibia 3.7–4.1 times as long as maximum width. Metatarsomere 1 in lateral view 2.5–3.1 times as long as maximum height.

Taxonomic notes

Adults of *S. obesus* are very similar to those of *S. californicus*, but **both sexes** are distinguished from *S. californicus* by the pit density dorsally on the head, in **females** by a short metatarsomere 2, and in **males** by color pattern of the flagellum.

Females of *Sirex obesus* and dark winged females of *S. californicus* have been confused in the literature. Many females of *S. californicus* and all of those of *S. obesus* have very darkly tinted wings, so wing base tint is not diagnostic. Therefore, published information under *S. obesus* needs confirmation with voucher specimens (Middlekauff 1960, Cameron 1965).

Host and phenology

One specimen of *S. obesus* was reared from *Pinus ponderosa*. Based on 15 field-collected specimens, the earliest and latest capture dates are July 30 to September 23. Thirteen males were caught at hill tops on August 12 (1), August 24 (1), September 20 (4) and September 23 (7).

Range

MEXICO. USA: AZ, NM. Mexico. *Sirex obesus* is known from forested regions of southwestern United States (Fig. C9.6) and has been intercepted from Mexico at Nogales, Arizona and Brownsville, Texas.

Specimens studied and included on range map: 11 females and 14 males from CNC, OSAC, UAIC, and

USNM.

Specimens for molecular studies: 10 specimens. See Fig. E2.5f.

USA. Arizona: 2008, *CNCS 1037*, 599; 2008, *CNCS 1038*, 578; 2008, *CNCS 1039*, 606; 2008, *CNCS 1040*,

593; 2007, *CNCS 1041*, 599.

New Mexico: 2004, *CNCS 1091*, 597; 2004, *CNCS 1092*, 597; 2004, *CNCS 1093*, 593; 2004, *CNCS 1094*, 584; 2004, *CNCS 1095*, 594.



C15.1: *S. obesus* ♀



C15.2: *S. obesus* ♂



C15.3: *S. obesus* ♂

16. *Sirex varipes* Walker

Fig. C16.1, Schiff *et al.* 2006: 54, 55 (female habitus)

Fig. C16.2, Schiff *et al.* 2006: 53 (male habitus)

Fig. C16.3 (map)

Sirex varipes Walker, 1866: 342. Holotype, female (BMNH, according to Kirby, 1882), not examined. Walker 1873: 78. Burks 1958: 16, Smith 1979: 128. Type locality: Vancouver Island, British Columbia.

Sirex varipes; Dalla Torre, 1894: 393 (unjustified emendation).

Sirex juvenicus cyaneus; Konow, 1898: 17, 81, 90, (not Fabricius, 1781: 419).

Sirex cyaneus; Bradley, 1913: 14, (not Fabricius, 1781: 419); accepted by Ries 1951: 83.

Sirex juvenicus juvenicus x *juvenicus californicus*; Benson, 1962: 252.

Diagnostic combination

Among **females** with a light reddish brown metafemur, black abdomen, and long tarsal pad (pad length 0.7–0.8 as long as ventral length of tarsomere) [*abietinus*, *cyaneus* and *nitidus*], almost all those of *S. varipes* are recognized by the black (with dark blue metallic reflections) longitudinal band along part of or most of the dorsal surface of the metatibia, and usually black on dorsal surface of the protibia and mesotibia. Among **males** with a reddish brown metafemur and mainly black metatibia [*abietinus*, *cyaneus*, *nitidus* and *noctilio*], those of *S. varipes* are recognized by the black surface of most of the mesotibia and almost all of mesotarsomere 1 (often mesotarsomeres 2 and 3 as well) and the very narrow pale base of metatibia (length of pale area shorter than minimum width of tibia at base).

FEMALE. Description

Color. Body, antenna and palps black with dark blue metallic reflections. Coxae and usually tarsomeres 5 black; femora (except brown base) and tarsomeres 1–4 light reddish brown; protibia and mesotibia usually mostly black with dark blue metallic reflections (Fig. B2.72), but in some specimens completely light reddish brown, and metatibia light reddish brown with a dark blue metallic longitudinal band along dorsal surface (black longitudinal band absent in the palest specimens) (Fig. B2.72). Fore wing clear, at most light yellowish brown behind stigma.

Head. Gena with pits 0.0–4.0 pit diameters apart; vertex and postocellar area with pits 0.0–3.0 pit diameters apart, and each pit diameter about 0.1–0.2 that of lateral ocellus.

Thorax. Mesoscutum with few coarse, net-like pits in median area. Metatarsomere 2 in lateral view 3.0–3.6

times as long as high, and its length about 1.1–1.3 times length of tarsomeres 3 + 4; tarsal pad 0.7–0.8 times as long as ventral length of tarsomere. Fore wing vein 3A absent.

Abdomen. Median basin of tergum 9 with basal width 0.9–1.2 times as long as median length, maximum width 1.2–1.5 times as long as median length, and median length 0.55–0.7 times as long as cornus length. Cornus in dorsal view short, with edges straight or slightly rounded in apical third, its median length 0.9–1.3 times as long as maximum width of abdomen at junction of terga 9 and 10. **Sheath.** Length 0.7–0.85 times as long as fore wing length, basal section 0.9–1.05 times as long as length of apical section. **Ovipositor.** Lancet with 35–38 annuli (basal 2–4 annuli difficult to see); junction of basal and apical section of sheath aligned between 10th and 11th to 12th and 13th annuli, with 27–31 pits beginning with annuli 3–5. Pits near middle annuli or area at base of apical section of sheath 0.3–0.5 times as long as an annulus (pits gradually and markedly decreasing in size toward base), about 0.5–0.6 times as high as lancet height in lateral view, and 1.5–2.3 times as long as high (Fig. B2.71); annulus 10 length/ovipositor diameter (lance + lancet) not measured. Last 3–5 annuli before teeth annuli as well as first tooth annulus with ridge on ventral edge of pit. Edge of apical 6–8 annuli before teeth annuli extending as ridge to ventral edge of lancet.

MALE. Description

Color. Head and thorax black with dark blue metallic reflections. Coxae, mesotibia (at least most of dorsal surface), mesotarsomere 1 (usually mesotarsomeres 2 and 3) (Fig. B2.136), metatibia (except extreme base), and metatarsomeres 1–3 black (Fig. B2.138); femora, protibia and protarsus, at least base of mesotibia, ventral surface of mesotarsomere 1 (in some specimen mesotarsomeres 2 and 3), metatarsomere 4, extreme base of metatibia (spot restricted to minimum constricted portion and less long than wide) (B2.138), and metatarsomere 4 light reddish brown. Fore wing lightly yellowish brown. Abdominal segments 1, 2, and in some specimens basomedian area of terga 3 up to a maximum of terga 3–8 black, remaining segments light reddish brown (Fig. B2.141).

Thorax. Metatibia 3.8–4.5 times as long as maximum width (Fig. B2.138). Metatarsomere 1 in lateral view 2.9–3.8 times as long as maximum height.

Taxonomic notes

We did not examine the type of *Sirex varipes*, but the description of the leg color pattern of the female type perfectly matches our concept of this species.

Sirex varipes has been confused with the European

S. juvenicus (Benson, 1962) and *S. torvus*. Females of *Sirex varipes* are easily distinguished from the latter two species by the size and proportions of pits at the middle and base of the ovipositor. Males of *Sirex varipes* are easily separated from *S. juvenicus* by the color pattern of the middle leg, but are very similar in color to males of *S. torvus*.

Almost all females of *Sirex varipes* examined could be correctly identified by metatibial color pattern. However, three females had completely pale metatibia. Such females may be confused with *S. cyaneus*, *S. abietinus* and *S. nitidus*. All four species share a long tarsal pad on metatarsomere 2. However in *S. varipes*, the ovipositor pit development in apical 0.25 is distinctive and consists of large and long pits.

Hosts and phenology

Sirex varipes has a wide host range. Based on 27 reared and confirmed specimens, all hosts are Pinaceae: *Abies amabilis* (10), *A. concolor* (3), *A. grandis* (1), *A. magnifica* (1), *A. lasiocarpa* (2), *Picea englemannii*, *P. sitchensis* (2), *Pinus ponderosa* (1), *Pseudotsuga menziesii* (6), and *Tsuga heterophylla* (1).

Based on 15 field-collected specimens, the main flight period is from early July to early October with a peak in August and September.

Range

CANADA: AB, BC, NS (emerged from western lumber). **USA:** CA, MT, NV, IA (wood bed frame), OH (wall probably associated with western lumber), NJ (from wood in home), OR, WA. *Sirex varipes*, a western species, known from southern British Columbia and southwestern Alberta south to California and Arizona (Fig. C16.3). There are a few records of adventive specimens emerged from lumber in eastern North America (IA, OH, NJ and NS) and Britain (Burks 1967), and we have seen one intercepted specimen from New Zealand (FRNZ). None have become established.

Specimens studied and included for the distribution map: 94 females and 46 males from CNC, MTEC, NFRC, OSAC, PFRC, UAIC, UCRC, and USNM.

Specimens for molecular studies: 20 specimens. See Fig. E2.5e.

CANADA. British Columbia: 2007, *CNCS 1046*, 621; 2002, *SIRCA 054*, 639; 2002, *SIRCA 055*, 630; 1999, *SIRCA 068*, 384; 1992, *SIRCA 070*, 348.

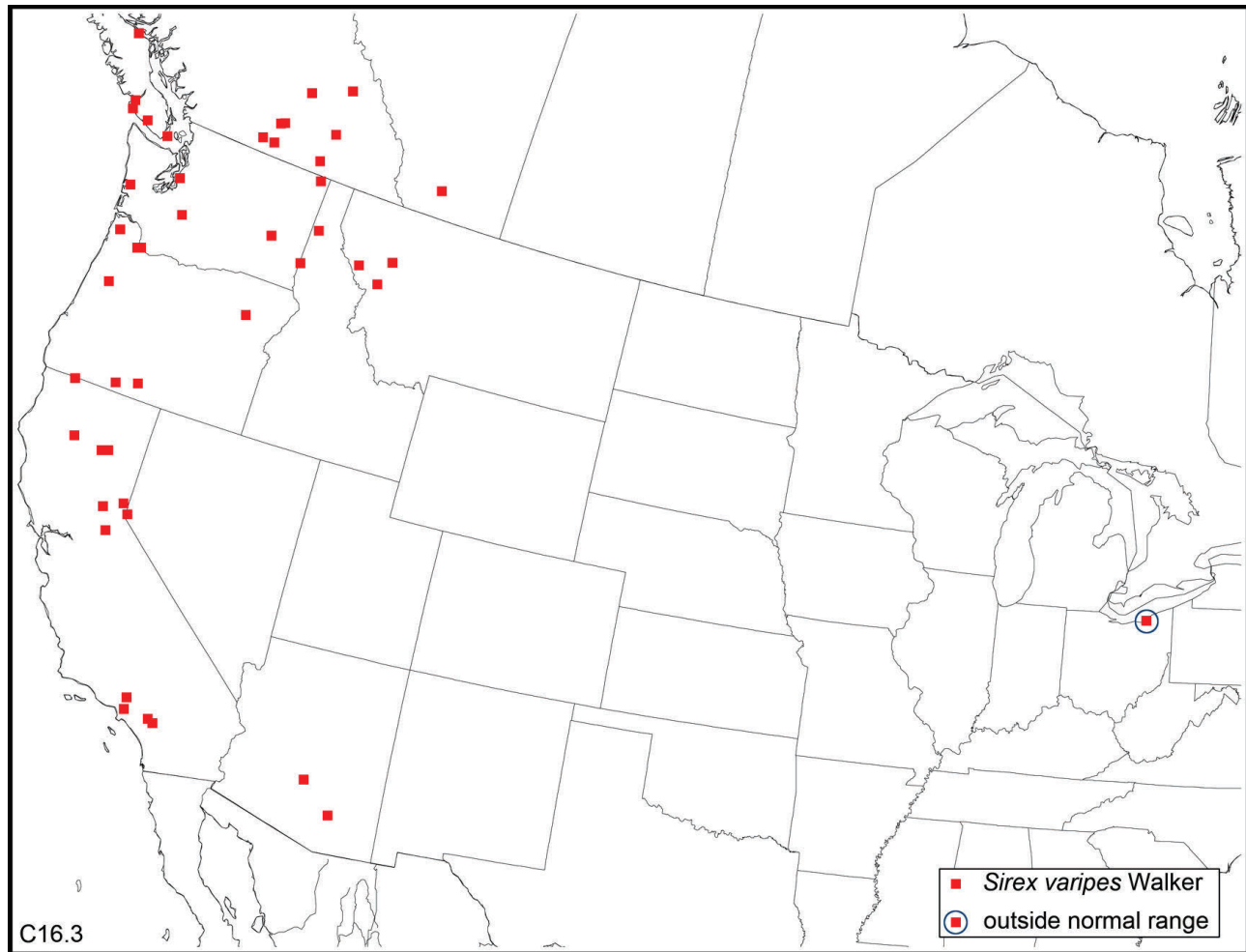
USA. California: 2005, *CBHR 96*, 658; 1999, *CBHR 102*, 658; 1999, *CBHR 104*, 658. **Idaho:** 2008, *CBHR 1450*, 658. **Oregon:** 2004, *CBHR 223*, 658; 2004, *CBHR 244*, 658; 2001, *CBHR 1363*, 658; 2001, *CBHR 1364*, 658. **Unknown state:** year unknown, *CBHR 117*, 658; year unknown, *CBHR 410*, 658; year unknown, *CBHR 411*, 658; year unknown, *CBHR 412*, 658; year unknown, *CBHR 413*, 658. **Washington:** 2005, *CBHR 213*, 658; 2005, *CBHR 247*, 658.



C16.1: *S. varipes* ♀



C16.2: *S. varipes* ♂



17. *Sirex xerophilus* Schiff, n. sp.

Fig. C17.1 (female habitus)

Fig. C17.2 (male habitus)

Fig. C9.6 (map)

Diagnostic combination

Among **females** with completely black legs and abdomen, and a clear fore wing [*mexicanus*], those of *S. xerophilus* are recognized by the coarse and crater-like pits over most of the median half of the mesoscutum. Among **males** with a reddish brown hind leg beyond the coxa [*californicus* and *obesus*], those of *S. xerophilus* are recognized by the completely reddish brown antenna and black coxae.

FEMALE. Description

Color. Body, legs, palps, and antenna black with dark blue metallic reflections. Fore wing lightly tinted (Fig. B.2.32).

Head. Gena with pits (except centrally) 0.0–1.5 pit diameters apart; vertex and postocellar area with pits 0.0–1.0 pit diameters apart; and each pit diameter about 0.2–0.45 that of lateral ocellus.

Thorax. Mesoscutum widely covered with net-like pits in median area (Fig. B2.45). Metatarsomere 2 in lateral view 2.2–2.6 times as long as high, and its length about 1.2 times length of tarsomeres 3 + 4; tarsal pad 0.3–0.5 times as long as ventral length of tarsomere. Fore wing vein 3A absent (Fig. B2.47).

Abdomen. Median basin of tergum 9 with basal width 1.0–1.3 times as long as median length, maximum width 1.2–1.6 times as long as median length, and median length about 0.7 times as long as cornus length. Cornus in dorsal view short, with edges angularly rounded or very angular midway, its median length 0.9–1.2 as long as maximum width of abdomen at junction of terga 9 and 10. **Sheath.** Length 0.7–0.9 times fore wing length, basal section 1.1–1.2 times as long as length of apical section.

Ovipositor. Lancet with 33–36 annuli (basal annuli clearly outlined); junction of basal and apical section of

sheath aligned between 11th and 12th to 13th and 14th annuli, with 29–32 pits beginning with annulus 2; pit of annulus 2 only extending to edge of annulus 1 (Fig. B2.51, base). Pits near middle annuli (Fig. B2.51) or area at base of apical section of sheath 0.7–0.8 times as long as annulus (pits slightly decreasing in size toward base, and about 0.6 times as high as lancet height in lateral view, with posterior edge hardly outlined, and 2.5–3.4 times as long as high (Fig. B2.51, middle); length/ovipositor diameter (lance + lancet) for annulus 2 is 1.9–2.35, for annulus 5 1.5–2.00, for annulus 10 1.4–1.7, and for annulus 13 1.40–1.60 (7 specimens). Last 4–5 annuli before teeth annuli as well as first tooth annulus with ridge on ventral edge of pit. Edge of apical 4–5 annuli before teeth annuli extending as ridge to ventral edge of lancet.

MALE. Description

Color. Head, palps, thorax, and abdominal segments 1 or 1 and 2 black with dark blue metallic reflections; remaining abdominal segments and antenna (a little darker apically) light reddish brown. Coxae black, remaining articles of legs reddish brown. Fore wing clear.

Thorax. Metatibia 4.0 times as long as maximum width. Metatarsomere 1 in lateral view 3.3 times as long as maximum height.

Type material

Holotype female (USNM) in perfect condition; labeled [White with red frame] [White] “Panguitch Utah” “Hopk. U.S. 4533j” “H. E. Burke Collector” “Pinus ponderosa”; [Red] “HOLOTYPE *Sirex xerophilus* N.M. Schiff, 2011”. Type locality: Panguitch, Garfield Co., UT.

Paratypes. 11 females and 1 male. **MEXICO. Chihuahua:** Intercepted at El Paso, Texas (#51422),

28.IX.1948, pine lumber (#48–16199) (2F, USNM); [no locality] maderita [lumber] pine, J. A. Backer (2F, USNM). **USA. Colorado:** Larimer Co., Big Elk Fire, 40°17'02"N 105°22'59"W, 16.IX.2005, S. M. McElway (5 F, CNC). **Utah:** Garfield Co., Panguitch, Hopk. U.S. 4533j, H. E. Burke, *Pinus ponderosa* (1F, 1M, USNM).

Origin of specific epithet

The name *xerophilus* is an adjective derived from two Greek words meaning “dry loving” because the species is found in dry ecosystems where its only recorded host, *Pinus ponderosa*, occurs.

Host and phenology

Specimens of *S. xerophilus* have been reared from *Pinus ponderosa* in Utah. They were also collected on pine lumber in Mexico.

One specimen was captured on September 16, three on September 17, two on September 28 and two on November 26.

Range

Mexico: (northern region). **United States:** CO, UT. *Sirex xerophilus* is known from southern Utah and northern Colorado south to northern Mexico (Fig. C9.6).

Specimens studied and included for the distribution map: 11 females and 1 male from CNC and USNM.

Specimens for molecular studies: 5 specimens. See Fig. E2.5b.

USA. Colorado: 2005, *CBHR* 538, 658; 2005, *CBHR* 541, 658; 2005, *CBHR* 542, 658; 2005, *CBHR* 544, 658; 2005, *CBHR* 545, 658.



C17.1: *S. xerophilus* ♀



C17.2: *S. xerophilus* ♂