THE SUCCESSFUL BIOLOGICAL CONTROL OF HARRISIA CACTUS (*ERIOCEREUS MARTINII*) IN QUEENSLAND

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Summary. Between 1974 and 1978, four species of insects from South America were introduced into Queensland against Harrisia cactus *(Eriocereus martinii)*. Three of these, a mealybug *(Hypogeococcus festerianus)*, a stem-boring cerambycid beetle *(Alcidion cereicola)*, and a stem-boring weevil *(Eriocereophaga humeridens)*, have established in the field.

The mealybug has proved unexpectedly damaging and large areas of cactus are dying after two to three years of heavy mealybug attack. The use of chemicals has been suspended in favour of manual distribution of the mealybug, and successful biological control is considered to have been achieved.

INTRODUCTION

Harrisia cactus is a native of Argentina and Paraguay and was introduced during the 1890's to Queensland, where it has since become a serious weed. In the Collinsville district, 68 000 ha are infested in a total of 3 000 000 ha, and there are smaller infestations at Rockhampton and Dingo, and at Gatton, Greenmount, Ipswich and Goondiwindi in Southern Queensland. Near Millmerran, there is a small infestation of a related species *Eriocereus tortuosus*, also referred to as Harrisia cactus.

A major control scheme using chemical and mechanical means was established by the State Government in 1951. A 3 year biological control programme to find, study, and introduce suitable insects into Australia was initiated in 1973, financed by the Queensland Government and undertaken by the Commonwealth Institute of Biological Control. Preliminary results were reported at a previous conference (McFadyen and Tomley 1978); this paper describes recent developments.

INSECT SPECIES INTRODUCED

Of 17 species of insects encountered feeding on Harrisia cactus, the following four were sent to Australia between 1974 and 1976 and subsequently released (McFadyen and Tomley 1978, 1981).

The stem boring beetle: *Alcidion cereicola*
The stem boring weevil: *Eriocereophaga humeridens*
The moth: *Cactoblastis* spp.
The mealybug: *Hypogeococcus festerianus*

A. cereicola was widely released in the Collinsville area during 1975-1978 where it established and spread rapidly. It has also been released at Gatton and Millmerran, and in 1979 on sword pear *(Acanthocereus pentagonus)* at Gogango. Because only larger plants are attacked, it has been most successful at Collinsville where in some localities it has caused or contributed to the collapse of large areas of cactus (see Figure 1). It has been least successful at Millmerran on *E. tortuosus* which is apparently too fleshy, and at Gogango no results are as yet known.

The weevil *E. humeridens* has been released at several sites in the Collinsville area, and at Goondiwindi, Greenmount, and Gatton. It has established at most sites, but numbers remain low and the effect on the cactus has been negligible.

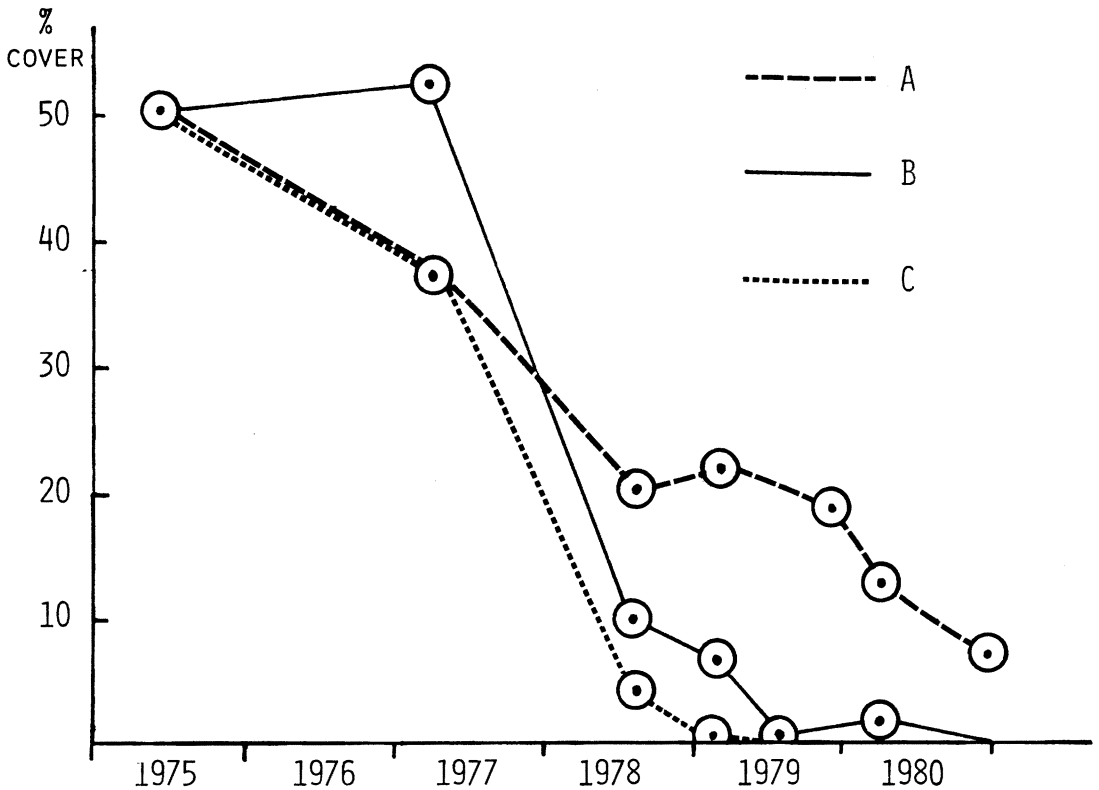
The moth *Cactoblastis* spp. is very similar to *C. cactorum* in biology and appearance but is confined to Harrisia cactus. It was released between 1978 and 1981 in the Collinsville area, and at Gatton, Greenmount and Millmerran. So far establishment has not occurred at any site, and it is thought that the water-stressed cactus of the late 1970's was not suitable for larval development. Other factors may also be involved. Releases continue and this is the only insect still being reared in the laboratory.

The mealybug *H. festerianus* was first released in 1975 in the Collinsville area, where it established and increased rapidly. In 1977, laboratory rearing was abandoned in favour of spreading infested material collected from areas of dense mealybug attack. Since then it has been released throughout the infested areas from Charters Towers in the north to Nebo in the south, and at Dingo, Gatton, Greenmount, Goondiwindi and also on *E. tortuosus* at Millmerran. Establishment, though slower in the south, has occurred at all sites.

EFFECT ON THE PLANT

Attack by *A. cereicola* on large woody plants destroys all stems to ground level, but does not affect the tubers. Secondary attack at the same time by various fungi increases the destruction, but does not prevent rapid regrowth which the beetle will not attack. This is demonstrated by site A in Figure 1, where in three years there was an initial reduction from an estimated 50% to about 20% cover, but no further reduction from this level till 1980 when mealybug present from 1978 began to affect the cactus. However, *A. cereicola* has been of importance in producing a rapid reduction of biomass in some of the densest cactus.

The mealybug initially infests growing tips and buds, deforming and arresting growth. As the plant produces axillary buds, these are in turn infested and a heavily attacked plant becomes a mass of knotted and twisted stems. Growth of new stems, flowers and fruits is prevented. If *A. cereicola* attacks a plant already infested by mealybug, regrowth from the tubers is arrested by the mealybug and the reduction in biomass is dramatic, as can be seen by Site C in Figure 1.



A - Dingo Bore site A (*Alcidion* released 1974, mealybug present 1978)

B - Dingo Bore site B (mealybug released 1975, *Alcidion* present 1978)

C - Stony Hill (*Alcidion* released 1974, mealybug released 1975)

Figure 1. Changes in percentage cover by Harrisia cactus at 3 sites at Collinsville (1975 measurement is an estimate only).

Until 1978 it was assumed that this was the limit of damage by the mealybug (McFadyen and Tomley 1978). However, cactus infested by mealybug in 1975 and 1976 was observed to have died in winter 1978. It has subsequently been confirmed that plants are killed when heavily infested with mealybug for about two years. Death usually occurs fairly suddenly, with the stems dessicating from the base up. When affected plants are examined, up to 75% of the tubers are also found to be dead. The exact cause of death is not known, but as affected plants have been supporting an enormous mealybug population for about two years and making little or no growth in this time, exhaustion of

carbohydrate reserves is the likely cause of death; this would explain the simultaneous death of most of the tuber system. Harris (1980) and Hartnell and Abrahamson (1979) showed that galls in the stems and flowers of thistles and golden rod (*Solidago* spp.) acted as metabolic sinks, consuming nutrients produced or stored elsewhere in the plant; the mealybug may act similarly.

When cactus in an infested area first begins to die from mealybug attack, not all plants die simultaneously. Seedlings continue to develop for two to three years, and some regrowth develops from deep tubers. Thus there is an initial rapid reduction of cactus to 5 to 10% cover, followed by a slower reduction to 0% cover over the next two to three years as the surviving plants and regrowth also succumb (Figure 1). At the earliest release site, (Site C on Figure 1), the cactus is now reduced to 14 small shoots (< 10 cm) in 1000 m^2.

ASSESSMENT TECHNIQUES

As described earlier (McFadyen and Tomley 1978), permanent line transects were used to measure percentage of the ground covered by cactus. This method was chosen because it is quick and non-destructive, particularly in dense cactus. Although insensitive to minor changes in biomass, the line transect method clearly shows the rapid reduction in cover from 50 to 0% over a four year period (Figure 1). However, once cactus cover has fallen below 5%, the line transects do not accurately show any further fluctuations. As cactus regrowth when the mealybug is no longer present may be a problem, it is important to monitor any such fluctuations.

Ten permanent quadrats of 10 by 10 m have therefore been established using the line transects as the baselines. Within each quadrat, all separate rooted stems or groups of stems are counted as plants, and the approximate total stem length noted. The number of plants per hectare and the metres of stem per hectare can then be calculated. At site B, there were 15 000 plants ha^{-1} in August 1979, which had dropped to 5000 by December 1980. At site C, 4000 plants ha^{-1} in March 1979 had dropped to 190 plants ha^{-1} by April 1980 and to 110 by December 1980. None of the cactus insects are now present at site C and it is possible that there will be a partial resurgence of cactus before any of the insects move back.

DISCUSSION

The success of the mealybug in controlling Harrisia cactus has exceeded expectations. In the initial release areas the cactus has been reduced to a density so low that it is difficult to find surviving plants, and the area affected is increasing each year. Since September 1979, the use of herbicides has been discontinued by the State Government Harrisia Cactus Eradication Scheme in Collinsville in favour of spreading the mealybug. It is anticipated that in another year or so, all major areas of cactus will have been infested with mealybug and no further action will be necessary other than continued monitoring for some years. It is still possible that after the mealybug has died out in an area, regrowth of the cactus may be a problem, but this would only be minor. Repeated re-introduction is successfully practised with cochineal to control tiger pear (Wilson 1960) and could be used for

Harrisia also. In southern Queensland, the mealybug takes longer to build up to damaging levels, with cactus at Gatton infested in 1976 to 1977 only beginning to die in 1981, but the ultimate result is the same. As Harrisia is a relatively minor problem in southern Queensland, this slower result would be acceptable.

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