TWO NEW INSECTS FOR THE BIOLOGICAL CONTROL OF PARTHENIUM WEED IN QUEENSLAND

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Summary. Two insects have been introduced from Mexico as part of a continuing programme for the biological control of parthenium weed (*Parthenium hysterophorus*) in Queensland. Extensive tests have shown them to be specific to parthenium weed. The leaf-feeding chrysomelid *Zygogramma bicolorata* is prolific and readily propagated in the laboratory; large field releases have been made but results are not yet available. The seed-feeding weevil *Smicronyx lutulentus* has proved difficult to rear and few releases have been made.

INTRODUCTION

Parthenium weed is an annual herb native to the neotropics and is now a serious weed in many parts of the world (Towers *et al.* 1977). It was first collected in Australia in 1955 from the upper Brisbane valley and in 1964 was recorded from the central highlands of Queensland where it appears to have established from contaminated grass seed imported from Texas (S. Everist, unpubl. report 1976). The infestation spread rapidly during the good seasons from 1973 to 1977 and now infests thousands of square kilometres in 21 shires. In 1975 parthenium weed was declared a noxious weed in Queensland, and in 1976 a containment scheme to control and prevent spread to uninfested areas was begun. A programme of biological control was initiated at the same time (Haseler 1976).

After surveys established that several insect species attacked the plant in north-eastern Mexico (F.D. Bennett, unpubl. report 1977), the Commonwealth Institute of Biological Control was contracted by the Queensland Department of Lands to carry out a three year study (subsequently extended to five years) of those insects and to send suitable species to Queensland for detailed testing in quarantine at the Alan Fletcher Research Station. This paper reports results on the first two species received in Queensland.

RESULTS

Smicronyx lutulentus. Adults of this small (1.5 to 2 mm) weevil are found in large numbers on parthenium weed in northern Mexico in the late summer feeding on the capitula and young tender leaves. Oviposition occurs in buds and newly-opened capitula, the females perforating the phyllaries to lay eggs among the sterile disc florets, usually near the outer perimeter of the disc. After hatching, the larvae feed initially among the disc florets and then burrow into the ovaries, where they feed and grow inside the developing achenes, reducing these to hollow shells. Only one larva develops per achene, but the early feeding may destroy more than one per larva. When the mature fruit dehisce and fall to the ground, the larvae burrow into the soil to pupate. There are four larval instars. At summer temperatures, the eggs hatch in seven days and the fourth instar is reached in a further nine days. There is an extended pre-pupal stage in the soil whose duration is influenced by temperature, being seven to eight weeks at 30^{o}C. Emergence is stimulated by moistening of the soil.

Field counts in Mexico showed two peaks of adult populations on the plants, a fairly small one in April and a large one in late August, which suggests that two generations occur per year. Larvae from eggs from the late summer generation spend an extended pre-pupal stage in the soil due to the low winter temperatures, emerging as adults in spring (April). Larvae from this generation then develop more rapidly through the pre-pupal stage to emerge as adults in the larger autumn (August) generation.

Adults collected in Mexico in early September and maintained in the laboratory had a median longevity of 57 days with 35% still alive 120 days after collection. The mean daily egg production was 3.23 per female (maximum 14) and mean total egg production per female was 237.13 (maximum 411).

Larvae were found to be parasitized by a pteromalid wasp, *Zatropis* sp. nr. *incertus* and a eulophid wasp, *Paracrias* sp.

Preliminary host-specificity tests were carried out in Mexico and further testing on a wider range of plants in quarantine in Australia (Table 1). Multiple-choice tests were used, the weevils being released into cages containing several test plants together with plants of parthenium weed, and the presence or absence of feeding and oviposition noted. As the larvae are not mobile, only the adults were tested. The results of the tests were unequivocal; no oviposition occurred in any plant except parthenium weed and the closely related *Parthenium confertum*; oviposition rates in the former were 2.75 to 5.13 times those in *P. confertum*.

Based on these results, permission for field releases was received from Australian authorities in December 1980. Unfortunately, this weevil has proved difficult to rear in the laboratory, partly because the very small size makes caging and handling difficult, but also because emergence after the pre-pupal period in soil is very variable, ranging from 0 to 75%. Overall, the laboratory colony is not even reaching replacement levels and only 400 adults have been released in the field. No results from the field release are yet available.

Table 1. Plants used in host specificity tests with parthenium insects.

Anacardiaceae: mango (*Mangifera indica*)

Annonaceae: custard apple (*Annona reticulata*)

Bromeliaceae: pineapple (*Ananas comosus*)

Caricaceae: papaw (*Carica papaya*)

Chenopodiaceae: beet (*Beta vulgaris*)

Coniferae: pine (*Pinus* spp.)

Convolvulaceae: sweet potato (*Ipomoea batata*)

Compositae: crop species - lettuce[1] (*Lactuca sativa*), guayule[1] (*Parthenium argentatum*), safflower[2] (*Carthamus tinctorius*), sunflower[1] (*Helianthus annuus*); native species - *Helichrysum*, *Brachycome*; ornamentals - zinnia[2], chrysanthemum[1], dahlia[2], coreopsis[2], cosmos[2], *Rudbeckia*[2]; weed species - *Ambrosia psilostachya*[2], *Ageratum conyzoides*, *Baccharis halimifolia*, *Bidens pilosa*[2], *Parthenium confertum*[2].

Cruciferae: cabbage (*Brassica oleracea*), turnip (*B. rapa*)

Cucurbitaceae: cucumber (*Cucumis* spp.), pumpkin (*Cucurbita maxima*)

Graminae: wheat (*Triticum* spp.), sugar cane (*Saccharum officinarum*), sorghum (*Sorghum vulgare*), maize (*Zea mays*), buffel grass, native grass (*Dicanthium*)

Lauraceae: avocado (*Persea americana*)

Leguminosae: peanut (*Arachis hypogaea*), lucerne (*Medicago sativa*), bean (*Phaseolus vulgaris*), soy bean (*Glycine max*), Siratro (*Macroptilium purpureum*)

Liliaceae: onion (*Allium cepa*)

Linaceae: linseed (*Linum usitatissimum*)

Malvaceae: cotton (*Gossypium* spp.)

Musaceae: banana (*Musa sapientum*)

Myrtaceae: *Eucalyptus* spp.

Passifloraceae: passionfruit (*Passiflora edulis*)

Proteaceae: macadamia nut (*Macadamia integrifolia*)

Rosaceae: strawberry (*Fragaria vesca*), rose (*Rosa* spp.), peach (*Prunus persica*), apple (*Malus sylvestris*)

Rubiaceae: coffee (*Coffea arabica*)

Rutaceae: orange (*Citrus sinensis*)

Solanaceae: potato (*Solanum tuberosum*), tobacco (*Nicotiana tabacum*), tomato (*Lycopersicon esculentum*), capsicum (*Capsicum* spp.)

Umbelliferae: celery (*Apium graveolens*), carrot (*Daucus carota*)

Vitaceae: grape (*Vitis* spp.)

Zingiberaceae: ginger (*Zingiber* spp.)

[1]Tested in both Mexico and Sherwood

[2]Tested in Mexico

Zygogramma bicolorata. Both adults and larvae of this chrysomelid feed on the foliage of parthenium weed, adults in Mexico being most abundant from May to August though found on the plant throughout the year. They are about 6 mm in length with elytra attractively marked with a pattern of dark brown or black lines on an off-white background. The eggs are laid singly or in small groups mostly on the undersurfaces of the leaves and hatch in four to six days. The young larvae feed at first in the leaf-axils and on young shoots, moving out to feed on the leaf-blades as they develop. There are four larval instars and mature larvae leave the plant to pupate in the soil. The combined larval and pupal periods occupy 23 to 28 days. The insect over-winters as adults in the soil, although if fresh young parthenium weed foliage is available and climatic conditions are mild, some adults may spend all or part of the overwintering period on the plant. There are probably two to three generations during the summer in Monterrey.

In Mexico, adults were collected in mid-August for longevity and fecundity studies. The estimates obtained are thus minimum values as these individuals had already been alive and ovipositing in the field for an unknown period when collected. Mean survival after collection of individuals maintained on parthenium weed foliage in the laboratory was 50 days (values for males and females not significantly different). Mean daily egg production per female was 15.44 (maximum 90) and mean total egg production per female was 836.13 (maximum 1786), which is greatly in excess of the fecundity recorded for related species of *Zygogramma* (Piper 1975; Goeden and Ricker 1979) and gives grounds for optimism regarding the potential of *Z. bicolorata* as a control agent for parthenium weed.

As with *Smicronyx lutulentus*, preliminary host-specificity tests using multiple-choice tests on a small number of plants were carried out in Mexico and more extensive testing at the Alan Fletcher Research Station (Table 1). As larvae are mobile, both adults and newly-hatched larvae were tested. Additional tests were performed using 11 different cultivars of sunflower (*Helianthus annuus*); newly-emerged and ovipositing adults and newly-hatched larvae were confined without choice on the sunflower, while controls were confined on parthenium weed. Some adult or larval feeding occurred on sunflower, but development could only be completed on *P. hysterophorus*, *P. confertum* and perennial ragweed (*Ambrosia psilostachya*) with development considerably slower on the latter. In field collections from areas in Mexico with parthenium weed, perennial ragweed and sunflower growing together, very few adults were found on the latter two species.

Permission for field releases was received from Australian authorities in December 1980. *Z. bicolorata* breeds readily in the laboratory, each generation taking five to seven weeks, and up to April 6, 1981, a total of 18 000 adults had been released at six sites north and south of Clermont and Emerald.

It is too early for results, but egg and larval survival seems to be reasonable, and adult dispersal is excellent. Some at least survived to a second generation. There was heavy rain during January and February 1981 in most of the parthenium weed areas and there should be abundant parthenium weed available till winter at least.

DISCUSSION

These are the first two insect species to be released on parthenium weed in Queensland and there is much interest locally in their success. It is unfortunate that *Smicronyx lutulentus* is proving difficult to rear, as Australian authorities prohibit the direct release of insects imported from overseas. If sufficient numbers can be released, this weevil should establish although it is hard to predict its impact on the plant. At best, the amount of seed could be severely reduced which in a short-lived annual such as parthenium weed might be very important. *Z. bicolorata* is a much more promising insect as it is a prolific and rapid breeder, and if present in large numbers causes severe defoliation which greatly reduces the competitiveness and survival of parthenium weed. However, predators and possibly erratic rainfall might limit its abundance.

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