

## **Parasitoids of the Heart-Shaped (Pyriform) Scale. *Protopulvinaria pyriformis* (Cockerell) (Hemiptera: Coccidae) on Avocados in South Africa**

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**Abstract.** The susceptibility of the various stages in a field population of the heart-shaped scale *Protopulvinaria pyriformis* (Cockerell) to parasitoids was investigated at biweekly intervals over a period of one year. Parasitism for the different instars varied, e.g., up to 70% parasitism was recorded in the adult female stage, whereas only 4% was recorded for the second instar. A 7% parasitism of the third instar occurred during the first generation (February) and 20% during the second generation (October). Up to 25% of all stages in the total population, except the first instar of the scale, were parasitized. The parasitoid species, probably *Metaphycus galbus* Annecke, *M. helviolus* Compere and *M. Stanleyi* Compere, played a major role and were responsible for approximately 64% of the total parasitism in this study, while *Coccophagus* and *Tetrastichus* spp. accounted for the remainder.

The heart-shaped or pyriform scale *Protopulvinaria pyriformis* (Cockerell) was discovered in Natal in 1916 (Brain, 1920) and has since become a minor pest of avocados in South Africa. It was also found to occur on guavas, citrus and various ornamentals (De Villiers, 1981). The heart-shaped scale is presently found in South and North America, Africa and the Mediterranean countries. Wysoki (1987) noted that it was a serious pest on avocados in Israel. This scale feeds mainly on the ventral side of avocado leaves and excretes honeydew, which settles on the lower leaves and fruit. Sooty mold develops on the honeydew, which causes a black coating on the fruit and leaves. This inhibits photosynthesis and leads to leaf drop, which can cause a crop reduction (Du Toit and De Villiers, 1988). The seasonal occurrence of the different stages of this scale was observed by De Villiers (1989). He found that two generations occurred per year. During the past seven years, the heart-shaped scale has developed into the most important pest on avocados in South Africa. The reason for this pest build up is as yet unknown. The aim of this study was to investigate the parasitoid complex of this insect. Robertson and De Villiers (1986) reported that various parasitoid species as well as two predatory beetles can control the scale population well.

### **Materials and Methods**

A biweekly population survey was carried out in a 25-year-old avocado orchard, cultivar Fuerte, at Woodhouse, Nelspruit, (30° 50' E and 25° 27' S). During each survey,

approximately 15 to 25 scale-infested leaves from a block of 25 data trees were collected. All the scale on each leaf were examined and separated according to their stage of development and physical condition, i.e., alive, dead or parasitized. Parasitized individuals were further divided into larvae, pupae and emerged adult parasitoids. Every parasitized individual was removed and placed in a gelatin capsule for adult emergence. Seven morphological stages of the scale were defined, namely: crawler, first instar, second instar, third instar, A- female, ring stage and A+ female. As a result of the short development period of certain stages, the development period of the scale was divided into four stages, namely: the first instar which includes the crawlers, the second instar, the third instar which includes mature, unsclerotised, females without eggs (A- stage) and finally the ring stage plus the mature, sclerotised females with eggs (A+ stage). The survey, which was carried out on the spring flush, started in January, 1989, and ended in October, 1989, when the leaves started to drop.

## Results

The parasitoids, which have not yet been identified to the species level, are divided into four groups; namely, group A, *Metaphycus* spp. A (Encyrtidae); group B, *Metaphycus* spp. B; group C, *Coccophagus* spp. (Aphelinidae) and *Tetrastichus* spp. (Eulophidae) and group D, *Marietta* spp. (Aphelinidae). Groups A to C are primary parasitoids while group D are secondary parasitoids which attack the primary parasitoids (Prinsloo, 1984). The heart-shaped scale and its parasitoids are divided into the different development stages, and will be discussed in that manner.

The First Instar. The survey of the first instar of the second generation heart-shaped scale showed a peak of 30 days from early April to early May (Fig. 1). No parasitism was found in this instar, possibly because the individuals of the first instar are too small to be parasitized by the parasitoids.

The Second Instar. The second instar of the second generation occurred from the beginning of April to the middle of October (Fig. 2). The first generation ended at the end of March. The second instars of the first and second generation overlapped in such a way that second instars were always present.

Parasitism of 3% and less was found in the second instar. Group C parasitoids were dominant during the entire second generation peak and represented 82.8% of the parasitism (Fig. 3), while group A parasitoids represented the other 17.2%. A definite parasitoid peak followed each instar's peak. (Fig. 2).

The Third Instar. The third instar individuals of the first generation were present from January to the first week in April, with a peak occurring in the third week of February (Fig. 4). The second generation's third instar occurred from the middle of June until November. A gradual accumulation of parasitoids was noticed from the middle of January and reached a peak of 44% at the beginning of May (Fig. 4). Initially groups A and C were dominant but were gradually overshadowed by group B (Fig. 5). Parasitism during the second generation later in 1989 was very low (3%) and only started

increasing from the third week in September (Fig. 4). During this period, group C was most prominent (up to 85.7%) while group B decreased gradually. The hyperparasitoid *Marietta* spp. (group D) increased from the third week in September until the middle of October to approximately 30% of the total parasitism.

The Mature Female (A +). The A+ stage extended from the last week in February to the middle of June (Fig. 6) and was followed by a gradual increase in parasitism to 70% in the middle of May. High parasitism of 40% to 100% was recorded from middle June to the end of September, but the A+ females comprised less than 2% of the population during this period. This parasitism, therefore, had little influence on the scale population. As far as the relationship between the different parasitoids is concerned, group A represented 35% to 40% of the parasitism at the beginning of the A+ stage, but decreased rapidly later (Fig. 7). Group B was initially responsible for approximately 40% of the parasitism which doubled in early May. Group C played a minor role, except at the end of the A+ stage in May, where it represented 50% of the parasitism. The hyperparasitoid *Marietta* spp. (group D) did not have an influence in the beginning, but increased gradually to 50% at the end of this period. The parasitism of the total scale population, with exception of the first instar, can be seen in Fig. 8. Approximately 2000 individuals per sample were examined.

At the end of the experiment, the scale population averaged approximately 225 individuals/leaf. The excessive excretion of honeydew and sooty mould which developed on it caused mainly the lower half of the trees to appear black.

## Conclusions

The complex of the parasitoids of the heart-shaped scale changes in conjunction with the developmental stage of the host and the season. No parasitoid group played a dominant role during the entire season. The *Metaphycus* groups A and B, which were dominant during late summer and autumn during the first generation scale, were mostly replaced in winter by *Coccophagus* and *Tetrastichus* group C. This parasitoid complex, which parasitized up to 25.2% of the total scale population during autumn, did not have the ability to reduce the host's numbers effectively during this trial. *Marietta* spp. has a negative influence on the parasitoid complex.

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## Literature Cited

- Brian, C.K. 1920. The Coccidae of South Africa. Bulletin Entomological Research 11:1-42.
- De Villiers, E.A. 1981. Hartvormige dopluis op avokado's. H.4. Farming in South Africa.

- De Villiers, E.A. 1989. Seisoensvoorkoms van verskillende stadia van die hartvormige dopluis op avokado's. S.A. Avocado Growers'. Assn. Yrbk. 12:58-59.
- Du Toit, W.J. and E.A. De Villiers. 1988. Die hartvormige dopluis, *Protopulvinaria pyriformis* (Cockerell) op avokado's. S.A. Avocado Growers'. Assn. Yrbk. 11:79-80.
- Prinsloo, G.L. 1984. An illustrated guide to the parasitic wasps associated with citrus pests in the Republic of South Africa. Science Bulletin, Dept. of Agriculture, Republic of South Africa. 402:1-119.
- Robertson, C.M. and E.A. De Villiers. 1986. Parasites of avocado pest bite the dust. Information Bulletin no. 168, CSFRI, Nelspruit, South Africa, p.9.
- Wysoki, M. 1987. A bibliography of the pyriform scale *Protopulvinaria pyriformis* (Cockerell), 1894 (Homoptera: Coccidae), up to 1986. Phytoparasitica 15:73-77.

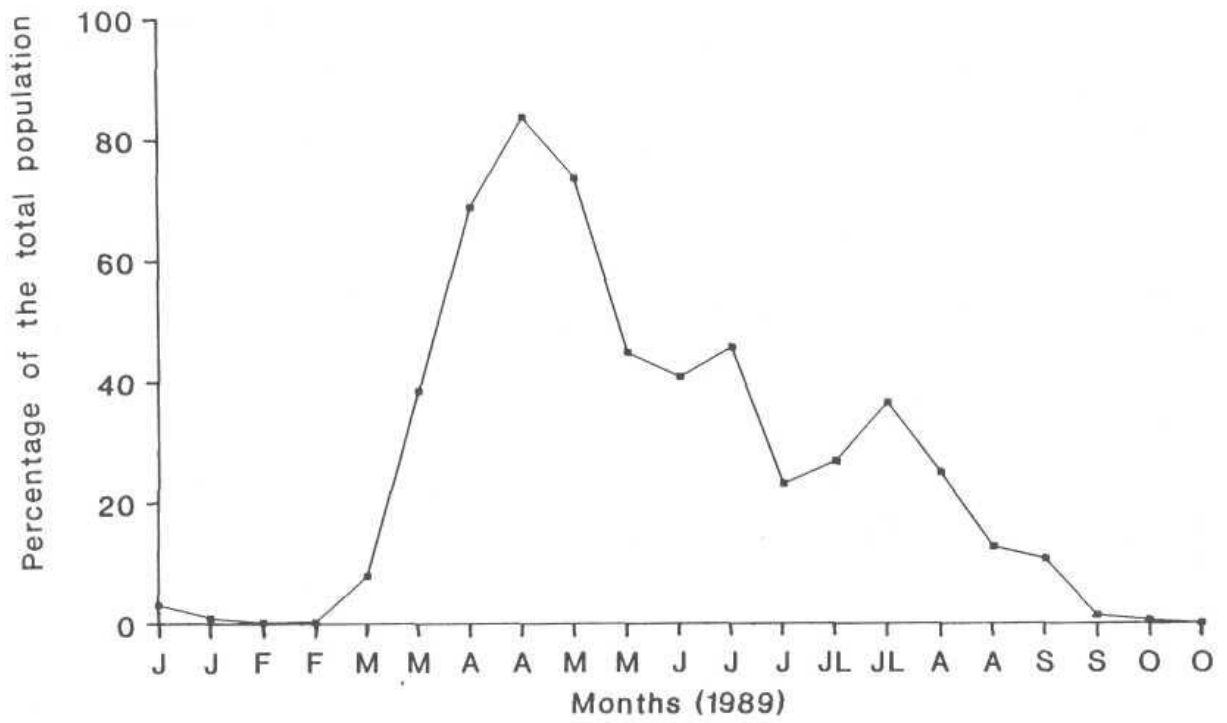


Fig. 1. The occurrence of the first instar nymphs of the heart-shaped scale.

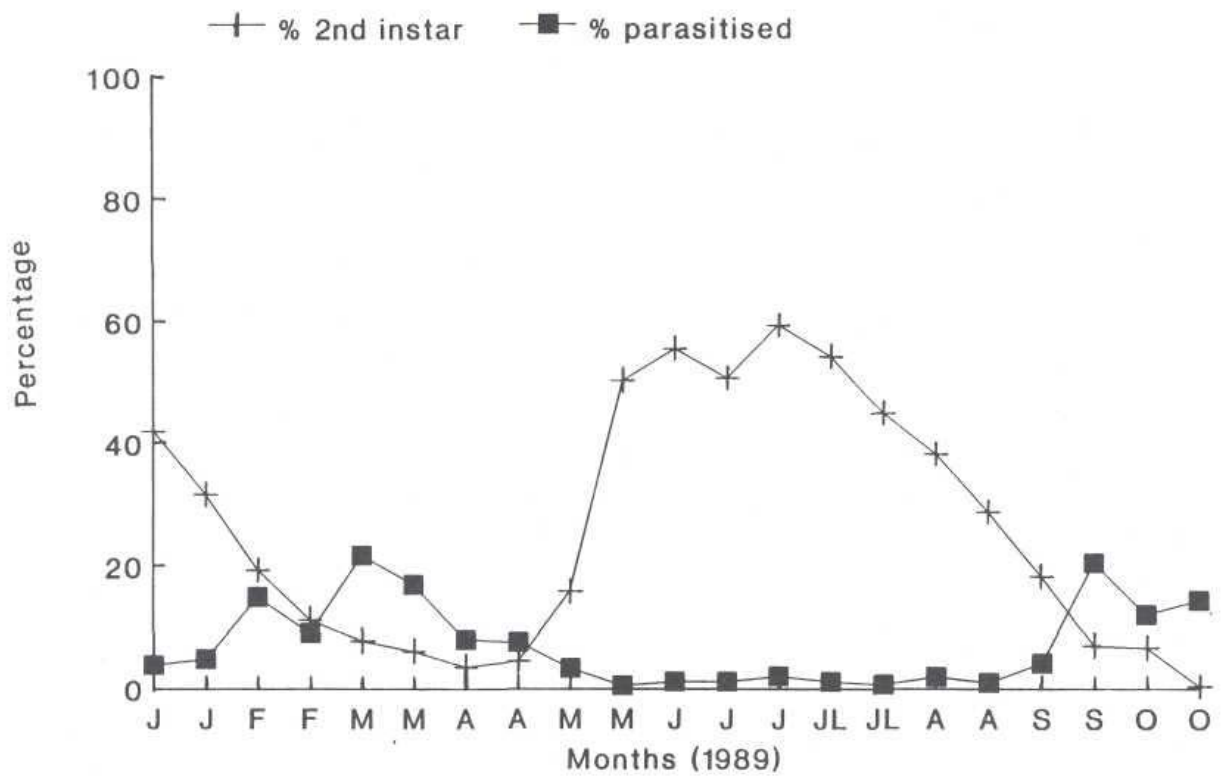


Fig. 2. The occurrence of the second instar nymphs of the heart-shaped scale as a percentage of the total population and the percentage parasitized.

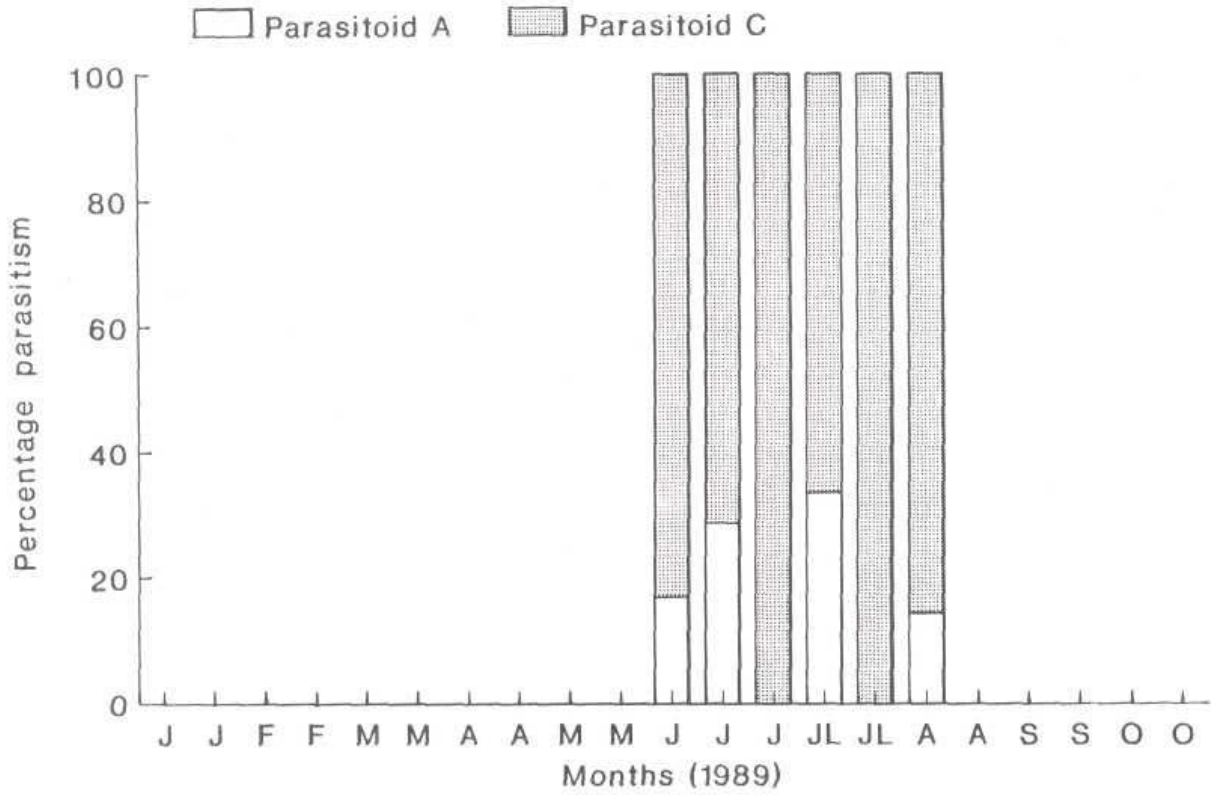


Fig. 3. The relationship between the parasitoids which were found in the second instar nymphs of the heart-shaped scale.

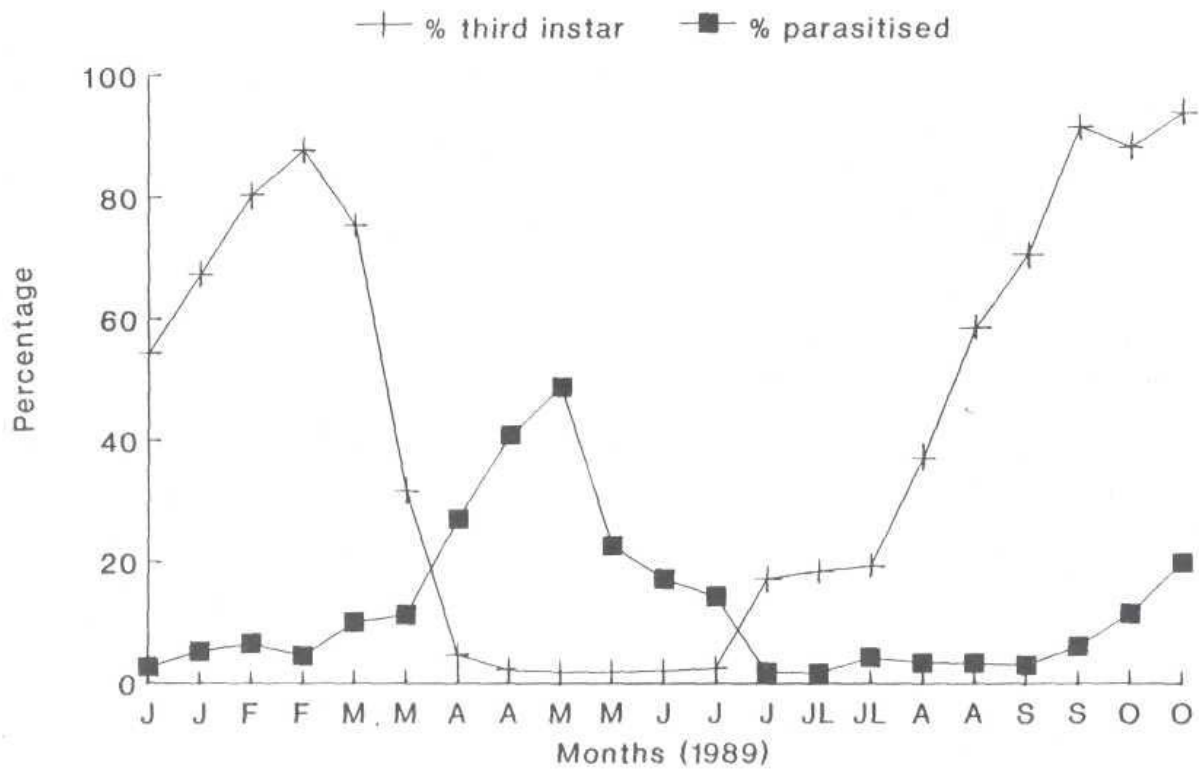


Fig. 4. The occurrence of the third instar nymphs of the heart-shaped scale as a percentage of the total population and the percentage parasitized.



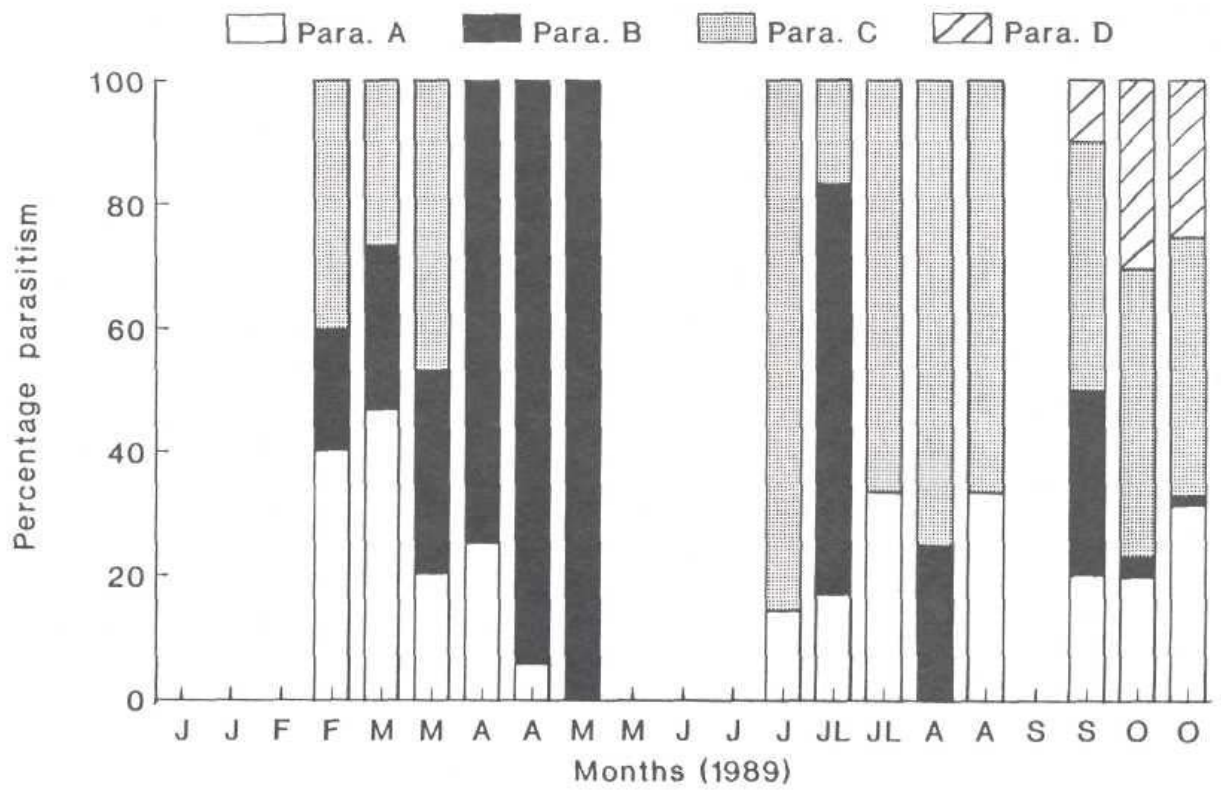


Fig. 5. The relationship between the parasitoids which were found in the third instar nymphs of the heart-shaped scale.

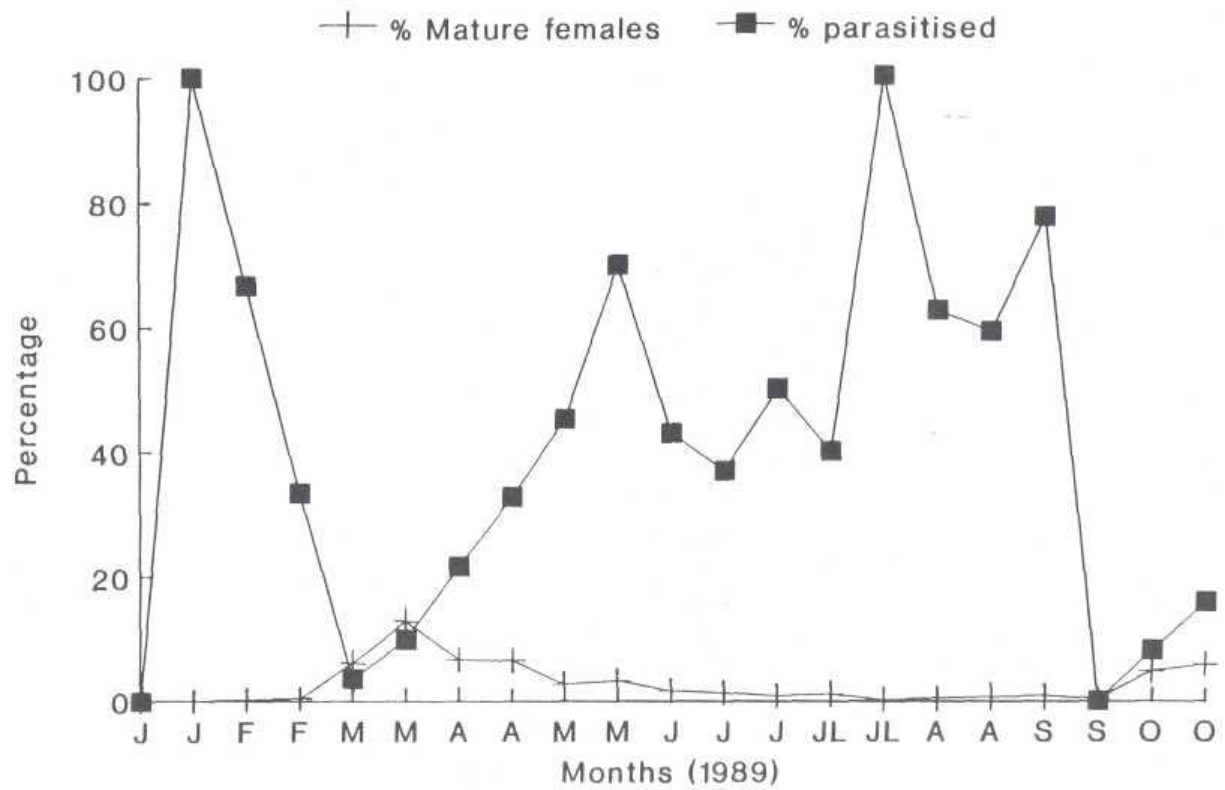


Fig. 6. The occurrence of the mature females (A +) as a percentage of the total population and the percentage parasitized.

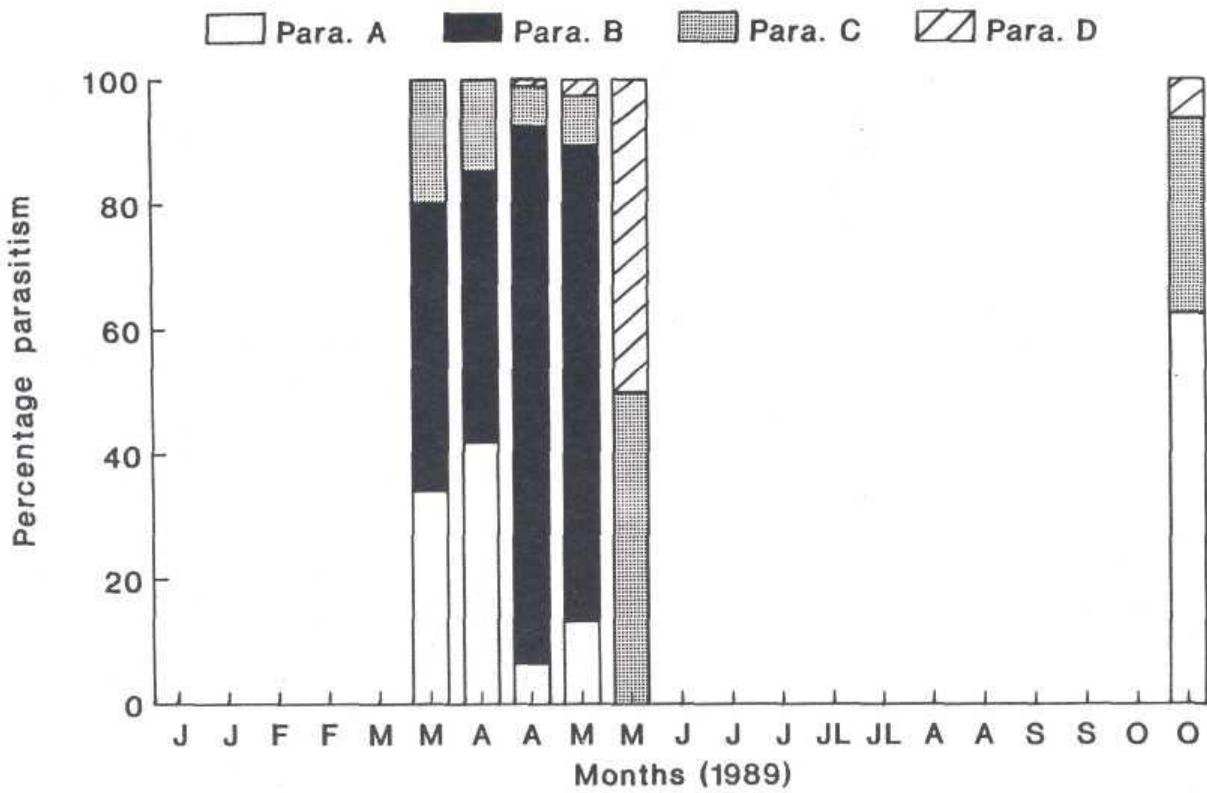


Fig. 7. The relationship between the parasitoids which were found in the mature females of the heart-shaped scale.

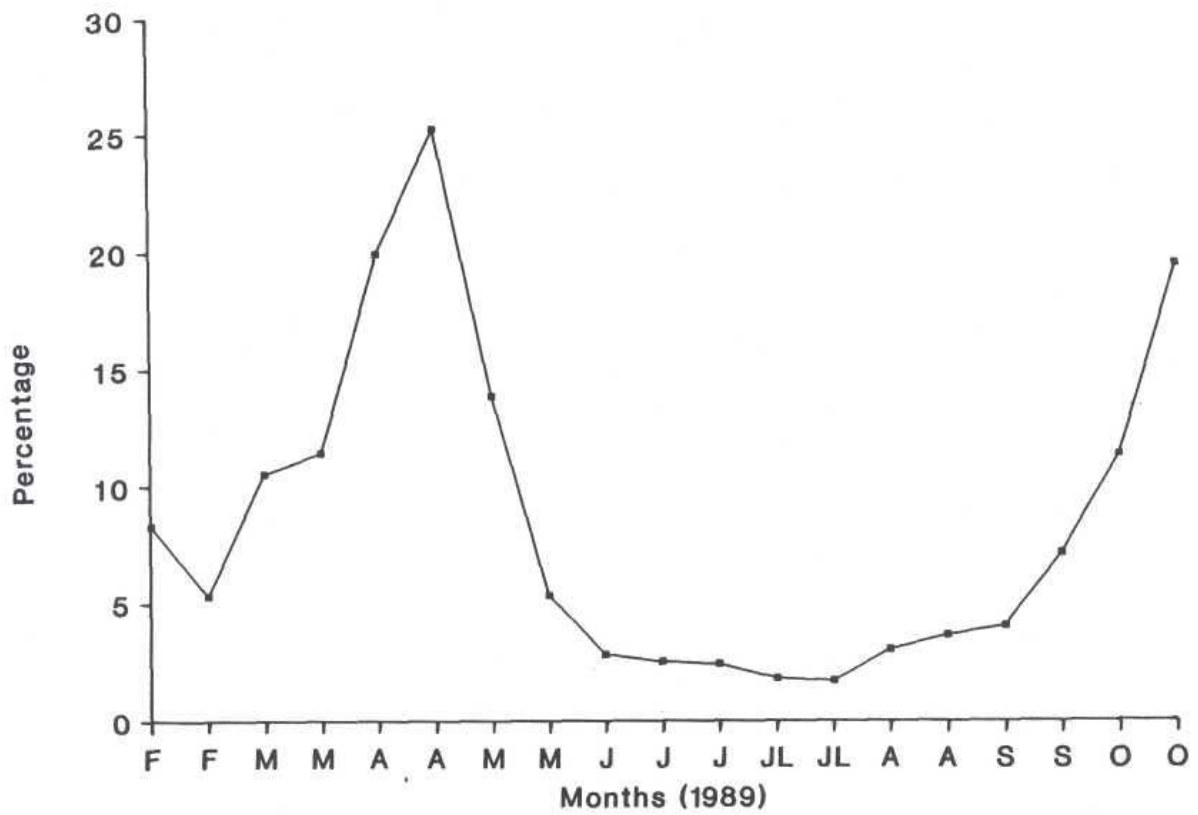


Fig. 8. Percentage parasitism of the total population during the season with exception of the first instar (n = 2000).