

Biological Control of the Orange Spiny Whitefly, *Aleurocanthus spiniferus* [Homoptera : Aleyrodidae] on Chuuk and Yap in Micronesia

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ABSTRACT

The orange spiny whitefly, *Aleurocanthus spiniferus* (Quaintance) (Homoptera : Aleyrodidae) was first reported on Yap in 1986 and on the island of Moen in Chuuk State of Federated States of Micronesia in 1948. A parasitoid, *Encarsia smithi* (Silvestri) (Hymenoptera : Aphelinidae), was introduced to Moen, on Nov. 1, 1989 and to Yap on Sept.26, Oct. 3 and Oct. 10, 1990 from Guam. In Moen, the establishment of the parasitoid was confirmed on Sept.5,1990 with a large reduction in population of the orange spiny whitefly. Similarly, in Yap, establishment of *E.smithi* was confirmed at the two release sites on March 13, 1991 and in most of the island on September 20,1991 in Yap.

KEY WORDS : *Aleurocanthus spiniferus*, orange spiny whitefly, *Encarsia smithi*, biological control, *Citrus* spp., Micronesia

The orange spiny whitefly (OSW), *Aleurocanthus spiniferus* (Quaintance) (Homoptera : Aleyrodidae) was first observed on Yap in 1986 (Nafus, 1990) and on the island of Moen in Chuuk State in 1948 by Moen (Takahashi, 1956). On both islands, there were no obvious signs for presence of local parasitoids of OSW nor any records of their introduction. Orange spiny whitefly-infested citrus trees had numerous small, brownish to black scales with a short fringe of white wax in the underside of many leaves. Honeydew produced by the OSW caused a black, sooty mold to grow and cover the leaf surface resulting in reduction in photosynthesis. As a result, fruit yield was reduced and heavy infestations reduced the vigour of the plants.

Introduction of parasitoids of OSW in Micronesia has given successful results in Guam (Peterson, 1955), Kosrae (Nafus, 1988) and Pohnpei (Muniappan *et al.*, 1992). On Guam, OSW was first recorded in 1951 by Peterson, and a biological control program was initiated in 1952 with the shipment of

parasitoids from Mexico (Peterson, 1955). Five hymenopteran species, *Encarsia smithi* (Silvestri), *E.clypealis* (Silvestri.), *E.opulenta* (Silvestri), *Eretmocerus serius* Silvestri, and *Amitus hesperidum* Silvestri were introduced to Guam. Of those five, *E.smithi* and *A.hesperidum* were reported to have become well established by Peterson in 1955, however, at present *E.smithi* is the most common species found on Guam.

In Kosrae, OSW was first observed in 1982 by Muniappan, and two shipments of adult *E.smithi* were sent from Guam by James Nechols in November 15 and 22, 1983. Establishment of *E.smithi* was confirmed by Donald Nafus in 1984 and 1986 with 77% and 86% of OSW parasitized, respectively (Nafus, 1988). In Pohnpei, when OSW was identified as a serious pest of citrus trees in the area of Kolonia in 1987 in the absence of any parasitoids, *E.smithi* was shipped from Guam in January of 1988 (Muniappan *et al.*, 1992). Sixty-five adults were released at two locations. The establishment of the parasitoid was confirmed in April 1988, and

OSW was no longer considered a major pest on the island in 1989.

This paper presents the results of biological control of *A.spiniferus* on two islands of Chuuk and Yap in Micronesia.

MATERIALS AND METHODS

Chuuk :

The island of Moen in Chuuk State was visited on Nov. 1-2, 1989. Six locations were examined for densities of OSW and the

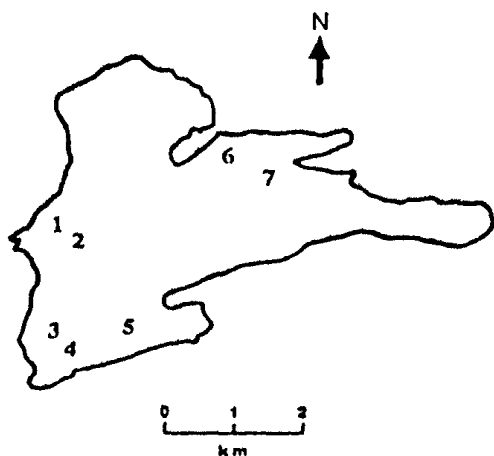


Fig. 1. Study sites on Moen (Chuuk): 1. Mwen #1 (release site); 2. Mwen #2; 3. Neauo #1; 4. Neauo #2; 5. Wichap; 6. Tunnuk; 7. Peniesenne

presence of local parasitoids (Fig. 1). Lime, *Citrus aurantifolia* (Christmann) Swingle, is the most common citrus tree grown in Chuuk. A tree was randomly selected from each location, and 10 newly-matured shoots were sampled from each tree except at a location in Mantaku, where infestation of a lemon tree, *C.limon* (L.) Burm f., was very low and only 11 infested leaves were collected to examine the establishment of the parasitoid. Each collected shoot was carefully examined and the number of leaves with OSW were counted. If the total number of leaves exceeded 100, then 100 leaves were randomly

sampled to count the number of leaves with OSW. Twenty-five OSW-infested leaves were then randomly selected to observe the presence of parasitoids. Each nymph of OSW was examined under a dissecting microscope. When the OSW had a live or dead parasitoid or there was a parasitoid exit hole, it was considered to be parasitized. If there was a live or dead nymph of OSW without a parasitoid, an adult of OSW about to emerge, or an adult OSW emergence hole, then it was considered unparasitized.

After pre-release examination of citrus trees, twentyseven adult females and ten males of *E.smithi* shipped from Guam were field-released on one of the heavily infested lime trees at Mwen (location #) on Nov.1, 1989. These parasitoids were field-collected and isolated for individual identification. Isolated *E.smithi* were pooled in test tubes with a strip of wax paper dipped in honey solution and dried prior to shipping.

The status of the OSW population and the establishment of the introduced parasitoid were investigated on Sept. 5-6, 1990. Of a total of seven lime trees examined, five were the same trees examined prior to the parasitoid release on Nov.1, 1989 (Fig. 1). At Montaku, the lemon tree studied in 1989 was cut and removed from the site prior to the 1990 survey. Nine to ten shoots with newly matured leaves per tree were sampled at each site. The same procedure used for estimating OSW population prior to release of the parasitoid was adopted for post-release estimation of OSW population density and parasitoid establishment.

Yap :

The first infestation of OSW was identified on citrus trees in Yap in October 1987. Its distribution was surveyed throughout the island in August, 1990 and again before the release of the parasitoid on Sept.26, 1990. Sites examined were two locations in Colonia (Nglog and Department of Resources &

Development (DRD) station), Gilman, Kanifay, Fanif, Mapp, Gachpar, Weloy, Makay and Tomil (Fig. 2). The methodology of the survey was the same as that of Chuuk. Sweet orange, *C.sinensis* (L.) Osbeck, tangerine, *C.reticulara* Blco., and sour orange, *C. aurantium* L., were the common citrus trees infested by OSW. Meanwhile, *E.smithi* was cultured in the Entomology laboratory at the University of Guam. Two clean lemon trees of about 1.2 m in height were grown in pots and were kept separately in muslin-covered wooden cages. Leaves of these trees were infested with OSW by releas-

ing field-collected adults. Field-collected *E. smithi* were released on the caged trees where OSW was well established. After at least one generation of culturing *E.smithi* in the laboratory, the adult parasitoids were shipped to Yap for field release. On September 26, 1990, 22 adult females and 3 adult males were released on a heavily infested tangerine tree in Tomil. The second field release was made on October 3 by introducing 42 females and 7 males on the same tree where the first release was made. An additional 42 females and 25 males were released on a sweet orange tree at the station of Department of Resources & Development (DRD station) in Colonia on Oct. 10. Thirteen females and 19 males of *E. smithi* were also released on a sweet orange on Gilman on the same day, however, since the tree was cut down soon after the release, it was not included in the later survey.

The post-release survey of the population density of OSW and the establishment of *E.smithi* was conducted on March 13-15, 1991 using the same procedure described above. After confirming the establishment of *E. smithi* at Tomil, the radius of spread of the parasitoid was estimated by checking citrus trees around the neighborhood. A similar survey was again conducted on September 20-22, 1991, to evaluate the establishment and spread of the parasitoid.

RESULTS AND DISCUSSION

After 10 months from the release, *E. smithi* has become well established and there was a great reduction of OSW on the island of Moen, Chuuk (Table 1). A tree at Mwen #1 had 91% of leaves covered with OSW before *E.smithi* was released on November, 1989 and by September, 1990, OSW infestation became negligible. At four other localities, Mwen #2, Neauo #1, Neauo #2 and Wichap, 18-27% of leaves of lime trees were infested with OSW after the parasitoid release in comparison with around 90% of leaves with OSW before release. The OSW parasitization ranged be-

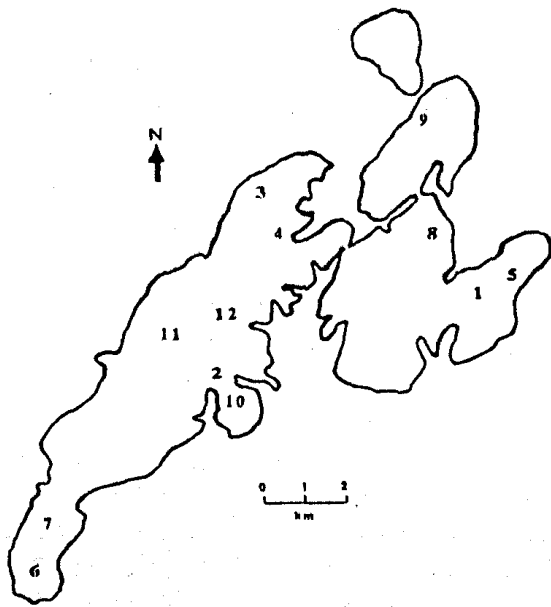


Fig. 2. Study site on Yap; 1. Tomil (release site); 2. DRD station (release site); 3. Fanif; 4. Fanif (Malwaly); 5. Gachpar; 6. Gilman; 7. Kanifay; 8. Makay; 9. Mapp; 10. Ngolog; 11. Weloy; 12. Weloy (Degoo).

Table 1. Infestation and parasitization of *Aleurocanthus spiniferus* before and after releasing *Encarsia smithi* on the island of Moen in Chuuk

Location	Plant	Date	No. of shoots sampled	Total no. of leaves examined	% of leaves with OSWs	Total no. of OSWs examined (on 25 leaves)	% OSWs with parasitoids ^z
Mwen #1 (release site)	Lime	11/1/89	10	100	91	1553	0
		9/5/90	10	89	0	-	-
Mwen #2 (near release site)	Lime	11/1/89	10	100	92	1680	0
		9/5/90	10	74	18	76	57
Neauo #1	Lime	11/1/89	10	100	97	2270	0
		9/5/90	10	81	27	42	38
Neauo #2	Lime	11/1/89	10	100	87	1495	0
		9/5/90	10	82	21	76	59
Tunnuk	Lime	11/1/89	10	100	94	3435	0
		9/5/90	10	102	100	2439	0
Mantaku	Lemon	11/1/89	-	-	-	759 ^y	0
		9/5/90	-	-	-	-	-
Wichap	Lime	11/1/89	-	-	-	-	-
		9/5/90	9	91	18	68	59
Peniesenne	Lime	11/1/89	-	-	-	-	-
		9/5/90	10	93	32	72	22 ^x

z Including the number of OSWs with parasitoid exit holes, live and dead parasitoids

y 11 infested leaves were collected to examine the presence of parasitoids

x Found the presence of *Encarsia* sp. other than *E. smithi*

tween 38 to 59% at these four locations, and only *E. smithi* was recovered from the sites. At Peniesenne, the farthest location from the release site, only 32% of leaves of a lime tree had OSW and 22% of OSW were parasitized. A specimen of the parasitoid collected from this location was found to be an *Encarsia* species different from *E. smithi*. *E. smithi* was not recovered at Peniesenne during this short survey period. At Tunnuk, a lime tree was heavily infested by OSW and neither *E. smithi* nor the *Encarsia* sp. (found only at Peniesenne) were recovered in September, 1990.

In March 1991, about 6 months after the first release, the establishment of *E. smithi* was confirmed at two release sites in Yap viz., Tomil and DRD station (Table 2). The percentage of OSW parasitized was still low on both locations. However, the presence of *E. smithi* was confirmed within a radius of 200

m after examining several citrus trees located 10m, 150m, 200m, 400m, and 800m distance from the release site at Tomil. The degree of infestation on some trees seemed to be less in March, 1991 compared with that in September 1990 regardless of the presence or absence of the parasitoid. In Kanifay, for example, the percentage of leaves with OSW had declined from 95% to 5% without any indications of parasitoid existence. Rainy storms that occurred during October-December in 1990 might have caused reduction in OSW from leaf surfaces. During the survey in September, 1991, *E. smithi* was recovered in a wider geographic area in Yap confirming establishment and the fast spread of the parasitoid on the island.

E. smithi proved its effectiveness in controlling *A. spiniferus* on two islands in Micronesia, Moen, (Chuuk) and Yap in ad-

Table 2. Infestation and parasitization of *Aleurocanthus spiniferus* before and after releasing *Encarsia smithi* in Yap

Location	Plant	Date	No. of shoots sampled	Total no. of leaves examined	% of leaves with OSWs	Total no. of OSWs examined ^z	% OSWs with parasitoids ^y
Release site 1							
Tomil	Tangerine	9/26/90	10	53	93	880(25)	0
		3/13/91	10	57	91	156(16)	39
		9/20/91					
Release site 2							
DRD station	Sweet orange	9/26/90	10	83	51	514(10)	0
		3/13/91	10	82	100	143(6)	27
		9/20/91	-	11	-	102(11)	45
Fanif	Sweet orange	9/26/90	10	91	100	6255(10)	0
		3/13/91	8	62	100	100(<25)	0
Fanif(Malway)	Sweet orange	9/20/91	-	7	-	100(7)	89
Gachpar	Sweet orange	9/26/90	10	75	100	1821(8)	0
		3/13/91	10	78	100	100(<25)	0
		9/20/91	-	8	-	100(8)	53
Gilman	Tangerine	9/20/91	-	11	-	68(11)	6
	Sweet orange	9/26/90	7	69	91	3015(5)	0
		3/13/91	10	84	100	100(<25)	0
		9/20/91	-	8	-	70(8)	51
Kanifay	Sour orange	9/26/90	6	42	98	759(10)	0
		3/31/91	10	89	5	100(<25)	0
Makay	Tangerine	9/26/90	10	63	95	354(15)	0
		3/13/91	-	-	-	100(<25)	0
		9/20/91	-	8	-	104(8)	88
Mapp	Tangerine	9/26/90	10	54	39	36(10)	0
		3/13/91	-	-	-	-	-
		9/20/91	-	6	-	31(6)	61
Ngolog	Sweet orange 1	9/20/91	-	6	-	31(6)	61
	Sweet orange 2	9/20/91	-	12	-	110(11)	66
	Tangerine	9/26/90	10	65	100	975(10)	0
		3/31/91	-	-	-	-	-
		9/20/91	-	1	-	5(1)	100
Weloy	Sweet orange	9/26/90	10	63	64	1399(6)	0
		3/13/91	9	55	42	100(<25)	0
Weloy (Degoo)	Sweet orange	9/20/91	-	3	-	8(3)	63

^z The number in a parenthesis indicate the number of infested leaves examined

^y Including the number of OSWs with parasitoid exit holes, live and dead parasitoids

dition to Kosrae and Pohnpei. On a small island like Moen, where citrus trees grow continuously without much isolation, and spread of this introduced parasitoid was fairly fast. Removal of dead OSW and sooty mold from the leaf surface was accelerated by heavy rains during typhoons and tropical storms. It is not certain at this time when and how *Encarsia* sp. found at Peniesenne in September, 1990 was introduced on the island and how effective this species is as a biocontrol agent.

Establishment of *E.smithi* was confirmed 6 months after its first release in Yap. However, Yap is a larger island than Moen and citrus trees are grown mainly within the isolated villages, which might have slowed down the rate of distribution of the parasitoid. Nevertheless, almost a year after the release date, the parasitoid was found at all sampling sites on the island and no OSW was found on the tangerine tree on which the parasitoid was initially released in Tomil (Table 2). We did not encounter any hyperparasitoids on either island.

In Micronesia, the biocontrol program of OSW has been successful. Biocontrol agent (s) were released on a total of 5 islands including Guam, Kosrae, Pohnpei, Moen, Yap. *E.smithi* was the only species released except in Guam where 4 other species were shipped from Mexico (Peterson, 1955). Biological control work on OSW in 4 other islands was conducted since 1983 by shipping adults of *E.smithi* from Guam. This species has proved to be effective in Kosrae (Nafus, 1986), Pohnpei (Muniappan *et al.*, 1992), Chuk

(Moen) and Yap in Micronesia and it could be considered as a very promising biocontrol agent for control of OSW in other parts of the world.

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