A SEED-FEEDING BEETLE FOR BIOLOGICAL CONTROL OF BROOM

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SUMMARY

Work has recently been undertaken at Silwood Park, England for New Zealand by the Commonwealth Agricultural Bureaux International Institute of Biological Control (CIBC) to identify suitable species for introduction for biological control of broom (*Cytisus scoparius*). Results of preliminary screening tests for the host range of the broom seed feeding beetle *Bruchidius villosus* are summarised here as well as results of tests carried out under quarantine at Lincoln, New Zealand. *B. villosus* has now been released from quarantine and is to be mass-reared for widespread distribution throughout New Zealand.

INTRODUCTION

The insect fauna of broom (*Cytisus scoparius*) in Europe has been well studied through a series of projects carried out by staff and students at Imperial College's field station at Silwood Park (Waloff 1968). A number of potentially suitable candidates for biological control of broom in New Zealand have been identified and several have been undergoing host testing in Britain and in New Zealand. Seed feeding insects have been considered first because they affect the reproduction and spread of broom rather than the growth of existing plants. Broom is still actively invading new sites unlike gorse which now has a fairly stable distribution. It is possible that reducing seed production will slow the invasion process.

Two species of seed feeding beetle have been studied, the weevil *Apion fuscirostre* and the bruchid *Bruchidius villosus*. We have not yet been successful in rephasing *A. fuscirostre* to southern hemisphere seasons so we have not been able to proceed with host specificity testing of plants native to New Zealand and not available in Britain. The reproductive diapause of *B. villosus* was, however, readily broken in the presence of broom flowers and pods. Female beetles lay their eggs on the outside of broom pods and emerging larvae burrow through the pod to feed inside the developing seeds, destroying them in the process. The biology of this beetle in the field in Britain has been studied by Parnell (1966). *B. villosus* (as *B. ater*) is also recorded from the north-eastern United States where broom has become established (Bottimer 1968).

Where practicable, 'choice' tests in which insects are given the opportunity to select either the test plant or their normal host are generally preferred for testing host specificity as these more reliably predict the true host range of the species. 'No-choice' tests, particularly those using excised plant material, are simple to perform and can be extremely useful for initial screening of large numbers of plant species. Positive results from such tests should, however, be treated with some caution. It has frequently been observed that insects held under artificial conditions may be forced to utilise host plants they would never select in the field since proper host selection mechanisms often do not operate under such conditions.

Some of the host specificity tests carried out with this beetle in Britain and under quarantine in New Zealand are described here.

MATERIALS AND METHODS

A selection of pod-forming crops plants, other plant species closely related to *C. scoparius*, and New Zealand native plants of the family Leguminosae were used in these tests.

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As *B. villosus* feeds only on pollen in the adult stage, oviposition and larval development are the critical factors in testing specificity. Thus testing was limited to pod forming plant species. Tests (a) and (b) (below) were carried out at Silwood Park, and test (c) under quarantine at Lincoln.

(a) 'No-choice' oviposition test.

Fourteen species (Table 1) were used in this test. Five or ten beetles were confined to whole potted plants or to the branches of larger plants inside a cotton mesh sleeve secured by a rubber band. After 4 weeks the beetles were removed and the numbers of eggs were counted. The plants were then re-sleeved and the pods allowed to mature. On maturation all the plants were re-examined and the pods opened to search for larvae and pupae. Tests were carried out in summer, when pods were available in the field, under ambient temperature and daylength conditions.

TABLE 1: 'No choice' oviposition test for *Bruchidius villosus* using whole plants or sleeved branches.

Test species	No. plants	No. pods	No. eggs laid	No. larvae	No. adults
Genisteae					
<i>Cytisus scoparius</i>	2	110	70	35	16
<i>Genista hispanica</i>	1	90	0	0	0
<i>G. pilosa</i>	1	4	0	0	0
<i>Ulex europaeus</i>	1	60	0	0	0
<i>Lupinus arboreus</i>	1	3	0	0	0
<i>Laburnum anagyroides</i>	4	90	0	0	0
Trifolieae					
<i>Medicago sativa</i>	1	8	0	0	0
<i>Trifolium dubium</i>	2	479	0	0	0
Vicieae					
<i>Vicia faba</i>	1	1	0	0	0
<i>V. hirsuta</i>	2	113	0	0	0
<i>V. sativa</i>	2	43	0	0	0
Glycininae					
<i>Glycine max</i>	1	12	0	0	0
Phaseolinae					
<i>Phaseolus vulgaris</i>	4	17	0	0	0
Coronillae					
<i>Coronilla varia</i>	2	21	0	*	*

* Plants died due to attack by *Tetranychus urticae*

(b) 'Choice' oviposition tests with whole plants.

In this test two potted plants of each species (Table 2) were placed with two similar sized broom plants in a cage 2.5 x 0.5 x 0.5 m. Over a period of 4 weeks a total of 200 beetles were collected from the field and placed in the cage. At the end of the oviposition period the plants were examined for eggs. When pods had matured they were re-examined for developing larvae and pupae.

(c) 'Choice' oviposition tests on cut shoots.

Native New Zealand Leguminosae and species of the tribe Genisteae (Table 3) were used.

Perspex boxes made by Prestige (220 x 130 x 100 mm), with flexible push-on lids and four, 25 mm diameter, gauze covered holes for ventilation, were used as test cages. A moistened piece of blotting paper was placed at the bottom of the cage, and several pieces of tissue paper were included to absorb excreta. Broom twigs bearing young green pods (approximately 200 mm long) were placed in vials of water in each test cage. A disc of plastizote, 6 mm thick, with the twigs pushed through its centre acted as a stopper for the vial which was supported on an angle to ensure the shoot remained in the

TABLE 2: 'Choice' oviposition test for *Bruchidius villosus* using whole plants.

Test species	No. plants	No. pods	No. eggs laid	No. larvae	No. adults
Genisteae					
<i>Cytisus scoparius</i>	2	67	351	5	0
<i>C. praecox</i> v "Allgold"	1	10	10	0	0
<i>Genista hispanica</i>	2	137	0	0	0
Trifolieae					
<i>Medicago sativa</i>	2	42	0	0	0
Vicieae					
<i>Vicia faba</i>	2	6	0	0	0
<i>Pisum sativum</i>	2	5	0	0	0
Glycininae					
<i>Glycine max</i>	2	10	0	0	0
Phaseolinae					
<i>Phaseolus vulgaris</i>	2	9	0	0	0

TABLE 3: 'Choice' oviposition test for *Bruchidius villosus* on cut shoots.

Test species	No. eggs on test species	No. eggs on broom (<i>C. scoparius</i>)
Genisteae		
<i>Chamaecytisus palmensis</i> (a)	0	76
(b)	0	111
<i>Cytisus multiflorus</i>	0	61
<i>Teline monspessulana</i>	0	50
Carmichaeliae		
<i>Carmichaelia petriei</i> (b)	0	4
(b)	0	66
<i>C. ovata</i>	0	61
<i>C. williamsii</i>	0	21
<i>Chordospartium stevensonii</i>	0	21
Galegeae		
<i>Clanthus puniceus</i>	0	38
Sophoreae		
<i>Sophora microphylla</i> (a)	0	46
(b)	0	17

water. Twigs of each test plant were selected as bearing approximately equal amounts of pod material and having pods which were judged to be at an equivalent development stage to the broom pods. Thus test material of a different plant species was placed in each cage with an equivalent amount of broom.

Ten adult beetles were held in each test cage for 6 days at 22-16°C day-night temperatures with a 14:10 h L:D regime during testing. Relative humidity was approximately 70%. Beetles were fed pollen and provided with cotton dental rolls soaked in a honey-water solution. After the beetles were removed all plant material and cages were carefully examined for eggs. The number of eggs found on pods of broom and the test species were recorded.

There were insufficient beetles available to run the tests concurrently, and towards the end of the trial period few adults remained. Thus the test with *Chordospartium stevensonii* was carried out with only six beetles. Two cages were set up for the first three plant species tested (*Chamaecytisus palmensis*, *Carmichaelia petriei* and *Sophora microphylla*), and the *C. palmensis* test ran for 7 instead of 6 days.

RESULTS

(a) In no-choice tests using whole potted plants or sleeved branches eggs were laid on pods of *C. scoparius* only and adults emerged from *C. scoparius* pods only (Table 1).

(b) In choice oviposition tests using whole potted plants eggs were laid on pods of *C. scoparius* and *C. praecox* only (Table 2). Larvae hatched only from *C. scoparius* pods.

(c) In the tests with twigs of three species in the tribe Genisteae and native New Zealand plants eggs were recovered only from *C. scoparius* pods (Table 3). No eggs were found on other parts of the twigs nor around the cages.

DISCUSSION

Results of these and other tests (O'Donnell unpublished) show that *B. villosus* is highly host specific and presents no threat to non-target species.

In November 1986 permission was given by the Ministry of Agriculture and Fisheries for *B. villosus* (as *B. ater*) to be released from quarantine. Currently it has only been released at Lincoln. We are mass-rearing beetles now for distribution to broom infested areas throughout the country. Results from observations on broom and *B. villosus* indicate that the reproductive biology of this beetle will be well synchronised with that of its host plant. This is in contrast to synchronisation between the gorse seed weevil and gorse. A high proportion of gorse seed escapes predation by the weevil because gorse has two flowering periods in New Zealand, and the weevil is reproductively inactive during the autumn seeding period (Cowley 1983).

Other broom-feeding species are under consideration for importation for biological control. Before proceeding with the importation of species which have the potential to attack existing broom stands, an assessment of the environmental impact of biological control of broom in New Zealand is being undertaken. The results of this are expected to be available by September 1987.

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