Current status of the red coconut scale, *Furcaspis oceanica* Lindinger (Homoptera: Diaspididae) and its parasitoid, *Adelencyrtus oceanicus* Doutt (Hymenoptera: Encyrtidae), in Guam

R. Muniappan, Jesse Bamba, Junard Cruz and **G.V.P. Reddy**, Agricultural Experiment Station, College of Agriculture and Life Sciences, University of Guam, Mangilao, Guam 96923, USA. Email rmuni@uog9.uog.edu

Summary

The red coconut scale (*Furcaspis oceanica* Lindinger), an introduced pest of the coconut palm (*Cocos nucifera* L.), had been present in Guam since the early 1970s. It was confined to the central region until 1987 and had spread throughout most of the island by 1996. A parasitoid, *Adelencyrtus oceanicus* (Doutt), introduced to control it in 1988/89, had also spread throughout most of Guam by 1996. A survey in January/February 2002 of 26 localities showed that the scale was present at very low levels and the parasitoid at high levels compared to a previous survey in 1996. This parasitoid is density independent and it is an effective biological control agent of the red coconut scale.

Keywords: Scale insect, *Furcaspis oceanica*, Homoptera, Diaspididae, parasitoid, *Adelencyrtus oceanicus*, Hymenoptera, Encyrtidae, coconut, biological control, Guam.

Introduction

The red coconut scale (*Furcaspis oceanica* Lindinger (Homoptera: Diaspididae)) is a native of the Caroline islands (Pemberton 1954). It was first described in the literature by Lindinger in 1909, from specimens collected at the Jaluit island in the Marshall Islands (Beardsley 1966). This scale was accidentally introduced into Guam in the early 1970s (Muniappan 1987). Until about 1987 it was found only in the central part of the island where infestations of coconut (*Cocos nucifera* L.) were quite severe. Infested coconut leaves initially appeared red to maroon due to the thick settling of the scales. As the infestation progressed infested leaves dried up and the fruits shrivelled and died (Muniappan 1987, Marutani and Muniappan 1989). By 1996 the scale was found to have spread throughout Guam except for the southern most village of Umatac (Lali and Muniappan 1996).

An encyrtid wasp, *Adelencyrtus oceanicus* (Doutt) (Hymenoptera: Encyrtidae), a known parasitoid of *A. oceanica*, collected from Ulithi and Koror, was released in Guam in 1988/89 (Muniappan and Marutani 1989). Observations that followed showed it had established (Marutani *et al.* 1992) and that its distribution was similar to its host's (Lali and Muniappan 1996).

The releases in Guam were made because the parasitoid, introduced into nearby Saipan 1948 (Doutt 1950), was found in 1987 to have established and reduced the *F. oceanica* population there to a very low level (Marutani and Muniappan 1989).

The present paper describes a survey of 26 localities on Guam in January/February 2002 to reassess the distribution of *F. oceanica* and the effectiveness of the parasitoid.

Materials and methods

Between 11 January and 7 February 2002 four 5–10 year old coconut palms were selected at random in each of 26 villages at Guam (Table 1). From each tree a 10 cm leaf length was cut at two places from a frond selected where generally high scale infestation typically occurred. These were placed in a plastic bag and brought to the laboratory where they were examined under a binocular microscope. A total of eight leaf samples were thus examined from each village to determine the number scales and *A. oceanicus* emergent holes. The data were analyzed using One-way ANOVA and means were separated by the Tukey's test. Regression coefficients were derived with total number of scales as the independent variable and the number of parasitoid holes (per cent parasitized) as the dependent variable.

Results

A total of 208 leaf samples were sampled and 54.8% of them were infested by *F. oceanica*. The population distribution of *F. oceanica* and its parasitoid in Guam is shown in Table 1. The population of *F. oceanica* was highest in the Harmon village (mean of 76.2, P=0.05) followed by Sinajana village (mean of 43.0), Malesso (mean of 25.7), Inarajan, Piti and Hagatna (means of 24.7, 20.5 and 20.5, respectively). Low population densities were recorded in all other villages listed (Tumon, Umatac,

Table 1. Mean number of scale insect, *Furcaspis oceanica* and the parasitoid, *Adelencyrtus oceanicus* at 26 villages in the island of Guam.

Village	Mean number of scales ± SD	Mean number of parasitized holes per two samples ± SD	Per cent of parasitism ± SD
Harmon	76.2 ± 77.1 a	31.2 ± 31.3 a	31.0 ± 0.2 de
Sinajana	43.0 ± 36.3 b	15.7 ± 10.7 b	30.2 ± 0.2 de
Malesso	25.7 ± 21.2 c	10.7 ± 11.3 c	0.0 ± 0.0 hi
Inarajan	24.7 ± 27.5 c	9.7 ± 9.7 cd	47.6 ± 0.1 b
Piti	20.5 ± 18.2 c	8.0 ± 9.6 cd	29.1 ± 0.2 de
Hagatna	20.5 ± 11.2 c	7.5 ± 4.5 de	34.2 ± 0.0 cd
Maite	12.5 ± 21.6 d	8.5 ± 16.3 cd	26.6 ± 0.3 f
Asan	12.5 ± 18.0 d	1.5 ± 1.7 gh	30.3 ± 0.4 de
Dededo	12.5 ± 15.8 d	4.7 ± 6.1 f	18.6 ± 0.2 g
Tumon	10.5 ± 9.5 de	4.2 ± 4.7 f	34.9 ± 0.3 cd
Umatac	9.7 ± 15.0 de	4.2 ± 6.5 f	48.4 ± 0.4 b
Tamuning	9.7 ± 18.1 de	0.0 ± 0.0 hi	0.0 ± 0.0 hi
Toto	9.5 ± 13.3 de	3.7 ± 6.1 fg	39.7 ± 0.4 c
Chalan Pago	7.7 ± 9.3 de	2.7 ± 3.7 fg	17.5 ± 0.2 g
Maina	7.5 ± 7.9 de	2.5 ± 3.3 fg	17.1 ± 0.2 g
Mong Mong	7.5 ± 5.6 de	1.7 ± 1.7 gh	26.7 ± 0.3 f
Mangilao	6.2 ± 9.2 ef	1.0 ± 1.4 gh	0.0 ± 0.0 hi
Ordat	5.2 ± 7.5 efg	1.0 ± 1.1 gh	0.0 ± 0.0 hi
Agana Heights	3.0 ± 3.5 gh	2.2 ± 3.3 fg	35.0 ± 0.4 cd
Yigo	3.0 ± 3.3 gh	0.2 ± 0.5 hi	3.1 ± 0.0 h
Yona	2.2 ± 2.2 gh	1.5 ± 1.2 gh	56.6 ± 0.4 a
Barrigada	0.5 ± 1.0 hi	0.2 ± 0.5 hi	0.0 ± 0.0 hi
Anigua	0.2 ± 0.5 hi	0.2 ± 0.5 hi	0.0 ± 0.0 hi
Agat	0.0 ± 0.0 hi	0.0 ± 0.0 hi	0.0 ± 0.0 hi
Molojloj	0.0 ± 0.0 hi	0.0 ± 0.0 hi	0.0 ± 0.0 hi
Talofofo	0.0 ± 0.0 hi	0.0 ± 0.0 hi	0.0 ± 0.0 hi
Mean ± SD	**12.7 ± 13.6**	**4.7 ± 5.2**	**20.2 ± 0.1**

Means with the same letters are not significantly different from each other (P=0.05, Tukey test).

Tamuning, Toto, Chalan Pago, Maina, Mong Mong, Mangilao, Ordat, Agana Heights, Yigo, Yona, Barrigada and Anigua) except Agat, Molojloj and Talofofo where no scale was found (Table 1).

The highest mean number of parasitoid holes in scale-infested leaves was recorded in Harmon (31.2, P=0.05, Tukey's test), followed by Sinajana, Malesso, Inarajan, Maite, Piti and Hagatna (7.5–15.7). Low mean number of holes (ranging 0.2–4.7) was found in all other villages except in Tamuning, Malojloj, Talofofo and Agat where no parasitoid emergence holes were found (Table 1). Per cent of parasitism was highest in Yona (56.6%, P=0.05, Tukey's test), followed by Umatac, Inarajan, Toto, Agana Heights, Tumon, Hagatna, Harmon, Asan, Sinajana, Piti, Mong Mong and Maiti (ranging 26.0–48.4%). A low degree of parasitism was recorded in Dededo, Chalan Pago, Maina and Yigo (ranging 3.1–18.6%). However, there was no parasitism observed in any other villages (Table 1).

There was a positive correlation between the total number of the scale and the number of parasitized scales (r^2 = 0.8901, Figure 1). The per cent parasitism was the same at low and high numbers of scales (Figure 2).

Discussion

In the 25 to 30 years following its accidental introduction into Guam in the early 1970s, the red coconut scale had spread island wide. In a previous survey of red coconut scale distribution on Guam Lali and Muniappan (1996) showed that it was present throughout the island except for the southern-most village and that populations were highest in the central part of the island. They found that the number of scales per standard leaf sample from over the entire island was high with an average scale density ranged from 106.1 to 312.7 scales per sample. They also found the introduced parasitoid had spread throughout Guam and recorded a maximum of 39.0% parasitism.

In the current survey the mean scale population density ranged from zero to 76.2 scales per sample. This indicates that the incidence of scale population has declined to a lower level mostly due to the action of the parasitoid. A maximum of 56.6% parasitism was observed indicating the steady increase in the success of the parasitoid over the last five years. As a result, there has been a considerable decline of scale population in most of the villages in Guam.

Practically no chemical control is used on Guam and the reduction in scale numbers is most likely due to the release of the parasitoid, *A. oceanicus*, in 1988/89. This is supported by the current data: the highest level of parasitism recorded in the previous survey was 39.0% (Lali and Muniappan 1996) and the maximum parasitism level recorded in January/February 2002 was 56.6%.

In the central parts of the island, Sinajana and Harmon, the mean numbers of scales were 43.0 and 76.2 respectively, the highest recorded, while no scale were found in the villages of Agat, Molojloj and Talofofo. Scale numbers were overall significantly lower in all localities per standard sample as compared to the previous survey. The parasitization was high in the southern part of the island indicating that the parasitoid population has been building up with the scale population, as this region was the last one to be infested by this scale.

Per cent parasitization remained constant at lower and higher densities of the scale population indicating that this parasitoid is density independent (Figures 1 and 2) and it effectively suppressed the population of its host 10 to 15 years after its introduction. In instances wherein immediate suppression of the pest population is warranted, the use of the insect growth regulators (IGRs) is a possibility. These are known to suppress the scale insect population and have little or no impact on the scales natural enemies. For example, when the IGR fenoxycarb (RO13-5223) was used as spray to control the citrus scale insect *Saissetia oleae* (Oliver) (Homoptera: Diaspididae), it suppressed the scale populations without affecting the normal development of parasitoid *Aphytis holoxanthus* Debach (Hymenoptera: Aphelinidae) (Peleg 1983). Likewise, when diofenolan (CGA 59205) was used to control the scale insect *Lepidosaphes beckii* (Newman) (Homoptera: Diaspididae) on citrus it did not affect the survival rate of the parasitoid *Aphelinid cales* Noacki (Hymenoptera: Aphelinidae) or other hymenopterous parasitoids, the lacewing predator *Chrysoperla carnea* Stephens (Neuroptea: Chrysopidae) or spiders (Sechser *et al*. 1994).

It is therefore concluded that the biocontrol agent, *A. oceanicus* has effectively suppressed the red coconut scale on Guam without any need for additional agents or other control methods.

Acknowledgements

We thank Dr. Prem Singh for his assistance in statistical analysis and Dr. G.R.W. Denton for reviewing the manuscript. We acknowledge two anonymous referees for their helpful comments and suggestions on the manuscript.

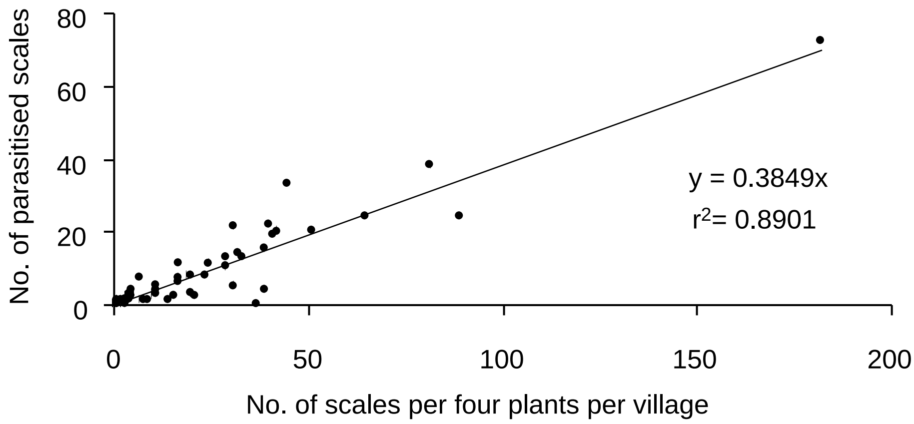

Figure 1. Correlation between the number of scales and the parasitoid holes.

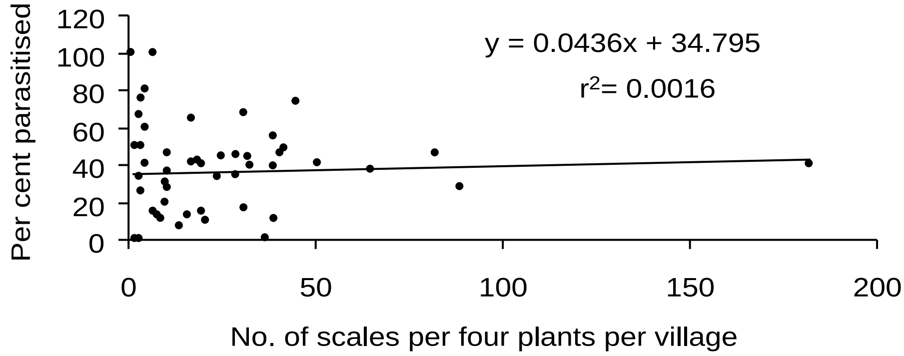

Figure 2. Correlation between the number of scales and the per cent parasitized.

References

Beardsley, J.M. (1966). Homoptera: Coccoidea. *Insects of Micronesia* 6, 377-562.

Doutt, R.L. (1950). The parasite complex of *Furcaspis oceanica* Lindinger. *Annals of the Entomological Society of America* 43, 501-7.

Lali, T.S. and Muniappan, R. (1996). Distribution of the red coconut scale, *Furcaspis oceanica* Lindinger (Homoptera: Diaspididae) and its introduced parasitoid, *Adelencyrtus oceanicus* Doutt (Hymenoptera: Encyrtidae) in Guam. *Journal of Biological Control* 10, 15-20.

Marutani, M. and Muniappan, R. (1989). Incidence of the red coconut scale, *Furcaspis oceanica* (Homoptera: Diaspididae) and its parasites in Micronesia. *Journal of Plant Protection in the Tropics* 6, 61-66.

Marutani, M., Muniappan, R. and Denton, G.R.W. (1992). Biological control of red coconut scale in Guam. *Journal of Plant Protection in the Tropics* 9, 63-67.

Muniappan, R. (1987). Status of red coconut scale in Micronesia. Fifth Regional Technical Meeting on Plant Protection, South Pacific Commission, New Caledonia, 5 p.

Muniappan, R. and Marutani, M. (1989). Biology and biological control of the red coconut scale, *Furcaspis oceanica* Lindinger. Tropical and Subtropical Agricultural Research under PL-89-106, Special Research Grants. Progress and Achievements, The Pacific Basin Group, 1989, 17-18.

Peleg, B.A. (1983). Effect of a new insect growth regulator, RO 13-5223, on hymenopterous parasites of scale insects. *Entomophaga* 28, 367-72.

Pemberton, D.C. (1954). Invertebrate Consultants Committee for the Pacific, Report for 1949-1954. The Pacific Science Board, National Academy of Sciences, National Science Council, Washington DC, 54 p.

Sechser, B., Reber, B. and Wesiak, H. (1994). Selectivity of diofenolan (CGA 59 205) and its potential for integrated scale control. Proceedings of the Brighton Crop Protection Conference, Pests and Diseases Volume 3, 1193-8.