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The effect of augmentative releases of indigenous parasitoids on populations of *Parlatoria oleae* (Colvée) (Hemiptera: Coccoidea) in olive groves in Egypt

Abstract - The aphelinid parasitoids, *Aphytis paramaculicornis* DeBach & Rosen, *A. chrysomphali* (Mercet) and *Encarsia aurantii* (Howard) (Hymenoptera: Aphelinidae) were mass reared and released at monthly intervals in olive groves infested with *Parlatoria oleae* (Colvée) at five locations in Egypt. A total of about 115,000 adult parasitoids were augmentatively released between March 2000 and Feb. 2001. Although the percentage parasitism of the scale increased in the experimental plots compared with the control plots after parasitoid release, there was no apparent reductions in the scale populations at any site. Only *E. aurantii* populations continued to increase during the months March through to September and this appeared to be the parasitoid best adapted to attack the *P. oleae* populations when they were near their peak; however, it did not become established at two of the sites. It is concluded that further augmentative releases are unlikely to improve the present biological control of *P. oleae* at any of these sites.

Key words: Armoured scale insects, biocontrol, natural enemies.

INTRODUCTION

The olive scale, *Parlatoria oleae* (Colvée) (Coccoidea: Diaspididae) is a well-known pest on deciduous, pome and stone trees and on ornamental plants in Egypt (Habib *et al.*,1971). This scale insect attacks most parts of the tree, causing wilting, branch death, defoliation and malformed growth and this leads to considerable loss in yield (Asfoor, 1997).

Many attempts to biologically control *P. oleae* using aphelinid parasitoids have been tried world-wide (Doutt, 1954; Huffaker *et al.*, 1962, 1965) and have been successful in such areas as California (Huffaker *et al.*, 1962) and Greece (Argyriou & Kourmadas, 1979). Five indigenous parasitoids have been recorded attacking *P. oleae* in Egypt (Abd-Rabou, 1997). Of these, the following aphelinids were considered to be the most effective: *Aphytis chrysomphali* Mercet, *A. paramaculicornis* DeBach & Rosen and *Encarsia aurantii* Howard.

The present paper describes some results from augmentative releases of these three indigenous parasitoids at five sites in Egypt with heavy infestations of *P. oleae* by monthly introductions. The parasitoids were initially collected from three localities, then mass reared and released at the five sites.

MATERIALS AND METHODS

Rearing: three small glasshouses were used to mass rear the parasitoids. The host plants were healthy, clean, dry squash fruits, in 50x40x40 cm cages. The parasitoid cultures were started from *A. chrysomphali, A. paramaculicornis* and *E. aurantii* collected from *P. oleae*-infested olives at El-Arish, Marsa Matruh and Northern Coast, respectively. This material included both parasitized and unparasitized *P. oleae* (2nd-instar nymphs and adult females) and was held in the laboratory until the adult parasitoids emerged.

First-instar nymphal *P. oleae* were scattered on squash fruits in the second glasshouse (27±2oC, 60±5% RH and 14:8h LD artificial light per day). Previous laboratory studies had shown that *A. paramaculicornis, A. chrysomphali* and *E. aurantii* took 21±1, 23±1 and 26±2 days respectively to develop from the time when oviposited to adult emergence under these glasshouse conditions. Prior to being parasitised, 2nd-instar nymphs and adult female *P. oleae* were mass cultured under the same glasshouse conditions and held for 32±0.5 days, until most *P. oleae* had reached the stages susceptible to parasitisation.

The *P. oleae*-infested squash fruits were then moved to the third glasshouse where the female parasitoids were released. New fruits bearing abundant 2nd instar and adult female *P. oleae* were offered to the parasitoids for oviposition at 35 day intervals.

The release sites: (i) Western Northern coast, 150 Km west of Alexandria (7–30oC; 65–75% RH); (ii) El-Arish, in North Sinai (7–32oC; 65–74% RH); (iii) Marsa-Matruh, 350 Km west of Alexandria (7–30oC; 64–72% RH); (iv) Ismailia, east of the Nile Delta (9–36oC; 56–75% RH), and (v) Fayoum, an isolated area located 110 Km south of Cairo (temperature range: 10-38.1oC; relative humidity: 53-70%).

Each site consisted of: (i) 2 experimental blocks, each consisting 40 trees, and (ii) a control block of 80 trees, situated about 600 m from the experimental blocks in the same olive grove.

Initial survey: the percentage parasitism at each site was determined prior to release in March.

Releases: the mass reared parasitoids were released at approximately monthly intervals from March 2000 to Feb. 2001. A total of about 57,000 *A. paramaculicornis*, 13,000 *A. chrysomphali* and 44,000 *E. aurantii* were released during the study period (Figs 1, 2 and 3). The small number of *A. chrysomphali* released was due to rearing

difficulties, mainly because *P. oleae* is not a specific host of this parasitoid. The actual number of parasitoids released per month depended on the populations available in the glasshouse.

The release methodology used was that advocated by Abd-Rabou (1998). Tubes containing one-day old adult parasitoids were tied to an infested portion of each release tree and the tubes opened at both ends to allow the parasitoids to emerge.

Sampling: the level of parasitism in each site was determined at 4-5 weeks intervals between April 2000 and March 2001. Samples, consisting of 30 *P. oleae*-infested leaves and 30 infested twigs (each 20 cm long) per block, were collected on the same day from both the experimental and control blocks. These were then transferred to the laboratory in well-ventilated boxes where the number of 2nd instar and adult female *P. oleae* were recorded per sample. Each sample of leaves and twigs was stored in a well-ventilated emergence container. All emerging parasitoids were identified and counted. Percent parasitism was calculated using the formula: %parasitism = (number emerging parasitoids/number hosts), assuming that only a single parasitoid emerged from each parasitised scale.

RESULTS AND DISCUSSION

Olive grove sites

(i) At the Northern Coast site, which has rather high humidity (65-75% RH), only *A. paramaculicornis* and *E. aurantii* were present prior to these releases (Fig. 1). The augmentative releases of these two parasitoids did increase their % parasitism, in the case of *A. paramaculicornis* from a peak in Jan. of about 7% in the control block to 16% in the experimental block; and for *E. aurantii* from a peak of about 44% in the control block to 71% in the experimental block. *A. chrysomphali*, which had not been present prior to their release, did appear to become established at a low level, with a peak % parasitism of nearly 11% in Dec./Jan.

(ii) El-Arish is characterized by colder and longer winters (7.5-31.6°C). All three parasitoids were present prior to the augmentative releases (Fig. 1) and there was little change in the % parasitism as a result.

(iii) Marsa-Matruh is another coastal area and, like the Northern Coast, also has quite high humidity (64-72% RH). *A. paramaculicornis* and *E. aurantii* were present prior to any releases (Fig. 2); with these two species, augmentative releases more or less doubled the % parasitism, from about just under 15% in the control block in January to well over 30% in the experimental blocks for *A. paramaculicornis*, and from nearly 35% in Nov. in the control blocks to about 60% at about this time in the experimental blocks for *E. aurantii*. *A. chrysomphali* was not present prior to their release, and the introduced populations reached about 12% in Nov. before dropping away during the winter.

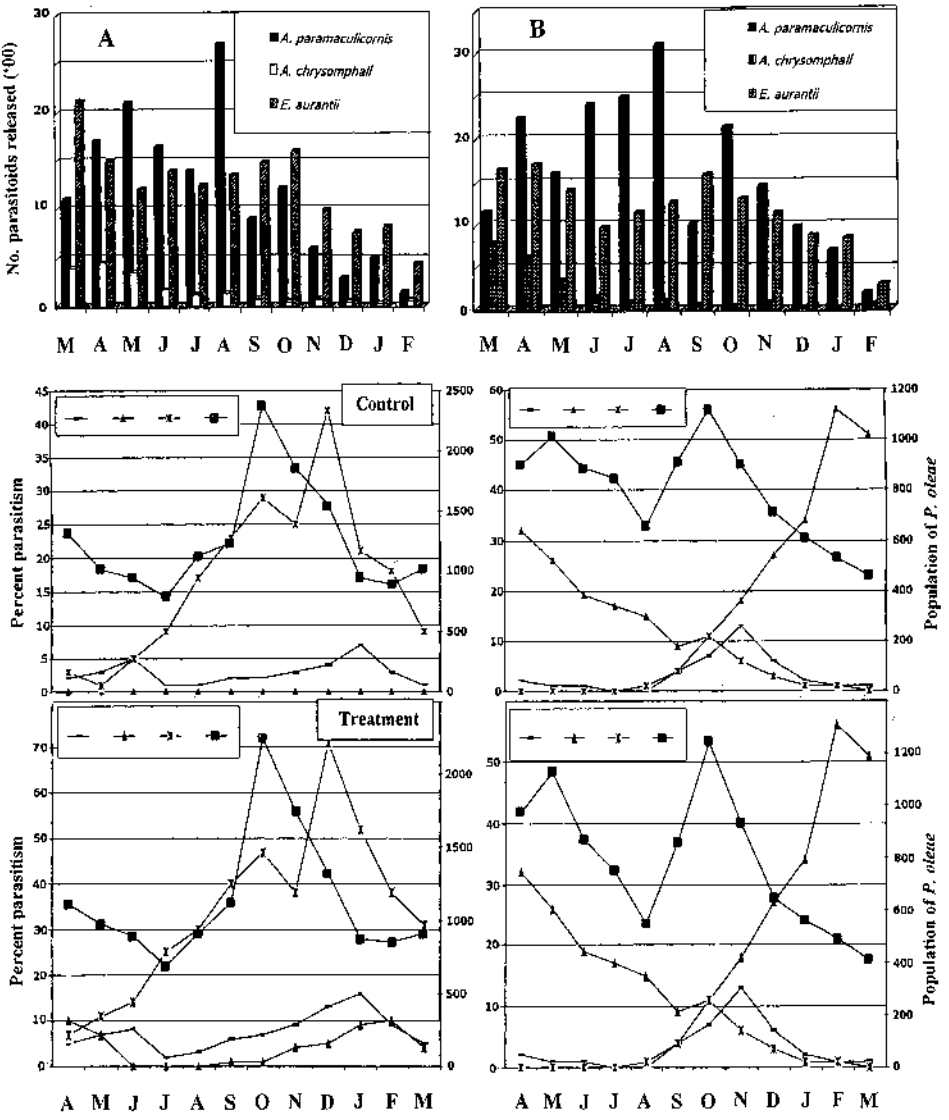

Fig. 1 - A: number of *A. paramaculicornis*, *A. chrysomphali* and *E. aurantii* released at the Northern Coast site between March 2000 and February 2001; and the number of *Parlatoria oleae* (black square), *A. paramaculicornis* (dash), *A. chrysomphali* (triangle) and *E. aurantii* (cross) from the Control block and from the Treatment blocks between April 2000 and March 2001. B: the same for the El-Arish site.

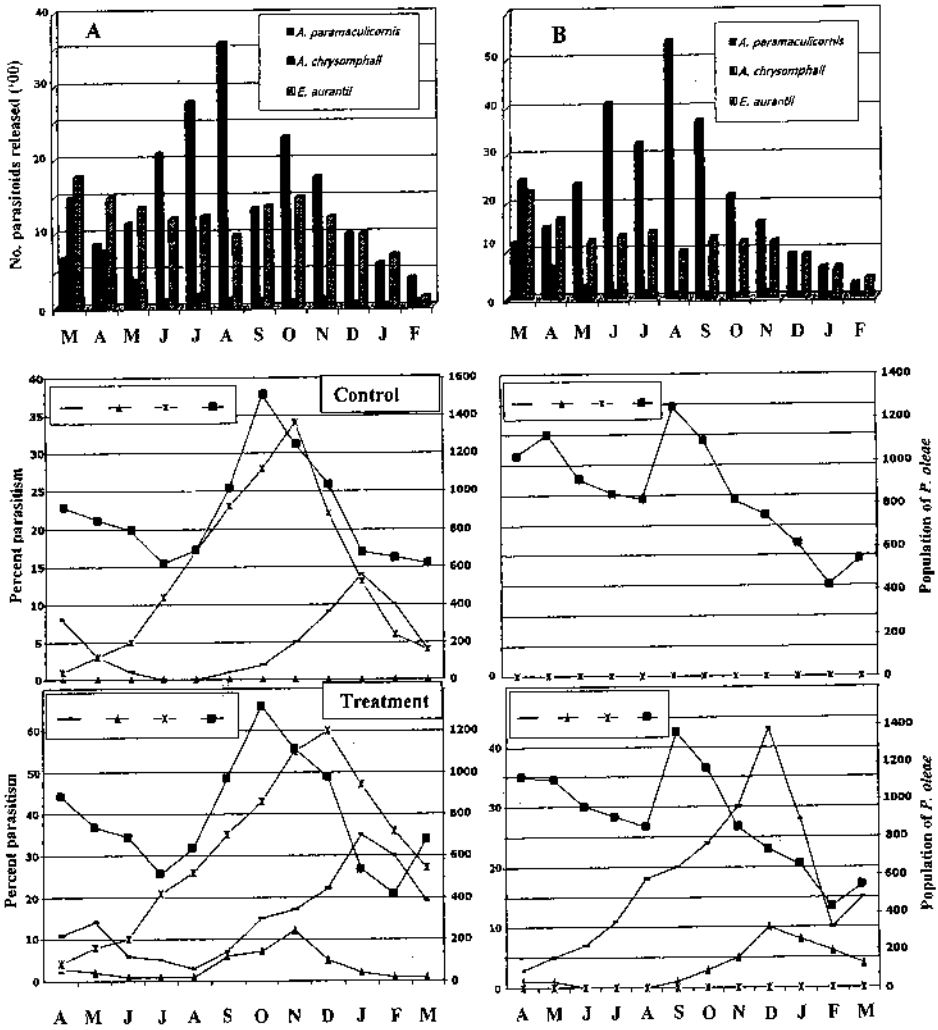

Fig. 2 - A: number of *A. paramaculicornis*, *A. chrysomphali* and *E. aurantii* released at the Marsa Matruh site between March 2000 and February 2001; and the number of *Parlatoria oleae* (black square), *A. paramaculicornis* (dash), *A. chrysomphali* (triangle) and *E. aurantii* (cross) from the Control block and from the Treatment blocks between April 2000 and March 2001. B: the same for the Ismailia site (note the complete absence of these three parasitoids prior to the experiment).

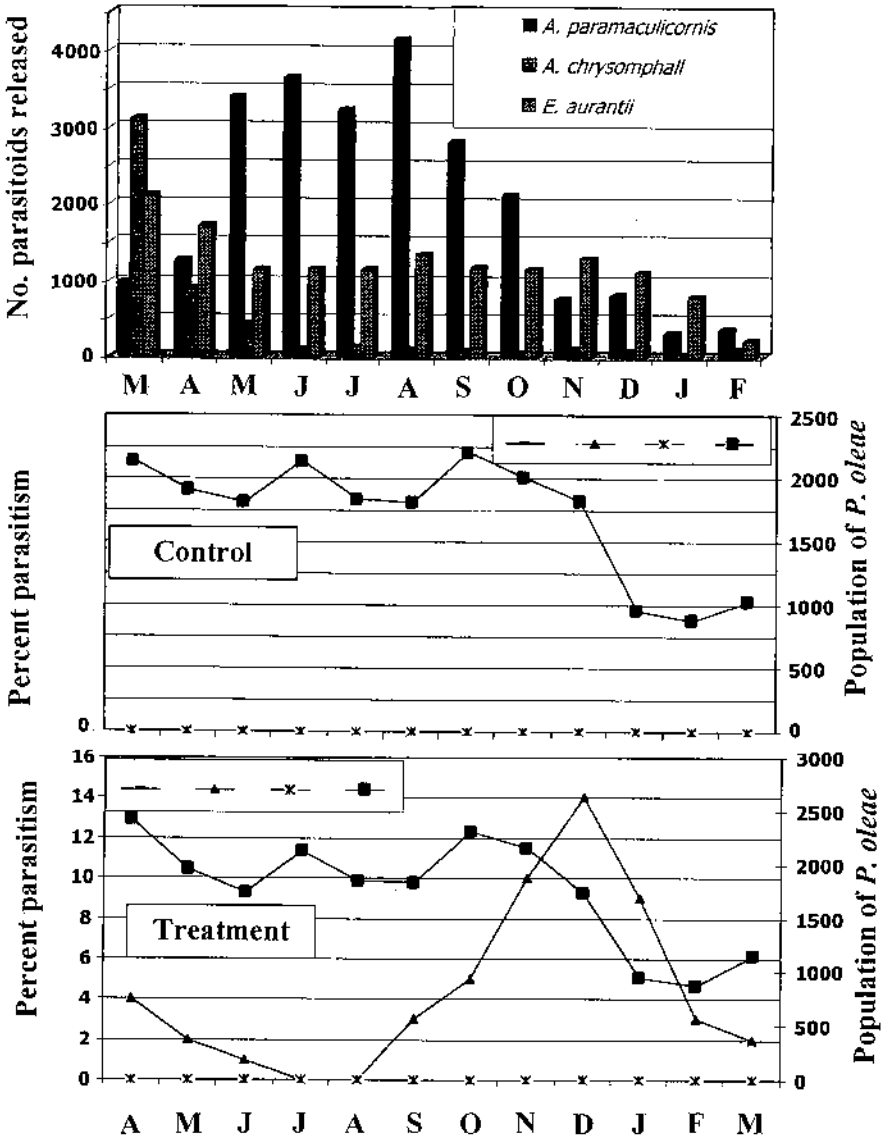

Fig. 3 - Number of *A. paramaculicornis*, *A. chrysomphali* and *E. aurantii* released at the Fayoum site between March 2000 and February 2001; and the number of *Parlatoria oleae* (black square), *A. paramaculicornis* (dash), *A. chrysomphali* (triangle) and *E. aurantii* (cross) from the Control block and from the Treatment blocks between April 2000 and March 2001 (note the complete absence of these three parasitoids prior to the experiment).

(iv) Ismailia is characterized by high humidity and mild temperature (60-75% RH and 9-36oC). None of the parasitoids were present prior to their introduction (Fig. 2). After introduction, *A. paramaculicornis* did rather well, rising to over 40% parasitism by Dec, before falling sharply through to February. *A. chrysomphali* eventually reached about 10% in Dec. despite the fact that very few were released in the letter half of the year. Despite about 1000 *E. aurantii* being released in most of the last 10 months and even larger numbers earlier, this species was never recovered.

(v) Fayoum (Fig. 5) is characterized by higher temperatures than at the other four locations (up to 38oC). As with Ismailia, none of these parasitoids were present prior to the start of the introductions. Only *A. chrysomphali* became established, despite about 15,000 *A. paramaculicornis* being introduced between June and October inclusive. *A. chrysomphali* peaked at about 14% in Dec. but then fell away to 2% in March. It seems unlikely that this species would remain established without further releases (Fig. 3).

Changes in P. oleae *populations:*

It is very noticeable that, despite the presence of these parasitoids and quite high levels of % parasitism at some times of the year, the populations of *P. oleae* in all experimental plots were remarkably similar to those in the control plots. It seems, therefore, that the release of these parasitoids into the five olive groves gave no obvious benefits in terms of control.

Changes in the parasitoid populations

(i) *A. chrysomphali*: prior to these releases, this parasitoid was only present at El-Arish. However, it did become established at low levels in all the other sites, despite only very small numbers being released each month. Only at it original established site, El-Arish, did *A. chrysomphali* peak at more than about 10% parasitism, reaching about 55% in Feb. In the other sites, it was present only in very low numbers during approximately June-Aug, but then increased to a peak of about 12-15% between Nov. and March, depending on the site.

(ii) *A. paramaculicornis* was present at three of the sites (Northern Coast, El-Arish and Marsa Matruh) prior to these releases. At the other two sites, it failed to become established at Fayoum (despite the large numbers released there) but did become established at Ismailia, where it became the dominant parasitoid, peaking at over 40% parasitism; at the Northern Coast and El-Arish sites, this species only reached a % parasitism of about 15% or less, although it did reach 35% at Marsa Matruh. Like *A. chrysomphali*, *A. paramaculicornis* was only present in low population during June to Sept., with a single peak between Nov. and Dec.

(iii) *A. aurantii* was not present at Ismailia or Fayoum prior to the releases but, unlike *A. paramaculicornis*, *E. aurantii* did not become established at either site. At the Northern Coast and Marsa Matruh sites, this was the dominant parasitoid species, peaking at over 35% even in the control plots. At El-Arish, it only peaked at perhaps

15%. At Northern Coast and Marsa Matruh, the populations were low at the start of the observations, but then rose steadily (even through June-Aug.) to a single peak about Dec. before falling off rapidly.

Relationships of parasitoid populations with those of P. oleae*:*

P. oleae had two population peaks (in April/May, and Oct.) at all sites except Fayoum, where it may have had three (April, July and October). The largest peak at all sites tended to be between Oct. and Dec., the exact month depending on the site. Of the parasitoids studied here, only *E. aurantii* appeared to be really adapted to changes in the *P. oleae* populations, the parasitoid populations peaking soon after those of the host scale.

Interactions between parasitoid species

It is noticeable that only a single parasitoid species was dominant at each site and that this was not changed by the augmentative releases. When *E. aurantii* was present, *A. paramaculicornis* was only present in low numbers (Northern Coast, El-Arish and Marsa Matruh). However, at Ismailia (where none of these three parasitoids were detected prior to their introduction), *E. aurantii* did not become established and here *A. paramaculicornis* became the dominant parasitoid. Prior to the releases, *A. chrysomphali* was only present in low numbers at Northern Coast, but was the dominant parasitoid at El-Arish, even in the presence of both the other species; it was the only parasitoid to become established at Fayoum. It would appear that the factors affecting these interactions are complex and require further study.

CONCLUSIONS

From the data presented here, it would appear that the augmentative releases tried here had little or no effect on the *P. oleae* populations, despite the apparent high % parasitism noted above. The use of augmentative releases of any of these parasitoid species does not, therefore, seem to be the best method to control *P. oleae* in olive groves in Egypt. Although there have been successful attempts to biologically control *P. oleae* using the aphelinid parasitoids (Doutt, 1954; Huffaker *et al.,* 1962, 1965), the lack of any effect in these trials may be because the three aphelinid species are all indigenous.

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