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First host record for Old World *Yelicones* (Hymenoptera: Braconidae: Rogadinae) adds to evidence that they are strictly parasitoids of Pyralidae (Lepidoptera)

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ABSTRACT

The highly distinctive parasitoid wasp genus *Yelicones* is cosmopolitan and not infrequently collected, but very little is known about its biology. Here we report that *Y. iranus* is a parasitoid of caterpillars of the pyralid moth *Phycita diaphana* in Israel, the first host record for the genus from outside of the Americas. We illustrate the wasp's mummified host, emergence hole and the wasp's own cocoon which is constructed within the tanned mummified host remains. We hypothesize that a physiological or behavioural association of *Yelicones* parasitoids with the Pyralidae commenced at least during the early Miocene (ca. 16 Mya).

KEYWORDS: Parasitoid wasp, *Yelicones*, first host record, pyralid moth, mummified host, biology.

INTRODUCTION

Fischer (1961) described a new braconid genus *Pectenopius* (with the type species *P. paradoxus* Fischer, 1961 from Papua New Guinea) but this was subsequently shown to be a subjective synonym of the highly distinctive, rogadine braconid *Yelicones* Cameron, 1887 (type species *Rogas delicatus* Cresson, 1872), and the two formally synonymised by Marsh (1979). Fischer (1963) added another species to his genus *Pectenopius*, *P. iranus*, which also belongs to *Yelicones*, described, as its name suggests, from Iran, but without any biological data.

Yelicones has a cosmopolitan distribution though it is predominantly tropical, and the great majority of its currently described 126 species come from the Neotropics. Thus far the only published host data for any members of the genus are for North American species which has been reared from a total of five species of microlepidoptera, all belonging to the Pyralidae: *Yelicones delicatus* (Cresson, 1872) from three Pyralidae Phycitini species and unidentified species from Puerto Rico from two species of Pyralidae Epipaschiinae (see Quicke & Kruft 1995). *Yelicones delicatus* is recorded from the eastern and central states of the USA (as far north as Wisconsin and New York), Dominican Republic, Mexico and Panama in the New World (Quicke & Kruft 1995), and from Israel in the Old World (Papp 1988). Papp

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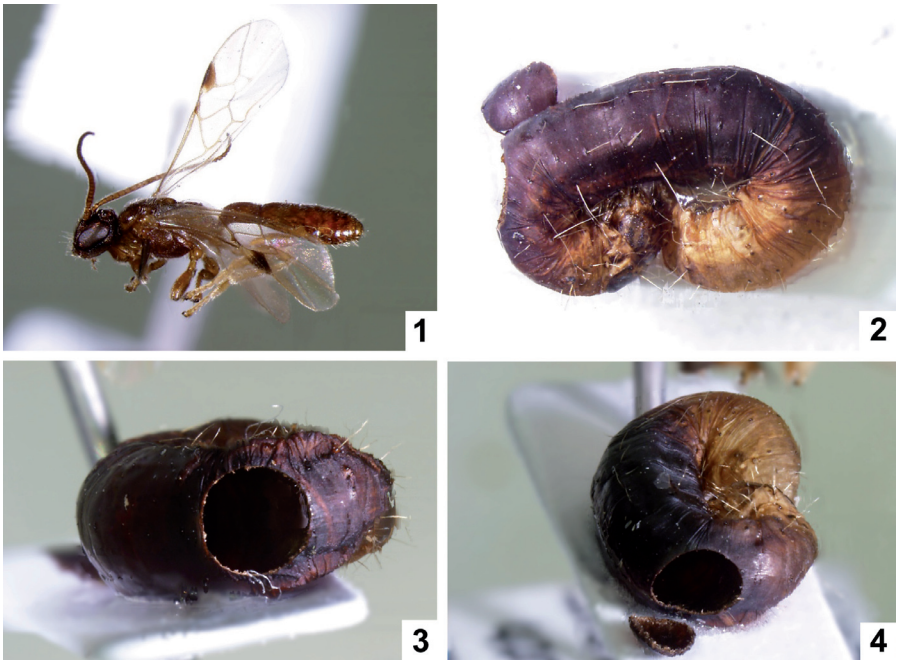
(1991) suggested that the Israeli '*delicatus*' material might have been the result of an inadvertent introduction from the New World, possibly with a host. Quicke and Kruft (1995), without examination of Papp's Israeli specimen, also suggested that it might have been the result of an introduction, but they also commented that "… a very similar but apparently distinct species is recorded from Egypt". The species referred to being *Y. vojnitsi* Papp, which was originally described from Tanzania (Papp 1992; Quicke & Chishti 1997). Subsequently Shaw (1998) reported *Y. vojnitsi* from Spain, suggesting a wide geographic distribution, and also noted that the Spanish specimen bore a closer resemblance to the type of than did the Egyptian specimen which he had also examined, leaving the possibility that the latter might not belong to this species. Papp later recognised that the Israeli *Yelicones* specimens he had seen, actually belonged to *Y. iranus* (Fischer) rather than the superficially similar *Y. delicatus*, and he identified material in the Tel Aviv University (TAU) collection as the former species in 2010.

Here we report multiple rearings of *Y. iranus* (Fig. 1) from a phycitine pyralid species collected at several sites in central Israel, thus adding to evidence that *Yelicones* species are specialist parasitoids of Pyralidae.



Figs 1–4: *Yelicones iranus* and its host remains: (1) adult wasp habitus; (2–4) mummified *Ph. diaphana* caterpillars, from which adult parasitoids were reared, showing neat, nearly circular emergence hole and high degree of tanning.

MATERIALS AND METHODS

A long series of *Yelicones iranus* were reared from caterpillars of the phycitine moth *Phycita diaphana* (Staudinger, 1870) (Pyralidae) on *Ricinus communis* L. (Euphorbiaceae) in the central part of Israel (Table 1) during June–October. Castor bean leaves attacked by caterpillars of different instars were collected in settlements and their vicinity on waste ground—in fallow fields, along roadsides, at the edges of cultivated land, etc.—and placed in rearing chambers along with shoots of the host plant. Rearing was done in the laboratory under room temperature. Cocoons of *Ph. diaphana* were placed in individual vials, and emerging parasitoids were sexed and counted. Most of emerging parasitoids were mounted with the remains of the host. The voucher material is kept in the collection of the Steinhardt National History Museum and Research Center, Tel Aviv University, Israel (SMNHTAU).

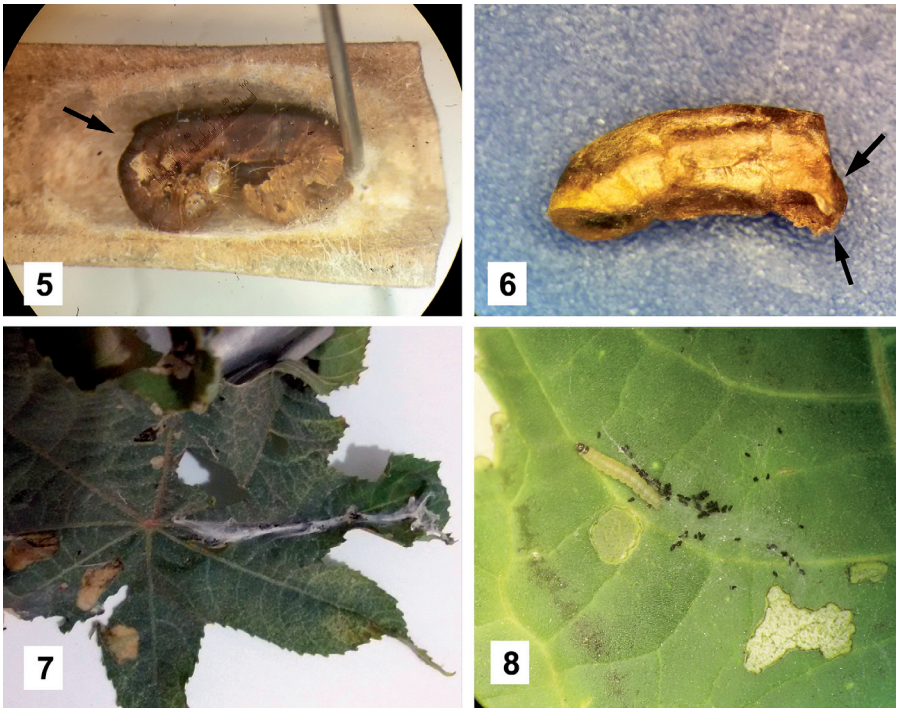
Table 1. Rearing data for examined specimens of *Yelicones iranus* ex *Phycita diaphana* on *Ricinus communis* in Israel.

Locality	Latitude & longitude	Parasitoid emergence	Number and sexes
Bet Dagan	32°00'N 34°50'E	26.x.2014	1♂
Nes Ziyyona	31°59'N 34°49'E	18.x.2015	1♂
Rehovot, ‘north’	31°53'N 34°48'E	29.vii.2015	1♂
		12.ix.2015	1♂
		29.ix.2015	2♀, 1♂
		16.x.2015	5♀, 2♂
		21.xi.2015	1♀
		10.vii.2017	1♀, 1♂
		20.viii.2017	2♀, 3♂
		14.ix.2017	2♀, 2♂
		24.ix.2017	2♀
Rehovot, ‘south’	31°54'N 34°49'E	2.x.2013	1♀
		15.viii.2017	1♂
		9.x.2017	1♀
		19.x.2017	2♀
		25.xi.2017	2♀, 2♂
Givat Brenner	31°52'N 34°49'E	16.x.2015	1♀
		19.x.2016	1♀
Mazkeret Batya	31°51'N 34°53'E	25.ix.2014	2♀, 2♂
		7.x.2014	12♀, 6♂
		20.x.2014	1♀, 2♂

RESULTS

Phycita diaphana is a common, invasive pest of *R. communis* throughout the Mediterranean region (Zilli & Pavesi 2015). In addition to *R. communis*, *Ph. diaphana* larvae are also found feeding on *Populus euphranica* Oliv. (Salicaceae) and *Chrozophora tintoria* (L.) (=*verbascifolia* (Willd.)) (Euphorbiaceae) (Wiltshire 1957; Özaslan *et al*. 2016).

Our observations suggest that the female of the parasitoid lays its egg in the host's larva of younger ages, when the caterpillar is often only weakly protected by its silk web compared to more mature individuals. After completing the development the host moth larva spins its cocoon before it is mummified (Fig. 5). The front and hind quarters of the mummified caterpillar are C-bent and sometimes almost coming into contact and forming a nearly O-shaped figure with the ventral



Figs 5–8: *Yelicones iranus* mummy and cocoon, and host *Ph. diaphana* caterpillar and the gallery: (5) card mounted opened *Ph. diaphana* cocoon with wasp mummy *in situ*, showing parasitoid emergence hole at anterior end to the left (arrowed); (6) cocoon made by *Y. iranus* larva within mummified *Ph. diaphana* caterpillar after host remains dissected away showing ventro-lateral 'ear'-like projections (arrowed); (7) leaf of *Ricinus communis* showing silk-sealed 'gallery' ('sleeve') in *R. communis* leaf inhabited by *Ph. diaphana* caterpillar; (8) early instar *Ph. diaphana* caterpillar in opened gallery.

surface of the larva inwards. The parasitoid's adult at the time of hatching gnaws a nearly circular exit hole always at the anterior end of the mummy and always strictly dorsally (Figs 2–5).

The parasitoid larva spins a thin silk cocoon of its own in the middle of the brown mummy of the moth larva, which occupies approximately half of the mummy's length. The cocoon (Fig. 6) is slightly curved, brownish and thin. It is attached to the host cuticle by two 'ear'-like ventro-lateral extensions in the anterior part of the cocoon (Fig. 6, arrowed); the posterior end of the cocoon is flattened and slanting. The adult wasp emerges through the hole in the anterior end of the cocoon and in the adjoining mummified host cuticle.

The apparent parasitization rates seemed to be mostly low (albeit we cannot quantify them precisely due to the way the collecting and recording of hosts were done), although in one case (Mazkeret Batya, 2014), where there were only two plants, some 30–40% population of the moth had been parasitized by *Y. iranus*.

In addition to the reared material there are 12 specimens of *Y. iranus* in the SMNHTAU collection (all identified by J. Papp in 2010): 1♂, Nizzanim, 31°43'N 34°39'E, 26.vii.2006, A. Freidberg; 11♀, Tel Aviv, light trap, 15.ix.2006 (3♀), 15.viii.2007 (4♀), 10.xi.2007 (4♀), W. Kuslitzky. It appears that females in particular are attracted to light.

DISCUSSION

The only published host records to date for any *Yelicones* species are for the North American *Y. delicatus* (Quicke & Kruft 1995). These are *Caristanius decoloralis* (Walker, 1863), *Nephopterix uvinella* (Ragonot, 1887) and *Psorosina hammondi* (Riley, 1872) (Muesebeck & Walkley 1951; Neunzig 1979), all in the pyralid subfamily Phycitinae. *Pococera baptisiella* (Fernald, 1887) and *P. scabridella* (Ragonot, 1899) (both Epipaschiinae) are the only published records for unidentified species of *Yelicones* (Wolcott 1924, 1948). Additional web-based records of the Pyralidae exist for some, as yet unidentified *Yelicones* species from Guanacaste in NW Costa Rica obtained as a result of Dan Janzen and Winnie Halwach's vast Lepidoptera rearing programme there (Janzen 2000; Janzen *et al*. 2009). Despite *Yelicones* being known from more than 30 Old World species, our observations are first to provide any host information for the Old World members of the genus.

Molecular and morphological phylogenetics have shown a clear differentiation between the New and Old World species of *Yelicones* (Areekul *et al.* 2005), with the sampled species of each region being reciprocally monophyletic. Molecular dating indicates that *Yelicones* arose between the late Eocene to early Miocene (16.79 to 41.58 Mya) (Zaldivar-Riverón *et al*. 2009). Thus, the finding that *Y. iranus* from the Middle East is also associated with Pyralidae, suggests a strong physiological or behavioural association with that group of hosts that has lasted for at least 16 million years (Zaldivar-Riverón *et al*. 2009).

There are no observations of *Yelicones* spp. actually attacking hosts. However, one of the most conspicuous features of this wasp is its highly modified legs with shortened tarsi and strongly pectinate claws (Areekul & Quicke 2006: fig. 407; Quicke 2015: fig. 10.7b). It is postulated that the densely pectenate claws are likely to be an adaptation to handling delicate, soft bodied host larvae directly during oviposition without damaging their cuticle (Quicke 2015: 175–176). The very short ovipositors of *Yelicones* spp. mean that they are seldom likely to be able to attack hosts indirectly through a substrate. Claw modifications might also be associated with accessing hosts within silken retreats, and their robust legs may be adaptations to allowing the adult females to force their way into the host's retreat as in Metopiinae ichneumonids (Quicke 2015: pp. 423–424).

Unlike the mummies of *Yelicones* investigated by Zaldivar-Riverón *et al.* (2009) those of the current species must be classified as 'hard' and heavily sclerotized. All the reared *Y. iranus* specimens had emerged from the mummified host in a strictly antero-dorsal position (Figs 2–4). As there are so few host records for the genus it can just be noted that most of the mummified host remains of *Y. delicatus* seen by Quicke & Shaw (2006) and Zaldivar-Riverón *et al*. (2009) had emergence holes at the posterior end, the consistency of anterior emergence in *Y. iranus* suggests that this is a species-specific character.

The 'ear'-like, antero-ventral extensions of the *Yelicones* cocoon are reported here for the first time. We hypothesise that they probably help stabilize the parasitoid larva within the host body to facilitate cocoon construction.

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