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Primeros registros de *Toxophora aurea* Macquart (Diptera: Bombyliidae: Toxophorinae) en Argentina, y comentarios sobre la biología de dos especies del género

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Abstract: The bee fly *Toxophora aurea* Macquart is reported for the first time in Argentina. One single specimen of this species was reared from a nest of *Isodontia costipennis* (Spinola) (Hymenoptera: Sphecidae) in the province of Formosa and others were captured in southern Misiones province, and others housed in entomological collections from the provinces Chaco, Santiago del Estero and Santa Fe. Data about the biology of *Toxophora leucon* Séguy from individuals reared in nests of *Cyphomenes anisitsii* (Brèthes), *Pachodyneurs guadulpensis* (Saussure) and *Zethus dicomboda* (Spinola) (Hymenoptera: Vespidae: Eumeninae) in the province of Formosa are also reported. These are the first data about the reproductive ecology of these parasitic flies in Argentina.

Keywords: Biology, Parasitic specie, Toxophorini.

Resumen: Se reporta la presencia del bombílido *Toxophora aurea* Macquart por primera vez en Argentina. Un único espécimen de esta especie fue obtenido a partir de un nido de *Isodontia costipennis* (Spinola) (Hymenoptera: Sphecidae) en la provincia de Formosa, otros fueron capturados en el sur de la provincia de Misiones, y otros depositados en colecciones entomológicas de las provincias de Chaco, Santiago del Estero and Santa Fe. También se informan datos de la biología de *Toxophora leucon* Séguy a partir de individuos obtenidos de nidos de *Cyphomenes anisitsii* (Brèthes), *Pachodyneurs guadulpensis* (Saussure) y *Zethus dicomboda* (Spinola) (Hymenoptera: Vespidae: Eumeninae) en la provincia de Formosa. Estos son los primeros datos acerca de la ecología reproductiva de estas especies de moscas parásitas en Argentina.

Palabras clave: Biología, Especies parásitas, Toxophorini.

The bee flies (Bombyliidae) constitute one of the largest families of Diptera, and most of its species are parasitoids or hyperparasitoids of other insects, primarily the immature stages of Coleoptera, Hymenoptera, Lepidoptera, and Diptera (Yeates & Greathead, 1997). In Argentina, there are 75 species in 25 genera and 7 subfamilies (Lamas & Evenhuis, 2014; Torretta et al., 2021); however, this figure may be

higher because this family has not been extensively studied in this country (Lamas & Evenhuis, 2014).

The subfamily Toxophorinae comprises three tribes: Gerontini, Systropodini and Toxophorini (Li et al., 2020). The two latter are recorded in Argentina (Lamas & Evenhuis, 2014). The tribe Toxophorini includes only the genus *Toxophora* Meigen, with 51 species, of which 11 are present in the Neotropical Region (Evenhuis & Greathead, 2015) and only two in Argentina: *T. amacula* Seguy and *T. leucon* Séguy (Lamas & Evenhuis, 2014). A new record, representing the third one in Argentina, for *T. aurea* Macquart is presented herein. The studied individuals are deposited in the following institutions: Cátedra de Botánica General (FAUBA), Facultad de Agronomía, Universidad de Buenos Aires, Argentina, Museo Argentino de Ciencias Naturales Bernardino Rivadavia (MACN), and Museo de La Plata (MLP).



Figs 1-2. Lateral *habitus* of species of *Toxophora* (Bombyliidae, Toxophorinae) reared from nests of wasps obtained in trap-nests in forests in Reserva El Bagual, Formosa province, northern Argentina. 1. *Toxophora aurea* Macquart. 2. *Toxophora leucon* Séguy.

Black arrow indicates macrosetae in pronotum. Scale bars = 2 mm.

The species of *Toxophora* are medium-sized flies, with a stout body with humped thorax, enlarged pronotum and macrosetae and with abdomen strongly convex (Figs. 1-2), wider than thorax at base and covered dorsally with yellow or white scales forming different patterns of spots and marks (Cunha et al., 2011). These species are ectoparasitoids of solitary wasps and bees (Hymenoptera) (Yeates & Greathead, 1997; Lamas et al., 2003), although the natural history is better known for the Nearctic species [summarized in Hull (1973)], there were few records for the Neotropical species: Assis & Camillo (1997) mentioned *Toxophora* sp. in one nest of *Pachodynerus brevithorax* (Saussure) (Vespidae), Auko et al. (2014) reared one individual of *T. leucon* from one nest of *Cyphomenes anisitsii* (Brèthes) (Vespidae), Rocha-Filho et al. (2019) obtained one individual of *T. leucon* from a nest of *Trypoxylon nitidum* F. Smith (Crabronidae), and Rocha-Filho et al. (2020) reared one individual of *T. leucon* from

one nest of *Ancistroceroides cf. atripes* (Fox) (Vespidae), one individual of an undetermined species of *Toxophora* from one nest of *Hypancistrocerus advena* Sausure (Vespidae) and several individuals of *Toxophora amphitea* Walker from nests of *A. cf. atripes*, *Minixi brasilianum* (Saussure) and *Pachodynerus guadulpensis* (Saussure) (all Vespidae). In a study about the pupae of two *Toxophora* species (Lamas et al., 2003), *Pachodynerus praecox* Saussure and *Centris analis* (Fabricius) (Apidae) were mentioned as hosts of *T. leucon* and one unidentified species of *Parancistrocerus* Bequaert (Vespidae: Eumeninae) as host of *Toxophora zikani* (d'Andretta & Carrera).

Here, we reported data about the biology of *T. aurea* (Fig. 1) and *T. leucon* (Fig. 2) in the Reserva El Bagual (26°18' S, 58°49' W), Formosa province, in northern Argentina, from individuals reared from wasp nests. The data were obtained from trap-nests placed in two heights (understory and canopy) in two forests within this Biological Reserve (Torretta & Marrero, 2019) and from one nest built in a stem of *Urolepis hecatantha* (DC.) R.M. King & H. Rob. (Asteraceae).

In total, 1,080 trap-nests, arranged in 72 bundles comprised by 15 canes each were placed in the field from October 2012 to April 2013 and inspected every season (spring: November 11-15; early summer: January 7-11, late summer: February 24-28 and autumn: March 29-April 2). Each trap-nest consisted of one hollow bamboo cane, which was cut so that a nodal septum closed one end of the cane (Aguiar & Garófalo, 2004). In each forest [see Torretta & Marrero (2019) for a detailed description of the study area], 36 bundles of trap-nests were placed in three transects separated by more than 1,000 m. In each transect the bundles were placed at intervals of 100-200 m and paired at two different heights (one bundle 1-2 m above the ground and another one 8-9 m within -or in the base of- the crown of tallest trees). At each visit, the traps with nests were removed and taken to the laboratory. There, the cells were separated in plastic vials with cotton plugs and numbered from 1 to n (starting from the innermost) and were kept in the laboratory at room temperature (ca. 15-25 °C) until adult emergence. Since trap-nests were collected at intervals 30-45 days, development time can only be estimated with an error of ± 20 days (Thiele, 2005). Of a total of 660 brood cells in 204 built nests (Torretta & Marrero, 2019), only four brood cells from four nests were attacked by *Toxophora* spp. The data obtained for *Toxophora* spp. from trap-nesting programme are presented in Table I.

Moreover, one nest of *C. anisitsii* was collected in January 2013, on a stem of *U. hecatantha* to 1.2 m above ground. The nest was spheroidal and built with mud containing four brood cells. On 24 March 2013 one male and one female of wasps emerged, and on 4 May 2013 one female of *T. leucon*.

Both species of *Toxophora* attacked wasp nests of three different families: Crabronidae, Sphecidae and Vespidae. The information for *T. aurea* represents the first report about its reproductive ecology. This species attacked *Isodontia costipennis* (Spinola), a species that uses pappi of Asteraceae (modified calyxes of flowers of this plant family) as cell

partitions and captured Orthoptera as prey for their offspring. In the studied forests, *I. costipennis* built nine nests [one in canopy (two brood cells) and eight in understory (22 brood cells)]; of them *T. aurea* only attacked one brood cell from one nest in the understory (Table I). From other brood cell of same nest reared several individuals of eulophid wasp *Melittobia* sp. (Table I). Nests from other populations of *I. costipennis* in Brazil are parasitized by flies of Sarcophagidae (Buschini & Woiski, 2006) and by ichneumonid wasp *Messatoporus* sp. (Soares et al., 2001) and in Argentina there are reports of *Messatoporus transversostriatus* (Spinola) (Martinez & Torretta, 2015). Our record represents the first association of a fly of the family Bombyliidae with this species of sphecid wasps.

Nest number	Host species	Date nest collection	Position nest	Host cells / <i>Toxophora</i> emerged (sex)	Estimated developmental range (months)	Other parasitic species associated
<i>Toxophora aurea</i>						
119	<i>Isodontia costipennis</i>	9-1-13	understory	2/1 (f)	0-1	<i>Melittobia</i> sp. (Hym., Eulophidae)
<i>Toxophora leucon</i>						
829	<i>Pachodynerus guadulpensis</i>	28-II-2013	understory	5/1 (f)	0-1	
1161	<i>Zethus dicomboda</i>	31-III-2013	understory	6/1 (f)	0-1	
1174	<i>Pachodynerus guadulpensis</i>	28-II-2013	canopy	4/1 (f)	0-1	<i>Melittobia</i> sp. (Hym., Eulophidae)

Table I. Species of *Toxophora* (Bombyliidae, Toxophorinae) rearing from nests of wasps obtained in trap-nests in forests in Reserva El Bagual, Formosa province, northern Argentina.
f: female. Hym.: Hymenoptera.

On the other hand, in the studied trap-nests, females of *T. leucon* attacked nests of *Pachodynerus guadulpensis* (Saussure) and *Zethus dicomboda* (Spinola), two eumenid wasp species that use mud as cell partitions and captured caterpillars as prey. The first species built 27 nests [nine in canopy (71 brood cells) and 18 in understory (102 brood cells)]; of them, only two brood cells from two nests (one nest from understory and one from canopy) were parasitized by *T. leucon*. One of these nests, was also attacked by *Melittobia* sp. (Table I). Other nests of *P. guadulpensis* were attacked by *Anthrax* sp. (Bombyliidae, one brood cell), *Amobia* sp. (Sarcophagidae, several individuals from two brood cells form one nests) and one species of Ichneumonidae (two individuals from one brood cell). Nests from other populations of *P. guadulpensis* were attacked in Argentina by two species of *Messatoporus* (Martinez & Torretta, 2015) and, in Brazil, they were parasitized by Sarcophagidae and Bombyliidae flies, and Chrysididae and Ichneumonidae wasps (Buschini & Buss, 2010), and *T. amphitea* (Rocha-Filho et al., 2020).

The other eumenid wasp *Z. dicomboda* only built four nests (19 brood cells), all in the understory (Torretta & Marrero, 2019). From one of these brood cells emerged one female of *T. leucon*. For this wasp species, information about organism predators is scarce, Torretta (2015) reported attacks by cuckoo wasp *Chrysis boutheryi* (Brèthes) (Chrysididae) in Argentina, and in our study site two nests were parasitized by other chrysidid wasp (Torretta, in prep.).

Our data for *T. leucon* agree with the limited data available for the species. The females attacked different species of wasps, which build mud nests as Vespidae: Eumeninae (Auko et al., 2014) and Crabronidae (Rocha-Filho et al., 2019, 2020). The emergence patterns of two parasitic *Toxophora* and its hosts were synchronized for all studied nests.

Parasitism of these species of *Toxophora* in our study site seems to be low. One possible explanation is that they have small populations, as can be seen by the small number of individuals in the collections and/or its scarce (or null) biological information. However, Torretta & Marrero (2019) reported that the mortality rate for assemblages of cavity-nesting bee and wasp species was higher than the parasitism rate in these forests, suggesting that mortality could be conditioned by the environmental conditions.

Toxophora aurea Macquart

Material examined. Argentina. Chaco: Resistencia, 1 male, 10-XII-1935, J.B. Daguerre (MACN). Formosa: San Francisco de Laishi, Reserva El Bagual, 1 female, 23-I-2013 (emergence date), J.P. Torretta (FAUBA). Misiones: San Ignacio, 1 female, 20-XII-2013, J.P. Torretta (FAUBA); 1 male, ex *Hyptis* sp., 14-I-2020, J.P. Torretta, A. Avalos, S. Reposi & L.J. Álvarez (MACN); 1 female, 15-I-2020, J.P. Torretta, A. Avalos, S. Reposi & L.J. Álvarez (MACN). Santa Fe: Piquete, 2 females, 5-I-1928, S.J. Bridarolli (MACN). Santiago del Estero: 1 female, without date, Wagner (MLP).

Distribution: Argentina (new records), Brazil, French Guiana, Guyana, Paraguay and Suriname.

Toxophora leucon Séguy

Material examined. Argentina. Formosa: San Francisco de Laishi, Reserva El Bagual, 3 females, 18-III-2013, 1-IV-2013 and 27-IV-2013 and 1 male, 4-V-2013 (emergence dates), J.P. Torretta (FAUBA, MACN). Corrientes: San Cosme, Camping El 15, 1 male, 16-XII-2015, J.P. Torretta (FAUBA).

Distribution: Argentina, Bolivia, Brazil and Paraguay.

In summary, in this paper we increase to 76 the number of species of Bombyliidae recorded from Argentina, present the first report about the reproductive ecology of *T. aurea* and add information on the biology of this genus of bee flies.

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