

## THE ROLE OF IMPORTED NATURAL ENEMIES IN SUPPRESSING RE-GROWTH OF PRICKLY PEAR, *OPUNTIA FICUS-INDICA*, IN SOUTH AFRICA

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### ABSTRACT

A cohort of 500 small prickly pear plants was followed for three years for life table analysis. The mortality of whole plants and of individual cladodes was monitored. More of the larger plants were infested with *Cactoblastis cactorum* but mostly small plants were killed: *Dactylopius opuntiae* was less effective in suppressing re-growth but its relative importance may change during drier seasons. Implications for the biological and chemical control of this weed are discussed.

### INTRODUCTION

Life table studies on insect populations are well known. Their aim is to measure mortality at each stage of the life cycle and to identify the main causes of this mortality. We know of no cases where life tables have been constructed for a weed with the express purpose of assessing the importance of its insect enemies, although Dempster and Lakhani (1979) have modelled the interactions between the cinnabar moth and ragwort. In this paper we report on the contribution of two natural enemies, *Cactoblastis cactorum* (Berg) and *Dactylopius opuntiae* (Cockerell), to mortality in a population of young prickly pears, *O. ficus-indica*, using a partial life table technique for our assessment.

Opuntias are ideal for life-table studies: (i) the plants are simple and well defined and their cladodes easily counted; (ii) only two insects, both imported natural enemies, *C. cactorum* and cochineal, kill significant numbers of *O. ficus-indica* in South Africa (Annecke and Moran 1978); and (iii) the symptoms of attack by each of these natural enemies are distinct and easily recognizable.

We started in 1977 with a cohort of 500 small prickly pear plants at three sites in the Eastern Cape province of South Africa. We examined them at three monthly intervals for three years and recorded plant growth and the causes of mortality of whole plants and of individual cladodes (Zimmermann and Malan 1980). The East Cape was previously the focus of biological control against prickly pear when an estimated 75 per cent of the original 900 000 ha of dense prickly pear was reclaimed through the action of cochineal supplemented by *C. cactorum* and aided by mechanical felling of the remaining woody stems in some areas (Annecke and Moran 1978). Our study sites were previously heavily infested with prickly pear and the plants in our cohort are a typical part of the residual infestation of prickly pears in these areas.

### RESULTS

The size distribution of the 500 plants in the original cohort is shown in Figure 1. The plants were divided into three categories (plants with 1 to 5, 6 to 10, and >10 cladodes) and this categorization was used in the following analysis.

Figure 2 shows the total percentage of prickly pear plants killed over three years and the causes of this mortality. Overall mortality is inversely related to plant size and *C. cactorum* killed the greatest percentage of small plants.

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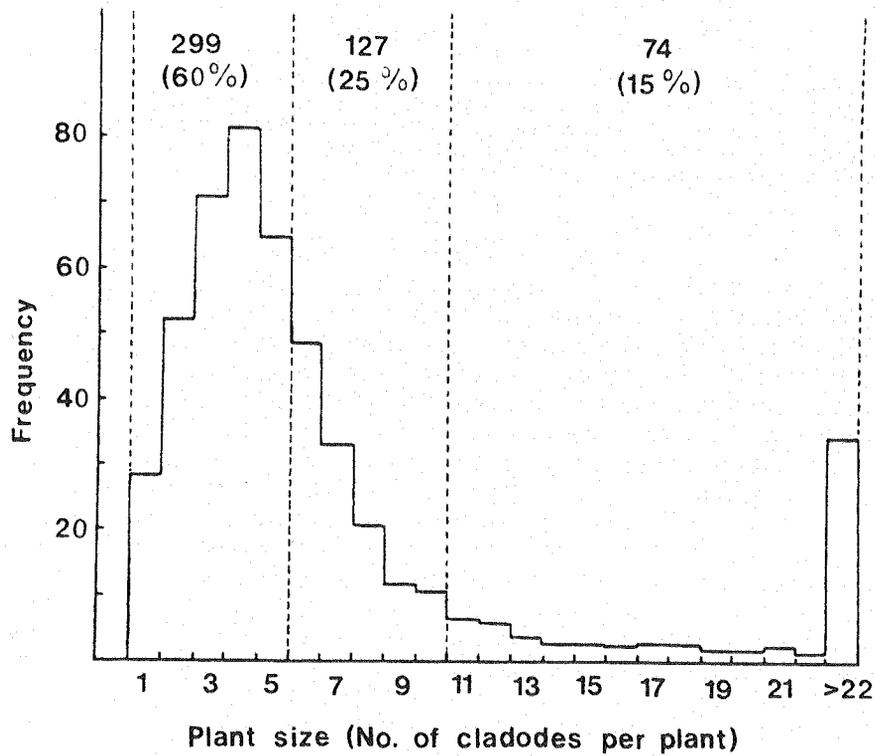


Figure 1. Size distribution of the cohort of 500 *Opuntia ficus-indica* plants. The population was arbitrarily divided into three size categories (broken lines): the number and percentage of plants in each size category is shown.

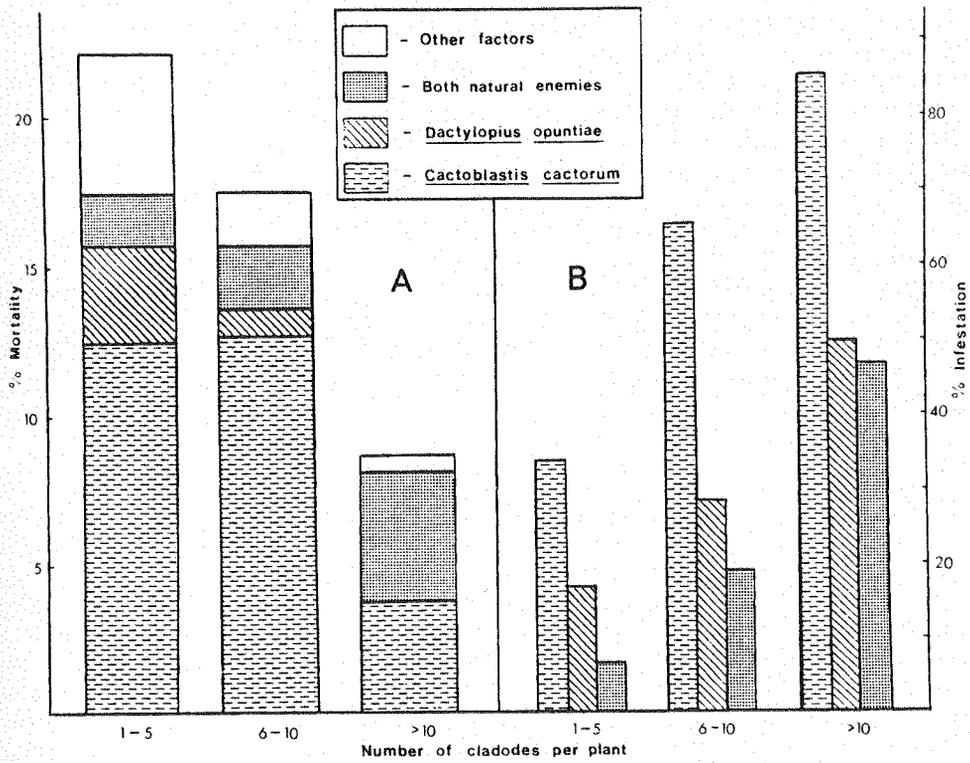


Figure 2. Percentage mortality (A) and percentage insect infestation (B) of *Opuntia ficus-indica* plants in three size categories.

Cochineal was a significant mortality factor only on the smallest plants and the combined action of both natural enemies becomes increasingly important in larger plants. The relative importance of *D. opuntiae* would be expected to increase during drier years (Petty 1948). Cattle and porcupines (*Hystrix africae-australis* Peters) contributed to mortality from 'other' causes and affected mostly the smaller plants.

The percentage infestation by each of the natural enemies individually, and combined, is shown in Figure 2B. This shows that the percentage infestation by *C. cactorum*, *D. opuntiae*, and by both natural enemies together, increases with plant size, for as the plants age, more of them become infested. But large plants, especially those with woody stems, are more tolerant of insect attack and loss of cladodes, and fewer die from these causes (Figure 2A).

Because *C. cactorum* is the dominant mortality factor among small prickly pear plants, we evaluated the role of this species in more detail. Figure 3 confirms that the percentage infestation of *O. ficus-indica* increased with plant size while percentage mortality decreased with plant size. Plants with more than 14 cladodes were never killed by *C. cactorum*.

Mortality of individual cladodes, caused by *C. cactorum*, on the experimental plants is shown in Figure 4. It is the winter generations of *C. cactorum* that caused the greatest loss of cladodes (about 85 per cent): the summer generation killed relatively few cladodes and this pattern was consistent over the three year study period.

## DISCUSSION

This evaluation of *O. ficus-indica* mortality helps to explain the outcome of the biological control campaign against prickly pear and provides some insight for the integrated control of *O. ficus-indica* in South Africa.

(i) When *C. cactorum* was first introduced into South Africa against the large, established infestations of *O. ficus-indica*, the species had limited impact and it was the cochineal, *D. opuntiae* that was the most impressive biological control agent. Our results show that *C. cactorum* cannot kill *O. ficus-indica* plants that have more than 14 cladodes. The plants on which they were released originally were considerably larger than this and it is not surprising that their effect was not spectacular. Further, very few colonies of *C. cactorum* are to be found on large *O. ficus-indica* plants in the field today. There is every indication that adult females ignore large plants as oviposition sites.

(ii) The pest prickly pears in Australia are much smaller plants than *O. ficus-indica* and more susceptible to *C. cactorum* attack. This must in part explain the dramatic and well known results of the biological control campaign there.

(iii) Our results, based on partial life tables for the plant, have indicated a high mortality of *C. cactorum* between the winter and summer generations. This is due to mortality in the late larvae and pupae of *C. cactorum* at the end of winter and this aspect is now under investigation.

(iv) *C. cactorum* is very effective at reducing residual populations of *O. ficus-indica* plants and kills many plants that have fewer than 14 cladodes. Herbicidal control of prickly pear should be confined only to large plants; natural enemies seem to be coping adequately with the smaller plants.

Our results suggest that partial life tables of plant populations can provide a valuable method of evaluating the effects of natural enemies in the biological

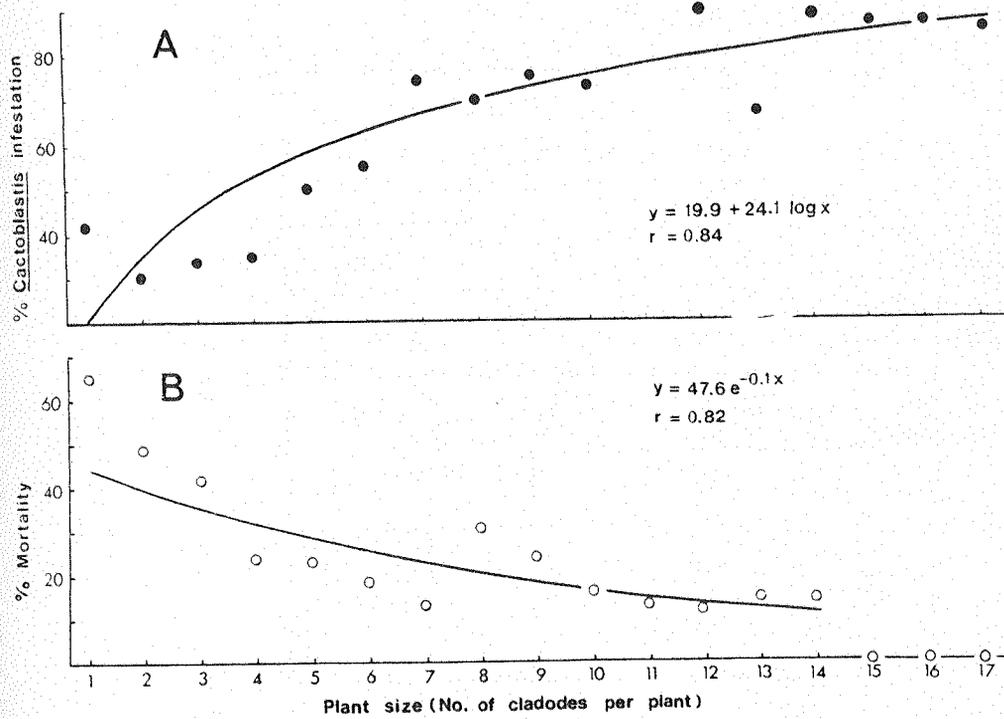


Figure 3. Percentage *Cactoblastis cactorum* infestation (A) and percentage mortality (B) of *Opuntia ficus-indica* plants of different sizes.

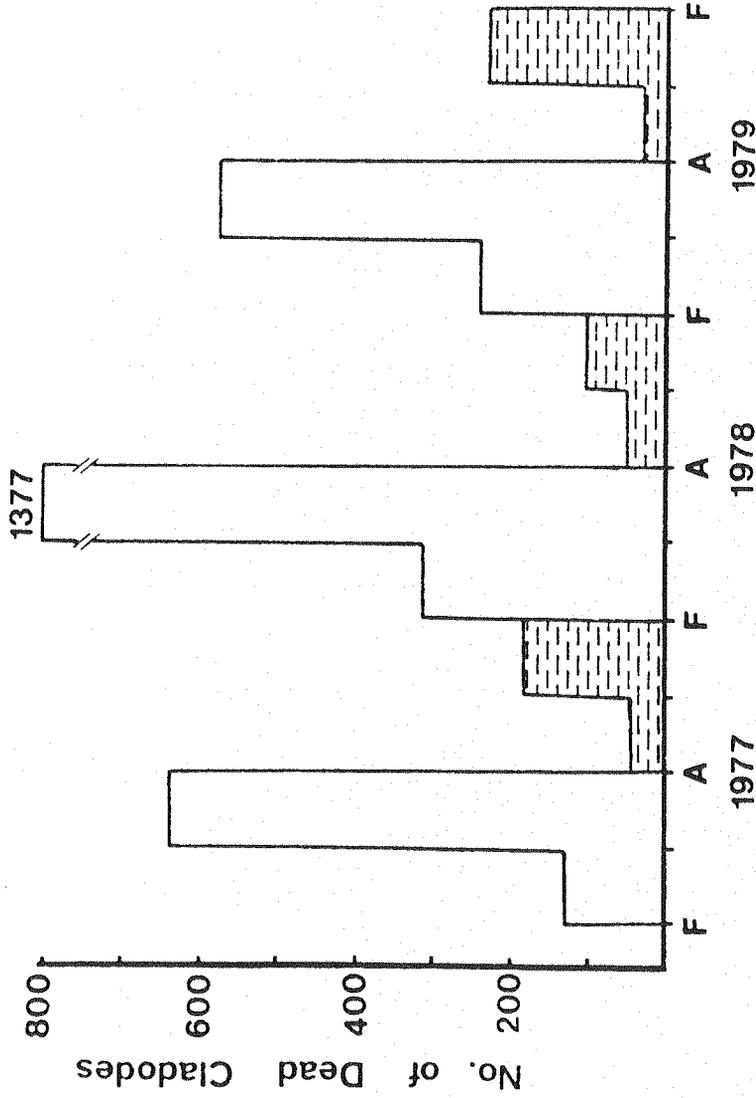


Figure 4. The number of cladodes of *Opuntia ficus-indica* destroyed by winter, and summer (diagonal lines) generations of *Cactoblastis cactorum*. F—February, A—August.

control of weeds. We are continuing these studies and aim at a complete life table budget for *O. ficus-indica* which will indicate whether populations of prickly pear in the East Cape are increasing or decreasing. Further plans for extending biological control, or for further integration of chemical and biological control of prickly pear, will be based on these findings.

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#### REFERENCES

- Annecke, D.P. and Moran, V.C. (1978). Critical reviews of biological pest control in South Africa. 2. The prickly pear, *Opuntia ficus-indica* (L.) Miller. *J. Ent. Soc. S. Afr.* 41:161-88.
- Dempster, J.P. and Lakhani, K.L. (1979). A population model for cinnabar moth and its food plant, ragwort. *J. Anim. Ecol.* 48:143-63.
- Pettey, F.W. (1948). The biological control of prickly pears in South Africa. *Sci. Bull. Dept. Agric. Fores., Union S. Afr.* 271:1-163.
- Zimmermann, H.G. and Malan, D.E. (1980). Present status of prickly pear (*Opuntia ficus-indica*) (L.) Mill. control in South Africa. Proc. 3rd Nat. Weeds Conf. S. Afr., Pretoria, 1977, pp.79-85.