First record and redescription of *Binodoxys brevicornis* (Hymenoptera: Braconidae: Aphidiinae) from Argentina

ZUMOFFEN, Leticia[1,2], Adriana SALVO[3], Cesar E. SALTO[1], Romina G. MANFRINO[1,2] & Keith S. PIKE[4]

[1]Área Investigación Agronomía, Protección Vegetal, Estación Experimental Agropecuaria INTA, Rafaela, Ruta Nacional 34, Km. 227, CP: 2300, Santa Fe, Argentina. Tel. + 54 03492440121 X 439.zumoffen.leticia@inta.gob.ar; leticiazumoffen@hotmail.com

[2]CONICET, INTA, Rafaela, Ruta Nacional 34, Km. 227, Santa Fe, Argentina.

[3]Centro de Investigaciones Entomológicas de Córdoba, Instituto Multidisciplinario de Biología Vegetal (CONICET), FCEFyN, Universidad Nacional de Córdoba, Córdoba, Argentina.

[4]Irrigated Agriculture Research and Extension Center, Washington State University, 24106 North Bunn Road, Prosser, Washington 99350, United States of America.

Primera cita y redescripción de *Binodoxys brevicornis* (Hymenoptera: Braconidae: Aphidiinae) en Argentina

■ **ABSTRACT.** *Binodoxys brevicornis* (Haliday) is reported for the first time for Argentina. This aphidiine was found parasitizing the aphid *Hyadaphis foeniculi* (Passerini) feeding on *Foeniculum vulgare* (Miller), a non-crop plant species commonly occurring near alfalfa crops. *Binodoxys brevicornis* is redescribed and illustrated.

KEY WORDS. Alfalfa. Aphid. Biological Control. *Foeniculum vulgare*. Parasitoid.

■ **RESUMEN.** *Binodoxys brevicornis* (Haliday) se cita por primera vez en Argentina. Este afidiino se encontró parasitando al pulgón *Hyadaphis foeniculi* (Passerini) en *Foeniculum vulgare* (Miller), una especie vegetal de crecimiento espontáneo, comúnmente asociada a los bordes de cultivos de alfalfa. *Binodoxys brevicornis* se redescribe e ilustra.

PALABRAS CLAVE: Alfalfa. Áfido. Control Biológico. *Foeniculum vulgare.* Parasitoide.

INTRODUCTION

The genus *Binodoxys* (Mackauer) is closely related to *Trioxys* (Haliday) and *Acanthocaudus* (Smith). Previously, *Binodoxys* was classified as *Trioxys* or *Trioxys* (*Binodoxys*). It can be distinguished from these related genera by the following combination of characteristics: tergite 1 (petiole) with primary and secondary tubercles; accessory prongs of female hypopygium absent; and fifth, sixth, and seventh terga of female without subapical row of pegs or spiny bristles (Stary, 1995; Sharkey & Wharton, 1997; Sampaio *et al.*, 2003). This taxonomic group is, collectively, one of the most diverse in the subfamily Aphidiinae (Tomanovic & Kavallieratos, 2002). Certain species of the group are important natural enemies of *Rhopalosiphum padi* (L.) (bird cherry-oat aphid), *Myzus persicae* (Sulzer) (green peach aphid), *Therioaphis trifolii,*

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(Monell) (yellow clover aphid) and other aphid species associated with plants in the genera *Medicago* and *Trifolium* (Stary, 1978). In Argentina, only one species of *Binodoxys* has been previously recorded: *B. tucumanus* (Stary) (originally described as *Trioxys* (*Binodoxys*)), a native species known only from Tucumán Province reared from *M. persicae* on potato (Stary & Delfino, 1986). Years after its release in Argentina, this parasitoid was observed in association with *M. persicae* (Stary *et al.*, 2007).

Alfalfa is one of the most well-known and widely used perennial leguminous crops, with Argentina being the second largest producer of alfalfa in the world, where this crop constitutes one of the most relevant forage resources for cattle (Basigalup & Ustarroz, 2007). Among the most important pest insects in alfalfa are aphids (Hemiptera: Aphididae), such as *T. trifolii*, *Acyrthosiphon pisum*, (Harris) and *A. kondoi* (Shinji). To control aphids, parasitoids of the subfamily Aphidiinae (Hymenoptera: Braconidae) are the most widely used biological agents. Considering that parasitoids may occur in different host aphids in both crop and non-crop plant species, moving from one site to another during the year (Stary & Cermeli, 1989), a careful exploration of the parasitoid species in fields and borders of alfalfa in Santa Fe Province, Argentina was started in 2009. The aims of this paper are to inform the occurrence of *B. brevicornis* in Argentina, to provide a redescription for adults of this species and also to supply information about its associations with aphids and plants in alfalfa crop fields.

MATERIAL AND METHODS

Sampled fields were located at INTA (Instituto Nacional de Tecnología Agropecuaria, Rafaela Experiment Station, 31°11_S; 61°29_W), in the west of Santa Fe Province, Argentine Pampa region. The zone is characterized by plains and extended landscapes. The annual average rainfall is 1050 mm (variation WE = 125 mm), distributed with an isohigro regime, with 70% of the rainfall in spring–summer, 23% during autumn and just 7% in winter. The annual mean temperature is 18.0 ºC (variation NS = 1.0 ºC), with 26.0 ºC and 12.7 ºC being the means in January and July, respectively, at the hottest and coldest months of the year and with an average thermal amplitude of 13.3 ºC (Panigatti, 1980; Panigatti & Mosconi, 1982). The traditional management practice used in the study site depended on the growth stage of the alfalfa: grazing (rotary strip up to a total density of 1.5 total cows per ha) on flowering buds, or being cut for hay or silage when 10–20% of flowering was reached (recommended practice for dairy cows) (Comeron & Romero, 2007). No insecticides were sprayed on alfalfa plants during the sampling period.

During a three year period (2009-2011), aphid colonies were fortnightly collected in both, alfalfa and non-crop vegetation in the borders, along one linear transect of 100 m on each habitat. Plant samples bearing both, live and mummified aphids, were collected. Aphididae samples were placed in plastic vials (~3 cm diameter x 10 cm in height) containing 95% ethanol for later identification using keys by Blackman & Eastop (2006a, 2006b). Mummified aphids were individually placed in plastic vials with cotton-top (~2 ml) until the adult parasitoid emergence. Adults were preserved in 95% ethanol, with representative specimens from rearings cleared and slide mounted whole or dissected following standard methods (see Fulbright *et al.*, 2007), and identified to species using keys, by Smith (1944), Pike *et al.* (2000), and by comparison with paratypes and species vouchers from Washington State University (WSU) holdings. Also, representative specimens identified as *Binodoxys brevicornis* (Haliday) from Argentina were examined and confirmed by European Aphidiine specialist Dr. P. Stary (Institute of Entomology, Acad. Sci. Czech Republic, Ceske Budejovice, Czech Republic). Illustrations of parasitoids were drawn from images taken with a DEC13MTM digital eyepiece camera through a Zeiss AxiolabTM compound microscope; morphological measurements (in mm) and

character ratios were derived from image-measuring software by D. Allison (Pike *et al.*, 2005). Descriptive morphology follows Sharkey & Wharton (1997), and Huber & Sharkey (1993). Voucher specimens are deposited in INTA and WSU collections.

RESULTS

Binodoxys brevicornis is recorded for the first time from Santa Fe, Argentina, parasitizing the aphid *Hyadaphis foeniculi* (Passerini) (honeysuckle aphid) in *Foeniculum vulgare* (Miller) (Apiaceae = Umbelliferae). Like the other Aphidiinae, *B. brevicornis* is a primary solitary koinobiont endoparasitoid of aphids (*H. foeniculi*, *Dysaphis apiifolia* (Theobald), *Aphis spiraecola* (Patch), *A. fabae* (Scopoli) and *Cavariella aegopodii* (Scopoli)). Adults are free-living and feed on honeydew, nectar, pollen and other plant secretions. Availability of these feeding resources can increase their longevity, oviposition potential and attack (Hoffmann & Frodsham, 1993; Jervis & Kidd, 1995; Lee *et al.*, 2004; Michelena *et al.*, 2004; Wackers, 2005; Bianchi & Wacker, 2008).

Adult description

Descriptions. FEMALE (n = 11)

Head (Fig. 1): Eyes averaging 150 µm in length range: 112-176 µm. Malar space equal to 1/5 of eye length. Antenna (Fig. 2, Table I) 10 segmented. Flagellomere 1 (= F_1), averaging 2.4 times as long as wide, with 1 to 5 placoids; (F_2) approximately equal to slightly greater than F_1 with 2 to 4 placoids, (F_5) averaging 1.8 as long as wide, with 3 to 4 placoids, preapical segment approximately equal to F_5, apical segments averaging nearly 4.0 time as long as wide, with 8 placoids.

Mesosoma: according to Tremblay (1975) and Stary (1979) this parasitoid has mesoscutum with 17-25 pleural setae (Fig. 3). Propodeum: smooth or with two longitudinal carinae (Fig. 6) with 8-10 anterior propodeal setae. Forewing (Fig. 4, Table I): stigma triangular tapering into R_1, averaging 3.0 times as long as wide. R_1 vein (=metacarpus) equal to about half stigma length. Radial sector 2.8 times as long as stigma width.

Metasoma: petiole (Fig. 5) 1.7 times width at spiracles; secondary tubercles not pronounced and not far spaced from spiracular tubercles. Genitalia, ovipositor sheath length slightly < 3 times sheath width at midpoint of narrower distal region of sheath (Fig. 7). The prongs are paired, straight to upwards arcuate, narrowed to the apex, with 3-4 dorsal setae.

Body length: about 2 mm.

Coloration: according to Mescheloff & Rosen (1993) this parasitoid has: head dark brown; mouthparts light: the clypeus and mandibles are light brown and remaining parts are yellowish. Antenna light brown, except scape, pedicel and narrow base of F_1 yellowish. Mesosoma blackish brown to brown; wing venations light brown. Metasoma light brown with areas yellowish. Legs brown to light brown, tarsi blackish. Ovipositor sheaths and prongs brown to light brown.

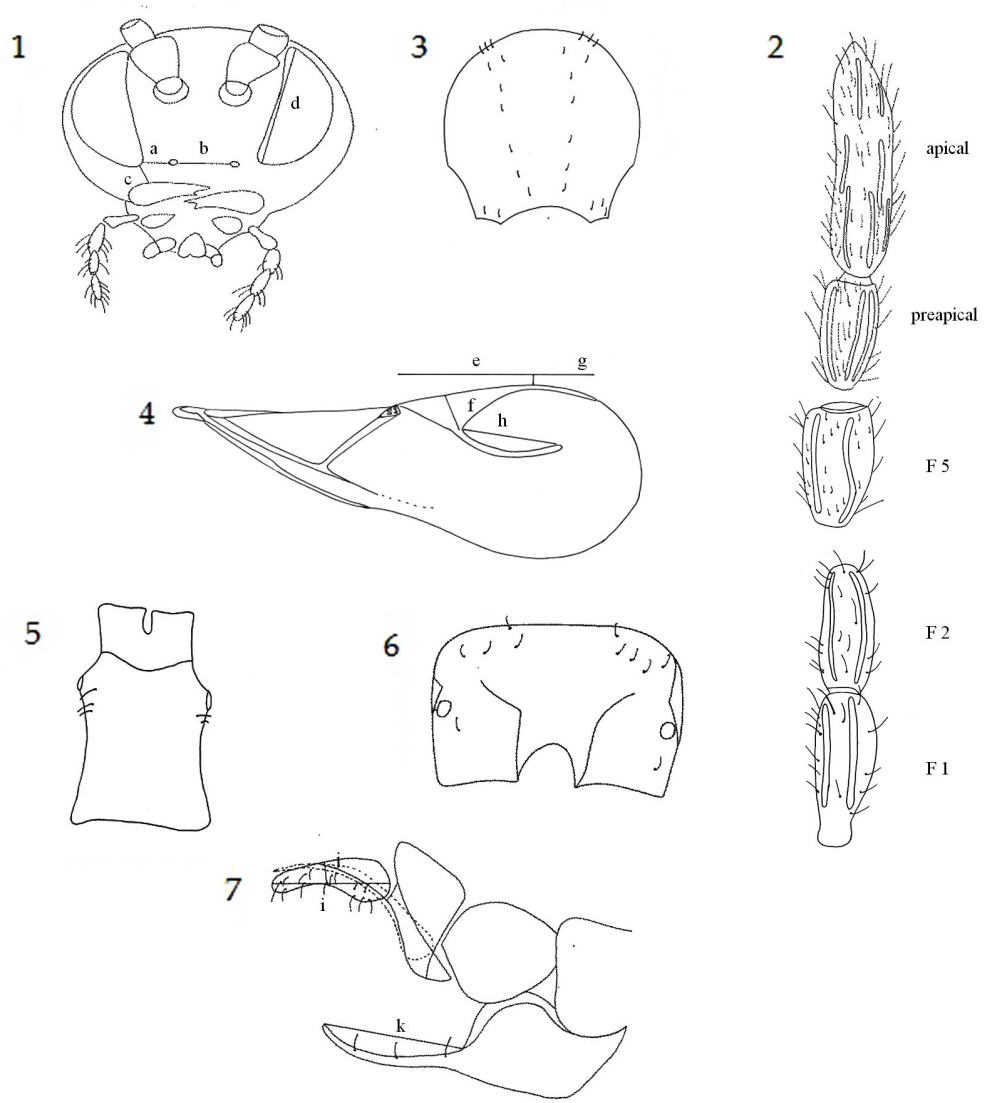
Known host aphids in Argentina: *Hyadaphis foeniculi.*

Distribution in Argentina: known currently only from Rafaela, Santa Fe.

MALE (n = 6): Antennae 12 segmented. Coloration similar to that of the female, except for the antennae, which are entirely brown with the yellowish base of F_1. (see Table 1 for full range of character measurements).

DISCUSSION AND CONCLUSION

Binodoxys brevicornis attacked the aphid *H. foeniculi* feeding on *F. vulgare*. This plant species spontaneously grows on the margins of alfalfa crops (Zumoffen *et al.*, 2012) and occurs from Salta Province, north of the country to Río Negro in the south of Argentina, being rather common in vacant lots, ditches, roads and railway embankments, fencing and grazing pastures (Marzocca, 1976). *Foeniculum vulgare* is an erect, aromatic perennial herb, indigenous to the shores of the Mediterranean widely naturalized in many parts of the world. Vegetative growth



Figs. 1-7. Morfological features (not to scale). 1, Head (a, tentorio-ocular distance; b, intertentorial distance; c, malar space; d, eye length); 2, Antennal flagellomeres; 3, Mesoscutum (setal number and arrangement shown); 4, Forewing (e, stigma length; f, stigma with; g, R1[= metacarpus]), h, RS vein [radial sector]; 5, Petiole; 6, Propodeum; 7, Ovipositors sheath (i, ovipositor sheath length; j, ovipositor sheath width at midpoint of narrower distal region; k, length of prong).

begins in autumn, flowers bloom in spring and summer and fruits are produced at the end of summer. Nectar carbohydrates of several Umbelliferae have been mentioned as essential for the fecundity and longevity of hymenopterous insects (Leius, 1961). This plant group has an important role in the interactions between phytophagous insects and their natural enemies, being considered a source of alternative food for predators and parasitoids such as *Cycloneda sanguinea, Coccinella ancoralis, Eriopis connexa* (all Coleoptera Coccinellidae), *Allograpta exotica* (Diptera: Syrphidae) and *Aphidius colemani* (Hymenoptera: Braconidae), increasing their efficiency in the regulation of pest aphids (Lopez *et al.*, 2003). Studies on *F. vulgare* highlighted its importance as

Table I. Feature measurements (µm), counts, and comparisons of female and male *B. brevicornis* (n= 11 female, n= 6 male).

	Female		Male	
	Avg.	(Range)	Avg.	(Range)
Head				
Antenna flagellomeres				
F_1 (length)	79	(66-88)	76	(68-83)
F_2 (length)	76	(69-80)	71	(67-77)
F_5 (length)	81	(77-84)	80	(77-83)
preapical (length)	83	(80-86)	76	(68-85)
apical (length)	181	(173-188)	122	(113-131)
F_1 (width)	32	(28-35)	36	(30-41)
F_2 (width)	36	(32-38)	37	(33-42)
F_5 (width)	44	(41-46)	41	(39-44)
preapical (width)	46	(43-49)	39	(38-40)
apical (width)	46	(41-49)	43	(40-47)
Antenna placoids				
F_1 (no.)	2.7	(1.0-5.0)	2.5	(2.0-3.0)
F_2 (no.)	3.0	(2.0-4.0)	3.3	(3.0-4.0)
F_5 (no.)	3.7	(3.0-4.0)	3.7	(3.0-5.0)
preapical (no.)	3.6	(3.0-4.0)	5.5	(5.0-6.0)
apical (no.)	8.0	8.0	6.5	(6.0-7.0)
Eye (length)	150	(112-176)	118	(93-139)
Malar space (length)	29	(21-38)	33	(29-40)
Inter-tentorial distance	89	(83-95)	88	(75-98)
Tentorio-ocular distance	12	(10-13)	28	(21-34)
Mesosoma				
Mesoscutal pleural setae (no.)	21	(17-25)	9.8	(7-13)
Wing				
Stigma (length)	287	(227-337)	282	(267-315)
Stigma (width)	96	(71-118)	97	(79-115)
R1 (length)	138	(106-175)	198	(144-266)
Radial sector vein	271	(172-325)	291	(255-332)
Propodeal setae, anterior area (no.)	8.3	(8-10)	8	(7-9)
Metasoma				
Petiole				
Length	177	(124-225)	162	(112-188)
Width	101	(88-118)	85	(81-88)
Genitalia				
Ovipositor sheath (length)	150	(115-171)		
Ovipositor sheath (width)	57	(47-65)		
Prong (length)	206	(158-242)		
Prong dorsal setae (no.)	3.4	(3.0-4.0)		
Comparisons				
Malar space/eye	0.2	(0.1-0.3)	0.27	(0.24-0.30)
F_1 (length/width)	2.4	(2.2-2.6)	2.1	(1.8-2.4)
F_2 (length)/ F_1 (length)	1.0	(1.0-1.1)	1.0	(0.9-1.1)
F_2 (length/width)	2.1	(1.9-2.1)	1.9	(1.8-2.0)
F_5 (length/width)	1.8	(1.7-1.9)	1.9	(1.8-1.9)
F_5 (length)/ F_2 (length)	1.0	(1.0-1.1)	1.07	(1.07-1.08)
Petiole (length/width)	1.7	(1.3-2.1)	1.9	(1.2-2.2)
Stigma (length/width)	3.0	(2.4-4.1)	2.9	(2.7-3.4)
Stigma (length)/R1 (length)	2.1	(1.6-2.7)	1.5	(1.0-1.9)
Ovipositor (length/width)	2.7	(2.5-2.9)		

a host of natural enemies and innocuous aphid species (*H. foeniculi*, *D. apiifolia,* and *C. aegopodii*) for extensive cropping (Stary & Cermeli, 1989; Beltrame & Salto, 2000). In Spain, *B. brevicornis* along with *Lysiphlebus testaceipes*, *L. fabarum,* and *Aphidius salicis* are reported to attack *H. foeniculi*, *D. apiifolia*, *C. aegopodii, A. spiraecola* and *A. fabae* (Michelena *et al.*, 2004). In low densities, *A. colemani* and *Diaeretiella rapae* (Mcintosh) were observed parasitizing *D. apiifolia* and *H. foeniculi* respectively (López *et al.*, 2003; Manfrino *et al.*, 2011). In 1990, *B. brevicornis* was imported from Czechoslovakia and released in California to help control the European asparagus aphid (*Brachycorynella asparagi* Mordv) (Daane *et al.*, 1992). Field performance of this parasitic wasp indicates it has the potentiality to become permanently established in California. It might also prove useful as a parasitoid of *C. aegopodii* on vegetables (carrots, dill, etc.) (Stary, 1990). In different regions of Iran, Aphidiinae in the *Binodoxys-Trioxys* group are known to attack aphid pests of medicinal plants; *B. brevicornis* is also reported to parasitize *C. aegopodii* feeding on *Salix alba* (Salicaceae) (Talebi *et al.*, 2009). In Brazil, *B. brevicornis* is associated with aphid species, *C. aegopodii* and *H. foeniculi* (Sampaio *et al.*, 2003; Stary *et al.*, 2007).

Our data indicates that *B. brevicornis* was associated with aphids on *F. vulgare* during mainly the flowering period of the plant (October-February). The crop diversity in small gardens is classified as highly useful for parasitoid survival and effectiveness. Considering that *B. brevicornis* attacks a non-pest aphid species feeding on *F. foeniculi*, a host plant usually growing in alfalfa margins, the potential value of this system for a biological control using banker plants should be considered in Argentina.

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