Revision of the World species of *Xeris* Costa (Hymenoptera: Siricidae)

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Abstract

Xeris is one of ten extant genera of Siricidae known as woodwasps or horntails. They are important wood-boring Hymenoptera from the Northern Hemisphere. Adults and larvae of *Xeris* are often intercepted at ports and are consequently of concern as potential alien invasive species.

The genus consists of 16 species with eight in the New World and eight in the Old World. Despite records of numerous intercepted specimens, no species has been accidentally established anywhere.

Five new species all by Goulet are described: *Xeris degrooti* **n. sp.**, *X. pallicoxae* **n. sp.**, *X. umbra* **n. sp.**, *X. xanthoceros*, **n. sp** and *X. xylocola* **n. sp.** Two new synonyms are proposed: *Neoxeris melanocephala* Saini and Singh, 1987 = *X. himalayensis* Bradley, 1934 and *X. indianus* Vasu and Saini, 1999 = *X. himalayensis* Bradley, 1934. Two synonyms are upheld: *Sirex nanus* O. F. Müller, 1776 = *X. spectrum* (Linnaeus, 1758) and *Sirex emarginatus* Fabricius, 1793 = *X. spectrum* (Linnaeus, 1758). Two changes in rank from subspecies to species level are proposed: *X. cobosi* Viedma and Suarez from *X. spectrum cobosi* and *X. malaisei* Maa from *X. spectrum malaisei*.

We characterize the genus, the world species are keyed and a partial reconstructed phylogeny is proposed. For each species we include the following (if available and/or pertinent): synonymic list, type material, diagnosis, description of one or both sexes, origin of specific name, geographical variation, taxonomic notes, biological notes, hosts and phenology (emergence or flight period data), and range.

DNA barcoding (cytochrome oxidase 1 – CO1) was shown to be a reliable identification tool for adult and larval Siricidae (Schiff et al. 2012). Larvae cannot be identified using classical morphological methods, but DNA barcoding can accurately distinguish larvae of *Xeris* spp. We include barcodes for nine of the 16 species (one species, *X. pallicoxae*, could be a complex of two species based on barcodes). DNA data has been most useful for confirming morphologically similar species, associating specimens with discrete color forms, and deciding the rank of populations. The results have proved to be accurate and in agreement with almost all species determined by classical morphological methods.

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A. General

1. Introduction

With a sudden interest in horntails following the accidental introduction of the European *Sirex noctilio* Fabricius into northern New York State (Hoebeke *et al*. 2005), there was a need to resolve numerous taxonomic problems, which resulted in a revision of the Western Hemisphere Siricidae (Schiff *et al*. 2012). In the latter paper, while attempting to understand Maa's (1949) concept of the North American *Xeris spectrum spectrum*, we had to study the European populations of *X. spectrum* as well as other subspecies of *X. spectrum* and remaining Eurasian species. Surprisingly, the North American population of *X. spectrum spectrum* was not *X. spectrum* but consisted of two species not found in Eurasia. Moreover, we discovered that the Eurasian *X. spectrum* was a complex of two species in Europe and four species in Asia, so no species are shared between North America and Asia. Moreover, there were still some nomenclatural problems with Eurasian species. We recently found another cryptic North American species of *Xeris* that was not included in Schiff *et al.* (2012). After further study of the above species complexes, based on over 2400 specimens, we felt confident doing this revision.

Adults of *Xeris* are usually large and elegant insects. Most collections have specimens. However, standard collecting methods rarely work to capture adults and only a few collections have large numbers of specimens. Adults are best collected by rearing from short sections of boles of dead trees. Adults have been found at the top of hills with short vegetation, others were attracted to fire in fire-prone forests, and some have been hand collected on trunks and stumps. As taxonomists are usually poorly equipped to collect Siricidae high in trees, our best friends are forest entomologists who have reared successfully Siricidae from sections of identified tree boles usually during their main research that often involves cerambycid or buprestid beetles.

Adults of *Xeris* are easily distinguished from other Siricidae. In both sexes, there is a small vertical ridge on the gena posterior to the eye. In addition, the metatibia has one spur at the apex and the hind wing has no anal cell. Females of almost all species are recognized by the unusually long ovipositor. Schiff *et al*. (2012) provide more information about their recognition and their phylogenetic position among the Siricidae.

Through 2014, seventeen names have been proposed for *Xeris*. The first species described was *Ichneumon spectrum* Linnaeus, 1758, based on a female. By 1800 two more species, based on males from northern Europe, were described, *Sirex nanus* O. F. Müller, 1776, and *S. emarginatus* Fabricius, 1793. Both have been treated as synonyms of *X. spectrum*. No new taxa were then proposed until 1865, when the area of study shifted to North America as western North America became accessible to entomologists. Five species were described from 1865–1900, *Urocerus caudatus* Cresson, 1865, *Sirex melancholicus* Westwood, 1874, *Urocerus morrisoni* Cresson, 1880, *Urocerus tarsalis* Cresson, 1880, and *Urocerus indecisus* MacGillivray, 1893. All five are still recognized here. During the period 1901–1950 Bradley (1913) published the first North American revision of *Xeris* and described *X. macgillivrayi*, a synonym of *X. tarsalis* (Schiff *et al*. 2012). Bradley (1934) described *X. himalayensis* from northern India, and Maa (1949) described *X. spectrum malaisei* from Taiwan and *X. spectrum townesi* from western North America. The latter was considered as a synonym of *X. indecisus* (Schiff *et al*. 2012). After 1950 three more taxa were described, *X. spectrum cobosi* Viedma and Suárez, 1961, from Morocco, *Neoxeris melanocephala* Saini and Singh, 1987, from India, here considered as a synonym of *X. himalayensis*, and *X. indianus* Vasu and Saini, 1999, from India, also considered here as a synonym of *X. himalayensis.* Since the year 2000 two new species were added, *X. chiricahua* Smith, 2012, from southwestern United States and *X. tropicalis* Goulet, 2012, from southernmost Mexico (Schiff *et al.* 2012).

Of the 17 names previously proposed six are here considered as synonyms leaving 11 valid species. None were retained as subspecies. We add five new species, one from the central Rocky Mountain region of USA, another from Europe, one from Laos, and two from China (Yunnan).

2. Material and Methods

2.1 Materials.

We based this study on more than 2400 specimens. Holotypes, lectotypes and syntypes, and specimens studied are preserved in the following 39 collections. The curator or lender name follows the institution name.

ANIC	Australian National Insect Collection, CSIRO, Australia Capital Territory, Australia. Nicole Fisher.
ANSP	Academy of Natural Sciences, Philadelphia, PA, USA. J. Weintraub.
BDUC	Biology Department, University of Calgary, Calgary, AB, Canada. R. Longair.
BMNH	Department of Entomology, The Natural History Museum, London, England. C. Gillette.
BYUC	Brigham Young University, Provo, UT, USA. S. M. Clark.
CFIA	Canadian Food Inspection Agency, Ottawa, ON, Canada. H. Douglas.
CNC	Canadian National Collection of Insects and Arachnids, Ottawa, ON, Canada. H. Goulet.
CUCC	Clemson University Arthropod Collection, Clemson University, Clemson, SC, USA. J. C. Morse.
CUIC	Cornell University Insect Collection, Department of Entomology, Cornell University, Ithaca, NY, USA. E. R. Hoebeke.
DEBU	Department of Environmental Biology, University of Guelph, ON, Canada. S. A. Marshall & S. Paiero.
EDUM	Entomology Department, University of Manitoba, Winnipeg, MB, Canada. †R. E. Roughley.
FRLC	Atlantic Forestry Centre, Natural Resurces Canada, Fredericton, NB, Canada. J. Sweeney.
FRNZ	Scion – next generation biomaterials, Te Papa Tipu Innovation Park, Rotorua, New Zealand. S. Sopow.
GLFC	Great Lake Forest Centre, Natural Resources Canada, Sault Ste. Marie, ON, Canada. K. Nystrom.
INHS	Insect Collection, Illinois Natural History Survey, Champaign, IL, USA.
INIFAP	Campo Experimental Pabellón, Pabellón de Artiga, Aguascaliente, C. P. 20660, Mexico, G. Danchez-Martinez.
LECQ	Laurentian Forestry Centre, Natural Resource Canada, Ste. Foy, QC, Canada. J. Klimaszewski.
LEMQ	Lyman Entomological Museum and Research Laboratory, MacDonald College, McGill University, Ste. Anne de Bellevue, QC, Canada. T. A. Wheeler.
LSUK	Linnean Society, Burlington House, Piccadilly, London, England.
MNCN	Museo Nacional de Ciencias Naturales, Paseo de la Castellana, Spain. M. París.
MRNQ	Ministère des Ressources Naturelles, Direction de l'Environnement et de la Protection des Forêts, Service des Relevés et des Diagnostiques, Québec, QC, Canada. C. Piché.
MTEC	Department of Entomology, Montana State University, Bozeman, MT, USA. M. A. Ivie.
NFRC	Northern Forestry Centre, Natural Resource Canada, Northwest Region, Edmonton, AB, Canada. G. Pohl.
NSMT	Department of Zoology, National Museum of Nature and Science, Tsukuba, Ibaraki, Japan. A. Shinohara.
OLML	Oberösterreichische Landesmuseen, Linz, Austria. C. Reitstatter.
OSAC	Oregon State Arthropod Collection, Department of Zoology, Oregon State University, Corvallis, OR, USA. C. Marshall.
OXUM	Hope Entomological Collections, University Museum, Oxford, England. J. E. Hogan.
PFRC	Pacific Forestry Centre, Natural Resource Canada, Victoria, BC, Canada. L. Humble.
PUPC	Department of Zoology, Punjabi University, Patiala-147002, India. M. S. Saini.
ROME	Department of Entomology, Royal Ontario Museum, Toronto, ON, Canada. C. Darling.
SDEI	Senckenberg Deutsches Entomologisches Institut, Münchenberg, Germany. A. Taeger and S. M. Blank.
UAIC	Department of Entomology Collection, University of Arizona, Tucson, AZ, USA. D. Madison.
UAM	University of Alaska Museum, Fairbanks, AK, USA. D. Sikes.
UASM	Department of Zoology, Strickland Entomological Museum, University of Alberta, Edmonton, AB, Canada. D. Shpeley.
UCRC	University of California, Riverside, CA, USA. D. Yanega.
TARI	Taiwan Agricultural Research Institute, Taichung, Taiwan. Chi-Feng Lee.
USNM	National Museum of Natural History, Smithsonian Institution, Washington, DC, USA. D.R. Smith.
USFS–AK	USDA Forest Service, State and Private Forestry, Forest Health Protection, Fairbanks Unit, Fairbanks, AK. USA. J. J. Kruse.
USFS–GA	USDA Forest Service, Southern Research Station, Athens, GA, USA. D. Miller.
USFS–MS	USDA Forest Service, Stoneville, MS, USA. N. M. Schiff.
ZMUC	Department of Entomology, Zoological Museum, University of Copenhagen, Universitetsparken, Copenhagen, Denmark. L. Vilhelmsen.
ZMUN	Natural history Museum, University of Oslo, Department of Zoology, Insect Collection, Oslo, Norway. Lars Ove Hansen.

2.2 Methods.

Most specimens in collections were reared from sections of conifer boles as described in Spradbery and Kirk (1978). Some specimens were captured on stumps or boles, trapped using Lindgren funnel and cross-vane traps, collected at forest fires in western North America, or captured on hilltops with short vegetations.

Rearing from conifer boles is most effective in gathering males and females of *Xeris* with tree host information. A siricid survey was done across Europe, Turkey and North Africa by Spradbery and Kirk (1978); 6205 specimens of *Xeris* were collected. In summary, they located dead, dying, or damaged conifers, searched for round siricid emergence holes, dead or live ovipositing siricid females or their parasitoids, and woodpecker damage. Using an axe, they checked the bole of each tree by cutting small disks for evidence of frass-packed galleries made by siricid larvae, live siricid larvae, and characteristic brown stains from the siricid symbiotic fungus, *Amylosterum* sp. Attacked boles were sent to an insectary, organized by locality and tree specimen in coded bins, and emerged specimens were preserved and labelled with the tree name, collection date, and other pertinent information.

Images were made using a range of image capture systems: MZ16 Leica binocular microscope and an attached Leica DFC420. Some specimens were photographed using DSLR Canon Rebel Xti and T2i cameras with a 100 mm macro and MPE-65 lens. Multiple images through a range of focal planes from top to bottom were taken of many structures and these combined using Combine ZM or ZP (Hadley, 2010), or Zerene to produce a single, focused image. Specimens were illuminated with a 13 watt daylight fluorescent lamp or flash through a semi-transparent plastic surface and reflected with a matt aluminum surface. The final combined image was improved using Adobe Photoshop® 7, CS4 or CS6, and plates were assembled using the same software. Corel Draw® 9.0 was used to generate barcode trees.

Characters under the "MALE. Description" are additional to those given under the "FEMALE. Description" excluding those of the "Cornus", the "Sheath" and the "Ovipositor"

Methods for DNA studies

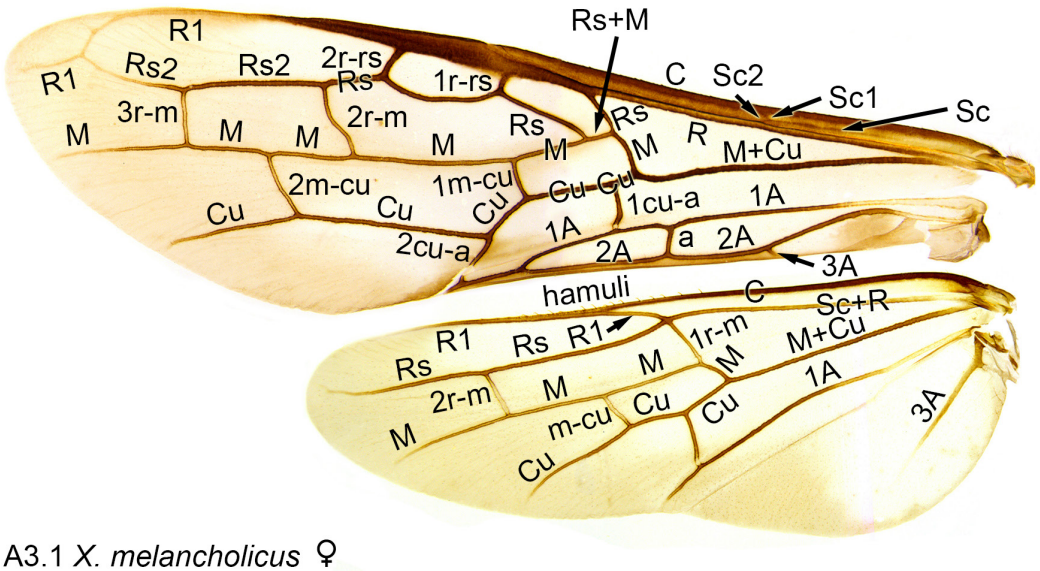
Adult horntails were collected by hand, in traps or by rearing from numerous locations in North America and around the world. Larvae were mostly intercepted over the last 30–40 years at ports in woody packing material and sent to the USDA Systematic Entomology Laboratory, Washington DC, for identification to family. All specimens were stored in alcohol, although some were trapped in a different liquid and then transferred to ethanol, and either sent to the Center for Bottomland Hardwoods Research in Stoneville, MS, or for most specimens from the Canadian National Collection, Ottawa, to the Biodiversity Institute of Ontario, Guelph, for sequencing. DNA barcode (CO1) sequences were generated in Mississippi using the extraction, amplification and sequencing protocols of Schiff et al. (2012) or in Guelph by the standard protocols detailed by Fernandez –Triana *et al.* (1979). Most Mississippi samples were sequenced using oligo's LCO 1490 and HCO 2198 (Folmer *et al.* 1994) but in a few cases HCO 2198 was paired with a novel oligo WES1 (5'GGCTTTTCTCTACTAATCATAAGGATATTGG 3'). Most Ottawa samples were sequenced in Guelph using primers LepF1 and LepR1 but some of the more degraded samples were sequenced in pieces using the oligo pairs (LepF1, RonMWASPdeg_t1) and (LepR1, C_ANTMR1D) see BOLDSYSTEMS primer database at http://www.boldsystems.org/index.php/Public_Primer_PrimerSearch. Analysis was performed using DNAStar by Lasergene. Sequences for each specimen were combined into individual specimen contigs using Seqman, aligned by Clustal V and used to construct a Neighbor-Joining, tree (Saitou and Nei 1987) in DNAStar Megalign. Bootstrap values were calculated from 1000 trials and a random seed of 111. A single representative sequence for each taxon was used to generate an approximate table of pair distances between species also using Megalign.

3. Morphology

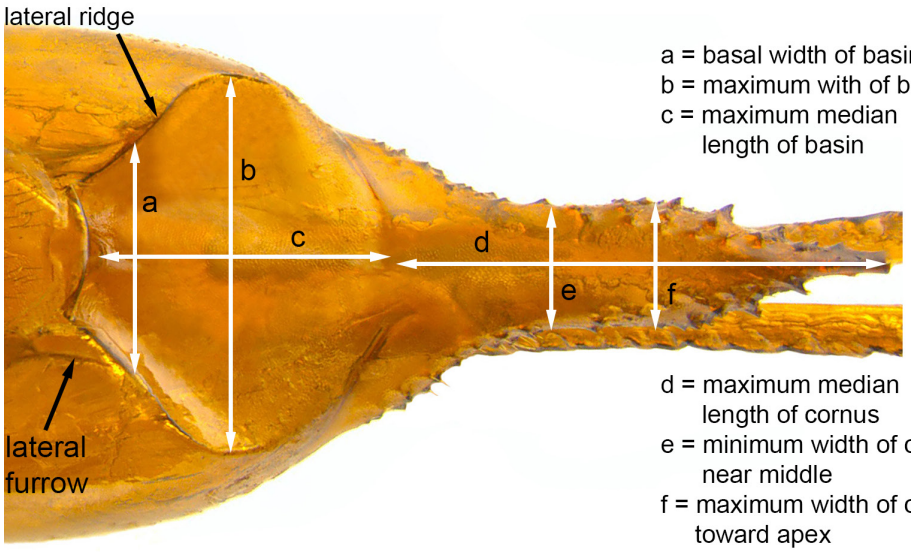
Schiff *et al*. (2012) discussed structural terms and most are reproduced here.

Wings. The veins of the fore and hind wings of *Xeris* are illustrated in Fig. A3.1. One of the most striking features of Siricidae is the incredible variation in wing venation, including the appearance or the disappearance of veins symmetrically or asymmetrically on both wings (e.g., see habitus images in Schiff *et al.* (2006)). Such variation is very rarely seen in other Hymenoptera, a group where wing veins are important for classification. Despite the exceptional variation in veins of Siricidae, wing venation was used in keys to subfamily and genera (Schiff *et al*. 2012), usually supplemented with others features not associated with wings.

Female abdomen. The female abdomen has ten terga (singular: tergum) dorsally and seven sterna (singular: sternum) ventrally (Fig. B1.3). Terga 8–10 are conspicuously modified. Tergum 8 is greatly enlarged and extended posteriorly. Tergum 9 is the largest and has a deeply impressed dorsomedian impression, the median basin (Fig. B1.5), also known as the precornal basin. The lateral edges of the median basin are sharply outlined in the anterior 0.5 (Fig. B1.5). The anterior edge of the basin, when visible, is ridge-like and its lateral limits are outlined by two slightly convergent furrows. The maximum width of the basin at its base is measured between the outer furrows, which are usually clearly



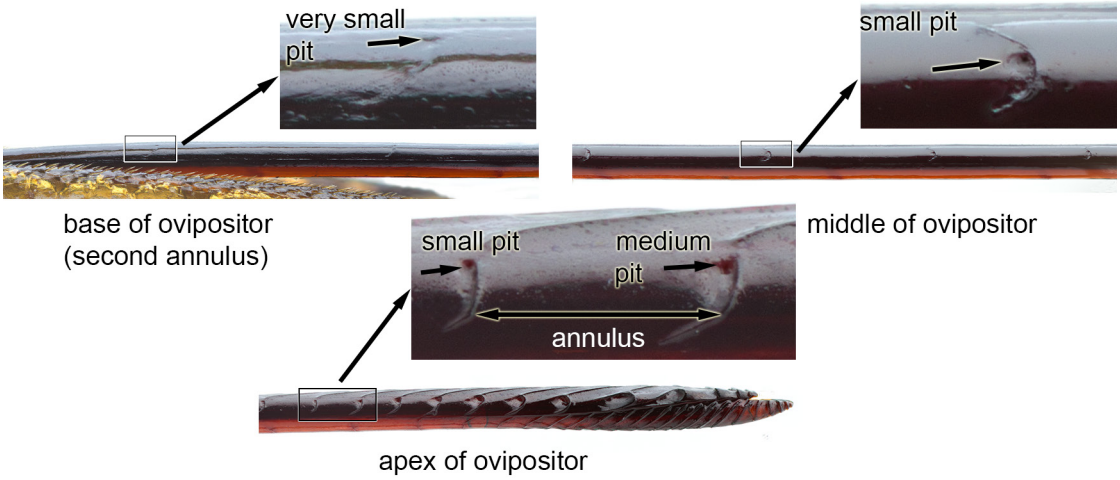
A3.1 *X. melancholicus* ♀



a = basal width of basin
b = maximum with of basin
c = maximum median length of basin

d = maximum median length of cornus
e = minimum width of cornus near middle
f = maximum width of cornus toward apex

A3.2 *X. tarsalis* ♀



A3.3 *X. spectrum* ♀

outlined and black on specimens with a reddish brown-abdomen. The posterior edge of the basin is outlined by a furrow between terga 9 and 10. Tergum 10 is modified as a long sharp horn-like projection, the cornus (Fig. A3.2). The cornus at its apex forms a short tube, probably used to assist adults to exit their larval host tunnels.

The abdomen posterior to sternum 7 (Fig. B1.7) has an ovipositor that is covered by two sheaths when not in use.

Each sheath consists of three parts: a basal small sclerite dorsobasally (valvifer 1), a long basoventral sclerite (valvifer 2), and an apical sclerite (valvula 3). The last two sclerites are here referred to, as basal section and apical section of the sheath (Fig. B1.7). The lengths of these sections are compared to one another.

The ovipositor consists of a fused pair of dorsal lances (valvula 2) and a pair of ventral lancets (valvula 1). The lance and lancet slide along each other and help move the egg along the ovipositor as well as drill in wood and remove the resulting sawdust for egg deposition. The part detailed in the following description is the lancet, which is divided in numerous sections called annuli (singular: annulus) (Fig. A3.3). Lancet annuli usually are outlined by vertical to slanted ridges (Fig. A3.3). Annuli are present at the base of the lancet but in most species of *Xeris* several basal annuli are difficult to distinguish because each annulus is barely outlined dorsally near the lance. The number of annuli varies within species and occasionally between species. The apex of the lancet consists of four annuli each with a large tooth (Fig. A3.3). The last four or five annuli or all annuli anterior to these four apical toothed annuli have a pit adjacent to the annulus line or ridge (Fig. A3.3). Annuli anterior to the teeth annuli and the last apical four or five annuli may have a small to very small pit or a large pit. To photograph the lancet for the best range of tonalities we oriented it toward the light. Therefore contrary to standard, we present images of the ovipositor in lateral view but with the ventral edge of the lancet at the top rather than at the bottom of the image. This view is most similar to what will be seen by users when viewing a female abdomen in lateral view with the ventral surface facing away from the user (toward the top of the page, as in our images).

Male abdomen. The male abdomen has eight terga dorsally and nine sterna ventrally (Fig. B1.4). Tergum 8 is slightly longer than the preceding terga (Fig. B1.6). The posterior edge of sternum 8 has a V-shaped median indentation or cleft, and sternum 9 extends posteriorly as a horn or cornus (Fig. B1.4). The lateral portion of the genitalia (the harpes) is usually visible between tergum 8 and sternum 9, but this was not studied.

Sculpture. In addition to structural terms for body parts, we opt for English terms to designate surface features, such as ridges (carinae), furrows (sulci), pits, and microsculpture.

Measurements. Because of the great variation in size (body length 9 to 35 mm) for most well sampled species, only ratios from measurements of two structures of a specimen were used. When possible, at least 30 specimens of each sex were measured. Means and standard deviations were calculated using Microsoft Excel software. The main measurements are the length of the basal and apical sections of the ovipositor sheath (Fig. B1.7) and those of tergum 9 and 10 in dorsal view (Fig. A3.2). The range of a measurement is given in the identification keys based on the calculation of two standard deviations. If a measurement falls within the overlap between values of the calculated two standard deviations, the character was rejected in favor of other characters, but if it is outside the range of the overlap portion, it is considered as a useful key character with a 1% chance of error.

For ovipositor characters with meristic values (e.g., the number of the annulus or annuli of the ovipositor aligned with the junction of the basal and apical sheath sections, the number of annuli with a very small pit on the ovipositor, and total number of annuli on the ovipositor), we recorded the range.

4. Biology

4.1 Introduction.

Not much has been published on the biology of *Xeris* species. The Asiatic *X. malaisei* (published as *X. spectrum spectrum* in Fukuda *et al*. 1997) from Japan is the only species with significant biological information. There is also some information on the biology of what is probably *X. spectrum* (Francke-Grossmann 1954), the more commonly captured species in Germany.

The most interesting feature of *X. malaisei* (Fukuda *et al*. 1997), and also *X. caudatus* (Schiff *et al*. 2012), is that females do not carry symbiotic fungus in their mycangia. The question is, therefore, what do larvae eat during their development? Females of most species of siricine Siricidae carry arthrospores of *Amylostereum* spp., one of the siricid host-specific basidiomycete fungi. During oviposition the fungus is deposited on each egg placed in the sap wood. The fungus produces an enzyme to decompose the wood cellulose or lignin, changing it into a form that can be assimilated by the larvae and making larval development possible. Fukuda *et al*. (1997) clearly showed that larvae of *X. malaisei* develop only if *A. chailletii* or *A. areolatum* are present at the oviposition site. Both species of fungi are equally accepted by *Xeris* larvae. Their observations confirm those of Francke-Grossmann (1954) on *X. spectrum* where females often deposit their eggs in trees already infested with *Sirex* and *Urocerus* spp. Moreover, the emergence holes of *X.*

malaisei are in close proximity to those of other horntails (Fukuda *et al*. 1997). This suggests that females of *Xeris* are attracted by odors emitted by *Amylostereum* fungi inoculated by other fungus carrying horntails.

The emergence cycle of well-sampled species show interesting and distinct patterns. We have data from three species. *X. spectrum* has one emergence peak in late spring (Fig. C12.8), *X. pallicoxae* has a double emergence peak in late spring and early summer followed by a very small emergence in late September and early October (Fig. C11.9), and *X. malaisei* shows two clearly separated peaks of emergences, one in spring and one in summer (Fukuda et al. 1997) (Fig. C8.4). The spring oviposition cycle offers *X. malaisei* larvae a very viable fungus but more competition with other horntail larvae, whereas a summer oviposition cycle offers the *Xeris* larvae a less viable fungus with less competition from other horntail larvae (Fukuda et al. 1997).

4.2 Hosts.

Hosts of North American species of *Xeris* are summarized from Cameron (1965), Middlekauff (1960), Ries (1951), Smith (1979), and Schiff et al. (2012), and those of Eurasia by Spradberrry and Kirk (1978), Fukuda and Hijii (1997). In the list below we provide rearing records for nine species of *Xeris* from two families of conifers representing 12 genera and 36 species. The host cited is the plant on which the larvae actually fed or the female was found ovipositing. Plant species on which adults were found resting are not included. In the "Hosts" section under each species treated, we list the plant species attacked and, when possible, we add in parenthesis the number of specimens we recorded from a given host, or published records when we are confident of the accuracy of the identification.

CUPRESSACEAE

Cupressus macrocarpa
Xeris tarsalis (Cresson)
Cryptomeria japonica
Xeris malaisei Maa
Juniperus occidentalis
Xeris tarsalis (Cresson)
Calocedrus decurrens
Xeris indecisus (MacGillivray)
Xeris tarsalis (Cresson)
Thuja plicata
Xeris tarsalis (Cresson)

PINACEAE

***Abies* sp.**
Xeris indecisus (MacGillivray)
Abies alba
Xeris spectrum (Linnaeus) and/or *X. pallicoxae* n. sp.
Abies balsamea
Xeris caudatus (Cresson)
Xeris melancholicus (Westwood)
Abies borisii-regis
Xeris pallicoxae n. sp.
Abies bornmuelleriana
Xeris pallicoxae n.sp.
Abies cilicia
Xeris pallicoxae n.sp.
Abies concolor
Xeris caudatus (Cresson)
Xeris indecisus (MacGillivray)
Xeris morrisoni (Cresson)
Abies equi-trojan
Xeris pallicoxae n. sp.
Abies firma
Xeris malaisei Maa
Abies grandis
Xeris indecisus (MacGillivray)
Abies lasiocarpa
Xeris caudatus (Cresson)
Xeris indecisus (MacGillivray)
Abies magnifica
Xeris indecisus (MacGillivray)
Abies pindrow
Xeris himalayensis Bradley
Abies pinsapo maroccana
Xeris cobosi Viedma and Suárez (probable host)

Cedrus deodara
Xeris himalayensis Bradley

Larix decidua
Xeris spectrum (Linnaeus) and/or *X. pallicoxae* n. sp.
Larix occidentalis
Xeris caudatus (Cresson)
Xeris indecisus (MacGillivray)

Picea abies
Xeris indecisus (MacGillivray)
Xeris spectrum (Linnaeus) and/or *X. pallicoxae* n. sp.
Picea engelmannii
Xeris caudatus (Cresson)
Picea glauca
Xeris caudatus (Cresson)
Xeris melancholicus (Westwood)
Picea orientalis
Xeris spectrum (Linnaeus) and/or *X. pallicoxae* n. sp.
Picea pungens
Xeris caudatus (Cresson)
Xeris morrisoni (Cresson)
Picea sitchensis

Xeris indecisus (MacGillivray)
Xeris spectrum (Linnaeus) and/or *X. pallicoxae* n. sp.

Picea smithiana
Xeris himalayensis Bradley

Pinus banksiana
Xeris melancholicus (Westwood)

Pinus contorta
Xeris caudatus (Cresson)
Xeris indecisus (MacGillivray)

Pinus pinaster
Xeris spectrum (Linnaeus) and/or *X. pallicoxae* n. sp.

Pinus ponderosa
Xeris caudatus Cresson)
Xeris indecisus (MacGillivray)

Pinus roxburghii
Xeris himalayensis Bradley

Pinus sylvestris
Xeris spectrum (Linnaeus) and/or *X. pallicoxae* n. sp.

Pseudotsuga menziesii
Xeris caudatus (Cresson)
Xeris indecisus (MacGillivray)
Xeris morrisoni (Cresson)

Tsuga heterophylla
Xeris indecisus (MacGillivray)

4.3 Parasitoids.

Though several species of parasitoids are associated with Siricidae on conifers, they belong to only a few hymenopteran families. Few parasitoid species have been associated with species of *Xeris* (Spradbery and Kirk 1978, and collections studied here). It is likely that more species of the known parasitoids of other siricid genera associated with conifers also attack larvae of *Xeris*.

IBALIIDAE

***Ibalia leucospoides* (Hochenwarth)**
Xeris spectrum and/or *X. pallicoxae* – (Spradbery and Kirk 1978)

***Ibalia rufipes drewseni* Borries**
Xeris spectrum and/or *X. pallicoxae* – (Spradbery and Kirk 1978)

ICHNEUMONIDAE

***Megarhyssa rixator* (Schellenberg)**
Xeris spectrum and/or *X. pallicoxae* – (Spradbery and Kirk 1978)

***Megarhyssa nortoni* (Cresson)**
Xeris morrisoni (Cresson) – (Townes 1944)

***Poemenia hectica* (Gravenhorst)**
Xeris spectrum and/or *X. pallicoxae* – (Schimitschek 1974)

***Pseudorhyssa sternata* Merrill**
(cleptoparasite of *Rhyssa persuasoria* (Linnaeus) – (Spradbery 1969).

***Rhyssa amoena* (Gravenhorst)**
Xeris spectrum and/or *X. pallicoxae* – (Spradbery and Kirk 1978)

***Rhyssa persuasoria* (Linnaeus)**
Xeris sp. – (search behavior – Spradbery 1970)
Xeris spectrum and/or *X. pallicoxae* – (Minamikawa 1969, Spradbery and Kirk 1978)
Xeris spectrum himalayensis Bradley – (Dharmadhikari and Achan 1965)

STEPHANIDAE

***Schlettererius cinctipes* (Cresson)**
Xeris sp.

B. Key to species

1. Use of keys.

Specimen condition and preparation. Clean specimens (greasy specimens are quite common in collections) with wings slightly open (needed to view the dorsal surface of the abdomen) are preferable when possible. At least one antenna and one leg of each pair must be present and complete.

It is often important to know the sex of the specimen to be keyed. Males and females are easily separated. The main sexual differences for all species are on the pronotum, the hind leg, and the abdomen.

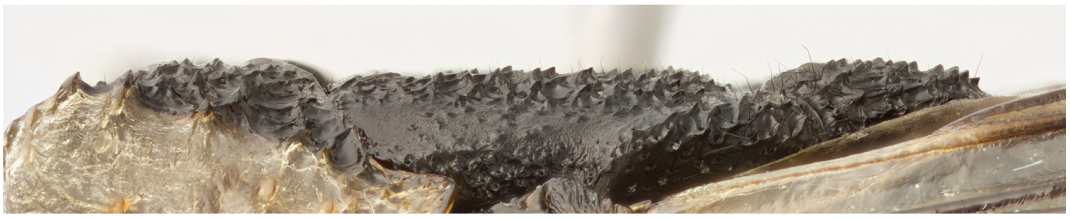
Female features are:

- Long sword-like sheath ventral to abdominal segment 9 and posterior to sternum 7 covering the ovipositor (Fig. B1.7).
- Abdomen large, particularly terga 8 and 9 (Fig. B1.3 and B1.5).
- Tergum 9 with a very large median impression (median basin) (Fig. B1.5).
- Tergum 10 extending posteriorly as a long horn (cornus) (Fig. B1.3 and B1.5).
- Setae on dorsal surface of pronotum abundant and long (Fig. B1.1 and insert).
- Hind leg in lateral view similar in proportions but longer than fore and middle legs (Fig. B1.8).

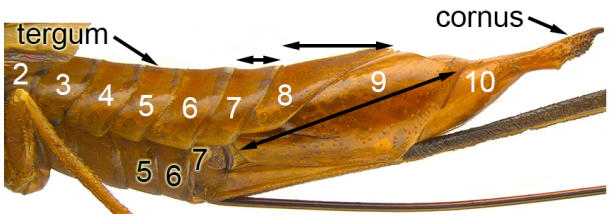
Male features are:

- Abdomen without sword-like extension (Fig. B1.4).
- Abdomen slender and apical tergum similar to but a little longer than preceding terga (Figs.

B1.1 *X. melancholicus* ♀

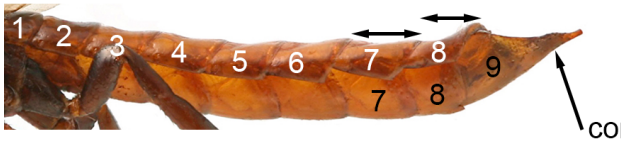


B1.2 *X. melancholicus* ♂



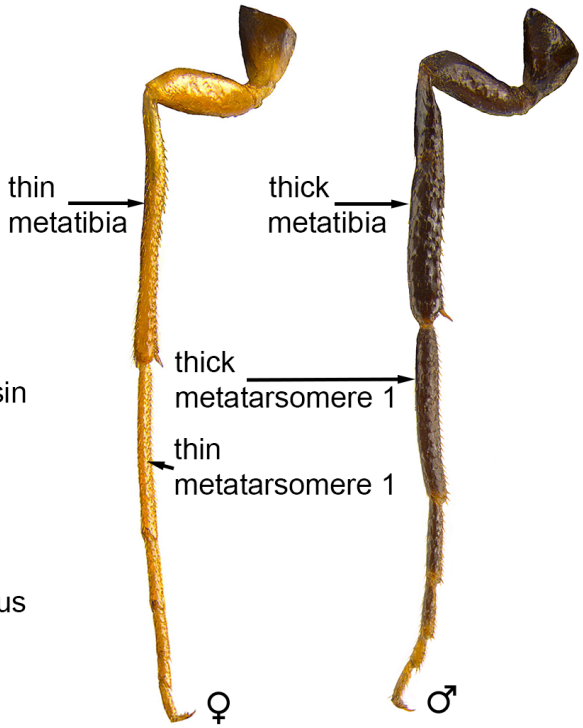
B1.3 *X. indecisus* ♀

B1.5 *X. malaisei* ♀

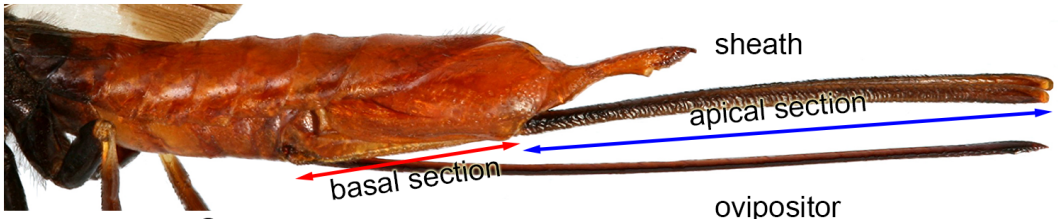


B1.4 *X. indecisus* ♂

B1.6 *X. spectrum* ♂



B1.8 *X. indecisus*



B1.7 *X. tropicalis* ♀

B1.4 and B1.6).
- Tergum 8 (the last tergum) without a median impression (Fig. B1.6).
- Sternum 9 (the last sternum) extending posteriorly as a short horn (cornus) (Fig. B1.4).
- Setae on dorsal surface of pronotum absent, or extremely small and difficult to see (Fig. B1.2).
- Metatibia and metatarsomere 1 in lateral view clearly enlarged relative to pro- and mesotibia and pro- and mesotarsomere 1 (Fig. B1.8).

Male identification does not require dissection; female identification occasionally may require it. The complete ovipositor can easily be pulled out of its sheaths either after relaxing a dried specimen for about 36 hours in a very humid atmosphere (in a closed container with a wet paper towel or sponge) or immediately before or after pinning an alcohol preserved specimen. To see most or all the ovipositor of a relaxed or recently mounted alcohol preserved specimen, insert an insect pin between the ovipositor and the apical section of the sheath and gently slide the pin toward the base of the sheath. This will force the ovipositor out of the sheath. Ensure that the ovipositor remains out of the sheath. Use a fine paintbrush dipped in 95% alcohol to remove any dirt from the ovipositor. A concentrated solution of detergent in water may be necessary to remove persistent oil drops. The specimen is now ready to be examined and keyed.

Lighting. The light source is important. The best light is diffused light either directly from a daylight fluorescent light (13 watts is usually satisfactory) or produced with a semi-opaque plastic between the light source and the specimen. Good diffusion is achieved when the plastic is about 20 mm from the specimen. This type of lighting eliminates all or most glare from smooth surfaces. Such lighting makes structural features very clear and has been used throughout our work as illustrated in the numerous figures. We use a small (5 by 7 cm) piece of transparent plastic (Mylar) placed vertically on a base of modeling clay about 20 mm from the specimen to provide a sharp and glare free image (e.g., ovipositor pits). A dissecting microscope with a magnifying range of 40–60 times is recommended to view most structures clearly.

Key construction. Each couplet is arranged in contrasting pairs of statements labelled, respectively, with upper and lower case letters. Each statement almost always describes one feature of a character. For example in couplet 1C and 1c (e.g., relative size of eye height relative to head height) different expressions of the same character would be found. Information that is not compared in the alternate part of the couplet is given in brackets (e.g., additional characters, notes and range). Clarification notes are given in parentheses. Almost all statements of each couplet are illustrated. Two figures with the same statement code show a range of variation for a character state. The illustration shown is not necessarily that of the species of the specimen at hand, but is a similar expression of the character state to be observed. Therefore, other structures in the figure should be ignored as they do not necessarily represent those of the specimen being keyed. Plates of figures are organized so that the contrasting statements of each character are adjacent to one another. Arrows and morphological terms are added for clarity.

2. Key to species of *Xeris*

1 A) Vertex densely pitted and without or almost without smooth surfaces (Fig. B2.1).

B) Maximum distance between outer genal edges shorter than maximum distance between outer edges of eyes (in frontal view outer edges of gena intersected by outer edges of eyes) (Fig. B2.4).

C) Maximum eye height in lateral view 0.53–0.61 times maximum head height (measured from genal transverse ridge above mandible to top of head) (Fig. B2.6).

D) Ventral surface of propleuron with clearly impressed meshes of microsculpture between teeth; sculpticells scale-like (Fig. B2.9).

E) In female, apical section of sheath without longitudinal ridge between dorsal and ventral edges (Fig. B2.12, insert); sheath with basal section 0.5–0.6 times as long as apical section (Fig. B2.12).

[Additional characters. Lateral surface of pronotum with sharply reticulate pattern around one or more pits (Fig. B2.15); ovipositor with a pit on each annulus anterior to teeth annuli and each pit large and extending anteriorly toward preceding annulus as a shallow furrow (Fig. B2.16); sheath with junction of basal and apical sections aligned between annuli 8 and 9 of ovipositor. Note. All known hosts are Cupressaceae. Range. Western United States between Washington and California.]

..... *Xeris tarsalis* (Cresson, 1880)

– a) Vertex less densely pitted, with obvious smooth surfaces on outer sides of median furrow (Figs. B2.2 and B2.3).

b) Maximum distance between outer genal edges slightly or very clearly wider than maximum distance between outer edges of eyes, thus, in frontal view, outer edge of gena not intersected by outer edges of eyes (Fig. B2.5).

c) Maximum eye height in lateral view at most 0.54 times maximum head height (measured from genal transverse ridge above mandible) (Figs. B2.7 and B2.8).

d) Ventral surface of propleuron without or with lightly impressed meshes of microsculpture, so bright between pits and teeth (Figs. B2.10 and B2.11).

e) In female, apical section of sheath with longitudinal ridge between dorsal and ventral edges (Fig. B2.13, insert); sheath with basal section at most 0.46 times as long as apical section (Figs. B2.13 and B2.14).

[Note. Known hosts are almost always Pinaceae except one of the recorded hosts of *X. malaisei*.]

..... 2

2(1) A) Gena dorsal to mandible with broadly rounded and coarsely pitted transverse ridge (Fig. B2.17).

B) Distance between lateral ocellus and nearest eye edge about 1.0 times distance between inner edges of lateral ocelli (Fig. B2.19).

C) Propleuron in ventral view densely pitted (Fig. B2.21).

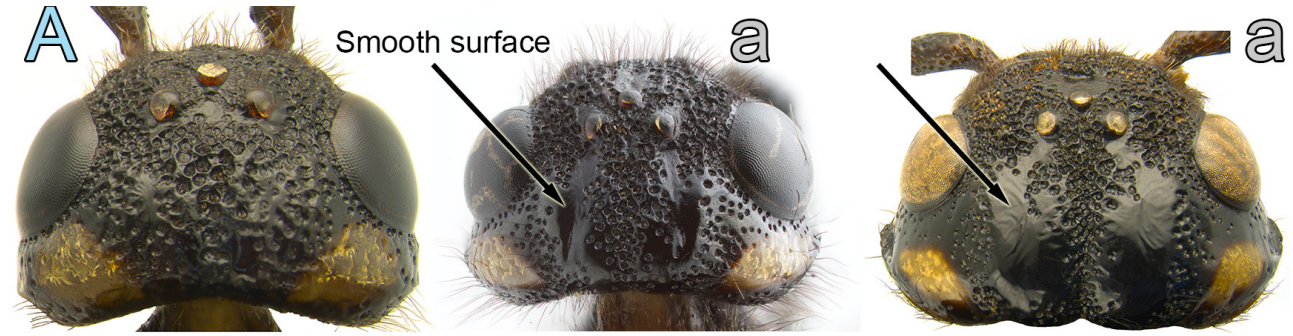
D) In female, femora black, tibiae and metatarsomere 1 light reddish brown in basal 0.1 (Fig. B2.23).

[Additional characters. Gena below eye and genal ridge (including adjacent occiput) densely pitted (Fig. B2.27 and B2.28); setae on clypeus twice as long as diameter of lateral ocellus (Figs. B2.27 and B2.28); in female, sheath with basal section 0.4 times as long as apical section (Fig. B2.29), with abdomen red, and with darkly tinted wings except for clear basal 0.3 of hind wing (Fig. B2.30). Note. The male is unknown, but characters A, B and C probably apply. Range. Southernmost Mexico in the state of Chiapas.]

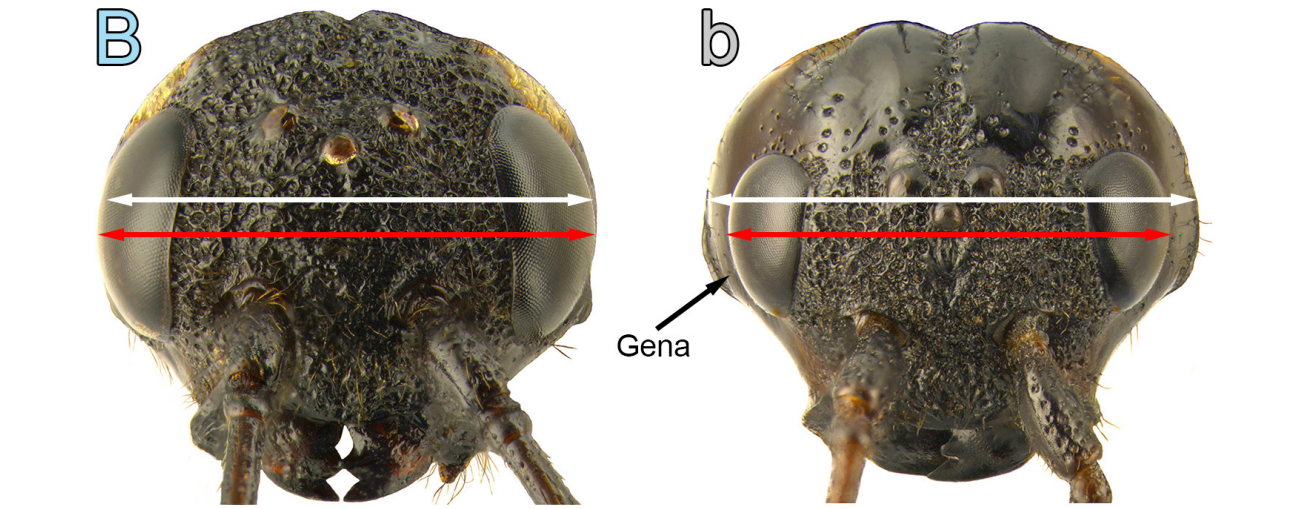
..... *Xeris tropicalis* Goulet, 2011

– a) Gena dorsal to mandible with sharp and smooth transverse ridge (Fig. B2.18).

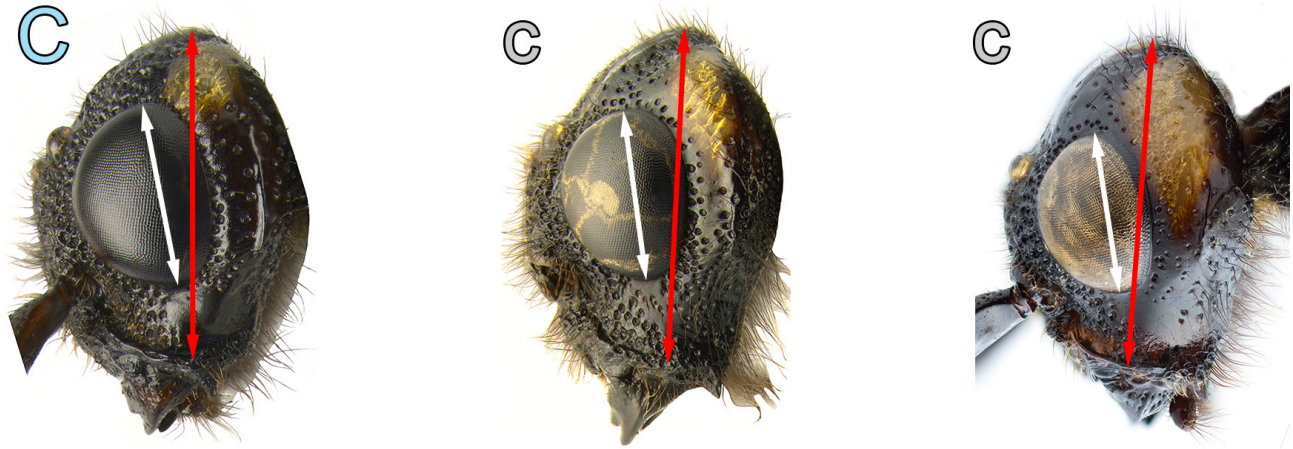
b) Distance between lateral ocellus and nearest eye edge 1.15–1.50 times distance between inner edges of lateral ocelli (Fig. B2.20).



B2.1 *X. tarsalis* ♀ B2.2 *X. tropicalis* ♀ B2.3 *X. indecisus* ♀



B2.4 *X. tarsalis* ♀ B2.5 *X. melancholicus* ♀

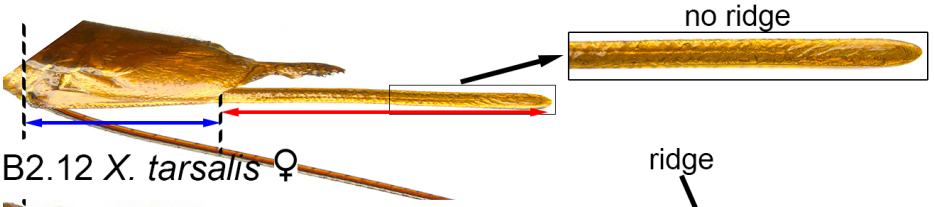


B2.6 *X. tarsalis* ♀ B2.7 *X. tropicalis* ♀ B2.8 *X. malaisei* ♀

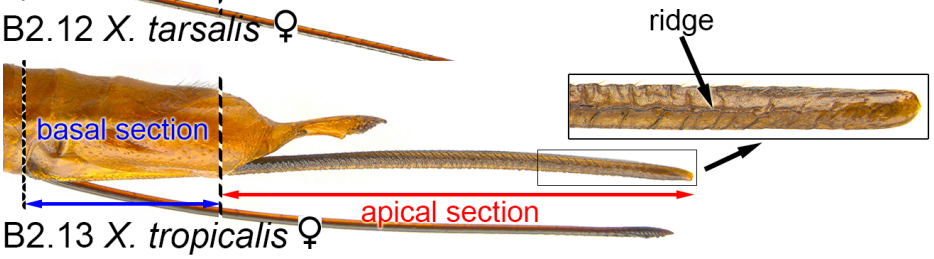
B2.9 *X. tarsalis* ♂

B2.10 *X. tropicalis* ♀

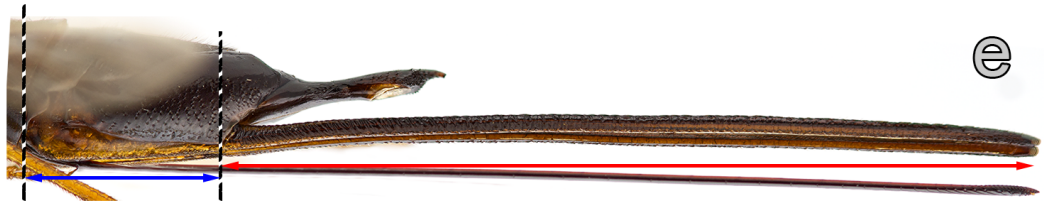
B2.11 *X. spectrum* ♀



B2.12 *X. tarsalis* ♀

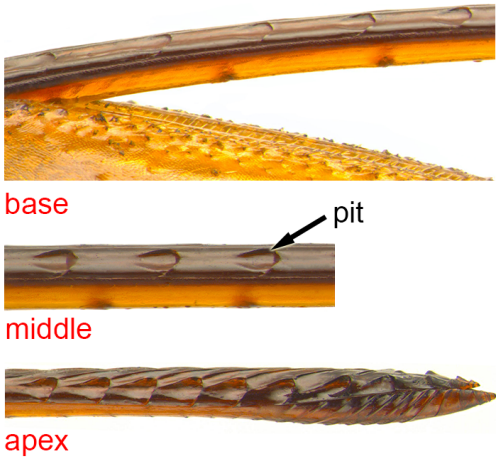


B2.13 *X. tropicalis* ♀

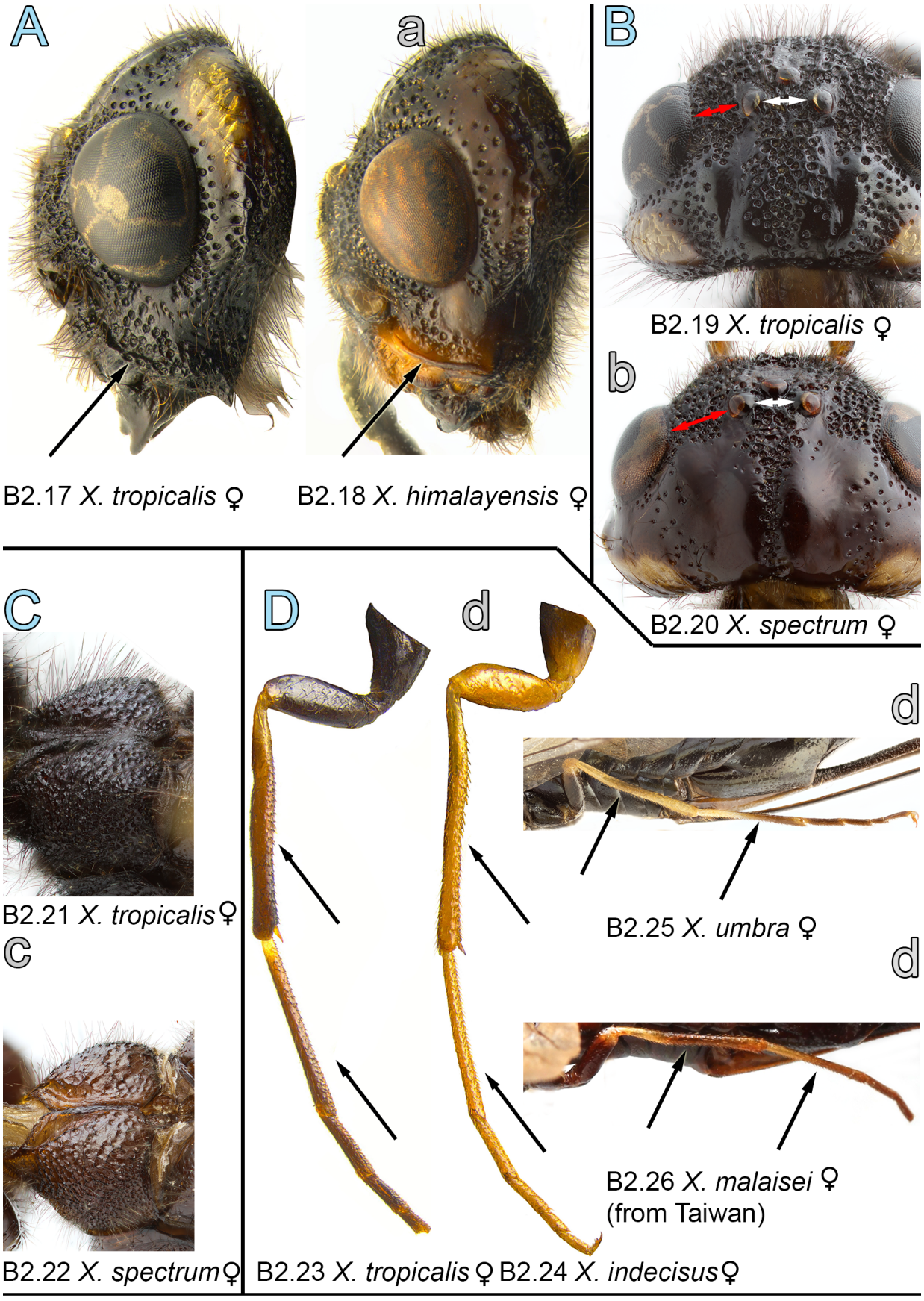


B2.14 *X. spectrum* ♀

B2.15 *X. tarsalis* ♂



B2.16 *X. tarsalis* ♀


A
a
B
B2.17 X. tropicalis ♀
B2.18 X. himalayensis ♀
B2.19 X. tropicalis ♀
b
B2.20 X. spectrum ♀
C
B2.21 X. tropicalis ♀
c
B2.22 X. spectrum ♀
D
d
d
B2.25 X. umbra ♀
d
B2.26 X. malaisei ♀
(from Taiwan)
B2.23 X. tropicalis ♀ B2.24 X. indecisus ♀

c) Propleuron in ventral view not sharply pitted or not pitted, surface in most specimens consisting of few to many isolated teeth (Fig. B2.22).

d) In female, femora varying from black to light reddish brown, tibiae and tarsi light reddish brown (Fig. B2.24), **or** tibiae and metatarsomere 1 black but light reddish brown in at least basal 0.3 (Figs. B2.25 and B2.26).

..... 3

3(1) A) Gena below eye and genal ridge (including adjacent occiput) densely pitted (Fig. B2.31, black arrow).

B) Clypeus with setae 1.0–1.5 times as long as diameter of lateral ocellus (Fig. B2.33, red arrow) and vertex quite densely pitted between dorsal edge of eye and occiput outside postocellar area (Fig. B2.33, black arrow);

[Additional characters. Flagellum black (as in Fig. B2.35). Pronotum in dorsal view with a yellowish-white longitudinal band along margin between anterolateral to posterolateral angles (Fig. 2.36). In male, base of metatibia with clearly outlined white spot [not present in other Nearctic species] (Fig. B2.38). Abdomen black (Fig. B2.37). Range. Arizona and Colorado in southwestern United States.]

.....*Xeris chiricahua* Smith, 2012

– a) Gena below eye and genal ridge smooth, without or with very few pits (Fig. B2.32, black arrow).

b) Clypeus with setae 0.6–0.7 times as long as diameter of lateral ocellus (Figs. B2.32, red arrow), **or** setae 1.0–1.4 times as long (only *X. umbra*) (Fig. 2.34, red arrow) and vertex pits scattered between dorsal edge of eye and occiput ouside postocellar area (Fig. B2.34, black arrow).

..... 4

4(3) A) Fore wing with cell C darkly tinted (yellowish brown to dark brown) and with base of stigma on both sides of junction with vein 1r-rs black or somewhat paler (as in Fig. B2.39).

B) Vertex with pits denser (usually touching) and bigger (0.2–0.5 times diameter of lateral ocellus) between dorsal edge of eye and occiput outside postocellar area (Fig. B2.41), **or** pits as in "b" (Fig. B2. 42) and fore wing cell C color as in "A".

..... 5

– a) Fore wing cell C very lightly tinted (yellowish white) and with base of stigma on both sides of junction with vein 1r-rs clearly white or yellowish white (Fig. B2.40).

b) Vertex with pits sparser (usually not touching) and smaller (0.05–0.25 times diameter of lateral ocellus) between eye dorsal edge and occiput outside postocellar area (Fig. B2.43).

[Range. Europe and Asia.]

..... 12

5(4) A) Vertex between dorsal edge of eye and occiput outside postocellar area with dense (usually touching) and big pits (0.2–0.5 times diameter of lateral ocellus) (Fig. B2.44).

B) Gena with pits between eye outer edge and genal ridge large (0.2–0.4 times diameter of lateral ocellus) (Fig. B2.46).

C) In female, procoxa black (Fig. B2.48) and flagellum black (as in Fig. B2.50) or partly to completely light reddish brown (Figs. B2.51 and B2.52), **or** procoxa light reddish brown (Fig. B2.53) and flagellum completely light reddish brown (Fig. B2.52).

D) In female, pronotum in dorsal view black or with a yellowish-white spot at anterolateral corner not extending to posterolateral corner (Figs. B2.54 and B2.55).

E) In male, pronotum in dorsal view black or black with a yellowish-white anterolateral spot at most extending posteriorly but not reaching posterolateral corner and much narrower posteriorly (Figs. B2.57 and B2.58).

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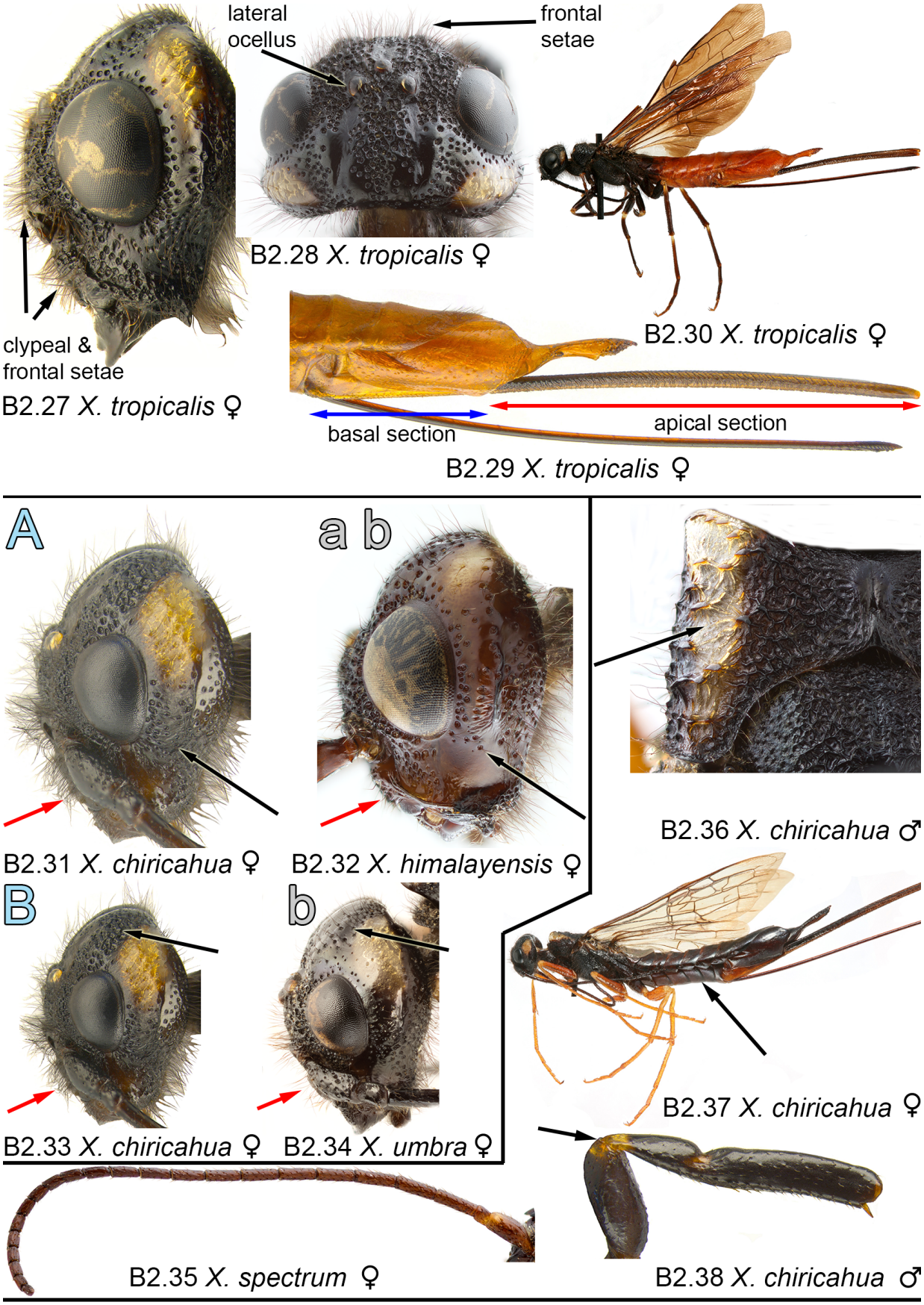
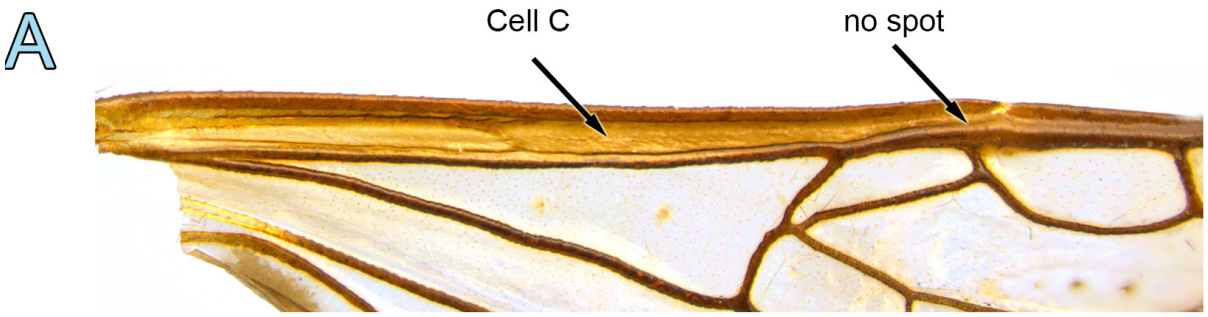
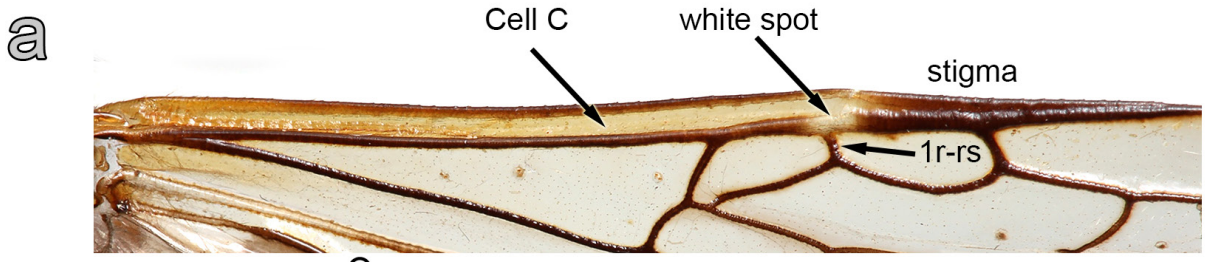

lateral ocellus
frontal setae
B2.28 X. tropicalis ♀
B2.30 X. tropicalis ♀
clypeal & frontal setae
B2.27 X. tropicalis ♀
basal section
apical section
B2.29 X. tropicalis ♀
A
a b
B2.31 X. chiricahua ♀
B2.32 X. himalayensis ♀
B2.36 X. chiricahua ♂
B
b
B2.33 X. chiricahua ♀
B2.34 X. umbra ♀
B2.37 X. chiricahua ♀
B2.35 X. spectrum ♀
B2.38 X. chiricahua ♂



B2.39 *X. melancholicus* ♀



B2.40 *X. pallicoxae* ♀

B2.41 *X. indecisus* ♀

B2.42 *X. melancholicus* ♀

B2.43 *X. spectrum* ♀

– a) Vertex between dorsal edge of eye and occiput outside postocellar area with pits sparse (rarely touching) and smaller (0.2–0.25 times diameter of lateral ocellus) (Fig. B2.45).

b) Gena with pits between eye outer edge and genal ridge smaller (0.05–0.15 times diameter of lateral ocellus) (Fig. B2.47).

c) In female, procoxa light reddish brown (Fig. 2.49) and flagellum black (as in Fig. B2.50).

d) In female, pronotum in dorsal view black with a yellowish-white longitudinal band between anterolateral corner and posterolateral corner (Fig. B2.56).

e) In male, pronotum in dorsal view black with a longitudinal yellowish-white band between anterolateral and posterolateral corners (Fig. B2.59)

[Range. North America.]

..... 11

6(5) A) Abdomen reddish brown (Fig. B2.60), **or** black and matching state of following characters (Fig. B2.61).

B) In female, flagellum partly or completely light reddish brown (Figs. B2.62 and B2.63)

C) In female, fore wing completely to mainly darkly tinted (Fig. B2.65), **or** with darkly tinted central and apical bands (old specimens maybe bleached and difficult to evaluate for this feature) (Fig. B2.66).

D) In male, metatibia black, **or** with an indistinct reddish-brown or brown spot at base (Figs. B2.68 and B2.69).

[Range. North America.]

..... 7

– a) Abdomen black (as in Fig. B2.61)

b) In female, flagellum black (as in Fig. B2.64)

c) In female, fore wing clear or with very lightly tinted central and apical bands (as in Fig. B2.67).

d) In male, metatibia clearly yellowish white at base (as Fig. B2.70).

[Range. Morocco (Rif), Western Himalaya.]

..... 10

7(6) A) In female, coxae, trochanters and femora black (Fig. B2.71).

B) In female, flagellum black in basal 0.3, gradually becoming light reddish brown in apical 0.7 (Fig. B2.73).

C) Gena narrow, its maximum length from eye to genal ridge 0.40–0.50 times as long as maximum eye length (Fig. B2.76).

[Range. Arizona and Colorado in southwestern United States.]

.....*Xeris morrisoni* (Cresson, 1880)

– a) In female, coxae black to mainly reddish brown, trochanters and femora light reddish brown (Fig. B2.72).

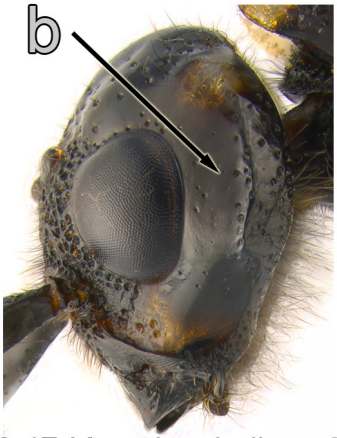
b) In female, flagellum black in basal 0.7 and light reddish brown in apical 0.3 (Fig. B2.74), or completely light reddish brown (Fig. B2.75).

c) Gena wide, its maximum length from eye to genal ridge 0.50–0.70 times as long as maximum eye length (Fig. B2.77).

..... 8

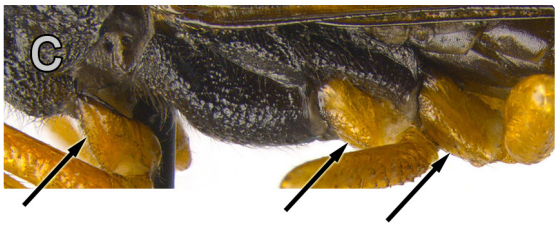
B2.44 *X. indecisus* ♀

B2.45 *X. melancholicus* ♀



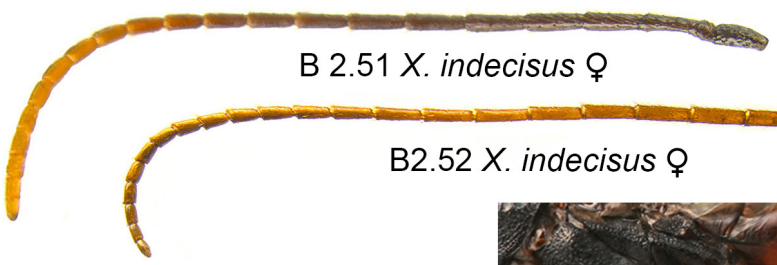
B2.46 *X. indecisus* ♀ B2.47 *X. melancholicus* ♀

B2.48 *X. himalayensis* ♀



B2.49 *X. melancholicus* ♀

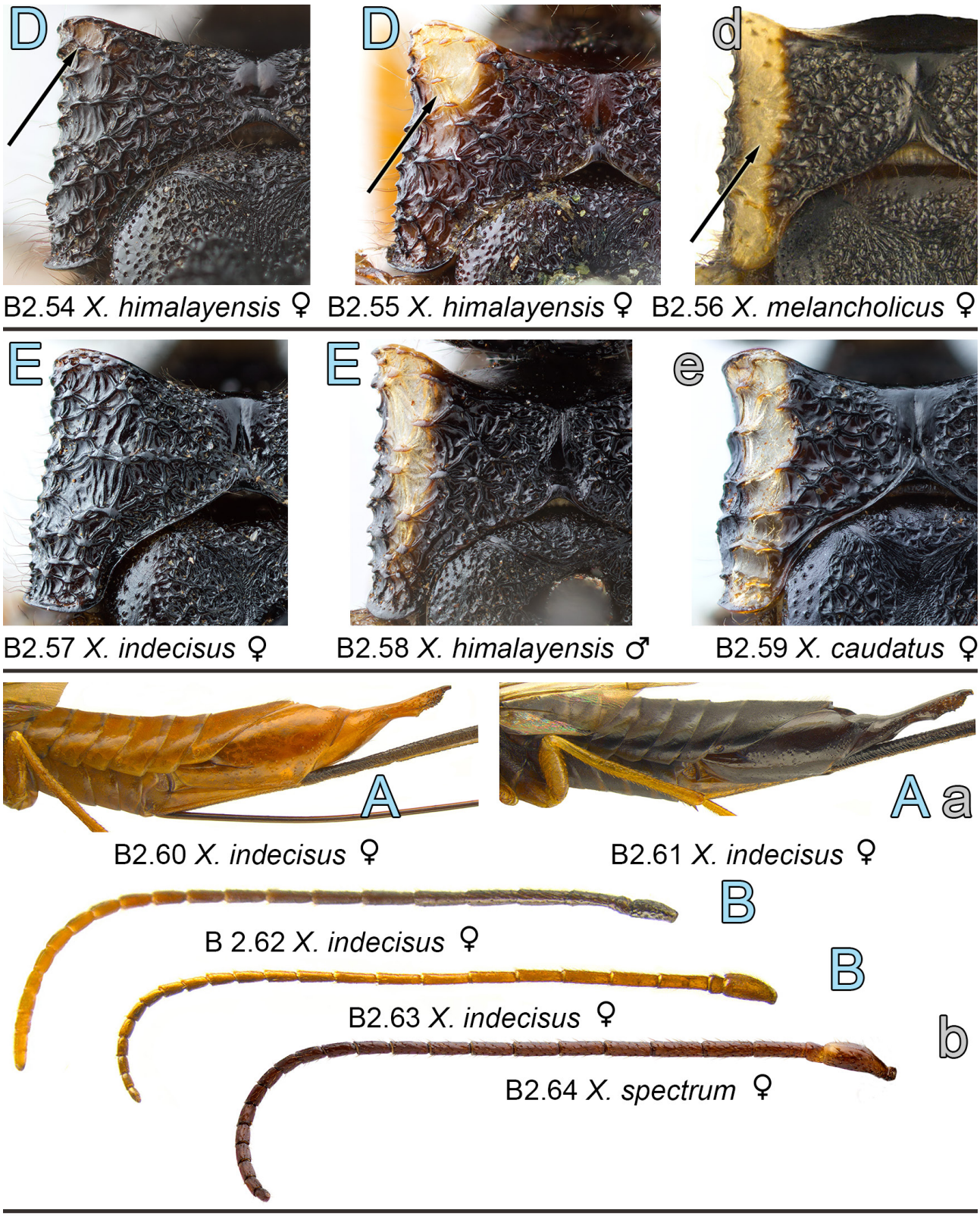
B2.50 *X. spectrum* ♀



B 2.51 *X. indecisus* ♀

B2.52 *X. indecisus* ♀

B2.53 *X. indecisus* ♀


D
D
d
B2.54 X. himalayensis ♀
B2.55 X. himalayensis ♀
B2.56 X. melancholicus ♀
E
E
e
B2.57 X. indecisus ♀
B2.58 X. himalayensis ♂
B2.59 X. caudatus ♀
A
A a
B2.60 X. indecisus ♀
B2.61 X. indecisus ♀
B
B 2.62 X. indecisus ♀
B
B2.63 X. indecisus ♀
b
B2.64 X. spectrum ♀

8(7) A) Abdomen black (Fig. B2.78).

B) In female, flagellum light reddish brown in apical 0.3 (rarely completely light reddish brown) (Fig. B2.80).

[Range. Forested regions of western Canada and United States.]

.....*Xeris indecisus* (MacGillivray, 1893)

– a) Abdomen reddish brown (Fig. B2.79) and

b) In female, flagellum completely light reddish brown (fig. B2.81).

..... 9

9(8) A) In female, fore wing with darkly tinted central and apical bands (Fig. B2.82).

[Note. Males of *X. indecisus* and *X. degrooti* are indistinguishable. Only *X. indecisus* is recorded from southern British Columbia, Washington, northern Idaho, Montana, western Oregon, and California. In the central portion of the Rocky Mountain ranges both species are sympatric.]

.....*Xeris indecisus* (MacGillivray, 1893)

– a) In female, fore wing completely darkly tinted (Fig. B2.83).

[Note. Specimens from at least South Dakota and probably those from Wyoming, Utah, eastern Nevada, Colorado, New Mexico and Arizona could belong to *X. degrooti*. However, both species may be sympatric in this region. Neither males nor females could be distinguished morphologically despite a remarkable 9% difference between their barcodes.]

.....*Xeris degrooti* Goulet, n. sp. and *Xeris indecisus* (MacGillivray, 1893)

10(6) A) Clypeus in lateral view with setae about 0.6–0.7 times as long as diameter of lateral ocellus (Fig. B2.84).

B) In female, coxae mainly light reddish brown (Fig. B2.86).

[Range. Morocco, Tizi-Ifri and Talasse N'Tane.]

..... *Xeris cobosi* Viedma and Suárez, 1961

– a) Clypeus in lateral view with setae about 0.7–1.2 times as long as diameter of lateral ocellus (Fig. B2.85).

b) In female, coxae black (Fig. B2.87).

[Range. High elevations in Pakistan, India, Nepal and China.]

.....*Xeris himalayensis* Bradley, 1934

11(5) A) In female, sheath with basal section more than 0.27 times length of apical section (if 0.25–0.27, use characters B and C) (Fig. B2.88).

B) In most females, tergum 10 with meshes of microsculpture lightly impressed on laterobasal angle in dorsal view (Fig. B2.90).

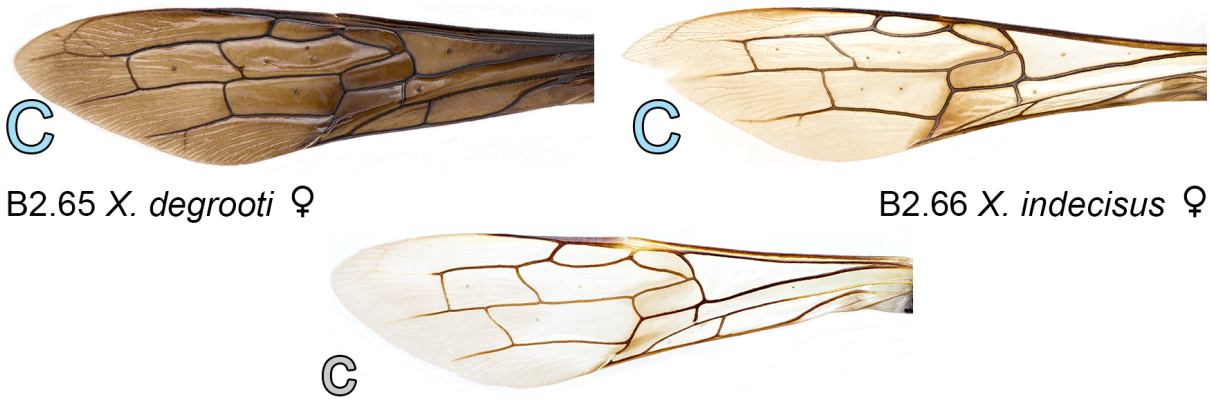
C) In most females, abdominal tergum 9 in lateral view with meshes of microsculpture clearly impressed with scale-like sculpticells on surface posterior to and above lateral furrow, thus surface slightly matt (Fig. B2.92).

[Range. Recorded from central Alberta to Nova Scotia and south (east of Prairie region) to Minnesota and Maine. This species and *X. caudatus* are sympatric in the central regions of Alberta and Saskatchewan. Note. Males cannot be recognized on morphological features, but can be distinguished by their barcodes.]

..... *Xeris melancholicus* (Westwood, 1874)

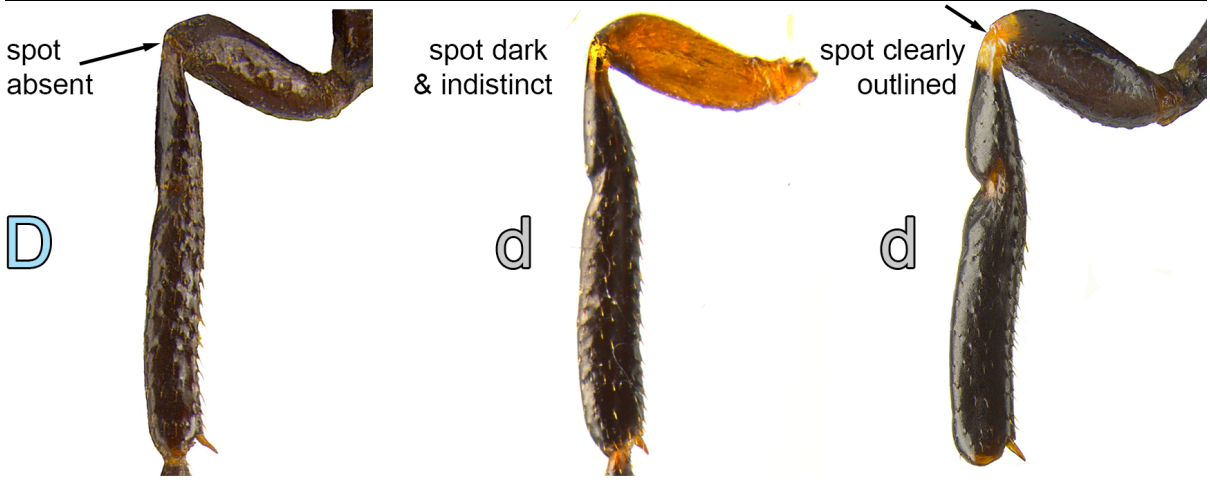
– a) In female, sheath with basal section less than 0.25 times length of apical section (if 0.25–0.27, use characters b and c) (Fig. B2.89).

b) In most females, tergum 10 without meshes of microsculpture on laterobasal angle in dorsal view (Fig. B2.91).

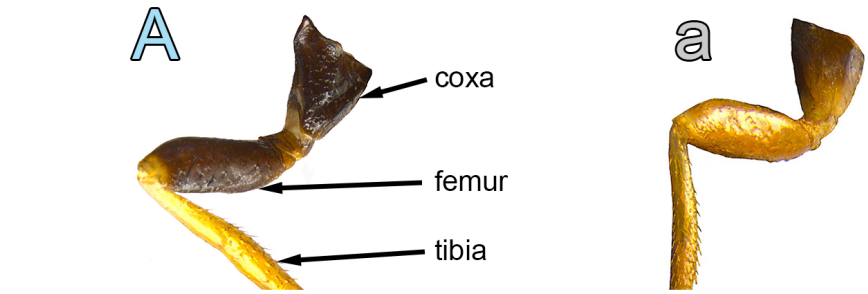


B2.65 *X. degrooti* ♀ B2.66 *X. indecisus* ♀

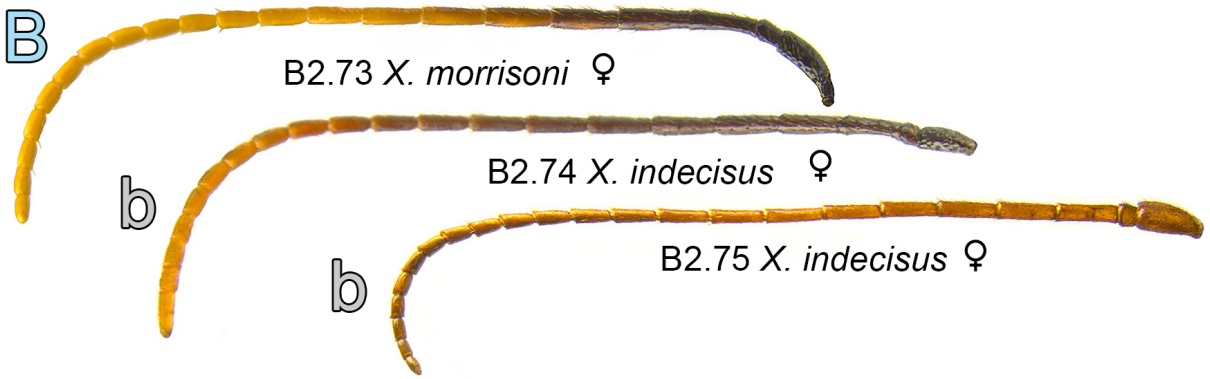
B2.67 *X. malaisei* ♀



B2.68 *X. indecisus* ♂ B2.69 *X. melancholicus* ♂ B2.70 *X. chiricahua* ♂



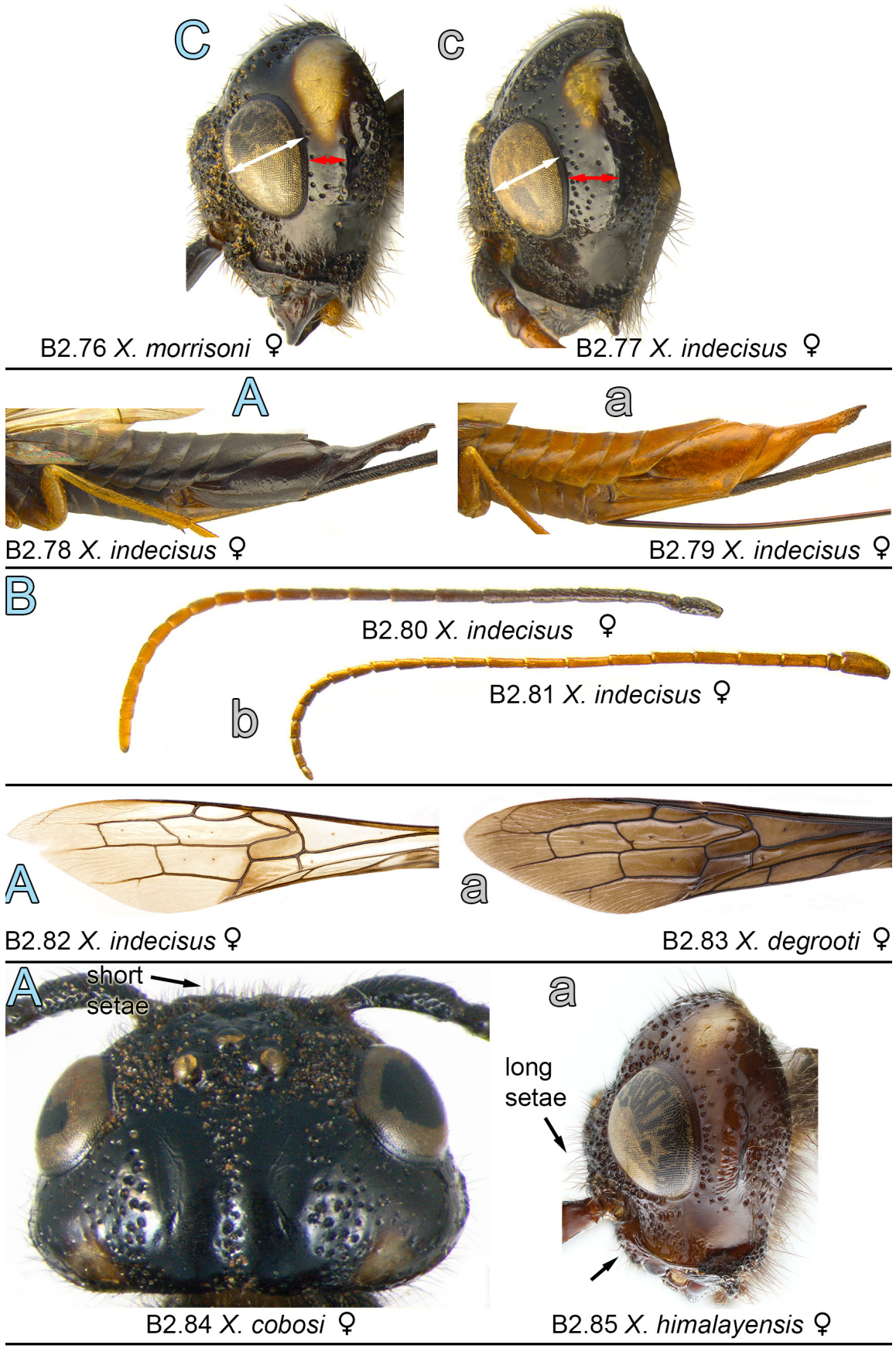
B2.71 *X. morrisoni* ♀ B2.72 *X. indecisus* ♀

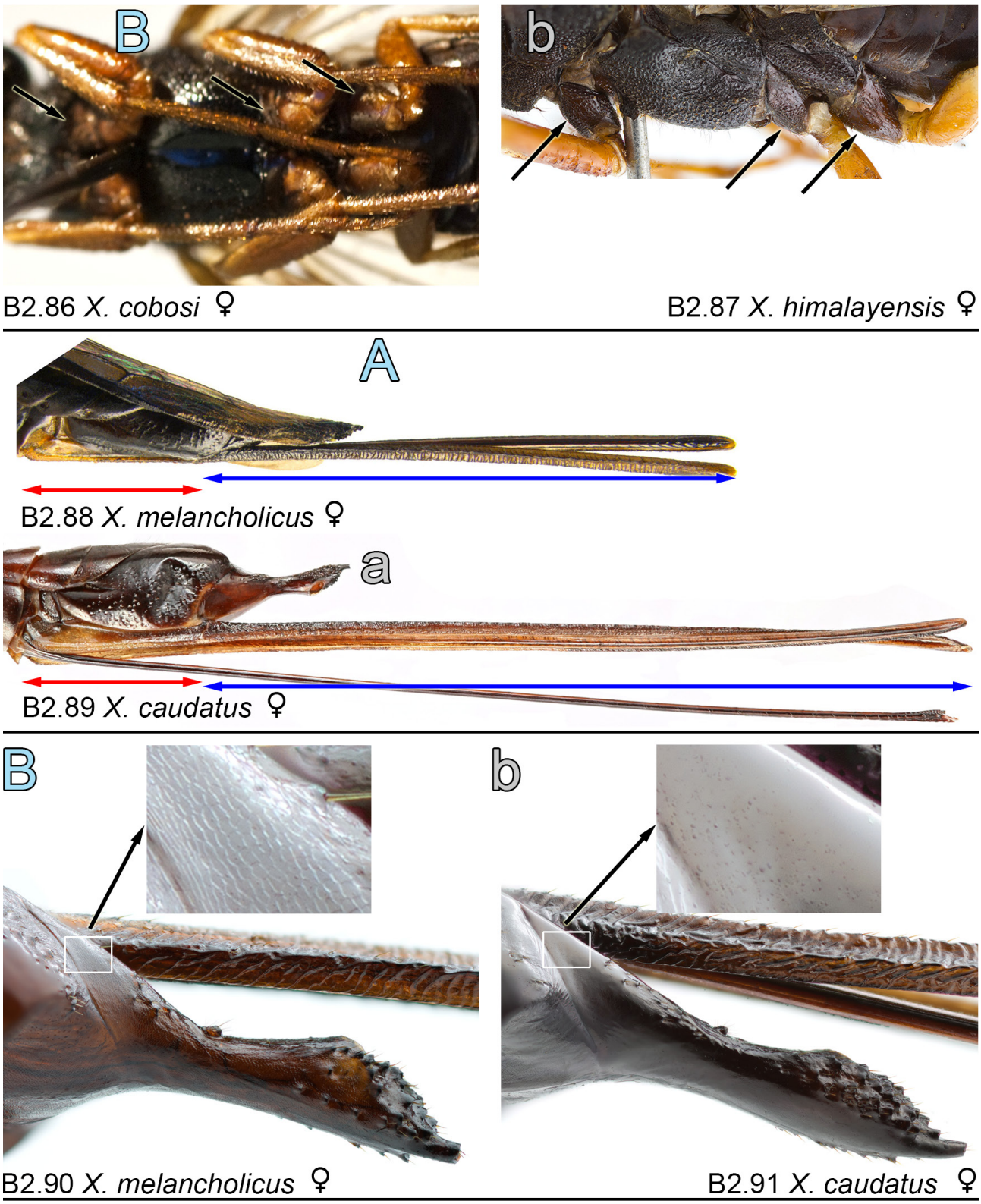


B2.73 *X. morrisoni* ♀

B2.74 *X. indecisus* ♀

B2.75 *X. indecisus* ♀


C
c
B2.76 X. morrisoni ♀
B2.77 X. indecisus ♀
A
a
B2.78 X. indecisus ♀
B2.79 X. indecisus ♀
B
B2.80 X. indecisus ♀
b
B2.81 X. indecisus ♀
A
a
B2.82 X. indecisus ♀
B2.83 X. degrooti ♀
A
short
setae
a
long
setae
B2.84 X. cobosi ♀
B2.85 X. himalayensis ♀


B
b
B2.86 *X. cobosi* ♀
B2.87 *X. himalayensis* ♀
A
B2.88 *X. melancholicus* ♀
a
B2.89 *X. caudatus* ♀
B
b
B2.90 *X. melancholicus* ♀
B2.91 *X. caudatus* ♀

c) In most females, abdominal tergum 9 in lateral view with meshes of microsculpture not well impressed, with sculpticells almost flat and somewhat scale-like on surface posterior to and above lateral furrow, thus surface shiny (Fig. B2.93).

[Range. Recorded from the Rocky Mountains to the Pacific coast between Alaska and California but also occurring east of the Rocky Mountains in Alberta and Northern Saskatchewan. This species and *X. melancholicus* are sympatric in the central regions of the above two provinces. Note. Males cannot be recognized on morphological features, but can be distinguished by their barcodes.]

.....*Xeris caudatus* Cresson, 1865

12(4) A) Pronotum in dorsal view with yellowish-white longitudinal band very smooth between large teeth (Fig. B2.94).

B) Pronotum in lateral view almost entirely without coarse pits (pit base slightly to clearly raised as a tooth or cone and not fused with nearby teeth) (Fig. B2.96).

C) In female, coxae light reddish brown (Fig. B2.98).

[Additional characters. In male, gena with yellowish-white spot large, almost always sharply outlined, and extending to genal ridge but not behind ridge on occiput (Fig. B2.100); hind leg with metafemur reddish brown to completely black, apex of metatarsomere 1 narrowly reddish brown, and in most males, with black central transverse band on metatarsomere 2 (Fig. B2.101). Range. Central Europe.]

.....*Xeris pallicoxae* Goulet, n. sp.

– a) Pronotum in dorsal view with surface of lateral margin (usually margin yellowish white) bearing small ridges between large teeth (Fig. B2.95).

b) Pronotum in lateral view with coarse reticulate pits over 0.3–0.9 of surface (Fig. B2.97).

c) In female, coxae black, at least on outer surface (Fig. B2.99).

..... 13

13(12) A) Clypeus with setae 1.0–1.4 times as long as length of lateral ocellus (Fig. B2.102).

B) Metanotum posterior to cenchrus and on lateral 0.5 of metascutellum with fine, isolated pits (Fig. B2.104).

C) In female, trochanters black, pro- and mesofemur brown, metafemur mostly black, and tarsomeres 1 (in apical 0.5) and all of tarsomeres 2–5 black, tibiae and basal 0.5 of metatarsomere 1 light reddish brown (Fig. B2.106).

D) In female, tergum 10 in dorsal view with teeth along lateral margin in apical 0.3 very small but larger toward apex (Fig. B2.109).

E) In male, pro- and mesotibiae black or at most clearly or indistinctly yellowish white in basal 0.1 (Fig. B2.111).

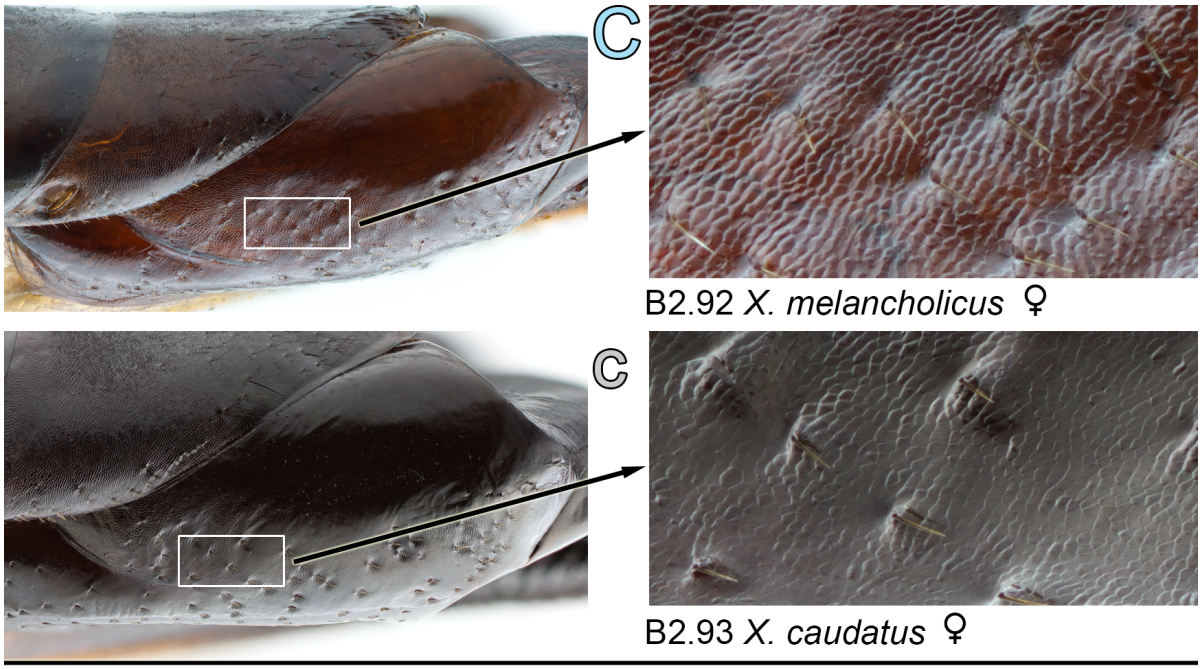
[Additional characters. In female, flagellum black (Fig. B2.113). Range. China, Yunnan.]

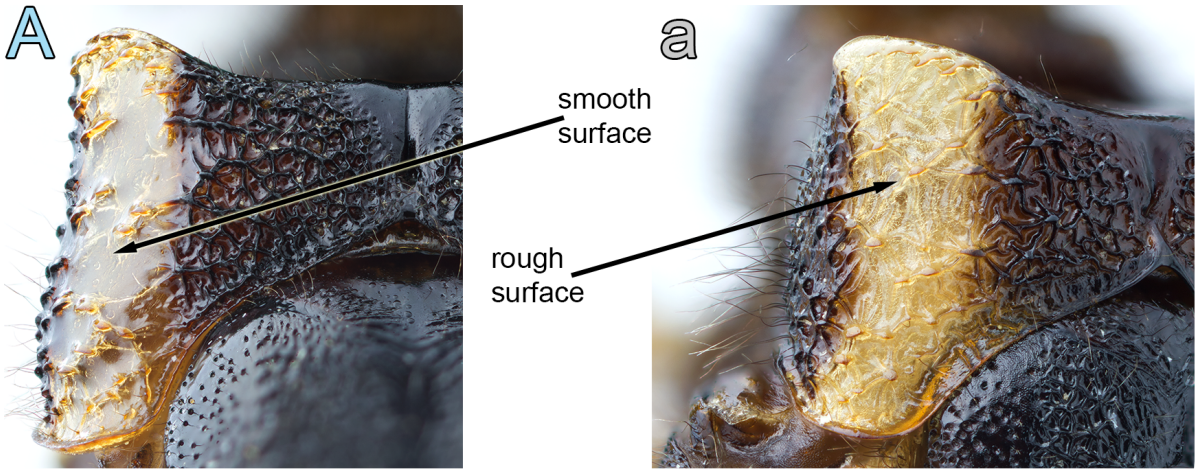
.....*Xeris umbra* Goulet, n. sp.

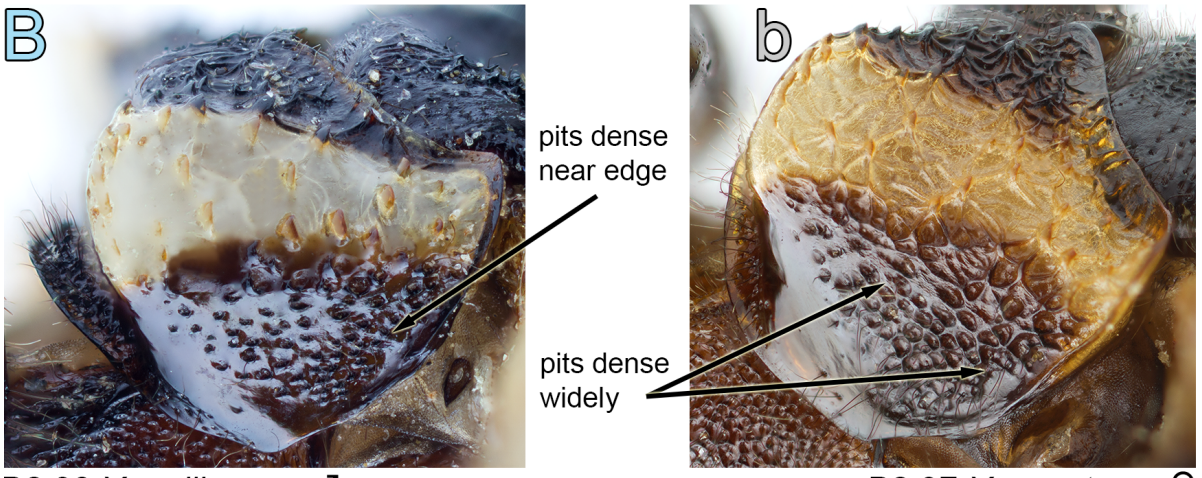
– a) Clypeus with setae 0.6–0.7 as long as length of lateral ocellus Fig. B2.103).

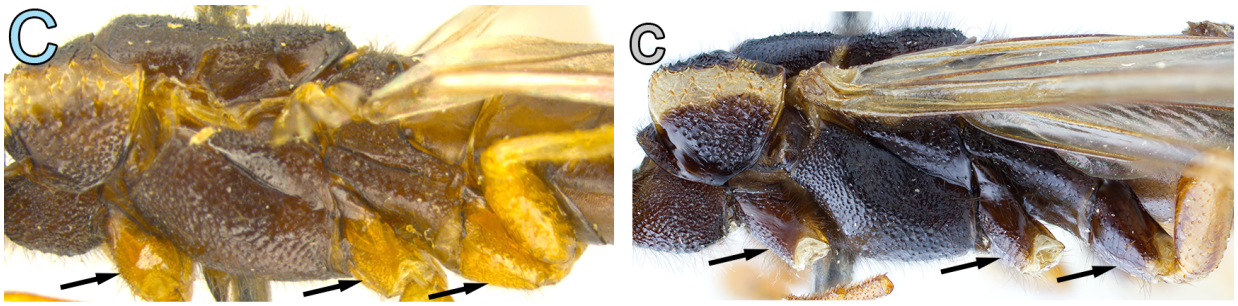
b) Metanotum posterior to cenchrus and on lateral 0.5 of metascutellum with coarse, dense and usually polygonal pits (Fig. B2.105).

c) In female, legs below coxae light reddish brown (Fig. B2.107), or metafemur mostly black, tarsomeres (apical 0.6) and all of tarsomeres 2–5 black, tibiae in basal and apical 0.3 and mesofemur light reddish brown (Fig. B2.108, hind leg).

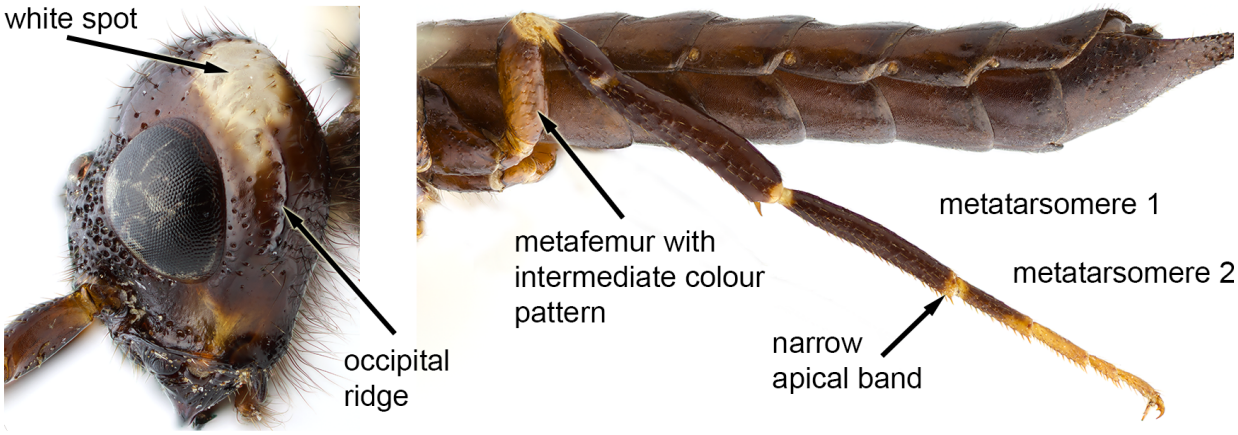

C
B2.92 *X. melancholicus* ♀
c
B2.93 *X. caudatus* ♀


A
smooth surface
rough surface
a
B2.94 *X. pallicoxae* ♀
B2.95 *X. spectrum* ♀

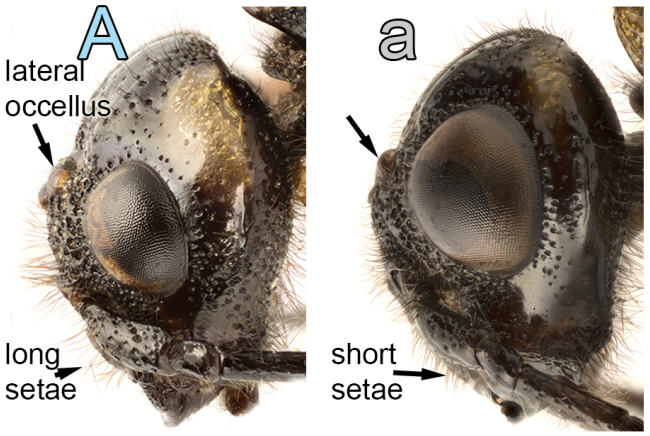

B
pits dense near edge
pits dense widely
b
B2.96 *X. pallicoxae* ♂
B2.97 *X. spectrum* ♀



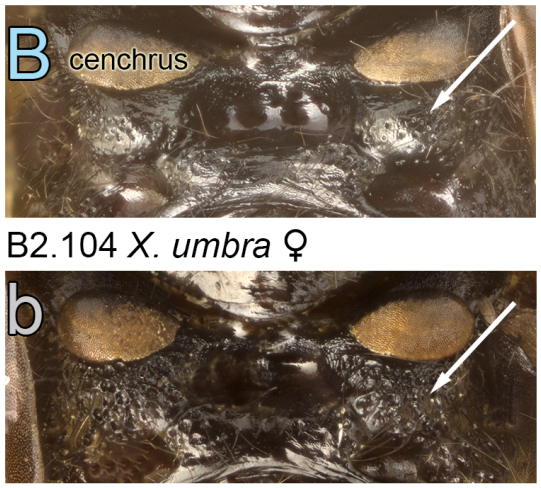
B2.98 X. *pallicoxae* ♀ B2.99 *X. spectrum* ♀



B2.100 *X. pallicoxae* ♂ B2.101 *X. pallicoxae* ♂



B2.102 *X. umbra* ♂ B2.103 *X. xylocola* ♀



B2.104 *X. umbra* ♀

B2.105 *X. xylocola* ♀

B2.106 *X. umbra* ♀

B2.107 *X. xylocola* ♀

B2.108 *X. malaisei* ♀ (from Taiwan)

d) In female, tergum 10 in dorsal view with teeth along lateral margin in apical 0.3 large (Fig. B2.110).

e) In male, pro- and mesotibia clearly yellowish white in basal 0.5–0.6 and quite sharply separated from black apex (Fig. B2.112).

[Note. The male of *X. xanthoceros* (couplet 17) is unknown. Characters "a" and "b" probably apply.]

..... 14

14(13) A) In female, flagellum black (Fig. B2.114).

B) In male, tarsomeres 2–5 light reddish brown (metatarsomere 2 may have an indistinct dark central spot) (Fig. B2.118).

C) In male, metatarsomere 1 black, but broadly reddish brown at apical margin (Fig. B2.120).

D) In male, metafemur (almost always) and trochanter reddish brown (Fig. B2.122).

[Additional characters. Tergum 10 with surface anterior to anus often light reddish brown (Fig. B2.124). Range. Transpalaearctic, mainly in cold temperate and boreal regions.]

.....*Xeris spectrum* (Linnaeus, 1758)

– a) In female, flagellum light reddish brown in apical 0.3–0.7 Figs B2.115, B2.116 and B2.117).

b) In male, at least tarsomeres 5 dark brown, **or** black and usually tarsomeres 2–5 dark brown or black (Fig. B2.119).

c) In male, metatarsomere 1 black to apex, at most narrowly reddish brown at apical margin (Fig. B2.121).

d) In male, metafemur and trochanter black (Fig. B2.123).

[Note. The male of *X. xanthoceros* (couplet 17) is unknown. Character "b", "c" and "d" are likely to apply. Range. Eastern Asia from extreme southeastern Russia to Laos and Taiwan.]

..... 15

15(14) A) Pronotum in lateral view with deep and coarse polygonal pits on about 0.9 of surface (Fig. B2.125).

B) In female, flagellum black in basal 0.5 (7 or 8 basal flagellomeres) and light reddish brown apically (Figs. B2.127).

C) In male, gena with yellowish-white spot large, sharply outlined, and extending to genal ridge and clearly behind ridge on occiput (spot comma-like) (Fig. B2.130).

D) In male, pro- and mesotarsomeres 1 light reddish brown (Fig. B2.132).

[Range. Laos, Huaphan.]

.....*Xeris xylocola* Goulet, n. sp.

– a) Pronotum in lateral view with coarse polygonal pits on posterior 0.5 of surface (as in Fig. B2.126).

b) In female, flagellum black either in basal 0.3 (Fig. B2.129) or in basal 0.7 (Fig. B2.128) and light reddish brown apically.

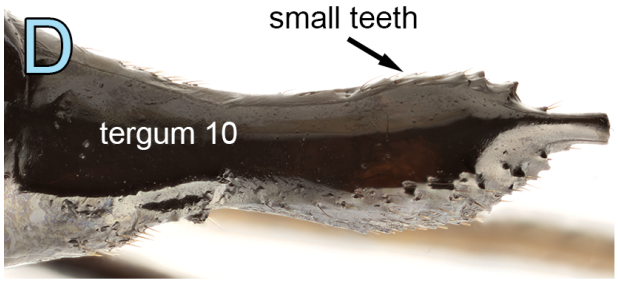
c) In male, gena with yellowish-white spot large, sharply (rarely indistinctly) outlined, and extending to genal ridge but not behind ridge on occiput (Fig. B2.131).

d) In male, pro- and mesotarsomeres 1 light reddish brown in basal 0.1–0.8 and black thereafter (Fig. B2.133).

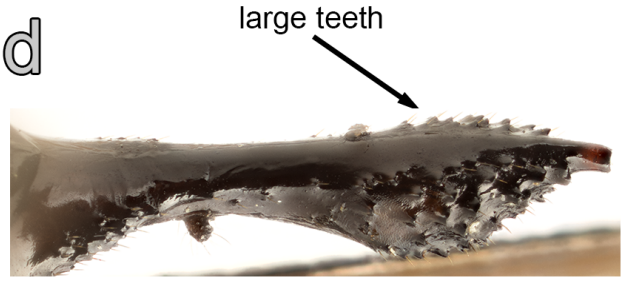
[Note. The male of *X. xanthoceros* (couplet 16) is unknown. Character "a" probably applies, but character states "c" and "d" may not apply.]

..... 16

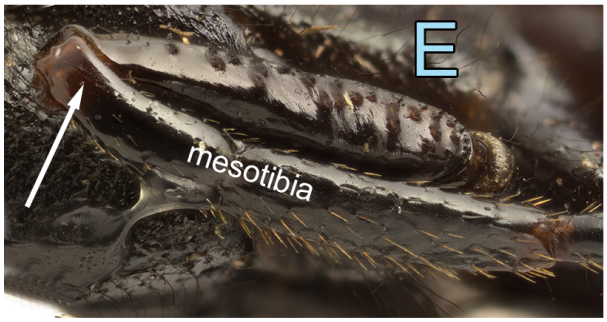
16(15) A) Pronotum medially in dorsal view with a wide shiny surface and with a deep impression near center (Fig. B2.134, insert).



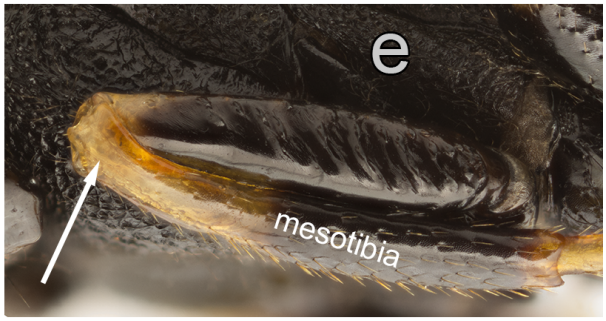
B2.109 *X. umbra* ♀



B2.110 *X. xylocola* ♀

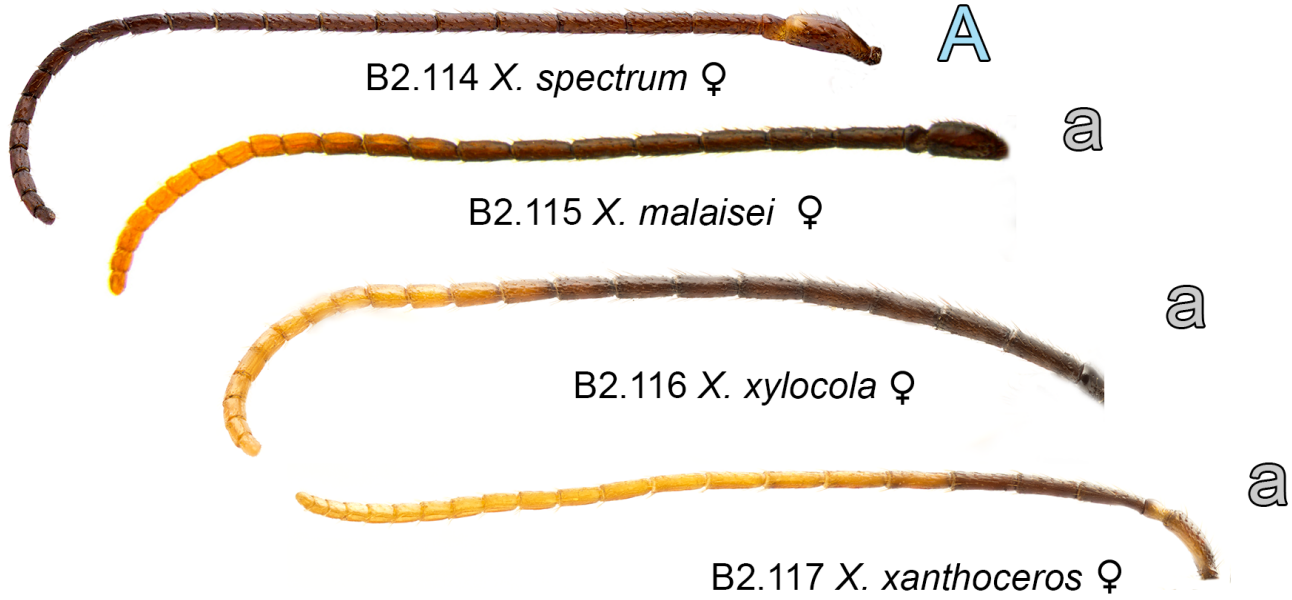


B2.111 *X. umbra* ♀



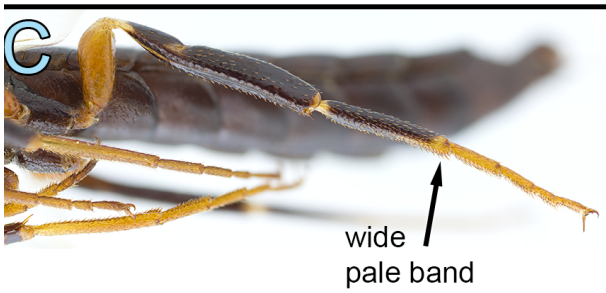
B2.112 *X. xylocola* ♀

B2.113 *X. umbra* ♀

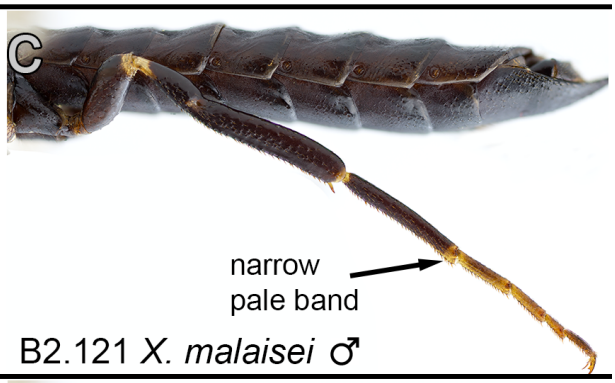


B2.118 *X. spectrum* ♂

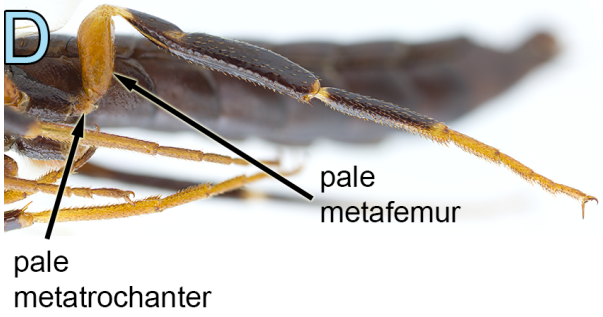
B2.119 *X. malaisei* ♂



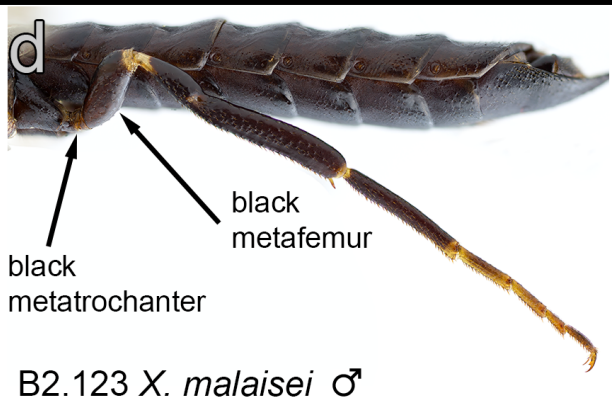
B2.120 *X. spectrum* ♂



B2.121 *X. malaisei* ♂

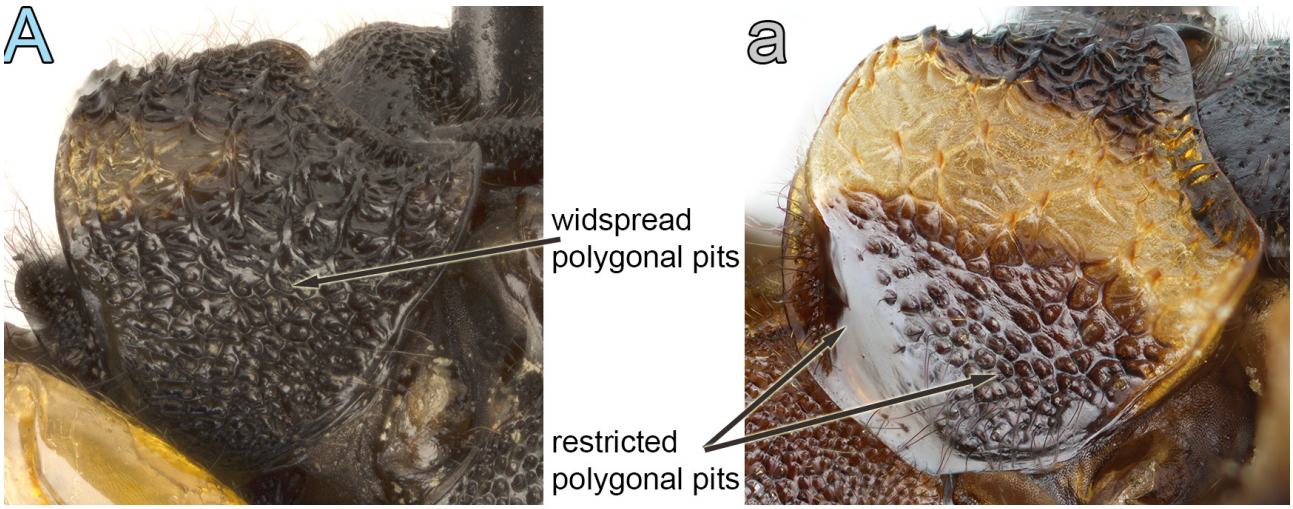


B2.122 *X. spectrum* ♂

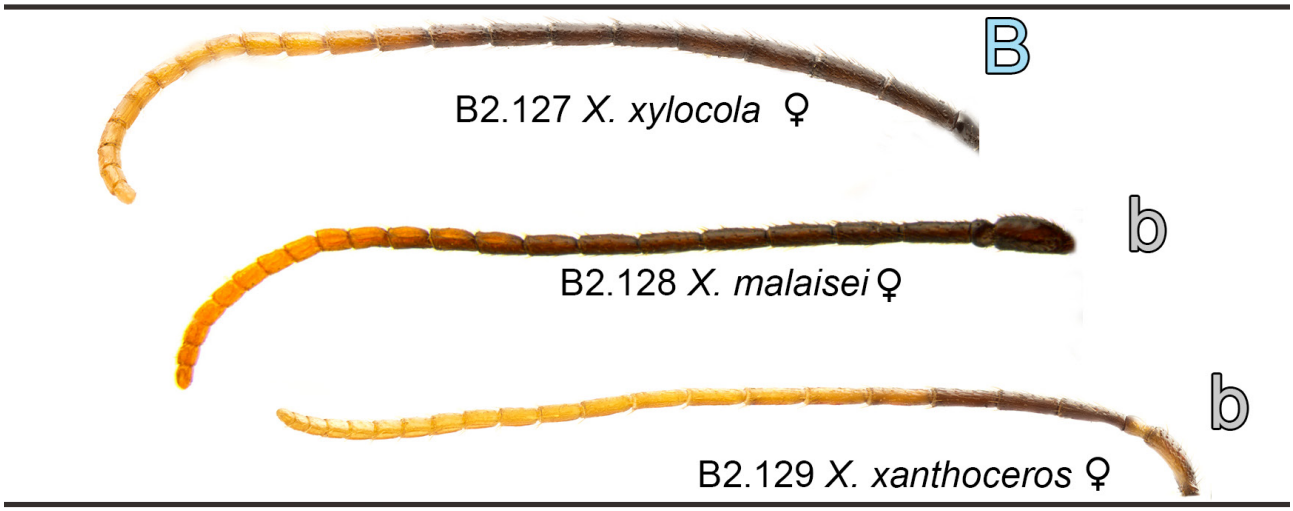


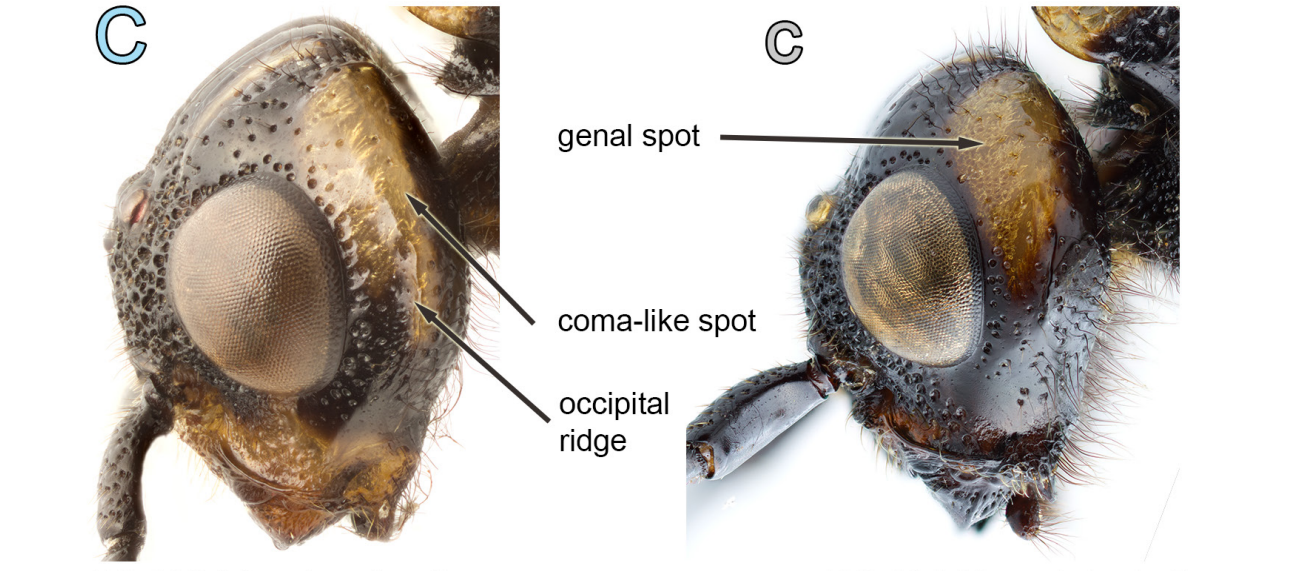
B2.123 *X. malaisei* ♂

B2,124 *X. spectrum* ♀



B2.125 *X. xylocola* ♀ B2.126 *X. spectrum* ♀





B2.130 *X. xylocola* ♂ B2.131 *X. malaisei* ♂

B) In female, flagellum black in basal 0.7–0.75 (9–10 basal flagellomeres) and light reddish brown apically (Fig. B2.136).

C) In female, last labial palpomere black (Fig. B2.138).

D) In female, tergum 8 dull over surface (sculpticells scale-like at or near lateral edge) (as in Fig. B2.140).

[Additional character. In female, pronotum in dorsal view along lateral margin with a yellowish-white band (usually wide except at high elevation) (Fig. B2.142). Range. China (northeastern region), Japan (Hokkaido and Honshu), Russia (Primorsky Kray), South Korea, and Taiwan (high elevation).]

– ..... *Xeris malaisei* Maa, 1949

a) Pronotum medially in dorsal view with a narrow shiny surface and without an impression near center Fig. B2.135).

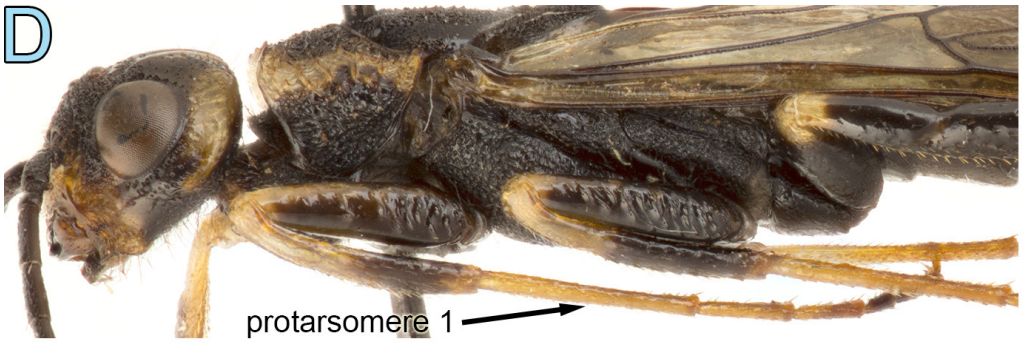
b) In female, flagellum black in basal 0.3 (3 or 4 basal flagellar segments) and light reddish brown beyond flagellomere 4 (Fig. B2.137).

c) In female, last labial palpomere reddish brown (Fig. B2.139).

d) In female, tergum 8 shiny along most of lateral margin (sculpticells flat or meshes absent) (Fig. B2.141).

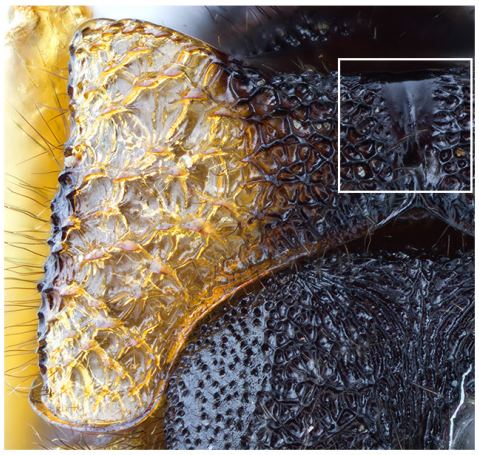
[Note. The male of *X. xanthoceros* is unknown, characters "16a", "14c" and "14d" probably applies. Additional characters. In female, pronotum black except for a trace of a pale narrow spot along margin of anterolateral corner (Fig. B2.143). Range. China, Yunnan.]

..... *Xeris xanthoceros* Goulet, n. sp.

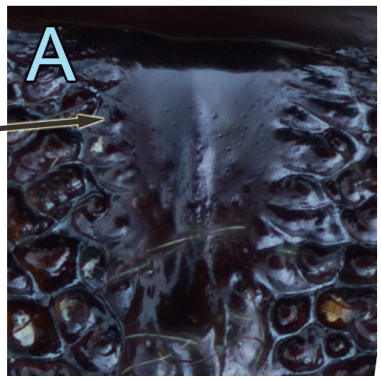


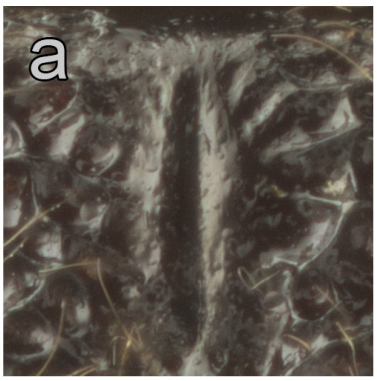
B2,132 *X. xylocola* ♂

B2.133 *X. malaisei* ♂



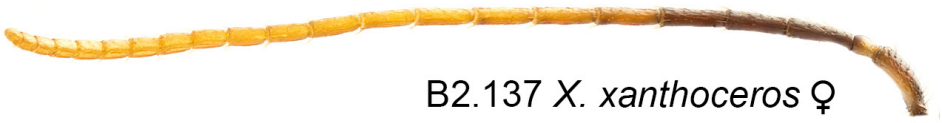
B2.134 *X. malaisei* ♀



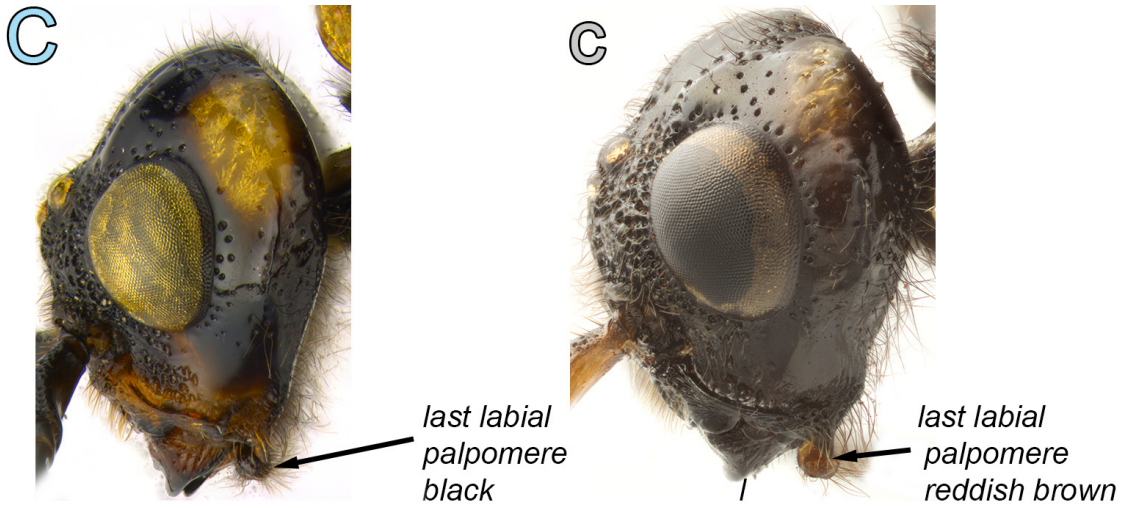


B2.135 *X. malaisei* ♀

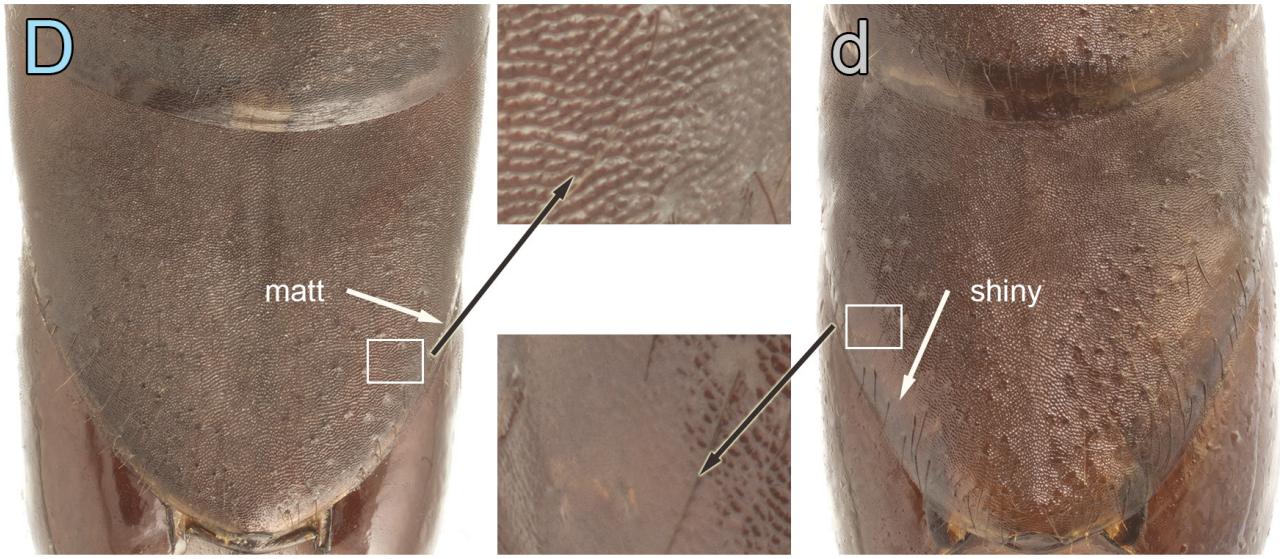
B2.136 *X. malaisei* ♀



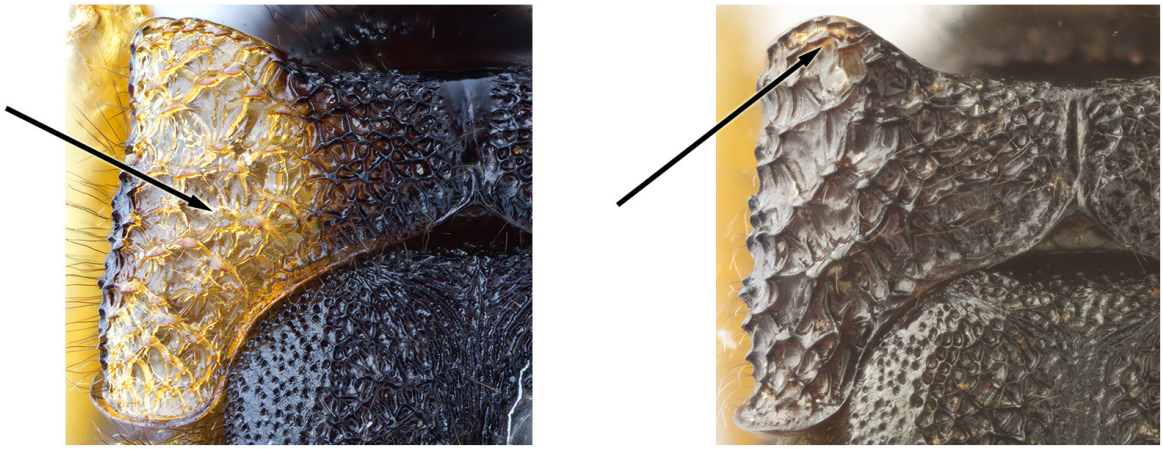
B2.137 *X. xanthoceros* ♀



B2.138 *X. malaisei* ♀ B2.139 *X. xanthoceros* ♀



B2.140 *X. spectrum* ♀ B2.141 *X. xanthoceros* ♀



B2.142 *X. malaisei* ♀ B2.143 *X. xanthoceros* ♀

C. Taxonomic treatment

1. Genus *Xeris* A. Costa

Fig. C1.1 (live female)

Xeris A. Costa, 1894: 259. Type species: *Ichneumon spectrum* Linnaeus, 1758; monotypic. Konow, 1896: 41; Ashmead, 1898: 179; Konow, 1898a: 73–74; Konow, 1905a: 9; Konow, 1905b: 125–128; Schmiedeknecht, 1907: 769–772; Bradley, 1913: 5, 6, 8, 22, 23; Enslin, 1918: 705, 71; Schmiedeknecht, 1930 72; Hedicke, 1930: 74; Bradley, 1934: 145; Gussakovskij, 1935 2, 1: 47, 64–66, 343; Ross, 1937: 112; Hedicke, 1938: 23 (catalog); Takeuchi, 1938: 194–195; Benson, 1943: 34, 38; Berland, 1947: 72–74; Maa, 1949: 78–89; Benson, 1951: 22; Ries, 1951: 84 (catalog); Takeuchi, 1955: 3, 6, 8; Glowacki, 1956: 14; Burks, 1958: 17 (catalog); Takeuchi, 1962: 6, 11; Okutani, 1963: 24, 25; Burks, 1967: 27 (catalog); Middlekauff, 1960: 68; Smith, 1978: 83–84 (catalog); Smith, 1979: 129 (catalog); Viitasaari, 1984: 37; Vasu & Saini, 1999: 274 (in part); Saini, 2009: 65, 68, 79–80 (in part) (catalog); Taeger *et al*., 2010: 105 (catalog).

Sirex: Jurine, 1807: 76–79 (in part); Taschenberg, 1866: 29–30 (in part); Dalla Torre, 1894: 392–393 (in part); Konow, 1896: 41 (in part).

Urocerus: Lepeletier & Serville, 1828: 769; Leach, 1830: (9): 141.

Neoxeris Saini and Singh, 1987: 177. Type species: *Neoxeris melanocephala* Saini and Singh; monotypic. Saini, 2009: 67; Taeger *et al*., 2010: 100 (catalog). Synonym by Schiff *et al*., 2012: 244.

Diagnostic combination

Both sexes of *Xeris* are easily distinguished from all known extant genera of Siricidae by the gena with a small vertical ridge posterior to the eye. In addition, there is one metatibial spur and no anal cell on the hind wing.

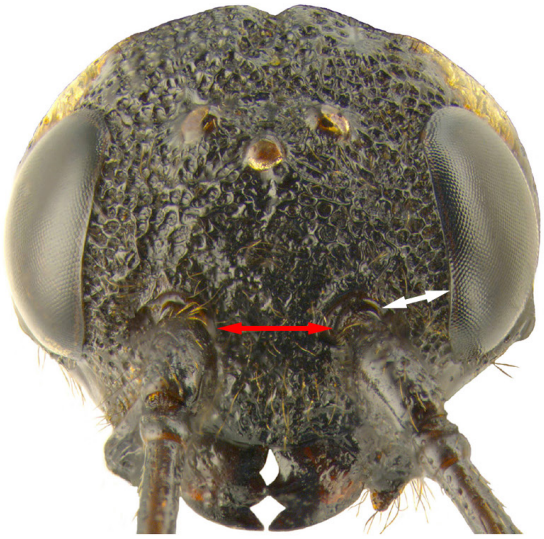
Description

Color. Black portions of body without metallic reflections. Head and thorax mainly to completely black; with white spot almost always present in dorsal 0.5; abdomen mainly reddish brown or black. Legs and antennae variously patterned with black and light reddish brown. Wings completely or partly darkly tinted or mainly clear.

Head. Antennal sockets with distance between their inner edges 1.4–2.0 times distance between outer edge of socket and nearest edge of eye (Fig. C1.2). Distance between nearest eye and lateral ocellus edges 0.9–1.7 times as long as distance between inner edges of lateral ocelli (Figs. C1.4 and C1.5). Minimum distance between inner edges of eyes about 1.3–1.7 times as long as maximum eye height (Fig. BC1.3). Gena with ridge behind eye (Fig. C1.6), and in lower 0.5 with posterior edge of pits not elevated. Head with setae sharp at apex. Antenna with 14 or more flagellomeres (smallest specimens have the lowest number), and middle flagellomeres in dorsal view 3.0–4.0 times as long as high (Fig. C1.7); in **female** apical 5–10 flagellomeres with sensory oval impressions on dorsal and ventral surfaces, in **male** with sensory oval impressions only on ventral surface; in **female** middle and basal flagellomeres with sensory pits over most surfaces except outer surface, in **male** with sensory pits over inner surface and a small section of outer surface.

Thorax. Pronotum smooth on anterior vertical surface. Mesoscutum densely pitted only over median 0.7, fine microsculpture on lateral 0.3 with isolated pits with anterolateral edge raised, and with notauli clearly outlined in anterior 0.3 (Fig. C1.8). Mesotarsomere 1 in lateral view not enlarged, its dorsal and ventral edges almost parallel, and base of tarsomere 0.7 or less its maximum height. In **female** metatarsomere 2 in lateral view with dorsal edge 4.0–6.0 times as long as maximum height (Fig. C1.9a). Metatarsomere 5 0.5–0.7 as long as metatarsomere 2 (Fig. C1.9b). Metatibia with one apical spur (Fig. C1.11), in **male** in lateral view 5.5–9.0 times as long as

C1.1 *X. spectrum* ♀

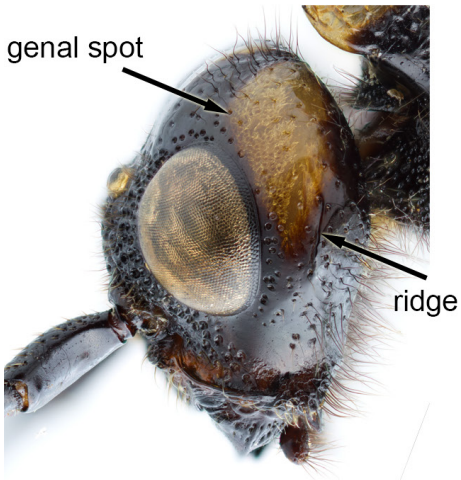


C1.2 *X. tarsalis* ♀

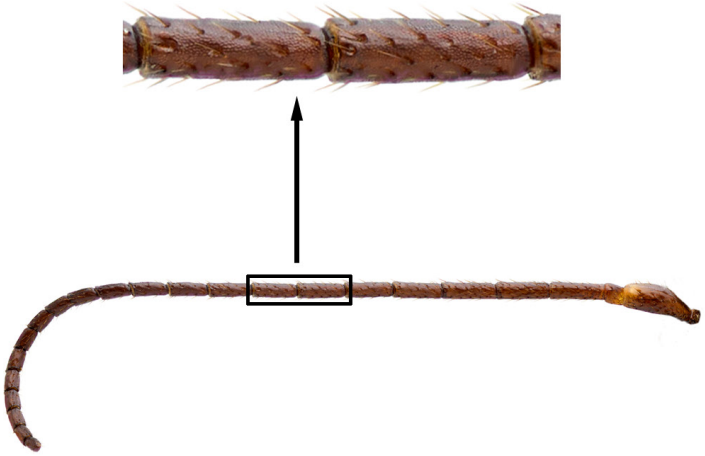
C1.3 *X. melancholicus* ♀

C1.4 *X. tarsalis* ♀

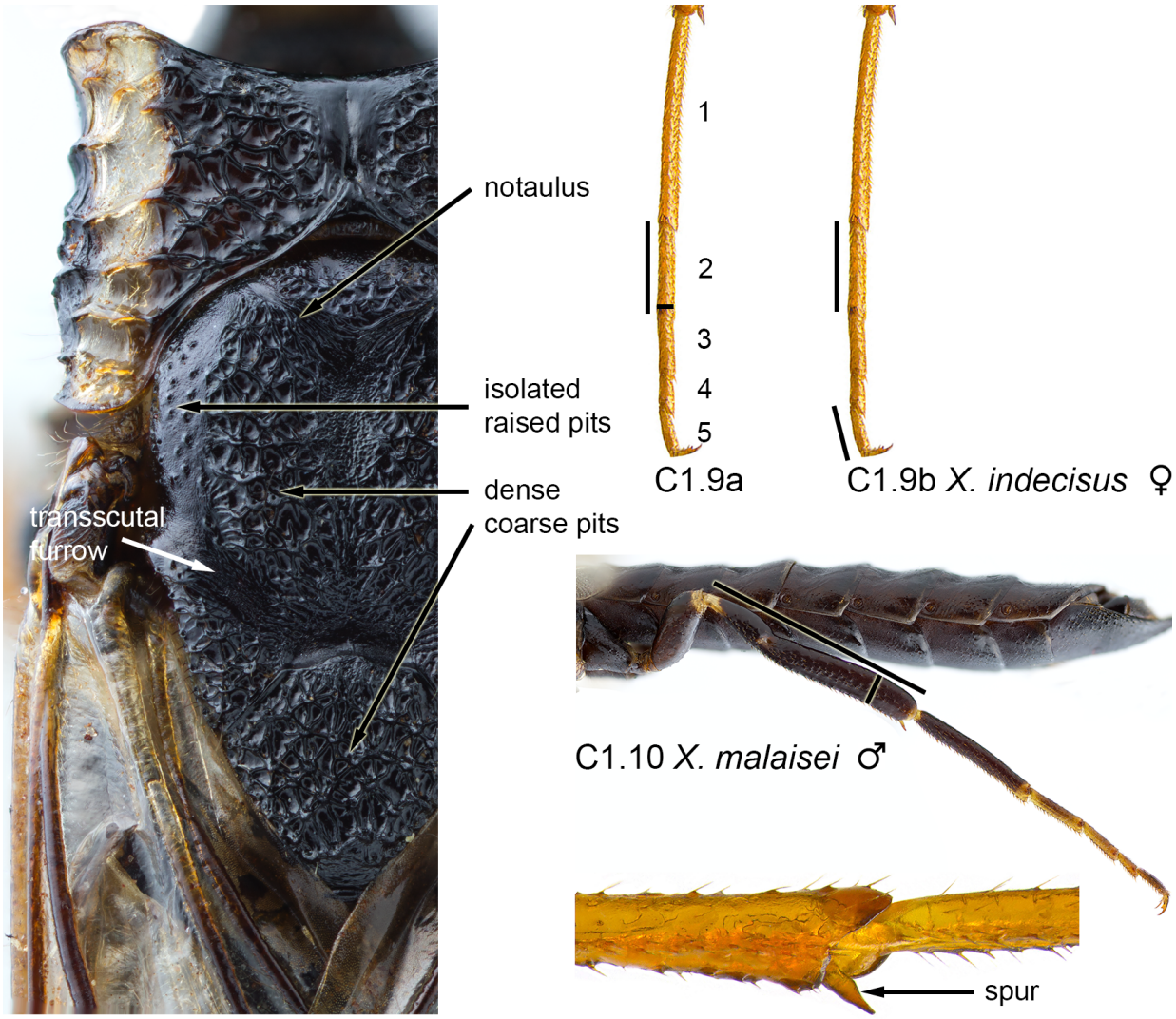
C1.5 *X. spectrum* ♀



C1.6 *X. malaisei* ♂



C1.7 *X. spectrum* ♀



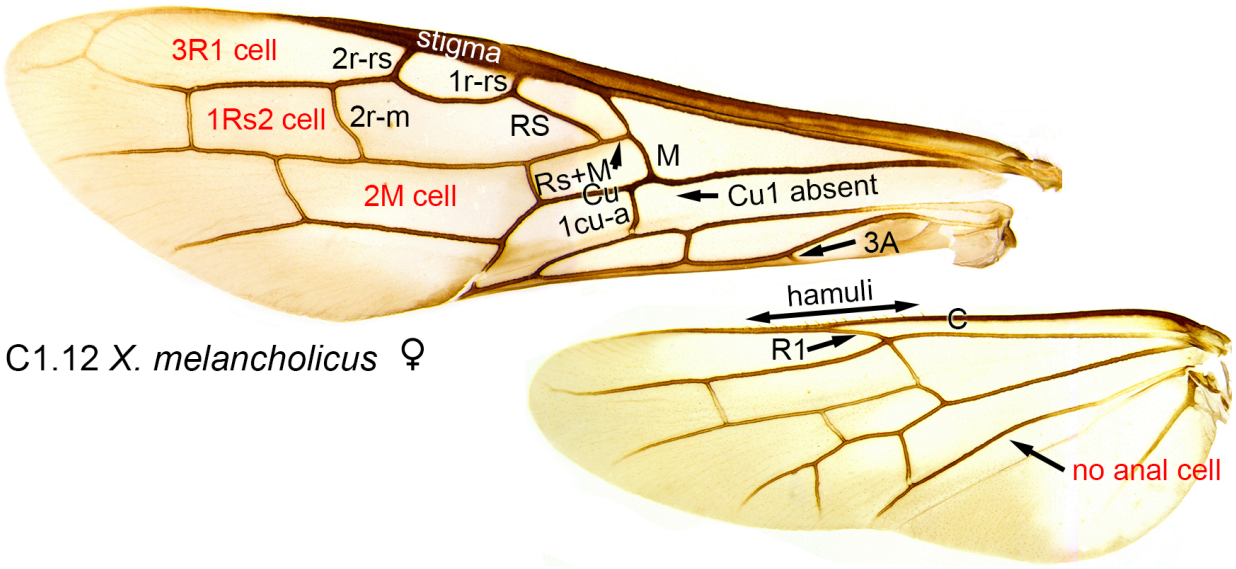
C1.8 *X. caudatus* ♂

C1.9a

C1.9b *X. indecisus* ♀

C1.10 *X. malaisei* ♂

C1.11 *X. chiricahua* ♀



C1.12 *X. melancholicus* ♀

C1.13 *X. melancholicus* ♀

maximum width (Fig. C1.10). Fore wing with apex acutely and angularly rounded, with vein 2r–m present and joined to cell 2M, with cell 1Rs2 clearly wider than long, with cell 3R1 3.5–4.5 times as wide as long, with vein 2r-rs joining stigma near middle, with stigma gradually attenuated even distal to junction with vein 2r-rs, with vein Rs (originating from vein 1r-rs) meeting Rs+M clearly before vein M, without vein Cu1, with vein 1cu–a joining vein Cu close to M (Fig. C1.12), and with vein 3A long, stump-like or absent. Hind wing with hamuli clearly present basal and apical to junction of veins R1 and C, and without anal cell (Fig. C1.13).

Abdomen. Female. Tergum 9 with lateral edges of median basin markedly divergent, straight anteriorly then rounded in posterior 0.5, sharply outlined for about 0.5 as long as median length of basin, and with base (outlined by black furrows laterally) 0.5–0.9 times as wide as median length of basin (Fig. C1.14). Tergum 10 with cornus in dorsal view long, narrow, and lateral edges either constricted near middle or not (Figs. C1.14 and C1.15), with cercus present but very small C1.16). ***Sheath.*** Length of basal section 0.2–0.6 as long as apical section (Figs. B2.12, B2.13 and B2.14); apical section with lateral surface sharply folded except at very base and apex (Fig. B2.13, insert) or not folded (Fig. B2.12, insert), and without teeth in apical third of dorsal margin (Fig. C1.19). ***Ovipositor.*** Lancet with any of annuli 3–10 aligned with junction of basal and apical sections of sheath; first tooth annulus with ridge on ventral edge and with shallow, and with long and open ended pit (Fig. C1.18); in *X. tarsalis* with large pit in each annulus from annulus 2 up to teeth annuli (Fig. C1.17, base, middle and apex) or, in most species, 4–7 annuli anterior to teeth annuli each with a small pit (the pit of each of this group annuli decreasing in size anteriorly) (Fig. C1.18, apex), the following anterior annuli with or without a very small pit (Fig. C1.18, base and middle); edge of last 5–7 annuli before teeth annuli ventral to pit sharply and acutely produced (Fig. C1.18, apex), and edge of last 7–14 annuli before teeth annuli extending as a sharp ridge to ventral edge of lancet (Fig C1.17, apex).

Taxonomic notes

Following the study of one paratype of *Neoxeris melanocephala* M. S. Saini and D. Singh, we confirmed that it is a typical member of the genus *Xeris*. This supports its synonymy by Schiff *et al*. (2012) under *Xeris* based then only on the description of *Neoxeris*.

Notes on affinities

Xeris is a natural lineage at the base of the Tremicinae (Schiff 2012). Though we did not succeed in doing a complete phylogenetic reconstruction of *Xeris* species, we are able to define the earliest lineage based on good evidence and to characterize some of the remaining lineages. The main problems in the phylogenetic reconstruction of *Xeris* are that the states of many characters differ only in degree (e.g., long and short, dense and scattered, few and many, etc.) and color pattern. The general color patterns of many Siricidae match that of many stinging insects. Such character states are highly subject to convergent evolution, and obscure relationships (e.g., females of *Tremex columba* (Linnaeus), may have up to three discrete patterns in some areas of the United States (Schiff *et al*. 2012)).

The pivotal characters are the ovipositor and its sheath, and to some extent the density of pits on the vertex, relative size of the eye, and the cornus.

Principles and methods of cladistic analysis and phylogenetic reconstruction are based mainly on Hennig (1966). For each lineage, an indented list of characters is given. For each character, the derived state is given first, followed, in brackets, by the ancestral state and its distribution within *Xeris* or in Siricidae.

1a *Xeris tarsalis* is defined by the following derived character states:

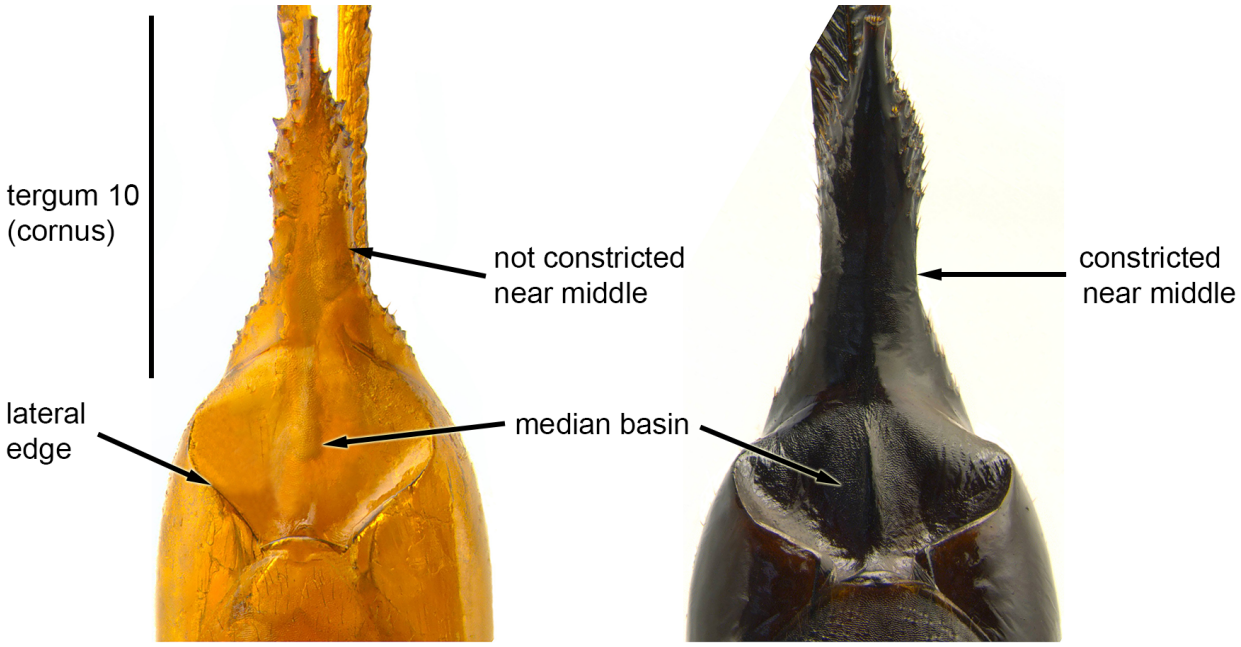
- Maximum width of gena in dorsal view equal or less than that maximum distance between outer edges of eyes (in frontal view, outer edges of eyes touching or slightly intersecting genae) (Fig. B2.4). [In almost all extant species of Siricidae, the maximum width of the genae in dorsal view is clearly greater than the maximum distance between the outer edges of eyes (Fig. B2.5).]

- Pronotum laterally with raised reticulate ridges enclosing one or usually more pits (Fig. B2.15). [In Siricidae, the lateral surface of the pronotum is pitted, and where densely so, the pits are polygonal with their edges forming a coarse net-like pattern (Fig. B2.97).]

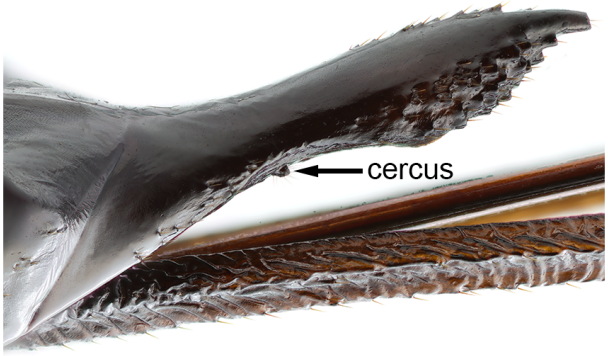
1aa All remaining species of *Xeris* (15 species) form a monophyletic group, united by the following shared derived character states:

- Ovipositor sheath with median ridge (Fig. B2.13, insert). [In Symphyta, the ridge is not present (Fig. B2.12, insert).]

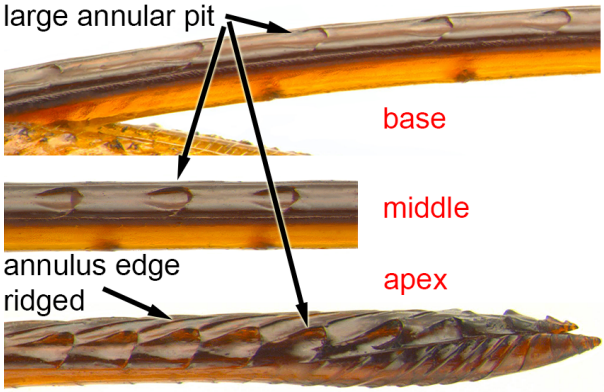
- Ovipositor sheath with basal section at most 0.45 as long as apical section (Fig. B2.12). [In Siricidae and Symphyta, the basal section is greater than 0.5 as long as the apical section (Figs. B2.13 and B2.14).]



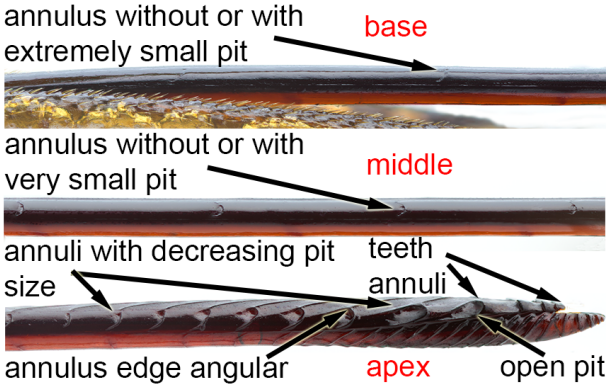
C1.14 *X. tarsalis* ♀ C1.15 *X. melancholicus* ♀



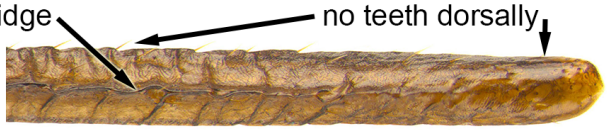
C1.16 *X. caudatus* ♀



C1.17 *X. tarsalis* ♀



C1.18 *X. spectrum* ♀



C1.19 *X. melancholicus* ♀

- Ovipositor with basal annuli hardly outlined, at most with a very small pit (Fig. A3.3, see basal and middle annuli and associated pit of ovipositor); larger pits present on the 4–7 apical annuli before tooth annuli; apical annuli with largest pit, then pits decreasing in size on anterior 4–6 annuli (Fig. A3.3, see apex of ovipositor). [In most Siricidae, pits are large and present from annulus 2 to first tooth annulus (Fig. B2.16, base, middle and apex), in some species pits are not present at the base but are not organized as above.]

- Ovipositor sheath with junction between the basal and apical sections aligned between 2nd and 5th annulus. [In Siricidae with annuli extending to the base of the ovipositor, the alignment is between the 8th and 15th annulus.]

- Vertex with pits covering over 0.6–0.9 of surface with a small to large smooth surface centered on postocellar furrow (Figs. B2.2 and B2.3). [In Siricidae, the pits, when present, are evenly spread out without a distinct smooth area around postocellar area bordered more laterally by dense pits (Fig. B2.1).]

- Cornus clearly constricted near middle (Fig. C1.15). [In most extant Siricidae, the cornus is not constricted or, if constricted, then it is toward the base not the middle (Fig. C.1.14).]

1b *Xeris tropicalis* is defined by the following derived character state:

- Gena with transverse ridge above mandible rounded and with large pits (Fig. B2.17). [In Siricidae and all other species of *Xeris*, the ridge is sharply outlined and without pits (Fig. B2.18)].

1bb Remaining species of *Xeris* (14 species) form a monophyletic group, united by the following shared derived character states:

- The distance between the outer edge of a lateral ocellus and the nearest edge of the eye is clearly longer (1.1–1.5 times) than the distance between the inner edges of the lateral ocelli (Fig. B2.20). [In most Symphyta and all extant Siricidae, the distance between the outer edge of a lateral ocellus and the nearest inner eye edge is about equal to the distance between the inner edges of the lateral ocelli (Figs. B2.1 and B2.2).]

- The eye relative to head height is relatively small (0.34–0.53) (Fig. B2.8). [In Siricidae, the eye relative to the head height is large (Figs. B2.6 and B2.7).]

- Vertex with a larger smooth surface around the postocellar region (Fig. B2.3). [In Siricidae, the pits, when present, are evenly spread apart with a distinct smooth area around postocellar area bordered more laterally by dense pits (Figs. B2.1 and B2.2).]

We are unable to reconstruct the next lineage because we have only two characters, giving different outcomes. The males of the following species have a white spot at the base of the metatibia (*X. chiricahua, X. himalayensis*, *X. malaisei, X. pallicoxae*, *X. spectrum, X. umbra, X. xanthoceros and X. xylocola*) (Fig. B2.70). If these form a natural lineage this choice would suggests that species with reduced number and size of pits on the vertex had evolved twice (once for *X. caudatus* and *X. melancholicus*, and again for the species mentioned above). The following species have a complete white band on the pronotum laterally in males at least (*X. caudatus*, *X. chiricahua*, *X. himalayensis*, *X. malaisei*, *X. melancholicus, X. pallicoxae*, *X. spectrum*,) (Fig. B2.95). If these form a natural lineage this choice would support that species with reduced number and size of pits on the vertex share a common ancestor. However, we have no data for *X. cobosi* and *X. xanthoceros* as the males are unknown. Therefore, the best thing is to define three natural groups among the 14 species. We cannot determine the relationships for three species (*X. chiricahua*, *X. himalayensis* and *X, cobosi*) as we found no shared and derived character state. Among the remaining eleven species, we recognize three natural lineages. The *indecisus*, the *caudatus* and the *spectrum* lineages, defined as follows.

The *indecisus* lineage (*X. indecisus*, *X. degrooti* and *X. morrisoni*) forms a monophyletic group, united by the following shared derived character state:

- In female, flagellum light reddish brown on at least apical 0.3 (Figs. B2.73, B2.74 and B2.75). [In all other species of *Xeris* except females of *X. malaisei, X. xanthoceros and X. xylocola*, the flagellum is completely black (Fig. B2.64).]

The *caudatus* lineage (*X. caudatus* and *X. melancholicus*) forms a monophyletic group, united by the following shared derived character state:

- Gena with pits very few and usually very small (Fig. B2.47). [In all other species of *Xeris*, pits are more numerous and larger in diameter (Figs. B2.46 and B2.138).]

The *spectrum* lineage (*X. malaisei, X. spectrum*, *X. pallicoxae*, *X. umbra*, *X. xanthoceros* and *X. xylocola*) forms a monophyletic group, united by the following shared derived character states:

- Fore wing with cell C light yellow (Fig. B2.40). [In all other species of *Xeris*, the cell C is more darkly tinted (Fig. B2.39).]

- Fore wing with vein R near base of stigma on both sides of junction with vein 1r-rs contrastingly white (Fig. B2.40). [In all other species of *Xeris*, the vein R near base of stigma is dark brown even at the junction with vein 1r-rs (Fig. B2.39).]

Diversity and distribution

Xeris is a moderate sized genus with 16 species. We recognize eight species from Eurasia and eight from the New World. There are no shared species. This is quite a different diversity of species than is recorded in the latest catalogs (Taeger and Blank 2011, Taeger *et al.* 2010) where two species were recorded from Eurasia, three from North America, and one Holarctic for a total of five species. All species occur in the northern hemisphere. In Eurasia they are recorded across temperate and boreal regions from coast to coast, and in southern regions they are restricted to high mountains in Morocco, India, China, and Taiwan. In the New World they are recorded from southern Mexico (Chiapas) to boreal regions of Canada and Alaska (for general distribution patterns, see chapter A section 5 in Schiff *et al*. (2012)). The greatest recorded diversity is in western North America, with six species. However, we suspect that additional species may be discovered in Mexico and especially in southern China and Laos at high elevation in the conifer zone.

2. *Xeris caudatus* (Cresson)

Fig. C2.1 (female habitus)
Fig. C2.2 (male habitus)

Urocerus caudatus Cresson, 1865: 247. Holotype female (ANSP), examined by D. R. Smith. Cresson 1916: 10. Type locality: "Colorado Territory". Norton, 1869: 363–364; Provancher, 1878: 231; Provancher, 1883: 241; Harrington, 1893: 148–149.

Sirex melancholicus; Cresson, 1880: 67 (not Westwood, 1874: 116).

Sirex caudata; Kirby, 1882: 382 (change in combination). Dalla Torre, 1894: 385; Kiaer, 1902: 407.

Xeris caudata; Ashmead, 1898: 180 (change in combination). Konow, 1898a: 74, 88; Howard, 1901: pl. 13, fig. 29; Konow 1905b: 125, 126; Konow, 1905a: 9; Rohwer, 1912: 96 (state); MacGillivray, 1916: 171; Schiff *et al*. 2012: 246.

Xeris spectrum race *caudata*; Bradley 1913: 23 (change in rank). Essig, 1926: 774; Hedicke, 1938: 24–25 (catalog).

Xeris spectrum; Maa, 1949: 86, 170 (not Linnaeus, 1758: 560 only for Nearctic records); Burks 1958: 17 (catalog); Middlekauff 1960: 70; Furniss & Carolin, 1977: 454, 457; Smith 1979: 129 (catalog); Smith & Schiff 2002: 185; Taeger *et. al*., 2010: 105 (in part for Nearctic species; catalog).

Diagnostic combination

Among specimens with small, scattered pits between dorsoposterior edge of eye and occiput outside postocellar area and with cell C of fore wing yellowish brown [*caudatus* and *melancholicus*], most females of *X. caudatus* are distinguished by the sheath with basal section usually less than 0.24 times length of apical section, usually by the absence of meshes of microsculpture on laterobasal angle of cornus in dorsal view, and by abdominal tergum 9 in lateral view with meshes of microsculpture usually not well impressed, with sculpticells almost flat and somewhat scale-like on surface posterior to and above lateral furrow (the surface thus shiny). Males have a black to reddish-brown, poorly defined spot at the base of metatibia but cannot be separated from those of *X. melancholicus*.

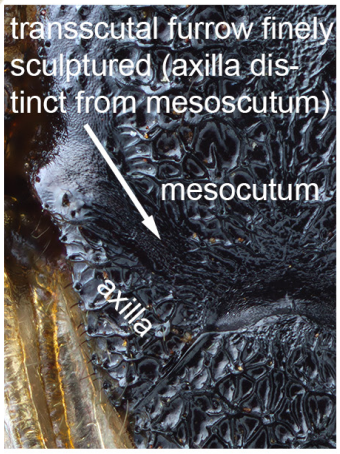
FEMALE. Description

Color. Head black except for small white spot on gena dorsal to middle of eye; white spot usually not extending down to genal ridge (as in Fig. B2.47); antenna black; last maxillary palpomere black. Thorax black except for white longitudinal band extending from posterolateral to anterolateral angles including vertical portion of anterior angle, the band 0.2–0.3 times as wide as lateral 0.5 of pronotum and not extending to lateral margin of pronotum (Fig. B2.59). Legs including coxae light reddish brown (coxae very narrowly black at anterior and posterior dorsal edges) (Fig. C2.1). Fore wing clear except for lightly tinted band in apical 0.25, and on posterior corner of cells 2CU and 3CU (as in Fig. B2.67); costal cell yellowish brown (possibly bleached in old specimens); most of area ventral to anal cells yellowish brown; veins black or brown (including veins C and R, and base of stigma on both sides of junction with vein 1r-rs) (as in Fig. B2.39). Abdomen black (Fig. C2.1). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye edge and lateral

C2.1 *X. caudatus* ♀

C2.2 *X. caudatus* ♂



C2.3 *X. caudatus* ♀

ocellus edge about 1.1–1.5 times as long as distance between inner edges of lateral ocelli (as in Fig. B2.20). Setae on clypeus 0.6–0.7 as long as diameter of a lateral ocellus (as in Fig. B2.47). Eye in lateral view (N = 20) with its maximum height 1.37–1.64 times as long as its maximum length (as in Fig. B2.47), and maximum height of eye 0.42–0.51 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (as in Fig. B2.8). Gena in dorsal view with maximum distance between outer edges clearly wider than maximum distance between outer edges of eyes (in frontal view outer edges of eyes clearly not intersecting genae) (as in Figs. B2.5 and B2.42); in lateral view with distance between outer edge of eye and genal ridge 0.48–0.61 times as long as maximum length of eye (as in Fig. B2.47, measurements as in Fig. B2.77), with almost no pits ventral to genal ridge, and with few and small to very small pits (diameter of pit 0.05–0.15 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (as in Fig. B2.47). Transverse ridge above mandible narrow, sharp and smooth (as in Fig. B2.18). Vertex scarcely pitted, pits medium in size (pit diameter 0.2–0.3 times lateral ocellus diameter), pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area; pits scattered (small specimens) to dense (large specimens) and medium in size along median furrow, a little more widespread near lateral ocelli (as in Fig. B2.42).

Thorax. Pronotum in lateral view with coarse polygonal pits on 0.1–0.7 of posterior surface (as in Fig. B2.97). Propleuron in lateral view with small pits posteriorly, each with or without tooth behind in posterior 0.5 of disc and with small polygonal pits in anterior 0.5 of disc (as in Fig. C12.7); in ventral view with scattered to moderately dense shallow small teeth with smooth surface in between (as in Fig. B2.11). Transscutal furrow of mesonotum clearly outlined and finely sculptured, thus mesoscutum and axilla clearly distinct (Fig. C2.3). Fore wing in apical 0.3 of vein 2A not subparallel with wing edge and less abruptly curved away from wing edge and broadly curved in central section (as in Fig. C12.6); vein 3A absent (58%), reduced to a stump (37%), rarely extending slightly as a short nebulous vein (5%), but not extending along posterior margin of wing.

Abdomen. Tergum 9 in lateral view with meshes of microsculpture on ventral half below and above longitudinal furrow and posterior to it generally shallowly impressed and sculpticells flat, or slightly raised posteriorly as scales above furrow, or occasionally more distinctly scale-like (Fig. B2.93, insert); median basin with base (outlined by two lateral black longitudinal furrows) 0.8 times as wide as its median length, with maximum width of basin 1.6 times as wide as its median length and basin about 0.5 times as long medially as median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) about 0.8 times as wide as maximum width subapically (as in Fig. C1.15), and its anterolateral angle generally without microsculpture meshes (Fig. B2.90, insert) or with some shallow meshes; with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.20–0.27 times as long as apical section (N = 90) (as in Fig. B2.89); lateral surface of apical section with well defined ridge (as in Fig. B2.13, insert); total length 1.2–1.4 times as long as fore wing length. ***Ovipositor.*** Lancet with 22–32 annuli (first 15 annuli hard to see, but still outlined; N = 9); junction of basal and apical sections of sheath aligned between 2nd–3rd annuli or occasionally 3rd annulus; major pits present on last 4–5 apical annuli before teeth annuli, and very small pit on each of the 7–15 preceding annuli (for middle and apical annuli as in Fig. C1.18).

MALE. Description

Color. Head with dorsal spot behind eye similar in size to female. Coxae, at least metatibia (usually all tibiae) and tarsomeres 1–5 black (apical articles 3–5 or 4 and 5 sometimes brown or reddish brown in old or teneral specimens); femora completely or mainly reddish-brown, and extreme base of tibiae in most specimens indistinctly outlined reddish-brown spot (trochanters, femora and tibiae as in Figs. B2.69, and tarsomeres as in Fig. B2.119).

Thorax. Metatibia with shallow notch on dorsal edge in basal 0.25.

Taxonomic notes

Both the North American *X. caudatus* and *X. melancholicus* have been confused with *X. spectrum*. The two North American species are not as closely related to *X. spectrum* as previously thought (Schiff *et al*. 2012). Their adults differ from those of *X. spectrum* in the color patterns of the fore wing costal cell and the base of the stigma around vein 1r-rs, and in pit size on gena between genal ridge and eye; in female by the few annuli of the ovipositor with very small pits on annuli anterior to main apical group of annuli before the teeth annuli, the color of the outer surface of coxae and, in most specimens, the color pattern of the cornus ventral surface anterior to anus; in male by the color pattern of the metatibia (and usually pro- and mesotibiae), and tarsi.

Adults of *X. caudatus* and *X. melancholicus* also differ from the similar *X. pallicoxae* in several structural and color character states. Females of *X. pallicoxae* are most similar to those of the two North American species because of the light reddish-brown coxae. Adults of the two North American species differ from *X. pallicoxae* by the fore wing color pattern of cell C and of the base

of the stigma around the junction with vein 1r-rs and by the microsculpture of the longitudinal white band along the lateral margin of the pronotum; in females by the macrosculpture on the lateral surface of the pronotum and the propleuron; in males by the color pattern of the metatibia (usually pro- and mesotibia) and tarsi. These differences support the specific distinction of *X. pallicoxae* from the two North American species.

Adults of *X. caudatus* and *X. melancholicus* differ from those of *X. malaisei*, *X. xanthoceros* and *X. xylocola* by the color pattern of cell C of the fore wing and of the base of the stigma around the junction with vein 1r-rs; in females by the coxal and flagellum color pattern, and by the ovipositor with few annuli anterior to main apical group of annuli before the teeth annuli with a very small pit; in males by the color pattern at the base of the metatibia (and usually pro- and mesotibia) and the trochanters.

Adults of *X. caudatus* and *X. malancholicus* differ from those of *X. umbra* by the coarser pits on metanotum posterior to cenchrus and outer 0.5 of metascutellum, by the color pattern of cell C of the fore wing and of the base of the stigma around the junction with vein 1r-rs; in females by the leg color pattern, and by the few annuli anterior to main apical group of annuli before the teeth annuli each with a very small pit; in males by the femur color pattern.

The main challenge is distinguishing *X. caudatus* from *X. melancholicus*. The two species were not recognized at first (Schiff *et al*. 2012). Barcodes were the clue. *Xeris caudatus* is in western North America and *X. melancholicus* is in eastern North America. They occur sympatrically in Alberta and central Saskatchewan. The barcode results distinguish both species unequivocally. We succeeded in separating only females with moderate success using morphology. The separation is based on the relative length of the apical section of the ovipositor sheath (about 70% of specimens segregated), Despite the overlap based on two standard deviations, the ratio of basal to apical sections of the sheath were most informative when comparing averages between states, provinces and large samples within these. The average in western states and provinces varies from 0.23–0.24 whereas in the east of Saskatchewan the averages vary from 0.29–0.30. There is a clear gap at the population level and this gap supports our species level separation. In addition we found some difference in the microsculpture type on the lateral surface of tergum 9 and on the anterolateral corner of tergum 10 dorsally (base of cornus) (about 70% of specimens segregated).

Cresson's type of *Urocerus caudatus*, a female from Colorado, is associated with the western species. Westwood's type of *Sirex melancholicus* is a male of unknown locality in North America and has a younger name. *Urocerus caudatus* is the oldest name, thus *X. caudatus* is used for this species.

Hosts and phenology

Xeris caudatus has a wide host range within Pinaceae (Middlekauff 1960, Cameron 1965, Morris 1967, Kirk 1975). The main hosts are firs. Based on 340 reared and confirmed specimens, the hosts are: *Abies balsamea* (15), *A. concolor* (298, Kirk, 1975), *A. lasiocarpa* (3, Morris 1967), *Picea engelmannii*, *P. glauca* (4), *P. pungens* (11), *P. contorta* (7), *P. ponderosa*, and *Pseudotsuga menziesii* (2) (Morris 1967).

Based on 213 field-collected specimens, the earliest and latest capture dates are June 12 and August 18. The main flight period is from the second half of June to the first half of August with a peak in the second half of July.

Range

Canada: Alberta, British Columbia, Saskatchewan. **United States:** Alaska, California, Colorado, Idaho, Montana, Oregon, South Dakota, Utah, Washingtopn, Wyoming. This is a western species, known from Alaska and Saskatchewan south to California and New Mexico (Cameron 1965) (see map C40.6 in Schiff *et al*. 2012).

Specimens studied: 223 females and 13 males from BDUC, BYUC, CNC, NFRC, EDUM, MTEC, OSAC, ROME, UAIC, UAM, UCRC, USFS–AK, USFS–GA, USFS–MS, and USNM.

Specimens for molecular studies: 47 specimens. See Fig. D1.2a. For each specimen the following is recorded: country, year, state/province, specimen code (in italics), and number of base pairs.

CANADA. Alberta: 2007*, SIR 112*, 658; 2007, *SIR 113*, 658; 2007, *SIR 114*, 658; 2007, *SIR 115*, 658; 2007, *SIR 117*, 658; 2007, *SIR 118*, 658; 2008, *SIR 130*, 658; 2008, *SIR 131*, 658; 2008, *SIR 133*, 658; 2008, *SIR 136*, 582; 2008, *SIR 138*, 658; 2008, *SIR 140*, 658. **British Columbia**. 2007, *SIR 120*, 658; 2008, *SIR 122*, 658; 2008, *SIR 123*, 658; 2008, *SIR 126*, 658; 2008, *SIR 128*, 658; **USA. Alaska**: 2010, *SIR 150*, 658. **Colorado**: *2008, CBHR 2008*, 658; *SIR 148*, 658; 2010*, SIR 149*, 658. **Montana**: 2007, *SIR 084*, 657; 2010, *SIR 145*, 658; 2010, *SIR 146*, 658; 2010, *SIR 147*, 658. **South Dakota**: 2010, *SIR 110*, 624. **Utah**: 2008, *CBHR 1943*, 658; 2008, *CBHR 1944*, 658; 2008, *CBHR 1945*, 658. **Washington**: 2005, *CBHR 214*, 658; 2005, *CBHR 229*, 658; 2005, *CBHR 236*, 658; 2005, *CBHR 236e*, 658; 2005, *CBHR 238*, 658; 2005, *CBHR 238b*, 658; 2005, *CBHR 238c*, 658; 2005, *CBHR 238d*, 658; 2008, *SIR 100*, 612; 2008, *SIR 101*, 658; 2008, *SIR 102*, 658; 2008, *SIR 103*, 658; 2008, *SIR 104*, 658; 2008, *SIR 105*, 658; 2008, *SIR 106*, 658; 2008, *SIR 107*, 658; 2008, *SIR 108*, 658; 2008, *SIR 109*, 658.

3. *Xeris chiricahua* Smith

Fig. C3.1 (female habitus)
Fig. C3.2 (male habitus)

Xeris chiricahua Smith, 2012: 251. Holotype female (USNM), labelled: [White] "RustlerPark ChiricahuaMts 13June56 ARIZ OLCartwright"; [White with red border] HOLOTYPE Xeris chiricahua Smith. Type locality: U.S.A., Arizona, Chiricahua Mountains, Rustler Park. Specimen in perfect condition. Schiff *et al.* 2012: 251.

Diagnostic combination

Among specimens with mainly clear wings and a white stripe on the lateral margin of the pronotum [*chiricahua*, *caudatus*, *malaisei*, *melancholicus*, *pallicoxae, spectrum*, and *xylocola*], *X. chiricahua* is recognized in both sexes by the long setae on the clypeus and frons, and by the dense pits on the gena ventral to the genal ridge.

FEMALE. Description

Color. Head black except for large white spot on gena dorsal to middle of eye extending down to genal ridge and on gena between ridge and eye (Fig. B2.31); antenna black (apical 0.25 dark brown); last maxillary palpomere black. Thorax black except for white stripe extending from posterolateral to anterolateral angles, narrowing toward posterior angle (Fig. B2.36), and extending on vertical portion below anterior angle, the band 0.3 times as wide as lateral 0.5 of pronotum and not extending to lateral margin of pronotum. Legs light reddish brown but black on pro- and mesocoxae, black or mostly light reddish brown on metacoxa (Fig. C3.1). Fore wing clear except for a lightly tinted band in apical 0.25 and on posterior corner of cells 2CU and 3CU (Fig. C3.1); costal cell brown and most of area ventral to anal cells yellowish brown (as in Fig. B2.39); veins black (including veins C and R, and base of stigma on both sides of junction with vein 1r-rs) (as in Fig. B2.39). Abdomen black (Fig. C3.1). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye and lateral ocellus edges about 1.1–1.5 times as long as distance between inner edges of lateral ocelli (as in Fig. C1.5). Setae on clypeus 1.0–1.5 times as long as diameter of a lateral ocellus (Fig. B2.33). Eye in lateral view (N=5) with its maximum height 1.3–1.6 times as long as its maximum length (Fig. B2.31), and maximum height of eye 0.34–0.48 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (as in Fig. B2.8). Gena in dorsal view with maximum distance between outer edges clearly wider than maximum distance between outer edges of eyes (Fig. C3.3) (in frontal view outer edges of eyes clearly not intersecting genae) (as in Fig. B2.5); in lateral view with distance between outer edge of eye and genal ridge 0.50–0.66 times as long as maximum length of eye (Fig. B2.31, measurements as in Fig. B2.77), with dense pits ventral to genal ridge and merged with pitted area of occiput (Fig. B2.31), and with quite dense and medium sized pits (diameter of pit about 0.2 times lateral ocellus diameter) between outer edge of eye and genal ridge (Fig. C3.3). Transverse ridge near mandible narrow, sharp and mainly smooth (as in Fig. B2.18). Vertex widely pitted and pits medium in size (diameter of pit 0.2–0.4 times lateral ocellus diameter) pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on about 0.5 of postocellar area (Fig. C3.3); pits quite dense and medium in size along all or most of sharply outlined median furrow, but a little more widespread near lateral ocelli (as in Fig. C3.3).

Thorax. Pronotum in lateral view with coarse polygonal pits on almost all of surface (as in Fig. B2.97). Propleuron in lateral view with small polygonal pits in posterior 0.5 of disc and with medium polygonal pits in anterior 0.5 of disc (as in Fig. C12.7); in ventral view with dense medium teeth with smooth surface in between (as in Fig. B2.11). Transscutal furrow of mesonotum clearly outlined and finely sculptured, thus mesoscutum and axilla clearly distinct (as in Fig. C2.3). Fore wing in middle 0.3 of vein 2A diverging very rarely slightly (Fig. C11.6) to usually considerably (as in Fig. C11.6) away from wing edge, and then more (as in Fig. C11.6) or less (as in Fig. C12.6) abruptly curved away from wing edge; vein 3A absent, or reduced to a stump, but not extending toward posterior wing edge.

Abdomen. Tergum 9 with meshes of microsculpture on ventral half below and above longitudinal furrow near center not well impressed and sculpticells clearly flat (slightly raised as scale above furrow) (as in Fig. B2.93, insert); median basin with base (outlined by two lateral black longitudinal furrows) 0.8 times as wide as its median length, with maximum width of basin 1.3–1.6 times as wide as its median length and basin 0.6–0.8 times as long as medially median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) 0.8 times as wide as maximum width of cornus subapically; with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.22–0.27 times as long as apical section (N = 4); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); total length 1.4–1.5 times as long as fore wing length. ***Ovipositor.*** Lancet with 26–30 annuli (first 15 annuli very hard to see, but still outlined (N = 2); junction of basal and apical sections of sheath aligned between 3rd–4th annuli; major pits present on 4–5 apical annuli before teeth annuli, and at most one preceding annuli with a very small pit (as in Fig C1.18 without

C3.1 *X. chiricahua* ♀

C3.2 *X. chiricahua* ♂

C3.3 *X. chiricahua* ♀

small pits).

MALE. Description

Color. Head with large white spot on gena dorsal to middle of eye similar in size to female. Coxae, femora (except for light reddish brown at extreme apex), tibiae (except for sharp outlined yellowish-white spot at very base) (Fig. B2.38) and tarsi 1 and 2 or 1–3 (except for light reddish-brown extreme apex) black, and tarsomeres 3–5 or 4 and 5 light reddish brown (Fig. C3.2).

Thorax. Metatibia with deep notch on dorsal edge in basal 0.25 (Figs. B2.38 and C3.2).

Taxonomic notes

At first sight, specimens of *X. chiricahua* are similar to those of *X. caudatus*, *X. malaisei*, *X. melancholicus*, *X. pallicoxae* and *X. spectrum* because they share the white longitudinal band on the lateral margin of the pronotum. Adults of *X. chiricahua* are distinguished from the above species by the length of frontal and clypeal setae, the much denser pits on the vertex, and the dense pits on the gena below ridge merging with pits of the occiput.

Hosts and phenology

The host of *X. chiricahua* is unknown, but females of *Xeris* with a long ovipositor and few pits on the ovipositor are known to attack Pinaceae. The Chiricahua Mountains are rich in pines at high elevations. The three specimens at the type locality were captured on June 13.

Range

United States: Arizona, Colorado. *Xeris chiricahua* is recorded from two localities in Arizona and one in Colorado. The species probably occurs in Mexico (see map C41.3 in Schiff *et al*. 2012 – note: the Chiricahua, AZ dot seems to be in New Mexico and the Colorado dot is missing and should be in the middle of Colorado along the front range).

Specimens studied: 4 females and 1 male from CNC and USNM.

4. *Xeris cobosi* Viedma and Suárez (new status)

Fig. C4.1 (female habitus, dorsal)
Fig. C4.2 (female habitus, lateral)
Fig. C4.3 (female habitus, ventral)

Xeris spectrum cobosi Viedma and Suárez, 1961: 20. Holotype female (MNCN), images of type kindly prepared by Mercedes Paris were examined. Specimen labels: "Tizi - Ifri, Rif, Coll. A Cobos/VII-1960"; Type number "2055"; MNCN number "50762". Type locality, Morocco, Tizi-Ifri. Type complete except right metatarsomeres 2–5 missing. Smith, 1978: 85 (catalog).

Diagnostic combination

Among specimens without a marginal lateral stripe on the pronotum (pronotum black), dense and numerous pits on vertex between dorsal edge of eye and occiput outside postocellar area, and black abdomen [*cobosi*, *himalayensis* and some *indecisus*], *X. cobosi* is recognized in the female and probably the male by the short setae of frons and clypeus (setae 0.6–0.7 times as long as the diameter of lateral ocellus) and clear fore wing, and in the female by the black flagellum and the light reddish-brown coxae.

FEMALE. Description

Color. Head black with white spot on gena dorsal to middle of eye, the white spot very small and not extending to genal ridge (Fig. C4.4); antenna black; last maxillary palpomere black. Thorax black with very small and indistinct brown spot in anterolateral angle of pronotum (Fig. C4.5). Legs beyond coxae light reddish brown (Fig. C4.2), coxae mainly light reddish brown (partly black on procoxa outer surface toward base) (Fig. C4.3). Fore wing clear except for lightly tinted band in apical 0.25 and on posterior corner of cells 2CU and 3CU (Fig. C4.1); costal cell yellowish brown (as in Fig. B2.39); most of area ventral to anal cells yellowish brown; veins black (including veins C, R, and base of stigma on both sides of junction with vein 1r-rs) (Fig. C4.1). Abdomen black (Fig. C4.1). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye edge and lateral ocellus edge about 1.1–1.5 times as long as distance between inner edges of lateral ocelli (as in Fig. C1.5). Setae on clypeus about as long as the diameter of a lateral ocellus (Fig. C4.4). Eye in lateral view (N = 1) with its maximum height 1.40 times as long as its maximum length (as in Fig. C4.4), and maximum height of eye 0.42 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (Fig. C4.4, measurements as in Fig. B2.8). Gena in dorsal view with maximum distance between outer edges clearly wider than maximum distance between outer edges of eyes (Fig. C4.5) (in frontal view outer edges of eyes clearly not intersecting genae) (as in Fig. B2.5); in lateral view with distance between outer edge of eye and genal ridge 0.55 times as long as maximum length of eye (Fig. C4.4, measurements as in Fig. B2.77), with few or no pits ventral to genal ridge (Fig. C4.4), and with many medium size pits (diameter of pit 0.2 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (Fig. C4.4). Transverse ridge above mandible narrow, sharp and mainly smooth (as in Fig. B2.18). Vertex densely pitted and pits medium in size

C4.1 *X. cobosi* ♀

C4.2 *X. cobosi* ♀

C4.3 *X. cobosi* ♀

C4.4 *X cobosi* ♀

C4.5 *X. cobosi* ♀

(diameter of pit 0.2–0.3 times lateral ocellus diameter), pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area (Fig. C4.5); pits scattered and medium in size along most of median furrow but more widespread near lateral ocelli (Fig. C4.5).

Thorax. Pronotum in lateral view with coarse polygonal pits on about 0.7 of posterior surface (as in Fig. B2.97). Propleuron in lateral ventral view (not seen in images). Transscutal furrow of mesonotum clearly outlined and finely sculptured, thus mesoscutum and axilla clearly distinct (as in Fig. C5.2). Fore wing in middle 0.3 of vein 2A diverging considerably away from wing edge (as in Fig. C12.6) and then not abruptly curved away from wing edge (as in Fig. C12.6); vein 3A reduced to a stump (N = 1).

Abdomen. Tergum 9 on ventral half below and above longitudinal furrow near center (meshes of microsculpture not seen in image); median basin with base (outlined by two lateral black longitudinal furrows; N = 1) about 0.7 times as wide as its median length, with maximum width of basin about 1.35 times as wide as its median length and basin about 0.52 times as long medially as median length of cornus (Fig. C4.1, measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) about 0.8 times as wide as maximum width subapically (as in Fig. C4.1); with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.36 times as long as apical section (N = 1) (Fig. C4.2); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); total length 1.2–1.4 times as long as fore wing length. ***Ovipositor.*** Not dissected out in image.

MALE. Unknown.

Taxonomic notes

Our recognition of *Xeris cobosi* is based on images of the holotype. In the female (and probably the male), the head sculpture, the color pattern of cell C and stigma at its base on both sides of junction with vein 1r-rs, and flagellum color suggest this species is close to *X. himalayensis*. The female is distinguished from females of *X. himalayensis* by the short setae on frons and clypeus (probably applies in the male) and by mainly reddish-brown coxae.

Hosts and phenology

The host of *X. cobosi* is not certain. However, Viedma and Suárez (1961) mentioned that *Cedrus atlantica* and *Abies pinsapo maroccana* were the main conifers at the site. Pruja (1959) captured one female from a fir forest (*A. pinsapo maroccana*) at Talasse N'Tane (altitude 1800 m), Morocco, in early July. We did not see the female captured by Pruja (1959), but its description matches that of *X. cobosi* (genal spot small, no lateral pale bands on the pronotum, and black veins on fore wing), not *X. spectrum*.

The single female was captured in July, 1960, by A. Cobos.

Range

Morocco: Tizi-Ifri (holotype); Talasse N'Tane.

Specimen studied: Images of the female holotype from MNCN.

5. *Xeris degrooti* Goulet, n. sp.

Fig. C5.1, (female habitus)

http://zoobank.org/NomenclaturalActs/FA080519-A6EF-4B34-A992-9AFB968DD38B

Type material

Holotype female (USNM) right mesotarsus missing (used for DNA extraction) otherwise in perfect condition; labelled [White with black frame] "29 May – 18 Aug 2008 Meade Co [not actually this county, see below] SD K Allen 5 EA E09"; [Blue] "SIR 158"; [Red] "HOLOTYPE Xeris degrooti H. Goulet, 2011". Type locality: USA. SD, Pennington Co [the site is about 100 m south of Meade Co in Pennington Co.], 44.140˚N 103.436˚W.

Paratypes. **South Dakota**: Pennington Co., 44.140˚N 103.436˚W 29.V−18.VIII.2008. (4F, CNC and USNM).

Diagnostic combination

Among adults with reddish-brown abdomen and without marginal stripe on the lateral margin of the pronotum [*degrooti*, *indecisus*, *morrisoni*, *tarsalis* and *tropicalis*], *X. degrooti* is recognized in both sexes by the wide gena (in frontal view maximum width between the outer edges of eyes clearly less than maximum width between genae), the narrow, sharp and mainly smooth transverse ridge above the mandible, the moderately wide gena relative to eye length, and in the female the darkly tinted wings. However, females and males of *X. degrooti* from the central Rocky Mountain region can only be distinguished from those of *X. indecisus* by their DNA barcodes.

FEMALE. Description

Color. Head black except for large white spot on gena dorsal to middle of eye extending down to genal ridge (as in Fig. B2.46); flagellum light reddish brown (as in Fig. B2.63); last maxillary palpomere reddish brown. Thorax completely black (Fig. 2.57) or pronotum with small diffused yellowish-white spot on vertical surface below anterolateral angle of pronotum, or uncommonly with a very narrow spot on anterolateral angle visible dorsally (as in Fig. B2.54). Legs light reddish brown except for coxae (Fig. C5.1); coxae almost all light reddish brown except on surface at dorsal angle (as in Fig. C7.1). Fore and hind wings darkly tinted brown (Fig. B2.65); costal cell brown; veins dark brown or black (including veins C and R, and base of stigma around junction with vein 1r-rs) (Fig. C5.1). Abdomen segments 1 or 1 and 2 black, and segments 2–10 or 3–10 reddish brown (pale form) (Fig. C5.1). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye and lateral ocellus edges about 1.1–1.5 times as long as distance between inner edges of lateral ocelli (as in Fig. C1.5). Setae on clypeus about as long as diameter of a lateral ocellus (as in Fig. B2.47). Eye in lateral view (N = 18) with its maximum height 1.23–1.62 times as long as its maximum length (as in Fig. B2.77), and maximum height of eye 0.43–0.50 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (as in Fig. B2.8). Gena in dorsal view with maximum distance between outer edges clearly wider than maximum distance between outer edges of eyes (as in Fig. B2.41) (in frontal view outer edges of eyes clearly not intersecting genae) (as in Fig. B2.5); in lateral view with distance between outer edge of eye and genal ridge 0.53–0.70 times as long as maximum length of eye (as in Fig. B2.77), with almost no pits ventral to genal ridge, and with many medium size pits (diameter of pit 0.2–0.3 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (as in Fig. B2.77). Transverse ridge above mandible narrow, sharp and mainly smooth (as in Figs. B2.18 and B2.46). Vertex quite densely pitted and pits medium in size (diameter of pit about 0.3 times lateral ocellus diameter), pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area (as in Fig. B2.44); pits dense, narrowly distributed and medium in size along all median furrow (not sharply outlined) but a little more widespread near lateral ocelli (as in Fig. B2.44).

Thorax. Pronotum in lateral view with coarse polygonal pits absent or at most on 0.1 of posterior surface (as in Fig. B2.97). Propleuron in lateral view with medium size polygonal pits on most of disc (as in Fig. C12.7); in ventral view with scattered to moderately dense small teeth with smooth surface in between (as in Fig. B2.11). Transscutal furrow of mesonotum clearly outlined and finely sculptured, thus mesoscutum and axilla clearly distinct (Fig. C5.2). Fore wing in middle 0.3 of vein 2A diverging very rarely slightly (as in Fig. C11.6) to usually considerably (as in Fig. C12.6) away from wing edge, and then more (as in Fig. C11.6) or less (as in Fig. C12.6) abruptly curved away from wing edge; vein 3A absent (75%), reduced to a stump (25%), but not extending slightly as a nebulous vein or along posterior margin of wing.

Abdomen. Tergum 9 with meshes of microsculpture on ventral half below and above longitudinal furrow near center not well impressed and sculpticells clearly flat (slightly raised as scale above furrow) (as in Fig. B2.93, insert); median basin with base (outlined by two lateral black longitudinal furrows) 0.7–1.0 times as wide as its median length, with maximum width of basin 1.3–1.7 times as wide as its median length, and basin 0.5 times as long medially as median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its

C5.1 *X. degrooti* ♀

C5.2 *X. degrooti* ♀

minimum width (at constriction) 0.8 times as wide as maximum width of cornus subapically; with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.20–0.31 times as long as apical section (N = 40) (Fig. C5.1); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); total length 1.2–1.5 times as long as fore wing length. ***Ovipositor.*** Lancet with 25–30 annuli (first 15 annuli difficult to see, but still outlined; N= 15); junction of basal and apical sections of sheath aligned between 2nd and 3rd annuli or occasionally 3rd annulus; major pits present on last 4–6 apical annuli before teeth annuli, and with a very small pit on at most each of the 6 preceding annuli (as in Fig. C1.18 with few or no small pits).

MALE. Not recognized.

Taxonomic notes

Early in our study, we examined some females from the central Rocky Mountain region which were very similar in color pattern to those studied from along the Cascades and the coastal regions from southern British Columbia to California in the Sierra Nevada. However, in the Central Rocky Mountain region there were no specimens with a black abdomen, and all females had darkly tinted wings. We interpreted this difference as geographical variation, but we did not create a subspecies for the central Rocky Mountain population (Schiff *et al*. 2012).

We then received a large sample from the Black Hills in North Dakota and sent some specimens for sequencing. The only two sequences obtained had a barcode (12%) amazingly distinct from *X. indecisus*. We suspected contamination of the samples so more specimens of this sample were sent. To our surprise we got three more sequences of the new type and seven sequences of *X. indecisus*. With a 12% difference in their barcode, we assumed that structural differences could be found, but after intensive work we failed to find any differences. We have barcodes for five specimens recognizable as the new sequence, for seven specimens of *X. indecisus* from the same locality, and for 21 specimens of *X. indecisus* from coastal and southern British Columbia and California in the Sierra Nevada. The differences between significant base pairs (about 60) of these two species were consistent across the 658 based pairs.

We can distinguish *X. degrooti* from all specimens of *X. indecisus* with black abdomen, and from all females of *X. indecisus* with reddish-brown abdomen but with mainly clear wings. However, we cannot distinguish *X. degrooti* from females *of X. indecisus* with reddish-brown abdomen and darkly tinted wings, or males with a reddish-brown abdomen. Because barcodes distinguish both species unequivocally, we recognize *X. degrooti* as a species distinct from *X. indecisus*.

We have seen males and females from Arizona (Coconino Co., North Rim (4 F, 3 M, BYUC)) and Utah (Panguitch [Hopkins # 45296] (4 F, 1 M, USNM); Summit Co., 26 Jun – 18 Sep 2008 S. Munson 65SD E15 (1 F, CNC); Bunnels Fork (1 F, BYUC); Provo environ (1 F, BYUC); Tmpanogas near Provo (5 F, BYUC)). We suspect that they could be *X. degrooti*, but could not certify their identity.

Origin of specific epithet

The name *degrooti* is in honor of the late Peter de Groot (Canadian Forest Service, Sault Ste. Marie, Ontario, Canada) who made significant contributions towards a better understanding of the Siricidae and helped us generously in our work on the New World Siricidae by sending us numerous live and preserved specimens.

Hosts and phenology

The host is unknown, but *Pinus ponderosa* is numerous at the type locality. We suspect that the host range may be similar to that of *X. indecisus*.

Specimens were trapped between May 29 and August 18.

Range

Xeris degrooti is a western species in forested areas of South Dakota and possibly occuring in Arizona and Utah in the central and southern Rocky Mountains.

Specimens studied: 5 females CNC, USFS–GA, and USNM.

Specimens for molecular studies: 5 specimens. See Fig. D1.2b. For each specimen the following is recorded: country, year, state/province, specimen code (in italics), and number of base pairs.

USA. South Dakota: 2007, *SIR 155*, 486; 2007, *SIR 158*, 658; 2007, *CNCHYM 02488*, 539; 2011, *CNCHYM 02491*, 227; 2007; *CNCHYM 03056*, 164.

6. *Xeris himalayensis* Bradley

Fig. C6.1.1 (female habitus)
Fig. C6.2 (male, lateral habitus)
Fig. C6.3 (male, dorsal habitus)

Xeris himalayensis Bradley, 1934: 145. Holotype female (USNM), examined by Henri Goulet, labelled: [White] "Deoban 9000 ft Chakrata, Div., 17.18.vi.23 CFC Beeson"; [White] "39"; [Red] " HOLOTYPE Xeris himalayensis ♀ J. C. Bradley"; [White barcode] USNM ENT 00778280". Type locality: "India, Uttaranchal, Deoban Chakrata, 3000 m". Type in perfect condition. Hedicke, 1938: 23 (catalog); Benson, 1941: 397; Benson, 1943: 30, 31, 32, 47; Benson, 1951: 22; Viedma & Suárez, 1961: 20, 22, 23; Ashraf, 1964: 66 (hosts); Dharmadhikari & Achan, 1965: 77–78 (hosts); Vasu & Saini, 1999: 275 (species status re-instated);

C6.1 *X. himalayensis* ♀

C6.2 *X. himalayensis* ♂

C6.3 *X. himalayensis* ♂

Xiao, 2006: 200; Wei *et al*., 2006: 556; Saini *et al*., 2006: 599; Saini, 2009: 81, 82; Taeger *et al*., 2010: 105.

Xeris spectrum himalayensis; Maa, 1949: 82, 88, 170 (change in status). Cameron, 1965: 15–16; Smith, 1978: 84 (catalog); Xiao & Wu, 1982: 350 Fig. 2; Xiao & Wu, 1983: 6, Plate IV Fig. 4; Xiao *et al*., 1992: 42; Xiao, 2006: 200.

Neoxeris melanocephala Saini & Singh, 1987: 177. Holotype female (INPC), not examined. Only one paratype studied, labelled: "Himachal Pradesh, Dalhousie, Kalatop", "2400 m, 13.7.1984, Saini and Singh". Type locality: "India, Himachal Pradesh, Dalhousie, Kalatop". Abe & Smith, 1991: 56; Saini *et al*., 2006: 598; Taeger *et al*., 2010: 105. NEW SYNONYM.

Xeris indianus Vasu & Saini 1999: 277. Holotype female (PUPC), not examined, labelled: "Uttar Pradesh, Konain (Chakrata), 2600 m, 25.5.1996, coll. M. S. Saini". Type locality: India, Uttar Pradesh, Konain (Chakrata). Saini *et al*., 2006: 599 (list); Saini, 2009: 81, 82, 83 (catalog); Taeger *et al*., 2010: 105 (catalog). NEW SYNONYM.

Diagnostic combination

Among specimens with a black abdomen, dense pits between dorsal edge of eye and occiput outside postocellar area [*himalayensis*, *chiricahua*, *indecius*, and *cobosi*], in females without a marginal lateral stripe on the pronotum (pronotum black, at most with an anterior white spot not extending to posterolateral angle) [*cobosi* and *indecisus*], *X. himalayensis* is recognized in both sexes by the frontal setae that are 0.7–1.2 times as long as the diameter of lateral ocellus and the clear fore wings, and in females by the black flagellum and coxae.

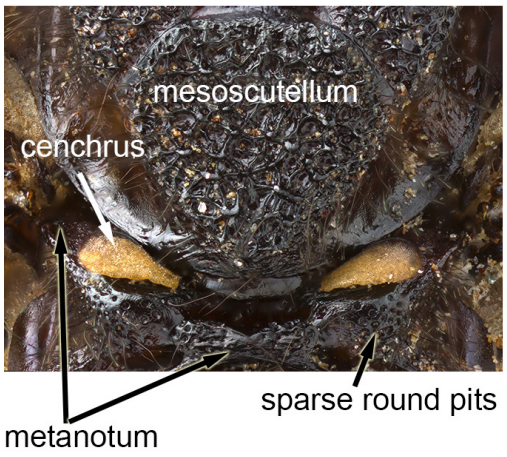
FEMALE. Description

Color. Head black or black with white spot on gena dorsal to middle of eye; white spot varying in size from absent to expanded over dorsal 0.5 of gena (Figs. C6.6, C6.7 and C6.8); antenna black; last maxillary palpomere black (Fig. C6.6). Thorax black or pronotum with white spot in anterior 0.5 of lateral margin (Fig. B2.54 and B2.55). Legs beyond coxae light reddish brown, coxae black (Fig. B2.48). Fore wing clear except for lightly tinted band in apical 0.25, and on posterior corner of cells 2CU and 3CU (as in Fig. B2.66); costal cell dark yellowish brown (paler in old specimens) (as in Fig. B2.39); most of area ventral to anal cells yellowish brown; veins C, R, and base of stigma on both sides of junction with vein 1r-rs black (as in Fig. B2.39). Abdomen black (Fig. C6.1). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye edge and lateral ocellus edge about 1.1–1.5 times as long as distance between inner edges of lateral ocelli (as in Fig. C1.5). Setae on clypeus 0.7–1.2 as long as the diameter of a lateral ocellus (Figs. B2.18 and C6.4). Eye in lateral view (N = 22) with its maximum height 1.22–1.56 times as long as its maximum length (Fig. B2.18), and maximum height of eye 0.43–0.53 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (as in Fig. B2.8). Gena in dorsal view with maximum distance between outer edges clearly wider than maximum distance between outer edges of eyes (Fig. C6.4) (in frontal view outer edges of eyes clearly not intersecting genae) (as in Fig. B2.5), and in lateral view with distance between outer edge of eye and genal ridge 0.37–0.56 times as long as maximum length of eye (Fig. B2.18, measurements as in Fig. B2.77), with few pits ventral to genal ridge, and with many medium to large size pits (diameter of pits 0.2–0.5 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (as in Fig. B2.32). Transverse ridge above mandible narrow, sharp and mainly smooth (Fig. B2.18). Vertex densely pitted and pits large (diameter of pit 0.4–0.6 times lateral ocellus diameter), pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area (Fig. C6.4); pits scattered and large in size along all of shallowly outlined and gutter-like median furrow but more widespread near lateral ocelli (Fig. C6.4).

Thorax. Pronotum in lateral view with coarse polygonal pits on 0.7–1.0 of posterior surface (as in Fig. B2.97). Propleuron in lateral view mainly with medium size polygonal pits (as in Fig. C12.7); in ventral view generally with dense small teeth with smooth surface in between (as in Fig. B2.11). Metanotum with surface posterior to cenchrus and lateral 0.5 of metascutellum finely pitted (pit 0.1 times as wide as diameter of lateral ocellus) (Fig. C6.4). Fore wing in middle 0.3 of vein 2A diverging very rarely slightly (as in Fig. C11.6) to usually considerably (as in Fig. C12.6) away from wing edge, and then more (as in Fig. C11.6) or less (as in Fig. C12.6) abruptly curved away from wing edge; vein 3A mainly absent, occasionally reduced to a stump, rarely extending slightly as a short nebulous vein, and rarely extending along posterior margin of wing (N = 10).

Abdomen. Tergum 9 with meshes of microsculpture on ventral half below and above longitudinal furrow near center not well impressed and sculpticells clearly flat (slightly raised as scales above furrow) (as in Fig. B2.93, insert); median basin with base (outlined by two lateral black longitudinal furrows; N = 1) about 0.7 times as wide as its median length, with maximum width of basin about 1.3 times as wide as its median length and basin about 0.5 times as long medially as median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) about



C6.4 *X. himalayensis* ♀

C6.5 *X. himalayensis* ♀

C6.6 *X. himalayensis* ♀

C6.7 *X. himalayensis* ♀

C6.8 *X. hymlayensis* ♂

0.8 times as wide as maximum width subapically (as in Fig. C1.15); with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.23–0.37 times as long as apical section (N = 28) (Fig. C6.1); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); total length 1.2–1.4 times as long as fore wing length. ***Ovipositor.*** Lancet with 28–32 annuli (first 15 annuli hard to see, but still outlined; N = 7); junction of basal and apical sections of sheath aligned with 3rd or between 3rd–4th annuli; major pits present on last 4–5 apical annuli before teeth annuli, and with 11–19 annuli with a very small pit on each of the preceding annuli, starting anywhere between 3rd–10th annuli (as in Fig. C1.18).

MALE. Description

Color. Head with dorsal spot behind eye very large, extending from vertex to surface between eye and genal ridge (Fig. C6.8). Pronotum with lateral spot often extending posteriorly as a band but not reaching posterolateral angle and much narrower posteriorly (Fig. C6.3). Coxae and trochanters black; femora reddish brown to black; tibiae black with sharply outlined white spot in basal 0.2; tarsomeres 1 and 2 or 1–3 black, tarsomeres 3–5 or 4 and 5 light reddish brown. (Fig. C6.2).

Thorax. Metatibia with shallow notch on dorsal edge in basal 0.25 (as in Fig. B2.86).

Taxonomic notes

The synonymy of this species was difficult to assess. We saw a paratype of *Neoxeris melanocephala*. This specimen perfectly matches specimens of *X. himalayensis*. Moreover, there is great variation in the expression of the genal spot in females studied: no spot or barely suggested 42%, small 26%, typical (e.g., *X. pallicoxae*) 16%, and as large as in males 16%. Therefore, the probability of finding specimens without a genal spot is very high. Our interpretation of *X. indianus* is based on the paper and keys to species of *Xeris* of India by Vasu and Saini (1999). The status of *X. indianus* is unclear as we have only a description. Dr. Saini tried hard to send us specimens, but they were damaged before leaving India and never arrived.

The first road block is the first couplet leading to *X. himalayensis* (key by Vasu *et al.* 1999). The tegula (it is the humeral plate), and the apical 0.5 of the cornus is described as yellow. The median fovea is in the form of a deep and transverse groove below the median ocellus. The frons is at the level of eyes. No such specimen (including the holotype) of *X. himalayensis* seen by us matches the above features. We do not know what species the single examined specimen from China is. In the above couplet it is not clear what the authors are referring to when mentioning a rugose and large triangular mesoscutellar appendage (to us they are probably describing the mesoscutellum not the appendage, and the mesoscutellum seems to be the mesoscutum!). In all species of *Xeris* studied the appendage is smooth and narrow (with not enough surfaces for pits). The second couplet separates *X. indianus* from *X. spectrum*. Wing color cannot be used here as it is variable and affected by the age of the pinned specimen. The median length of the pronotum varies between 3–5 times as long as the length of the median ocellus in our specimens. All characters fall within the range of variation of specimens we studied even from a single site. The *X. indianus* description of the females and males (with its very large genal spot) matches our specimens of *X. himalayensis*, including the holotype. Both have sympatric ranges. Moreover, their concept of *X. spectrum* falls within the normal variation of *X. himalayensis*. *Xeris spectrum* is a transpalaearctic species in boreal regions, nowhere near the Himalayan Mountains. Based on the above interpreted character states, we consider *X. indianus* as a junior synonym of *X. himalayensis*.

Geographical variation

We did not recognize any pattern of geographical variation from our limited sample. It seems that females without a genal spots are more commonly seen in Pakistan than elsewhere, and males may have a reddish-brown or black metafemur.

Hosts and phenology

Xeris himalayensis has a wide host range within Pinaceae (Ashraf 1964). The hosts are: *Abies pindrow*, *Cedrus deodara*, *Picea smithiana*, and *Pinus roxburghii.*

Based on 28 field-collected specimens, the earliest and latest capture dates (they may be emergence dates) are late February to mid-July.

Range

India: Kashmir, Punjab, Himachal Pradesh, Uttar Pradesh. *Xeris himalayensis* is recorded along the Himalayan Mountain range from Pakistan to Nepal between 1700 and 3000 meters.

Specimens studied: 25 females and 18 males from PUPC, CNC, FRNZ, SDEI, and USNM.

Specimens for molecular studies: 1 specimen. See Fig. D1.1. For the specimen the following is recorded: country, year, state/province, specimen code (in italics), and number of base pairs.

NEPAL. Simikot: 2014, *DEIGISHym19732*, 658.

7. *Xeris indecisus* (MacGillivray)

Fig. C7.1, (female with reddish-brown abdomen, habitus); Schiff *et al.* 2006: 84, 85

Fig. C7.2, (female with black abdomen, habitus); Schiff *et al.* 2006: 95, 96

Fig. C7.3, (male with reddish-brown abdomen, habitus); Schiff *et al.* 2006: 83

Fig. C7.4, (male with black abdomen, habitus); Schiff *et al.* 2006: 91

Fig. C7.5 (live male with dark abdomen)

Fig. C7.6 (live female with dark abdomen)

Urocerus indecisus MacGillivray, 1893: 243. Holotype male (INHS, Webb, 1980), not examined. Type locality, near Olympia, Washington. Frison, 1927: 268 (type) Schiff *et al*., 2012: 253.

Xeris morrisoni; Konow, 1898b: 226 (not Cresson, 1880: 35). Bradley, 1913: 24; Essig, 1926: 774–775 (hosts); Bedard, 1938: 194 (host); Hedicke, 1938: 23 (catalog); Ries, 1951: 84 (catalog), Middlekauff, 1960: 69 (taxonomy, hosts and parasitoids); Morris, 1967: 60–62 (host).

Xeris morrisoni indecisus; Maa, 1949: 85 (change in combination and rank). Burks, 1958: 17 (catalog); Smith, 1979: 129 (catalog); Taeger *et al*., 2010: 105 (catalog).

Xeris spectrum townesi Maa, 1949: 88. Holotype female (USNM), examined by D. R. Smith and H. Goulet. Type locality: "Hoquiam [Washington]". Burks, 1958: 17 (catalog), Burks, 1967: 27 (catalog); Smith, 1979: 129 (catalog); Taeger *et al*., 2010: 105. Synonymized by Schiff *et al*., 2012: 253.

Xeris indecisus; Schiff *et al*., 2012: 253 (change in rank).

Diagnostic combination

Among specimens without a longitudinal band on the lateral margin of the pronotum and with dense pits between dorsoposterior edge of eye and occiput outside postocellar area [*indecisus*, *cobosi*, *degrooti*, *himalayensis*, *morrisoni*, *tarsalis* and *tropicalis*], *X. indecisus* is recognized in both sexes by the wide gena (in frontal view maximum width between the outer edges of eyes clearly less than maximum width between genae), the narrow, sharp and mainly smooth transverse ridge above the mandible, the reddish-brown or black abdomen and, in females, by the lightly tinted wings with darkly tinted apical and median bands and by the light reddish-brown flagellum or apical 0.3 of flagellum. However, females and males of *X. indecisus* with reddish-brown abdomen from the central Rocky Mountain region can only be distinguished from those of *X. degrooti* by their DNA barcodes.

FEMALE. Description

Color. Head black except for large white spot on gena dorsal to middle of eye extending down to genal ridge (Fig. B2.46); flagellum black but reddish brown on 8–12 apical flagellomeres (black abdomen form) (Fig. B2.51), or completely light reddish brown (reddish-brown abdomen form, but unusually also for the black abdomen form) (Fig. B2.52); last maxillary palpomere reddish brown (at least at base) or black. Thorax completely black (Fig. 2.57) or with small to large white spot on vertical surface near anterolateral angle of pronotum (spot absent in dorsal view, or present and very narrow) (as in Figs. B2.54 and B2.55). Legs above coxae light reddish brown (Figs C7.1 and C7.2); coxae almost all light reddish brown except on surface at dorsal angle (especially in specimens with reddish-brown abdomen) to brown (Fig. B2.53), or black with reddish-brown apex (Fig. C7.2). Fore and hind wings lightly tinted brown but fore wing with a clearly outlined darker band below base of stigma in cells 1R1, 1M and 2CU and in apical 0.25 (Fig. B2.66) or rarely wing darkly tinted (as in Fig. B2.65); costal cell brown (as in Fig. B2.39); veins dark brown or black (including veins C and R, and base of stigma around junction with vein 1r-rs) (as in Fig. B2.39). Abdomen segments 1 or 1 and 2 black, and segments 2–10 or 3–10 reddish brown (pale form) (Fig. B2.60), or abdomen black (Fig. B2.61). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye edge and lateral ocellus edge about 1.1–1.5 times as long as distance between inner edges of lateral ocelli (as in Fig. C1.5). Setae on clypeus about as long as diameter of a lateral ocellus (Fig. B2.77). Eye in lateral view (N = 20) with its maximum height 1.36–1.67 times as long as its maximum length (Fig. B2.77), and maximum height of eye 0.42–0.50 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (as in Fig. B2.77, measurements as in Fig. B2.8). Gena in dorsal view with maximum distance between outer edges clearly wider than maximum distance between outer edges of eyes (Fig. B2.41) (in frontal view outer edges of eyes clearly not intersecting genae) (as in Fig. B2.5); in lateral view with distance between outer edge of eye and genal ridge 0.50–0.64 times as long as maximum length of eye (Fig. B2.77), with almost no pits ventral to genal ridge, and with many medium size pits (diameter of pit 0.2–0.25 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (Fig. B2.77). Transverse ridge above mandible narrow, sharp and mainly smooth (Fig. B2.77). Vertex quite densely pitted and pits medium in size (diameter of pit about 0.3 times lateral ocellus diameter), pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area (Fig. B2.41); pits dense, narrowly distributed and medium in

C7.1 *X. indecisus* with reddish brown abdomen ♀

C7.2 *X. indecisus* with black abdomen ♀

C7.3 *X. indecisus* with reddish brown abdomen ♂

C7.4 *X. indecisus* with black abdomen ♂

size along median furrow (not sharply outlined), a little more widespread near lateral ocelli (as in Fig. B2.41).

Thorax. Pronotum in lateral view with coarse polygonal pits on 0.1–0.7 (commonly 0.2 to 0.3) of posterior surface (as in Fig. B2.97). Propleuron in lateral view with medium size polygonal pits on most of surface (as in Fig. C12.7); in ventral view with scattered to moderately dense small teeth with smooth surface in between (as in Fig. B2.11). Transscutal furrow of mesonotum clearly outlined and finely sculptured, thus mesoscutum and axilla clearly distinct (as in Fig. C5.2). Fore wing in middle 0.3 of vein 2A diverging very rarely slightly (as in Fig. C11.6) to usually considerably (as in Fig. C12.6) away from wing edge, and then more (as in Fig. C11.6) or less (as in Fig. C12.6) abruptly curved away from wing edge; vein 3A absent (81%), reduced to a stump (18%), or rarely extending slightly as a nebulous vein (1%), but not extending along posterior margin of wing.

Abdomen. Tergum 9 with meshes of microsculpture on ventral half below and above longitudinal furrow near center not well impressed and sculpticells clearly flat (slightly raised as scale above furrow) (as in Fig. B2.93, insert); median basin with base (outlined by two lateral black longitudinal furrows) 0.7 times as wide as its median length, with maximum width of basin 1.3 times as wide as its median length, and median length 0.5 times as long medially as median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) 0.8 times as wide as maximum width of cornus subapically; with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.20–0.31 times as long as apical section (N = 60) (Figs. C7.1 and C7.2); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); length 1.2–1.5 times as long as fore wing length. ***Ovipositor.*** Lancet with 26–33 annuli (first 15 annuli difficult to see, but still outlined; N = 15); junction of basal and apical sections of sheath aligned between 2nd–3rd annuli, at 3rd annulus or between 3rd–4th annuli; major pits present on last 4–6 apical annuli before teeth annuli and with a very small pit on at most each of the 6 preceding annuli (as in Fig. C1.18).

MALE. Description

Color. Head with dorsal spot behind as large as in females (Figs. C7.3 and C7.4). Antenna, coxae, femora (pro– and mesofemur black in most specimens to mainly reddish brown in some), tibiae (except for diffused brown spot at very base in some specimens) and tarsi (except reddish-brown tarsomeres 3–5 or 4 and 5) black. Pronotum in dorsal view black (Fig. B2.54) or with white spot extending at most toward posterolateral angle (Figs. B2.55 and B2.58). Fore wing basically clear (Figs C7.3, and C7.4). Abdomen black on segments 1 and 2 and laterally on terga 3–8, and reddish brown elsewhere (pale form) (Fig. C7.3), or completely black (dark form) (Fig. C7.4).

Thorax. Metatibia with shallow notch on dorsal edge in basal 0.25 (Fig. B2.68).

Taxonomic notes

The holotype of *Urocerus indecisus* was not examined. The description (especially the femora and pronotal color pattern) matches our concept for this species.

Xeris spectrum townesi specimens share with *X. indecisus* the large spot size on the gena, and the denser pits on the gena and vertex; females share the flagellum and the pronotum color, and males share the pronotum and metafemur color. Males of the pale abdomen form match the description of the type of *U. indecisus*, and females of the black abdomen form match *Xeris spectrum townesi*. Both sexes of both color forms are easily associated. Both color forms have the same range and adults are often found together. The pale abdomen and dark abdomen forms were classified until now as two species (Maa 1949, Ries 1951, Middlekauff 1960, Smith 1979). Information from morphology and DNA barcoding confirms that the two color forms belong to the same species.

Xeris indecisus has been ranked as a subspecies of *X. morrisoni* (Maa 1949, Middlekauff 1960, Smith 1979). However, the information from morphology and DNA barcoding confirms that the two populations are distinct (Schiff *et al*. 2012).

Specimens of *X. indecisus* from the central Rocky Mountain region with reddish-brown abdomen and **in females** with darkly tinted wings could be confused with those of *X. degrooti*. Adults of both species cannot yet be segregated on structures. See "Taxonomic notes" under *X. degrooti*.

Though the side of the vertex is densely pitted in *X. himalayensis* and *X. cobosi*, **females** of these two species have a black flagellum whereas those of *X. indecisus* have the apical 0.3 or all of the flagellum light reddish brown. **Males** of *X. himalayensis* (male unknown in *X. cobosi*) have a clearly outlined yellowish-white spot at the base of the metatibia whereas those of *X. indecisus* have a dark brown poorly defined spot at the base of the metatibia or have a completely black metatibia.

Geographical variation

Adults of *X. indecisus* have two distinct color forms: the abdomen is either mainly reddish brown or completely black. Both color forms are known from the coastal and interior regions of British Columbia south to California. We cannot recognize any geographical variation pattern between these two color forms.

Less obvious are variations in ovipositor length. The

C7.5 *X. indecisus* with black abdomen ♂

C7.6 *X. indecisus* with black abdomen ♀

basal section of the sheath is proportional to body size, but the apical section is not. We calculated the ratio between the basal and apical section as a general measure of relative size for the ovipositor. Females (N = 10) from Lake Tahoe, California, have a ratio of 0.20–0.25 (mean = 0.23). In Oregon and British Columbia, females (N = 44) have ratios of 0.20– 0.32 (average 0.25). Therefore specimens from California have a relatively longer apical section of the sheath. DNA barcodes based on 21 specimens from regions with long and short ovipositors do not segregate specimens into two groups. We see no reasons to recognize subspecies.

However, in the central Rocky Mountain region, there are no specimens of *X. indecisus* with a black abdomen. All specimens have a reddish-brown abdomen and wings of females are darkly tinted. We do not want to officially recognize this population as subspecifically distinct because the sample is rather small and the females of this species and *X. degrooti* cannot be recognized except by their DNA barcodes.

Hosts and phenology

Xeris indecisus has a wide host range (Bedard 1938 – under *X. morrisoni*, Cameron 1965, Morris 1967). Based on 121 reared and confirmed specimens, all but one host are Pinaceae: *Abies* sp. (13), *A. concolor* (17), *A. grandis* (10), *A. lasiocarpa* (8)*, A. magnifica*, *Larix occidentalis* (12)*, Picea* sp. (1), *P. sitchensis* (10), *Pinus contorta* (2), *P. ponderosa, Pseudotsuga menziesii* (28), and *Tsuga heterophylla* (20). There is only one record from *Calocedrus decurrens* (Cupressaceae).

Based on 24 field-collected specimens, the earliest and latest capture dates are May 18 and September 11. The main flight period is from the first half of June to the first half of September.

Range

Canada: Britsh Columbia. **United States:** California, Colorado, Idaho, Montana, Nevada, Oregon, South Dakota, Utah, Washington. *Xeris indecisus*, a widespread western species in forested regions, is recorded from British Columbia, Montana, and South Dakota to California, Arizona and Colorado (Burks 1967, Cameron 1965, Smith 1979) (see map C42.6 in Schiff *et al*. 2012). The specimens of *X. indecisus* recorded by Burks (1967) under *X. spectrum townesi* from Arizona need confirmation as they could be specimens of *X. chiricahua*. One female from the west coast of the United States was intercepted in Osaka, Japan (Okutani 1965). We have seen a female intercepted in New Zealand (FRNZ and PANZ) and one more intercepted at Slough (near Windsor, England) as an infestation in a control laboratory (BMNH).

Specimens studied and included for distribution map: 234 females and 113 males BYUC, CFIA, CNC, DEBU, EDUM, MTEC, OSAC, PFRC, ROME, UASM, UCRC, USFS–GA, USFS–MS, and USNM.

Specimens for molecular studies: 29 specimens from Canada (British Columbia) and United States (California, Colorado, Oregon and Washington). See Fig. D1.2c. For each specimen the following is recorded: country, year, state/province, specimen code (in italics), and number of base pairs.

CANADA. British Columbia: 2006, *CBHR 418*, 658; 2006, *CBHR 419*, 658. **USA. California**: 1999, *CBHR 33*, 658; 1999, *CBHR 98*, 658; 2007, *SIR 075*, 421; 2007, *SIR 076*, 600; 2007, *SIR 077*, 586; 2007, *SIR 078*, 654. **Colorado**: 2005, *CBHR 189*, 658. **Oregon**: 1999, *CBHR 108*, 658; 2006, *CBHR 385*, 658; 2006, *CBHR 1078*, 658; 2007, *SIR 074*, 421; 2007, *SIR 080*, 615; 2007, *SIR 081*, 421. **South Dakota**: 2007, *CNCHYM 02489*, 422; 2007, *CNCHYM 02493*, 422; 2007, *CNCHYM 02492*, 129; 2007, *CNCHYM 03050*, 410; 2007, *CNCHYM 03051*, 374. **Utah**: 2008, *CNCHYM 03047*, 382. **Washington**: 2005, *CBHR 210,* 658; 2005, *CBHR 215*, 658; 2005, *CBHR 216*, 658; 2005, *CBHR 228*, 658; 2005, *CBHR 235*, 658; 2005, *CBHR 239*, 658; 2005, *CBHR 254*, 658; 2008, *CBHR 1310*, 658.

8. *Xeris malaisei* Maa, new status

Fig. C8.1 (female habitus)
Fig. C8.2 (male habitus)

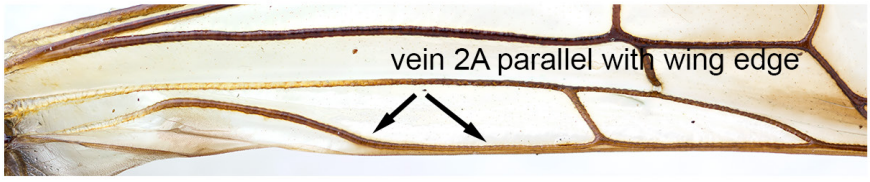
Xeris spectrum malaisei Maa, 1949: 88. Syntype females (TARI), examined by Henri Goulet. Though, Maa (1949) did not mention specifically a specimen as holotype, one of the two specimens from the same locality has a label identifying it as a holotype. The segregated specimen is labelled: [White] "TAIWAN TAIHEIZAN 9.v.1942 A. MUTUURA"; [White with black frame] "Xeris spectrum malaisei subsp. n. Holotype ♀ det. T. MAA 1949"; [red circle] "TARI". Type locality, Taiwan, Taiheizan. Maa, 1950: 21; Cameron, 1965: 16; Chou & Naito, 1991: 91; Xiao *et al.*, 1992: 42; Xiao, 2006: 200; Wei, *et al*,. 2006: 557 ; Schiff et al. 2012 : 248.

Diagnostic combination

Among specimens with a light yellow cell C in the fore wing, with a white base of stigma on both sides of junction with vein 1r-rs, and with short setae (0.6–0.7 times as long as diameter of lateral ocellus) on the clypeus [*malaisei*, *pallicoxae*, *spectrum*, *xanthoceros* and *xylocola*], *X. malaisei* is recognized in both sexes by the wide smooth median area dorsally on the pronotum, in females by the reddish-brown color in apical 0.3 of antenna, and in males by the the dark brown or black metatarsomere 5.

C8.1 *X. malaisei* ♀

C8.2 *X. malaisei* ♂



C8.3 *X. malaisei* ♀

FEMALE. Description

Color. Head black except for white spot on gena dorsal to middle of eye; white spot basically oval, extending to genal ridge (Figs. B2.8 and B2.139); antenna black and reddish brown in apical 0.25–0.3 (Fig. B2.115); last maxillary palpomere black (Fig. B2.8). Thorax black except for white longitudinal band extending from posterolateral to anterolateral angles of pronotum including vertical portion of anterolateral angle, the band 0.4–0.7 times as wide as lateral 0.5 of pronotum and usually (at low elevation) extending to lateral margin of pronotum (as in Fig. B2.134). Coxae black and legs beyond coxae light reddish brown (Fig. C8.1) except in Taiwan where coxae, trochanters, diffused area in middle of metafemur, apical 0.5 of tarsomeres 1 and tarsomeres 2–5 brown (Fig. B2.108). Fore wing clear except for lightly tinted band in apical 0.25, and on posterior corner of cells 2CU and 3CU (Fig. B2.67); costal cell very light yellow (possibly bleached in old specimens) (as in Fig. B2.40); most of area ventral to anal cells yellowish brown; veins black (including veins C and R, but base of stigma on both sides of junction with vein 1r-rs white) (as in Fig. B2.40). Abdomen black (Fig. C8.1). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye edge and lateral ocellus edge about 1.1–1.5 times as long as distance between inner edges of lateral ocelli (as in Fig. C1.5). Setae on clypeus 0.6–0.7 as long as diameter of a lateral ocellus (Fig. B2.8). Eye in lateral view (N = 20) with its maximum height 1.2–1.6 times as long as its maximum length (as in Fig. B2.8), and maximum height of eye 0.44–0.53 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (Fig. B2.8). Gena in dorsal view with maximum distance between outer edges clearly wider than maximum distance between outer edges of eyes (as in Fig. B2.41) (in frontal view outer edges of eyes clearly not intersecting genae) (as in Fig. B2.5), in lateral view with distance between outer edge of eye and genal ridge 0.32–0.54 times as long as maximum length of eye (Fig. B2.8, measurements as in Fig. B2.77), and with very small to moderate size pits (diameter of pit 0.05–0.2 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (Figs. B2.8 and B2.131). Transverse ridge above mandible narrow, sharp and mainly smooth (as in Fig. B2.18), with few or no pits ventral to genal ridge. Vertex scarcely pitted and pits medium in size (diameter of pit 0.2–0.25 times lateral ocellus diameter), pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area (as in Fig. B2.43); pits scattered and medium in size along all of shallowly outlined and gutter-like median furrow but a little more widespread near lateral ocelli (as in Fig. B2.43).

Thorax. Pronotum in lateral view with coarse polygonal pits on 0.3–0.7 of posterior surface (as in Fig. B2.97). Propleuron in lateral view basically with medium polygonal pits (as in Fig. C12.7); in ventral view generally with dense small teeth often in front of impressed pit with smooth surface in between (as in Fig. B2.11). Fore wing in middle 0.3 of vein 2A diverging very slightly away from wing edge (Fig. C8.3), and then more abruptly curved away from wing edge (Fig. C8.3); vein 3A absent (91%) or reduced to a stump (9%), not extending slightly as a short nebulous vein, and not extending along posterior margin of wing (N = 33).

Abdomen. Tergum 9 with meshes of microsculpture on ventral half above longitudinal furrow near center well impressed and sculpticells clearly scale-like (as in Fig. B2.92, insert); median basin with base (outlined by two lateral black longitudinal furrows; N = 6) 0.7–1.1 times as wide as its median length, with maximum width of basin 1.4–1.76 times as wide as its median length, and basin 0.43–0.47 times as long medially as median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) about 0.8 times as wide as maximum width subapically (as in Fig. C1.15); with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.26–0.46 times as long as apical section (N = 32) (Fig. C8.1); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); length 1.2–1.4 times as long as fore wing length. ***Ovipositor.*** Lancet with 27–33 annuli (first 15 annuli hard to see, but still outlined; N = 15); junction of basal and apical sections of sheath aligned between 3rd–4th or 4th–5th annuli; major pits present on last 4–5 apical annuli before teeth annuli, and 8–20 preceding annuli with a with very small pit, on each the preceding annuli 2–14 (as in Fig. C1.18).

MALE. Description

Color. Head with dorsal spot behind eye usually larger in size than in many females and extending between eye and genal ridge (Fig. B2.131). Pronotum with lateral longitudinal band narrower than in females (0.3 times as wide as pronotal half), the band becoming narrower posteriorly and not extending to lateral edge of pronotum (Fig. C8.2). Coxae black; trochanter generally black; pro- and mesofemur reddish brown to black, metafemur black; tibiae light reddish brown in basal 0.3 and sharply separated from black surfaces, protibia light reddish brown with a narrow to wide longitudinal band in apical 0.5 along outer 0.2–0.5 of dorsal surface and often with very narrow longitudinal inner band on dorsal surface with black in apical 0.5, mesotibia light reddish brown with black transverse band in apical 0.6, and metatibia black except for sharply outlined yellowish-white spot at base (Fig. C8.2 and for hind leg Fig. B2.123); pro- and

mesotarsomeres 1 light reddish brown in basal 0.1–0.8 and black thereafter; tarsomeres 2, 3, 4 and 5 dark brown to black, metatarsomere 1 black (except reddish-brown base and extreme apex) (Figs. B2.119, B2.121 and C8.2). **Thorax.** Fore wing in apical 0.3 of vein 2A not subparallel with wing edge and less abruptly curved away from wing edge and broadly curved in central section (as in Fig. C11.6). Metatibia with shallow notch on dorsal edge in basal 0.25 (Fig, B2.119).

Taxonomic notes

Until we studied the syntype females of *X. malaisei*, we did not associate them with the northern specimens from northern China, Korea, Japan and Russia. Maa (1949) stressed the color pattern of the femora. Maa (1950) reported a third female matching the first two. In Taiwan, the color pattern of the femora, trochanters, tarsi, and the marginal longitudinal band of the pronotum is darker than farther north in eastern Asia. The Taiwanese specimens are found at high elevation with a markedly increased precipitation which probably selects for dark specimens (Goulet 1986, see Geographical Variation under *Dolerus yukonensis* Norton). In Hokkaido, the northern major Japanese island, specimens at high elevation also have darker color patterns especially on the pronotum. For these reasons we do not put too much weight on color patterns.

Other structures were considered as more significant in studying both populations. The Taiwanese females share with those farther north the fore wing anal vein shape, the length of the apical section of the sheath relative to the basal section, the number of annuli with a small pits anterior to the apical annuli with large pits, the flagellum color pattern, and the sculpture of the lateral surface of the pronotum and of the propleuron. Therefore, we consider the populations of northern China, Korea, Japan, and adjacent Russia as conspecific with the Taiwanese population. We do not recognize them as subspecies.

Xeris malaisei females are distinguished from *X. caudatus*, *X. melancholicus* and *X. pallicoxae* by coxal and flagellum color, from *X. caudatus* and *X. melancholicus* by color at base of stigma at junction with vein 1r-rs and costal cell. *Xeris malaisei* females are distinguished from *X. pallicoxae* by a very small pit on many annuli preceding the typical apical annuli, by the macrosculpture on the longitudinal band and lateral surface of the pronotum and on the lateral surface of the propleuron, and in males by femur color. *Xeris malaisei* is also distinguished from *X. spectrum* by genal spot shape, in females by shape of fore wing vein 2A, and in males by the tarsi color pattern. *X. malaisei* is also quite similar to *X. xanthoceros* and *X. xylocola*. Females of both species have a flagellum that is more extensively light reddish brown than in *X. malaisei*. Both sexes of *X. malaisei* differ from these species by the shape of fore wing vein 2A.

Geographical variation

As noted under "Taxonomic Notes", the females of *Xeris malaisei* from Taiwan are more darkly colored (e.g., black metafemur) than in the northern portion of the range. In the north at low elevations, the longitudinal marginal band may be very large (each band may be 0.5–0.7 as wide as the dorsal half of the pronotum) and in males tarsomere 1 is mainly pale in basal 0.3–0.8. However, in the mountains of Hokkaido, some specimens have narrow longitudinal bands on the pronotum that may not extend to the posterolateral angle (each band may be 0.2–0.4 as wide as the dorsal half of the pronotum) and in males tarsomere 1 is mostly black. It seems that the cooler the environment due to altitude and/or latitude the darker the specimens.

Hosts and phenology

Xeris malaisei probably has a wide host range. The reported hosts are *Cryptomeria japonica* (Cupressaceae) and *Abies firma* (Pinaceae) (Fukuda and Hijii, 1997).

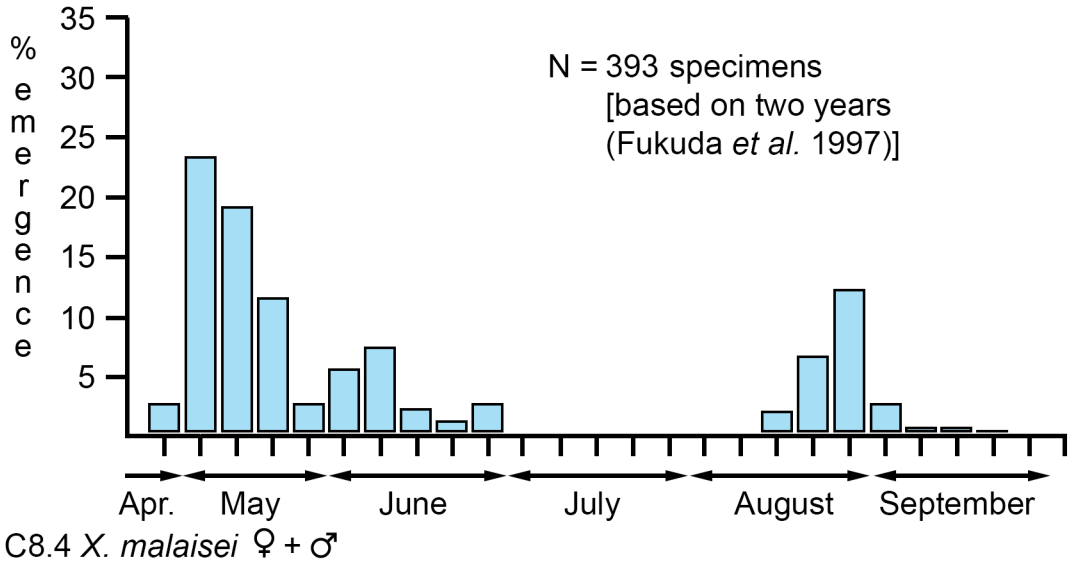
Based on 53 field-collected specimens, the earliest and latest capture dates are May 30 and August 11. Fukuda and Hijii (1997) published their work under the name *X. spectrum*. Most likely their specimens refer this species, the most common species in Japan. In Japan, *X. spectrum* is very rare. Contrary to *X. spectrum* in Europe with only one major emergence period in late June, Fukuda *et al.* (1997) has shown that *X. malaisei* has two major and isolated emergence periods, in mid-May (late April to late June, N = about 225) and mid-August (August to late September, N = about 168) (Fig. C8.4).

Range

CHINA (Jilin - Northeastern region**)**. **JAPAN (Hokkaido, Honshu)**. **RUSSIA (Primorsky kray)**. **SOUTH KOREA**. **TAIWAN (**high elevation**)**. *Xeris malaisei* has been intercepted at several ports. In United States, most intercepted specimens (6) originated from Japan and were recorded at ports on both coasts (California: Long Beach, Los Angeles, San Diego; Georgia: Savannah; Louisiana: Baton Rouge) and one specimen intercepted in New Orleans, Louisiana could have originated from China. In New Zealand all specimens (7) were intercepted from both islands (Dunedin, Napier and Wellington). The intercepted specimens came from crates pine cable drums, *Cryptomeria japonica* dunnage (a favorite host tree in Japan Fukuda and Hijii (1997)), and wood products.

Specimens studied: 44 females and 42 males from ANIC, CNC, FRNZ, NSMT, SDEI, and USNM.

Specimens for molecular studies: 8. See Fig. D1.2d.



For each specimen the following is recorded: country, year, state/province, specimen code (in italics), and number of base pairs.

JAPAN: *CBHR 1001*, 658; *CBHR 1002*, 658; *CBHR 1003*, 658; *S79*, 658; *S10*, 658; *S92*, 658; *S218b*, 658; *S491*, 658.

9. *Xeris melancholicus* (Westwood)

Fig. C9.1, (female habitus); Schiff *et al.* 2006: 92, 93 Fig. C9.2 (male habitus)

Sirex melancholicus Westwood, 1874: 116, pl. XXI, fig. 8. Holotype male (OXUM), images of male prepared by James E. Hogan and sent to Henri Goulet for study. Type locality "America Septentrionalis".

Xeris melancholicus: Schiff *et al*. 2012: 259.

Urocerus caudata; Cresson, 1880: 67 (not Cresson, 1865: 247–248). Synonymy by Provancher 1883: 241; Harrington, 1893: 148–149.

Xeris spectrum spectrum; Maa, 1949: 86 (in part) (not Linnaeus, 1758: 560 for Nearctic records); Burks, 1958: 17, Smith, 1979: 129 (catalog); Taeger *et al*., 2010: 105 (in part, catalog).

Xeris spectrum; Middlekauff, 1960: 70 (not Linnaeus, 1758: 560 only for Nearctic records); Smith & Schiff, 2002: 185.

Diagnostic combination

Among specimens with small and scattered pits between dorsoposterior edge of eye and occiput outside postocellar area and with fore wing cell C yellowish brown [*melancholicus* and *caudatus*], *X. melancholicus* is distinguished in most females by the sheath with basal section usually more than 0.27 times length of apical section, usually by the presence of meshes of microsculpture on laterobasal angle of cornus in dorsal view, and by abdominal tergum 9 in lateral view with meshes of microsculpture usually well impressed, with sculpticells scale-like on surface posterior to and above lateral furrow (surface thus dull). Males have a black to reddish-brown, poorly defined spot at the base of metatibia but cannot be separated from those of *X. caudatus*.

FEMALE. Description

Color. Head black except for small white spot on gena dorsal to middle of eye; white spot usually not extending to genal ridge (Fig. B2.47); antenna black; last maxillary palpomere black (Fig. B2.47). Thorax black except for white longitudinal band extending from posterolateral to anterolateral angles including vertical portion of anterior angle, the band 0.2–0.3 times as wide as lateral 0.5 of pronotum and not extending to lateral margin of pronotum (as in Fig. B2.56). Legs including coxae light reddish brown (coxae very narrowly black at anterior and posterior dorsal edges) (Fig. B2.49). Fore wing clear except for lightly tinted band in apical 0.25, and on posterior corner of cells 2CU and 3CU (as in Fig. B2.67); costal cell yellowish brown (possibly bleached in old specimens) (Fig. B2.39); most of area ventral to anal cells yellowish brown; veins black or brown (including veins C and R, and base of stigma on both sides of junction with vein 1r-rs) (Fig. B2.39). Abdomen black (Fig. C9.1). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye edge and lateral ocellus edge about 1.1–1.5 times as long as distance between inner edges of lateral ocelli (as in Fig. C1.5). Setae on clypeus about as long as diameter of a lateral ocellus (Fig. B2.47). Eye in lateral view (N = 20) with its maximum height 1.37–1.64 times as long as its

C9.1 *X. melancholicus* ♀

C9.2 *X. melancholicus* ♂

maximum length (Fig. B2.47), and maximum height of eye 0.42–0.51 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (as in Fig. B2.8). Gena in dorsal view with maximum distance between outer edges clearly wider than maximum distance between outer edges of eyes (Fig. B2.42) (in frontal view outer edges of eyes clearly not intersecting genae) (Fig. B2.5), in lateral view with distance between outer edge of eye and genal ridge 0.48–0.61 times as long as maximum length of eye (Fig. B2.47, measurements as in Fig. B2.77), with almost no pits ventral to genal ridge, and with few small to very small pits (diameter of pit 0.05–0.15 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (Fig. B2.47). Transverse ridge above mandible narrow, sharp and mainly smooth (Fig. B2.47). Vertex scarcely pitted and pits medium in size (pit diameter 0.2–0.3 times lateral ocellus diameter), pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area (Fig. B2.42); pits scattered (small specimens) or dense (large specimens) and medium in size along median furrow, a little more widespread near lateral ocelli (Fig. B2.42).

Thorax. Pronotum in lateral view without coarse polygonal pits or with coarse polygonal pits on as much as 0.7 of posterior surface (as in Fig. B2.97). Propleuron in lateral view with small pits at base with tooth behind in posterior 0.5 and with medium polygonal pits in anterior 0.5 (as in Fig. C12.7); in ventral view with scattered to moderately dense, shallow small teeth with smooth surface in between (as in Fig. B2.11). Transscutal furrow of mesonotum clearly outlined and finely sculptured, thus mesoscutum and axilla clearly distinct (Fig. C9.3). Fore wing in middle 0.3 of vein 2A diverging very rarely slightly (as in Fig. C11.6) to usually considerably (as in Fig. C12.6) away from wing edge, and then more (as in Fig. C11.6) or less (as in Fig. C12.6) abruptly curved away from wing edge; vein 3A absent (73%), reduced to a stump (24%), rarely extending slightly as a short nebulous vein (3%), but not extending along posterior margin of wing.

Abdomen. Tergum 9 with meshes of microsculpture on ventral half below longitudinal furrow near center clearly impressed and sculpticells slightly raised as scales, and above longitudinal furrow near center well impressed and sculpticells clearly scale-like (Fig. B2.92. insert); median basin with base (outlined by two lateral black longitudinal furrows) 0.8 times as wide as its median length, with maximum width of basin 1.6 times as wide as its median length and basin about 0.5 times as long medially as median length of cornus (Fig. C1.15, measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) about 0.8 times as wide as maximum width subapically (Fig. C1.15) and its anterolateral angle in dorsal view generally with microsculpture meshes weakly to clearly impressed near angle (Fig. B2.90, insert); with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.24–0.35 times as long as apical section (N = 54) (Fig. C9.1); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); length 1.2–1.4 times as long as fore wing length. ***Ovipositor.*** Lancet with 25–29 annuli (first 15 annuli hard to see, but still outlined; N = 14) (Fig. C9.1); junction of basal and apical sections of sheath aligned usually between 2nd and 3rd annuli, or occasionally on 3rd annulus, or on 3rd–4th annuli; major pits present on last 4–5 apical annuli before teeth annuli, and with a very small pit on each of the 9–15 preceding annuli (as in Fig. C1.18).

MALE. Description

Color. Head with dorsal spot behind eye similar in size to female. Coxae, tibiae (usually all tibiae) and tarsomeres 1–5 black (apical tarsomeres 3–5 or 4 and 5 sometimes brown or reddish brown in old or teneral specimens) (Fig. C9.2); femora completely or mainly reddish brown, and extreme base of tibiae in most specimens with indistinctly outlined reddish-brown spot (Figs. B2.69 and C9.2).

Thorax. Metatibia with shallow notch on dorsal edge in basal 0.25 (Fig. B2.69 and C9.2, and tarsomeres as in Fig. B2.119).

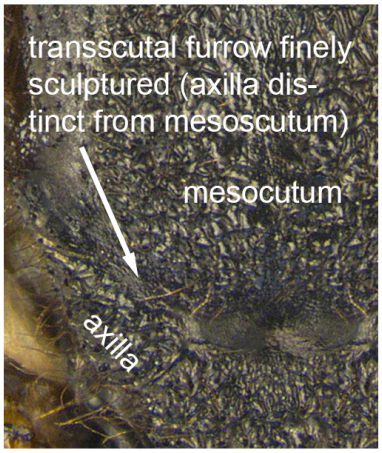
Taxonomic notes

Initially we thought that *X. caudatus* was a well-defined and widespread species in North America. We had several bar coded specimens from eastern North America confirming our concept. However, it was not to remain so straight forward. A population from the Cascade Mountains, Washington, based on a rather distinct barcode relative to eastern specimens was discovered (Schiff *et al*. 2012). For more information see "Taxonomic notes" under *X. caudatus*.

Schiff *et al*. (2012) did not know if the eastern species was named or not. They did not assign with certainty the holotype of *S. melancholicus* to this species because the type locality, North America, was not informative and we did not have a good diagnostic character for distinguishing males of the western *X. caudatus* from those of the eastern species. In spite of this and to avoid creating a synonym, they assigned Westwood's name, *X. melancholicus*, to this species rather than giving it a new name (Schiff *et al.* 2012).

Specimens of *X. melancholicus*, like *X. caudatus*, are quite easily distinguished from Euroasiatic species of *Xeris* with longitudinal white bands on the pronotum, as discussed under *X. caudatus*. The discussion between the Eurasian species and *X. melancholicus* is the same as that of *X. caudatus* and so is not repeated (see "Taxonomic

C9.3 *X. melancholicus* ♂



C9.4 *X. melancholicus* ♀

notes" under *X. caudatus*). However, specimens of *X. melancholicus* and *X. caudatus* are very difficult to segregate. We succeeded in separating females only, with moderate success. The separation is based on the relative length of the apical section of the ovipositor sheath, the microsculpture type on the lateral surface of tergum 9 and on the anterolateral corner of tergum 10 (base of cornus) dorsally.

Biological notes

Males and females of *X. melancholicus* were observed aggregating at the highest point of Mount Rigaud, Quebec. Though mating was not observed, we assume that both sexes come together for this purpose.

Hosts and phenology

Xeris melancholicus has a wide host range (Middlekauff 1960, Stillwell 1960, Cameron 1965, Morris 1967, Kirk 1975). Based on 24 reared and confirmed specimens, all are Pinaceae: *Abies balsamea* (15)*, Larix occidentalis, Picea glauca* (4)*,* and *Pinus banksiana* (5).

Based on 155 field-collected specimens, the earliest and latest capture dates are June 12 and August 18. The main flight period is from the second half of June to the first half of August with a peak in the second half of July.

Range

Canada: Alberta, Manitoba, New Brunswick, Nova Scotia, Ontario, Quebec, Saskatchewan. **United States:** Connecticut, Maine, Michigan, Minnesota, New York. *Xeris melancholicus*, a widespread species, is recorded from central Alberta to Nova Scotia, Michigan and Connecticut (see map C40.6 in Schiff *et al*. 2012 – note: though mentioned in the text, there are no records from BC; records from NY were accidentally omitted from the text; records from MN are new).

Specimens studied: 126 females and 44 males from CNC, CUIC, FRLC, GLFC, LECQ, LEMQ, MNRQ, NFRC, ROME, USFS–GA, USFS–MS, and USNM.

Specimens for molecular studies: 16 specimens (Schiff *et al*. 2012). See Fig. D1.2c. For each specimen the following is recorded: country, year, state/province, specimen code (in italics), and number of base pairs.

CANADA. Alberta: 2008, *SIR 086*, 576; 2008, *SIR 087*, 563; 2008, *SIR 088*, 515; 2008, *SIR 089*, 579; 2007, *SIR 111*, 658; 2007, *SIR 137*, 658; 2007, *SIR 144*, 657. **Nova Scotia**: 2006, *CBHR 297*, 658; 2005, *CBHR 300*, 658. **Ontario**: 2007, *GLSIR 041*, 658; 2007, *GLSIR 042*, 616. **USA. Michigan**: 2005, *CBHR 203*, 658. **Minnesota**: 2008, *CBHR 1375*, 658; 2008, *CBHR 1461*, 534; 2008, *CBHR 1462*, 578. **New York**: 2006, *CBHR 603*, 658.

10. *Xeris morrisoni* (Cresson)

Fig. C10.1, (female habitus); Schiff *et al.* 2006: 88, 89
Fig. C10.2, (male habitus); Schiff *et al.* 2006: 87

Urocerus morrisoni Cresson, 1880: 35. Lectotype female (ANSP), designated by Cresson (1916), examined by D. R. Smith and H. Goulet. Type locality: "Colorado". Harrington, 1893: 149; Cresson, 1916: 10 (notes about type from Colorado).

Sirex morrisonii; Kirby, 1882: 382 (change in combination and spelling). Dalla Torre, 1894: 390.

Xeris morrisoni; Ashmead, 1898: 180 (change in combination). Konow, 1898a: 74, 83; Howard, 1901: pl. 14, fig. 36; Konow, 1905b: 125, 126; Konow, 1905a: 9 (catalog); Bradley, 1913: 22, 23, 24; Hedicke, 1938: 23 (catalog); Benson, 1943: 30, 31 (measurements); Ries, 1951: 84 (catalog, Hosts); Furniss & Carolin, 1977: 454, 457 (host and range); Schiff *et al*., 2012: 263.

Urocerus tarsalis; synonymy by Konow, 1898a: 88 (not Cresson, 1880: 35). Bradley, 1913: 24; Ries, 1951: 84.

Urocerus indecisus; synonymy by Konow, 1898b: 226 (not MacGillivray, 1893: 243). Bradley, 1913: 24; 1951: 84.

Xeris morrisoni morrisoni; Maa, 1949: 80, 83–85 (change in rank) (hosts). Burks, 1958: 17 (catalog and hosts); Cameron, 1965: 15 (hosts); Burks, 1967: 27 (new state record); Kirk, 1975: 57–58 (host); Smith, 1979: 129 (catalog and hosts); Taeger *et al.*, 2010: 105 (catalog).

Diagnostic combination

Among adults with reddish-brown abdomen and without marginal stripe on the lateral margin of the pronotum [*morrisoni*, *degrooti*, *indecisus*, *tarsalis* and *tropicalis*], *X. morrisoni* is recognized in both sexes by the wide gena (in frontal view maximum width between the outer edges of eyes clearly less than outer edges of genae), and the narrow, sharp and mainly smooth transverse ridge above the mandible, in females by the black femora, and in males by the narrow width of the gena between the genal ridge and the outer edge of eye that is less than 0.5 times as wide as the maximum eye length.

FEMALE. Description

Color. Head black except for a large white spot on gena dorsal to middle of eye extending down to genal ridge (Fig. B2.76); flagellum black in basal 0.3–0.5 but reddish brown in apical 0.5–0.7 (Fig. B2.73); last maxillary palpomere reddish brown (Fig. B2.76). Thorax completely black or with small to large white spot on vertical surface near anterolateral angle of pronotum (spot very narrow if visible in dorsal view) (as in Fig. B2.54). Legs light reddish brown except for black coxae,

C10.1 *X. morrisoni* ♀

C10.2 *X. morrisoni* ♂

trochanters and femora (Fig. C10.1). Fore and hind wings darkly tinted brown (Fig. C10.1); costal cell brown; veins dark brown or black (including veins C and R, and base of stigma around junction with vein 1r-rs). Abdomen segments 1 or 1 and 2 black, and segments 2–10 or 3–10 reddish brown (Fig. C10.1 and as Fig. B2.60). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye edge and lateral ocellus edge about 1.1–1.5 times as long as distance between inner edges of lateral ocelli (as in Fig. C1.5). Setae on clypeus 0.6–0.7 as long as diameter of a lateral ocellus (Fig. B2.76). Eye in lateral view (N = 20) with maximum height 1.35–1.60 times as long as its maximum length (Fig. B2.76), and maximum height of eye 0.42–0.51 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (as in Fig. B2.8). Gena in dorsal view with maximum distance between outer edges clearly wider than maximum distance between outer edges of eyes (as in Fig. B2.41) (in frontal view outer edges of eyes clearly not intersecting genae) (as in Fig. B2.5); in lateral view with distance between outer edge of eye and genal ridge 0.43–0.50 as long as maximum length of eye (Fig. B2.76), with almost no pits ventral to genal ridge, and with many medium size pits (diameter of pit 0.2–0.25 times lateral ocellus diameter) between outer edge of eye and genal ridge pits (mainly near eye) (Fig. B2.76). Transverse ridge above mandible narrow, sharp and mainly smooth (Fig. B2.76). Vertex quite densely pitted and pits medium in size (diameter of pit about 0.3 times lateral ocellus diameter), pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area (as in Fig. B2.41); pits dense, narrowly distributed and medium in size along all median furrow (not sharply outlined), but a little more widespread near lateral ocelli (as in Fig. B2.41).

Thorax. Pronotum in lateral view with coarse polygonal pits on 0.3–0.7 of posterior surface (as in Fig. B2.97). Propleuron in lateral view with medium size polygonal pits on most of disc (as in Fig. C12.7); in ventral view with scattered to moderately dense small teeth with smooth surface in between (as in Fig. B2.11). Fore wing in middle 0.3 of vein 2A diverging very rarely slightly (as in Fig. C11.6) to usually considerably (as in Fig. C12.6) away from wing edge and then more (as in Fig. C11.6) or less (as in Fig. C12.6) abruptly curved away from wing edge; vein 3A absent.

Abdomen. Tergum 9 with meshes of microsculpture on ventral half below and above longitudinal furrow near center not well impressed and sculpticells clearly flat (slightly raised as scale above furrow) (as in Fig. B2.93, insert); median basin with base (outlined by two lateral black longitudinal furrows) 0.7 times as wide as its median length, with maximum width of basin 1.3 times as wide as its median length, and basin 0.7 times as long medially as median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) 0.8 times as wide as maximum width of cornus subapically; with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.22–0.30 times as long as apical section (N = 6) (Fig. C10.1); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); length 1.2–1.5 times as long as fore wing length. ***Ovipositor.*** Lancet with 31–34 annuli (first 15 annuli difficult to see, but still outlined; N = 3); junction of basal and apical sections of sheath aligned between 3rd– 4th annuli; major pits present on last 4–6 apical annuli before teeth annuli, and with or without a very small pit on preceding annulus (as in Fig. C1.18).

MALE. Description

Color. Head with dorsal spot behind eye similar in size to female. Antenna, coxae, femora, tibiae and tarsi (except reddish-brown tarsomeres 3–5 or 4 and 5) black (Fig. C10.2). Pronotum in dorsal view black or with white spot on anterior angle (Fig. C10.2). Abdomen black on segments 1 and 2 and laterally on terga 3–8, and reddish brown elsewhere (Fig. C10.2).

Thorax. Metatibia with shallow notch on dorsal edge in basal 0.25 (as in Fig. B2.68).

Taxonomic notes

Xeris morrisoni is similar to *X. indecisus* (pale abdomen form) and *X. degrooti*. The DNA barcodes support the species level status of these species. No specimen has intermediate structures and color patterns between *X. morrisoni* and the above species. *Xeris morrisoni* has been found sympatrically with *X. chiricahua* and either or both *X. degrooti* and *X. indecisus*.

Hosts and phenology

Xeris morrisoni has a moderately wide host range. Based on 232 reared and confirmed specimens, all are Pinaceae: *Abies concolor* (228; most specimen records from Kirk (1975)), *Picea pungens* (1), and *Pseudotsuga menziesii* (3). Based on other, better sampled species of this genus, we expect that this species has a wider host range.

Based on 13 field-collected specimens, the earliest and latest capture dates are from early June to late July.

Range

Mexico: Chihuahua (Ocampo Sierra La Magdelena), Durango (Guanacevi, Ej. Toro, C. Barajas) and from the Sierra Madre Occidentale of Mexico between 2,700 to 3,100 m. **United States:** Arizona, Colorado. *Xeris morrisoni* is recorded from forested regions of southwestern United States (Burks 1958, Burks 1967,

Cameron 1965, Smith 1979) (for United States localities see map 42.6 in Schiff et al. 2012).

Specimens studied and included for the distribution map: 11 females and 6 males from INIFAP, OSAC, UAIC, and USNM.

Specimens for molecular studies: 6 specimens from United States (Colorado) (Schiff *et al*. 2012). See Fig. D1.2b. For each specimen the following is recorded: country, year, state/province, specimen code (in italics), and number of base pairs.

USA. Colorado: 2005, *CBHR 190*, 658; 2005, *CBHR 533*, 627; 2005, *CBHR 534*, 658; 2005, *CBHR 535*, 608; 2005, *CBHR 536*, 658; 2005, *CBHR 537*, 658.

11. *Xeris pallicoxae* Goulet n. sp.

Fig. C11.1 (female habitus)

Fig. C11.2 (male habitus)

http://zoobank.org/NomenclaturalActs/D325C568-0275-4737-81D8-A71957C9EFE4

Xeris spectrum; auctorum (in part) (not Linnaeus, 1758: 560 only for European records).

Type material

Holotype female (SDEI), in perfect condition, labelled [White label] "14.vii.1996 D, BW WT, Wehrhalden Kirchspielwald, Schwarze Säge-Markstein, E. Jansen leg."; [White] "Xeris specrum (Linnė) ♀ E.Jansen det. '97";[White] "Ex coll E. Jansen"; [Red] "HOLOTYPE Xeris pallicoxae ♀ H. Goulet, 2011".

Paratypes. 336 females and 669 males. **ALGERIA**: [probably mislabelled] (1 M, BMNH). **AUSTRIA**: Kämten Waidischtal near Ferlach (2 M, Col. E. Jansen); Lower Austria, Lunz am See, 47.86˚N 15.03˚E (2 F, SDEI; 1 M, USNM) Paznautal (1 F, BMNH); Tyrol (1 M, BMNH). **BELGIUM**: Bois de Roi, Exp. 163(5) (1 F, BMNH). **BULGARIA**: Borovetz, Exp. 197(5) (2 F, BMNH). **CZECH REPUBLIC**: Bohemia, Chodau (6 F, 1 M, BMNH) ; Hodruso, Exp 601(6) (2 M, BMNH); Orličky – N Sucky VRCH 980 M NN (3 M, SDEI - Col. E. Jansen); Dobříš (1 F, 1 M, NSMT). **CROATIA**: Fusine, (Holzlagerplatz) and vicinity (2 F, SDEI). **DENMARK**: intercepted in New Zealand, Auckland (1 F, FRNZ). **FRANCE**: Auvergne. Dép., Haute Loire, Le Bouchet-bas, Les Roches (1 F, Col. E. Jansen) ; Cantal R. Alagnon, Le Lioran (1 M, BMNH); Cisai, Exp(3) (2 F, 2 M, BMNH); Forêt de Belleme, Exp. 176(5) (13 F, 17 M, BMNH); Forêt d'Ecouves, Exp. 175(3) (3 F, 5 M, BMNH); Le Boreon, Exp. 103(3), (5 F, 27 M, BMNH); Montfort sue Risle 49º18.503'N 0º40.887'E (1 F, 2 M, USNM); St. Jean de Mont, Exp 148(7) (1 F, BMNH); Turini, Exp. 148(7) (1 F, BMNH); Turini, Exp. 105(4) (6 F, 45 M, BMNH); Turini, Exp. 106(5) (1 F, BMNH); Turini, Exp. 195(4) (1 F, 2 M, BMNH); Vosges, Exp. 193(6) (11 F, 18 M, BMNH); Corsica, D'Aitone, Exp. 1208 (1 F, 11 M, BMNH); intercepted in USA, KS, Kansas City (1 F, USNM); intercepted in USA, CA, Long Beach (1 F, USNM); intercepted in USA, TX, Houston (1 F, USNM); intercepted in New Zealand, Invercargil, Aluminium Smelter Bluff (12 F, 9 M, FRNZ). **GERMANY**: Ebesberger, Exp. 126(4) (2 F, 1 M, BMNH); Fallingbostel, Exp. 117(8) (1 F, BMNH); Forstamt Rantzeau, 128(3) (1 M, BMNH); Gahrenburg, Exp. 116(4) (2 F, BMNH); Baden Württemberg, Ottenhöfen 7415 NW Eichhaldenfirst 570 (1 M, SDEI [Müncheberg HYM-00151]); Thuringia, Friedrichroda, 50.87˚N 10.57˚E (1 F, SDEI; 1 M, USNM); Baden Württemberg, Schönmünzack (1 F, SDEI); Gomaringen near Tübingen (1 M allotype, SDEI) ; intercepted in USA, AL, Mobile (1 F, USNM); intercepted in USA, PA, Philadelphia (1 F, 2 M, USNM); intercepted in USA NY, New York (1 F, USNM); intercepted in USA, NC, Monroe (2 F, USNM); intercepted in USA, LA, New Orleans (1 F, USNM); intercepted in Puerto Rico, Ponce (1 F, USNM); intercepted in New Zealand, Auckland (1 F, FRNZ). **?GERMANY**: Rossberg near RT (1 M, SDEI); vicinity of Feldkirch Mossbrugger (2 M, SDEI); Sud-Vogesen (1 M, SDEI); Germsbach (2 M, SDEI); Erzgebirge Lange (1 F, USNM). **GREECE**: Agios, 676 (1 F, 2 M, BMNH); Elari, Exp. 673 (5 F, 4 M, BMNH); Evia, Exp. 675 (2 M, BMNH); Glyfada, Exp. 669 (1 M, BMNH); Granitis, 669 (6 F, 3 M, BMNH); Parnis, 674 (3 F, 1 M, BMNH); Pertouli, 672 (2 F, 8 M, BMNH); Attika, Parnis Oros, 38.17˚N 23.67˚E (1 F, SDEI); Parnassos massif, 38.53˚N 22.62˚E (1 F, SDEI). **HUNGARY**: Retyezáth, 300–400 m (1 F, BMNH); [locality unknown] (1 M, SDEI). **ITALY**: Bibbiena, 190(4) (1 F, 1 M, BMNH); Bolzano, 192(4) (1 M, BMNH); Camaldoli, Exp 188(4) (16 F, 26 M, BMNH); F. Campiggna (1 F, BMNH); Lama, Exp 115(4) (23 F, 86 M, BMNH); Pratovecchio, 114(4) (40 F, 26 M, BMNH); Sabaudia, Exp. 187 (1 F, BMNH); Uimbra, Exp. 677 (1 F, 1 M, BMNH); unknown locality, Exp. 238 (6 F, 2 M, BMNH); Calabria, Alt. 1850 m, Paganetti (4 M, SDEI); intercepted in USA, LA, New Orleans (1 F, USNM); intercepted in USA, CA, Long Beach (1 F, USNM); intercepted in USA, GA, Savannah from (5 M, USNM); intercepted in USA, CA, Auckland (2 F, 1 M, USNM); intercepted in USA, NY, New York (1 M, USNM); intercepted in USA, TX, Houston (1 M, USNM). **NETHERLANDS**: intercepted in USA, NY, New York (1 M, USNM). **NORWAY**: Mordmarker, Exp. 143(9) (1 M, BMNH). **POLAND**: Schlesien (1 M, SDEI); Szczawa, 49˚36'N 20˚18'E (8 F, USNM). **ROMANIA**: Transsylvania (1 F, SDEI); intercepted in USA, TX, Houston (1 F, USNM). **SCANDINAVIA**: [country unspecified] intercepted in England (3 F, BMNH). **SLOVAKIA**:

C11.1 *X. pallicoxae* ♀

C11.2 *X. pallicoxae* ♂

Pieninsky Nat. Park (1 F, SDEI). **SWITZERLAND**: Chatillon, Exp. 31(F) (1 F, BMNH); Chatillon, Exp. 36 (1 F, BMNH); Chatillon, Exp. 224 (1 F, BMNH); Corbières, 110(4) (1 M, BMNH); Grison, Engadine (1 F, BMNH); Le Noir Bois, Exp. 172(6) (3 F, 2 M, BMNH); Lucelle, Exp. 173(7) (7 F, 10 M, BMNH); Lucelle, Exp. 196(7) (1 F, 7 M, BMNH); Riaz, Exp. 109(5) (1 M, BMNH): unknown locality, Exp. 229 (29 F, 95 M, BMNH); unknown locality, Exp. 224 (3 F, 5 M, BMNH); unknown locality, Exp. 332 (1 F, BMNH); intercepted in New Zealand, Auckland (1 M, FRNZ). **TURKEY**: Bulgaz, Exp. 664 (1 F, 3 M, BMNH); Bulgaz, Exp. 665 (5 M, BMNH); Cangal Kastmanu, Exp. 656 (1 M, BMNH); Eqner Karsanti, Exp. 667 (9 F, 16 M, BMNH); Namrun Mersin, Exp. 664 (1 F, 4 M, BMNH); Santa Trabzan, Exp. 655 (1 M, BMNH); Sogur Karsanti, Exp. 665 (7 F, 10 M, BMNH); Urgulu Bucak, Exp. 662 (1 F, 1 M, BMNH): Uludag, Borsa, Exp. 658 (2 F, BMNH); Zigana Dagi, 1500–1800 m (3 F, BMNH). **UNITED KINGDOM**: **England**, Essex, Harrowich (1 F, BMNH); Hampshire, Romsey, Aubridge, Ex Larix (0 F, 67 M, BMNH); Oxfordshire, Nuneham Park, Ex Pinus sylvestrix) (2 F, BMNH); **Britain** (1 F, BMNH); **Wales**, Cynwyd, Exp. 178(7) (2 M, BMNH). **YUGOSLAVIA**: Belasica, Exp. 123(4) (1 F, BMNH); Brezna, Exp. 604(2) (3 F, 1 M, BMNH); Crni Lug, Exp. 141(5) (4 F, 2 M, BMNH); Dobra Voda, Exp. 604(2) (1 F, 8 M, BMNH); Hurbache, Exp. 134(2) (1 F, BMNH); Kraljevo, Exp. 132(3) (1 F, BMNH); Mavrovi, Exp. 125(3) (2 F, 3 M, BMNH); Mokopaly, Exp. 140(4) (3 F, 1 M, BMNH); Toliscina, Exp. 121(2) (4 F, 2 M, BMNH); unknown locality, Exp. 228 (2 F, 3 M, BMNH); unknown locality, Exp. 246(a), 246(B), 246(C) (15 F, 77 M, BMNH); intercepted in New Zealand (1 M, FRNZ). **Europe**: intercepted in New Zealand (1 F, FRNZ); [unknown country] (2 F, BMNH). **Unknown**: intercepted in New Zealand, Auckland (1 F, FRNZ). One specimen intercepted in Malta reported from Bombay, India is no doubt incorrect (1 F, BMNH).

Diagnostic combination

Among specimens with small and more scattered pits between dorsoposterior edge of eye and occiput outside postocellar area, with a yellowish-white fore wing cell C, and with short setae on the head (0.6–0.7 as long as diameter of a lateral ocellus) [*pallicoxae*, *malaisei*, *spectrum*, *xanthoceros* and *xylocola*], *X. pallicoxae* is recognized in both sexes by the smooth surface between large teeth on the white longitudinal band of the pronotum and by the white base of stigma on both sides of junction with vein 1r-rs, in females by the black antenna and mainly reddish-brown coxae, and **in males** by the light reddish-brown tarsomeres 3–5 and by the narrow reddish-brown transverse band at the apex of mesotarsomere 1 (narrower than basal pale band).

FEMALE. Description

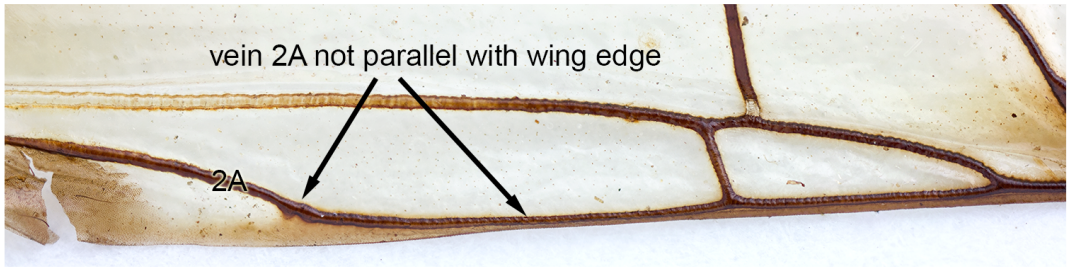
Color. Head black except for small white spot on gena dorsal to middle of eye; white spot usually clearly outlined and not extending down to genal ridge (Fig. C11.3); antenna black; last maxillary palpomere reddish brown (Fig. C11.3). Thorax black except for white longitudinal band extending from posterolateral to anterolateral angles including vertical portion of anterior angle, the band 0.4 times as wide as 0.5 lateral width of pronotum and extending to lateral margin of pronotum (only apex of teeth black along pronotal edge) (Fig. B2.94). Legs including coxae light reddish brown (coxae very narrowly black at anterior or anterior and posterior dorsal edges, rarely a little more on ventral surface) (Fig. B2.98). Fore wing clear except for lightly tinted band in apical 0.25, and on posterior corner of cells 2CU and 3CU (as in Fig. B2.67); costal cell light yellow (paler in old specimens) (Fig. B2.40); most of area ventral to anal cells yellowish brown; veins black (but veins C and R black, but base of veins C and R, and base of stigma on both sides of junction with vein 1r-rs contrastingly white (Fig. B2.40). Abdomen black (Fig. C11.1). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye and lateral ocellus edges about 1.1–1.5 times as long as distance between inner edges of lateral ocelli (as in Fig. C1.5). Setae on clypeus 0.6–0.7 as long as diameter of a lateral ocellus. Eye in lateral view (N = 20) with its maximum height 1.24–1.58 times as long as its maximum length (as in Fig. C11.3), and maximum height of eye 0.42–0.51 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (Fig. C11.3, measurements as in Fig. B2.8). Gena in dorsal view with maximum distance between outer edges clearly wider than maximum distance between outer edges of eyes (as in Fig. B2.43) (in frontal view outer edges of eyes clearly not intersecting genae) (as in Fig. B2.5); in lateral view with distance between outer edge of eye and genal ridge 0.32–0.64 times as long as maximum length of eye (Fig. C11.3), with few or no pits ventral to genal ridge, and with very small to moderate size pits (diameter of pit 0.05–0.2 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (Fig. C11.3). Transverse ridge above mandible narrow, sharp and mainly smooth (Fig. C11.3). Vertex scarcely pitted and pits medium in size (diameter of pit 0.2–0.35 times lateral ocellus diameter), pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area (Fig. B2.43; pits scattered and medium in size along all of shallowly outlined gutter-like median furrow but a little more widespread near lateral ocelli (as in Fig. B2.43).

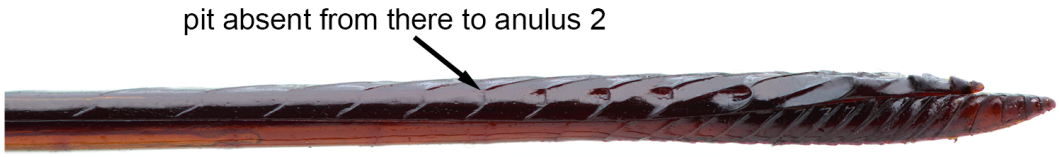
C11.3 *X. pallicoxae* ♀

C11.4 *X. pallicoxae* ♂

C11.5 *X. pallicoxae* ♀



C11. 6 *X. pallicoxae* ♀



C11.7 *X. pallicoxae* ♀

C11.8 *X. pallicoxae* ♀

Thorax. Pronotum in dorsal view along yellowish-white longitudinal band smooth between large teeth (Fig. B2.94) and in lateral view without coarse polygonal pits or with very few pits on 0.1 of posterior surface (Fig. B2.96). Propleuron in lateral view basically without pits but with tooth-like projections sometime fusing anteriorly with other teeth and not forming coarse pits (Fig. C11.5); in ventral view generally with scattered shallow small teeth with smooth surface in between (Fig. B2.11). Transscutal furrow of mesonotum clearly outlined and finely sculptured, thus mesoscutum and axilla clearly distinct (Fig. C11.8). Fore wing in middle 0.3 of vein 2A diverging very rarely slightly (Fig. C11.6) to usually considerably (as in Fig. C12.6) away from wing edge and then more (Fig. C11.6) or less (as in Fig. C12.6) abruptly curved away from wing edge; vein 3A absent (29%), reduced to a stump (32%), extending slightly as a short nebulous vein (21%), and extending along posterior margin of wing (18%) (N = 34).

Abdomen. Tergum 9 with meshes of microsculpture on ventral half below and above longitudinal furrow near center not well impressed and sculpticells clearly flat (slightly raised as scale above furrow) (as in Fig. B2.93, insert); median basin with base (outlined by two lateral black longitudinal furrows; N = 3) 0.7–1.0 times as wide as its median length, with maximum width of basin 1.6–2.0 times as wide as its median length, and basin 0.3–0.5 times as long medially as median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) about 0.8 times as wide as maximum width subapically (as in Fig. C1.15); with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.21–0.35 times as long as apical section (N = 44) (Fig. C11.1); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); length 1.2–1.4 times as long as fore wing length. ***Ovipositor.*** Lancet with 22–32 annuli (first 15 annuli hard to see, but still outlined; N = 14); junction of basal and apical sections of sheath aligned between 3rd–4th annuli; major pits present on last 4–5 apical annuli before teeth annuli, and without a pit on each of the preceding annuli (Fig. C11.7).

MALE. Description

Color. Head with dorsal spot behind eye clearly outlined, larger than in female, and extending to genal ridge (Fig. C11.2). Coxae black; trochanter partly to completely reddish brown; femora reddish brown to black; tibiae whitish yellow in basal 0.3 and sharply outlined, protibia light reddish brown with a wide longitudinal band on outer margin in apical 0.5 or with black transverse band in apical 0.5, mesotibia light reddish brown with black transverse band in apical 0.6, and metatibia except at base black; tarsi light reddish brown except for black dorsal longitudinal band on mesotarsomere 2 (rarely all black) (Figs. B2.101 and C11.2); metatarsomere 1 yellowish white at base and narrowly reddish brown at apex (rarely black on pro- and mesotarsomeres 2 and almost never on tarsomeres 3), and with brown or black central transverse band or cloud on metatarsomere 2 in most specimens. (Figs. B2.101 and C11.2).

Thorax. Metatibia with shallow notch on dorsal edge in basal 0.25 (Figs. B2.101 and C11.2).

Taxonomic notes

We were surprised to uncover an undescribed European species under *X. spectrum*. This was the result of a detailed study of the American species known traditionally as *X. spectrum spectrum*, (see "Taxonomic notes" under *X. caudatus*). Females of *X. pallicoxae* are separated from those of *X. spectrum* on color of coxae, and on the absence of a small pit on each of the annuli anterior to the typical group of subapical annuli with larger pit, males on the color pattern of mesotarsomere 1 and metatarsomere 1, and both sexes on the lack or almost lack of coarse pits on the vertical surface of the pronotum in lateral view, on the sculpture on the lateral surface of the propleuron and on the lack of microsculpture between large teeth along the longitudinal yellowish-white band on the pronotum.

When everything looks straight forward, complications show up. The DNA barcode neighbor-joining tree of *X. pallicoxae* may consist of two species named here "Type 1" and "Type 2" (see Fig. D1.2e and discussion under "Mitochondrial DNA results"). The sequences are based on larvae (USNM) and there is a divergence of 2.2% between the two groups of DNA barcodes. In the analysis of the main emergence cycle of *X. pallicoxae* we noted the unusual two adult emergence peaks one in early June and another in late June (see Fig. C11.9). Normally a species emergence consists of one peak over a one month period in studied Siricidae (Schiff *et al*., 2012). Therefore, the two peaks in adult emergence is a clue supporting the DNA barcode results. We are unable to assign the name *X. pallicoxae* to either type as the data is based on larvae. Fresh adults for barcoding are needed to associate them with the larval barcodes and eventually find morphological differences to distinguish the adults.

Origin of specific epithet

The specific name "*pallicoxae*" means "pale coxae" characteristic of females of this European species.

Geographical variation

We noted no geographical differences among females of *Xeris pallicoxae* over its range. However, males show a pattern. The metafemur color varies from

reddish brown to black. In Central Europe and on the island of Corsica (France) a black metafemur is the dominant color. Elsewhere between France and Turkey in the Mediterranean region, a reddish-brown metafemur dominates. In Italy, specimens with intermediate color pattern are common. However at the extreme eastern portion of the *X. pallicoxae* range in Turkey, specimens with intermediate color pattern are uncommon.

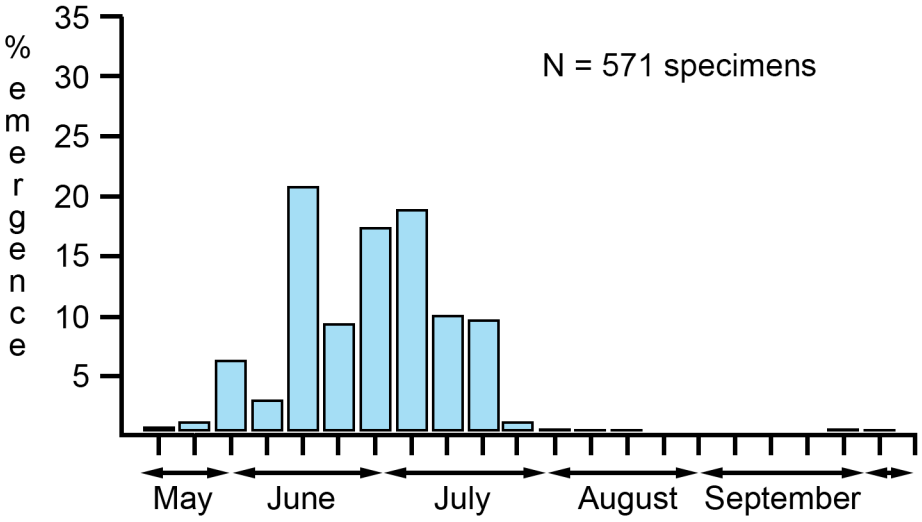
Hosts and phenology

We studied 822 specimens (BMNH) of *X. pallicoxae* collected by P. J. Spradbery and A. A. Kirk between 1963 and 1970. Each specimen's label includes the name "Frank Wilson" who did not collect the specimen but supervised the rearing program sponsored by the Australian government. This is only a portion of 6205 specimens collected by them.

The published result of the emergence period and the host range (Spradbery and Kirk 1978) is a mixture of specimens of *X. pallicoxae* and *X. spectrum*. Their emergence period was based on specimens from Turini in southeastern France. We saw about 35% (87 specimens) of their Turini sample. This sample consists of 79% *X. pallicoxae* and 21% *X. spectrum*. Comparing results of the emergence distribution from Central Europe with that from Mediterranean Europe including Turkey, we found that emergence starts in mid-May along the Mediterranean region and in late May in Central Europe. In both regions there are two clear emergence peaks in spring. Based on 571 specimens, the first peak occurs in the first week of June and the second in the last week of June (Fig. C11.9). The major emergence period is followed by a very small emergence in late September and early October. These results are similar over the years, but there could be a general shift of one week either way. In contrast, *Xeris spectrum* shows only one emergence period, with a single peak in late June.

One sample from Hampshire, England, collected from a *Larix* bole was unusual because of the size difference between specimens emerged from the first and second year after the tree was cut down. Specimens from the first year (N = 40 males) were clearly smaller than those of the second year (N = 27 males). The maximum head width in dorsal view was 2.7 mm (standard deviation = 0.22; range 2.1–3.2 mm) for the first year and 3.7 mm (standard deviation = 0.35; range 2.1–4.2 mm) for the second year. Four specimens from the second year were well within the range of those of the first year sample (2.1–3.0) whereas all other specimens were greater than 3.3 mm. *Xeris* females do not carry fungi within their reduced mycangia. Therefore, a possible hypothesis is that specimens of *X. pallicoxae* from the first year sample were in competition for the fungus (brought previously by females of *Urocerus* and/or *Sirex*) with larvae of *Urocerus* and/or *Sirex*, whereas those of the second year with lower numbers of larvae would have most of the fungus to themselves.

Xeris pallicoxae has a moderately wide host range within Pinaceae. Based on 20% of specimens at the BNMH (162) collected by Spradbery and Kirk, *X. pallicoxae* was reared from a wide variety of firs (*Abies alba*, *A. borisii-regis*, *A. cilicica*, and *A. bornmuelleriana*), spruce (*Picea abies*) and and Pine (*Pinus radiata*). Spradbery and Kirk (1978) reported *X. spectrum* from *A. equi-trojan* in Greece where we have seen only *X. pallicoxae*. Amazingly, 97% of specimens were reared from firs. This may reflect a relatively greater abundance of firs than spruces in sites sampled by Spradbery and Kirk rather than a marked preference of *X. pallicoxae* for firs. Spruces are very uncommon in the Mediterranean region



C11.9 *X. pallicoxae* ♀+♂

based on their known distribution and their sample's host data (Spradbery and Kirk 1978).

Range

EUROPE: AUSTRIA, **BELGIUM**, **BULGARIA**, **CZECH REPUBLIC**, **CROATIA**, **DENMARK**, **FRANCE** (continental), **FRANCE** (Corsica), **GERMANY**, **GREECE**, **HUNGARY**, **ITALY**, **NETHERLANDS**, **NORWAY**, **POLAND**, **ROMANIA**, **SLOVAKIA**, **SWITZERLAND**, **TURKEY**, **UNITED KINGDOM**, and **YUGOSLAVIA**. *Xeris pallicoxae* is a widespread European species from Denmark and Poland south to Italy and from France to Turkey, and most captured specimens south of Germany belong to this species.

Numerous specimens of *Xeris pallicoxae* have been intercepted at ports in the United States (22) and New Zealand (27) from the following European countries: Denmark (New Zealand), France (United States and New Zealand), Germany (United States, New Zealand and Puerto Rico), Italy (United States), Romania (United States), Switzerland (New Zealand), and Yugoslavia (New Zealand). The species is not established outside Europe.

Specimens studied: 337 females and 669 males from BMNH, CNC, EIHU, SDEI, SDEI - Col. E. Jansen, and USNM.

Specimens for molecular studies: 21 specimens. See Fig. D1.2e. For each specimen the following is recorded: country, year, state/province, specimen code (in italics), and number of base pairs.

EUROPE. Austria: *S516*, 631. **Belgium**: 1975, *S65*, 658. **France**: 1978, *S293*, 658; 1977, *S497*, 658. **Germany**: 1979, *S68*, 658; 1977, *S473*, 658; 1978, *S179*, 658; 1978, *S198*, 658; 1977, *S269*, 658; 1978, *S296*, 658; 1977, *S344*, 658; 1977, *S347*, 658; 1978, *S394*, 658; 1978, *S426*, 658; 1981, *S442*, 658; 1977, *S474*, 658; 1977, *S487*, 658. **Italy**: 1971, *S76*, 658; 1972, *S82*, 658; 1973, *S126*, 658; 1977, *S264*, 658.

12. *Xeris spectrum* (Linnaeus)

Fig. C12.1 (female habitus)
Fig. C12.2 (male habitus)

Grand ichneumon noir à jambes rousses, DeGeer, 1752, 567 (pre-Linnean description) ; Göze, 1778 : 1(4) : 21–22, pl. 36, Fig. 6.

Ichneumon spectrum Linnaeus, 1758: 560. Syntype female (LSUK), not examined but images of type (from the Linnean Society of London – http//linnean-online.org/16307/) studied, labelled [brownish white and hand written] "Ichneumon", and [brownish white and hand written] "spectrum". Brünnich, 1761:17; Malaise & Benson, 1934: 12 (confirmation of specimen as type); Abe & Smith, 1991: 90; Vasu & Saini, 1999: 279.

Sirex spectrum; Linnaeus, 1760 [1761]: 396 (change in combination). O. F. Müller, 1764: 70; Linnaeus, 1767: 929; Fabricius, 1775: 326; Fueßlin, 1775: 48; P. L. S. Müller, 1775: 838; O. F. Müller, 1776: 150; Fabricius, 1781: 419; Retzius, 1783: 67; Fabricius, 1787: 257; Ström, 1788: 276; Thunberg, 1788: 84; De Villers, 1789: 128; Karsten, 1789: 57; Gmelin 1790: 2672; Christ, 1791: 417; Fabricius, 1793: 126; Panzer, 1798: plate 16; Donovan 1798: 25; Ludvig, 1799: 36; Shrank, 1802: 224; Walckener, 1802 : 45; Klug, 1803 : 39; Fabricius 1804: 50; Bechstein & Scharfenberg, 1805: 869; Panzer 1806: 55; Turton, 1806: 427; C. Huber, 1807: 235; Jurine, 1807: 79; Lamarck, 1817: 67; Bechstein, 1818: 142, 448; Billberg, 1820: 98; Lepeletier, 1828: 438; Lamarck, 1835: 376; Stephens, 1835: 115; Dahlbom, 1835: 16; Hartig, 1837: 385; Zetterstedt, 1838: 357; Blanchard, 1840: 246; Siebold, 1844: 357; Ratzeburg, 1844: 144; Eversmann, 1847: 67; Dufour, 1854: 201(anatomy); Kirchner, 1854: 290; Costa, 1860: 4; Ratzeburg, 1863: 187; Kawall, 1864: 302; Ratzeburg, 1866: 227; Taschenberg, 1866: 29, 30; Kirchner, 1867: 21: Thomson, 1871: 327; Walker, 1873a: 359; Walker, 1873b: 78; Ghiliani, 1873: 242; Kaltenbach, 1874: 699; Mocsáry, 1878: 198; Siebke, H. 1880: 29; E. André, 1880: 68 or 69 (catalog); André, 1882: 555, 557; Magretti, 1882: 291; Kirby, 1882: 375; Brischke & Zaddach, 1883: 321, 322; Mocsáry, 1886a: 12; Mocsáry, 1886b: 68, 71, 72; Berlese, 1890: 183; Cameron, 1890: 134, 135; Cobelli, 1891: 8, 27; Steck, 1893: 10; Dalla Torre, 1894: 393, 394; Costa, 1894: 259 (Subgenus (Subgenus *Xeris*); Griffini, 1895 (1894): 132; Strobl, 1895: 279; Costa, 1895 (Subgenus *Xeris*): 186; Kiaer, 1896: 27, 28; Strand, 1898: 82; Kiaer, 1902: 408; Ghigi, 1905: 24; Rudow, 1909: 136 (biological notes); Nielson & Henriksen, 1915: 19; Scheidter, 1923: 89; Torka, 1926: 166 (oviposition and parasitoids); Leonardi, 1927: 469 (parasitoids); Jansson, 1939: 37 (parasitoids and behavior).

Ichneumon (*Sirex*) *spectrum*; Scopoli, 1763: 282.

Sirex nanus O. F. Müller, 1776: 151. Type, a male from Denmark or Norway, probably destroyed. Dalla Torre, 1894: 391. Synonymized by Konow, 1898b: 226. Konow,1905a: 9; Konow, 1905b: 125; Enslin, 1918: 711; Hedicke, 1938: 23; Berland, 1947: 73; Middlekauff, 1960: 70; Smith, 1978: 88; Smith, 1979: 129; Taeger *et al*., 2010: 105. SYNONYM UPHELD.

Sirex emarginatus Fabricius, 1793: 128. Holotype, male (ZMUC), images of holotype (from the Fabrician collection in Danmark) studied. Synonymy by Klug 1803: 39. Turton, 1806: 428; Latreille, 1807: 244; Dalla Torre, 1894: 392; Konow, 1905a: 9; Berland, 1947: 73; Middlekauff, 1960: 70; Zimsen, 1964: 361; Smith, 1978: 88; Smith, 1979: 129; Taeger *et al*., 2010:

C12.1 *X. spectrum* ♀

C12.2 *X. spectrum* ♂

105. SYNONYM UPHELD.

Xiphydria emarginata; Fabricius, 1804: 53 (change in combination). Bilberg, 1820: 98.

Urocerus spectrum; Latreille, 1805: 156 (change in combination). Latreille, 1807: 243; Lepeletier, 1828: 769; Leach, 1830: 141.

Xeris spectrum; Costa, 1894: 259 (change in combination). Konow, 1898a: 74, 88; Konow, 1898b: 226; Konow, 1905a: 9; Konow, 1905b: 125; Schmiedeknecht, 1907: 772; Bradley 1913: 23; Enslin, 1918: 711, 750 (hosts); Forsius, 1919: 25; A. Müller, 1920 70: 20; Maidl, 1923: 34; Bischoff, 1925: 336; Koornneef, 1925: 357 (hosts); Dovnar-Zapolskij, 1929: 47 (hosts); Bezares, 1929: 83–107; Schmiedeknecht, 1930: 74; Hedicke, 1930:74 (hosts); Dovnar-Zapolskij, 1931: 44; Obarski, 1931a: 48 (hosts); Obarski, 1931b: 368; Yano, 1932: 474; Ass & Funtikow, 1932: 557–578 (biology, hosts and parasitoids); Reichert, 1933: 72 (hosts); Gussakovskij, 1935: 65, 343 (key and distribution); Benson, 1935: 73; Maréchal, 1935: 58; Conde, 1935: 70 (hosts); Takeuchi, 1936: 59; Hedicke, 1938: 23; Takeuchi, 1938: 194; Kôno & Sugihara, 1939: 109 (hosts); Yasumatsu, 1938: fig. 577; Francke-Grossmann, 1939: 647–680 (fungus association); Benson, 1940: 191; Gregor & Bata, 1940: 211; Lozovoyi, 1941: 206; Benson, 1943: 30, 31, 32, 48; Kjellander, 1945: 3–6, 13; Berland 1947: 73 (hosts and parasitoids); Obrtel, 1948: 11; Takeuchi, 1949: 47 (hosts); Maa 1949: 86, 170; Miyatake, 1950: 39; Andguladze, 1951: 224; Benson, 1951: 22; Gusev, 1951: 383 (hosts); Ries, 1951: 84 (North American catalog); Vité, 1952: 112, 1953: 47 (hosts); Tsinovskii, 1953: 32 (hosts); Ionescu, 1954: 330; Zhelokhovtsev *et al*., 1955: 294; Benson, 1955: 352; Takeuchi, 1955: 3, 8 (hosts); Glowacki, 1956: 14 (hosts); Ceballos, 1956: 134; Cherepanov, 1956: 73; Iwata, 1958: 51 (ovaries); Burks, 1958: 17; Stroganova, 1959: 11 (reference quoted in Stroganova, 1968); Bakke, 1960: 118, 120; Bednarz, 1960: 211 (hosts); Aerts, 1960: 310 (hosts); Precupetu & Negru, 1961: 82, 86–87 (Hosts); Viedma & Suárez, 1961: 19–24 (separation from *cobosi*); Takeuchi, 1962: 6, 11 (hosts); Taylor, 1962: 274; Kim, 1963: 295; Ceballos, 1963: 61 (hosts); Okutani, 1963: 25 (larva and hosts); Stroganova, 1963: 26, 38–41; Byalaya, 1963: 27, 28 (larva); Byalaya, 1964a: 23–41 (hosts); Byalaya 1964b: 42–63 (larva in key); Isaev & Tarasova, 1965: 9 (hosts); Zemkova, 1965: 21 (hosts); Togashi, 1965a: 231(restal papillae); Togashi, 1965b: 244; Roberti et.al., 1965: 88; Krivolutskaya & Stroganova, 1966: 61 (hosts); Bachmaier, 1966: 131 (distribution and hosts); Byalaya, 1966: 159, 163 (hosts); Tassi, 1966: 47; Weiffenbach, 1967: 99 (parasitoids); Okutani, 1967: 44 (hosts); Stroganova, 1968: 58–62, Figs. 19, 20 (hosts); Hoop, 1968: 70; Scobiola-Palade, 1968: 379; Schimitschek, 1968: 45–60 (biology, parasitoids and hosts); Wolf , 1968: 427; Ko, 1969: 314 (hosts); Wolf, 1969a: 1–39; Wolf, 1969b: 2, 6; 281–301 (reference mentioned by Smith 1978 but not found); Kim, 1970: 137, 736; Togashi, 1972: 35; Schedl, 1972: 105 (hosts); Scobiola-Palade & Istrate, 1972: 282, 287 (hosts); Gobbi, 1973: 31 (parasitoids); Móczár & Zombori, 1973: 56; Togashi, 1973: 103; Zombori, 1973: 469; Zombori, 1974a: 176; Zombori, 1974b: 239; Stroganova, 1976: 264; Schedl, 1980: 8; Smith, 1982: 16; Midtgaard 1988: 59; Blank *et al*., 1998: 33; Taeger *et al*., 1998: 129; Taeger & Blank, 1998: 338; Vasu & Saini, 1999: 279; Wei *et al*., 2006: 556; Taeger *et al*., 2006: 470; Taeger & Blank, 2006: 326; Taeger *et al*., 2010: 105; Schiff *et al*., 2012: 247, 248.

Xeris spectrum spectrum; Maa, 1949: 82, 86, 87 (change in status), 170 (catalog and hosts). Cameron, 1965: 16 (hosts); Smith, 1978: 88 (catalog, hosts); Xiao & Wu, 1983: Plate IV Figs. 3–5; Chou & Naito, 1991: 85–95; Xiao *et al.*, 1992: 42; Xiao, 2006: 200; Taeger *et al*., 2010: 105 (catalog).

Xeris spectrum; Vasu & Saini, 1999: 275, 270 281 (not Linnaeus, 1758: 560).

Diagnostic combination

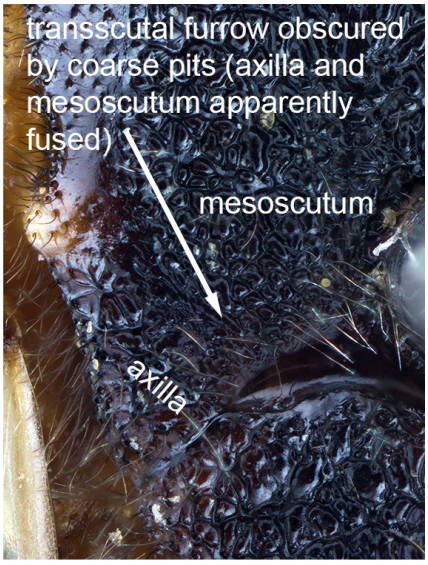
Among specimens with small, more scattered pits between dorsoposterior edge of eye and occiput outside postocellar area, with a yellowish-white fore wing cell C, and with short setae on the head (0.6–0.7 as long as diameter of a lateral ocellus) [*spectrum*, *malaisei*, *xanthoceros*, and *xylocola*], *X. spectrum* is recognized in both sexes by the wide yellowish-white longitudinal band on the lateral margin of the pronotum in dorsal view, in females by the black antenna, and in males by the light reddish-brown tarsomeres 3–5 and by the wide reddish-brown transverse band at the apex of metatarsomere 1 (about as wide or wider than basal pale band).

FEMALE. Description

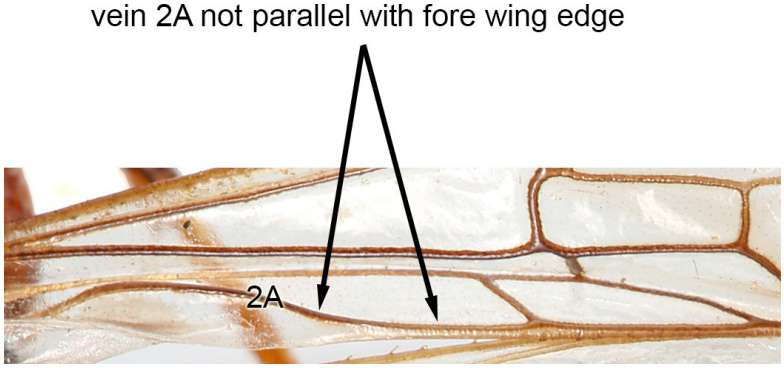
Color. Head black except for white spot (rarely missing) on gena dorsal to middle of eye; white spot often not clearly outlined and ranging from very small behind level of genal ridge to large with ventral edge extending on both sides of genal ridge (basically comma-shape) (Figs. C12.3 and Fig. C12.4); antenna black (Figs. B2.35 and B2.114)); last maxillary palpomere reddish brown at base or all black (Fig. C12.3). Thorax black except for white longitudinal marginal band extending from posterolateral to anterolateral angles including vertical portion of anterior angle, the band 0.4 times as wide as lateral 0.5 of pronotum and extending to lateral margin of pronotum (only apex of teeth black along pronotal edge) (Fig. B2.95). Legs beyond coxae light reddish brown; coxae at least black or brown on outer surface or all black, but

C12.3 *X. spectrum* ♀

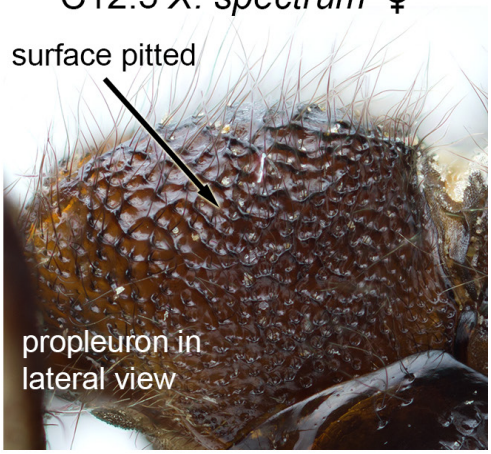
C12.4 *X. spectrum* ♂



C12.5 *X. spectrum* ♀



C12.6 *X. spectrum* ♀



C12.7 *X. spectrum* ♀

in a few specimens metacoxa completely light reddish brown (Fig. B2.99). Fore wing clear except for lightly tinted band in apical 0.25, and on posterior corner of cells 2CU and 3CU (as in Fig. B2. 67); costal cell very light yellow (paler in old specimens) (as in Fig. B2.40); most of area ventral to anal cells yellowish brown; veins black but white at base of stigma on both sides of junction with vein 1r-rs and base of veins C and R (as in Fig. B2.40). Abdomen black except cornus in 90% specimens with light reddish-brown spot anterior to anal opening, spot varying from small lateral spot lateral to anus to as much as most of ventral surface (Fig. B2.124). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye edge and lateral ocellus edge about 1.1–1.5 times as long as distance between inner edges of lateral ocelli (Fig. B2.20). Setae on clypeus 0.6–0.7 as long as diameter of a lateral ocellus (Fig. C12.3). Eye in lateral view (N = 12) with its maximum height 1.22–1.62 times as long as its maximum length (Fig. C12.3), and maximum height of eye 0.43–0.52 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (Fig. C12.3), measurements as in Fig. B2.54). Gena in dorsal view with maximum distance between outer edges clearly wider than maximum distance between outer edges of eyes (Fig. B2.22) (in frontal view outer edges of eyes clearly not intersecting genae) (as in Fig. B2.5); in lateral view with distance between outer edge of eye and genal ridge 0.37–0.59 times as long as maximum length of eye (Fig. 2.123), measurements as in Fig. B2.77), with few or no pits ventral to genal ridge, and with very small to moderate size pits (diameter of pit 0.05–0.2 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (Fig. C12.3). Transverse ridge above mandible narrow, sharp and mainly smooth (Fig. C12.3). Vertex scarcely pitted and pits medium in size (diameter of pits 0.2–0.25 times lateral ocellus diameter), pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area (fig. B2.43); pits scattered and medium in size along all of shallowly outlined and gutter-like median furrow but a little more widespread near lateral ocelli (as in Fig. B2.43).

Thorax. Pronotum in dorsal view along yellowish-white longitudinal band with irregular ridges between large teeth (Fig. B2.95) and in lateral view with coarse polygonal pits on 0.3–0.7 of posterior surface (Fig. B2.97). Propleuron in lateral view with small polygonal pits over most of surface (Fig. C12.7); in ventral view generally with dense small teeth often forming coarse polygonal pits with smooth or shallowly meshed surface in between (Fig. B2.11). Transscutal furrow of mesonotum obscured by coarse pits, thus mesoscutum and axilla apparently fused (Fig. C12.5). Fore wing in middle 0.3 of vein 2A diverging considerably (Fig. C12.6) away from wing edge, and then less (Fig. C12.6) abruptly curved away from wing edge; vein 3A absent (60%), reduced to a stump (20%), extending slightly as a short nebulous vein (6%), and extending along posterior margin of wing (14%) (N = 51).

Abdomen. Tergum 9 with meshes of microsculpture on ventral half below longitudinal furrow near center clearly impressed and sculpticells slightly raised as scales, meshes above longitudinal furrow near center well impressed and sculpticells clearly scale-like (as in Fig. B2.92, insert); median basin with base (outlined by two lateral black longitudinal furrows; N = 6) 0.8–1.2 times as wide as its median length, with maximum width of basin 1.4–2.0 times as wide as its median length and basin 0.36–0.41 times as long medially as median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) about 0.8 times as wide as maximum width subapically (as in Fig. C1.15); with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.23–0.31 times as long as apical section (N = 43) (Fig. C12.1); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); length 1.2–1.4 times as long as fore wing length. ***Ovipositor.*** Lancet with 27–33 annuli (first 15 annuli hard to see, but still outlined; N = 16); junction of basal and apical sections of sheath aligned between 3rd and 4th annuli; major pits present on last 4–5 apical annuli before teeth annuli, and with very small pit on all or almost all of preceding annuli (as in Fig. C1.18).

MALE. Description

Color. Head with dorsal spot behind eye usually clearly outlined, larger in size than spot of most females, and extending to both sides of genal ridge (basically coma-like) (Fig. C12.4). Pronotum with lateral band narrower than in females (0.3 as wide as pronotal 0.5), band becoming narrower posteriorly and not extending to lateral edge of pronotum. Coxae black; trochanter generally (94%) completely reddish brown or mainly brown; femora reddish brown to black (in most specimens reddish brown); tibiae light reddish brown in basal 0.3 and sharply separated from black surfaces, protibia light reddish brown with a narrow to wide longitudinal black band in apical 0.5 along outer 0.2–05 of dorsal surface and often with very narrow longitudinal light reddish-brown inner band, mesotibia light reddish brown with black transverse band in apical 0.6, and metatibia black except for sharply outlined yellowish-white spot at base (Figs. B2.122 and C12.2); tarsi light reddish brown except for black metatarsomere 1 (except for long reddish-brown spot at apex, apical spot longer than basal spot) (as in Figs. B2.118, B2.120 and C12.2).

Thorax. Metatibia with shallow notch on dorsal edge in

basal 0.25 (Figs. B2.118 and C12.2).

Taxonomic notes

The type specimen of *Ichneumon spectrum* is problematic. Taeger (pers. comm.) pointed out that Linnaeus (1758) clearly refers to more than one specimen. Because the specimen in London agrees with the description (Malaise and Benson, 1934), this could be enough for a lectotype designation. For now I agree with Taeger, and it is best to regard this specimen as a syntype rather than the holotype as proposed by Malaise and Benson (1934).

Xeris spectrum was treated by Maa (1949) as a polytypic species. Except for *X. himalayensis*, this is still so in the latest catalogs (Taeger and Blank 2008, Taeger *et al.* 2010). As discussed below, *X. spectrum* has no subspecies and is restricted to the Palaearctic Region. We consider *X. spectrum* auct. as a complex of two species (see "taxonomic notes" under *X. pallicoxae*). *Xeris spectrum* extends from the Atlantic coast to the Pacific coast of Eurasia in temperate and boreal regions.

Two names have been treated as synonyms of *X. spectrum*: *Sirex emarginatus* and *S. nanus*. Despite the generally accepted synonymy proposed by by Klug (1803) for *S. emarginatus* and Konow (1898b) for *S. nanus*, without reference to the descriptions and the holotypes we were able to uphold the accepted synonymy of *X. emarginatus* after our study of images of the male type. The recognition is based on the size and shape of the genal spot and the color pattern at the apex of metatarsomere 1.

Xeris nanus is more complicated. Smetana and Herman (2001) clearly stated that Müller's private collection (if it ever existed) was destroyed by the British fleet during the siege of Copenhagen in 1801. So we are left only with his description. The male (recognized from the description) of *X. nanus* best fits males of *X. spectrum* because Müller (1776) described its legs as reddish brown except for the black metatibia with white basal transverse band [*pedibus ferrugineis: tibiis posticis fuscis annulo albo*] and the metatarsi annulated [*tibiis tarsisque posticis annularis*]. If Müller had a male of *X. pallicoxae*, a less likely event in Norway where *X. spectrum* markedly dominates, his description of the leg color would have treated the mesotarsus color in the same manner as the metatarsus color because both are annulated. In males of *X. spectrum*, the pro- and mesotarsomeres are completely reddish brown and clearly not annulated. Therefore, we treat *X. nanus* as a junior synonym of *X. spectrum*.

None of the subspecies proposed by Maa (1949) are retained. There is no evidence of gene flow between any of Maa's subspecies of *X. spectrum*. All of them, except *X. spectrum townsei* Maa, a junior synonym of *X. indecisus* (Schiff *et al*. 2012), differ constantly in color pattern and structures. See "Taxonomic notes" under each of the mentioned names for more information on color and structural differences. *Xeris malaisei*, a species originally from Taiwan, is widespread in northern China, Korea, Japan and extreme southeastern Russia. In the northern part of its range, *X. malaisei* is sympatric with *X. spectrum*. *Xeris cobosi* was not known to Maa (1949) but was included as a subspecies of *X. spectrum* by Viedma and Suárez (1961) and its status remained as such (Taeger and Blank 2011, Taeger *et al.* 2010). *Xeris cobosi* is related to but distinct from *X. himalayensis*. *Xeris spectrum* is distinguished from *X. pallicoxae* in females by coxal color pattern and the distribution of a very small pit on each of the annuli anterior to typical annuli with larger pit before teeth annuli, in males by the color pattern of the mesotarsomere 1 (usually), and metatarsomere 1, and in both sexes by the sculpture on the marginal yellowish-white band of the pronotum (the most easily evaluated character state) and the vertical lateral surface of the pronotum, and by the sculpture on the lateral and ventral surfaces of the propleuron. *Xeris spectrum* is distinguished from *X. malaisei* in females by the shape of fore wing vein 2A and the flagellum color pattern, and in males by coxae and tarsi color. The North American populations considered till recently as *X. spectrum spectrum* are specifically distinct from *X. spectrum* and consist of two very similar species, *X. caudatus* and *X. melancholicus* (Schiff *et. al*., 2012). These two American species are distinguished from *X. spectrum* in females on coxal color pattern, the distribution of annular pits on annuli anterior to the apical annular group of major pits, in males on tibial color pattern at base (best seen on metatibia), and in both sexes on the dark brown base of stigma at junction with vein 1r-rs and the yellowish-brown fore wing cell C, and on pit size and abundance on gena between eye and genal ridge.

Xeris umbra, *X. xanthoceros* and *X. xylocola*, though more darkly colored, are related to *X. spectrum* and *X. malaisei* because of the presence of an extremely small pit on each of the basal annuli. *X. umbra*, the darkest species of *Xeris*, is distinguished from *X. spectrum* in both sexes by the size of setae on the clypeus and the leg color pattern, in females by the sculpticells centrally on tergum 8 and the teeth size in apical 0.3 of the cornus, in males by the almost completely or completely black legs. *X. xanthoceros* and *X. xylocola* are distinguished from *X. spectrum* in both sexes by the narrow shiny surface medially on the pronotum in dorsal view, and the mainly black pronotum in dorsal view, and in females by the light reddish-brown flagellum in apical 0.5–0.7.

Finally, the user should be aware that the refences based on European specimens could refer to *X. spectrum*, *X. pallicoxae*, or both species.

Geographical variation

Adults of *X. spectrum* show one difference in color pattern between Europe and the far eastern regions of Asia. Near the Pacific coast, the few females studied have completely black coxae. We cannot evaluate this color change as we did not have access to specimens between Europe and the Pacific coast drainage area. The change may be restricted to the Pacific drainage area or it may gradually change across Russia.

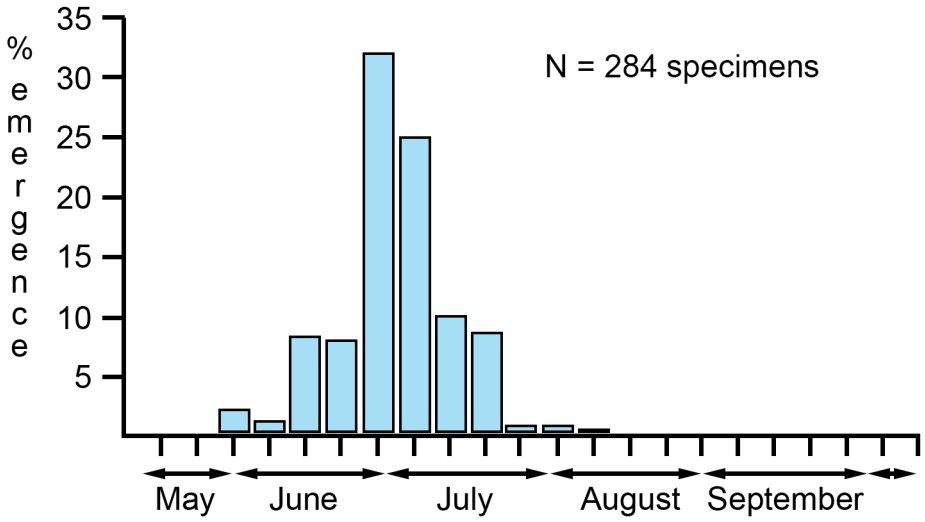
Hosts and phenology

We studied 291 specimens (BMNH) of *X. spectrum* collected by P. J. Spradbery and A. A. Kirk between 1963 and 1970. Each specimen's label includes the name "Frank Wilson" who did not collect the specimens but supervised the rearing program sponsored by the Australian government. This is only a portion of about 6205 specimens of *X. pallicoxae* and *X. spectrum* collected by them.

The results of the emergence period and the host range published (Spradbery and Kirk 1978) is based on a mixture of specimens of *X. pallicoxae* and *X. spectrum*. Their emergence period of "*X. spectrum*" was based on specimens from Turini in southeastern France. We saw about 35% (67 specimens) of their Turini sample. This sample consists of 79% *X. pallicoxae* and 21% *X. spectrum*. Most specimens of *X. spectrum* are from central and northern Europe so we pooled 284 specimens to determine phenology. The emergence cycle started in late May and ended in late July with only one clear emergence peak in late June (Fig. C12.8). These results are similar over the years, but there could be a general shift of one week either way. *Xeris pallicoxae* in contrast shows two emergence peaks during the same period with two clear peaks, one in early June and another in late June, and a very small emergence in late summer.

Xeris spectrum has a moderately wide host range within Pinaceae. Based on 150 specimens (20% of specimens at the BNMH) from Spradbery and Kirk, *X. spectrum* was reared from *Abies alba* (fir) and *Picea abies* (spruce). Amazingly, 90% of specimens were reared from *Picea abies*. This may reflect a relatively greater abundance of spruces than firs in some of the sites sampled by Spradbery and Kirk rather than a marked preference of *X. spectrum* for spruce. Spruces are common north of France and very uncommon in the Mediterranean region, based on their known distribution and their samples host data (Spradbery and Kirk 1978). Spradbery mentioned other hosts, but we are not sure yet if they should be assigned to *X. spectrum*. Except for intercepted specimens from New Zealand and the United States (acronym given in square brackets), the following published data under *X. spectrum* almost certainly includes specimens of *X. pallicoxae*. The hosts are Pinaceae: *Abies* sp. [FRNZ], *A. alba* (Enslin 1918, Spradbery *et al*. 1978), *A. borisii-regis* (Spradbery *et al*. 1978), *A. cilicia* (Spradbery *et al*. 1978), *A. equi-trojan* (Spradbery *et al*. 1978), *Larix decidua* (Spradbery *et al*. 1978), *Picea* sp. [FRNZ], *P. abies* (Enslin 1918, Spradbery *et al*. 1978) [FRNZ, USNM], *P. orientalis* (Spradbery *et al*. 1978), *P. sitchensis* (Spradbery *et al*. 1978), *Pinus* sp. [FRNZ], *P. pinaster* (Spradbery *et al.* 1978), and *P. sylvestris* (Enslin 1918, Spradbery *et al*. 1978).

Spradbery and Kirk (1978) listed parasitoids associated with larvae of *X. spectrum* and almost certainly those of *X. pallicoxae*. They included *Ibalia leucospoides leucospoides* (Hochenwarth), *I. rufipes drewseni* (Borries) (Ibaliidae) and *Megarhyssa emarginatoria* (Thunberg), *Rhyssa persuasoria* (Linnaeus), and *R.*



C12.8 *X. spectrum* ♀+♂

amoena (Gravenhorst) (Ichneumonidae).

Range

EUROPE: AUSTRIA, **BELGIUM**, **CZECH REPUBLIC**, **FINLAND**, **FRANCE**, **GERMANY**, **HUNGARY**, **ITALY**, **NETHERLANDS**, **NORWAY**, **POLAND**, **ROMANIA**, **RUSSIA** (Transbaikal, region east of Lake Baikal), **SPAIN**, **SWEDEN**, **SWITZERLAND**, and **TURKEY**. **EASTERN ASIA: JAPAN**, **RUSSIA**. Benson (1955) reports a specimen from Israel emerged from pine timber imported from Yugoslavia (Benson, 1955). *Xeris spectrum* has a transpalaearctic range from Scandinavia to easternmost Russia and Japan (apparently very rare). In Europe it is known as far south as Spain, Italy, and Hungary. Most specimens seen were north of France and Switzerland. The species no doubt occurs in northern China (Maa 1949) but we have not seen specimens.

Numerous specimens of *X. spectrum* have been intercepted at ports in the United States (7) and New Zealand (14) from the following European countries: Belgium (United States and New Zealand), Germany (United States and New Zealand), Italy (United States), Netherlands (New Zealand), Poland (United States), Russia (Japan), Switzerland (New Zealand), Turkey (United States). The species is not established outside Europe.

Specimens studied: 195 females and 250 males from BMNH, CNC, NMST, SDEI, SDEI - Col. E. Jansen, USNM, and ZMUN.

Specimens for molecular studies: 16 specimens. See Fig. D1.2d. For each specimen the following is recorded: country, year, state/province, specimen code (in italics), and number of base pairs.

EUROPE. Austria: *S69*, 658. **Germany**: 1975, *S64*, 658; 1977, *S216*, 658; 1977, *S272*, 658; 1977, *S274*, 658; 1977, *S342*, 658; 1978, *S355*, 658; 1977, *S373*, 658; 1977, *S376*, 658; 1977, *S464*, 658. **France**: 1978, *S220*, 658. **Italy**: 2005, *CBHR 41*, 658; 1978, *S235*, 658. **Japan**: 1977, *S375*, 658. **Netherlands**: 2007, *CBHR* 1090, 658. **Russia (eastern)**: *SIR 161*.

13. *Xeris tarsalis* (Cresson)

Fig. C13.1, (female habitus); Schiff *et al.* 2006: 98, 99
Fig. C13.2, (male habitus) ; Schiff *et al.* 2006: 97

Urocerus tarsalis Cresson, 1880: 52. Holotype female (ANSP), examined by D. R. Smith. Type locality: "Washington Territory". Harrington, 1893: 148; Cresson 1916: 10.

Sirex tarsalis; Kirby, 1882: 382 (change in combination). Dalla Torre, 1894: 393.

Xeris macgillivrayi Bradley, 1913: 24, figs. 30, 35. Holotype female [published measurements suggest one specimen] (CUIC) [according to Maa (1949), but not listed by Hoebeke (1980)], not examined. Type locality: "Collected near Olympia, Washington by Mr. T. Kincaid", as hand stamped on some copies, but no locality, number of specimens and depository given. Hedicke, 1938: 23 (catalog); Ries, 1951: 84; Middlekauff 1960: 69 (hosts). Synonymy by Maa 1949: 80, 82–83; Burks 1958: 17, Cameron, 1965: 16 (hosts); Westcott, 1971: 310 (host).

Xeris tarsalis; Maa, 1949: 82, 83 (change in combination). Burks 1958: 17 (catalog and hosts); Cameron, 1965: 16 (hosts); Westcott, 1971: 310 (hosts); Furniss & Carolin, 1977: 454, 457 (host and range); Smith 1979: 129 (catalog and hosts); Taeger *et al*., 2010: 105 (catalog); Schiff *et al*., 2012: 265.

Xeris morrisoni; synonymy by Konow, 1898a: 88 (not Cresson, 1880: 35). Bradley, 1913: 24; Hedicke, 1938: 23 (catalog); Ries, 1951: 84 (catalog); Middlekauff, 1960: 69.

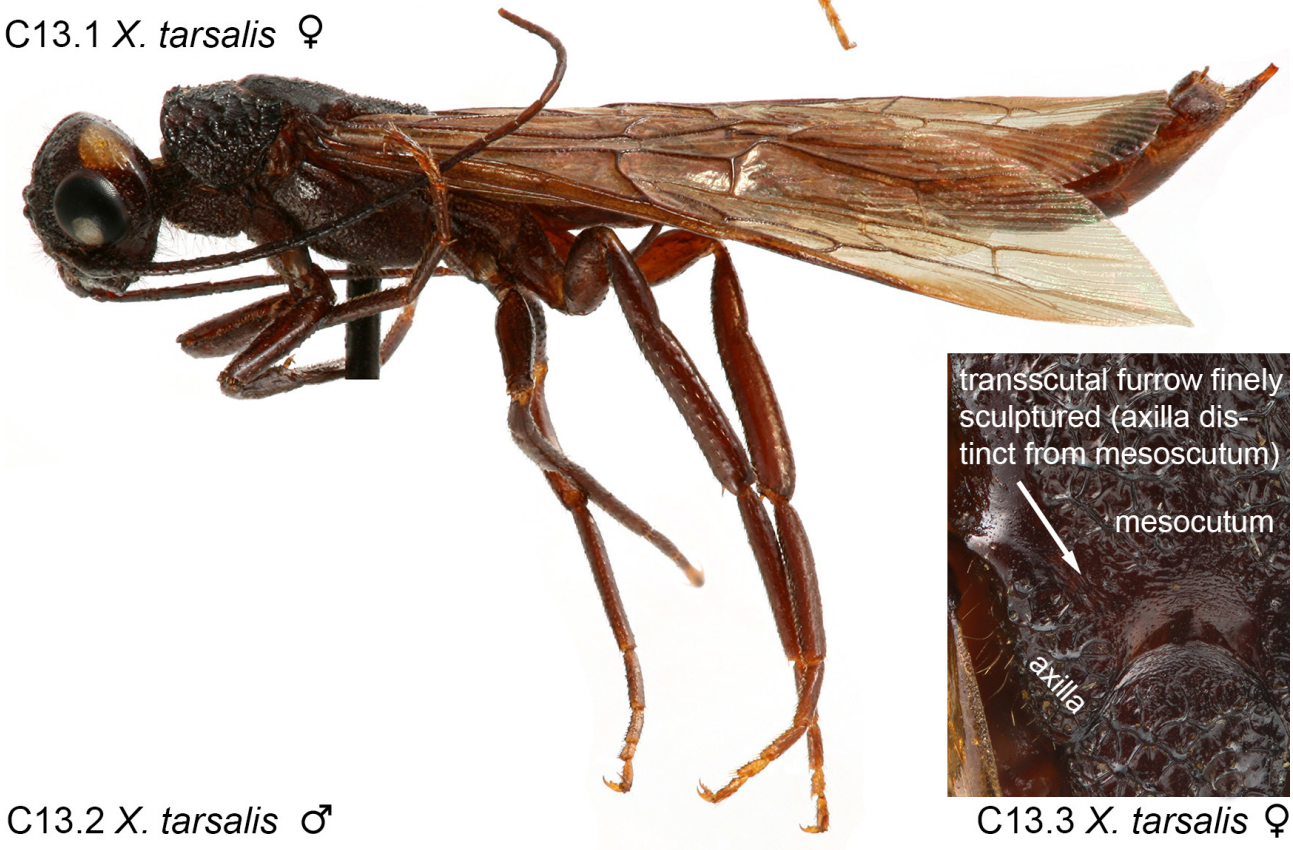
Diagnostic combination

Both sexes of *X. tarsalis* are easily distinguished from all other *Xeris* species in both sexes by the narrow gena (in frontal view, the outer edges of eyes touching or slightly intersecting the genae) and by the widespread and dense pits covering almost the entire vertex, and in females by the short apical section of the sheath (the basal section of sheath is about 0.6 times as long as the apical section) and by the absence of a lateral ridge on the apical section of the sheath.

FEMALE. Description

Color. Head and thorax black except for small white spot on gena dorsal to middle of eye; white spot not extending down to genal ridge (Fig. B2.6); antenna black but becoming reddish brown in apical 0.3 (Fig. C13.1); last maxillary palpomere black. Thorax black (Fig. C13.1). Legs black but becoming reddish brown at base of tibiae and apex of metatibia, and tarsi reddish brown (Fig. C13.1). Fore and hind wings darkly tinted (including cell C) (as in Fig. B2.57), veins black or brown (including veins C, R and base of stigma on both sides of junction with vein 1r-rs) (as in Fig. B2.57). Abdominal segments 2–10 and sheath reddish brown but black on tergum 1, and lateral edge of terga 2–7 and sterna 2–7 (Fig. C13.1).
Head. Distance between nearest eye edge and lateral ocellus edge about 0.8–1.0 times as long as distance between inner edges of lateral ocelli (Fig. C1.4). Setae on clypeus slightly 0.7 as lon as diameter of a lateral ocellus Fig. B2.6). Eye in lateral view (20 specimens measured) with its maximum height 1.21–1.37 times as long as its maximum length (Fig. B2.6), and maximum height of eye 0.52–0.60 times as long as maximum height of head (from

C13.1 *X. tarsalis* ♀



C13.2 *X. tarsalis* ♂

C13.3 *X. tarsalis* ♀

transverse ridge on gena above mandible to top of head) (Fig. B2.6). Gena in dorsal view with maximum distance between outer edges as wide as maximum width between outer edges of eyes (Fig. B2.1) (in frontal view, outer edges of eyes touching or slightly intersecting genae) (Fig. B2.4); in lateral view with distance between outer edge of eye and genal ridge 0.42–0.64 times as long as maximum length of eye (Fig. B2.6). Gena with almost no pits ventral to genal ridge, and with many pits (diameter of pit 0.3 times lateral ocellus diameter) between outer edge of eye and genal ridge pits (Fig. B2.6). Transverse ridge near mandible narrow, sharp and mainly smooth (Fig. B2.6). Vertex densely pitted and pits large in size (diameter of pit 0.3–0.4 times lateral ocellus diameter) with almost no smooth sublateral area, and densely pitted along median gutter-like furrow (Fig. B2.1).

Thorax. Pronotum in lateral view with coarse polygonal pits outlined by sharp ridges in a reticulate pattern on 0.95 of surface (Fig. B2.15). Propleuron in lateral view with medium size polygonal pits on most of disc (as in Fig. C12.7); in ventral view with scattered to moderately dense, shallow small teeth and with clearly outlined microsculpture meshes in between (sculpticells scale-like) (Fig. B2.9). Transscutal furrow of mesonotum clearly outlined and finely sculptured, thus mesoscutum and axilla clearly distinct (Fig. C13.3). Fore wing in middle 0.3 of vein 2A diverging very rarely slightly (as in Fig. C11.6) to usually considerably (as in Fig. C12.6) away from wing edge and then more (as in Fig. C11.6) or less (as in Fig. C12.6) abruptly curved away from wing edge; vein 3A extending toward posterior wing margin as a nebulous vein.

Abdomen. Tergum 9 with meshes of microsculpture on sublateral and dorsal surfaces shallowly outlined and sculpticells flat (surface bright), and dorsal surface outside median basin smooth (as in Fig. B2.93, insert); median basin with base (outlined by two lateral black longitudinal furrows) 0.7 times as wide as its median length, maximum width of basin 1.3 times as wide as its median length, and basin 0.6 times as long as median length of cornus (measurements as in Fig. A3.2). Cornus not constricted in dorsal view, its minimum width equal to maximum width subapically (Fig. C1.14); with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.6 times as long as apical section (N = 20) (Fig. B2.12); lateral surface of apical section without ridge (Fig. B2.12, insert); length 1.0–1.1 times as long as fore wing length. ***Ovipositor.*** Lancet with 35–37 annuli (all annuli clearly outlined; N = 5); junction of basal and apical sections of sheath aligned between 8th and 9th annuli, or 9th and 10th annuli; pit present and large on each of the annuli before teeth annuli, with anterior end extending to each preceding annulus as shallow furrow (Fig. B2.16).

MALE. Description

Color. Head with dorsal spot behind eye similar in size to female. Antenna, coxae, tibiae and tarsi (except tarsomeres 3–5 or 4 and 5) black (Fig. C13.2). Abdomen reddish brown or paler on terga 2–7 or 2–8, and black on tergum 1 or 1 and 2, and on sterna 2–9 (Fig. C13.2).

Thorax. Metatibia with shallow notch on dorsal edge in basal 0.25 (Fig. C13.2).

Taxonomic notes

Females of *X. tarsalis* have an unusually short ovipositor. However, the most unusual feature is the presence on the ovipositor of a large pit for each annulus from annulus 2 up to the teeth annuli. In all other species of *Xeris*, the ovipositor is smooth except for a few small pits near the apex or an extremely small pit on one or more annuli anterior to the typical apical group of pits. This structural difference may reflect a different life style. For example, the common *X. caudatus* has small mycangia, but no fungus in them (Schiff *et al*. 2012). Larvae of *X. caudatus* probably survive on fungi brought by other Siricidae, as observed by Fukuda *et al*. (1997) with *X. malaisei* in Japan. When considering that the main hosts all belonging to the Cupressaceae, a family almost never used by North American *Xeris*, it would not surprise us if females of *X. tarsalis* might be able to carry fungal oidea in their mycangia.

Hosts and phenology

Xeris tarsalis has a moderate host range (Middlekauff 1960, Cameron 1965, Westcott 1971). Based on 138 reared and confirmed specimens, all host are Cupressaceae: *Cupressus macrocarpa* (131), *Juniperus sp.* (2), *J. occidentalis* (3) [from scorched trees (Westcott 1998)], *Calocedrus decurrens* (5), and *Thuja plicata*.

Based on 108 field-collected specimens, the earliest and latest capture dates are early March to early October. The main flight period is from early July to early October with a peak from early September to early October.

Range

United States: California (Middlekauff, 1960), Oregon, South Carolina (probably not established), Washington. *Xeris tarsalis* is known from the Cascade Mountains and Sierra Nevada west to the Pacific coast (Cameron 1965, Smith 1979) (see map C41.3 in Schiff *et al*. 2012). One female was collected emerging from wood in South Carolina, and we have seen a female (FRNZ) intercepted in Auckland, New Zealand.

Specimens studied and included for the distribution map: 67 females and 77 males from CUCC, OSAC and USNM.

14. *Xeris tropicalis* Goulet

Fig. C14.1 (female habitus)

Xeris tropicalis Goulet, 2012: 267. Holotype female (CNC), labelled: [White] "6 mi.N.E. San Cristobal L. C., Chis. Mex. V.19 1969 H. E. Howden", [White & black frame] "Xeris tarsalis (Cr.) D. R. Smith 75", [Red] "HOLOTYPE Xeris tropicalis Goulet CNC No. 23908". Type locality: Mexico, Chiapas, San Cristobal de las Casas. Specimen in perfect condition except left antenna broken and glued on label. Schiff *et al*., 2012: 267.

Xeris tarsalis; Smith, 1978: 89; Smith, 1988:243 (not Cresson, 1880: 52).

Diagnostic combination

Though only the female is known, we assumed that both sexes of *X. tropicalis* will be recognized by the broadly rounded and coarsely pitted transverse ridge dorsal to the mandible, the widespread and dense pits on the head dorsally, and the dense pits on the gena ventral to the genal ridge that are continuous with pits on the occiput.

FEMALE. Description

Color. Head and thorax black except for white spot extending from dorsal edge of eye to surface between genal ridge and outer edge of eye (Fig. B2.17); antenna black but 7 apical flagellomeres reddish brown; last maxillary palpomere black. Pronotum in dorsal view with small white spot on anterolateral corner (Fig. C14.1). Legs black except sharply yellowish white at extreme apex of femora, basal 0.2 of tibiae, and base of tarsomere 1 (Figs. B2.23 and C14.1). Wings very darkly tinted except for clear basal 0.3 of hind wing, veins black or brown (including veins C, R and base of stigma on both sides of junction with vein 1r-rs) (Fig. C14.1 and as in Fig. B2.65). Abdomen black at base, but reddish brown after tergum 1. Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest edge eye edge and lateral ocellus edge 0.95 times as long as distance between inner edges of lateral ocelli (Fig. B2.19). Setae on frons and clypeus twice as long as diameter of a lateral ocellus (Figs. B2.17 and B2.27). Eye in lateral view (N = 1) with its maximum height 1.23 times as long as its maximum length (Fig. B2.17), and maximum height of eye 0.51 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (Fig. B2.7). Gena in dorsal view with maximum distance between outer edges hardly wider than maximum width between outer edges of eyes (Fig. B2.2) (in frontal view, outer edges of eyes not intersecting genae, but very close to them) (less markedly so than in Fig. B2.5); in lateral view with distance between outer edge of eye and genal ridge 0.42 times as long as maximum length of eye (Fig. B2.17, measurements as in Fig. B2.77). Gena densely pitted ventral to genal ridge (Fig. B2.17), and with many very small to medium size pits (diameter of pit 0.05–0.3 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (Fig. B2.17). Transverse ridge above mandible broadly rounded and coarsely pitted (Fig. B2.17). Vertex densely pitted and pits medium in size (diameter of pit 0.2–0.3 times lateral ocellus diameter), pits present on dorsoposterior edge of eye to occiput outside postocellar area, absent on small portion of postocellar area (Fig. B2.28); pits dense, medium in size, and widespread along all very shallow gutter-like median furrow, a little more widespread near lateral ocelli (Fig. B2.28).

Thorax. Pronotum in lateral view without polygonal pits on surface. Propleuron in lateral view with medium size polygonal pits on most of disc (as in Fig. C12.7); in ventral view with dense pits (hardly raised anteriorly) and a few smooth surfaces between pits with shallowly impressed meshes of microsculpture (Fig. B2.10). Transscutal furrow of mesonotum clearly outlined and finely sculptured, thus mesoscutum and axilla clearly distinct (Fig. C14.3). Fore wing in middle 0.3 of vein 2A diverging considerably (as in Fig. C12.6) away from wing edge, and then less (as in Fig. C12.6) abruptly curved away from wing edge; vein 3A reduced to a stump or absent.

Abdomen. Tergum 9 with meshes of microsculpture on ventral half below and above longitudinal furrow near center not well impressed and sculpticells clearly flat (slightly raised as scale above furrow) (as in Fig. B2.93, insert); median basin with base (outlined by two lateral black longitudinal furrows) 0.8 times as wide as its median length of basin, with maximum width of basin 1.7 times as wide as its median length, and basin 0.45 times as long medially as median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) 0.85 times as wide as maximum width subapically; with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.4 times as long as apical section (N = 1) (Fig. B2.13); lateral surface of apical section with well-defined ridge (Fig. B2.13, insert); as long as fore wing length. ***Ovipositor.*** Lancet with 31 annuli (first 14 annuli outlined but difficult to see; N= 1); junction of basal and apical sections of sheath aligned between 4th and 5th annuli; major pits present on last 6 annuli before teeth annuli, and a very small pit on each of the two preceding annuli (as in Fig. C1.18).

MALE. Unknown.

Taxonomic notes

C14.1 *X. tropicalis* ♀

C14.2 *X. tropicalis* ♀

At first sight the female of this species resembles that of *X. tarsalis* (Smith 1978), but upon close examination there are amazingly marked differences on the sheath and the ovipositor. We found additional structural differences on the pronotum and the propleuron sculpture, and color differences on in the legs and hind wing. In several characters (proportion between basal and apical sections of the sheath, between height of eye and height of head) this species represents an intermediate stage between *X. tarsalis* and the remaining species of *Xeris*. The female is unique in having numerous pits on the transverse ridge above the mandible and in leg color.

Host and phenology

The host of *X. tropicalis* is unknown but conifers are suspected. The single female was captured in mid-May.

Range

Mexico: Chiapas. *Xeris tropicalis* is only known from the holotype, with the type locality in southernmost Mexico (see map C41.3 in Schiff *et al*. 2012).

15. *Xeris umbra* Goulet n. sp.

Fig. C15.1 (female habitus)
Fig. C15.2 (male habitus)
http://zoobank.org/NomenclaturalActs/F69FF7EF-3751-409A-86EF-1E4F66D14021

Type material

Holotype. Female (OLML), in perfect condition (apical five flagellomeres of left antenna glued), labelled [White] "China, Yunnan prov. 1.-19.7.1992 Heishui 35 km N of Lijiang 27, 13 N 100, 19 E Lgt. S.Becvar"; [White] "LI egg. 1992/93ex Coll.j.Halada"; [Red] "HOLOTYPE Xeris umbra ♀ H. Goulet, 2015".

Paratypes. (6 males). CHINA: Yannan, Heishui 35 km N of Lijiang 27, 13 N 100,19 E (2 M, OLML); Yunnan, 25 km E Zhongdian 22.6.1998 3500 m Leg. S. Muzin (3 M, OLML); Yunnan, Yulongshan Mts. 3500-4000m 27.10N 100.13E 16-19/6. 1993 Vít Kubàň (1 M, OLML).

Diagnostic combination

Among specimens with a yellowish-white fore wing cell C cell and with vertex bearing less dense pits (usually not touching) and finer pits (0.05–0.25 times of lateral ocellus) between the eye dorsal edge and the occiput outside postocellar area [*umbra*, *malaisei*, *pallicoxae, spectrum, xanthoceros* and *xylocola*], *X. umbra* is recognized in both sexes by the long setae on the clypeus (setae 1.0–1.4 times as long as length of lateral ocellus) and the very fine and poorly outlined pits on metanotum posterior to cenchrus and laterally on metascutellum, and in females by the small teeth on the apical 0.3 of cornus.

FEMALE. Description

Color. Head black except for white spot (rarely missing) on gena dorsal to middle of eye; white spot often not clearly outlined and small, and with ventral edge not extending to genal ridge (Fig. C15.3); antenna black; last maxillary palpomere black (Fig. C15.3). Thorax black (Fig. B2.67). Legs with coxae, trochanters, basal 0.8 of femora black, and apical 0.5 of tarsomeres 1 black, tarsomeres 2–5 brown; apical 0.2 of femora, tibiae and basal 0.5 of tarsomeres 1 light reddish brown (Figs. B2.106 and C15.1). Fore wing clear except for lightly tinted band in apical 0.25, and along a central band outlined by cells 2CU, 3CU, 1M and 1R1 (as in Fig. B2. 67); cell C very light yellow (paler in old specimens) (as in Fig. B2.40); most of area ventral to anal cells yellowish brown; veins black but white at base of stigma on both sides of junction with vein 1r-rs (as in Fig. B2.40). Abdomen black (Fig. C15.1). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye edge and lateral ocellus edge about 1.5 times as long as distance between inner edges of lateral ocelli (as in Fig. B2.20). Setae on clypeus setae 1.0–1.4 times as long as length of lateral ocellus (Figs. B2.102 and C15.3). Eye in lateral view (N = 1) with its maximum height 1.5 times as long as its maximum length (Figs. B2.102 and C15.3), and maximum height of eye 0.46 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head (Fig. B2.102), measurements as in Fig. B2.8). Gena in dorsal view with maximum distance between outer edges clearly wider than maximum distance between outer edges of eyes (Fig. B2.43), in frontal view outer edges of eyes clearly not intersecting genae (as in Fig. B2.5); in lateral view with distance between outer edge of eye and genal ridge 0.4 times as long as maximum length of eye (Figs. B2.102 and C15.3), measurements as in Fig. B2.77), with few or no pits ventral to genal ridge, and with many small size pits (diameter of pit 0.1 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (Figs. B2.102 and C15.3). Transverse ridge above mandible narrow, sharp and mainly smooth (Fig. C15.3). Vertex scarcely pitted and pits medium in size (diameter of pits 0.2–0.4 times lateral ocellus diameter) (Fig. B2.43); pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area, pits dense medium in size along all of shallowly outlined and gutter-like median furrow but a little more widespread near lateral ocelli (as in Fig. B2.43).

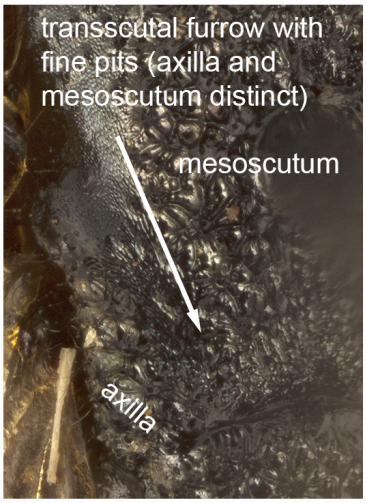
Thorax. Pronotum in dorsal view along lateral margin with irregular ridges between large teeth (Fig. B2.95) and with a wide shiny surface medially, surface widest

C15.1 *X. umbra* ♀

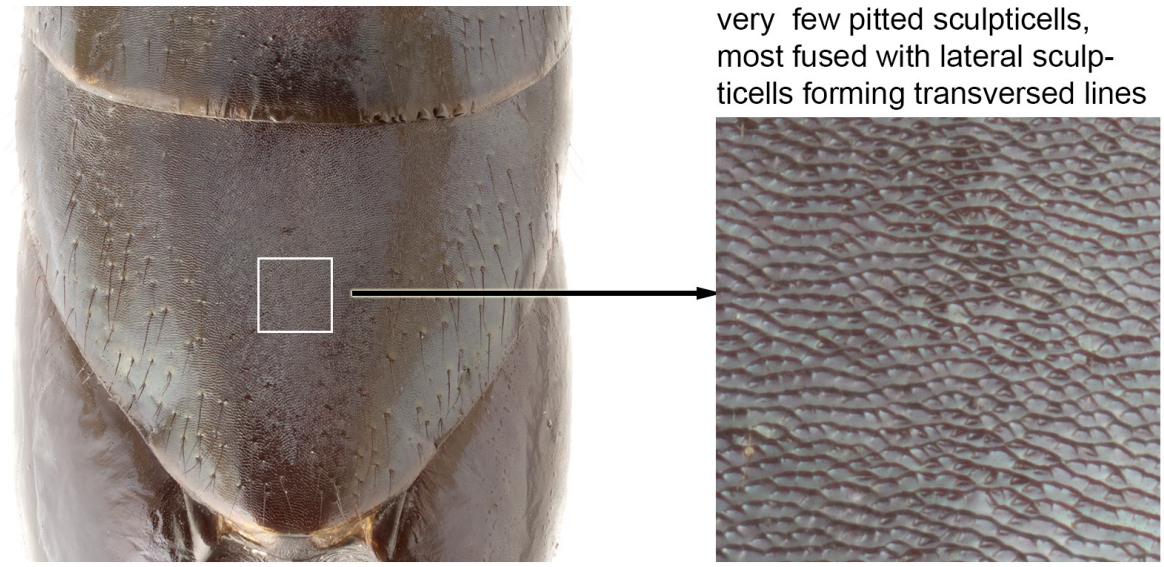
C15.2 *X. umbra* ♂

C15.3 *X. umbra* ♀

C15.4 *X. umbra* ♂



C15.5 *X. umbra* ♂


very few pitted sculpticells,
most fused with lateral sculp-
ticells forming transversed lines

C15.6 *X.umbra* ♀

anteriorly with a deep impression behind middle (as in Fig. B2.134, insert); in lateral view with coarse polygonal pits on 0.5 of posterior surface (Fig. B2.97). Propleuron in lateral view with small polygonal pits over most of surface (as in Fig. C12.7); in ventral view generally with dense teeth often forming shallow pits with shallowly impressed meshed of microsculpture in between (Fig. B2.11). Transscutal furrow of mesonotum obscured by coarse pits, thus mesoscutum and axilla apparently fused (Fig. C15.5). Metanotum with surface posterior to cenchrus and lateral 0.5 of metascutellum finely pitted (pit 0.1 times as wide as diameter of lateral ocellus) (Fig. B2.104). Fore wing in middle 0.3 of vein 2A diverging considerably (as in Fig. C12.6) away from wing edge, and then less (as in Fig. C12.6) abruptly curved away from wing edge; vein 3A absent.

Abdomen. Tergum 8 on central area consisting mainly of partly fused and flat sculpticells forming transverse lines of various lengths, pitted sculpticells uncommon medially and not so deep (Fig. 15.6); lateral margin shiny on apical 0.5 (as in Fig. B2.141, insert). Tergum 9 with meshes of microsculpture on ventral half below longitudinal furrow near center impressed and sculpticells mainly flat, meshes above longitudinal furrow near center well impressed and sculpticells clearly scale-like (as in Fig. B2.92, insert); median basin with base (outlined by two lateral black longitudinal furrows; N = 1) 0.85 times as wide as its median length, with maximum width of basin 1.3 times as wide as its median length and basin 0.45 times as long medially as median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) about 0.8 times as wide as maximum width subapically (as in Fig. C1.15); with small teeth in apical 0.3 (Fig. B2.109). ***Sheath.*** Basal section 0.36 times as long as apical section (N = 1) (Fig. C15.1); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); length 1.2 times as long as fore wing length. ***Ovipositor.*** Lancet with annuli beyond 7 missing; junction of basal and apical sections of sheath aligned between 3rd and 4th annuli; apical section of ovipositor missing, probably major pits present on last 4–5 apical annuli before teeth annuli, and with small to very small pit on all or almost all of preceding annuli up to annulus 5 (as in Fig. C1.18).

MALE. Description

Color. Head with dorsal spot behind eye clearly outlined, larger in size than spot in female, and extending to genal ridge (Fig. C15.4). Pronotum dorsally completely black, or black with anterolateral corner yellowish white, or black with anterolateral corner yellowish white extended toward posterolateral corner, or black with yellowish-white band extending to posterolateral corner; anterior vertical surface below anterolateral corner with a black, or brown, or white spot (as in Figs. B2.57, B2.54, B2.55, B2.58). Legs black, or with basal 0.1 of tibiae clearly yellowish white. (Figs. B2.111 and C15.2). Fore wing almost completely clear except for a light tint around the junction of veins Cu and 2cu-a and cell 1R1 (Fig. C15.2).

Thorax. Metatibia with a shallow to deep notch on dorsal edge in basal 0.25 (Fig. C15.2).

Taxonomic notes

Adults of *X. umbra* are the darkest specimens of *Xeris*. They are easily distinguished on color pattern and some structural features from all other species of *Xeris*. They are related to the *X. spectrum* lineage as shown by the presence of a very small pit on each of the most basal annuli.

Origin of specific epithet

The specific name "*umbra*" is a noun in apposition meaning "shadow" referring to the very dark color pattern of both sexes.

Range

CHINA, Yunnan.

16. *Xeris xanthoceros* Goulet n. sp.

Fig. C16.1 (female habitus)

http://zoobank.org/NomenclaturalActs/D45059E9-9D35-4235-B9DE-611C3DBFD050

Type material

Holotype. Female (OLML), in good condition but four last flagellomeres on the left and 8 on the right missing, and apical section of right sheath glued on point, labelled [White] "China, Yunnan, 2, 5-3, 8km 27,20N; 100, 11E Habashan mts. SE slope 3.-6. Lgt. S.Becvar, 1995"; [Red] "HOLOTYPE Xeris xanthoceros ♀ H. Goulet, 2015".

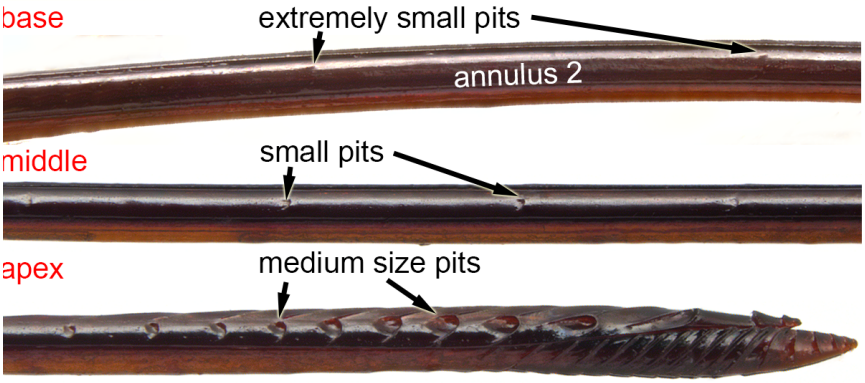
Diagnostic combination

Among specimens with a light yellow fore wing cell C cell and with short setae on the head [*xanthoceros*, *malaisei*, *pallicoxae*, *spectrum*, and *xylocola*], *X. xanthoceros* is recognized in the female and probably the male by the narrow shiny surface medially on the pronotum dorsally and the more restricted coarse pits on the lateral surface of the pronotum, and in the female by the light reddish-brown flagellum beyond flagellomere 4 and by the black pronotum.

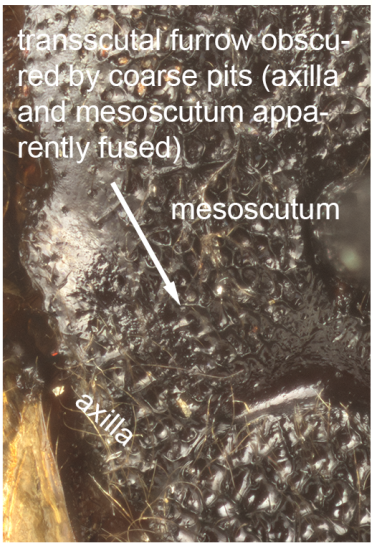
FEMALE. Description

Color. Head black except for white spot (rarely missing) on gena dorsal to middle of eye; white spot not clearly

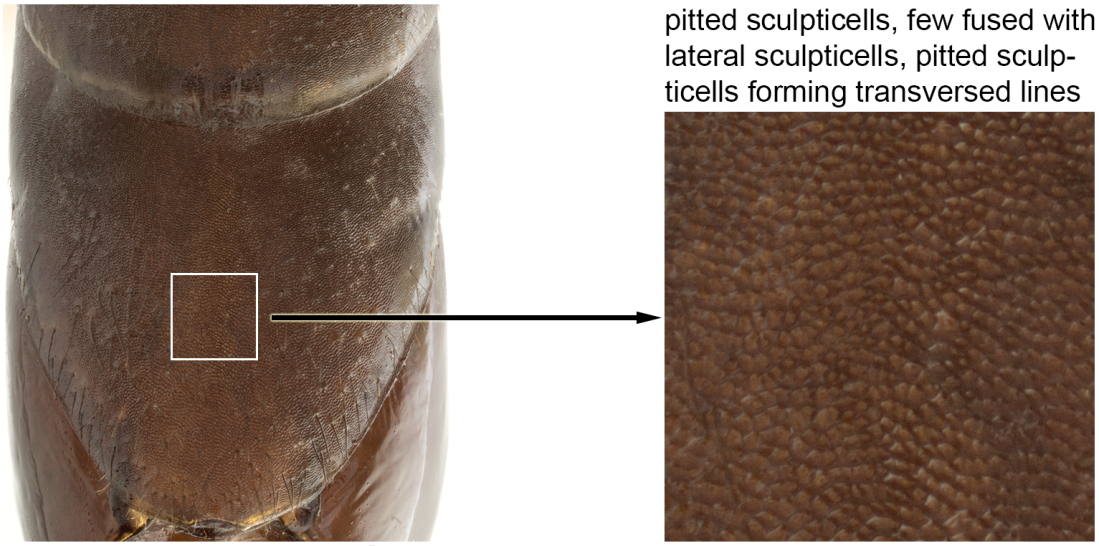
C16.1 *X. xanthoceros* ♀



C16.2 *X. xanthoceros* ♀



C16.3 *X. xanthoceros* ♀



C16.4 *X. xanthoceros* ♀

outlined and ventral edge not extending to genal ridge (Fig. B2.139); scape and pedicel light reddish brown ventrally and brown dorsally, flagellomere 1–3 brown and following flagellomeres light reddish brown; last maxillary palpomere reddish brown (Fig. B2.117). Thorax black except for yellowish-white band on pronotum along margin and below anterolateral corner (Fig. B2.143). Legs beyond coxae light reddish brown; coxae black (Fig. C16.1). Fore wing clear except for lightly tinted band in apical 0.25, and near junction of veins CU and 2 cu-a (as in Fig. B2. 67); costal cell very light yellow (paler in old specimens) (as in Fig. B2.40); most of area ventral to anal cells yellowish brown; veins black but white at base of stigma on both sides of junction with vein 1r-rs (as in Fig. B2.40). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye edge and lateral ocellus edge about 1.3 times as long as distance between inner edges of lateral ocelli (as inFig. B2.20). Setae on clypeus 0.6–0.7 as long as length of lateral ocellus (Fig. B2.139). Eye in lateral view (N = 1) with its maximum height 1.4 times as long as its maximum length (Fig. B2.139), and maximum height of eye 0.53 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (Fig. B2.139), measurements as in Fig. B2.8). Gena in dorsal view with maximum distance between outer edges a little wider than maximum distance between outer edges of eyes (as in Fig. B2.43) (in frontal view outer edges of eyes clearly not intersecting genae) (as in Fig. B2.5); in lateral view with distance between outer edge of eye and genal ridge 0.45 times as long as maximum length of eye (Fig. 2.139), measurements as in Fig. B2.77), with few or no pits ventral to genal ridge, and with small to moderate size pits (diameter of pit 0.1–0.2 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (Fig. B2.139). Transverse ridge above mandible narrow, sharp and mainly smooth (Fig. B2.139). Vertex scarcely pitted and pits medium in size (diameter of pits 0.2–0.3 times lateral ocellus diameter), pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area, pits dense and medium in size along all of shallowly outlined and gutter-like median furrow but a little more widespread near lateral ocelli (as in Fig. B2.43).

Thorax. Pronotum in dorsal view along yellowish-white longitudinal band with irregular ridges between large teeth (Fig. B2.95) and with a narrow parallel shiny surface medially, the surface without impression (Fig. B2.135); in lateral view with coarse polygonal pits on 0.3–0.7 of posterior surface (Fig. B2.97). Propleuron in lateral view with small polygonal pits over most of surface (Fig. C12.7); in ventral view generally with dense small teeth often forming coarse polygonal pits with smooth or shallowly meshed surface in between (Fig. B2.11). Transscutal furrow of mesonotum obscured by coarse pits, thus mesoscutum and axilla apparently fused (Fig. C16.3). Metanotum with surface posterior to cenchrus and lateral 0.5 of metascutellum coarsely pitted (pit 0.1–1.5 times as wide as diameter of lateral ocellus) (as in Fig. B2.105). Fore wing in middle 0.3 of vein 2A diverging considerably (Fig. C12.6) away from wing edge and then less (Fig. C12.6) abruptly curved away from wing edge; vein 3A reduced to a stump (N = 1).

Abdomen. Tergum 8 on central area with deeply pitted sculpticells forming transverse lines of various lengths, and lateral margin not shiny (Fig. B2.141, insert). Tergum 9 with meshes of microsculpture on ventral half below longitudinal furrow near center clearly impressed and sculpticells flat, meshes above longitudinal furrow near center well impressed and sculpticells scale-like (as in Fig. B2.92, insert); median basin with base (outlined by two lateral black longitudinal furrows; N = 1) 0.9 times as wide as its median length, with maximum width of basin 1.4 times as wide as its median length and basin 0.57 times as long medially as median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) about 0.8 times as wide as maximum width subapically (as in Fig. C1.15); with large teeth in apical 0.3 (as in Fig. B2.110). ***Sheath.*** Basal section 0.30 times as long as apical section (N = 1) (Fig. C16.1); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); length 1.4 times as long as fore wing length. ***Ovipositor.*** Lancet with 28 annuli (first 5 annuli hard to see, but still outlined; N = 1); junction of basal and apical sections of sheath aligned between 3rd and 4th annuli; major pits present on last 8 apical annuli before teeth annuli, and with a small pit on each of the annuli 2–6 annuli and a very small pit on each of the annuli 7–19 (Fig. C16.2).

MALE. Unknown.

Taxonomic notes

Xeris xanthoceros is related to species of the *X. spectrum* lineage based on the presence of a pit on each of the most basal annuli. It is also similar to females of *X. xylocola* and *X. malaisei* because of their partially light reddish-brown flagellum. It is closest to *X. xylocola* because of the narrow shiny median surface of the pronotum in dorsal view. The two species are segregated on color pattern and structure.

Origin of specific epithet

The specific name "*xanthoceros*", a noun, means "yellow horn" referring to the mainly light reddish-brown flagellum of the female.

Range

CHINA, Yunnan.

17. *Xeris xylocola* Goulet n. sp.

Fig. C17.1 (female habitus)
Fig. C17.2 (male habitus)
http://zoobank.org/NomenclaturalActs/5D2922BD-06B4-4F60-A3D5-D603FFC6C304

Type material

Holotype. Female (OLML), in perfect condition, labelled [White] " LAO, Hua Phan Prov. Ban Salui; Phou Pan-Mt 20˚13'30"N / 103˚59'26"E GPS 1350-1900m, 06.05.2010 Leg. C. Holzschuh + locals"; [Red] "HOLOTYPE Xeris xylocola ♀ H. Goulet, 2015".

Paratypes (3 females and 1 male). Same locality as holotype except for collecting date. 28-29.iv.2010 (1F, OLML); 19.v.2011 (2M, OLML); 28.v.2011 (1M, OLML); 15-16.v.2012 (1F, OLML).

Diagnostic combination

Among specimens with a light yellow fore wing cell C and with short setae on the head [*malaisei*, *pallicoxae*, *spectrum*, and *xanthoceros*], *X. xylocola* is distinguished in both sexes by the narrow shiny surface medially on the pronotum and the widespread coarse pits on most of the lateral surface of the pronotum, in females by the light reddish-brown spot above and below the anterolateral corner of the pronotum, and the reddish-brown flagellum beyond flagellomere 7–10, and in males by the well outlined yellowish-white spot extending on both sides of the genal ridge (spot basically comma-like).

FEMALE. Description

Color. Head black except for white spot (rarely missing) on gena dorsal to middle of eye; white spot not clear, or not clearly outlined and ventral edge not extending to genal ridge (Fig. B2.103); scape and pedicel black, flagellomere 1–7 or 1–10 black and following flagellomeres light reddish brown; last maxillary palpomere black (Fig. B2.116). Thorax black except for yellowish-white band on pronotum along margin and below anterolateral corner (Fig. B2.125). Legs beyond coxae light reddish brown; coxae black (Figs. B2.132 and C17.1). Fore wing clear except for lightly tinted band in apical 0.25, and near junction of veins CU and 2 cu-a (as in Fig. B2. 67); cell C very light yellow (paler in old specimens) (as in Fig. B2.40); most of area ventral to anal cells yellowish brown; veins black but white at base of stigma on both sides of junction with vein 1r-rs (as in Fig. B2.40). Sheath with apical section black and basal section reddish brown.

Head. Distance between nearest eye edge and lateral ocellus edge about 1.5–1.9 times as long as distance between inner edges of lateral ocelli (as in Fig. B2.20). Setae on frons and clypeus 0.6–0.7 as long as as long as diameter of a lateral ocellus (Fig. B2.103). Eye in lateral view (N = 4) with its maximum height 1.29–1.54 times as long as its maximum length (Fig. B2.103), and maximum height of eye 0.50–0.53 times as long as maximum height of head (from transverse ridge on gena above mandible to top of head) (Fig. B2.103), measurements as in Fig. B2.8). Gena in dorsal view with maximum distance between outer edges a little wider than maximum distance between outer edges of eyes (as in Fig. B2.43) (in frontal view outer edges of eyes not intersecting genae) (Fig. C17.5 and as in Fig. B2.5); in lateral view with distance between outer edge of eye and genal ridge 0.35–0.42 times as long as maximum length of eye (Fig. 2.103, measurements as in Fig. B2.77), with few or no pits ventral to genal ridge, and with very small to moderate size pits (diameter of pit 0.15–0.2 times lateral ocellus diameter) between outer edge of eye and genal ridge (mainly near eye) (Fig. B2.103). Transverse ridge above mandible narrow, sharp and mainly smooth (Fig. B2.103). Vertex scarcely pitted and pits medium in size (diameter of pits 0.2–0.25 times lateral ocellus diameter), pits present from dorsoposterior edge of eye to occiput outside postocellar area, absent on most of postocellar area, pits dense and medium in size along all of clearly outlined and gutter-like median furrow but a little more widespread near lateral ocelli (as in Fig. C17.4).

Thorax. Pronotum in dorsal view along lateral margin with irregular ridges between large teeth (Fig. B2.95) and in lateral view with coarse polygonal pits on almost all of surface (Fig. B2.125). Propleuron in lateral view with small polygonal pits over most of surface (Fig. C12.7); in ventral view generally with dense medium sized teeth often fused laterally with other teeth, with smooth or shallowly meshed surface in between (Fig. B2.11). Transscutal furrow of mesonotum obscured by coarse pits, thus mesoscutum and axilla apparently fused (Fig. C17.3). Metanotum with surface posterior to cenchrus and lateral 0.5 of metascutellum coarsely pitted (pit 0.1–1.5 times as wide as diameter of lateral ocellus) (Fig. B2.105). Fore wing in middle 0.3 of vein 2A diverging considerably (Fig. C12.6) away from wing edge, and then less (Fig. C12.6) abruptly curved away from wing edge; vein 3A absent, reduced to a stump, or extending along posterior margin of wing (N = 4).

Abdomen. Tergum 8 on central area with deeply pitted sculpticells forming transverse lines of various lengths, and lateral margin in central 0.3 shiny (as in Fig. B2.141, insert). Tergum 9 with meshes of microsculpture on ventral half below longitudinal furrow near center clearly impressed and sculpticells slightly raised as scales, meshes above longitudinal furrow near center

C17.1 *X. xylocola* ♀

C17.2 *X. xylocola* ♂

C17.3 *X. xylocola* ♀

C17.4 *X. xylocola* ♂

C17.5 *X. xylocola* ♂

well impressed and sculpticells clearly scale-like (as in Fig. B2.92, insert); median basin with base (outlined by two lateral black longitudinal furrows; N = 4) 0.8–1.0 times as wide as its median length, with maximum width of basin 1.6–1.7 times as wide as its median length and basin 0.40–0.46 times as long medially as median length of cornus (measurements as in Fig. A3.2). Cornus constricted in dorsal view, its minimum width (at constriction) about 0.8 times as wide as maximum width subapically (as in Fig. C1.15); with large teeth in apical 0.3 (Fig. B2.110). ***Sheath.*** Basal section 0.28–0.29 times as long as apical section (N = 4) (Fig. C17.1); lateral surface of apical section with well-defined ridge (as in Fig. B2.13, insert); length 1.3–1.4 times as long as fore wing length. ***Ovipositor.*** Lancet with 29–30 annuli (first 15 annuli hard to see, but still outlined (N = 4); junction of basal and apical sections of sheath aligned between 3rd and 4th annuli; major pits present on last 7 or 8 apical annuli before teeth annuli, and with a very small pit on each of the annuli 2–5 or 2–10), and a small pit on each of the annuli 10–13 (as in Fig. C1.18).

MALE. Description

Color. Head generally with dorsal spot behind eye light reddish brown, clearly outlined, larger in size than spot of females, and extending to both sides of genal ridge (basically coma-like) (Fig. C17.2); clypeus, face, gena near mandible and postocellar furrow light reddish brown (except for dorsal spot, other pale spots may not be consistent based on other species of *Xeris* studied) (Figs. C17.2, C17.4 and C17.5). Pronotum with lateral band clearly outlined, about 0.3 times as wide as pronotal 0.5, the band remaining wide to posterolateral angle, and generally not extending to lateral edge of pronotum (Fig. B2.132). Coxae, trochanters and femora (except yellowish-white apex) black; protibia in basal 0.5 (Figs. B2.112 and B2.132), mesotibia in basal 0.4 (Figs. B2.132 and C17.2), and metatibia in basal 0.1 (Figs. B2.132 and C17.2) sharply light reddish brown, otherwise tibiae black. Pro- and mesotarsomeres 1, 2 and basal 0.5 of 3 light reddish brown, metatarsomere 1 mainly black (extreme base and apical 0.15 light reddish brown), metatarsomeres 2 brown; most of tarsomeres 3–5 of all legs dark brown or black (as in Fig. C17.2).

Thorax. Metatibia with shallow notch on dorsal edge in basal 0.25 (Fig. C17.2).

Taxonomic notes

Xeris xylocola is part of the *X. spectrum* lineage as shown by the presence of a pit on each of the most basal annuli. Adults of *X. xylocola* and *X. xanthoceros* are closely related based on the narrow shiny surface medially on the pronotum. This character state probably applies to both sexes. However, both sexes probably differ in the pit distribution on the lateral surface of the pronotum and in females in the color pattern of the flagellum.

Origin of specific epithet

The specific name "*xylocola*" means "living in wood" and is characteristic of larvae of Siricidae.

Range

ASIA: LAOS: Huaphan.

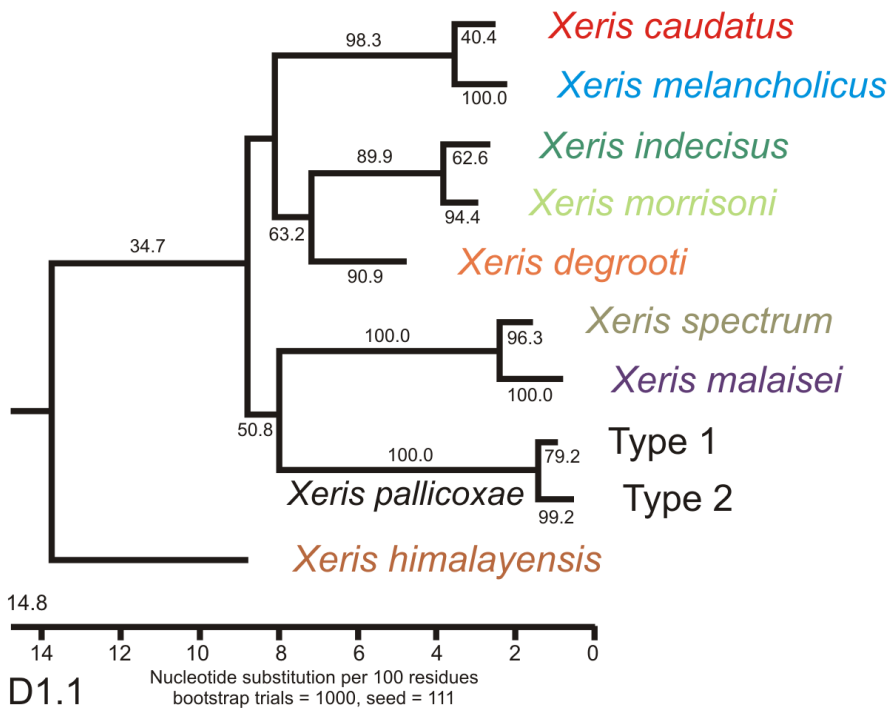
D. Mitochondrial DNA results

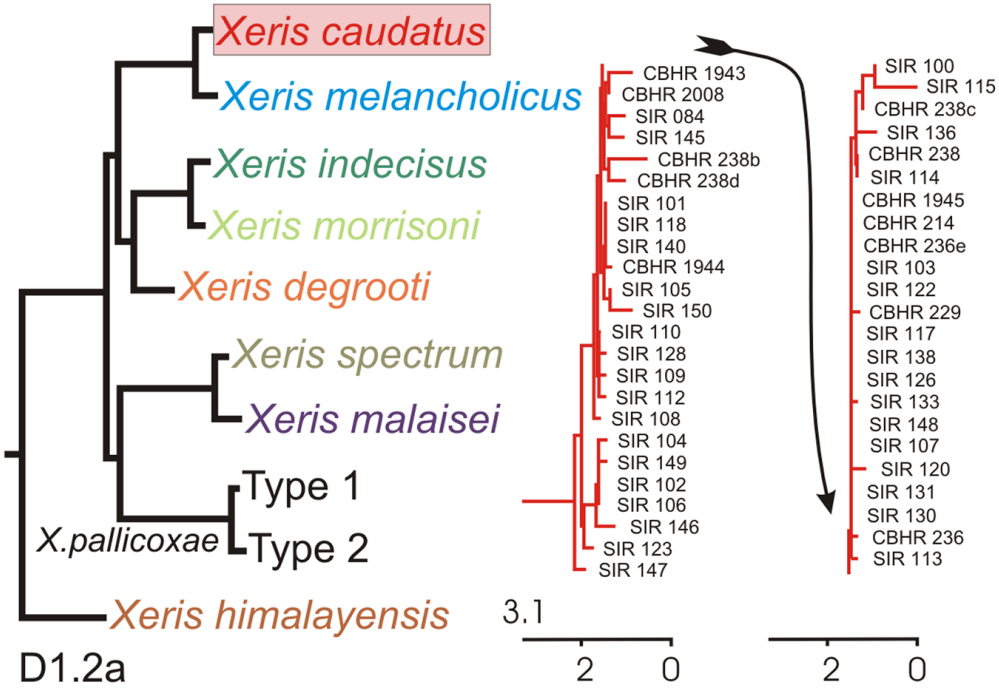
1. Introduction

Although the preponderance of this work is a worldwide morphological revision of the genus *Xeris*, DNA barcoding was also used to look for cryptic species and develop a database of sequences that could be used to identify larvae, the life stage most often intercepted in commerce (Schiff et al. 2012).

DNA barcodes, as we use them (i.e. 658 bp of Cytochrome Oxidase 1), were originally introduced as an easy, rapid, inexpensive way for investigators with no specialized taxonomic knowledge to assess biodiversity (Hebert et al. 2003). The methodology proved to be popular and barcodes were used to identify animal species including fish, birds and arthropods, to associate life stages and to uncover cryptic species (Ball and Armstrong 2006, Hajibabaei *et al.* 2006, Hebert *et al.* 2004, Hebert *et al.* 2004A, Hogg and Hebert 2004, Smith *et al.* 2006, Ward *et al.* 2005).

However, as more taxa were barcoded a variety of pitfalls and problems were identified including; heteroplasmy, where more than one haplotype is present in a single individual; accidentally sequencing nuclear pseudogenes of mitochondrial origin (NUMT's); bacterial mediated mitochondrial introgression; misleading results due to hybridization; insufficient variation and taxon discrimination (see discussion in Rubinoff *et al.* 2006, Blaxter *et al.* 2005, Linnen and Farrell 2007, 2008, Smith *et al.,* 2012, Whitworth *et al.* 2007). These limitations made using barcodes more complicated and to clarify when and how to use them. DeSalle (2006) drew a distinction between species discovery and species identification. He argued that barcodes alone were probably not sufficient for species discovery but that if there were a sequence database derived from identified specimens, barcodes could be used to identify unknown specimens with the caveat that some unknowns might not be identifiable. He further proposed that a novel barcode (haplotype) should be considered as a species hypothesis that should only be accepted with verification by a second method. Thus, DNA barcodes should have taxonomic utility but only if there is a database of knowledge with good taxon coverage and appropriate sampling.


Xeris caudatus
Xeris melancholicus
Xeris indecisus
Xeris morrisoni
Xeris degrooti
Xeris spectrum
Xeris malaisei
Type 1
Type 2
Xeris pallicoxae
Xeris himalayensis
98.3
40.4
100.0
89.9
62.6
94.4
63.2
90.9
34.7
100.0
96.3
100.0
50.8
100.0
79.2
99.2
14.8
14 12 10 8 6 4 2 0
Nucleotide substitution per 100 residues
bootstrap trials = 1000, seed = 111
D1.1


Xeris caudatus
Xeris melancholicus
Xeris indecisus
Xeris morrisoni
Xeris degrooti
Xeris spectrum
Xeris malaisei
Type 1
Type 2
X.pallicoxae
Xeris himalayensis
CBHR 1943
CBHR 2008
SIR 084
SIR 145
CBHR 238b
CBHR 238d
SIR 101
SIR 118
SIR 140
CBHR 1944
SIR 105
SIR 150
SIR 110
SIR 128
SIR 109
SIR 112
SIR 108
SIR 104
SIR 149
SIR 102
SIR 106
SIR 146
SIR 123
SIR 147
SIR 100
SIR 115
CBHR 238c
SIR 136
CBHR 238
SIR 114
CBHR 1945
CBHR 214
CBHR 236e
SIR 103
SIR 122
CBHR 229
SIR 117
SIR 138
SIR 126
SIR 133
SIR 148
SIR 107
SIR 120
SIR 131
SIR 130
CBHR 236
SIR 113
3.1
2 0
2 0
D1.2a

DNA barcodes have already proved useful in understanding siricid taxonomy. Based on barcodes, Schiff *et al.* (2012) synonymized color morphs that had been described as separate species, identified new species that were later supported by morphological characters and hypothesized two new cryptic species that they chose not to describe for lack of morphological characters. Based on these findings it seems likely that DNA barcodes would have utility in a worldwide revision of *Xeris*.

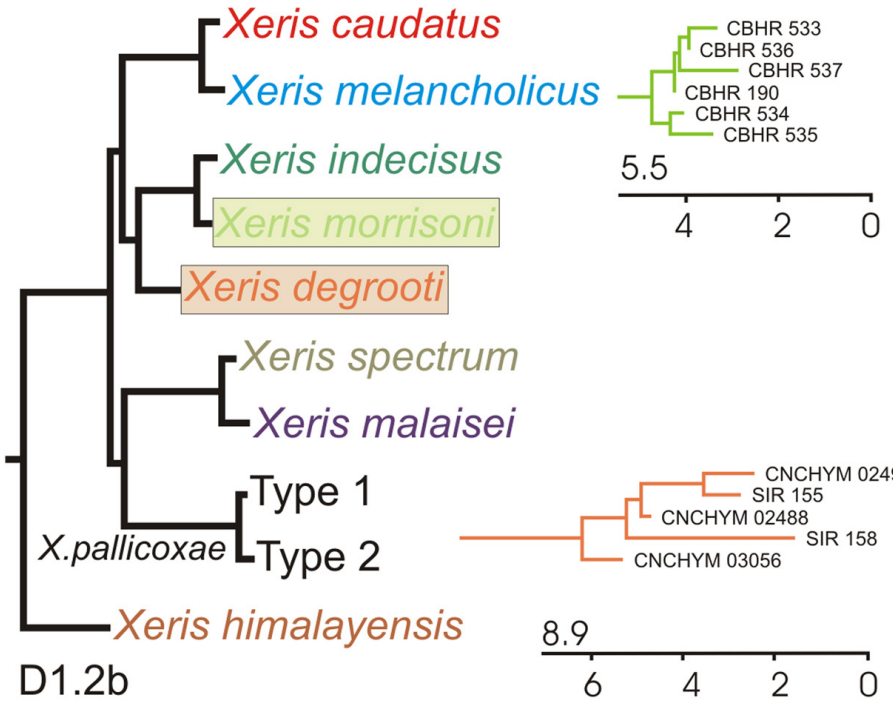
2. Results of DNA Analysis

Cytochrome oxidase 1 DNA barcodes, including 144 that were new for this study, were obtained for 149 specimens of the genus *Xeris* (see Table 2, under Appendices). 110 sequences (74%) were obtained from adult specimens identified using morphological keys to siricid genera and species and 39 sequences (26%) were obtained from larvae identified as *Xeris* by their placement in the barcode tree to Siricidae (Schiff et al. 2012). At least one complete sequence (658bp) was obtained for each taxon although only 117 of the barcodes (78%) were full length. Thirteen sequences (9%) were longer than 600bp, nine (6%) were longer than 500bp, eight (5%) were longer than 400bp and two (2%) were between 250 and 300bp in length. The distribution of sub full length sequences was not random. Four of five sequences (80%) of a new species, *Xeris degrooti,* were less than full length including the two shortest sequences used in the study (289bp and 290bp respectively) and four of six sequences (67%) of *Xeris morrisoni* were incomplete whereas all other taxa had at least 50% complete sequences. The length of each sequence is reported at the end of each species description in the section listing specimens for molecular studies.

Prior to sequencing, seven *Xeris* species could be morphologically recognized among the adult specimens. When a Neighbor-Joining phylogenetic tree was constructed from the 149 larval and adult sequences of this study, the resulting tree had 10 branches indicating three potential extra taxa, one from adult and two from larval specimens. Bootstrap analysis showed strong support (above 90) for all major branches except for *X. caudatus* and *X. indecisus* with bootstrap values of 40.4 and 62.6 respectively (Fig. D1.1). Figures D1.2a, D1.2b, D1.2c, D1.2d and D1.2e graphically represent the within and between species variation and clearly show that 100% of specimens assort to their respective taxa. Pairwise comparisons show that the divergence between all species pairs (45 comparisons) was greater than 10% except for *X. caudatus* and *X. melancholicus* (3.4%), *X. morrisoni* and *X. indecisus* (3.0%), *X. malaisei* and *X. spectrum* (4.1%) and *X. pallicoxae* "Type 1" and *X. pallicoxae* "Type 2" (2.2%) (see Table 1, under Appendices).

3. Discussion

When using more than one method to discriminate species one hopes for congruence of results. In this case, we expected that all the morphologically defined taxa would exactly match those identified by DNA sequencing of Cytochrome Oxidase 1. The neighbor joining tree (Fig. D1.2a–D1.2e) shows 149 specimens segregated into ten well differentiated haplotype groups but unfortunately, morphological analysis was not always able to resolve the same taxa. The most complicated problem was the resolution of the new species *X. degrooti* from the widespread North American species *X. indecisus*. Although we recognized color variation in *X. indecisus,* there was nothing to suggest a new species, especially in light of the considerable color variation in other Siricidae (Schiff *et al.* 2012), until specimens were barcoded. Five specimens formed a distinctive clade approximately 12% divergent from *X. indecisus*. Initially we were leery of the result, because the samples were obviously degraded (they were not collected into ethanol but another preservative and only later transferred to ethanol), most of the sequences used were incomplete with numerous individuals collected at the same time not producing any readable sequence and the divergence was quite large for North American *Xeris* species. However, the single complete sequence was a powerful hypothesis. Eventually, we were convinced, because the single complete sequence did not contain any stop-codons suggesting it was not a NUMT (a nuclear pseudogene of mitochondrial origin) one of the possible errors in barcoding (Lopez *et al.* 1994, Song *et al.* 2008, Pamilo *et al.* 2007, Koutroumpa *et al.* 2009), its closest blastn search match was *Xeris morrisoni* (89.2% identity, searched 20 March 2015) and its position in the tree was within, not basal to, the other *Xeris* species. Once we accepted the new species hypothesis, we used the sequence information to make sense of the morphological variation. The results are provided in detail under the species treatments for *X. degrooti* and *X. indecisus* but basically *X. degrooti* females can be separated from *X. indecisus* females with black abdomens and *X. indecisus* females with reddish abdomens and clear wings but not from *X. indecisus* females with reddish abdomens and darkly tinted wings. We further believe that putative male *X. degrooti* can be separated from male *X. indecisus* with black abdomens but not from those with reddish brown abdomens. Since none of the five sequenced specimens are males, we cannot be positive that the specimens we posit to be male *X. degrooti* actually are *X. degrooti* so we have chosen not to provide a male description. Although we are convinced of the validity of *X. degrooti*, we would still like to generate barcodes for more specimens of both genders and all color morphs over more of its putative


Xeris caudatus
Xeris melancholicus
Xeris indecisus
Xeris morrisoni
Xeris degrooti
Xeris spectrum
Xeris malaisei
Type 1
Type 2
X.pallicoxae
Xeris himalayensis
D1.2b
CBHR 533
CBHR 536
CBHR 537
CBHR 190
CBHR 534
CBHR 535
5.5
4
2
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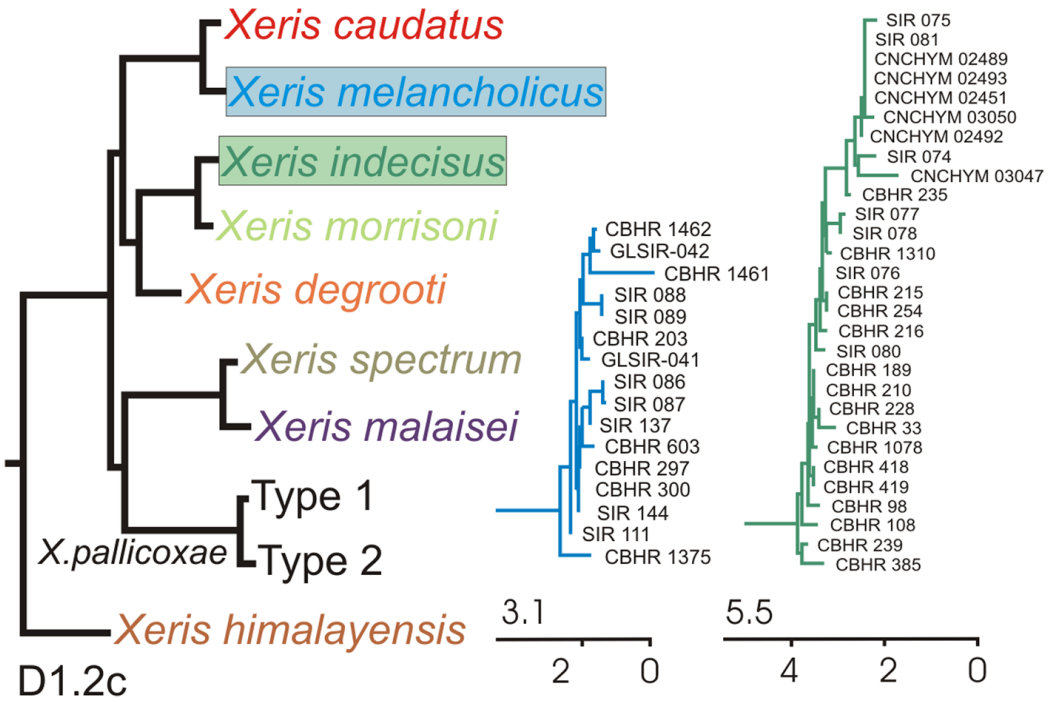
SIR 155
CNCHYM 02488
SIR 158
CNCHYM 03056
8.9
6
4
2
0


Xeris caudatus
Xeris melancholicus
Xeris indecisus
Xeris morrisoni
Xeris degrooti
Xeris spectrum
Xeris malaisei
Type 1
Type 2
X.pallicoxae
Xeris himalayensis
D1.2c
CBHR 1462
GLSIR-042
CBHR 1461
SIR 088
SIR 089
CBHR 203
GLSIR-041
SIR 086
SIR 087
SIR 137
CBHR 603
CBHR 297
CBHR 300
SIR 144
SIR 111
CBHR 1375
3.1
2
0
SIR 075
SIR 081
CNCHYM 02489
CNCHYM 02493
CNCHYM 02451
CNCHYM 03050
CNCHYM 02492
SIR 074
CNCHYM 03047
CBHR 235
SIR 077
SIR 078
CBHR 1310
SIR 076
CBHR 215
CBHR 254
CBHR 216
SIR 080
CBHR 189
CBHR 210
CBHR 228
CBHR 33
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CBHR 98
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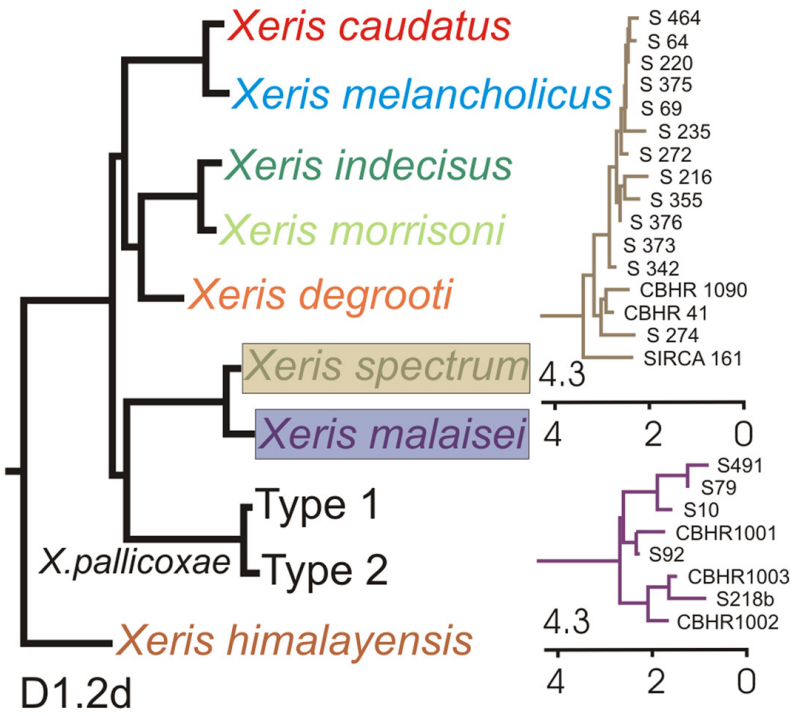
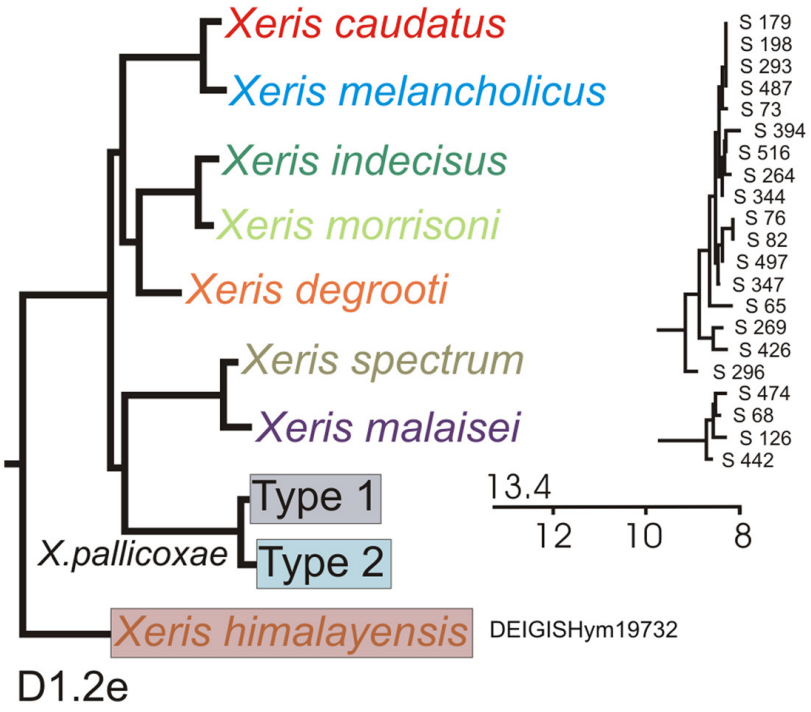
5.5
4
2
0


Xeris caudatus
Xeris melancholicus
Xeris indecisus
Xeris morrisoni
Xeris degrooti
Xeris spectrum
Xeris malaisei
Type 1
X.pallicoxae
Type 2
Xeris himalayensis
S 464
S 64
S 220
S 375
S 69
S 235
S 272
S 216
S 355
S 376
S 373
S 342
CBHR 1090
CBHR 41
S 274
SIRCA 161
4.3
4 2 0
S491
S79
S10
CBHR1001
S92
CBHR1003
S218b
CBHR1002
4.3
4 2 0

D1.2d


Xeris caudatus
Xeris melancholicus
Xeris indecisus
Xeris morrisoni
Xeris degrooti
Xeris spectrum
Xeris malaisei
Type 1
X.pallicoxae
Type 2
Xeris himalayensis
DEIGISHym19732
S 179
S 198
S 293
S 487
S 73
S 394
S 516
S 264
S 344
S 76
S 82
S 497
S 347
S 65
S 269
S 426
S 296
S 474
S 68
S 126
S 442
13.4
12 10 8

D1.2e

range.

Perhaps the most surprising result of this study was the independent discovery by both barcoding and morphology of the new species *X. pallicoxae* sympatric with *X. spectrum*. The current morphological analysis of *X. spectrum* of Western Europe revealed two species, *X. spectrum* and *X. pallicoxae* and barcode analysis of larval specimens revealed at least two and maybe three taxa that we refer to as *X. spectrum*, *X. pallicoxae* "Type 1" and *X. pallicoxae* "Type 2". The results are considered to be independent because all the sequences of *X. pallicoxae* "Type 1" and "Type 2" and most of the sequences of *X. spectrum* were derived from larval specimens and larvae could not be assigned to a species a priori because there are no keys to larvae of any Siricidae. Fortunately, we were able to obtain sequences of three adults of *X. spectrum* positively associating the name to the haplotype group but we were unable to obtain sequences of adult *X. pallicoxae* and therefore had to associate the species to the haplotype group by elimination. As there are two closely related (2.2% divergence see Table 1) *X. pallicoxae* haplotype groups, we believe one of them is *X. pallicoxae* and the other is a cryptic species close to *X. pallicoxae* waiting to be described. Unfortunately, we do not know which haplotype group is associated with the holotype of *X. pallicoxae* and which is associated with the new species. Consequently, we are forced to call the species *X. pallicoxae* "Type 1" and *X. pallicoxae* "Type 2" until adults of at least one species can be sequenced. Initially, we considered that the cryptic species might only be variation within *X. pallicoxae*, but a fairly large sample size, relatively high bootstrap support (Fig. D1.1 and D1.2e) and a second annual emergence peak (most siricids only have one, see Fig. C11.9) support the new cryptic species hypothesis.

The remaining barcode species complement morphological species nicely and support the morphological phylogenetic analysis fairly well (see "Notes on affinities" under *Xeris*). The *X. indecisus* lineage; *X. indecisus, X. morrisoni* and *X. degrooti* is supported as is the *X. caudatus* lineage of *X. caudatus* and *X. melancholicus*. Third, *Xeris malaisei* is recognized as a distinct species from *X. spectrum*. Finally, we were able to obtain a sequence of the Old World *X. himalayensis* from genbank. We were surprised to see that it was so divergent from the other *Xeris* species (16.9%–19.7%) but gratified to see that it clustered with the other *Xeris* within the Siricidae (Fig. D1.1).

4. Conclusion

The combination of classical morphological and DNA barcoding methods have allowed us to revise the siricid genus *Xeris* on a worldwide basis and add to the DNA database that enables identification of siricid larvae. DNA barcodes can unambiguously identify all species for which we were able to obtain sequences (9 of 16) and suggest there is a new cryptic species in Western Europe awaiting morphological description. One new North American species, *X. degrooti*, can only be positively identified using barcodes at this point but we expect additional sequences of different color morphs over more of the species range will help us clarify its morphological characteristics. This work demonstrates the utility of barcoding for generating species hypotheses and associating color morphs and different life stages.

E. Acknowledgements

For this study many colleagues generously contributed various elements that helped us produce a comprehensive revision. We are most appreciative and indebted to them for their support.

Systematic research is based on specimens stored in collections and looked after by conscientious colleagues. The quality of research is proportional to the number of specimens studied. We were fortunate to obtain a large number of them and are most thankful to the curators mentioned under "Materials and methods" that either facilitated our visit to their collection or sent us specimens on loan. With the establishment of *Sirex noctilio* in the Great Lakes region, many surveys were carried out and long series of specimens (including those of *Xeris*) were submitted to us for identification. We greatly appreciate the survey specimens of Siricidae generously given to us by H. Douglas (CFIA), D. Langor (NFRC), the late P. de Groot, K. Nystrom and I. Ochoa (GLFC), L. Humble and J. Smith (PFRC), J. Kruse (USFS–AK), D. Miller (USFS–GA), C. Piché (MNRQ), and J. Sweeney and J. Price (FRLC). These fresh and clean specimens permit us to study the DNA of significant specimens and enriched our collections.

We would like to thank A. Lancaster, for assistance in the lab and with rearing specimens and the following who helped either with specimens or in the field: I. Aguayo, M. Allen, R. Bashford, L. Bezark, C. Brodel, J. Cena M. Chain, K. Cote, D. Crook, E. Day, Y. DeMarino, P. Denke, D. Duerr, the Fish family, H. Hall, D. Haugen, S. Heydon, R. Hoebeke, B. Hofstrand, A. Horne, L. Humble, W. Johnson, V. Klasmer, R.L. Koch, B. Kondratieff, J. Kruse, J. LaBonte, P. Lago, E. Lisowski, V. Mastro, S. McElway, H. McLane, J. Meeker, D. Miller, A. and G. Mudge, D. Patterson, T. Price, J. Quine, L. Reid, V. Scott, C. Snyder, S. Spichiger, W. Tang, P. Tolesano, M. Ulyshen, M. Vardanega, G. Varkonyi, S. Vaughn, J. Vlach, and R. Westcott.

Traditionally, only morphological features were studied from specimens in collections. Lately, DNA sequencing of properly preserved specimens has opened

a new set of characters, previously unavailable. Many of the submitted specimens were freshly collected and offered us the opportunity to extract information from DNA barcodes (cytochrome c oxidase 1 – CO1). This new tool in conjunction with the classical morphological approach gave us much confidence in our conclusions. We greatly appreciate having access to specimens properly preserved for DNA sequencing provided by H. Douglas (CFIA), V. Grebennikov (CFIA), D. Langor (NFRC), P. de Groot, K. Nystrom and I. Ochoa (GLFC), L. Humble and J. Smith (PFRC), and D. Miller (USFS–GA). We greatly appreciate having access to *X. himalayensis* DNA barcode kindly provided by A. Taeger (SDEI). We are also very grateful for support from the Government of Canada through Genome Canada and the Ontario Genomics Institute in support of the International Barcode of Life Project. This funding allowed staff at the Biodiversity Institute of Ontario under the leadership of P. Hebert to sequence 100 specimens of *Xeris*, and covered the costs in the preparation and digitization of specimen data by J. Fernandez–Triana. We also appreciate the time spent by A. Smith and J. Fernandez–Triana explaining details of the results to Henri Goulet.

Adults of *Xeris* are easily damaged so we were worried about borrowing type specimens. We tried to study types during our visit to various North American collections but we did not have the opportunity to visit European collections. To avoid having types sent by post, we studied the description and previous opinions about each type. Then, we decided if photos of a type would be enough to resolve its identity. Through the kindness of M. París (MNCN), J. E. Hogan (OXUM), and L. Vilhelmsen (ZMUC), we were able to get the necessary pictures taken. We also had access to the Linnaean Society site for type images. All images of *X. cobosi* used in this paper were prepared by M. París (MNCN). Finding live *Xeris* specimens is a challenge. We appreciate access to two images of live females of *X. spectrum* for a thumbnail (image: http://www.biolib.cz/en/image/id1106/) and a habitus (image: DSCF068.jpg) from Ondřej Zicha (e-mail: ondrej.zicha@gmail.com) on line thumbnail).

Much information came from many colleagues. The following people kindly spent time trying to find specimens of unusual species in their respective collections, providing information about type's whereabouts, and hand carrying of such specimens. We are very grateful to C. P. D. T. Gillett (BMNH), H. Vardal (Swedish Museum of Natural History), Y. Bousquet (CNC), V. Grebennikov (CFIA), M. Sharkey (University of Kentucky), A. Shinohara (NSMT) for their efforts. When problems arise there is nothing better than your closest colleagues to discuss them. We are much indebted to L. Masner (CNC), and J. T. Huber (CNC). Sometimes questions go beyond Siricidae and even insects. We greatly appreciate detailed information by our esteemed botanical colleague G. Mitrow (National Collection of Vascular Plants, Department of Agriculture, Ottawa), about ranges of European conifers. Finally, we thank the late R. Roughley (EDUM), G. E. Ball and D. Shpeley (UASM) for courtesies extending during our visits to their respective institutions.

Locating and verifying references could become an extremely challenging task especially with older books and journals. We made a special effort to verify and quote completely each of the reference. We are especially thankful to P. Madaire, our librarian, who spent numerous hours helping us finding the information needed and to D. R. Smith who put at my disposal his very large reprint collection. I am also thankful to Y. Bousquet for a few difficult to find references.

At completion of a large manuscript, it is very difficult to see our own errors in the text. We are most thankful to reviewers, J. T. Huber, D. R. Smith and A. Taeger for their vey critical reading of the manuscript rounding up most errors and insuring the uniformity of style.

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Appendices

1. Sequence Pair Distances

Table 1. Consensus sequence pair distances of Xeris percent identity and divergence for all taxa (identity.meg ClustalV - Weighted - March 02, 2015).

PERCENT IDENTITY												
1	2	3	4	5	6	7	8	9	10		Code	Species
	96.7	87.5	88.3	85.7	84.8	85.1	85.1	86.6	83.3	**1**	CBHR	*caudatus*
3.4		88.3	87.8	86.2	84.5	85.3	85.3	86.3	83.1	**2**	CBHR	*melancholicus*
13.0	11.9		97.1	87.4	85.6	87.2	86.6	88.1	83.1	**3**	CBHR	*indecisus*
12.1	12.5	3.0		86.5	85.0	87.2	86.6	88.1	82.7	**4**	CBHR	*morrisoni*
14.8	14.2	13.0	14.1		96.0	86.0	85.1	84.5	82.5	**5**	CBHR	*spectrum*
15.6	15.8	15.1	15.8	4.1		84.8	83.9	83.9	81.5	**6**	CBHR	*malaisei*
15.8	15.8	13.6	13.6	15.1	16.4		97.9	84.8	82.1	**7**	S 68	*pallicoxae* "Type 2"
15.6	15.6	14.0	13.9	15.9	17.2	2.2		84.8	82.1	**8**	S82	*pallicoxae* "Type 1"
14.1	14.3	12.1	12.3	16.6	17.0	16.0	15.8		81.8	**9**	SIR 158	*degrooti*
16.9	17.3	16.9	17.9	17.6	18.8	19.7	18.5	18.4		10	DEIGISHym 19732	*himalayensis*
1	2	3	4	5	6	7	8	9	10			

2. Genbank Accession Numbers

Table 2. The specimen (CBHR and CNC), Bold and Genbank accession numbers are as follows. FASTA Sequences representing each of the 9 species of this study are deposited in Genbank and at the Center for Bottomland Hardwood Research Web Site. A set of files in one zip file can be downloaded from the CBHR site at the following URL: http://www.srs.fs.usda.gov/cbhr/products/downloads/2012_nms_SiricidFASTA.zip

Sequence #	Specimen Code	Species	BOLD code	Genbank	# seqs	Length
1	CBHR 33	*indecisus*		KP761936	2	658
2	CBHR 41	*spectrum*		KP761937	2	658
3	CBHR 98	*indecisus*		KP761938	2	658
4	CBHR 108	*indecisus*		KP761939	2	658
5	CBHR 189	*indecisus*		KP761940	2	658
6	CBHR 190	*morrisoni*		JQ619812	2	658
7	CBHR 203	*melancholicus*		KP761941	2	658
8	CBHR 210	*indecisus*		KP761942	2	658
9	CBHR 214	*caudatus*		KP761943	2	658
10	CBHR 215	*indecisus*		KP761944	2	658
11	CBHR 216	*indecisus*		JQ619810	2	658
12	CBHR 228	*indecisus*		KP761945	2	658
13	CBHR 229	*caudatus*		JQ619809	2	658
14	CBHR 235	*indecisus*		KP761946	2	658
15	CBHR 236	*caudatus*		KP761947	2	658
16	CBHR 236e	*caudatus*		KP761948	2	658
17	CBHR 238	*caudatus*		KP761949	2	658
18	CBHR 238b	*caudatus*		KP761950	2	658
19	CBHR 238c	*caudatus*		KP761951	1	596
20	CBHR 238d	*caudatus*		KP761952	2	658
21	CBHR 239	*indecisus*		KP761953	2	658
22	CBHR 254	*indecisus*		KP761954	2	658

Sequence #	Specimen Code	Species	BOLD code	Genbank	# seqs	Length
23	CBHR 297	*melancholicus*		KP761955	2	658
24	CBHR 300	*melancholicus*		JQ619811	4	658
25	CBHR 385	*indecisus*		KP761956	2	658
26	CBHR 418	*indecisus*		KP761957	2	658
27	CBHR 419	*indecisus*		KP761958	2	658
28	CBHR 533	*morrisoni*		KP761959	1	605
29	CBHR 534	*morrisoni*		KP761960	2	658
30	CBHR 535	*morrisoni*		KP761961	2	567
31	CBHR 536	*morrisoni*		KP761962	2	656
32	CBHR 537	*morrisoni*		KP761963	3	657
33	CBHR 603	*melancholicus*		KP761964	2	658
34	CBHR 1001	*malaisei*		KP761965	2	658
35	CBHR 1002	*malaisei*		KP761966	2	658
36	CBHR 1003	*malaisei*		KP761967	2	658
37	CBHR 1078	*indecisus*		KP761968	2	658
38	CBHR 1090	*spectrum*		KP761969	2	658
39	CBHR 1310	*indecisus*		KP761970	2	658
40	CBHR1375	*melancholicus*		KP761971	2	658
41	CBHR 1461	*melancholicus*		KP761972	2	658
42	CBHR 1462	*melancholicus*		KP761973	2	578
43	CBHR 1943	*caudatus*		KP761974	2	658
44	CBHR 1944	*caudatus*		KP761975	2	658
45	CBHR 1945	*caudatus*		KP761976	2	658
46	CBHR 2008	*caudatus*		KP761977	2	658

Sequence #	Specimen Code	Species	BOLD code	Genbank	# seqs	Length
47	SIR 074	*indecisus*	CNCS1074	KP761978	2	427
48	SIR 075	*indecisus*	CNCS 1075	KP761979	2	426
49	SIR 076	*indecisus*	CNCS 1076	KP761980	2	658
50	SIR 077	*indecisus*	CNCS 1077	KP761981	1	576
51	SIR 078	*indecisus*	CNCS 1078	KP761982	2	658
52	SIR 080	*indecisus*	CNCS 1080	KP761983	2	658
53	SIR 081	*indecisus*	CNCS 1081	KP761984	2	426
54	SIR 084	*caudatus*	CNCS 1084	KP761985	2	658
55	SIR 086	*melancholicus*	CNCS 1086	KP761986	2	633
56	SIR 087	*melancholicus*	CNCS 1087	KP761987	2	621
57	SIR 088	*melancholicus*	CNCS 1088	KP761988	1	630
58	SIR 089	*melancholicus*	CNCS 1089	KP761989	2	630
59	CNCHYM 02488	*degrooti*	HYCND084	KP761990	3	629
60	CNCHYM 02489	*indecisus*	HYCND085	KP761991	2	426
61	CNCHYM 02491	*degrooti*	HYCND087	KP761992	1	290
62	CNCHYM 02492	*indecisus*	HYCND088	KP761993	2	427
63	CNCHYM 02493	*indecisus*	HYCND089	KP761994	2	426
64	CNCHYM 03047	*indecisus*	HYCND649	KP761995	3	609
65	CNCHYM 03050	*indecisus*	HYCND652	KP761996	2	423
66	CNCHYM 03051	*indecisus*	HYCND653	KP761997	2	426
67	CNCHYM 03056	*degrooti*	HYCND658	KP761998	2	584
68	S10	*malaisei*		KP761999	2	658
69	S64	*spectrum*		KP762000	2	658
70	S65	*pallicoxae*		KP762001	2	658

Sequence #	Specimen Code	Species	BOLD code	Genbank	# seqs	Length
71	S68	*pallicoxae*		KP762002	2	658
72	S69	*spectrum*		KP762003	2	658
73	S76	*pallicoxae*		KP762004	2	658
74	S79	*malaisei*		KP762005	2	658
75	S82	*pallicoxae*		KP762006	2	658
76	S92	*malaisei*		KP762007	2	658
77	S126	*pallicoxae*		KP762008	2	658
78	S179	*pallicoxae*		KP762009	2	658
79	S198	*pallicoxae*		KP762010	2	658
80	S216	*spectrum*		KP762011	2	658
81	S218b	*malaisei*		KP762012	2	658
82	S220	*spectrum*		KP762013	2	658
83	S235	*spectrum*		KP762014	2	658
84	S264	*pallicoxae*		KP762015	2	656
85	S269	*pallicoxae*		KP762016	2	658
86	S272	*spectrum*		KP762017	2	658
87	S274	*spectrum*		KP762018	2	658
88	S293	*pallicoxae*		KP762019	2	658
89	S296	*pallicoxae*		KP762020	2	658
90	S342	*spectrum*		KP762021	2	658
91	S344	*pallicoxae*		KP762022	2	658
92	S347	*pallicoxae*		KP762023	2	658
93	S355	*spectrum*		KP762024	2	658
94	S373	*spectrum*		KP762025	2	658

Sequence #	Specimen Code	Species	BOLD code	Genbank	# seqs	Length
95	S375	*spectrum*		KP762026	2	658
96	S376	*spectrum*		KP762027	2	658
97	S394	*pallicoxae*		KP762028	2	658
98	S426	*pallicoxae*		KP762029	2	658
99	S442	*pallicoxae*		KP762030	2	658
100	S464	*spectrum*		KP762031	2	658
101	S473	*pallicoxae*		KP762032	2	658
102	S474	*pallicoxae*		KP762033	2	658
103	S487	*pallicoxae*		KP762034	2	658
104	S491	*malaisei*		KP762035	2	658
105	S497	*pallicoxae*		KP762036	2	658
106	S516	*pallicoxae*		KP762037	2	627
107	GLSIR 041	*melancholicus*	SIRCA041	KP762038	2	632
108	GLSIR 042	*melancholicus*	SIRCA042	KP762039	2	566
109	SIR 100	*caudatus*	SIRCA095	KP762040	2	589
110	SIR 101	*caudatus*	SIRCA096	KP762041	2	658
111	SIR 102	*caudatus*	SIRCA097	KP762042	2	658
112	SIR 103	*caudatus*	SIRCA098	KP762043	2	658
113	SIR 104	*caudatus*	SIRCA099	KP762044	2	658
114	SIR 105	*caudatus*	SIRCA100	KP762045	2	658
115	SIR 106	*caudatus*	SIRCA101	KP762046	2	658
116	SIR 107	*caudatus*	SIRCA102	KP762047	2	658
117	SIR 108	*caudatus*	SIRCA103	KP762048	2	658
118	SIR 109	*caudatus*	SIRCA104	KP762049	2	658

Sequence #	Specimen Code	Species	BOLD code	Genbank	# seqs	Length
119	SIR 110	*caudatus*	SIRCA105	KP762050	2	521
120	SIR 111	*melancholicus*	SIRCA106	KP762051	2	658
121	SIR 112	*caudatus*	SIRCA107	KP762052	2	658
122	SIR 113	*caudatus*	SIRCA108	KP762053	2	658
123	SIR 114	*caudatus*	SIRCA109	KP762054	2	658
124	SIR 115	*caudatus*	SIRCA110	KP762055	2	570
125	SIR 117	*caudatus*	SIRCA 112	KP762056	2	658
126	SIR 118	*caudatus*	SIRCA 113	KP762057	2	658
127	SIR 120	*caudatus*	SIRCA115	KP762058	2	658
128	SIR 122	*caudatus*	SIRCA117	KP762059	2	658
129	SIR 123	*caudatus*	SIRCA118	KP762060	2	658
130	SIR 126	*caudatus*	SIRCA121	KP762061	2	658
131	SIR 128	*caudatus*	SIRCA123	KP762062	2	658
132	SIR 130	*caudatus*	SIRCA 125	KP762063	2	658
133	SIR 126	*caudatus*	SIRCA 126	KP762064	2	658
134	SIR 133	*caudatus*	SIRCA 128	KP762065	2	658
135	SIR 136	*caudatus*	SIRCA131	KP762066	1	609
136	SIR 137	*melancholicus*	SIRCA132	KP762067	2	658
137	SIR 138	*caudatus*	SIRCA133	KP762068	2	658
138	SIR 140	*caudatus*	SIRCA135	KP762069	2	658
139	SIR 144	*melancholicus*	SIRCA139	KP762070	2	658
140	SIR 145	*caudatus*	SIRCA140	KP762071	2	658
141	SIR 146	*caudatus*	SIRCA141	KP762072	2	658
142	SIR 147	*caudatus*	SIRCA142	KP762073	2	658

Sequence #	Specimen Code	Species	BOLD code	Genbank	# seqs	Length
143	SIR 148	*caudatus*	SIRCA143	KP762074	2	658
144	SIR 149	*caudatus*	SIRCA144	KP762075	2	658
145	SIR 150	*caudatus*	SIRCA145	KP762076	2	658
146	SIR 155	*degrooti*	SIRCA150	KP762077	1	289
147	SIR 158	*degrooti*	SIRCA153	KP762078	2	658
148	SIR 161	*caudatus*	SIRCA156	KP762079	2	658