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Rearing methods of two braconid parasitoids used in the biological control of *Ceratitis capitata*

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Abstract: A research work about the possibilities of carrying out the biological control of the Mediterranean fruit fly, *Ceratitis capitata*, with exotic parasitoids has been started in Spain. For that purpose, two hymenopterous braconid species, the larva-pupal parasitoid *Diachasmimorpha tryoni* and the egg-pupal parasitoid *Fopius arisanus*, have been imported from Hawaii, maintained in quarantine facilities, and reared in laboratory conditions. The rearing methodologies for each parasitoid species and the results obtained are discussed.

Key words: Tephritidae, Braconidae, Medfly, *Ceratitis capitata*, biological control, parasitoid rearing, *Diachasmimorpha tryoni, Fopius arisanus*

Introduction

The biological control of the Mediterranean Fruit Fly, *Ceratitis capitata* (Wiedemann, 1824) (Diptera, Tephritidae), has been developed and applied in field in several countries, and in some cases this method has reached a great success in the management of the pest (see Table 1). The first attempt to use biological control methods against the Medfly with exotic parasitoids was performed in Australia in 1902; nowadays classical biological control of Medfly is successfully being used in South America and Central America and in Hawaii (Wong *et al.*, 1991; Headrick & Goeden, 1996; Sivinski, 1996; Bautista *et al.*, 1999; Morales *et al.*, 1999).

In Spain, Medfly biological control had been attempted at the beginning of the XX Century by the importation of exotic parasitoids: in the 1930's two species of braconids (Hymenoptera, Braconidae), *Opius humilis* Silvestri, 1913 (= *Psyttalia incisi* (Silvestri, 1913)) and *Opius tryoni* Cameron, 1911 (= *Diachasmimorpha tryoni* (Cameron, 1911)) from Hawaii were imported into the Valencian Comunity (Spain), but it was not a success due to the failure of the parasitoid rearing process in laboratory (Gómez Clemente, 1932, 1934). Later, the hymenopterous eulophid *Tetrastichus giffardianus* Silvestri, 1915 was introduced into the island of Tenerife (Canary Islands) in 1960, and nowadays this parasitoid can be found in the field parasitizing the Medfly, but no analysis about its beneficial effect has been performed (Moner *et al.*, 1988). Another braconid parasitoid species, *Diachasmimorpha longicaudata* (Ashmead, 1905), was imported by the I.N.I.A. (Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria, Madrid, Spain) in 1979 from Greece and it is still being kept on a laboratory rearing, but it has never been tested against the pest in field trials.

Now, once again our research group is considering to study the possibilities of using exotic parasitoid species as biological control agents against the Medfly in Spain, but this work will take into account the new methods to rear insects in laboratory and their later release in field. For that purpose, we have imported two braconid species from Hawaii: *Diachasmimorpha tryoni* (Cameron, 1911) and *Fopius arisanus* (Sonan, 1932) (Hymenoptera, Braconidae, Opiinae).

D. tryoni is one of the candidate species for the control of the Medfly in Hawaii (Wong & Ramadan, 1992), and also it is now being used in biological control programmes in Guatemala (Sivinski, 1996). *F. arisanus* is an important candidate for the augmentative release method against the Medfly in Central America (Harris & Bautista, 1996; Vargas *et al.*, 1999), and its mass rearing has recently been improved (Wong & Ramadan, 1992; Bautista *et al.*, 1999; Calvitti *et al.*, 2002). This will facilitate the use of this parasitoid in control programmes.

In this publication we explain the procedures used for the importation and the laboratory rearing of the insects.

Table 1. Hymenoptera species recorded as parasitoids of *Ceratitis capitata*. Capital letter at right of scientific names indicates the countries where they are extensively used in biological control programmes against the Medfly (H: Hawaii, F: Florida, C: Costa Rica, G: Guatemala, A: Argentina).

Hymenoptera: Braconidae: Opiinae		other Hymenoptera		
		Diapriidae:	*Coptera haywardi* (Oglobin)	
Biosteres fullawayi (Silvestri)	H		*Coptera occidentalis* (Muesebeck)	
Diachasmimorpha longicaudata (Ashmead)	HFCGA		*Coptera silvestri* Kieffer	H
Diachasmimorpha kraussii (Fullaway)	HG	Chalcididae:	*Dirhinus anthracina* Walker	H
Diachasmimorpha tryoni (Cameron)	HG		*Dirhinus giffardii* (Silvestri)	
Doryctobracon crawfordi (Viereck)	G	Eulophidae:	*Aceratoneuromyia indica* (Silvestri)	A
Fopius arisanus (Sonan)	HC		*Tetrastichus giffardianus* Silvestri	H
Fopius vandenboschi (Fullaway)	H	Pteromalidae:	*Muscidifurax raptor* (Girault & Sanders)	
Psyttalia concolor (Szepligeti)	H		*Pachycrepoideus vindemmiae* (Rondani)	A
Psyttalia incisi (Silvestri)		Eucoilidae:	*Ganaspis carvalhoi* (Dettmer)	
			Odontosema anastrephae (Borgmeier)	

Material and methods

Importation and quarantine

Both *D. tryoni* and *F. arisanus* were imported from the U.S. Pacific Basin Agricultural Research Center (USDA-ARS) at Hawaii in August 2002.

The original lots of parasitized pupae of *Ceratitis capitata* were put in the quarantine facility located at our Center. After a few days, adults of both parasitoids began to emerge from parasitized pupae. Some of these wasps were prepared for a voucher collection.

When the *D. tryoni* population reached 3rd generation, and that of *F. arisanus* reached 2nd generation, the parasitoid rearings were transferred to a climatic room.

Parasitoid rearing

The rearing of both parasitoids is being developed on the fruit fly *C. capitata* as host material. The host is being reared on artifical diet in accordance with Albajes & Santiago-Alvarez (1980).

The rearing process is explained in Figure 1. The parasitoids are placed into the Adult Cage. In the Parasitoidism phase, larvae of third instar and eggs of *C. capitata* are exposed to parasitoids in order for them to be attacked by *D. tryoni* and *F. arisanus* respectively in each case: the larvae are put on the mesh of the upper side of the adult cage, and the eggs are placed in an artificial "egg-laying bottle", as described in Calvitti *et al.* (2002) which in turn is introduced into the adult cage. The host, as third instar or egg, continues its development on a plate with the artificial diet up to the pupal stage. The plate with putative parasitized pupae is placed into a new cage in which the adult parasitoids emerge from host pupae.

The general aspects of these rearing methodologies have been provided by colleagues from I.N.I.A. (Spain) for *D. tryoni* (Jiménez & Castillo, 1992) and from E.N.E.A. (Italy) for *F. arisanus* (Calvitti *et al.*, 2002).

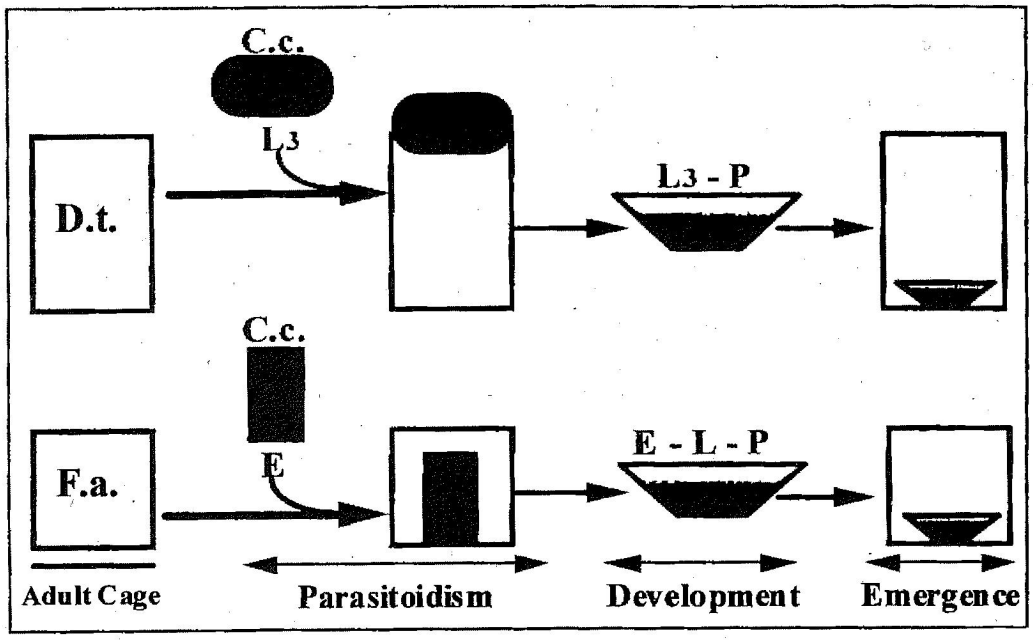

Figure 1. Rearing phases of the parasitoids *Diachasmimorpha tryoni* (D.t.) and *Fopius arisanus* (F.a.) on the host *Ceratitis capitata* (C.c.). E: egg, L: larval stage, L3: third larval instar, P: pupa.

Results and discussion

In this moment, both parasitoid populations are successfully maintained in laboratory. In the case of *D. tryoni*, it has reached the 5th Spanish generation. *F. arisanus*, because of its longer life cycle, has reached the 3rd Spanish generation.

We are trying to improve the rearing methodology in order to know the best parameters and conditions (i.e. age or stage of the host, time of exposure to parasitoidism, age of parasitoids, ...) as this will facilitate the mass rearing and field releases of these insects.

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