



***Walkeromya plumipes* (Philippi) (Diptera: Bombyliidae), a parasitoid associated with carpenter bees (Hymenoptera: Apidae: Xylocopini) in Argentina**

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Abstract

This is the first record of the association between *Walkeromya plumipes* (Philippi) (Diptera: Bombyliidae) and *Xylocopa Latreille* (Hymenoptera: Apidae) in Argentina. The pupal development and morphology of *Walkeromya plumipes*, a parasitoid of *Xylocopa splendidula* Lepeletier, are described. A parasitized nest was collected from Santiago del Estero province, Argentina. The development of the bombyliid fly and large carpenter bees in the nest were observed in the laboratory for a period of 28 days. A detailed description of the fly adult and pupal stages were carried out. This is the first record of *W. plumipes* parasitizing *X. splendidula*. This is also the first complete description of this fly species, including male genitalia. With the data presented here the geographical distribution of the parasite is expanded. The results suggest a close relation between the parasitoid and its host, as the genus *Walkeromya* Paranov has been found parasitizing only carpenter bees of genus *Xylocopa*.

Key words: pupal development, genitalia description, host-parasitoid association

Introduction

Members of the Bombyliidae are most frequently found in arid and semiarid portions of the world, with a few specialized forms occurring in moist tropical climates (Evenhuis, 1989). Larvae of all reared species of Bombyliidae are parasitoids (most often ectoparasitoids) or predators of other insects, primarily of immature stages of the large endopterygote orders of Coleoptera, Hymenoptera, Lepidoptera, Orthoptera, and Diptera (Boesi *et al.* 2009). The Bombyliid-*Xylocopa* association in the Neotropics is little known. The only two genera of Bombyliidae known to be associated with the genus *Xylocopa* are *Walkeromya* and *Xenox* Evenhuis, both members of the subfamily Anthracinae. Most records of this particular host-parasitoid association have been described for Nearctic *Xylocopa* species. The species *Xenox delila* (Loew), *X. simson* Fabricius, *X. simson habrasus* (Martson), *X. tigrinus* (De Greer) and *X. xylocopae* (Marstson) are recorded as parasites of *Xylocopa* in the U.S. and Mexico (Nininger 1916; Hurd 1959, 1978; Marston 1970; Minckley 1989). The only host record for *Walkeromya* spp. was by F. D. Bennett who raised a female from *Xylocopa submordax* Cockerell (now *X. (Neoxylocopa) transitoria* Perez) in Trinidad, vouchers are deposited in the National Museum of Natural History, USA (Hull 1973). The present study describes the association between these bee flies and a carpenter bee in Argentina, providing information for the first time on the pupal development and a redescription of the fly.

Material and methods

This study was carried out on a nest of *Xylocopa (Schonherria) splendidula* parasitized by a species of Bombyliidae. The nest was collected in Atamisqui (28°38'54"S 64°04'58"W, 120 m.s.m), Santiago del Estero province,

Argentina on 21 March 2009, from a peri-saline environment of the dry Chaco region. The development of bombyliid flies and large carpenter bees were observed in the laboratory. The nest was carefully opened, keeping larvae of bees and parasitoid in the nest. Two nest partitions were secured by tape to continue observing and photographing their development (Fig.3). Taxonomy of the bombyliid species follows Evenhuis & Greathead (1999) and the morphological terminology follows McAlpine *et al.* (1981). External morphological structures were studied using an Olympus® SZX12 stereomicroscope. The last three abdominal segments of the fly were macerated for 24 hours in a 10% potassium hydroxide solution and then rinsed with distilled water for dissecting male genitalia using a dissecting microscope. Cleared genitalia were placed in a glass microvial filled with glycerin, which was then attached to the pin supporting the remainder of the insect. Genitalia and wings photographs were taken with an Olympus® DP12 digital camera attached to an Olympus® SZX12 stereomicroscope. Photographic artifacts were removed using Adobe Photoshop®. Voucher specimens of the Bombyliid and bee species are deposited in the Museo de La Plata, La Plata, Argentina.

Results

The parasitoid found in the nests of *Xylocopa splendidula* was identified as *Walkeromyia plumipes* (Philippi, 1873) (Diptera: Bombyliidae). *Walkeromyia* is a Neotropical genus that includes two species: *W. lurida* (Walker) from Brazil, Paraguay and Trinidad & Tobago and *W. plumipes* (Philippi) from Mendoza (Argentina) but also erroneously Chile (cf. Paramonov 1951). The original description of *W. plumipes* and additional descriptions by Paramonov (1934; 1951) are the only known information for this species. The genitalia had not been described before this study.

Taxonomy

Walkeromyia Paramonov

Walkeromyia Paramonov, 1934: 22. Type species: *Anthrax lurida* Walker, 1857, by original designation.

The reduced fleshy proboscis and labellum, shortened ventral oral recess, wing venation and the bare katatergite in front of the haltere place this genus in the tribe Anthracini, subfamily Anthracinae (Hull 1973). Although Hull (1973) suggested that *Walkeromyia* should be placed within a separate tribe, Walkeromyini, it remains within Anthracini. *Walkeromyia* differs from other Anthracini in its long conical flagellomere and the lack of a hair tuft at the apex of antenna. Characteristics of the genus are the long dense band of slender black scales on the male hind legs, and the generally uniformly brownish yellow wings.

Walkeromyia plumipes (Philippi, 1873)

(Figs. 1–3)

Anthrax plumipes Philippi, 1873: 307. Type locality: Argentina, Mendoza. Type lost in MNHC.

Redescription. Male (Fig. 1a–c). Body length: 13–16 mm; wing length: 14–15 mm.

Head: Eyes separated by twice the width of ocellar triangle. Frons with black pile and black tomentum. Face brown, rounded, with black hairs and black tomentum, some whitish pile near oral cavity. Scape brown, rectangular, with black hairs at apex, three times as long as pedicel; pedicel brown, twice as wide as long, bare; flagellomere brown, as long as scape and pedicel combined; conical, slightly flattened; stylus minute, terminal. Proboscis short, not projecting beyond oral margin. Palpi fulvous, reduced, with black hairs. Occiput with short white hairs and black scales.

Thorax: Anterior margin of mesonotum with white pile, with scattered black hairs; tomentum on disc entirely black, with scattered white scales; longer white scales on posterior margin, near scutellum; black bristles on postalar corners. Mesopleuron with black pile, not tomentose. Proepimeron with white hairs on anterior half and black

hairs on posterior half. Coxae with black pile, not tomentose. Legs fulvous, tarsi yellow, fore and mid femora black with short black scales, hind leg with a band of long flattened black scales covering the whole leg; bristles black. Halter stem brown, knob fulvous. Scutellum brown, with black tomentum; bristles black. Setulae on basicosta fulvous with black tips. Wing brownish darker along veins, cell centers hyaline or faintly pigmented (Fig. 1c); r-m cross-vein behind middle of cell dm; no cross-vein between R4 and R2+3; cell r5 slightly narrowed towards wing margin; vein CuA1 with first and second sections each twice the length of r-m cross-vein, third section as long as two first sections combined; cell a as wide as cell cup; alula well developed.

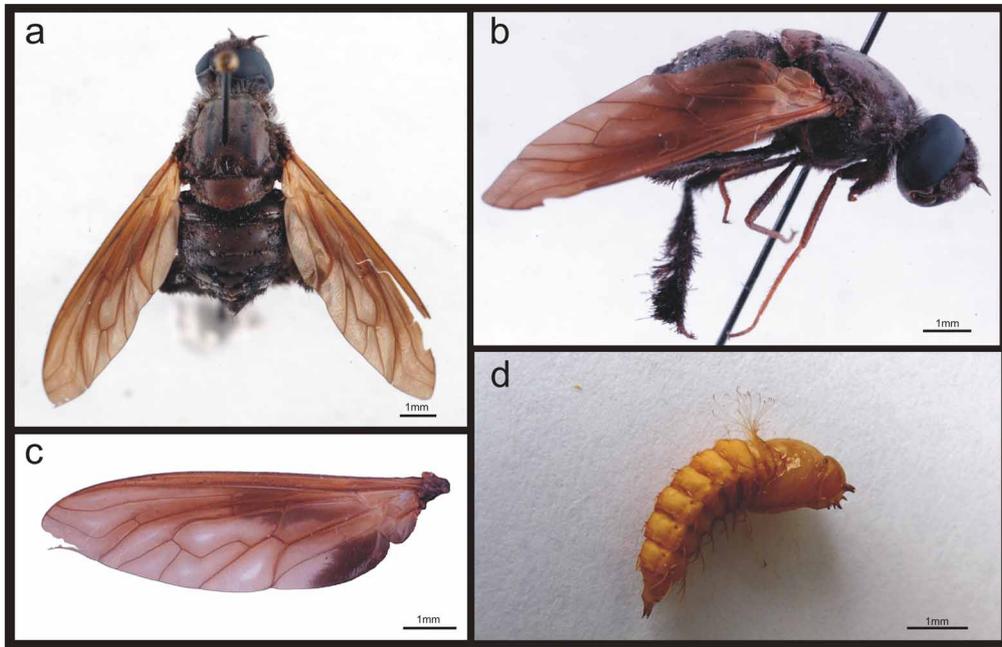


FIGURE 1. Adult and pupa of male of *W. plumipes*. **a** and **b** dorsal and lateral view; **c**, wing; **d**, pupa, lateral view.

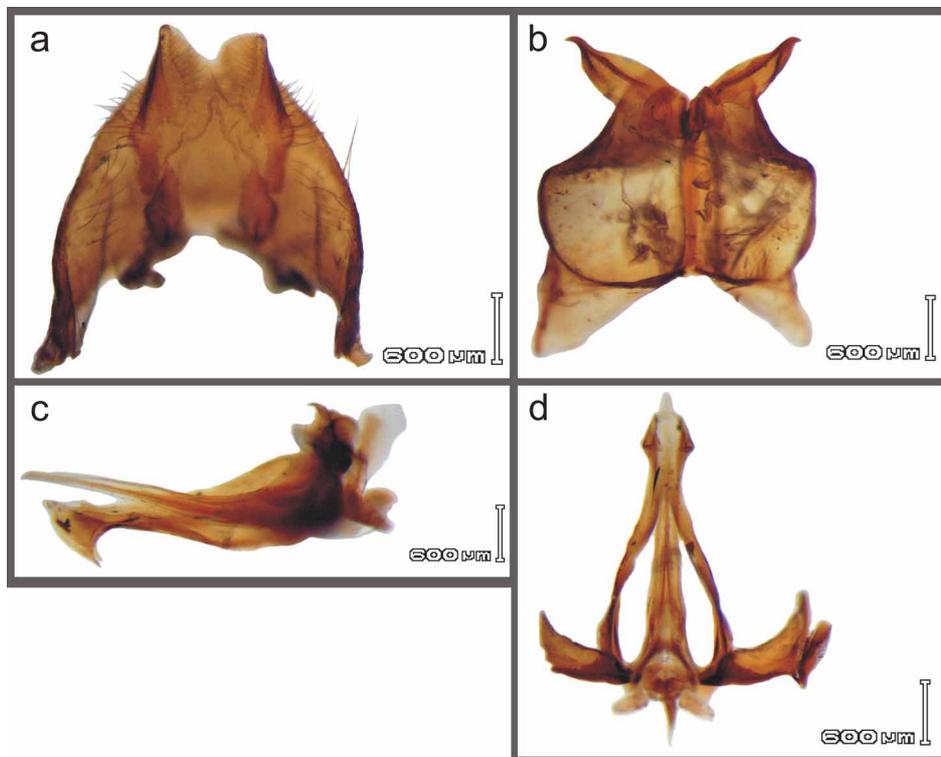


FIGURE 2. Genitalia of male of *W. plumipes*. **a**, epandrium dorsal view; **b**, gonocoxite ventral view; **c**, epiphallus lateral view; **d**, epiphallus ventral view.



FIGURE 3. Longitudinal section of the nest of *Xylocopa (Sch.) splendidula* showing the development of carpenter bee and parasitoid bee fly in a period of 28 days. **a**, 21-III-2009; **b**, 22-III-2009; **c**, 24-III-2009; **d**, 25-III-2009; **e**, 27-III-2009; **f**, 29-III-2009; **g**, 4-IV-2009; **h**, 10-IV-2009; **i**, 14-IV-2009; **j**, 17-IV-2009.

Abdomen: Dorsum with black pile on center of tergite one, except white hair on sides of tergite one, remainder with black pile; black tomentum with some white scales laterally on tergite six. Venter with black pile, not tomentose. Genitalia brown with black hairs; epandrium in lateral view, trapezoid, dorsal portion wider, cercus well exposed, epandrium subtriangular in dorsal view (Fig. 2a), posterior tip rounded, anterior corners elongated forward; gonocoxite in lateral view wider at middle with anterior hooked extension and posterior narrow tip; gonocoxite in ventral view (Fig. 2b) distinctly subquadrate, narrowing apically, anterior corners extending forward, medially divided; gonostylus with a basal process narrowing toward tip, tip slightly hooked in ventral view; epiphallus in lateral view slightly curved (Fig. 2c), apex swollen, hooked antero-dorsally; epiphallus in ventral view medially divided (Fig. 2d), united only in apical third, basal half separated in two, wide at base narrowing toward apex, swollen near tip; aedeagus spine-like, slightly longer than epiphallus; gonopore terminal.

Pupal stage (Figs. 1d): Integument of pupa yellowish hyaline with yellow setae and reddish brown black-tipped tubercles. Cephalic tubercles formed almost in straight line, medial tubercle situated slightly outside line between apices of anterior and posterior tubercles and closer to posterior tubercle. Tubercles broad basally, tapering to sharp apex, with sharp ventrolateral and dorsolateral ridges. Posterior tubercle short. Anterior facial tubercles compressed anteroposteriorly, connected by mesal ridge, with acute lateral apices. With a row of long curved bristles at the junction of the thorax and abdomen. Abdominal tergites two to six with a dorsal row of strong spines adhering to the cuticle except at their tips, tergite seven with a row of simple smaller spines, tergite eight without spines dorsally; sides of segments two to seven with a row of six wide, long flattened outgrowths, four in pleurites,

two on sides of sternites. Anal tubercles about four times longer than medial width of one lobe, separated, broad basally, tapering to sharp apex, sclerotized at tip, slightly swollen dorsally before apex.

Female. Not collected in this study.

Material examined. ARGENTINA. 1♂, Buenos Aires, La Plata (34°53'S 50°01'W, 12 mts), II-2009, L. Álvarez; 2♂ and pupal case, Santiago del Estero, Dpto. Atamisqui (28°38'54"S 64°04'58"W, 120 mts), 21-III-2009, M. Lucia & L. Álvarez. All in the nests of *X. splendidula*.

Host. *Xylocopa (Schonherria) splendidula* Lepeletier.

Distribution. Argentina: Buenos Aires, Mendoza and Santiago del Estero provinces.

Biological observations. The larva of *W. plumipes* developed in a cell of a nest of *Xylocopa splendidula* built in the dead culms of *Arundo donax* L. The sequence of images in figure 3a shows the development of a larva located in the right-hand cell that corresponds to the parasitoid, we assume that it is the final non-feeding larval stage. There are two pre-pupal stages of the *Xylocopa splendidula* in the remaining cells and located to the left near the entrance of the nest is the last empty cell. Figures 3 b–c show the beginning of the pupation of the larval bee and parasitoid bee fly. The following images (Fig. 3. d–i) show the development of the pupal stage of bees and parasitoid fly. On the last pre-emergence day, the bee fly pupa was observed to move to the nest entrance for adult emergence. The last image (Fig 3 j) shows the emergence of the adult *W. plumipes* bee fly and the two remaining bees with their still-in-progress cycle. The two adults of carpenter bees were males. The observation of the pupal stage of the parasitoid lasted 28 days. This clearly shows the unsynchronized development of the adult parasitoid with emergence prior to that of unparasitized bees.

Discussion

According to Paramonov (1951), who redescribed both species with specimens from the British Museum in 1934, *Walkeromya plumipes* can be distinguished from *W. lurida* mainly by wing pigmentation, yellowish in *W. lurida*, and darker in *W. plumipes*. Unfortunately no genitalic description was made and the specimen Paramonov used for the *W. lurida* redescription was destroyed during the World War II. Another difference between these species is their geographical distribution. In this study the localities known for *W. plumipes* increased to include Santiago del Estero and Buenos Aires province, along with the Mendoza province, the type locality. The true distribution of *W. plumipes* may be wider and even continuous with *W. lurida*. A detailed study on both species, including genitalia and specimens descriptions from intermediate regions are needed to determine if these two species are synonyms.

There is little known of host-parasitoid associations as reported in this study, especially data related to the development of parasites in conjunction with the life cycle of carpenter bees. We report for the first time the association between a bee fly and a *Xylocopa* species in Argentina. As *X. splendidula* is widely distributed in Argentina and much more common and abundant than other carpenter bee species, we consider that these host-parasitoid associations could be recorded in other regions of the country. The absence of records may be due to scarce field work related to the study and monitoring of carpenter bee nesting sites.

Evidence suggests that the bee fly *W. plumipes* has a narrow host range limited to *X. splendidula* (this study) and possibly *X. transitoria* (Hull 1973). Nevertheless, future studies on the biology of this parasitoid, will demonstrate if these bee flies parasitize species of other bees with similar nesting habits or if there is host specificity with a particular carpenter bee species. These studies will contribute to a better understanding of the ecological relationship between bee fly and its hosts.

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References

- Boesi, R., Polidori, C. & Andrietti, F. (2009) Searching for the Right Target: Oviposition and Feeding Behavior in *Bombylius* Bee Flies (Diptera: Bombyliidae). *Zoological Studies*, 48,141–150.

- Evenhuis, N.L. (1989) Family Bombyliidae. In: Evenhuis, N.L. (Ed.), *Catalog of the Diptera of the Australasian and Oceanian Regions*. Bishop Museum Press, Honolulu & E.J. Brill, Leiden, pp. 359–374. Available from: <http://hbs.bishopmuseum.org/aocat/bombyliidae.html> (January 2011).
- Evenhuis, N.L. & Greathead, D.J. (1999) *World catalogue of bee flies (Diptera: Bombyliidae)*. Backhuys Publishers, Leiden, 756 pp.
- Hull F.M. (1973) *Bee flies of the world. The genera of the family Bombyliidae*. Smithsonian Institution Press, Washington, D.C., 687 pp.
- Hurd, P.D., Jr. (1959) Bee fly parasitism of the American carpenter bees belonging to the genus *Xylocopa* Latreille (Diptera; Hymenoptera). *Journal of the Kansas Entomological Society*, 32, 53–58.
- Hurd, P.D. (1978) *An annotated catalog of the carpenter bees (genus Xylocopa Latr.) of the Western Hemisphere (Hymenoptera, Anthophoridae)*. Smithsonian Institution Press, Washington D.C., 106 pp.
- Marston, N. (1970) Revision of new world species of *Anthrax* (Diptera: Bombyliidae), other than the *Anthrax albofasciatus* group. *Smithsonian Contributions to Zoology*, 43, 1–148.
- McAlpine, J.F., Peterson, B.V., Shewell, G.E., Teskey, H. J., Vockeroth J.R. & Wood, D.M. (1981) *Manual of Nearctic Diptera, vol. 1*. Ottawa: Research Branch, Agriculture Canada, Monograph 27.
- Minckley, R.L. (1989) Host records and biological notes for two *Anthrax* species in Arizona (Diptera: Bombyliidae). *Journal of the Kansas Entomological Society*, 62, 274–278.
- Nininger, H.H. (1916) Studies in the Life Histories of Two Carpenter Bees of California, with Notes on Certain Parasites. *Journal of Entomology and Zoology*, 8, 158–165.
- Paramonov, S.J. (1934) Über einige exotische (hauptsächlich südamerikanische) Bombyliiden (Dipteren). *Konowia*, 13, 22–34.
- Paramonov, S.J. (1951) On two South American species of *Walkeromyia* Param. (Bombyliidae, Diptera). *Revista de Entomología, Río de Janeiro*, 22, 353–356.
- Philippi, R.A. (1873) Chilenische Insekten. *Stettiner Entomologische Zeitung*, 34, 296–316.
- Walker, F. (1857) Characters of undescribed Diptera in the collection of W.W. Saunders, *Transactions of the Entomological Society of London*, 4, 119–158.