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Siricid Guide

GUIDE TO THE SIRICID WOODWASPS OF NORTH AMERICA

NATHAN M. SCHIFF, STEVEN A. VALLEY, JAMES R. LABONTE, AND DAVID R. SMITH



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Cover photo: Lateral view of *Sirex noctilio* female.

GUIDE TO THE SIRICID WOODWASPS OF NORTH AMERICA

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Introduction

The Siricidae are a family of large, colorful, stingless wasps whose larvae bore into wood. They are members of the suborder Symphyta (sawflies, and horntails or woodwasps) of the insect order Hymenoptera (ants, wasps, and bees), and are characterized by having a broad waist and an ovipositor modified to insert eggs into wood.

Worldwide, the family Siricidae has approximately 100 species in 2 subfamilies and 11 genera. The species are widely distributed in the forests of the Northern Hemisphere with some as far south as Cuba, northern Central America, New Guinea, the Philippines, Vietnam, northern India, and northern Africa. No species are known to be native to Australia or South America, but two species are known from tropical Africa.

In North America north of Mexico, there are 23 species and subspecies of Siricidae in 5 genera representing both subfamilies: the Tremicinae, which are associated mostly with hardwoods, and the Siricinae, which feed on conifers. Several siricids in North America, such as *Eriotremex formosanus* and *Urocerus sab*, were introduced from other countries with imported goods. Wood-boring larvae of siricids often take more than a year to develop. If they are not noticed when the wood is cut, they can be readily transported within lumber, furniture, or wood packing material to a new State or country. When their development is completed far from their country of origin, they emerge from the wood and start looking for hosts in their new habitat.

While most species of siricids are of only minor importance in their native forests, exotic species can be quite damaging. *Sirex noctilio*, a species native to Europe, Asia, and North Africa, has been very destructive to plantations of introduced North American pines in several Southern Hemisphere countries. It was so destructive to Monterey pines in Australia and New Zealand that the Australians started a research program in the 1960s to control it. A European nematode, *Deladenus siricidicola*, has proven extremely effective as a classical biological control agent for *Sirex noctilio* in both Australia and New Zealand. In the last 25 years, *Sirex noctilio* has been introduced accidentally to plantations of North American pines in South Africa and several South American countries. Currently, South Africa, Argentina, Uruguay, Chile, and Brazil have started control programs with this nematode.

In 2005, *Sirex noctilio* was discovered in New York and Canada. A program is being developed to control it, but there are unique problems in North America, the most basic of which is identification of this pest. In contrast to the Southern Hemisphere countries, which have no native siricid species, North America has many siricids, including several that are very similar to *Sirex noctilio*. This guide, including keys and photographic figures, was produced as a reference to help foresters, land managers, students, and all those concerned with our native forests identify North American Siricidae, including the introduced *Sirex noctilio*.

Woodwasp Biology

The biology of siricid woodwasps is a complex interaction between three organisms: the woodwasp, a symbiotic wood-decaying fungus, and the host tree. Woodwasp larvae, like most wood-boring insects, do not make enzymes that digest wood, so they require a symbiont to break down the wood. Siricids use wood-decaying fungi that females carry in specialized abdominal glands called mycangia. When a female lays eggs in a tree, she also inserts some of the fungus, which grows rapidly and excretes wood digesting enzymes. The larvae then feed on the fungus and digested wood. In some species, especially *Sirex noctilio*, the female also injects toxic mucus into the tree, which helps the fungus colonize the wood and kill the tree.

Depending on the species and the latitude, the woodwasp larva takes from 1 to 3 years to develop before the adult emerges, typically in the late summer or fall. Males emerge from the tree first and disperse, preventing inbreeding. They gather with other males high up in trees and wait for females. When females emerge, they fly to stressed or wounded trees to mate and lay their eggs. Many species of siricids in Western North America are attracted to forest fires presumably because fires stress or kill trees.

Siricids, like all Hymenoptera and some other insects, have a complex sex determination system called haplo-diploidy. In this arrangement, all the males are haploid with only one set of chromosomes, while females are diploid with two sets of chromosomes. Unmated females only produce male progeny while mated females can produce both male and female offspring. This system often results in skewed sex ratios when siricids are reared from a tree or piece of wood.

Siricids have several native predators and parasitoids in North America. The most common are large ichneumonid wasps in the genus *Megarhyssa*. These wasps have very long, thin ovipositors to

lay their eggs on siricid larvae deep in the wood. Individuals of *Megarhyssa* can sometimes be followed to find siricid-infested trees. Occasionally, *Megarhyssa* females can be seen hanging from a tree by their ovipositors, which can become stuck during oviposition. A second family of wasps that parasitize Siricidae is the Ibaliidae. In general, *Ibalia* individuals, which have a distinctive, laterally compressed, oblong abdomen, are much smaller than *Megarhyssa* individuals and probably parasitize younger siricid larvae.

Perhaps the most significant organisms that attack siricids are parasitic nematodes in the family Neotylenchidae. There are several native species in North America; the European species, *Deladenus siricidicola*, has been used to control *Sirex noctilio* in the Southern Hemisphere. These nematodes are quite remarkable, having two very different adult forms with different life cycles depending on their environment. In the presence of fresh fungus, juveniles develop into a fungus-feeding form. If the fungus is old or the juveniles are near a siricid larva, the nematodes develop into a parasitic form. The female parasitic nematodes penetrate the cuticle of the siricid larva and enter the body cavity. When the siricid pupates, the female nematode produces juvenile nematodes that feed on the eggs of female or the testes of male siricid hosts. Even though the nematodes have consumed her eggs, the female siricid continues to oviposit them into host trees, effectively spreading the nematodes. In this manner, these nematodes can spread through the forest and control the siricids.

Identifying Siricidae

General Description

Adult siricids have a typical insect body plan composed of three parts: head, thorax, and abdomen. Each part has its own set of distinguishing features or appendages. The head has the eyes, mouthparts, and antennae; the thorax has three pairs of legs and two pairs of membranous wings; and the abdomen has the digestive and reproductive organs. In the Siricidae, the abdominal appendages are quite distinctive. Both sexes have a short dorsal spine or horn at the apex of the abdomen called the cornus, giving rise to one of the common names for the family, horntail. Females also have a ventral ovipositor in a sheath. Since many of the body parts used in the keys have technical names that might be unfamiliar to the reader, they have been identified in the photograph on page 5.

Size and Color Variation

An unusual feature of siricids is that they exhibit extreme variation in body size. Fully developed adults of the same species may range in body length from 1 to 5 centimeters, excluding the ovipositor. This variation has been observed in many species and even among individuals reared from the same tree. Size cannot be used to distinguish species; the characters in the keys will be sufficient to identify small and large individuals.

Color is a useful character for identifying siricid species, but there can be considerable variation. We have tried to use contrasting characters such as red versus blue, and the keys should identify most specimens, but there are at least two kinds of variation that may be confusing. First, there is true variation where a color may not be as described or figured. Examples of this kind of color variation include some specimens of *Urocerus cressoni*, which

do not appear to have white spots behind the eyes, and specimens of *Tremex columba*, which can vary from reddish brown to dark brown with yellow stripes. The second kind of color variation is seen in newly emerged specimens that were not completely tanned or hardened when killed. In these cases, the abdomen or appendages are a lighter color than expected.

We use the colors red and blue to describe body parts of many species in the keys and descriptions. Unfortunately, there are many shades of red and blue, and it is often difficult to agree on the exact shade of a particular body part. In this guide, therefore, red covers the range of shades from reddish brown through orange red to orange yellow, and blue covers the range from navy to black. In general, red is used as a contrast to blue or black.

How to Use This Guide

This guide contains keys to genera and species, and photographs and descriptions of species and subspecies. It is designed so the user can identify most woodwasps by comparison of specimens with the species photographs. For each species, there are lateral and dorsal images to facilitate comparison. Females of most siricids are readily recognizable, except for a group of species in the genus *Sirex* that are blue with short ovipositors. These specimens need to be identified using the key to *Sirex* species on page 16. Males of most *Sirex* species are uncommon and some of the species are not easily identifiable. The key takes *Sirex* species as far as possible with the characters available. We have tried to make the keys simple to use, with highly contrasting characters. Wherever characters are not obvious from the general images, we have provided detailed images in the keys. Note that not all images are to scale.

Until the user becomes familiar with the species, the best strategy is to determine the genus with the key to genera and then use the appropriate key

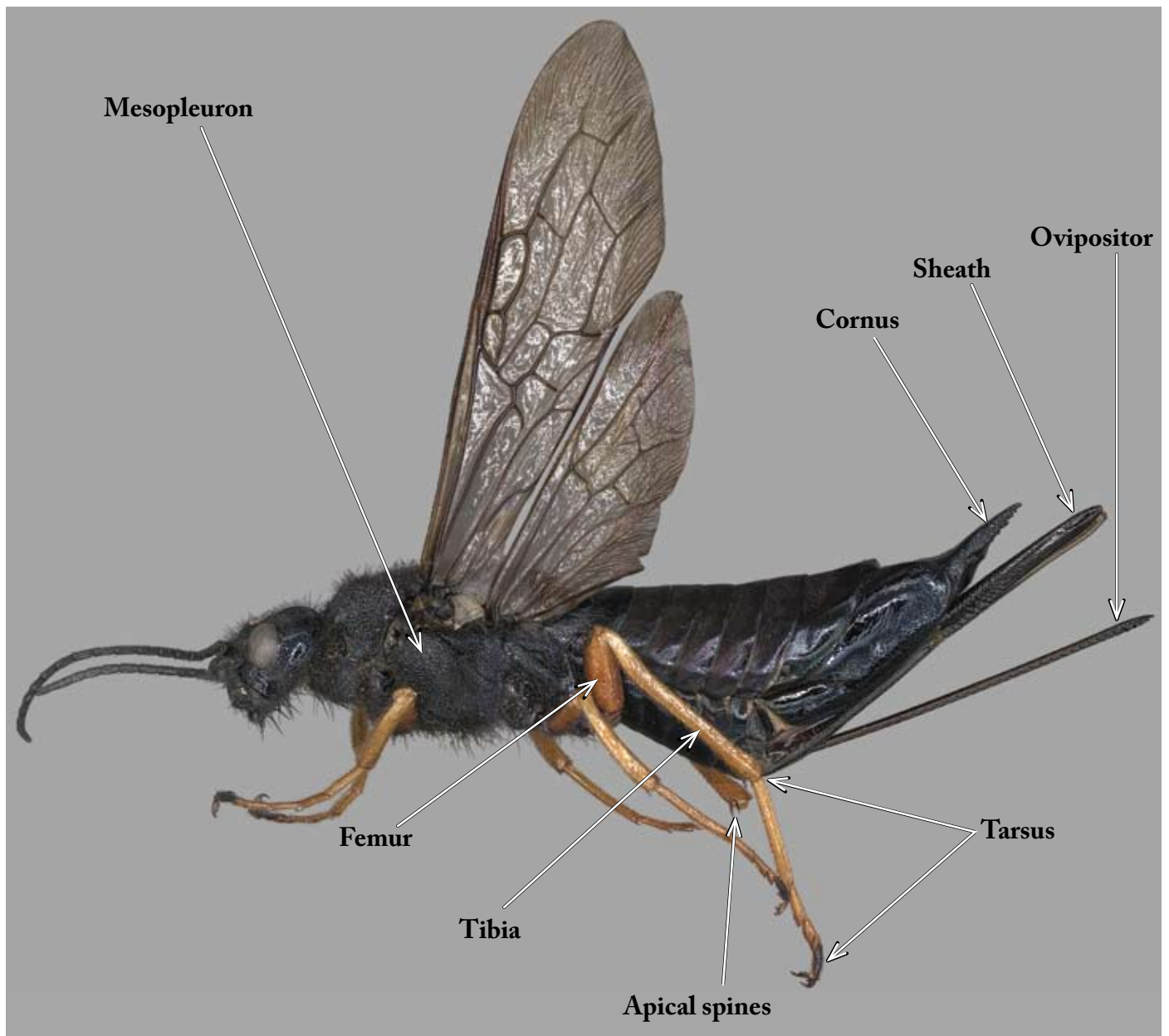
to species. After a specimen is identified, it should be verified by comparison with the photographs and descriptions. The descriptive notes describe only females, as they are much more commonly encountered than males and descriptions of males would have to be detailed and lengthy. When the user becomes familiar with many of the species, the key characters can be used to abbreviate the identification process. The key characters are normally enough to separate the specimen from the species that is most similar to it.

If a species cannot be identified with certainty or if users believe they have discovered a population of *Sirex noctilio*, they should contact one of the following: State department of agriculture; State department of forestry; local cooperative extension office; USDA Animal and Plant Health Inspection Service, Plant Protection and Quarantine; or USDA Forest Service.

Keys

The taxonomy of North American Siricidae is currently in a state of flux. Some characters used in the past are more variable than previously thought, and there are not enough specimens, especially males, to unambiguously define the limits of some species. Several species will likely be redefined in the future. As there is an immediate need for this guide,

we have followed the *Catalog of Hymenoptera in America North of Mexico* (Smith 1979) to determine our list of species. We hope this guide and interest in *Sirex noctilio* will stimulate the collection of siricid specimens and lead to a revision of the family.



Key to Genera of Siricidae of North America

- | | |
|--|---------------------------------------|
| 1. Antennae with less than 16 segments (figure 1) | <i>Tremex columba</i> (page 13) |
| Antennae with more than 20 segments (figure 1) | 2 |
| 2. Abdomen with long golden hairs | <i>Eriotremex formosanus</i> (page 9) |
| Abdomen without long golden hairs | 3 |
| 3. Head with pale spot behind eyes (figure 2);
female cornus long and slender (figure 3) | 4 |
| Head behind eyes uniformly dark (figure 2);
female cornus short and triangular (figure 3) | <i>Sirex</i> (key on page 16) |
| 4. Hind tibia with one apical spur (figure 4) | <i>Xeris</i> (key on page 80) |
| Hind tibia with two apical spurs (figure 4) | <i>Urocerus</i> (key on page 56) |



Figure 1. Antennae of (top to bottom) *Eriotremex*, *Tremex*, *Xeris*, *Urocerus*, and *Sirex*.



Figure 2. Color variation of the area behind the eyes of siricids: top left, *Sirex juvencus californicus* completely dark; top right, *Urocerus sah* completely pale; bottom left, *Urocerus taxodii* with small pale spots; bottom right *Xeris morrisoni morrisoni* with large pale spots.



Figure 3. Triangular cornus of *Sirex* (left) versus slender cornus of *Xeris* (center) and *Urocerus* (right).



Figure 4. Two apical spurs of *Urocerus* (top) versus one apical spur of *Xeris* (bottom).

SUBFAMILY TREMICINAE

Eriotremex formosanus (Matsumura)

- Status:** Exotic from southeastern Asia
- Distribution:** Southeastern United States (Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Texas, and Virginia)
- Hosts:** Oak, hickory, sweetgum, and probably other hardwoods. Females have been observed ovipositing into and sitting on pines.
- Descriptive notes:** Female *Eriotremex formosanus* are large brown- and yellow-striped wasps with short, blunt, black antennae. They appear similar to the striped form of *Tremex columba*, except that they have long golden hairs on the dorsum of the abdomen.
- Key characters:** Antennae short, blunt, black; abdomen with long yellow hairs on dorsum



Eriotremex formosanus, male dorsal



Eriotremex formosanus, male lateral

Images of male *Eriotremex formosanus* by Joe MacGown.



Eriotremex formosanus, female dorsal



Eriotremex formosanus, female lateral

Tremex columba (Linnaeus)

Common name: Pigeon tremex

Status: Native

Distribution: In the East: Nova Scotia, New Brunswick, and Quebec, south to Florida then west to the Rockies. In the West: Colorado, Utah, Arizona, Mexico, and a few records from southern California.

Hosts: Beech, elm, hickory, maple, oak, poplar, apple, pear, sycamore, and hackberry.
Tremex columba will probably attack other deciduous hardwoods, especially trees that are weakened or dying.

Descriptive notes: Female *Tremex columba* are large wasps with short, blunt, brown antennae. There is considerable color variation in the species, but females tend to be dark to light brown with yellow stripes on the abdomen; males tend to be brown to orange with less distinctive markings.

Key characters: Antennae short, blunt, brown; abdomen without golden hairs



Tremex columba, male dorsal

Tremex columba, male lateral



Tremex columba, female dorsal



Tremex columba, female lateral

SUBFAMILY SIRICINAE

Key to *Sirex* Species

1. Female	2
Male	11
2. Abdomen red	3
Abdomen blue black	4
3. Wings black; Eastern North America	<i>Sirex nigricornis</i> (page 45)
Wings banded; Western North America	<i>Sirex behrensii</i> (page 23)
4. Ovipositor length medium or long (figure 5)	5
Ovipositor short (figure 5)	6
5. Ovipositor long (figure 5); tibiae and tarsi red	<i>Sirex longicauda</i> (page 43)
Ovipositor medium length (figure 5); legs black	<i>Sirex areolatus</i> (page 19)
6. Ovipositor with large pits close together (figure 6); mesopleuron densely punctured (figure 7); legs always red	<i>Sirex noctilio</i> (page 49)
Ovipositor with small pits distantly spaced (figure 6); mesopleuron with smooth areas between punctures (figure 7); legs red or black	7
7. Antennae reddish brown at base; legs red	<i>Sirex juvencus juvencus</i> (page 39)
Antennae black; legs red or black	8
8. Legs black	9
Legs at least partially red	10
9. Eastern North America ¹	<i>Sirex edwardsii</i> (page 31)
Western North America ¹	<i>Sirex juvencus californicus</i> (page 35)
10. Legs red with blue surfaces; Pacific Northwest	<i>Sirex varipes</i> (page 53)
Legs red	<i>Sirex cyaneus</i> (page 27)
11. Abdomen reddish, black at base and apex	12
Abdomen reddish with only one or two basal segments black	16

¹Woodwasps can be transported out of their native range with commerce, but, until the group is revised, geographic range is a useful character.

12. Hind femur black Hind femur red	13 15
13. Abdominal segments 3–7 yellow Abdominal segments 5–6 yellow	14 <i>Sirex edwardsii</i> (page 31)
14. Fore and mid tibiae and tarsi red Fore and mid tibiae and tarsi black	<i>Sirex longicauda</i> (page 43) <i>Sirex areolatus</i> (page 19)
15. Abdominal segments 4–7 yellow; antennae brownish at base Abdominal segments 3–7 yellow; antennae black	<i>Sirex juvencus juvencus</i> (page 39) <i>Sirex noctilio</i> (page 49)
16. Hind femur black Hind femur red	<i>Sirex nigricornis</i> (page 45) 17
17. Hind tibia, hind tarsus, and base of antennae red Hind tibia, hind tarsus, and base of antennae black	<i>Sirex behrensii</i> (page 23), <i>Sirex juvencus californicus</i> (page 35) <i>Sirex cyaneus</i> (page 27), <i>Sirex varipes</i> (page 53)



Figure 5. Abdomens and ovipositors of (top to bottom) *Sirex cyaneus* (short), *Sirex areolatus* (medium), and *Sirex longicauda* (long).



Figure 6. Ovipositors of (left to right) *Sirex cyaneus*, *Sirex noctilio*, and *Sirex juvencus juvencus*, showing pit size and spacing. The *Sirex noctilio* ovipositor has large pits that are close together. The *Sirex juvencus juvencus* and *Sirex cyaneus* ovipositors have pits that are small relative to the width of the ovipositor, and they are relatively far apart. The scissors in this figure indicate that the ovipositors have been cut in half so that more of their length can be shown. Individual ovipositors are shown with the tip on the left and the basal portion on the right.



Figure 7. Mesopleura of (top to bottom) *Sirex cyaneus*, *Sirex juvencus juvencus*, and *Sirex noctilio*. The punctures in *Sirex noctilio* are much closer together than in the other species, which have smooth, shiny areas between punctures.

***Sirex areolatus* (Cresson)**

Status: Native

Distribution: Honduras, New Mexico, and Colorado through the Western United States and north to British Columbia. Specimens from Virginia, Florida, and Europe may be adventive, emerging from imported lumber.

Hosts: Cypress, juniper, incense cedar, pine, Douglas-fir, redwood, and baldcypress

Descriptive notes: Female *Sirex areolatus* are large blue-black wasps with medium-length ovipositors and blue-black legs. The wings are very light clear brown. The female specimen shown here has the head pushed forward, exposing white neck muscles. This white area is not visible in most specimens.

Key characters: Body and legs blue; ovipositor medium length



Sirex areolatus, male dorsal



Sirex areolatus, male lateral



Sirex areolatus, female dorsal



Sirex areolatus, female lateral

Sirex behrensii (Cresson)

- Status:** Native
- Distribution:** Idaho, Nevada, Washington, Oregon, and California
- Hosts:** Cypress and pine
- Descriptive notes:** Female *Sirex behrensii* are large blue or black wasps with red abdomens and black antennae. The wings are hyaline with two distinct dark bands.
- Key characters:** Abdomen red; wings banded; Western North America



Sirex behrensii, male dorsal



Sirex behrensii, male lateral



Sirex bebensii, female dorsal



Sirex bebensii, female lateral

Sirex cyaneus Fabricius

Common name: Blue horntail

Status: Native

Distribution: Newfoundland to British Columbia, south to North Carolina, Illinois, Kansas, and California; also New Mexico and Europe

Hosts: Fir, larch, spruce, pine, and Douglas-fir

Descriptive notes: Female *Sirex cyaneus* are large blue wasps with short ovipositors and reddish-yellow legs. The wings vary from hyaline to dark. *Sirex cyaneus* looks very similar to *Sirex noctilio*. It can be separated from *Sirex noctilio* by the very small, distantly spaced pits on the ovipositor and flattened spaces between punctures on the mesopleuron. *Sirex cyaneus* can be separated from *Sirex juvencus juvencus* by the color of the antennae.

Key characters: Ovipositor short; body blue; legs reddish yellow; ovipositor with widely spaced pits; flattened spaces between mesopleural punctures



Sirex cyaneus, male dorsal



Sirex cyaneus, male lateral



Sirex cyaneus, female dorsal



Sirex cyaneus, female lateral

Sirex edwardsii Brullé

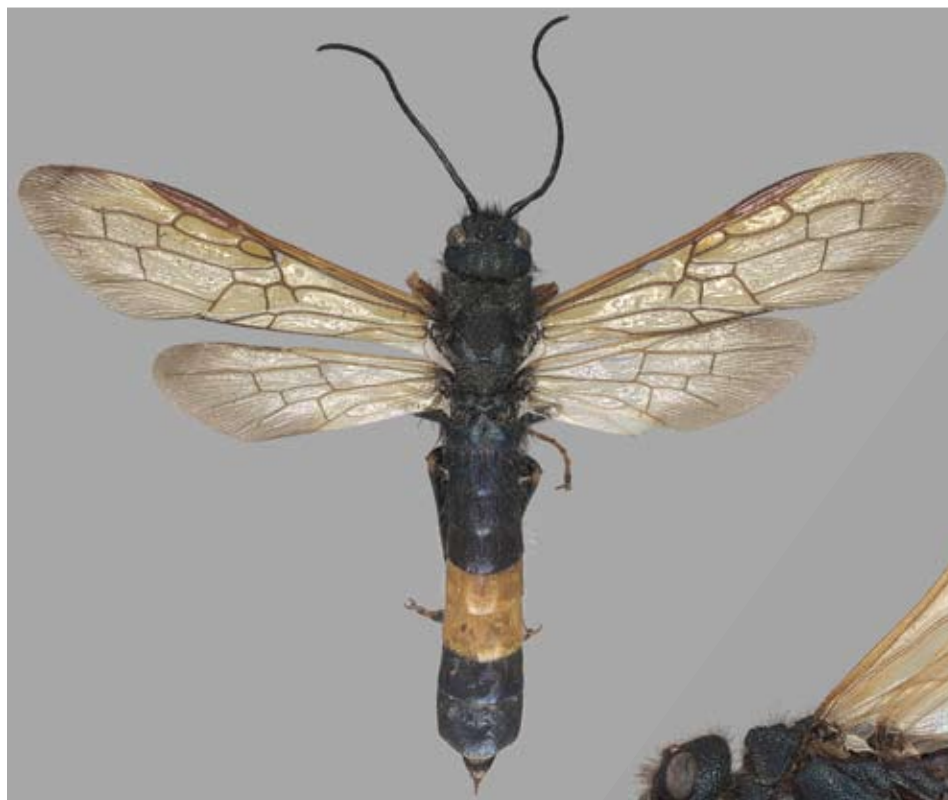
Status: Native

Distribution: Quebec to Georgia and Alabama, west to Saskatchewan, Wisconsin, Arkansas, Louisiana, Mississippi

Hosts: Spruce and pine

Descriptive notes: Female *Sirex edwardsii* are large blue-black wasps with short ovipositors, blue-black legs, and uniformly dark brown wings. This species is similar to dark-winged forms of *Sirex juvencus californicus*. Currently, the easiest way to separate them is by geographical range.

Key characters: Body blue black; wings black; Eastern North America



Sirex edwardsii, male dorsal



Sirex edwardsii, male lateral



Sirex edwardsii, female dorsal



Sirex edwardsii, female lateral

Sirex juvencus californicus (Ashmead)

- Status:** Native
- Distribution:** Western North America (British Columbia, Alberta, Washington, Oregon, California, Montana, Wyoming, Colorado, South Dakota, Utah, New Mexico, and Mexico)
- Hosts:** Cypress, larch, pine, and Douglas-fir
- Descriptive notes:** Female *Sirex juvencus californicus* are large blue wasps with short ovipositors and dark-blue legs. The wings range from hyaline with two smoky brown bands to uniformly black.
- Key characters:** Ovipositor short; body and legs blue; Western North America



Sirex juvencus californicus,
male dorsal



Sirex juvencus californicus, male lateral



Sirex juvencus californicus, female dorsal



Sirex juvencus californicus, female lateral

Sirex juvencus juvencus (Linnaeus)

Status: Presumably introduced

Distribution: Canada (Labrador, Newfoundland, Nova Scotia, New Brunswick, British Columbia, and the Yukon Territory). In the United States, it is recorded from New Jersey. It is native to Europe and Asia, and has been intercepted in New Zealand, Australia, and the Philippines.

Hosts: Fir, larch, spruce, and pine

Descriptive notes: Female *Sirex juvencus juvencus* are large blue wasps with red legs, short ovipositors, and hyaline wings. The basal segments of the antennae of both sexes are often reddish brown (see photo below), as opposed to completely black in *Sirex cyaneus*.

Key characters: Ovipositor short; body blue; legs red; base of antennae reddish



Sirex juvencus juvencus, male lateral



Sirex juvencus juvencus, male dorsal



Sirex juvencus juvencus, antennal segments



Sirex juvenicus juvenicus, female dorsal



Sirex juvenicus juvenicus, female lateral

Sirex longicauda Middlekauff

Status: Native

Distribution: California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, and Utah. There are records from several Eastern States (Kansas, Nebraska, Ohio, Virginia, and West Virginia), but these wasps probably emerged from wood infested in Western States.

Hosts: Fir, pine, and Douglas-fir

Descriptive notes: Female *Sirex longicauda* are large blue wasps with red legs and extremely long ovipositors.

Key characters: Body blue; ovipositor very long



Sirex longicauda, male dorsal



Sirex longicauda, male lateral



Sirex longicauda, female dorsal

Sirex longicauda, female lateral

Sirex nigricornis Fabricius

- Status:** Native
- Distribution:** Quebec to Florida, west to Saskatchewan, Wisconsin, Ohio, Indiana, Arkansas, Louisiana, Mississippi, and Texas
- Hosts:** Pine and spruce
- Descriptive notes:** Female *Sirex nigricornis* are large black wasps with uniformly dark wings and red abdomens. The eye color of the male specimens shown is an artifact of preservation; most male specimens have dark eyes.
- Key characters:** Abdomen red; wings uniformly dark; Eastern North America



Sirex nigricornis, male dorsal



Sirex nigricornis, male lateral



Sirex nigricornis, female dorsal



Sirex nigricornis, female lateral

***Sirex noctilio* Fabricius**

- Common names:** Sirex woodwasp and European woodwasp
- Status:** Exotic from Europe, Asia, and North Africa. Introduced to Australia, New Zealand, South Africa, South America, and North America.
- Distribution:** Ontario, Manitoba, New York, and Pennsylvania
- Hosts:** Fir, larch, spruce, pine, and Douglas-fir
- Descriptive notes:** Female *Sirex noctilio* are blue wasps with short ovipositors and red legs. They can be separated from *Sirex cyaneus* by the large, closely spaced pits on the ovipositor and the absence of smooth shiny areas between punctures on the mesopleuron.
- Key characters:** Body blue; legs red; ovipositor short with large, closely spaced pits; mesopleuron densely punctured



Sirex noctilio, male dorsal



Sirex noctilio, male lateral



Sirex noctilio, female dorsal



Sirex noctilio, female lateral

Sirex varipes Walker

- Status:** Native
- Distribution:** British Columbia, Washington, Oregon, California, Nevada, and Montana
- Hosts:** Fir, spruce, and pine
- Descriptive notes:** Female *Sirex varipes* are large blue wasps with short ovipositors and red legs that have blue on the outer surfaces. Males of this species are not well characterized; they are recognized by association with females caught at the same time.
- Key characters:** Body blue; legs red with blue sheen on forward surfaces



Sirex varipes, male dorsal



Sirex varipes, male lateral



Sirex varipes, female dorsal



Sirex varipes, female lateral

Key to *Urocerus* Species

- | | |
|---|--|
| 1. Female | 2 |
| Male | 7 |
| 2. Wings brown to black | 3 |
| Wings pale to bright yellow | 5 |
| 3. Abdomen black | 4 |
| Abdomen mostly red | <i>Urocerus cressoni</i> (page 67) |
| 4. Cornus yellowish brown to orange | <i>Urocerus taxodii</i> (page 77) |
| Cornus black | <i>Urocerus albicornis</i> (page 59) |
| 5. Thorax with yellow markings | <i>Urocerus sah</i> (page 75) |
| Thorax black | 6 |
| 6. Abdomen black | <i>Urocerus californicus</i> (page 63) |
| Abdomen yellow at base and with a yellow band | <i>Urocerus gigas flavicornis</i> ¹ (page 71) |
| 7. Head mostly yellow to yellow orange | <i>Urocerus sah</i> (page 75) |
| Head largely black with two pale spots behind eyes | 8 |
| 8. Abdomen red; wings dark | 9 |
| Abdomen black and yellow or reddish; wings yellow | 10 |
| 9. Legs black | <i>Urocerus cressoni</i> (page 67) |
| Legs with dark orange on fore and mid legs,
and white on hind legs | <i>Urocerus taxodii</i> (page 77) |
| 10. Abdomen reddish; wings yellow | <i>Urocerus californicus</i> (page 63) |
| Abdomen black with broad yellow band | 11 |
| 11. Hind basitarsus 4.0–5.5 times longer than broad
(figure 8) | <i>Urocerus gigas flavicornis</i> ¹ (page 71) |
| Hind basitarsus 6.5–8.0 times longer than broad
(figure 8) | <i>Urocerus albicornis</i> (page 59) |

¹ There are several subspecies of *Urocerus gigas* in Europe and Asia. *Urocerus gigas flavicornis* is native to North America.



Figure 8. Lateral view of hind basitarsus of male *Urocerus gigas flavicornis* (4.0–5.5 times longer than broad) (top) compared with male *Urocerus albicornis* (6.5–8.0 times longer than broad) (bottom).

Urocerus albicornis (Fabricius)

- Status:** Native
- Distribution:** Newfoundland to British Columbia, south to North Carolina, Michigan, Missouri, New Mexico, California, Oregon, and Washington
- Hosts:** Fir, larch, spruce, pine, Douglas-fir, hemlock, and western redcedar
- Descriptive notes:** Female *Urocerus albicornis* are large black wasps with uniformly brown wings. There are two white spots on the head, the antennae are white except at the base and tips, and the femora and tibiae are white at the base and black distally.
- Key characters:** Body black; antennae white; wings brown



Urocerus albicornis,
male dorsal

Urocerus albicornis, male lateral



Urocerus albicornis, female dorsal



Urocerus albicornis, female lateral

Urocerus californicus Norton

Status: Native

Distribution: Montana, Colorado, and New Mexico, west to British Columbia, Washington, Oregon, and California

Hosts: Fir, larch, incense cedar, spruce, Douglas-fir, and hemlock

Descriptive notes: Female *Urocerus californicus* are large black wasps with bright yellow wings, yellow antennae, and two yellow spots behind the eyes. The femora and tibiae are yellow at the base and black distally.

Key characters: Body black; antennae yellow; wings bright yellow



Urocerus californicus, male dorsal



Urocerus californicus, male lateral



Urocerus californicus, female dorsal



Urocerus californicus, female lateral

Urocerus cressoni Norton

Status: Native

Distribution: Nova Scotia, New Brunswick, Quebec, and Ontario south to Florida and west to Wisconsin, Minnesota, and Montana

Hosts: Fir, spruce, and pine

Descriptive notes: Female *Urocerus cressoni* are large wasps with black heads and thoraxes, red abdomens, and brown wings. There are two white spots behind the eyes and the antennae are black with white tips. The male is very similar to the female in coloration.

Key characters: Head and thorax black; abdomen red; antennae white-tipped



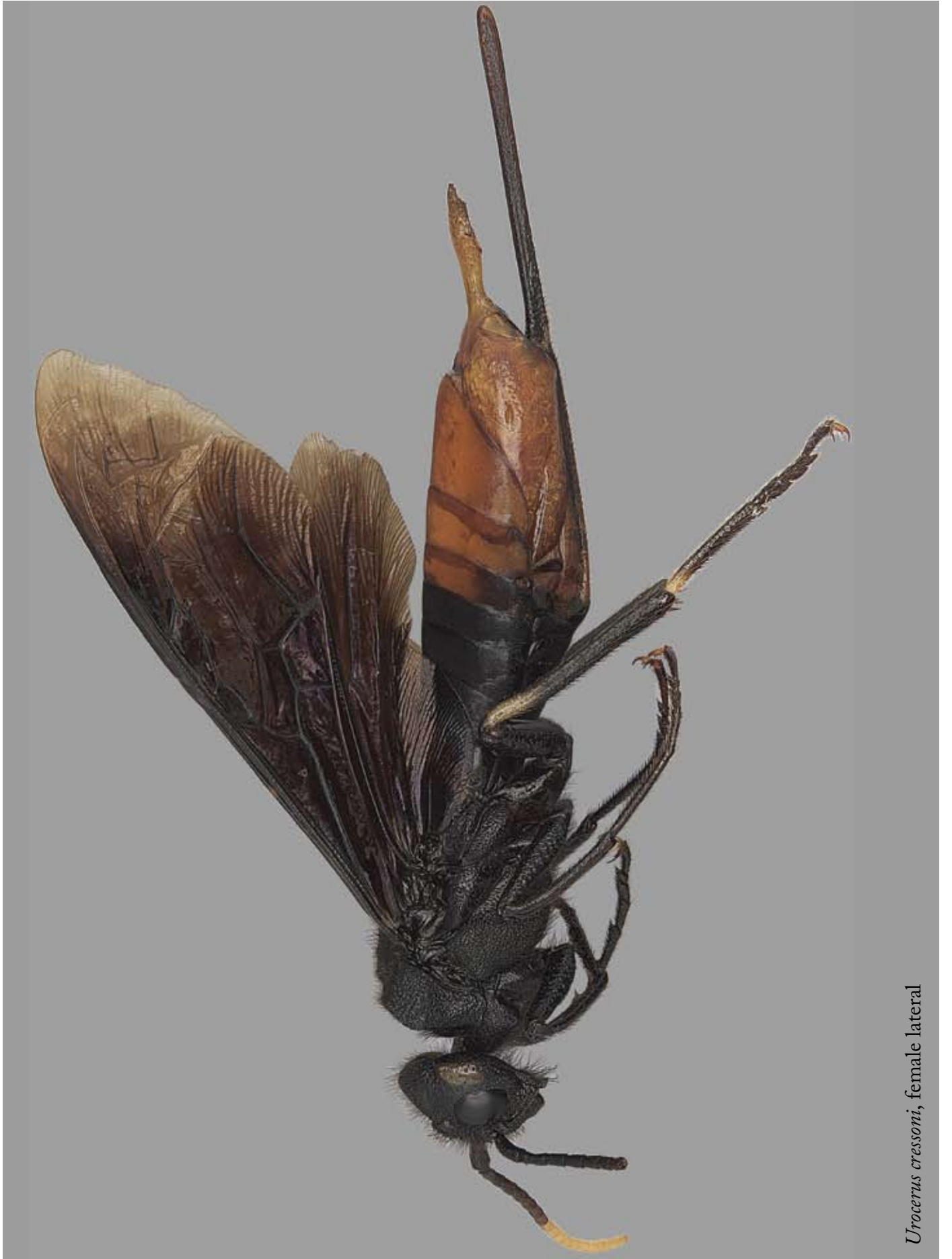
Urocerus cressoni, male dorsal



Urocerus cressoni, male lateral



Urocerus cressoni, female dorsal



Urocerus cressoni, female lateral

Urocerus gigas flavicornis (Fabricius)

Status: Native

Distribution: Labrador to Alaska, south to New Hampshire, Colorado, New Mexico, Arizona, and California

Hosts: Fir, larch, spruce, pine, and Douglas-fir

Descriptive notes: Female *Urocerus gigas flavicornis* are large black wasps with two yellow bands at the base and the middle of the abdomen, and two yellow spots behind the eyes. The antennae are yellow and the wings are hyaline with a faint yellow tinge. The femora are black with yellow tibiae and tarsi.

Key characters: Body black; abdomen with yellow bands; antennae yellow



Urocerus gigas flavicornis, male dorsal



Urocerus gigas flavicornis, male lateral



Urocerus gigas flavicornis, female dorsal



Urocerus gigas flavicornis, female lateral

Urocerus sah (Mocsáry)

- Status:** Exotic
- Distribution:** North Africa, Asia Minor, the Near East, and southern Russia. It is adventive in New Hampshire.
- Hosts:** Fir, spruce, and pine
- Descriptive notes:** Female *Urocerus sah* are black with yellow wings, antennae, upper half of mesepisternum, and legs except hind femora and basal two-thirds of hind tibiae. There is a yellow band across the abdomen and the yellow on the top of the head is continuous, not with two discrete spots like North American species of *Urocerus*. Male *Urocerus sah* have not been collected in North America; therefore, no specimens could be photographed for this guide.
- Key characters:** Head with entire area behind the eyes yellow, not just discrete spots



Urocerus sah, female lateral



Urocerus sab, female dorsal

Urocerus taxodii (Ashmead)

Status: Native

Distribution: Florida, Mississippi, Missouri, Virginia, and Washington, DC

Hosts: Baldcypress

Descriptive notes: Female *Urocerus taxodii* are black medium-sized wasps with dark wings, white-tipped antennae, white spots behind the eyes, and a long, light-brown cornus. Males are similar to females except the abdomen is orange and the wings are hyaline.

Key characters: Apical antennal segments pale; cornus light brown to yellow



Urocerus taxodii, male dorsal



Urocerus taxodii, male lateral



Urocerus taxodii, female dorsal



Urocerus taxodii, female lateral

Key to *Xeris* Species

- | | |
|--|---|
| 1. Female | 2 |
| Male | 4 |
| 2. Abdomen red | 3 |
| Abdomen black | <i>Xeris spectrum</i> ¹ (pages 91 and 95) |
| 3. Cornus constricted in the middle (figure 9) | <i>Xeris morrisoni</i> ¹ (pages 83 and 87) |
| Cornus not constricted in the middle (figure 9) | <i>Xeris tarsalis</i> (page 97) |
| 4. Abdomen black | <i>Xeris spectrum</i> ¹ (pages 91 and 95) |
| Abdomen mostly red | 5 |
| 5. Top of head coarsely and densely pitted around median line; no polished areas along median line (figure 10) | <i>Xeris tarsalis</i> (page 97) |
| Top of head sparsely pitted; polished areas flanking median line (figure 10) | <i>Xeris morrisoni</i> ¹ (pages 83 and 87) |



Figure 9. Cornus of (left to right) *Xeris tarsalis*, *Xeris morrisoni indecisus*, and *Xeris spectrum townesi*.

¹ *Xeris spectrum* and *Xeris morrisoni* each have two subspecies:

- *Xeris spectrum spectrum* has broad white longitudinal stripes on the upper corners of the pronotum and black antennae.
- *Xeris spectrum townesi* has a black pronotum, and the antennae vary from entirely reddish to black at the base with a red tip.
- *Xeris morrisoni morrisoni* has legs and antennae that are black basally and red distally.
- *Xeris morrisoni indecisus* has legs and antennae that are uniformly red, except the two basal segments of the antennae may be black.



Figure 10. Top of head of *Xeris tarsalis* (top) and *Xeris morrisoni morrisoni* (bottom) showing pitting around median line.

Xeris morrisoni indecisus (MacGillivray)

- Status:** Native
- Distribution:** British Columbia, Washington, Oregon, California, Nevada, Idaho, and Utah
- Hosts:** Fir, incense cedar, spruce, hemlock, Douglas-fir, and larch
- Descriptive notes:** Female *Xeris morrisoni indecisus* are large, slender wasps with very long ovipositors and red abdomens, legs, and antennae. They have two white spots behind the eyes and the wings are hyaline with faint smoky bands. The cornus is constricted in the middle.
- Key characters:** Cornus constricted; legs uniformly red



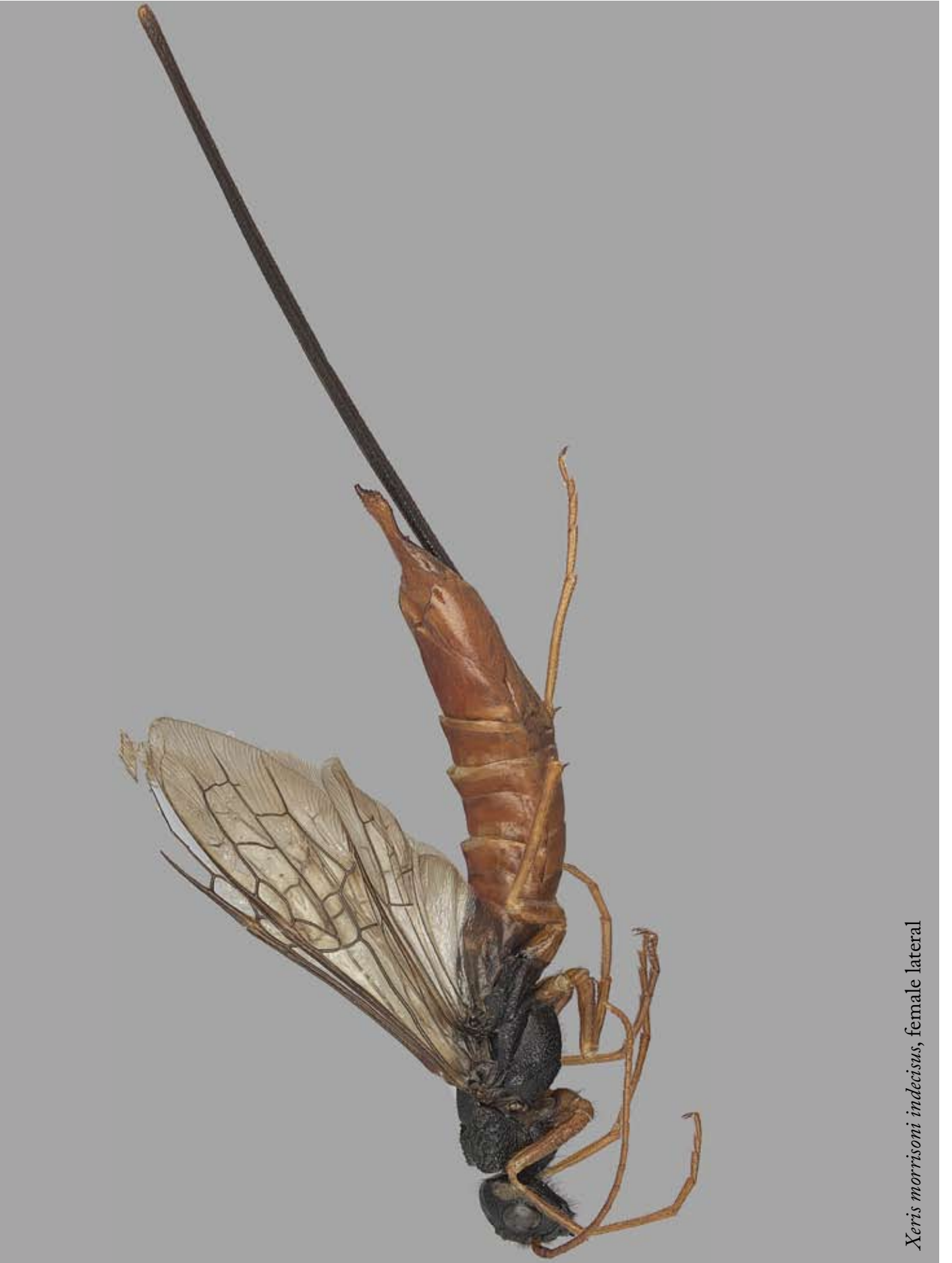
Xeris morrisoni indecisus, male dorsal



Xeris morrisoni indecisus, male lateral



Xeris morrisoni indecicus, female dorsal



Xeris morrisoni indecisus, female lateral

Xeris morrisoni morrisoni (Cresson)

- Status:** Native
- Distribution:** Arizona and Colorado
- Hosts:** Fir, spruce, and Douglas-fir
- Descriptive notes:** Female *Xeris morrisoni morrisoni* are large, slender wasps with very long ovipositors and red abdomens. Their legs and antennae are black at the base and red distally. They have two white spots behind the eyes and the wings are hyaline with faint smoky bands. The cornus is constricted in the middle.
- Key characters:** Cornus constricted; legs dark at base and red distally

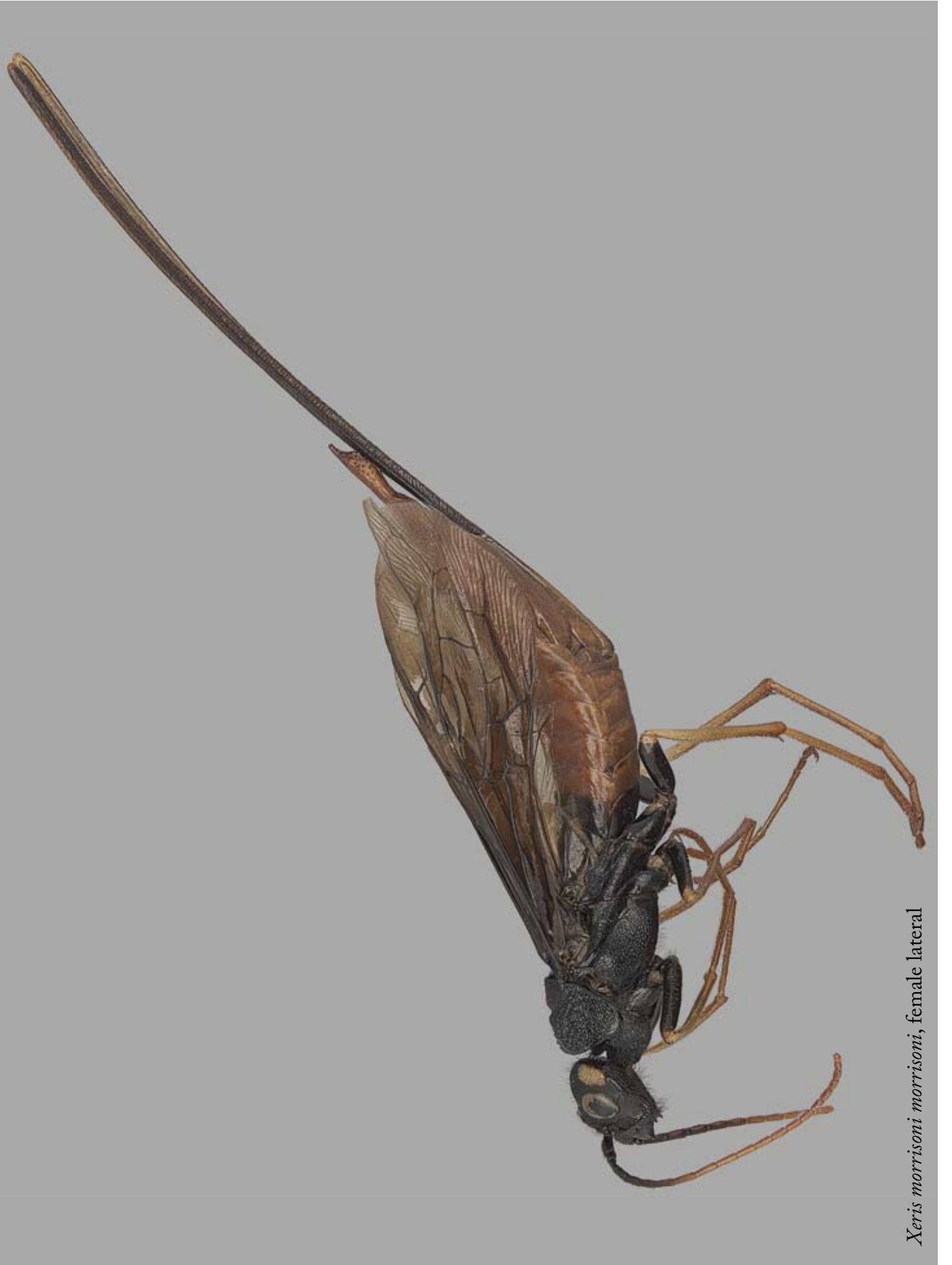


Xeris morrisoni morrisoni, male dorsal

Xeris morrisoni morrisoni, male lateral



Xeris morrisoni morrisoni, female dorsal



Xeris morrisoni morrisoni, female lateral

Xeris spectrum spectrum (Linnaeus)

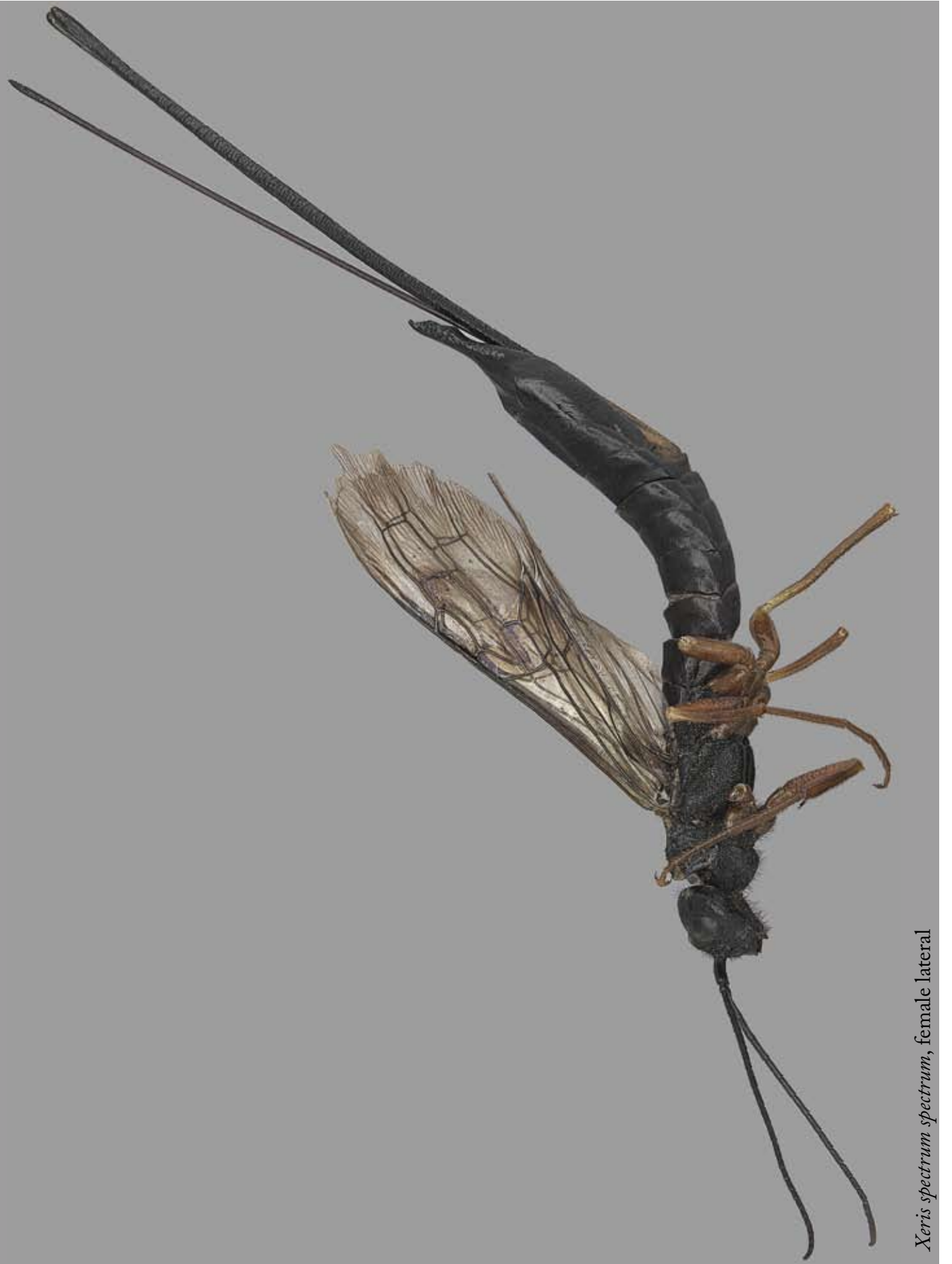
- Status:** Native to North America, Europe, Asia, and North Africa
- Distribution:** New Brunswick, Connecticut, Michigan, Colorado, Arizona, Washington, Oregon, and California
- Hosts:** Fir, larch, spruce, pine, and Douglas-fir
- Descriptive notes:** Female *Xeris spectrum spectrum* are large, slender black wasps with very long ovipositors, black antennae, and red legs. They have two white spots behind the eyes, lateral white margins along the pronotum, and the wings are hyaline with faint smoky bands. At this time, subspecies of male *Xeris spectrum* cannot be differentiated. We have included a photograph of the species for general reference.
- Key characters:** Antennae black; pronotum with white lateral margins



Xeris spectrum, male lateral



Xeris spectrum spectrum, female dorsal



Xeris spectrum spectrum, female lateral

Xeris spectrum townesi Maa

- Status:** Native
- Distribution:** British Columbia, Washington, Oregon, California, Nevada, and Montana
- Hosts:** Fir, spruce, Douglas-fir, pine, and hemlock
- Descriptive notes:** Female *Xeris spectrum townesi* are large, slender black wasps with very long ovipositors and red legs. The antennae vary from black at the base with red at the apex to all red. There are two white spots behind the eyes, and the wings are hyaline with faint smoky bands. At this time, subspecies of male *Xeris spectrum* cannot be differentiated. We have included a photograph of the species for general reference under the description of *Xeris spectrum spectrum* on page 91.
- Key characters:** Distal portion of antennae or entire antennae pale reddish; entire pronotum black



Xeris spectrum townesi, female lateral



Xeris spectrum townesi, female dorsal

Xeris tarsalis (Cresson)

Status: Native

Distribution: Washington, Oregon, California, and Mexico

Hosts: Cypress, juniper, incense cedar, and possibly northern white cedar

Descriptive notes: Female *Xeris tarsalis* are large, slender wasps with long ovipositors, hyaline wings, and black antennae with red tips. They have two white spots behind the eyes and legs that are dark at the base and light at the apex. Males are similar to females in color except the tip of the abdomen is black. The cornus is uniformly wide at the middle, not constricted.

Key characters: Head and thorax black; abdomen red; cornus not constricted



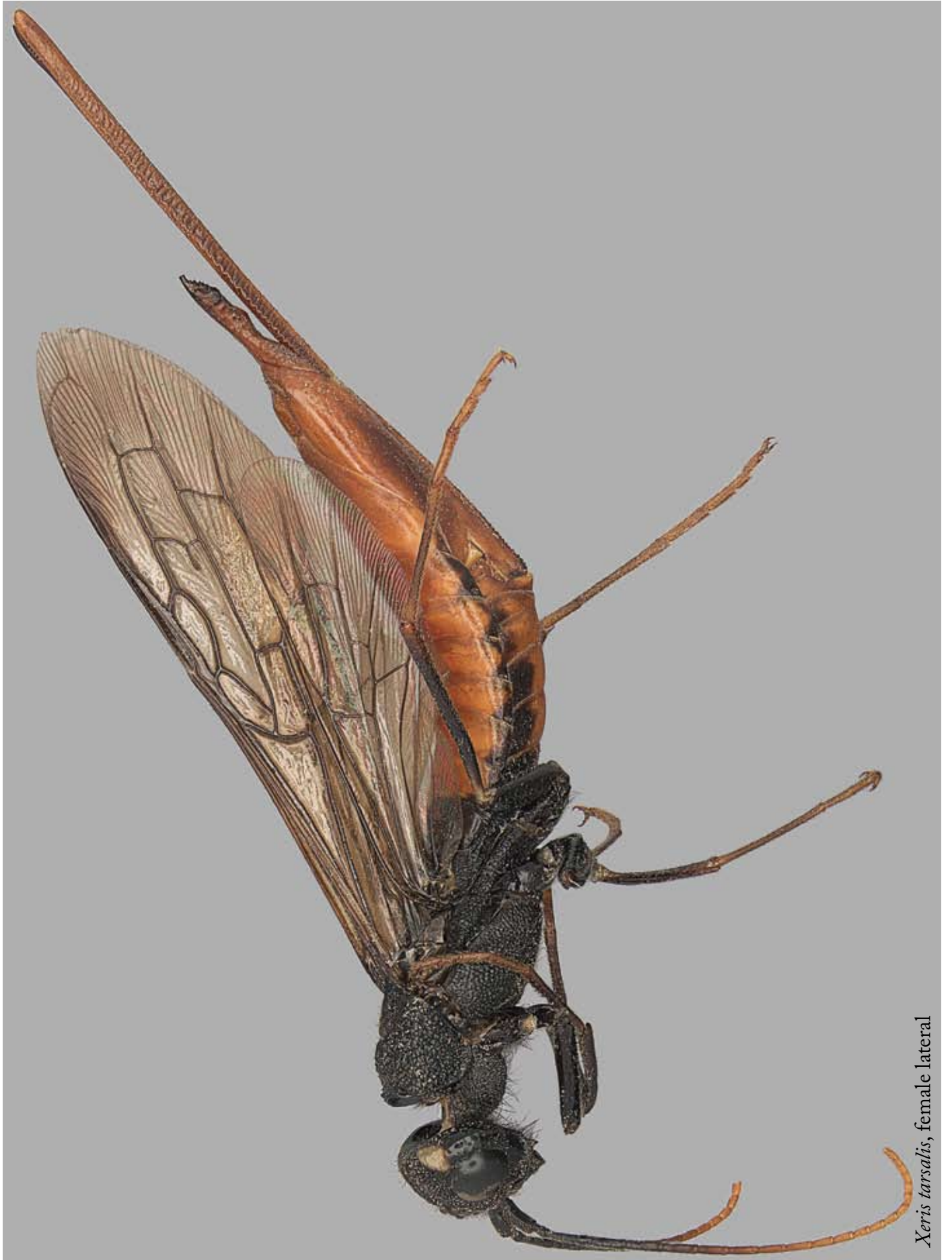
Xeris tarsalis, male dorsal



Xeris tarsalis, male lateral



Xeris tarsalis, female dorsal



Xeris tarsalis, female lateral

About the Images

Our goal was to produce images to make identifications easy for both specialists and nonspecialists. The images were taken at the Oregon Department of Agriculture with a Leica MZ16 stereoscope with axial imaging fitted with a Spot Insight™ digital camera. Depth of focus is extremely shallow when subjects are photographed through a microscope because, as magnification increases, the focus zone becomes a plane of decreasing depth. This is a significant problem in photomacrography, especially when the subject is a three-dimensional object like an insect. One way to increase the depth of focus is to decrease the size of the aperture, but this decreases the amount of light reaching the camera and introduces an effect called diffraction, which degrades image sharpness.

Our solution with the Leica system is to take a series of images, each of which has a shallow plane in focus but together make a “stack” of images from the top to the bottom of the subject. We process the stack digitally to combine the sharp (in focus) pixels from each layer. The resulting composite image has sharp focus throughout its depth. This process has challenges of its own. Further digital processing is necessary to remove artifacts of combining the stack, to sharpen the image, and—where possible—to remove distracting objects from the image, such as dirt, dust, and insect pins. Lighting is a critical

component of this technique because we want to show not only color, but shape, surface texture, and topography, as well as shininess and metallic reflectance. The subjects of this project were usually too large to fit in the field of view of the scope, so images of small portions of each specimen were photographed in a grid pattern. The “tiles” of all the grids were then stitched together to create an image of the whole insect.

The specimens themselves created challenges because they were often covered with dirt, debris, and sometimes other artifacts introduced by traps or other collecting methods. Specimens of many species are rare, fragile, and difficult or impossible to clean without damage, and they were rarely pinned in the most photogenic poses.

The computer software controlling the microscope and camera, and creating the extended depth-of-focus composite was Image-Pro® Plus (Media Cybernetics, Inc.) and In-Focus (Meyer Instruments, Inc.). Adobe® Photoshop® was used for all other post-capture processing, including stitching the tile segments of each image together.

All images, except for those of male *Eriotremex formosanus*, were taken by Steven Valley.

Selected References

The following references are provided for those readers who would like to further investigate the biology and identification of siricid woodwasps.

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