GUMP STATION MOOREA

FACT SHEET

# BIOLOGICAL CONTROL OF THE GLASSY-WINGED SHARPSHOOTER IN FRENCH POLYNESIA

## INDEX:



## BIOCONTROL PROGRAM:

| | |
|---|---|
| **Location:** | French Polynesia |
| **Period:** | June 2004—May 2006 |
| **Target:** | Glassy-winged sharpshooter (*Homalodisca vitripennis*) |
| **Method:** | Biological control |
| **Objective:** | Reduce the pest population |
| | Assess the collateral risk to native fauna |
| **Control agent:** | Egg parasitoid (*Gonatocerus ashmeadi*) |
| **Bases:** | Gump Station, University of California Berkeley (Moorea) |
| | Rural Development Service of French Polynesia (Papara) |
| **Sponsors:** | French Polynesia, Ministry of Agriculture |
| | University of California, Berkeley and Riverside |
| | Secretariat of the Pacific Community |
| **Conventions:** | 4.0328/PR/MAE/SDR and 6.0655/PR/MAE/SDR |

# THE GLASSY-WINGED SHARPSHOOTER (GWSS)

The glassy-winged sharpshooter (GWSS) *Homalodisca vitripennis* (Germar) [formerly *H. coagulata* (Say)] (Hemiptera : Cicadellidae) is an invasive species in French Polynesia. Adults and nymphs of GWSS are xylophagous (feed on sap). This pest can consume up to 100 times its body weight per day. As a result, the pest excretes copious amounts of watery liquid which is continuously discharged from heavily infested trees. GWSS has thus earned the common local name "*mouche pisseuse*" (pissing fly). GWSS can feed on more than 150 plant species in 34 plant families. GWSS females lay eggs on the undersides of leaves. The life cycle of GWSS takes approximately 4 months.

## Distribution

GWSS is native to the southeast U.S.A. and northeast Mexico. In the late 1980's, this pest invaded California via transport of ornamental plants containing eggs. GWSS then invaded Tahiti in 1999 and Hawaii in 2004 (probably from California). It was detected in Easter Island in 2005 (probably from French Polynesia).

*GWSS adult*

## Nuisances

Following its arrival, GWSS proliferated and spread rapidly in French Polynesia. In 2003, its abundance in Tahiti was ~1,000 times higher than in its natural range in Florida. The humid tropical climate with moderately high year round temperature and high rainfall, and the absence of natural specific enemies in French Polynesia offered ideal conditions for massive year round reproduction by GWSS.

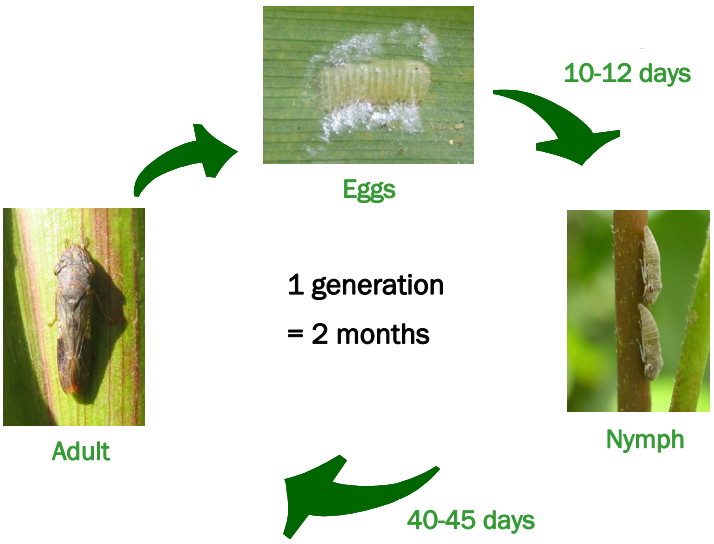
GWSS is a major agricultural, environmental and social pest. Such high removal of xylem fluids by thousands of feeding nymphs and adults is suspected to retard plant growth and to cause decline in fruit production. GWSS is also a vector of a lethal plant pathogenic bacterium *Xylella fastidiosa*. Moreover, the GWSS is a public annoyance in FP both because of the rain from highly infested trees and because the insects tend to congregate around light sources at night.


*World distribution of the GWSS*

**Glassy-Winged Sharpshooter**

- is an invasive species in the Pacific region
- originated from Florida/ Mexico
- has invaded 10 islands in French Polynesia
- is spread by the transportation of plants containing eggs
- consumes up to 1, 000 times its body weight/day
- is an agricultural, environmental and social nuisance

*Life cycle of the Glassy-Winged Sharpshooter*

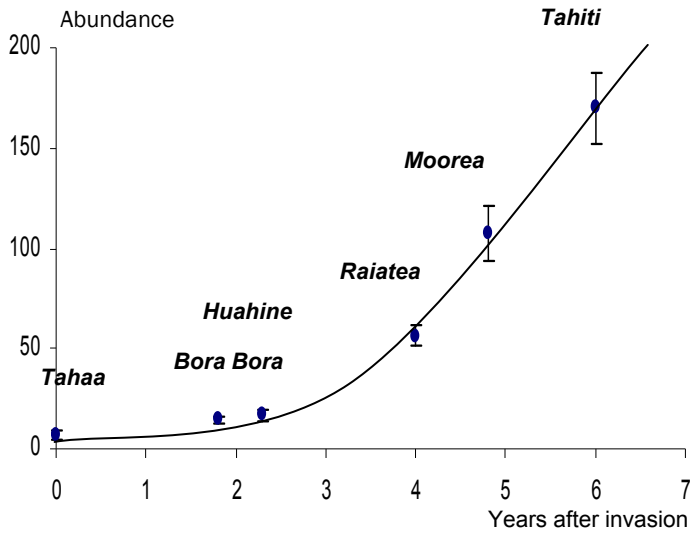



*GWSS abundance in Tahiti in 2005*

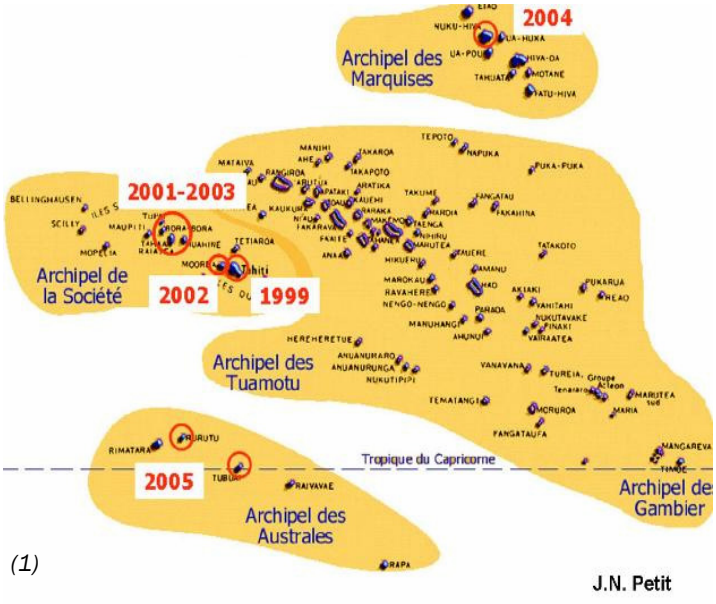
# GLASSY-WINGED SHARPSHOOTER DEMOGRAPHY IN FRENCH POLYNESIA

In French Polynesia, GWSS reproduced and spread very rapidly and is currently found on almost all islands in the Society Island group (Tahiti invaded in 1999, Moorea in 2002, Tahaa, Raiatea, Huahine, Bora Bora, Maupiti in 2001-2005) and has also been recorded on Nuku Hiva in the Marquesas (2004), on Tubuai and Rurutu (both 2005), and in the Australs (2005). It is unknown whether or not GWSS has arrived in the Tuamotu or the Gambier group of islands (except Rangiroa).

GWSS abundance within each island was significantly correlated with its invasion date (the last islands invaded have the lowest densities). Abundance in Leeward islands, Marquesas and Australs was 10 times lower than in Tahiti and Moorea. GWSS populations were mainly concentrated in urbanized areas of each island.




*GWSS abundance (nymphs collected per minute of sampling with a sweep net on Hibiscus), related to the date of invasion*

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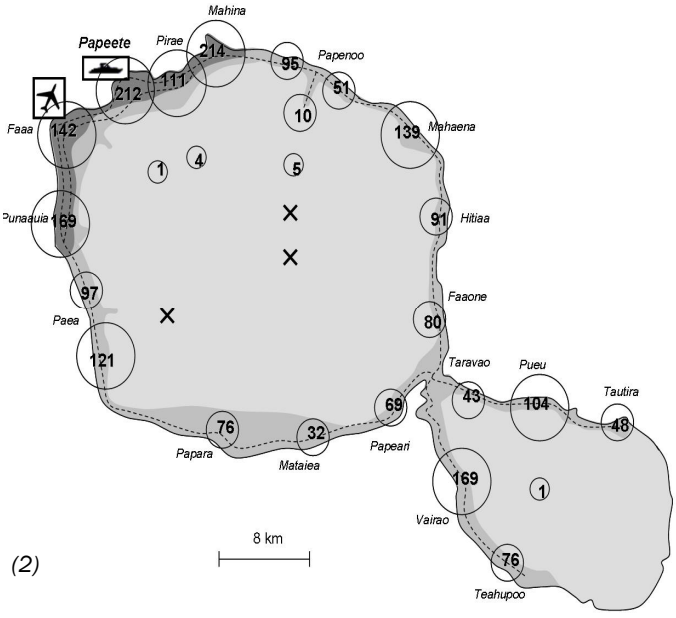


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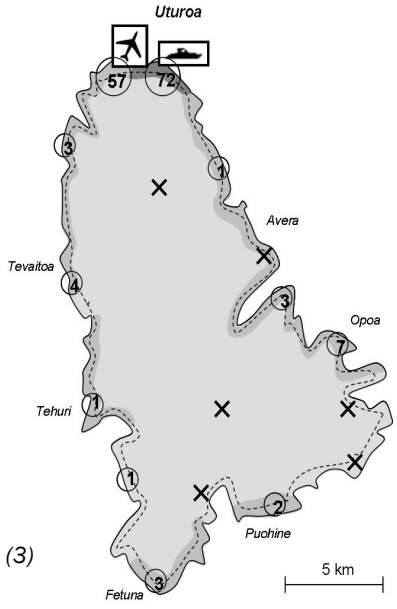


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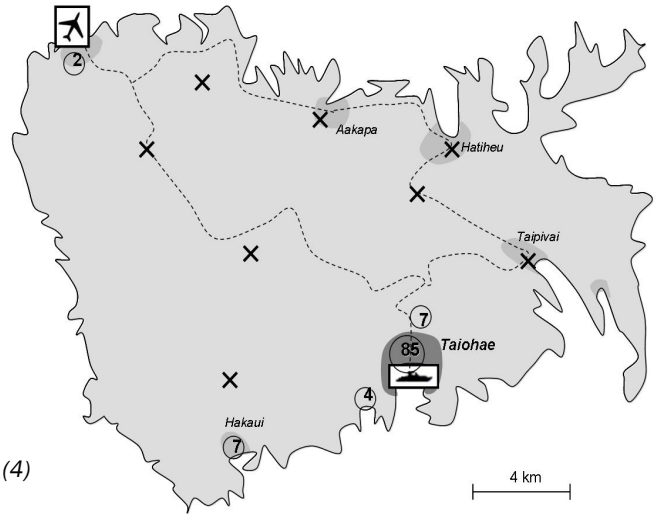



(4)

(1) GWSS dispersal in French Polynesia

(2) GWSS abundance (nymphs collected per minute of sampling with a sweep net on Hibiscus, cross for absence) in Tahiti in April 2005

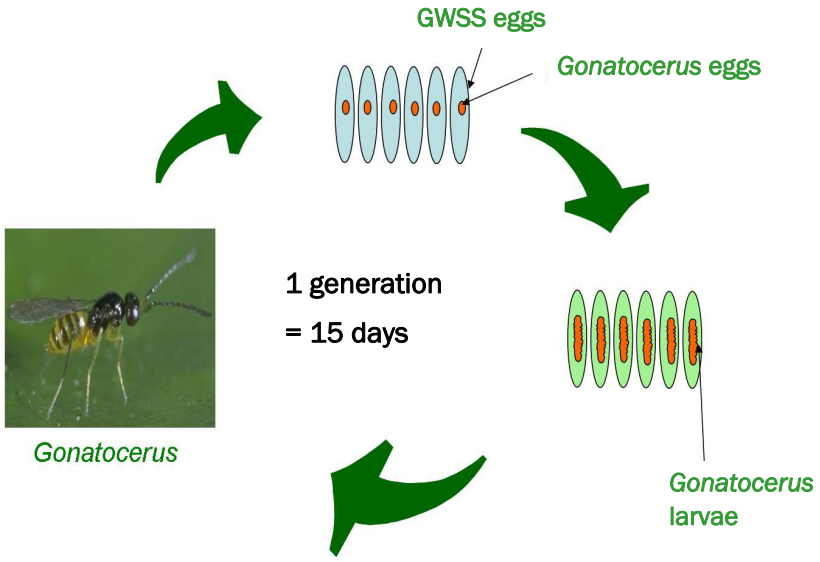
(3) in Raiatea (Leeward Islands) in June 2005

(4) in Nuku Hiva (Marquesas) in November 2005

## PARASITOÏD *GONATOCERUS ASHMEADI*

The egg parasitoid, *Gonatocerus ashmeadi* Girault (Hymenoptera : Mymaridae), is a natural enemy of GWSS. It is native to south-eastern USA and north-eastern Mexico where it is a common and very effective parasitoid associated with GWSS. *Gonatocerus ashmeadi* attacks the eggs of GWSS. Female *G. ashmeadi* lay one egg inside a single GWSS egg. The parasitoid larva grows inside the GWSS egg consuming its contents. After approximately 12 days of development, an adult parasitoid emerges from the parasitized GWSS egg.


*Gonatocerus ashmeadi adult (above)*




*Gonatocerus ashmeadi life cycle (on the left)*

### *Gonatocerus ashmeadi*

- is harmless to humans and animals (it doesn't sting)
- is not an agricultural pest (it feeds on nectar)
- is extremely specialized (it attacks only one tribe of cicadellids)
- is well adapted to the tropical climate and is easy to mass rear
- develops 3 to 4 times faster than GWSS
- is strictly dependant on GWSS eggs for its reproduction

Parasitoids used for the biocontrol program in French Polynesia were reared in a secure quarantine facility at the Entomological Laboratory of the Rural Development Service in Papara ( Tahiti). Mass production of *G. ashmeadi* involved four permanent set ups: *(1)* a plant nursery to produce host plants for GWSS to lay eggs on; *(2)* a GWSS colony used to produce eggs for parasitoids to attack (3), and *(4)* a parasitoid colony.




## RISK ASSESSMENT ON NATIVE CICADELLIDS

An primary requirement for classical biological control of GWSS in French Polynesia is the necessity to minimize non-target impacts. Particular attention has been paid to the identification and assessment of risk to non-target native fauna, in particular, native Cicadellids. Surveys and preparation of an inventory of native species collected from French Polynesia have been initiated to reduce the possibility that overlooked indigenous species could be inadvertently put at risk. Only five species of cicadellids had been recorded from Society Islands before our studies (3 native species and 2 exotic). During our surveys, 25 species from 12 genera have been collected in this archipelago (16 native species and 9 exotic). Also, 9 species have been collected in the Marquesas and 7 species in the Australs. Most of the native species collected are new to science and in need of detailed studies.

*Gonatocerus ashmeadi* is a specialized parasitoid that attacks cicadellid eggs in the tribe Proconiini. Thus, the introduction of *G. ashmeadi* in French Polynesia is considered low risk for native cicadellids as surveys have clearly indicated that there are no indigenous representatives in this tribe that may be potential hosts for *G. ashmeadi*.

Moreover, all known hosts of *G. ashmeadi* are cicadellids of moderately large size (1.5-2cm in length) which lay fairly large eggs (2.5- 3 mm in length) that occur in clusters or masses. All cicadellids found in Society Islands are small and most of them appear to lay their eggs on herbs, or singly on leaves and not in clusters or masses.

Therefore, native cicadellids of French Polynesia are considered to be at low risk of attack by the parasitoid *G. ashmeadi*.

*Compared sizes of GWSS (above) and 2 native cicadellids (below)*

**Only 5 cicadellid species had been described from Society Islands, 25 species were recorded during this program**

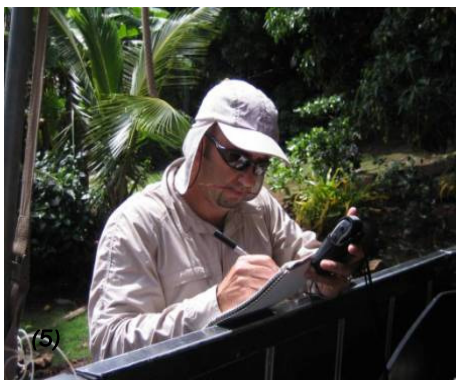
(1)

(2)

*(1) Native cicadellids of Society Islands. (2) Inventory sites in Tahiti, (3) Bora Bora, (4) Marau and (5) in Marquesas*

(3)

(4)



(5)

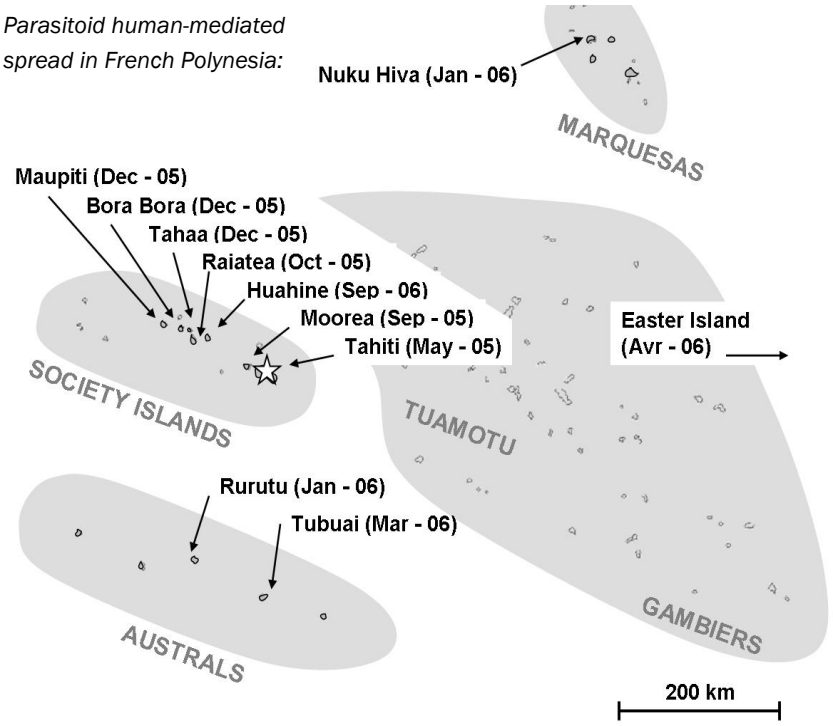
## INTRODUCTION OF THE PARASITOID *GONATOCERUS ASHMEADI*

Available data on native species and potential non-target impacts were presented to the Council of Ministers of French Polynesia in April 2005. The Council decided that release of *G. ashmeadi* from quarantine for liberation and establishment in the field should be initiated in May 2005. The Commission of Natural Monuments and Sites of French Polynesia gave its approval for releases in Society Islands in April 2005, in the Marquesas in February 2006 and in the Australs in April 2006.

The first release of *G. ashmeadi* began on May 2, 2005 at experimental sites in Papenoo, on the north end of Tahiti. On September 2005, releases of *G. ashmeadi* began on the whole island of Tahiti. A total of 14,000 parasitoids were released in 27 sites located around the island. Parasitoids established successfully at release sites and reproduced rapidly in the wild.

A short time after its introduction in Tahiti, *G. ashmeadi* had spread in every island of French Polynesia infested by the GWSS, through the uncontrolled transportation of plants containing parasitized eggs of GWSS, from September 2005 to April 2006. Complementary official releases of *G. ashmeadi* have been achieved on some islands to consolidate existing parasitoid populations and increase their genetic variability.

*Parasitoid human-mediated spread in French Polynesia:*




*First release of parasitoids on Tahiti (right)*

**_Gonatocerus ashmeadi_ was spread through the uncontrolled transportation of plants in every island of French Polynesia infested by the GWSS**

## MONITORING THE PARASITOID EFFICIENCY : METHODS

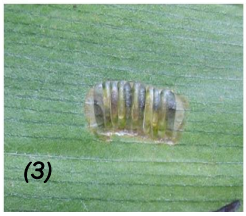
Monitoring of released parasitoids permitted assessment of parasitoid establishment, dispersal, and parasitism rates. GWSS abundance was monitored with yellow sticky cards *(2)* and time count from regularly monitored field sites. At the same time, a map of GWSS densities was regularly made for each infested island by sweep netting *Hibiscus* for a fixed time period *(1)*. Parasitism rate was monitored through the collection of GWSS eggs on the field *(3)* (healthy vs parasitized, fresh vs hatched). Collection of these data was necessary to evaluate the effectiveness of *G. ashmeadi* releases against GWSS and to streamline the release strategy.



*Fresh Healthy eggs*

*Hatched healthy eggs*

*Fresh parasitized eggs*



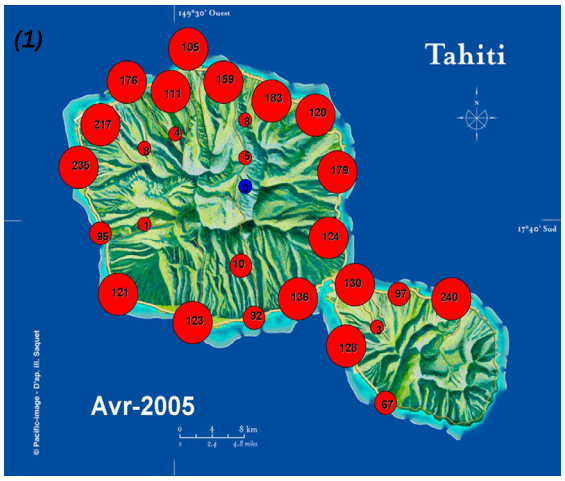

*Hatched parasitized eggs*

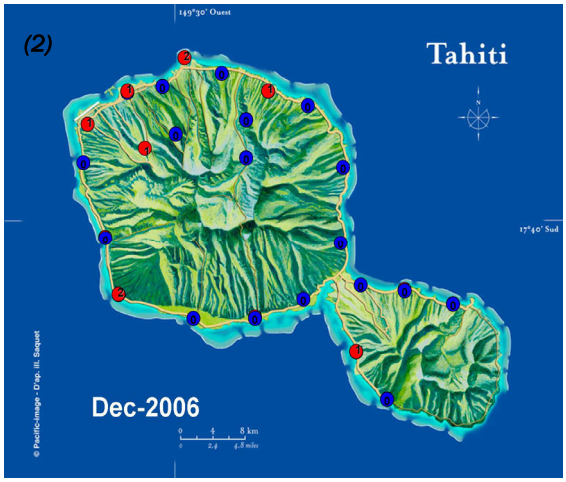
# PARASITOID IMPACT ON THE GLASSY-WINGED SHARSHOOTER

Survey results indicate that *G. ashmeadi* has had a catastrophic impact on GWSS populations on every island of French Polynesia. Prior to parasitoid release, GWSS densities on Tahiti averaged 170 nymphs per minute sampling effort with a sweep net. Since December 2005, the number of GWSS nymphs has been maintained at a very low level with an average of 0.4 nymphs per minute. This represents a decrease of ~99% in GWSS nymph densities. GWSS eggs parasitism rate has averaged around 80-100% since August 2005, with a decrease to 45% during the cool season from June to September 2006 (with no increase of GWSS abundance). The same impact is observed on every island controlled by the parasitoid. Eradication of GWSS in French Polynesia was not a goal on this program (it is an unlikely outcome of biocontrol in general); both GWSS and parasitoid populations are likely to remain at low abundances.

Therefore, a year and a half after *G. ashmeadi* introduction in French Polynesia, GWSS populations have been controlled efficiently on every island infested by the pest, and the agricultural, environmental and social nuisances created by GWSS have been markedly reduced.

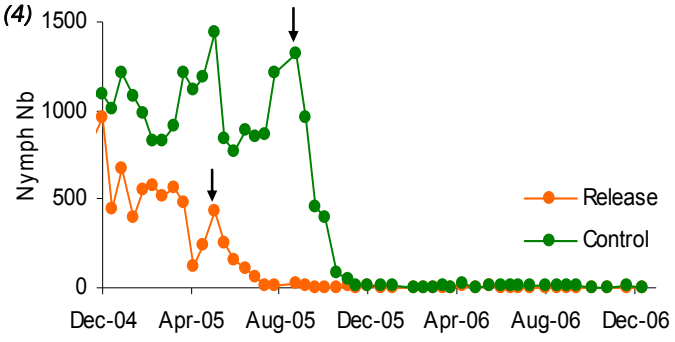
**GWSS abundance has been reduced by more than 95% after the parasitoid introduction on every infested island**

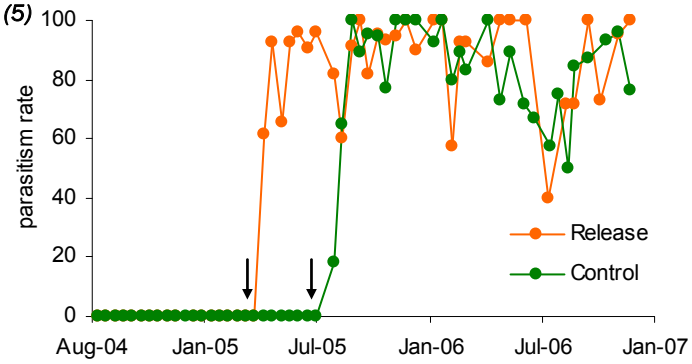



*(1) GWSS abundance on Tahiti (nymph/minute sweep netting) in April 2005 (2) and in December 2006. (4) GWSS abundance and (5) parasitism rate at a release site (Tapahi) and a control site (Maraa) on the coast (black arrow = parasitoid introduction or arrival).*

*(3) Control efficiency in every controlled island.*




| (3) | GWSS abd. before ctrl[1] | Parasitism rate min/max[2] | GWSS abd. After ctrl[3] | Abundance decrease |
|---|---|---|---|---|
| **Windward Islands** | | | | |
| Tahiti | 170 ± 18 | 45-99 % | 0.4 ± 1,2 | 99.8% |
| Moorea | 108 ± 14 | 45-99 % | 0.5 ± 0,9 | 99.5% |
| **Leeward Islands** | | | | |
| | 57 ± 5 | 80-95 % | 0.6 ± 0,3 | 98.9% |
| Huahine | 17 ± 3 | 82-96 % | 0.3 ± 0.8 | 98.2% |
| Bora Bora | 15 ± 2 | 65-92 % | 0.3 ± 0,5 | 98.7% |
| Tahaa | 7 ± 2 | - | 0.2 ± 0,4 | 97.1% |
| Maupiti | - | - | 0.2 ± 0,5 | - |
| **Marquesas** | | | | |
| Nuku Hiva | 42 ± 8 | 98% | 0.7 ± 1,2 | 98.3% |
| Hiva Hoa | 0 | - | - | - |
| Ua Pou | 0 | - | - | - |
| Ua Huka | 0 | - | - | - |
| Tahuata | 0 | - | - | - |
| **Australs** | | | | |
| Rurutu | - | 87-92 % | 0.8 ± 0,9 | - |
| Tubuai | 10 ± 2 | 93-99 % | 0.7 ± 0,9 | 93.0% |
| Raivavae | 0 | - | - | - |
| **Tuamotu** | | | | |
| Rangiroa | 0 | - | - | - |

*[1] GWSS abundance (nymph/minute sweep netting on Hibiscus) in 2005*
*[2] Parasitism rate during the cool season (min) and the hot season (max)*
*[3] GWSS abundance (nymph/minute sweep netting on Hibiscus) in 2006*

## REFERENCES


- Grandgirard J., Hoddle M.S., Petit J., Roderick G.K., Davies N., 2006. Engineering an invasion: classical biological control of the glassy-winged sharpshooter, *Homalodisca vitripennis*, by the egg parasitoid *Gonatocerus ashmeadi* in Tahiti and Moorea, French Polynesia. Submitted to Biological Invasion

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- Grandgirard J., Hoddle M.S., Roderick G.K., Petit J.N., Percy D., Putoa R., Garnier C., Davies N., 2006. Invasion of French Polynesia by the Glassy-Winged Sharpshooter, *Homalodisca coagulata* (Hemiptera : Cicadellidae): A new threat to the South Pacific. Pacific Science 60(4):429-438


## INTERNATIONAL CONFERENCES

- Tropical Island Ecosystems and Sustainable Development Conference, 4 décembre 2006, Gump station, Moorea, Polynésie Française

- Point Étape de la recherche Française dans le Pacifique, novembre 2006, Papeete, Tahiti

- California Conference for Biological Control V, 25-27 juillet 2006, Riverside, CA, USA

- Regional Technical Meeting on Plant Protection 13th, 5-9 Juin 2006, Nadi, Fiji Islands

- International workshop on leafhoppers and planthoppers of economic significance 6 th, août 2005, Berkeley, Californie, USA

- Pacific Entomology Conference 11 th, février 2005, Honolulu, Hawaii, USA

- Assise de la recherche française dans le Pacifique, août 2004, Nouméa, Nouvelle Calédonie

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