# THE INTRODUCTION OF *ENCARSIA GUADELOUPAE* (HYMENOPTERA, APHELINIDAE) FOR CONTROL OF *ALEURODUCUS DISPERSUS* AND *LECANOIDEUS FLOCCISSIMUS* (HOMOPTERA, ALEYRODIDAE) ON TENERIFE

**B.W. Nijhof[1], L. Oudman[1], R. Torres[2] and C. Garrido[2]**

[1]Nijhof Biologische Gewasbescherming, Vogelzangsteeg 19, 9479 TE Noordlaren, The Netherlands
[2]Servicio Tecnico de Agricultura, Cabildo Insular de Tenerife, Sta. Cruz de Tenerife, Islas Canarias

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**Summary**

A case of classical biological control is described, introducing the parasitoid *Encarsia guadeloupae* for the control of the whiteflies *Aleuroducus dispersus* and *Lecanoideus floccissimus* by means of mass-rearing followed by release in the field.

## INTRODUCTION

Since the early 1990's there has been a sharp increase in numbers of whiteflies on ornamentals and food crops on Tenerife (Canary Islands). This was first thought to be caused by the spiralling whitefly *Aleuroducus dispersus* Russell, which is highly polyphagous (Manzano *et al.*, 1993). This species was first detected on the Canary Islands in 1962 (Russell, 1965) and it has been a minor problem on six of the seven Canary Islands since then.

Problems started especially in the rapid growing tourist-settlements in the south of Tenerife. Infestations of all kinds of ornamentals such as *Washingtonia* palms, *Ficus* trees and *Strelitzia* spp. became very serious. Also in cities in the north, like Puerto de la Cruz and the capital Santa Cruz, the populations of whiteflies increased rapidly. *Musa*, a main crop on Tenerife and important for the banana-export, was also heavily infested.

The cause of this sudden increase was not clear, but thought to be partly caused by several abnormal dry and warm winters and partly caused by the exponentially increasing planting area's of exotic ornamentals in the tourist-resorts.

In 1997 the Cabildo of Tenerife agreed to start a mass-culture of the parasitoid *Encarsia* nr. *haitiensis* Dozier in cooperation with the Dutch biological control company NIJHOF BGB. *E.* nr. *haitiensis* was successfully introduced many times in biological control programs of *A. dispersus* in other parts of the world (Waterhouse and Norris, 1989). A population of *E.* nr. *haitiensis* was obtained from cultures on Fiji and Taiwan.

However, during 1997 it became clear that another whitefly species, namely *Lecanoideus floccissimus* Martin Hernandez-Suarez Carnero, was the main cause of the increasing whitefly infestations (Martin *et al.*, 1997). This species was unknown by then, but also appeared to be highly polyphagous. It lives on many plantspecies together with *A. dispersus*, pupae and adults of both species occurring side by side on the same leaf. Up to now *L. floccissimus* is only known from Tenerife and Ecuador (Carnero *et al.*, 1997).

*A. dispersus* is in some periods of the year well parasitised by the naturally occurring parasitoid *Encarsia hispida* De Santis. However, no parasitation of *L.*

*floccissimus* could be discovered on Tenerife. This explained the fast growing population of this whitefly.

During the project of mass-rearing *E.* nr. *haitiensis* it became evident that, probably due to the conditions in the rearing-chambers, no progeny of this parasitoid could be produced. However, the parasitoid *Encarsia guadeloupae* Viggiani had been unintentionally co-introduced in the culture and its numbers were rapidly increasing.

*E. guadeloupae* is known as an effective parasitoid of *A. dispersus* (Neuenschwander *et al.*, 1994; Liang-yih Chou, personal communication). It is also known as a parasitoid of *Trialeurodes vaporariorum* (Viggiani, 1993).

To our surprise *E. guadeloupae* appeared to parasitise *L. floccissimus* as well in our rearing-chambers. This phenomenon was unknown till then (Nijhof and Oudman, 1999).

Therefore, the goal of the project was changed. The new aim became to establish a mass-culture of *E. guadeloupae* and to release this parasitoid in the field.

## MATERIALS AND METHODS

### Culture

The rearing-station was situated in the south-east of Tenerife about 100 metres from the sea. This site is far from urbanisation and there are no possible hostplants of whiteflies nearby.

The rearing-station was a special type of warehouse, the roof and walls constructed partly from double polyester elements and partly from special carton grates and stone. The carton grates facilitate ventilation. Inside this building four rearing chambers were constructed from aluminium frames with the roof and walls partly glass and partly insect-gauze (0.22 x 0.31mm mesh-width) and the roof from this gauze. The four rearing chambers, referred to as A, B, C and D, each had their own entrance with a double-door system and a floor-surface of 30 $m^2$.

The indoor climate fluctuated with the time of the year and the weather (Table 1) because there was no technical controlled heating or ventilation. However, the construction of the outer-building provided a relatively stable climate inside the rearing chambers, with limited fluctuations during the day (Table 1).

*Table 1. Temperature (T °C.) and relative humidity (RH %) in the rearing chambers.*

| Chamber | Min.T | Max.T | Mean T | Min.RH | Max.RH |
|---|---|---|---|---|---|
| A | 15 | 35 | 24 | 24 | 91 |
| B | 15 | 30 | 21 | 30 | 94 |
| C | 17 | 30 | 23 | 54 | 98 |
| D | 16 | 32 | 22 | 23 | 88 |

In the beginning of September 1998 light-intensity in the rearing chambers was measured. The light intensity in chambers B, C and D was relatively low. When it was cloudy, light intensity inside was ca. 12% of the value outside (ca. 10.000 LUX) and when it was sunny, light intensity inside was ca. 2% of the outside value (ca. 100.000 LUX). Only chamber A had relatively high light intensity which was close to that of the outside on a cloudy day.

In each chamber 28 plants were present as hostplants for *Aleuroducus dispersus*. The plantspecies were: *Coccoloba uvifera, Mascarena verschaffeltii, Musa acuminata, Strelitzia augusta, Terminalia catappa* and *Washingtonia filifera.*

Several introductions of adult *A. dispersus* whiteflies were made in each chamber (Figure 1). The adult whiteflies were collected from the field on Tenerife. The first and second introduction were done by releasing adult whiteflies in the chambers. The third introduction of whiteflies was done in closed bags around some leafs of the hostplants.

In week 33 of 1998 adults of *L. floccissimus* were time introduced for the first time in chamber A (Figures 2 and 3). These adults were also collected from the field. Later on *L. floccissimus* was introduced also in the other chambers.

As mentioned earlier, we never observed progeny of the introduced *E.* nr. *haitiensis*. In week 40 we detected *E. guadeloupae* in chamber B. The confirmation of our identification was made by E. Hernandez of the I.C.I.A. on Tenerife.

Because *E. guadeloupae* was until then not present on Tenerife, it is most likely that it was unintendly introduced together with *E.* nr. *haitiensis* from Fiji or Taiwan. The habitus of the female of *E. guadeloupae* is very similar to that of the male of *E.* nr. *haitiensis*.

Later on, *E. guadeloupae* was introduced from chamber B into chambers A and C. Chamber D was kept as a stock-culture of *A. dispersus*. From here, plants infested with whiteflies were put into the other chambers and new host-plants for whiteflies were put into chamber D.

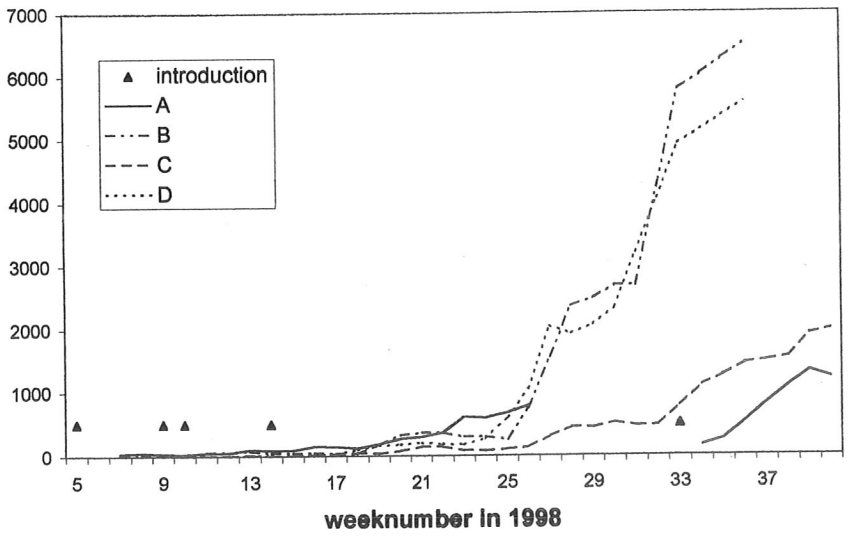


*Figure 1. Numbers of adult* Aleuroducus dispersus *in rearing chambers A, B, C, and D.*

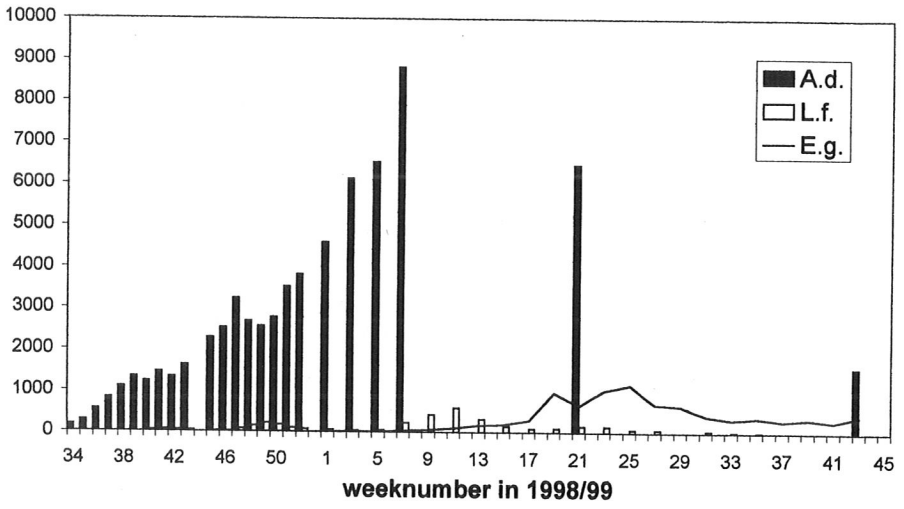


*Figure 2. Numbers of whiteflies* Aleuroducus dispersus *(A.d.) and* Lecanoideus floccissimus *(L.f.) and parasitoid* Encarsia guadeloupae *(E.g) in rearing chamber A. (*A. dispersus *was in 1999 after week 7 only counted in week 21 and 43).*

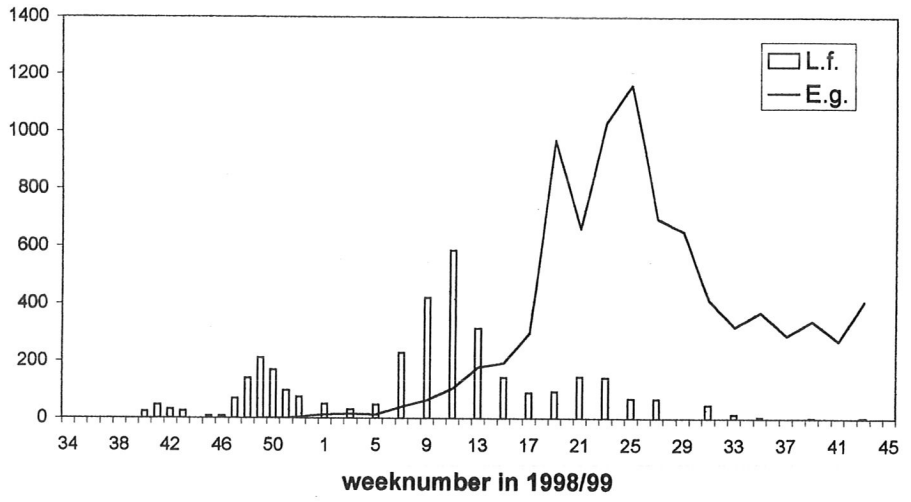


*Figure 3. Numbers* of Lecanoideus floccissimus *(L.f.) and* Encarsia guadeloupae *(E.g) in rearing chamber A (partial enlargement of Figure 2).*

**Release**

*E. guadeloupae* was released in the field for the first time in December 1998. In March 1999 the second series of releases were done. These first series of releases were done with pupae of *E. guadeloupae* on plants infested with *A. dispersus*.

From May 1999 on, many releases of *E. guadeloupae* were done in the most infected regions of Tenerife. From then on the releases were made mainly with adult *E. guadeloupae* and concentrated on plants infested with *L. floccissimus*. The releases were continued until October 1999.

## RESULTS

**Culture**

The chambers produced high numbers of *A. dispersus* (Figure 1). We stopped counting the adults after they reached numbers of almost 7000. In 1998 we had an infestation by (the endemic) *Encarsia hispida* in chamber A and cleaned up this chamber completely in week 27 of 1998. This culture was restarted in week 33. In chamber A we counted the maximum number of 8817 adult *A. dispersus* (Figure 2).

Chamber A was the only chamber in which we were able to build up a population of *L. floccissimus*. The maximum number of adult *L. floccissimus* was 584 in week 11 of 1999 (Figures 2 and 3).

In week 18 of 1999 we detected the first parasitation by *E. guadeloupae* in larvae of *L. floccissimus* in chamber A. This was the first record ever of *E. guadeloupae* parasitising *L. floccissimus*. From week 11 on the numbers of *L. floccissimus* declined sharply and in week 43 the last two adults were seen (Figure 2 and 3).

The failure of establishing a population of *L. floccissimus* in chamber B was probably a consequence of the very efficient parasitation of *L. floccissimus* by *E. guadeloupae* and the high numbers of this parasitoid already present in this chamber. We observed that *E. guadeloupae* is attracted to fresh oviposition sites of the whiteflies and does probably oviposit in the first and second instars. The third and fourth instar, especially of *L. floccissimus*, seem too much protected against parasitation by their wax excretions. Another cause of the failure of getting settled a population *L. floccissimus* in chambers B, C and D may have been the low light intensities in these chambers.

The adults of *E. guadeloupae* present in each chamber were counted. The maximum number counted in chamber A was 1163 (Figure 2 and 3). From december 1998 until october 1999 a total of 9490 *E. guadeloupae* were collected from the chambers for release in the field.

**Release in the field**

After the discovery that *E. guadeloupae* was parasitising *L. floccissimus*, the releases were concentrated on plants with high infestations of this whitefly-species. Releases were made are on plants of the following families:

- *Anacardiaceae: Schinus terebinthefolius*
- *Arecaceae: Archontophoenix spec., Areca spec., Chamaerops humilis, Cocos nucifera, Howea forsteriana, Phoenix canariensis, Washingtonia filifera.*
- *Caesalpiniaceae: Bauhinia purpurea*
- *Combretaceae: Terminalia catappa*
- *Moraceae: Ficus benjamina, F. elastica, F. nitida, F. rubiginosa*
- *Musaceae: Heliconia spec., Musa acuminata, Strelitzia augusta*
- *Polygonaceae: Coccoloba uvifera*
- *Sterculiaceae: Brachychiton spec.*

The first parasitised *L. floccissimus* in the field were detected in June 1999, 45 days after release of *E. guadeloupae* on this spot. Because of the heavy wax-secretions of *L. floccissimus* it is very difficult to detect full or empty parasitised larvae in the field-samples, but the adults of *E. guadeloupae* are detected easily at the oviposition-sites. So

we checked the release-sites for establishment by spotting adult *E. guadeloupae*. On 16 of the 23 release-sites we checked *E. guadeloupae* was found. High numbers were seen at 8 of these sites and at 4 sites we estimated that more than 1000 adults were present.

At 7 release-sites no *E. guadeloupae* could be found. Three of these sites were clearly sprayed with insecticides. In two municipalities of Tenerife (Adeje and Puerto de la Cruz), the spraying with insecticides in combination with high pressure, was done systematically in commission of the local authorities. Because of this policy it was very difficult to make successful releases of *E. guadeloupae* in those public plantations.

*E. guadeloupae* was established in all regions of the island and was discovered also on *A. dispersus* in the field. We observed parasitoids in the lower as well as in the higher parts of the plants (up to 10 meters high). We also found them on plants and locations were no actual releases were made. So within a few months they spread spontaneously.

During our checks in the field no other parasites of *L. floccissimus* were found. However, several species of predators were observed, among others*: Cryptolaemus montrouzieri, Delphastus catalinae*, and *Anthocorus spec.*. However, none of these seemed to be able to control the whiteflies.

## CONCLUSIONS

Once again, the success of this project was an example of serendipity (e.g. Van Andel, 1994). We never have imported intentionally *Encarsia guadeloupae* to start a massculture for control of *Aleuroducus dispersus* and *Lecanoideus floccissimus* on Tenerife. Because *L. floccissimus* was unknown until 1997, there was no knowledge about its natural enemies. However, *E. guadeloupae* showed to be a very efficient parasitoid of *L. floccissimus* in our culture and also in the field.

A question to answer is if *E. guadeloupae* can control the populations of *A. dispersus* and *L. floccissimus* sufficiently in all regions of Tenerife on all hostplants year-round?

At this moment there is a serious problem with the policy of some authorities to spray the whiteflies with insecticides. Not only do they disturb the spreading of *Encarsia guadeloupae*, these chemical treatments cost a lot of money. Moreover, they are probably less efficient, unhealthy and bad for the control of other pests. We hope that when *Encarsia guadeloupae* shows to be an effective parasitoid in the field it will be more easy to convince the people concerned to stop this practice.

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