

## Research Article

**A new case of gynandromorphism in *Xylocopa frontalis* (Olivier) (Hymenoptera: Apidae), with an updated review of records in Xylocopinae Latreille**

Un nuevo caso de ginandromorfismo en *Xylocopa frontalis* (Olivier) (Hymenoptera: Apidae), con una revisión actualizada de registros en Xylocopinae Latreille

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**Abstract.** The description and illustration of a new case of gynandromorphism in *Xylocopa* (*Neoxylocopa*) *frontalis* (Olivier) is presented from a single specimen collected in Tena, Cundinamarca, Colombia and currently deposited at the Museo Entomológico Facultad de Ciencias Agrarias, Universidad Nacional de Colombia, Bogotá, Colombia (UNAB). In addition, an updated review and synthesis of the records of gynandromorphy in the subfamily Xylocopinae Latreille is provided. The specimen herein described belongs to the mosaic category of gynandromorphy and correspond to the third record of this species.

**Key words:** Anthophila, Apoidea, carpenter bees, gynandromorph.

**Resumen.** La descripción e ilustración de un nuevo caso de ginandromorfismo en *Xylocopa* (*Neoxylocopa*) *frontalis* (Olivier) es presentada a partir de un espécimen recolectado en Tena, Cundinamarca, Colombia y actualmente depositado en el Museo Entomológico, Facultad de Ciencias Agrarias, Universidad Nacional de Colombia, Bogotá, Colombia (UNAB). Además, se proporciona una revisión actualizada y una síntesis de los registros de ginandromorfía en la subfamilia Xylocopinae Latreille. El espécimen aquí descrito pertenece a la categoría de ginandromorfía de mosaico y corresponde al tercer registro de esta especie.

**Palabras clave:** Abejas carpinteras, Anthophila, Apoidea, ginandromorfo.

## Introduction

The sex determination in most bees and hymenopterans is widely known by have a haplodiploid system in which fertilized eggs develop into females and those unfertilized develop into males -known as arrhenotoky (Michener 2007). However, hermaphrodite specimens rarely occur in natural conditions and can be recognized for exhibit traits of both sexes in a single individual. Depending on the features that the hermaphrodite exhibits, the individuals can be referred to as gynandromorph or intersex. The former is recognized because the specimen has phenotypic characteristics of male and female combined and

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is genetically chimeric, while the latter is genetically uniform and exhibits phenotypic characteristics of the opposite sex or an intermediate sexual phenotype (Narita *et al.* 2010; Ramos and Ruz 2013).

The study of the gynandromorphs (or gynanders) has increased in the last decades due to its relevance in the understanding of development processes and events of genetic abnormalities (Narita *et al.* 2010; Yang and Abouheif 2011). Its origin is still a matter of discussion and various mechanisms have been proposed such as the loss of chromosomes, the fertilization of binuclear eggs and the association with external agents as parasites or symbionts, among others (Wcislo *et al.* 2004; Michez *et al.* 2009; Narita *et al.* 2010). In addition to development and genetics studies, hypotheses about phenotype standardization have also been made. Based on diverse records of gynandromorphy in Hymenoptera and bees, Dalla-Torre and Friese (1899) proposed the following classification: lateral (each sexual trait distributed on the right-left axis), transversal (each sexual trait distributed on the dorsal-ventral axis), frontal (each sexual trait distributed on the anterior-posterior axis), and mixed (a sexual trait distributed randomly); and the most recent proposal was made by Michez *et al.* (2009) as follows: transversal (both sexual traits are distributed in two asymmetrical parts), bilateral (most of a sexual trait is symmetrical and equal distributed) and mosaic (a sexual trait distributed randomly).

Approximately 140 cases of gynandromorphy have been recorded in bees of 36 genera, being most occurrences in leaf-cutting bees (*e.g.* *Megachile* Latreille) and carpenter bees (*e.g.* *Xylocopa* Latreille) (Wcislo *et al.* 2004; Michez *et al.* 2009; Hinojosa-Díaz *et al.* 2012; Lucia and Gonzalez 2013; Vivallo 2015; Zama and Coelho 2017; Almeida *et al.* 2018; Onufenko 2018; Prashantha *et al.* 2018). Recent records have also been made in orchids bees of the genus *Euglossa* Latreille (Giangarelli and Sofia 2011; Hinojosa-Díaz *et al.* 2012; Camargo and Gonçalves 2013; Suzuki *et al.* 2014), oil-collecting bees of the tribe Centridini and Tapinotaspidini (Alvarez *et al.* 2019), stingless bees of the genus *Paratetrapedia* Schwarz and sweat bees of the genus *Augochlora* Smith (Alvarez *et al.* 2014).

In the same way, reviews and synthesis of cases of gynandromorphy have been carried out previously. Wcislo *et al.* (2004) provided the first review of gynandromorphism in bees, summarizing the deviant phenotypes of 64 species and categorizing them according to Dalla-Torre and Friese (1899). Later, Michez *et al.* (2009) made a synthesis of gynandromorphy in wild bees listing 102 cases and categorizing according to their own proposal. Finally, Hinojosa-Díaz *et al.* (2012) presented an updated review to date with the inclusion of new records in bees reported since the first revision of 2004, and Lucia and Gonzalez (2013) did a review of gynandromorphism in bees of the genus *Xylocopa* Latreille, summarizing the information of 14 cases of 12 species.

Herein I describe a new case of gynandromorphism in the carpenter bee *Xylocopa* (*Neoxylocopa*)*frontalis* (Olivier, 1789) from a single specimen collected in Tena, Cundinamarca, Colombia. In addition, I also provide an updated review of gynandromorphy occurrences that have been reported to date in Xylocopinae Latreille, 1809 and I make a brief comparison regarding the information and classification system used in previous reviews.

## Material and Methods

The morphological description of the gynander follows the terminology proposed by Hurd and Moure (1963) and Michener (2007); metasomal terga and sterna are indicated as T1, T2, S1, S2, etc. Measurements are given in millimeters (mm) and some specific in OD (maximum diameter of the median ocellus); the mesosoma width was measured between the outer margins of tegula; the forewing length was measured from the posterior margin of tegula to the wing tip and the metasoma width was measured across the apical margin of the second tergum (T2). The term “terminalia” is here used to describe the characteristics

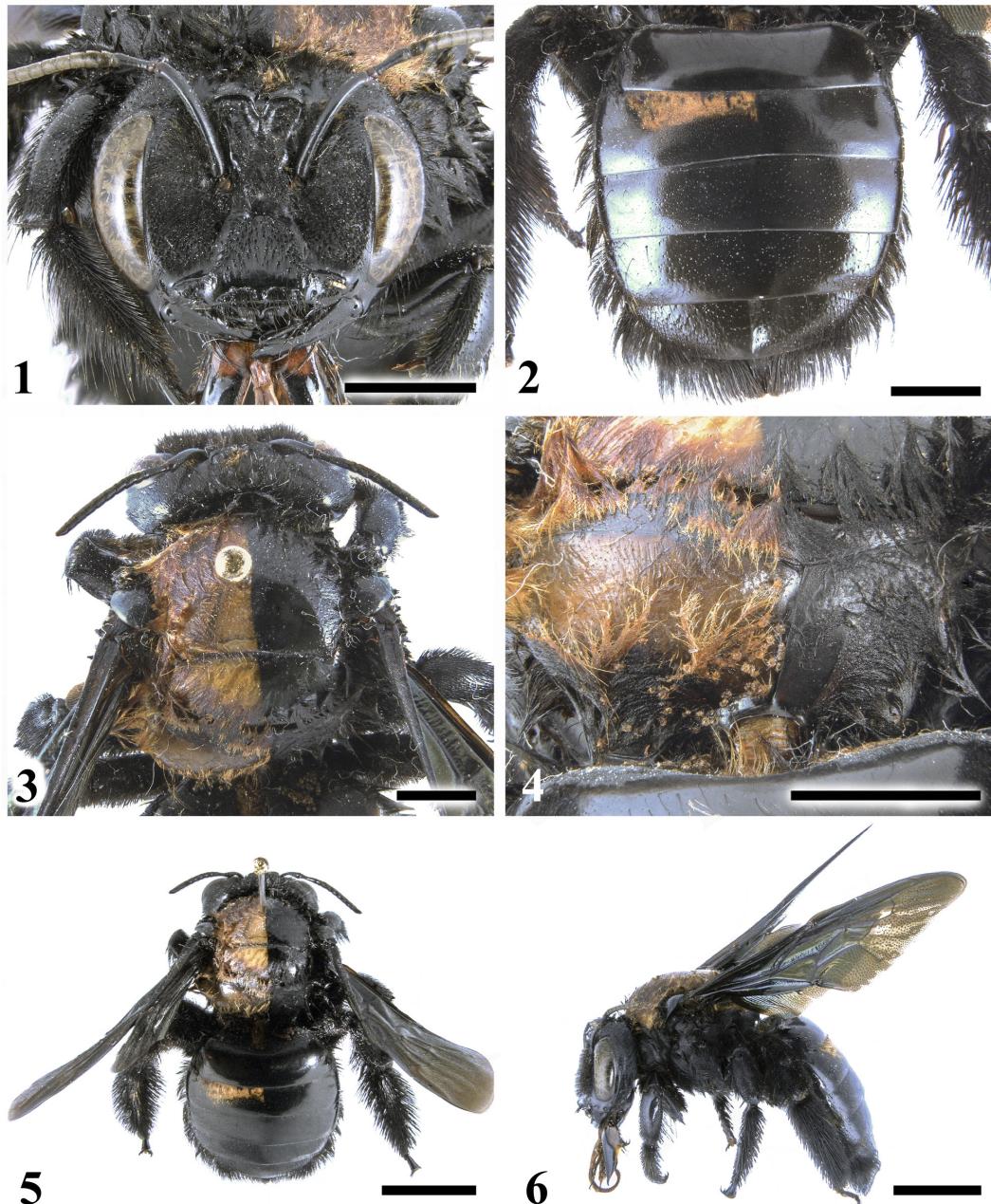
of the terga and sterna 6 and 7 and the genital apparatus. The photographs were taken using a Leica M205A stereomicroscopic equipped with a camera and the software LAS 4© (Leica Application Suite), and posteriorly were enhanced with Adobe Photoshop® (ver. 13.0) and Adobe Lightroom® (ver. 7.0). The records of gynandromorphy in Xylocopinae known to the date were summarized in a table following the formats of Wcislo *et al.* (2004), Nielsen (2010) and Lucia and Gonzalez (2013). Each case was briefly described according to the information available in the references and categorized in accordance with the classification proposed by Michez *et al.* (2009). Localities are presented in the following format: COUNTRY, County/Department/Province/Region/State, Specific locality. The repositories cited are: Entomological Collection of California Academy of Sciences, San Francisco, California, USA (CAS); Coleção Entomológica, Universidade Federal de Sergipe, Aracaju, Sergipe, Brazil (CEUFS); Department of Entomology, University of Agricultural Sciences, Gandhi Krishi Vignan Kendra, Bengaluru, Karnataka, India (GKVK); Essig Museum of Entomology, University of California, Berkeley, California, USA (EMEC); Museum and Institute of Zoology, Polish Academy of Sciences in Warsaw, Warsaw, Poland (MIZ); Museo de La Plata, La Plata, Argentina (MLP); Muséum National d'Histoire Naturelle, Paris, France (MNHN); Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil (MNRJ); Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil (MZUSP); Naturhistorisches Museum Basel, Basel, Switzerland (NMB); United States National Museum of Natural History, Smithsonian Institution, Washington, USA (NMNH); National Museums of Kenya, Nairobi, Kenya (NMK); Naturhistorisches Museum Wien, Vienna, Austria (NMW); National Collections of Natural History, Tel Aviv University, Israel (TAUI) and Entomology Research Museum, University of California, Riverside, California, USA (UCRC).

## Results

### *Xylocopa (Neoxylocopa) frontalis* (Olivier, 1789) Gynandromorph (Figs. 1-6)

**Material examined.** One gynander with the following label data: Colombia, Cundinamarca, Municipio Tena, Vereda Los Rosales, 1384 m alt; Captura Jama en cultivo de Banano, Mar-2010 Col R. Forero\UNAB4310. Deposited at the Museo Entomológico Facultad de Ciencias Agrarias, Universidad Nacional de Colombia, Bogotá, Colombia (UNAB).

**Morphological description.** Approximated body length: 32 mm, head length: 8.8 mm, head width 7.5 mm, mesosoma width 10.6 mm, metasoma width 11.8 mm; forewing length 26.1 mm, hindwing length 7.8 mm. *Head:* Resembles that of female with some male traits on left basal half of clypeus, close to left lateral ocellus and above to ocelar carina. Integument predominantly black as in female except with an oval yellow macule on left basal half of clypeus close to epistomal suture. Pubescence mostly black with few yellow-reddish hairs near to left lateral ocellus and above to left side of ocelar carina; simple and plumose hair inter mixed on paraocular areas (0.2–0.3x OD) and simple longer hairs on basal half of clypeus and lower genae (0.3–0.6x OD). Paraocular areas and clypeus with coarse and dense punctuation (1–2x puncture width), sparser and finer on vertex and genae; impunctate areas above to lateral ocelli. Epistomal suture carinate mainly on basal lateral margins where is pronounced; labrum with three basal protuberances, middle tubercle slightly longer; head broader than long (1.3: 1); upper and lower interocular distance equal (5.8 mm); middle interocular distance 6 mm; interalveolar distance 1.3 mm; alveolocular distance 1.8 mm; antennae with 11 flagellomeres (Length of scape, pedicel and three first flagellomeres 3.6: 0.4: 1: 0.4: 0.5); length of carina ocelar 2.4 mm.



**Figures 1-6.** Gynander of *Xylocopa (Neoxylocopa) frontalis* (Olivier, 1789) from Colombia, Cundinamarca, Tena. 1. Head, frontal view. 2. Metasoma, dorsal view. 3. Mesosoma, dorsal view. 4. Detail of propodeum, dorsal view. 5. Dorsal habitus. 6. Lateral habitus, right side. Scale bars: 5 mm (Figs. 1, 2, 3, 4); 10 mm (Figs. 5, 6).

**Mesosoma:** Mostly as in female except with male features on left half of dorsum and posterior area. Integument and pubescence predominantly black female-like except left half of mesoscutellum, mesoscutum, metanotum and propodeum yellowish brown. Abundant plumose hairs on mesepisternum ( $0.2-0.3 \times$  OD) and glabrous towards disc of mesoscutum and anterior margin of mesoscutellum; hairs denser and longer on left half of dorsum and posterior area. Left half of propodeum expanded due the exocrine glands

as in males and right half with part of the propodeal triangle commonly found in females. Fore and hind wings dark brown with greenish iridescence. Legs as in female, with black pubescence except ferruginous on dorsal surface of fore tibia and basitibial plates with forked tips on hind tibiae. *Metasoma*: Overall female but with male traits on left side of T2. Integument black female-like but with a yellowish brown area on left side of disc of T2 near to apical margin of T1. Pubescence mostly black and with few yellowish hairs on lateral sides of T4 and T5; long, decumbent, simple hairs grouped in tufts on lateral sides (0.3–0.5x OD) and glabrous on discs except simple hairs barely noticeable on yellowish area of T2. Sparse and fine punctuation on terga (0.4–0.6x OD) with large impunctate areas across apical margins except very dense on yellowish area of T2 (0.1x OD). Ventral carina presented and conspicuous. *Terminalia*: Female-like, sting well developed; T6 with the characteristic preapical spines found in females of X. (*Neoxylocopa*).

## Discussion

The specimen herein described was classified in the category mosaic by exhibit male-like traits distributed randomly on a predominantly female body and correspond to the third case of gynandromorphism in *Xylocopa* (*Neoxylocopa*) *frontalis* (Olivier, 1789) in addition to the records made by Lucia and Gonzalez (2013) and Vivallo (2005). Including the new record here described, there are 32 cases of gynandromorphism in the subfamily Xylocopinae reported to date for 22 species of which 18 are of the genus *Xylocopa* Latreille and four are from *Ceratina* Latreille (Anexo 1).

In comparison with the information provided by Lucia and Gonzalez (2013), this review cited 10 new cases of gynandromorphy in *Xylocopa* Latreille and the new reports of seven species: *Xylocopa* (*Biluna*) *nasalis* Westwood, X. (*Koptotosoma*) *pubescens* Spinola, X. (*Neoxylocopa*) *augusti* Lepeletier, X. (N.) *darwini* Cockerell, X. (N.) *ordinaria* Smith, X. (*Schonherria*) *splendidula* Lepeletier and X. (*Xylocopoides*) *virginica* (Linnaeus). Most of the records correspond to species of the subgenus X. (*Neoxylocopa*), mainly the species X. (N.) *frontalis* (Olivier) and X. (N.) *varipuncta* Patton with three (including the record here described) and four cases respectively. The subgenus of the Old World X. (*Koptotosoma*) reports three cases, while X. (*Schonherria*) has two and the four remaining subgenera just one (X. (*Biluna*), X. (*Ctenoxylocopa*), X. (*Xylocopa*) and X. (*Xylocopoides*)). Likewise, most records were reported for species that occur in Neotropical Region and few were cited for Paleotropic and Australasian species.

This work compiles for first time the scarce information referring to gynandromorphy in *Ceratina* Latreille. In the discussion section present by Lucia *et al.* (2012), the gynanders of this genus known until then were cited but they had not been considered in any previous review or summary (e.g. Wcislo *et al.* 2004; Michez *et al.* 2009; Hinojosa-Díaz *et al.* 2012). A total of eight cases of gynandromorphism in four species of *Ceratina* were cited here, being most of reports in the subgenus and species C. (*Crewella*) *rupestris* Holmberg and C. (*Euceratina*) *dallatorreana* Friese. Almost all records correspond to New World species except by C. (*Pithitis*) *binghami* Cockerell from the Old World. The marked dimorphism that most species of *Xylocopa* have could be one of the reasons why there is a big difference in reports regarding *Ceratina*. Except for the cases described by Lucia *et al.* (2012) and Prashantha *et al.* (2018), the morphological descriptions of the gynanders of *Ceratina* are very ambiguous, possibly due to the difficulty of distinguishing the traits of each sex.

In contrast with the revisions made by Wcislo *et al.* (2004), Hinojosa-Díaz *et al.* (2012) and Lucia and Gonzalez (2013), this work used the category of gynandromorphism proposed by Michez *et al.* (2009). According to this latter author, transversal and mosaic categories are the most common type of gynandromorphs described for bees.

However, despite the fact that they classify the cases of *Xylocopa (Koptortosoma) confusa* Perez, X. (K.) *nigrita* (Fabricius) and X. (*Schonherria*) *micans* Lepeletier as transversals, I did not consider any of them in that category because they do not show a pattern of distribution in none of the sexual traits. The predominant categories here were mosaic in 22 cases and bilateral in eight. For the cases of the species *Ceratina (Rhysoceratina) montana* Holmberg and X. (*Neoxylocopa*) *varipuncta* reported by Bonnet (1952), it was not possible to define the category of gynandromorphy because the morphological descriptions lacked information. Cases about gynandromorphism in species of the tribe Allodapini and Manueiliini (tribes also found in Xylocopinae) were not found.

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**Anexo 1.** Compilation of gynandromorphy records in Xylocopinae Latreille, 1802. 1 Cited as *Xylocopa ordinaria* and subsequently identified as *X. (Neoxylocopta) atamisqueensis* by Lucia and Gonzalez (2013); 2 Specimen lost in the fire (See Zamudio et al. 2018); ♀= female; ♂= male; ?= Probable repository.

Species	Locality	Category	Phenotype	Repository	Reference
<i>Xylocopta (Bilina) nasalis</i> Westwood	INDIA, Karnataka, Bengaluru	Mosaic	<i>Head:</i> ♀ overall with ♂ traits on left labrum and maculae on left side of clypeus, supraciliapal area and adjacent to median ocellus. <i>Mesosoma, metasoma and terminalia:</i> ♀-like.	GKVK	Prashantha et al. (2018)
<i>X. (Ctenoxylocopta) fenestrata</i> (Fabricius)	INDIA, Himalaya	Mosaic	<i>Head:</i> Bilateral, right side as ♂ and left side ♀. <i>Mesosoma:</i> right half with ♂ traits except legs, left side and appendages as ♀. <i>Mesosoma and terminalia:</i> Predominantly ♀.	Unknown	Maa (1940)
<i>X. (Koptortosoma) confusa</i> Perez	AUSTRALIA, South Australia, Burnside	Mosaic	<i>Head:</i> Predominantly ♀ with some pubescence as ♂ on right side. <i>Mesosoma:</i> ♀ overall except right fore and middle leg and right wings with ♂ traits. <i>Metasoma:</i> Bilateral, right half as ♂ and left half as ♀. <i>Terminalia:</i> ♂-like, genital capsule anomalous.	NMB?	Handschin (1935)
<i>X. (K.) nigrita</i> (Fabricius)	KENYA, Kericho County, Kericho	Bilateral	<i>Head and mesosoma:</i> Bilateral, left half ♂-like and right half ♀. <i>Mesosoma:</i> Mostly bilateral as the anterior tagma except S4-S6 with ♀ features. <i>Terminalia:</i> ♀-like.	NMK	Carcasson (1965)
<i>X. (K.) pubescens</i> Spinola	ISRAEL	Mosaic	<i>Head:</i> Bilateral in part, right half mostly ♂ and left half and mandibles as ♀. <i>Mesosoma:</i> Predominantly ♀ except foreleg with ♂ features. <i>Metasoma:</i> Bilateral, right half as ♀ and left half as ♂. <i>Terminalia:</i> not examined.	TAUI	Guershon and Ionescu-Hirsch (2012)
<i>X. (Neoxylocopta) atamisqueensis</i> Lucia and Abrahamovich	ARGENTINA, Mendoza	Mosaic	<i>Head:</i> Mostly ♀ except face, gena and lower left half of clypeus with ♂ features. <i>Mesosoma:</i> Predominantly ♀ except left half of mesoscutum and mesoscutellum with pubescence as ♂. <i>Metasoma:</i> Mostly ♀. <i>Terminalia:</i> not examined.	MIZ	Enderlein (1913a) <sup>1</sup>
<i>X. (N.) augusti</i> Lepetier	ARGENTINA, Buenos Aires, Pehuenco	Mosaic	<i>Head:</i> Predominantly ♀ except ♂ maculae on mandibles basally, left side of clypeus and paracocular area, right scape and gena. <i>Mesosoma:</i> Mixed, mostly ♂. <i>Mesosoma:</i> ♂-like except ♀ pubescence on some segments. <i>Terminalia:</i> ♂-like, genital capsule anomalous.	MLP	Lucia et al. (2015)

X. ( <i>N.</i> ) <i>brasiliense</i> (Linnaeus)	ARGENTINA, Santiago del Estero Barrancas	Mosaic	<i>Head:</i> Almost bilateral, left half as ♂, clypeus and right half as ♀. <i>Mesosoma:</i> Overall ♀ except ♂ on left half of mesoscutellum, mesoscutum, metanotum and propodeum. <i>Metasoma:</i> Mostly bilateral, left half ♂ and right half ♀. <i>Terminalia:</i> S6 as ♀ and T6 as ♀, with sting.	MNHN	Benoist and Berland (1935)
BRAZIL, São Paulo, Jundiaí		Mosaic	<i>Head:</i> Bilateral in part, ♀-like on right half except right occipital area and gena, and ♂ on left half except left occipital area and gena. <i>Mesosoma:</i> As ♀ except right side of pronotum and mesoscutum, mesoscutellum, metanotum, left side of propodeum, right forewing and fore leg with ♂ traits. <i>Metasoma:</i> Predominantly ♀ except ♂ on right side of T1 and T2, left side of T3 and T4 and left half of S3 an S5. <i>Terminalia:</i> ♀-like.	MZUSP	Almeida et al. (2018)
X. ( <i>N.</i> ) <i>darwini</i> Cockerell	ECUADOR, Galápagos Province, North Coast of Isabella Island	Mosaic	<i>Head:</i> ♀-like. <i>Mesosoma:</i> Predominantly ♀ except right side of meseepisternum, metepisternum and mesoscutellum, right middle and hind leg and right wings with ♂ features. <i>Metasoma:</i> Mostly ♀ except right half of terga and S2 as ♂. <i>Terminalia:</i> ♀ sting apparatus and ♂ features on S7.	NMNH	Zama and Coelho (2017)
X. ( <i>N.</i> ) <i>frontalis</i> (Olivier)	PARAGUAY, Guairá, Villarica	Mosaic	<i>Head:</i> ♀-like with some ♂ features on left side of occiput. <i>Mesosoma</i> and <i>metasoma:</i> mostly ♂ traits on right side and ♀ on left side. <i>Terminalia:</i> left half of T6 as ♀ and right half as ♂, genital capsule missing.	MLP	Lucia and Gonzalez (2013)
BRAZIL, Santa Catarina, Corupá		Mosaic	<i>Head:</i> Bilateral, right half as ♀ and left half ♂. <i>Mesosoma:</i> Bilateral, right half ♂ and left half ♀. <i>Metasoma:</i> ♀ overall with ♂ traits on left half of T1, anterior left half of T2–T4 and right half of S2 and S3. <i>Terminalia:</i> not examined.	MNRJ <sup>2</sup>	Vivallo (2015)
COLOMBIA, Cundinamarca, Tena		Mosaic	<i>Head:</i> ♀-like. <i>Mesosoma:</i> As ♀ including legs and wings except left half of mesoscutellum, mesoscutum, metanotum and propodeum as ♂. <i>Metasoma:</i> predominantly ♀ except right anterior half of S2 with ♂ traits. <i>Terminalia:</i> ♀-like.	UNAB	This study

X. ( <i>N.</i> ) <i>mendozana</i> Enderlein Argentina, Mendoza	ARGENTINA, Mendoza	Bilateral	<i>Head</i> and <i>mesosoma</i> : Mostly bilateral, right half as ♂ and left half as ♀. <i>Metasoma</i> : ♀ overall with some ♂ traits on right side. <i>Terminalia</i> : Not examined.	MIZ	Enderlein (1913b)
X. ( <i>N.</i> ) <i>nigrocincta</i> Smith	ARGENTINA, Misiones	Mosaic	<i>Head</i> : Bilateral, right half ♂ and left half ♀. <i>Mesosoma</i> : Predominantly ♀ except right half of pronotum, pronotal lobe and distal half of fore tibia with ♂ traits. <i>Metasoma</i> : As ♀ with light coloration on integument. <i>Terminalia</i> : ♀-like.	MLP	Lucia <i>et al.</i> (2009)
X. ( <i>N.</i> ) <i>ordinaria</i> Smith	BRAZIL, Sergipe, Itabatana	Bilateral	<i>Head</i> , <i>mesosoma</i> and <i>metasoma</i> : Bilateral, right half ♀ and left half ♂. <i>Terminalia</i> : Anomalous, gonostylus, lancet and hemitergite as ♀ and half portion of T7 as ♂.	CEUFS	Almeida <i>et al.</i> (2018)
X. ( <i>N.</i> ) <i>varipuncta</i> Patton	UNITED STATES, Hawaii, Island of Maui	Undetermined	♀ overall with some ♂ traits.	Unknown	Krauss (1928)
UNITED STATES, Hawaii, Kailua	UNITED STATES, Hawaii, Kailua	Bilateral	<i>Head</i> , <i>mesosoma</i> and <i>metasoma</i> : Bilateral, left half as ♂ and right half ♀. <i>Terminalia</i> : Not examined.	Unknown	Bonnet (1952)
UNITED STATES, California	UNITED STATES, California	Bilateral	<i>Head</i> : Predominantly bilateral, right half ♀ and left half ♂. <i>Mesosoma</i> and <i>metasoma</i> : Mostly bilateral, right half ♀ and left half ♂, with some ♀ traits on T2 and T3. <i>Terminalia</i> : ♀-like.	UCRC	Gordh and Gulmahamad (1975)
UNITED STATES, California, Riverside	UNITED STATES, California, Riverside	Bilateral	<i>Head</i> : Mostly bilateral, right half ♀ and left half ♂. <i>Mesosoma</i> : Predominantly ♀ except mesoscutum medially fore and mid legs, left wings, left posterior margin of mesoscutellum and left half of metanotum and propodeum with ♂ traits. <i>Metasoma</i> : Mostly ♀, with some ♂ features on left side of T1-T3 and T6. <i>Terminalia</i> : ♀-like.	CAS	Zama and Coelho (2017)
X. ( <i>Schonherria</i> ) <i>micanis</i> Lepeletier	UNITED STATES, Texas	Mosaic	<i>Head</i> : Mostly bilateral, right half ♂ and left half ♀. <i>Mesosoma</i> and <i>metasoma</i> : Bilateral, ♀-like on right half and ♂ on left half. <i>Terminalia</i> : Genital capsule anomalous.	NMW	Maidli (1912)
X. ( <i>S.</i> ) <i>splendida</i> Lepeletier	ARGENTINA, Buenos Aires, La Plata	Mosaic	<i>Head</i> : Bilateral, ♀-like on left half and mostly ♂ on right half. <i>Mesosoma</i> , <i>metasoma</i> and <i>terminalia</i> : ♀-like.	MLP	Lucia <i>et al.</i> (2012)

<i>X. (Xylocopa) violacea</i> (Linnaeus)	ITALY, Friuli-Venezia Giulia, Trieste	Mosaic	<i>Head</i> : Bilateral, as ♀ on left half and ♂ on right half. <i>Mesosoma</i> : Predominantly ♂ except right side with ♀ traits. <i>Terminalia</i> : not examined.	Unknown	Kriechbaumer (1872)
<i>X. (Xylocopoides) virginica</i> (Linnaeus)	UNITED STATES, Ohio, South Bass Island	Mosaic	<i>Head</i> : Mostly bilateral, left half as ♀, right half and mandibles as ♂. <i>Mesosoma</i> : Overall ♂ except right middle and hind legs with ♀ features. <i>Metasoma</i> : Bilateral, as ♀ on left side and ♂ on right side. <i>Terminalia</i> : Only S6 visible as ♀ but with ♂ traits; genitalia anomalous with mixed features of both sexes.	NMNH	Milliron <i>et al.</i> 1958
<i>Ceratina (Crewella) rufipes</i> Holmberg	ARGENTINA, Buenos Aires, Berisso	Mosaic	<i>Head</i> : ♂-like. <i>Mesosoma</i> : ♀ overall except fore and middle legs as ♂. <i>Metasoma</i> : with six exposed segments as ♀ but general appearance as ♂. <i>Terminalia</i> : ♀-like.	MLP	Lucia <i>et al.</i> (2012)
<i>ARGENTINA, Buenos Aires, Berisso</i>	ARGENTINA, Buenos Aires, Parque Pereyra Iracola	Mosaic	<i>Head</i> : Predominantly ♂ except ♀ features on antennae. <i>Mesosoma</i> , <i>metasoma</i> and <i>terminalia</i> : Mostly ♀.	MLP	Lucia <i>et al.</i> (2012)
<i>ARGENTINA, Buenos Aires, Parque Pereyra Iracola</i>	ARGENTINA, Buenos Aires, Parque Pereyra Iracola	Mosaic	<i>Head</i> : Bilateral in part, mandibles and right half ♀, left half as ♂. <i>Mesosoma</i> : Predominantly ♀ except left side of pronotum and left fore leg with ♂ traits. <i>Metasoma</i> : with seven exposed terga as ♂ but with ♀ appearance. <i>Terminalia</i> : Anomalous and bilateral, part of gonobase, penis valve and a single gonostylus on right side, part of sting on left side.	MLP	Lucia <i>et al.</i> (2012)
<i>C. (Euceratina) dallatorreana</i> Friese	UNITED STATES, California, Butte	Mosaic	Metallic integument. ♀-like anteriorly. <i>Terminalia</i> : T7 conical and nearly pointed as ♂.	EMEC?	Daly (1966)
	UNITED STATES, California, Butte	Mosaic	Nonmetallic integument ♀-like anteriorly. <i>Terminalia</i> : T7 conical and nearly pointed as ♂.	EMEC?	Daly (1966)
	UNITED STATES, California, Solano	Mosaic	Nonmetallic integument. ♀-like anteriorly. <i>Terminalia</i> : T7 conical and nearly pointed as ♂.	EMEC?	Daly (1966)
<i>C. (Pithitis) binghami</i> Cockerell	INDIA, Karnataka, Bengaluru	Mosaic	<i>Head</i> : Bilateral, right half ♀ and left half ♂. <i>Mesosoma</i> , <i>metasoma</i> and <i>terminalia</i> : ♀-like.	GVK	Prashantha <i>et al.</i> (2018)
<i>C. (Rhyssoceratina) montana</i> Holmberg	ARGENTINA, Buenos Aires, Tandil	Undetermined	<i>Head</i> : ♂ overall except 12 flagellomeres. <i>Metasoma</i> : Superficially as ♂ but with six segments on metasoma.	Unknown	Holmberg (1884)