

A New Gynandromorph of *Xylocopa frontalis* With a Review of Gynandromorphism in *Xylocopa* (Hymenoptera: Apidae: Xylocopini)

MARIANO LUCIA¹ AND VICTOR. H. GONZALEZ^{2,3,4}Ann. Entomol. Soc. Am. 106(6): 853–856 (2013); DOI: <http://dx.doi.org/10.1603/ANI13085>

ABSTRACT A new case of gynandromorphism in bees is described and illustrated for the first time for *Xylocopa* (*Neoxylocopa*) *frontalis* (Olivier), a widely distributed carpenter bee in the neotropical region. The mixed gynandromorph, recorded from a single specimen from Paraguay, exhibits a mixture of male and female features in all tagmata. Previous literature records of gynandromorphs in *Xylocopa* Latreille are summarized, and the species identity of some gynandromorphs recorded for South America is revised. Including the specimen described herein, gynandromorphs are now known for a total of 12 species in *Xylocopa*, half of them in the neotropical subgenus *Neoxylocopa*.

KEY WORDS Anthophila, carpenter bee, Paraguay

Gynandromorphs are sexually abnormal individuals that display secondary characters of both sexes (certain regions of the body are male while others are female). Gynandromorphs are currently known for 114 species of bees belonging to 29 genera of all families and from all major biogeographic regions of the world. However, most gynandromorphs (79%) are known from species of the Holarctic region, with a significant number recorded from species in the genera *Megachile* s.l. Latreille (Megachilidae) and *Andrena* F. (Andrenidae) (Wcislo et al. 2004, Michez et al. 2009, Hinojosa-Díaz et al. 2012). Given the paucity of records from other regions and limited research on this phenomenon, it is not known whether such a prevalence of gynandromorphs in species of those genera and from that region of the world is because of a sampling bias or a true predisposition within those lineages toward gynandromorphism.

Herein, we document for the first time a mixed gynandromorph in *Xylocopa* (*Neoxylocopa*) *frontalis* (Olivier) (Apidae, Xylocopini). This species is among the largest, commonest, and widespread carpenter bees in the Americas, ranging from Mexico to Argentina (Moure 2007). Furthermore, in some countries such as Colombia and Brazil, *X. frontalis* is among the main pollinators of passion fruits (*Passiflora* spp.) (e.g., Benevides et al. 2009, Gonzalez et al. 2009, Siqueira et al. 2009). We also summarize the cases of gynandromorphs known in *Xylocopa* Latreille and re-

vised the taxonomic identity of some of these records for South America. To date, gynandromorphs have been documented for 11 species of *Xylocopa* belonging to 5 of the 31 subgenera worldwide; half of the records are for species in the neotropical subgenus *Neoxylocopa* Michener (Hinojosa-Díaz et al. 2012, Lucia et al. 2012).

Materials and Methods

External morphological structures were studied using a Nikon SMZ 745T stereomicroscope (Nikon, Tokyo, Japan) and photographs were taken with a Canon Power Shot A520 digital camera (Canon, Tokyo, Japan) attached to it. Digital images were assembled using CombineZM open software. As in other studies of gynandromorphs, deviant morphological features are described in detail. Morphological terminology follows Michener (2007). The abbreviations T, S, and F are herein used for metasomal terga and sterna and flagellar segments, respectively. To facilitate comparisons, gynandromorphs in *Xylocopa* were summarized following the format of Wcislo et al. (2004) as well as the classification of gynandromorphs by Dalla Torre and Friese (1899) as follows: bilateral (divided in left–right), antero–posterior, transverse (dorsal–ventral), and mixed (mosaics or different combinations).

Results

Xylocopa (*Neoxylocopa*) *frontalis*

(Figs. 1–4)

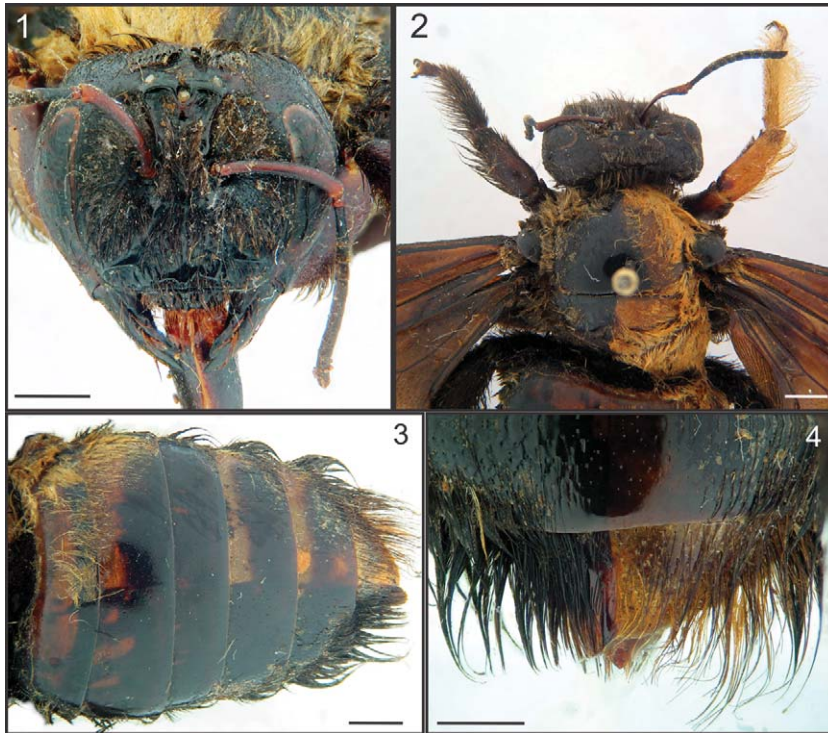
Description. Body length 26.4 mm, head length 6.7 mm, head width 8.1 mm, mesosoma width (measured between lateral margins of tegulae) 10.3 mm, metasoma width (measured across T2) 11.5 mm. *Head* (Fig.

¹ División Entomología, Museo de La Plata, Universidad Nacional de La Plata, CONICET, Consejo Nacional de Investigaciones Científicas y Técnicas, Paseo del Bosque s/n, 1900FWA, La Plata, Argentina.

² Southwestern Oklahoma State University, Biological Sciences, 100 Campus Dr., Weatherford, Oklahoma 73096.

³ Division of Entomology, Natural History Museum, 1501 Crestline Dr.—Suite 140, University of Kansas, Lawrence, Kansas 66045.

⁴ Corresponding author, e-mail: victorgonzab@gmail.com.



Figs. 1–4. Gynandromorph of *Xylocopa* (*Neoxylocopa*) *frontalis* (Olivier)—(1) facial view, (2) head and mesosoma in dorsal view, (3) metasoma in dorsal view, and (4) sixth tergum in dorsal view. Scale bars: 2 mm. (Online figure in color.)

1): entirely female-like, except some yellow hairs on left side of occiput as in male; integument and pubescence dark brown to black; scape light brown; conspicuous carinae below lateral ocelli; upper interorbital distance 5.6 mm; lower interorbital distance 5.5 mm; interalveolar distance 1.4 mm; alveolocular distance 1.8 mm. Antenna with 12 segments (length of scape, pedicel, and F1: 3.3 mm, 0.3 mm, and 1.1 mm, respectively). *Mesosoma*: mixed (Fig. 2). *Right side*: pronotum, scutum (except black on posterior central portion), metanotum, and propodeum with pubescence and integument yellow as in normal male; propodeum expanded (“inflated”) as in normal male because of exocrine glands; tegula size male-like (length: 2.75 mm, width: 2.15 mm), but integumental color black as in normal female; anterior leg with male-like pretarsal claws and tarsus, tibia with mixed features of both sexes, remaining segments, medial and posterior legs as in normal female. *Left side*: mostly female-like except yellow pubescence on anterior and lateral areas of scutum; tegula size female-like (length: 2.60 mm, width: 1.65 mm); wings dark brown with violet iridescence, right fore wing with some light areas. *Metasoma*: mixed (Fig. 3), with six exposed terga and six exposed sterna. Sterna and T3 as in normal female, T1 no perfectly divided into right side male and left side female, but right side appears male-like, wider, with yellow, plumose hairs, left side female-like. Remaining metasomal segments as follows: *Right side*, T2 male-like with yellow simple hairs; T4–6 with

male-like appearance. *Left side*, T2 with integumental color mixed of yellow and ferruginous patches, T4–6 as in normal female. T6 with lateral preapical spine and pygidial spine as in a normal female on left side, right side with appearance of normal male (Fig. 4). Genital capsule is missing from specimen.

Material Examined. One gynandromorph, Paraguay, Villa Rica, 5–II–1948, Coll. F.H. Schade, deposited in the División Entomología, Museo de La Plata, Argentina.

Discussion

The gynandromorph of *X. frontalis* described herein belongs to the mixed or mosaic class because it shows sex tissues (female and male) distributed randomly in the body. This is the most common type of gynandromorphs described for bees (Wcislo et al. 2004). Including this new gynandromorph and that recently described by Ramos and Ruz (2013), the total number of gynandromorphs known in bees ascends to 119 species in 30 genera. Table 1 lists all 12 gynandromorph cases, including the one described herein, currently known in *Xylocopa*. Half of the species of *Xylocopa* with known gynandromorphs belong to the neotropical subgenus *Neoxylocopa*. Individuals with sexually deviant phenotypes in this subgenus are more likely to be detected than in other subgenera of *Xylocopa* because females are black while males are usually yellow or testaceous. Table 1 also includes three

Table 1. Gynandromorphs recorded from species of *Xylocopa*

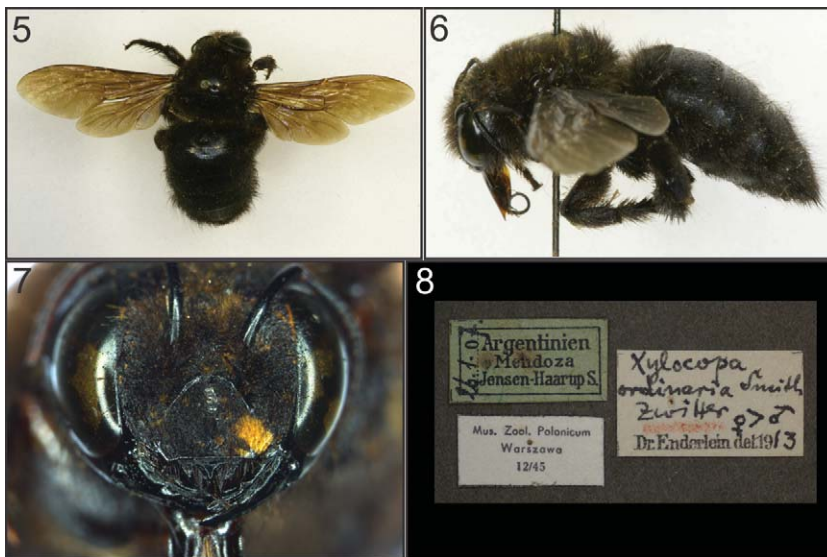
Species of <i>Xylocopa</i>	Gynandromorph class	Deviant phenotypic characteristics	Reference
<i>X. (Ctenoxylocopa) fenestrata</i> (F.)	Mixed	Right side of head and mesosoma (excluding legs) ♂, rest of body ♀-like	Maa (1940)
<i>X. (Koptortosoma) nigrita</i> (F.)	Bilateral	Left side ♂, right side ♀, except for last segment of metasoma, S4–6 ♀	Carcasson (1965)
<i>X. (K.) confusa</i> Pérez	Mixed	Head ♀; left side of mesosoma and metasoma ♀; genitalia with sagitta, stipes, and cardo reduced on ♀ side; right side ♂	Handschin (1935)
<i>X. (Neoxylocopa) mendozana</i> Enderlein	Mixed	Right half of head and mesosoma and metasomal terga ♂; left half of head and mesosoma and all sterna ♀	Enderlein (1913a)
<i>X. (N.) nigrocincta</i> Smith	Mixed	Head with right half ♂, left half ♀; mesosoma ♀-like except protorax and distal half of fore tibia ♂-like; metasoma ♀	Lucia et al. (2009)
<i>X. (N.) varipuncta</i> Patton	Undetermined	Mix black (♀) and yellow (♂) color	Krauss (1928)
	Bilateral	Left side ♂, right side ♀	Bonnet (1952)
	Bilateral	Left side ♂, right side ♀	Gordh and Gulmahamad (1975)
<i>X. (N.) atamisquensis</i> Lucia & Abrahamovich	Mixed	Left side of clypeus ♂-like, with large yellow integumental spot; face ♂-like, with small, scattered, yellow spots (Fig. 7). Pubescence on face and dorsum of mesosoma with mixed ♂ and ♀ features	Enderlein (1913b) ^a
	Mixed	Left side of head and mesosoma ♂, right side ♀; T1–4 with left side ♂-like, right side ♀-like; T5 left side ♀-like, right side ♂-like; T6 ♂-like, S6 ♀-like	Benoist and Berland (1935) ^b
<i>X. (N.) frontalis</i> (Olivier)	Mixed	Head ♀; right side of mesosoma ♂-like, left side ♀-like, all legs ♀-like (except right pro pretarsal claws and tarsus); metasoma with mixture of male and female characters	This study
<i>X. (Schonherria) micans</i> Lepeletier	Bilateral	Left side of head ♀, right side ♂; left side of mesosoma and metasoma ♂, right side ♀; left side of genitalia ♂, right side undescribed	Maidl (1912)
<i>X. (S.) splendidula</i> Lepeletier	Mixed	Head, right half upper part of eye, integument of supraclypeal area and most part of clypeus and labrum ♂-like; rest of body ♀	Lucia et al. (2012)
<i>X. (Xylocopa) violacea</i> (L.)	Mixed	Head with left side ♀-like, right side ♂; mesosoma with left side ♂-like, right side ♀-like. All legs ♂	Kriechbaumer (1872)

^a Listed as *X. ordinaria* Smith.

^b Probably a specimen of *X. atamisquensis* Lucia & Abrahamovich (see text).

records for *Xylocopa varipuncta* Patton, which were overlooked in previous reviews, and the correct species name for a gynandromorph collected in the prov-

ince of Mendoza, Argentina, and described by Enderlein (1913a,b) as *Xylocopa ordinaria* Smith. This gynandromorph was examined by one of us (M.L.),



Figs. 5–8. Gynandromorph of *Xylocopa (Neoxylocopa) atamisquensis* Lucia & Abrahamovich—(5, 6) dorsal and lateral habitus, (7) facial view, and (8) specimen labels (photos by Tomasz Hufiejt). (Online figure in color.)

and it actually is a specimen of *Xylocopa atamisquensis* Lucia & Abrahamovich (Figs. 5–8). Similarly, the gynandromorph collected in the Argentinean province of Santiago del Estero and described by Benoist and Berland (1935) as *Xylocopa brasilianorum* (L.) might also be a specimen of *X. atamisquensis*. First, *X. brasilianorum* does not occur in Argentina (Moure 2007). Second, *X. atamisquensis* is widespread in Argentina, and Santiago del Estero is the type locality of this species (Lucia and Abrahamovich 2010). Third, older literature records referred to *X. atamisquensis* either as *X. ordinaria* Smith or *X. brasilianorum* (Lucia et al. in preparation). However, we have not been able to examine this specimen to confirm this record.

Acknowledgments

We are grateful to two anonymous reviewers for comments and suggestions that improved the manuscript, and to the Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina (CONICET) for continued support. Partial support to V.H.G. was provided by the Department of Biological Sciences, Southwestern Oklahoma State University. Tomasz Huflejt (Polish Academy of Sciences, Zoology Museum and Institute, Warsaw) kindly provided the photographs of the gynandromorph of *X. atamisquensis*. This is a contribution of the Division of Entomology, University of Kansas Natural History Museum.

References Cited

- Benevides, C. R., M. C. Gaglianone, and M. Hoffmann. 2009. Visitantes florais do maracujá-amarelo (*Passiflora edulis* f. *flavicarpa* Deg. Passifloraceae) em áreas de cultivo com diferentes proximidades a fragmentos florestais na região norte fluminense. RJ. Rev. Bras. Entomol. 53: 415–421.
- Benoist, R., and L. Berland. 1935. Trois cas de gynandromorphisme chez les hyménoptères aculéates. Arch. Mus. Hist. Nat. 12: 435–438.
- Bonnet, B. 1952. *Xylocopa varipuncta* gynandromorph. Proc. Hawaii Entomol. Soc. 14:359.
- Carcasson, R. H. 1965. A remarkable gynandrous carpenter bee. J. East Afr. Nat. Hist. Soc. 25: 75.
- Dalla Torre, K. W., and H. Friese. 1899. Die hermaphroditen und gynandromorphen hymenopteren. Ber. Naturwiss.-Med. Ver. Innsb. 24: 1–96.
- Enderlein, G. 1913a. Ein hervorragenden zwitter von *Xylocopa mendozana* aus Argentinien. Stett. Entomol. Zeit. 74: 124–140.
- Enderlein, G. 1913b. Zur kenntnis des xylocopen Südamerikas und über einen zwitter von *Xylocopa ordinaria*. Arch. Naturg. 7: 156–170.
- Gonzalez, V. H., M. M. Gonzalez, and Y. Cuellar. 2009. Notas biológicas y taxonómicas sobre los abejorros del maracuyá del género *Xylocopa* (Hymenoptera: Apidae, Xylocopini) en Colombia. Acta Biol. Colomb. 14: 31–40.
- Gordh, G., and H. Gulmahamad. 1975. A bilateral gynandromorphic *Xylocopa* taken in California (Hymenoptera: Apidae). Proc. Entomol. Soc. Wash. 77: 269–273.
- Handschin, E. 1935. Beobachtungen an einem Zwitter von *Xylocopa confusa* Perez. Bull. Soc. Entomol. Suisse. 16: 312–317.
- Hinojosa-Díaz, I. A., V. H. Gonzalez, R. Ayala, J. Mérida, P. Sagot, and M. S. Engel. 2012. New orchid and leaf-cutter bee gynandromorphs, with an updated review (Hymenoptera, Apoidea). Zoosyst. Evol. 88: 205–214.
- Krauss, N. H. 1928. *Xylocopa varipuncta*. Proc. Hawaii Entomol. Soc. 7: 22.
- Kriechbaumer, J. 1872. *Xylocopa violacea* gynandromorph. In Vers. Deutsche Natur. Acrzte in Liepzig. 45: 137.
- Lucia, M., and A. H. Abrahamovich. 2010. A new species of large carpenter bee, *Xylocopa* (Hymenoptera: Apidae), from Argentina. Entomol. News 121: 243–248.
- Lucia, M., A. H. Abrahamovich, and L. J. Alvarez. 2009. A Gynandromorph of *Xylocopa nigrocincta* Smith (Hymenoptera: Apidae). Neotrop. Entomol. 38: 155–157.
- Lucia, M., L. J. Alvarez, and A. H. Abrahamovich. 2012. Gynandromorphism in Xylocopinae Bees (Hymenoptera: Apidae): description of four new cases. Zootaxa 3401: 37–42.
- Maa, T. C. 1940. On the monstrosity of certain *Xylocopa*-species (Hymenoptera: Xylocopidae). Lingnan Sci. J. 19: 83–85.
- Maidl, F. 1912. Über einen fall von lateraler gynandromorphie bei einer holzbiene (*Xylocopa micans* Lep.). Verh. Zool.-Bot. Ges. Wien. 62: 19–26.
- Michener, C. D. 2007. The bees of the world, 2nd ed. Johns Hopkins University Press, Baltimore, MD.
- Michez, D., P. Rasmont, M. Terzo, and N. J. Vereecken. 2009. A synthesis of gynandromorphy among wild bees (Hymenoptera: Apoidea), with an annotated description of several new cases. Ann. Soc. Entomol. Fr. 45: 365–375.
- Moure, J. S. 2007. Xylocopini Latreille, 1802, pp. 637–673. In J. S. Moure, D. Urban, and G.A.R. Melo (eds.), Catalogue of Bees (Hymenoptera, Apoidea) in the Neotropical Region. Sociedade Brasileira de Entomologia, Curitiba, Brazil. (<http://www.moure.cria.org.br/catalogue>).
- Ramos, K. S., and L. Ruz. 2013. First record of intersexual phenotype in Calliopsini bees (Hymenoptera, Apidae, Andreninae): an unusual specimen of *Acamptopoeum submetallicum* (Spinola). Zootaxa 3609: 239–242.
- Siqueira, K.M.M., L.H.P. Kiill, C. F. Martins, I. B. Lemos, S. P. Monteiro, and S. P. Feitoza. 2009. Ecologia da polinização do maracujá-amarelo, na região do vale do submédio São Francisco. Rev. Bras. Fruticultura 31: 1–12.
- Wcislo, W. T., V. H. Gonzalez, and L. Arneson. 2004. A review of deviant phenotypes in bees in relation to brood parasitism, and a gynandromorph of *Megalopta genalis* (Hymenoptera: Halictidae). J. Nat. Hist. 38: 1443–1457.

Received 23 May 2013; accepted 30 July 2013.