

Gynandromorphism in Xylocopinae Bees (Hymenoptera: Apidae): description of four new cases

MARIANO LUCIA, LEOPOLDO J. ALVAREZ & ALBERTO H. ABRAHAMOVICH

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

E-mail: mlucia@fcnym.unlp.edu.ar, lalvarez@fcnym.unlp.edu.ar, albertoa@fcnym.unlp.edu.ar

Abstract

Four new gynandromorph Xylocopinae bees from Argentina are described and illustrated; one specimen of *Xylocopa splendidula* Latreille and three of *Ceratina rupestris* Holmberg. All specimens are mosaic gynandromorphs as they display mixed female-male characters in different parts of the body.

Key words: Gynandromorphs, Carpenter Bees, Argentina

Introduction

Gynandromorphs are sexually abnormal individuals that display secondary characters of both sexes. Sex anomalies occur relatively frequently among bees and may be of striking appearance in species where the two sexes are markedly dissimilar in structure or color (Engel 2007). Gynandromorphs are interesting because they provide the possibility to recognize both female and male characters in the same specimen, allowing to match the different sexes with reasonable certainty when unknown. Among bees, most reports of gynandromorphism come from the families Megachilidae and Apidae (Ornosa Gallego 1984; Gonzalez 2004; Wcislo *et al.* 2004; Oliveira and Andrade 2006; Lucia *et al.* 2009; Michez *et al.* 2009; Sampson *et al.* 2010; Giangarelli and Sofia 2011). The subfamily Xylocopinae of Apidae includes four tribes: Manuelliini, Xylocopini, Ceratinini and Allodapini; the first three tribes are monotypic and include the genera *Manuelia* Vachal, *Xylocopa* Latreille and *Ceratina* Latreille respectively (Michener 2007). In this subfamily gynandromorphs have been described for *Xylocopa* (Wcislo *et al.* 2004; Lucia *et al.* 2009) and *Ceratina* (Holmberg 1874; Daly 1966). In this paper we describe and illustrate four new cases of gynandromorphism within Xylocopinae for two species, *Ceratina (Crewella) rupestris* Holmberg and *Xylocopa (Schonnherria) splendidula* Lepeletier.

Material and methods

External morphological structures were studied using a Nikon SMZ 745T stereomicroscope and photographs were taken with a Canon Power Shot® A520 digital camera attached to it. Digital images were mounted using CombineZM open source software (Hadley 2011). The terminology used in this work is that proposed by Michener (2007). All measures are expressed in millimeters. Abbreviations used below are T and S for terga and sterna. Voucher specimens are deposited in the entomological collection of Museo de La Plata, Argentina (MLP).

Description of gynandromorphs

Xylocopa (Schonherria) splendidula

(Figs. 1–2)

Body length 15.7, width (through the tegula) 6.7. General appearance female-like, color of body black with strong violaceous reflections. Antennae brown. Pubescence mainly black, except for tufts of white hairs on sides of T5 as in normal female. *Head*: it shows female characters with a mixture of some male characters: mandibles and antennae exhibit female features; left side with female characters and right side with mixed female and male characters. *Left side*: general appearance female-like, labrum with median tubercle (cut at half) and remarked lateral tubercle; distance between inner orbit and lateral ocellus 0.53; orbitoccipital distance 1.52 times median ocellar diameter. *Right side*: upper part of eye as normal male, lower part as normal female. Integument of supraclypeal area and most part of clypeus with yellow coloration as normal male. Labrum as in male; distance between inner orbit and lateral ocellus 0.28; orbitoccipital distance 0.59 times median ocellar diameter. *Mesosoma* and *metasoma* entirely female-like; with genital structure developed as a sting. *Material examined*: one gynandromorph, ARGENTINA, Buenos Aires, La Plata, (34°55'09" S, 57°56'52" W, 27 m a.s.l.). The specimen was located in the collection of Museo de La Plata, Argentina (MLP).

Ceratina (Crewella) rupestris

(Figs. 3–11)

Gynandromorph I (Figs. 3–4): Body length 10, head length 2.2, head width 2.15, mesosoma width (through the tegula) 3.1 and metasoma width (through the T2) 3.06. General color of body metallic blue-green, except black in mandibles, apical half of clypeus and labrum; antennae dark brown to black; legs brown, except the coxae and femora with blue-green coloration. *Head*: (Fig. 3) entirely male-like. Length and width of the left eye, 1.75:1.1, ocellorbital distance 0.4; antennae with 13 articles (length of scape, pedicel and F1:0.52:0.14:0.26); yellow markings at base of labrum, spot at mandible base, three spots in apical half of clypeus, one in parocular area ending just at the level of antennal socket and a small elongate stripe behind the eye. *Mesosoma*: partially asymmetric, fore and middle legs as in males, hind legs female-like; fore legs with a yellow stripe extending full length of tibia and small pale apical maculation on outer surface of femur and trochanter; rest of mesosoma with female features. Wings subhyaline. *Metasoma*: Symmetric, with six exposed terga and sterna as in females, but general appearance male-like. Genital structure developed as a sting, corresponding to the female. *Material examined*: one gynandromorph, ARGENTINA, Buenos Aires, Berisso (34°52'25" S, 57°50'18" W, 6 m a.s.l.), 2-XII-2009, Col. L. Alvarez-M. Lucia (MLP). Captured using yellow Moericke traps.

Gynandromorph II (Figs. 5–6): As described in gynandromorph I, except as follows: Body length 10, head length 2.46, head width 2.35, mesosoma width (through the tegula) 3.23 and metasoma width (through the T2) 3.5. *Head*: (Fig. 5) normal male characters (except for antennae as in female). Length and width of left eye, 1.78:1.13, ocellorbital distance 0.42; antennae with 12 articles (length of scape, pedicel and F1: 0.54:0.16:0.30). *Material examined*: one gynandromorph, ARGENTINA, Buenos Aires, Berisso (34°52'25" S, 57°50'18" W, 6 m a.s.l.), 2-XII-2009, Col. L. Alvarez-M. Lucia (MLP). Captured using yellow Moericke traps.

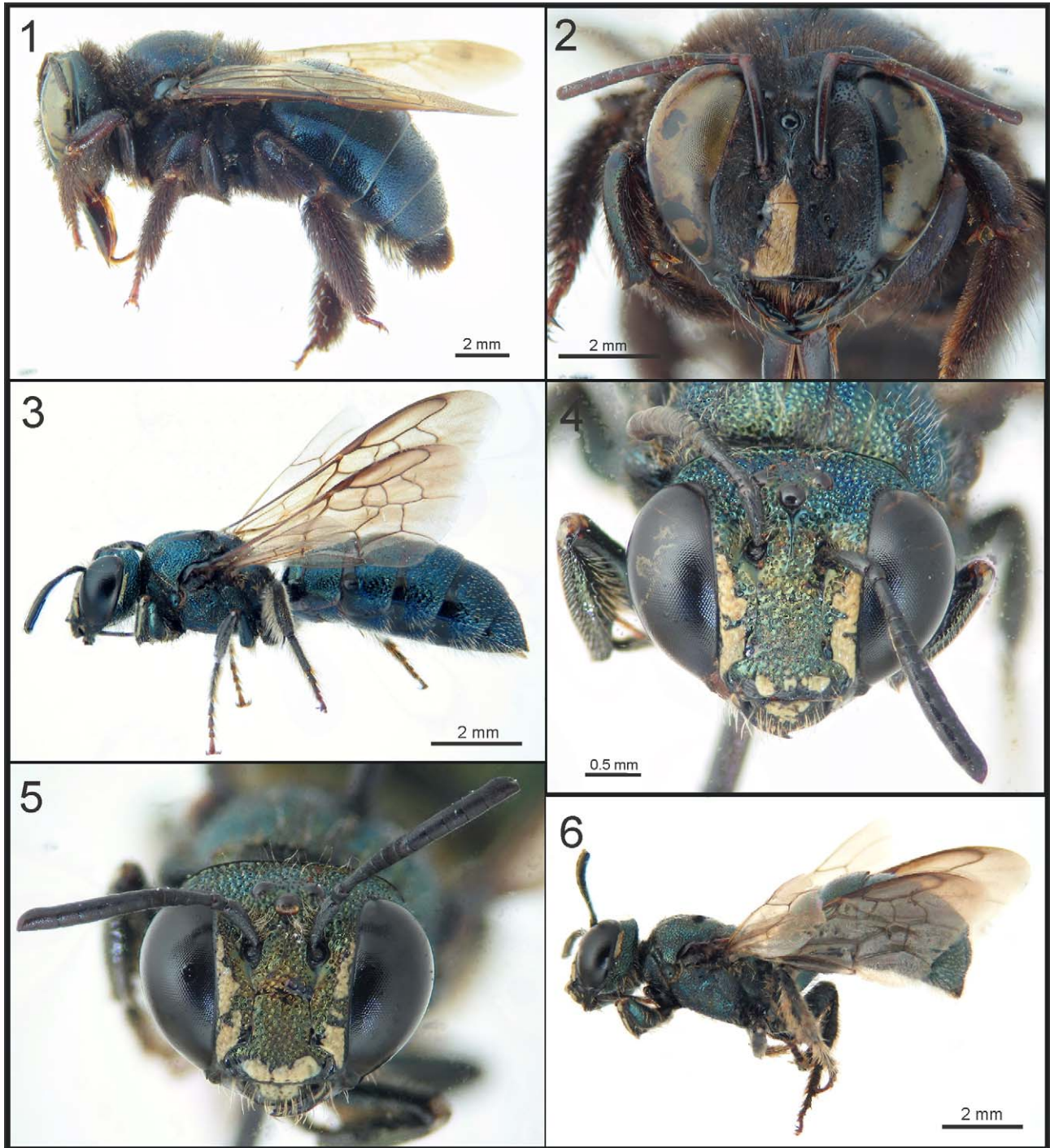
Gynandromorph III (Figs. 7–11): Body length 10, mesosoma width (through the tegula) 3.15, metasoma width (through the T2) 3.5. General coloration of body metallic blue-green, except mandibles, apical half of clypeus and labrum black; antennae dark brown to black; legs brown, except coxae and femora blue-green (Fig. 7). *Head*: shows a mixture of male and female characters (Fig. 8). Left side exhibits male features (except mandible), right side female features (except for mandible as in male). Length and width of the left eye (male) 1.84 and 1.1, ocellorbital distance, 0.34; length and width of the right eye (female), 1.74 and 1; distance between lateral ocelli and the orbit, 0.5. *Left side* with yellow markings as follows: labrum basally, apical half of clypeus, medially divided spot in parocular area ending just above antennal socket, and small elongate stripe behind the eye. Mandible black; antenna is broken but scape length is as in normal male. *Right side* with yellow markings between clypeus and lower margin of eye, small spot at the level of antennal socket near eye margin, elongate stripe behind eye and spot at base of mandible; labrum as in normal female, antenna is broken but scape length is as in normal

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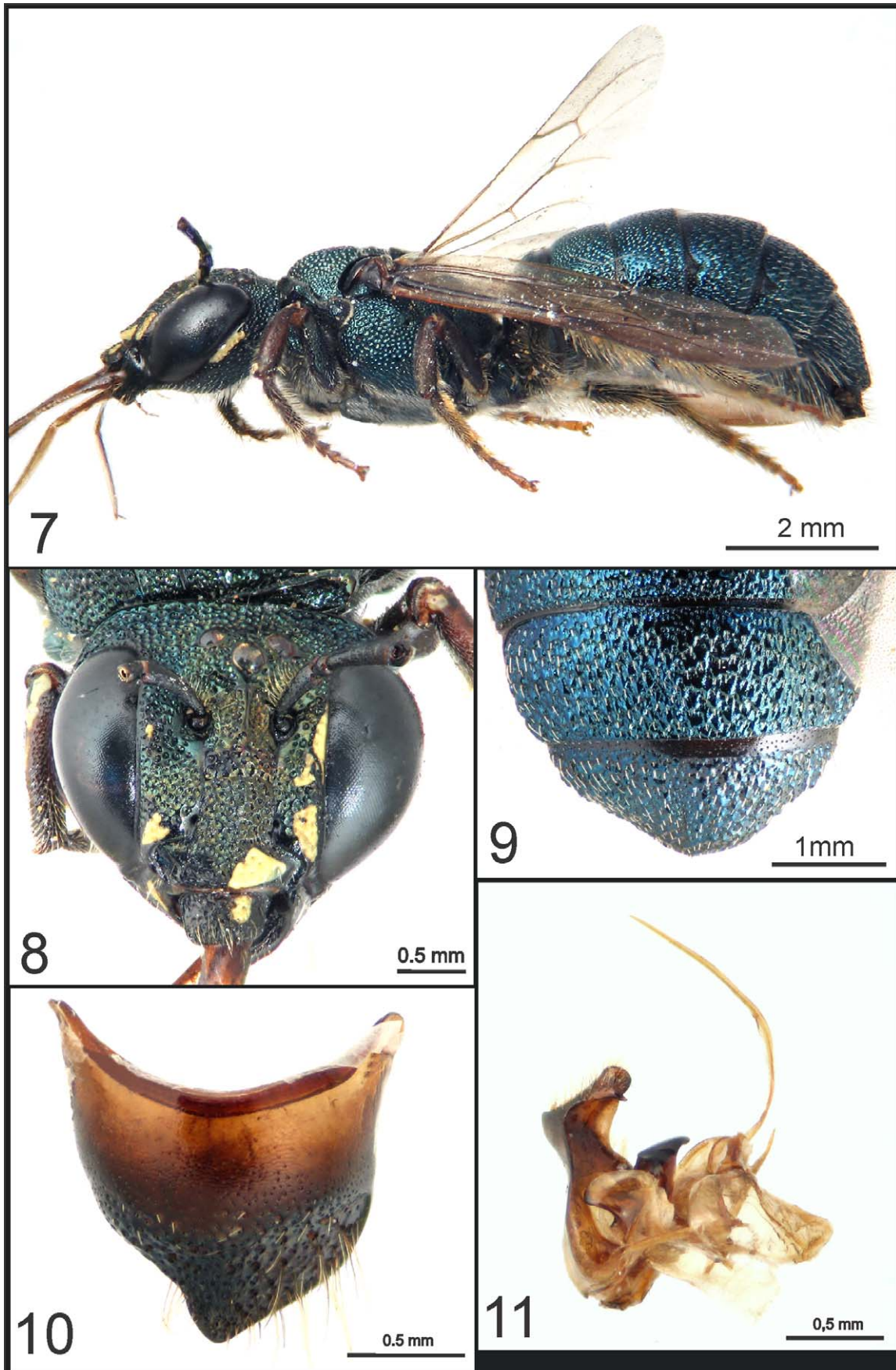
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female. *Mesosoma*: partially asymmetric, left side of pronotum and left foreleg typical of males, with yellow stripe marking extending the full length of tibia and small pale apical maculation in the femur; rest of mesosoma typical of females. Wings subhyaline. *Metasoma*: with seven exposed terga and six sterna, with appearance of a normal female. T6 and T7 irregularly developed, with left half tending male-like (Figs. 9–10). Genitalia bilaterally asymmetric, right side composed of a hemi-male genitalia showing part of the gonobase, a single penis valve and a single gonostylus; left side formed by part of a sting (Fig. 11). *Material examined*: one gynandromorph, ARGENTINA, Buenos Aires, Parque Pereyra Iraola, (34°50'S, 58°05'W, 6 m a.s.l.), 12-V-2003, Col. M Lucia (MLP). This specimen was collected foraging on *Verbena* sp. (Verbenaceae).



FIGURES 1–6. Gynandromorphs, body lateral and head frontal views. 1–2, *Xylocopa splendidula* and 3–6, *Ceratina rupestris* gynandromorphs I and II.



FIGURES 7–11. *Ceratina rupestris* gynandromorph III. 7, body lateral view; 8, head frontal view; 9, T6 dorsal view; 10, T7 dorsal view and 11, genitalia in dorsal view.

Discussion and conclusions

Gynandromorphism in *Xylocopa* is now known from eleven species: *X. (Xylocopa) violacea* (L.), *X. (Koptortosoma) confusa* Pérez, *X. (Ctenoxylocopa) fenestrata* (Fabricius), *X. (Neoxylocopa) mendozana* Enderlein, *X. (Schonherria) micans* Lepeletier, *X. (Koptortosoma) nigrita* (Fabricius), *X. (Neoxylocopa) nigrocincta* Smith, *X. (Neoxylocopa) varipuncta* Patton, *X. (Schonherria) splendidula* Lepeletier, *X. (Neoxylocopa) ordinaria* Smith and *X. (Neoxylocopa) "brasilianorum"* (L.) (probably another species since *X. brasilianorum* is not found in Argentina) (Kriechbaumer 1872; Maidl 1912; Enderlein 1913a,b; Benoist & Berland 1935; Handschin 1935; Maa 1940; Carcasson 1965; Gordh & Gulmahamad 1975; Lucia *et al.* 2009; this work), five of which occur in South America. Gynandromorphism in *Ceratina* is poorly understood, with occurrence reported in only three species (Holmberg 1884; Daly 1966; this work). The first description of a gynandromorph is that of Holmberg (1884: 139) from the original description *Ceratina montana*. The author describes a specimen with all the characteristics of a male, but with only 12 (versus 13) articles on the antennae and six segments in the metasoma, without recognizing that this specimen was a gynandromorph. The second reference was by Daly (1966) in *Ceratina dallatorreana* Friese, who reported three gynandromorphs having predominantly female structure in the anterior portion of the body and completely male structure posteriorly. Those *Ceratina* species, however, were not included in the list of gynandromorphs by Wcislo *et al.* (2004) and Michez *et al.* (2009). In this study, the gynandromorph of *X. splendidula* has a mix of male and female characters in the head while the remaining parts of the body are female-like. The gynandromorph III of *C. rupestris* possesses bilateral asymmetry in the head, irregular parts of both sexes in the mesosoma and metasoma, with bilateral asymmetry in the genitalia. Gynandromorphs I and II of *C. rupestris* differ from gynandromorph III in that nowhere in the body they have bilateral asymmetry. Gynandromorphs have been traditionally classified in four types: lateral, anterior-posterior, transverse and mixed (Dalla Torre & Friese 1899). Recently, a three-type classification has been proposed a) *bilateral*, if female and male body parts are equal and symmetric, b) *transverse*, if sex characteristics are distributed in two asymmetrical parts, and c) *mosaic*, if sex characteristics are distributed patchily throughout the body (Michez *et al.* 2009). All four gynandromorphs described in this study belong to the *mosaic* category (Michez *et al.* 2009). Future studies on the biology of the species of *Ceratina* and *Xylocopa* should prove useful in elucidating how gynandromorphism affects the survival and behaviour of individuals in natural conditions.

Acknowledgements

Thanks to Victor H. Gonzalez, to anonymous reviewers for comments and suggestions on the manuscript and Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina (CONICET) for continued support.

References

- Benoist, R. & Berland, L. (1935) Trois cas de gynandromorphisme chez les hyménoptères aculéates. *Archives du Muséum d'Histoire Naturelle*, 12, 435–438.
- Carcasson, R.H. (1965) A remarkable gynandrous carpenter bee. *Journal of the East Africa Natural History Society and National Museum*, 25, 75.
- Daly, H.V. (1966) Biological Studies on *Ceratina dallatorreana*, an alien Bee in California Which Reproduces by Parthenogenesis (Hymenoptera: Apoidea). *Annals of the Entomological Society of America*, 59, 1138–1154.
- Dalla, Torre, K.W. & Friese, H. (1899) Die hermaphroditen und gynandromorphen Hymenopteren, *Bericht des Naturwissenschaftlich-Medizinischen Vereins Innsbruck*, 24, 1–96.
- Engel, M.S.A. (2007) Lateral Gynandromorph in the Bee Genus *Thyreus* and the Sting Mechanism in the Melectini (Hymenoptera: Apidae). *American Museum Novitates*, 3553, 1–11.
- Enderlein, G. (1913a) Ein hervorragenden Zwitter von *Xylocopa mendozana* aus Argentinien. *Stettiner entomologische Zeitung*, 74, 124–140.
- Enderlein, G. (1913b) Zur Kenntnis des xylocopen Südamerikas und über einen Zwitter von *Xylocopa ordinaria*. *Archiv Für Naturgeschichte*, 7, 156–170.
- Giangarelli, D.C. & Sofia, S.H. (2011) First Record of a Gynandromorph Orchid Bee, *Euglossa iopocila* (Hymenoptera: Apidae: Euglossini). *Annals of the Entomological Society of America*, 104, 229–232.
- González, V.H. (2004) A gynandromorph of *Megachile (Austromegachile) montezuma* Cresson (Hymenoptera: Apoidea,

- Megachilidae). *Entomotropica*, 19, 155–156.
- Gordh, G. & Gulmahamad, H. (1975) A bilateral gynandromorphic *Xylocopa* taken in California (Hymenoptera: Apidae). Proceedings of the Entomological Society of Washington, 77, 269–273.
- Handschin, E. (1935) Beobachtungen an einem Zwitter von *Xylocopa confusa* Perez. *Bulletin de la Société Entomologique Suisse*, 16, 312–317.
- Hadley, A. (2011) CombineZP - Free image stacking software for depth of field correction. Available from <http://www.hadleyweb.pwp.blueyonder.co.uk/CZM/combinezm.htm> (accessed 21 September 2011).
- Holmberg, E.L. (1884) Viajes a las Sierras de Tandil y de la Tinta Himenópteros. *Actas de la Academia Nacional de Ciencias de Córdoba*, 5, 117–184
- Kriechbaumer, J. (1872) *Xylocopa violacea* gynandromorphy. *Versammlung Deutscher Naturforscher und Ärzte Leipzig*, 45, 137.
- Lucia, M., Abrahamovich, A.H. & Alvarez, L.J. (2009) A Gynandromorph of *Xylocopa nigrocincta* Smith (Hymenoptera: Apidae). *Neotropical Entomology*, 38, 155–157.
- Michener, C.D. (2007) *The Bees of the World (2nd Ed)*. Johns Hopkins University Press, Baltimore & London, 992 pp.
- Michez, D., Rasmont, P., Terzo, M. & Vereecken, N.J. (2009) A synthesis of gynandromorphy among wild bees (Hymenoptera: Apoidea), with an annotated description of several new cases. *Annales de la Societe Entomologique de France*, 45, 365–375.
- Maa, T.C. (1940) On the monstrosity of certain *Xylocopa*-species (Hymenoptera: Xylocopidae). *Lingnan Science Journal*, 19, 83–85.
- Maidl, F. (1912) Über einen Fall von lateraler Gynandromorphie bei einer Holzbiene (*Xylocopa micans* Lep.). *Verhandelingen der Koninklijke zoologisch-botanischen Gesellschaft in Wien*, 3, 19–26.
- Oliveira, F.F. de & M.A.P. de Andrade. (2006) Ginandromorfia em *Melipona mondury* Smith (Hymenoptera, Apidae, Meliponinae). *Sitientibus*, 6, 272–276.
- Ornosa Gallego, C. (1984) Un ginandromorfo de *Psithyrus rupestris* (F. 1793) (Hym., Apidac, Bombinae). *Boletín Asociación española de Entomología*, 8, 59–61.
- Sampson, B.J., Kirker, G.T. & Werle, C.T. (2010) Morphology, Courtship and Mating of a Mixed Bilateral Gynander of *Osmia ribifloris biedermannii* Michener (Hymenoptera: Megachilidae). *Journal of the Kansas Entomological Society*, 83, 347–351.
- Wcislo, W.T., Gonzalez, V.H & Arneson, L. (2004) A review of deviant phenotypes in bees in relation to brood parasitism, and a gynandromorphy of *Megalopta genalis* (Hymenoptera: Halictidae). *Journal of Natural History*, 38, 1443–1457.