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USEFULNESS OF THE GRASSHOPPER MONISTRIA DISCREPANS AS A BIOCONTROL AGENT FOR GREEN TURKEY BUSH (EREMOPHILA GILESII)*

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SUMMARY

The usefulness of the pyrgomorphid grasshopper *Monistria discrepans* (Walker) as a biological control agent for the woody weed, *Eremophila gilesii* F. Muell. (Myoporaceae), in south-west Queensland is assessed. *M. discrepans* is a poor prospect for control programmes because of its obligate univoltine life cycle, low reproductive rate, long mean-generation time, poor dispersal ability, and mortality caused by non-specific enemies.

I. INTRODUCTION

Green turkey bush, *Eremophila gilesii* F. Muell. (Myoporaceae), is a woody weed which occurs in dense patches on better-watered slopes of the Warrego and Paroo River catchments south-west of Charleville in south-western Queensland. Its distribution throughout Australia is given by Burrows (1971) and Barlow (1971). The species is confined largely to areas receiving between 60 and 70% of their annual rainfall during the summer months (October-March), and the approximate south-eastern limit of distribution in Queensland is the 5°C isotherm for mean minimum temperatures in June and July. Burrows (1971) has estimated that up to 1·62 million hectares have been rendered useless for grazing because of invasion by *E. gilesii*. Ecological studies of the weed by Burrows (1971, 1973) have indicated that stands in south-western Queensland are increasing in density and area under light stocking rates.

Mechanical and chemical control methods are effective, but limited because of their high cost (Burrows 1973). Burrows (1971) has suggested that control of infested areas might be possible by heavily stocking them with sheep after falls of rain exceeding 40 mm during the March to September flowering period, to prevent fruit set and limit seedling establishment. Light stocking during the summer would encourage grasses to fill the niches created as the stands decreased in density. However this management programme would have to be carried out over a long time period, (*E. gilesii* is thought to have a lifespan of about 10 years), and would be expensive in terms of temporary fencing and sheep husbandry (Burrows 1971).

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Spectacular control of dense stands of *E. gilesii* by a small wingless grasshopper, *Monistria pustulifera* (Walker), has been reported (Burrows 1974). Therefore between January 1973 and April 1975, Allsopp (1977b) made a comprehensive study of the insect fauna associated with the weed. Larvae of the sphingid, *Coenotes eremophilae* (Lucas), caused severe localised damage to the foliage; nymphs and adults of the pyrgomorphids *M. pustulifera* and *M. discrepans* (Walker) severely damaged the foliage, flowers and bark. During the period of the study *M. discrepans* far outnumbered *M. pustulifera,* and therefore was chosen for detailed investigation of its seasonal history, hosts, parasites, predators, and capacity for increase under laboratory conditions (Allsopp 1977a, 1978). Enough information on the biology of *M. discrepans* is now available to assess its effectiveness as a control agent for *E. gilesii.*

II. ESTIMATION OF USEFULNESS

Harris (1973) has proposed a list of 12 criteria for assessing the potential effectiveness of an insect species for the biological control of a particular weed. Within each criterion he has defined a range of possible attributes, each with a numerical score assigned to it. The more valuable the attribute, the higher the score. The sum of 12 individual scores is a measure of how promising the insect is in controlling that weed. The range of possible total scores is 0 to 45, and experience shows that a score of around 30 points indicates a good prospect, while a score of around 10 points is a poor one (Harris 1975). *M. discrepans* against *E. gilesii* is rated at an unencouraging 16 points (table 1), and the reasons for this will now be discussed.

TABLE 1

EVALUATION OF *Monistria discrepans* AS A BIOLOGICAL CONTROL AGENT FOR *Eremophila gilesii* USING THE HARRIS (1973) SCORING SYSTEM

Criterion and attribute most applicable to *M. discrepans*	Score
1. HOST SPECIFICITY B. Monophagous (Specialised on a species or species group)	1
2. DIRECT DAMAGE INFLICTED Defoliation, seedling damage, destruction of vascular tissue and prevention of seed set	3
3. INDIRECT DAMAGE INFLICTED A. None	0
4. PHENOLOGY OF ATTACK C. Limited period of activity increasing plant susceptibility to frost, drought, or competition from other vegetation	3
5. NUMBER OF GENERATIONS A. Obligate univoltine species	0
6. NO. PROGENY PER GENERATION A. Under 500	0
7. EXTRINSIC MORTALITY FACTORS A. Natural control largely by non-specific enemies or ecological factors	0
8. FEEDING BEHAVIOUR B. Gregarious or colonial feeders (intrinsic behaviour not precluding proximate feeding of larvae at high densities)	2
9. COMPATIBILITY WITH OTHER CONTROL AGENTS B. Compatibility good	2
10. DISTRIBUTION A. Local	0
11. EVIDENCE OF EFFECTIVENESS AS A CONTROL AGENT Controls some areas of the weed in some years, but exerts no overall control	1
12. SIZE OF AGENT C. Dry weight over 50 mg	4
TOTAL	16

M. discrepans is awarded maximum scores for size, feeding behaviour and compatibility with other control agents, and high scores for phenology of attack and direct damage inflicted on its host. The insect is primarily a defoliator, but also eats flowers, green fruit, and even bark, causing the death of stems, twigs and seedlings (Allsopp 1977b). There is no evidence of indirect damage by disease transmission or by rendering the host susceptible to invasion by other species. However, attack by other control agents is not hindered by *M. discrepans*, nor is gregarious feeding precluded by any of its behaviour patterns: in both nymphs and adults proximate feeding was observed and males and females fed, even while coupled. A high score has been given for phenology of attack because the period of activity of *M. discrepans*, though limited, coincides with the period of maximum vulnerability of *E. gilesii* to competitive pressures from grasses. This occurs from October to March, when 66% of the annual rainfall is received in the Charleville area. Eggs of *M. discrepans* undergo a diapause during winter, hatching in late September or early October, and adults are present by April (Allsopp 1978). Thus the insect attacks *E. gilesii* mainly during the late summer and early autumn.

The size of the biocontrol agent is important as a contributing factor to the biomass of its population. Field-collected *M. discrepans* had mean weights for males and females of 57·4 mg and 176·9 mg respectively, and therefore the maximum score is appropriate. However the population size and its capacity for increase are equally important factors. These are determined by the annual number of generations, number of progeny per generation, and extrinsic mortality factors. For these three critera *M. discrepans* was awarded scores of zero. Allsopp (1978) has shown that *M. discrepans* in south-western Queensland is an obligate univoltine species. Its net reproductive rate in the laboratory is 9·89 (Allsopp 1977a), and the rate in the field must be less than this because of parasitism, predation and ecological mortality factors. Field biology studies (Allsopp 1978) have demonstrated the importance of the parasitic flies *Ceracia fergusoni* (Malloch) and *Blaesoxipha pachytyli* (Skuse), the mites *Leptus* sp. and *Podapolipus* sp. nr. *lahillei* Naudo, and the fungus *Aspergillus flavus* Link as natural control agents of *M. discrepans*. The flies and the fungus, and possibly also the mites, are non-specific enemies; thus the responsiveness of their populations to increased numbers of *M. discrepans* is greater than that of enemies specific to that host.

A zero score for distribution is warranted when *M. discrepans* is being considered for control of *E. gilesii* over its entire range. When the distribution of *E. gilesii* (Burrows 1971; Barlow 1971) is plotted against that of *M. discrepans* (Allsopp 1976) overlap occurs only in the south-western Queensland study area. *E. gilesii* consists of three "subspecies" found in different areas (Barlow 1971). Only the "Queensland subspecies" which is tetraploid, in contrast to the other diploid "subspecies", occurs in this overlap area. Possibly *M. discrepans* is adapted only to the Queensland form of *E. gilesii*. On the other hand, the environmental tolerances of *M. discrepans* may make its survival and reproduction impossible outside its present range. However, if *M. discrepans* is considered for control of *E. gilesii* only in south-western Queensland, a score of four to six is warranted, as the insect occurs over most of the weed's range in that area, and should be well adapted to that particular strain of the weed.

Harris (1973) considers polyphagy to be a desirable attribute of biocontrol agents, because polyphagous species can exploit favourable circumstances, such as an increase in host abundance, more rapidly than monophagous species. Field collections and preliminary feeding tests (Allsopp 1978) indicate that *M. discrepans* is restricted to species of *Eremophila* and *Myoporum,* both Myoporaceae, so it is classed as an oligophagous species and receives a low Harris score. However, as Wapshere (1975) points out in his protocol for programmes for biological control of weeds, it is essential to demonstrate that the control agent will not attack economically important plants. From the point of view of safety, the restricted host range of *M. discrepans* is highly desirable. This host range could be confirmed using the centrifugal phylogenetic method of Wapshere (1974).

The overall Harris rating of *M. discrepans* indicates that it is a poor prospect as a biocontrol agent. This is also the case when two factors not included in the Harris list, ease of mass rearing and dispersal ability, are considered. Kok (1974) considers that a laboratory culture of the biocontrol agent should be maintained to ensure that sufficient numbers are available for releases timed to coincide with host abundance. However the capacity for increase of *M. discrepans* under laboratory conditions is low—it has a mean generation time of 257 days, with a low net reproductive rate. High dispersal ability minimises the number of release sites necessary, and allows the insect to respond to regrowth and spread of the weed. *M. discrepans* probably has low dispersal ability, because even the fully-winged forms are apparently unable to fly (Allsopp 1976).

III. DISCUSSION

In the science of biological control of weeds, exotic insects are usually imported to combat an introduced weed. Such enemies often have comparable roles in control of the same host species in regions where both have evolved and are endemic (Huffaker 1968). Hence the conservation of existing weed-feeding insects has been suggested by Andres (1971) as a method of controlling weeds.

The present analysis indicates that *M. discrepans* is of low potential for the control of *E. gilesii* in south-western Queensland. Although spectacular control of small areas of *E. gilesii* occurs in some years, factors such as low reproductive potential, high parasite load and poor dispersal ability make such occurrences sporadic. However, use of the insect could possibly be integrated with other control methods, including the hypothetical management system suggested by Burrows (1971).

In Burrows' system heavy stocking of areas of weed is used only during winter, and light stocking during the summer period of grass growth. Since *M. discrepans* is active during the summer and autumn, maintenance of its populations at high levels, possibly by strategic releases from a laboratory culture, would exert virtually continuous pressure on the weed. However the success of the technique would depend on mass rearing or extensive field collection of individuals, and more precise mapping of the distribution of *M. discrepans* and *E. gilesii* would be advisable. Such a programme of integrated control would be difficult to implement, and expensive.

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