Biological control of *Mimosa pigra* and its role in 21st century mimosa management

Grant Flanagan[1] and Mic Julien[2]

Abstract

Northern Territory land managers, government agencies and community have some 40 years experience of living with, and trying to manage, mimosa. In that time, best practice has evolved and the importance of integrating a variety of techniques is now well recognized and demonstrated. Biological control of mimosa, *Mimosa pigra* L., commenced in 1979. The program included a comprehensive survey of mimosa's native range. Potential agents were identified based on their abundance and impact in the field and on a capacity for mass rearing or culturing. A number of the agents released have had an impact and others recently released show promise of doing so, others have not. This paper proposes that other countries considering mimosa management can benefit from the 23 years of experience developed in Australia. They can select an effective suite of agents, establish them quickly, and utilise a range of other proven techniques and application methods. They have the opportunity to implement cost-effective management of mimosa quickly and effectively.

Keywords: mimosa management, integrated management, biological control, management recommendation.

Introduction

When it began in the late 1970s, the biological control project for mimosa, *Mimosa pigra* L., was one of the first comprehensive attempts to control a large woody weed by the introduction of a suite of natural enemies. The rationale was that such a suite of natural enemies would be required to reduce the vigour of mimosa and to reduce its competitive ability in its introduced range, the Northern Territory (NT), Australia. The aim was to suppress mimosa so that it would simply become a minor part of the flora, as it is in its native range.

[1] Kangaroo Island Natural Resources Board, PO Box 520, Kingscote, South Australia 5223 <grant.flanagan@internode.on.net>.

[2] CSIRO Entomology, 120 Meiers Road, Indooroopilly, Queensland 4068, Australia <mic.julien@csiro.au>.

Between 1979 and October 2002, 417 insects and pathogens were found feeding on mimosa in its native range (Harley *et al.* 1995). Forty-three of these showed sufficient promise to be further assessed for introduction into Australia (Heard and Segura 2004). Thirteen of these were selected for release in Australia and several have also been released in South-East Asia (Julien and Griffiths 1999, Hong Son *et al.* 2004, Suasa-ard *et al.* 2004). Several more are currently undergoing mass rearing and are in the early stages of release.

Four of the thirteen released have so far shown an ability to reduce the vigour of mimosa and its seed production. Another is locally abundant, two established but largely disappeared, one has only recently established, three more have been recently released but their establishment has yet to be confirmed, while two failed to establish (Paynter 2004).

The successes

Four of the species released are having a measurable impact on mimosa:

Acanthoscelides puniceus was one of two seed-feeding beetles released in 1983. These were the first agents released and they established readily and spread rapidly. The larvae of this beetle feed on the hard mature seed; the adults are pollen feeders. Prior to the establishment of the other three agents, *A. puniceus* typically destroyed less than 1% of seed (Wilson and Flanagan 1991, Van Rangelrooy and Wilson 1994), but now as part of a suite of agents it accounts for about 20% of seeds (Paynter 2004).

The moth *Neurostrota gunniella* (Busck), the larvae of which tunnel in the fresh tips and leaf pinnae, was released in 1989 and also spread rapidly. By the mid 1990s this moth was found throughout mimosa in the NT. When abundant, in summer, it is capable of reducing seed production by up to 60% (Lonsdale and Farrell 1998).

Another moth, the sesiid *Carmenta mimosa* Eichlin & Passoa, was also released in 1989. Despite rearing difficulties in Darwin, field populations were established and agents were collected from these nursery sites and redistributed (Hoskings and Rea 1999). *Carmenta* larvae tunnel into the stems and branches and are often found in the main trunks and occasionally in the roots. This agent is responsible for the most spectacular impact on the plant, killing branches, and after several years of sustained attack they will even kill large mature plants. This agent has spread steadily (Ostermeyer 2000) but not at the same rate *as A. puniceus* or *N. gunniella.* Current studies are quantifying the impact of *Carmenta* and determining the potential value of a redistribution program (Paynter 2004).

In 1994, the flower feeding weevil *Coelocephalapion pigrae* Kissinger was released. This agent also established and spread rapidly and is currently found over all but the mostly westerly mimosa infestations. The adults and larvae feed on the flowers and advanced buds and several larvae can destroy an entire inflorescence. The adults are able to feed on the leaves during the dry season when flowers are scarce. This enables them to build up large populations early in the wet season and in response to episodic flowerings that result from the irregular rainfall that occurs in the early wet season (October to December) and the late wet season (March to May).

Other agents with potential

Some species have become established but not abundant in Australia, or established initially but apparently failed to persist. The reasons for this are not known. However, in other countries with different climates and microclimates etc., these insects and pathogens may become abundant and contribute to the management of mimosa:

Chlamisus mimosae Karren is a chrysomelid. Both adults and larvae graze the bark of mimosa. These have become locally established on one river system and are occasionally abundant (Paynter 2004).

Two pathogens, *Phloeospora mimosae-pigrae* Evans & Carrion, and *Diabole cubensis* (Arthur & Johnson), established initially but failed to persist (Hennecke 2004).

The seed-feeding beetle, *Acanthoscelides quadridentatus* (Schaeffer), and the flower-feeding beetle, *Ceolocephalapion aculeatum* Fall, both established but are now rarely found in the NT.

Future biological control prospects

Two recently released agents hold a great deal of promise. These are the root- and seedling-feeding beetle, *Malacorhinus irregularis* Jacoby, and the leaf-feeding moth, *Macaria pallidata* (Warren). *Malacorhinus irregularis* is already established at one release site, while mass rearing of *M. pallidata* has only just commenced. The establishment of these agents will see a suite of agents attacking all parts of the plant, further reducing the vigour, seed production and competitive ability of mimosa.

21st century mimosa management

Mimosa managers, regardless of their location, can capitalise on over 20 years of biological control experience and 40 years of other forms of management that have been researched and tried in northern Australia. They can select the methods that show promise and those that suit their particular situation.

One thing we can be certain of is that policy bureaucrats and the executive arm of government will not support weed-control programs until there are major problems. By that time significant resources and an integrated management program will be required, and eradication unattainable. The Peter Faust Dam situation is a rare exception (Chopping 2004) and the pre-emptive action there is a result of the prolonged national profile that the mimosa problem in the NT has had. We have heard at this conference about the difficulties of raising the issue at the political level and getting the resources to deal with the situation in the Mekong Delta (Samouth 2004, Triet *et al.*

2004). Currently, similar difficulties are being experienced in relation to infestations in Irian Jaya and Papua New Guinea.

It is fortunate indeed then that we have never been better equipped to manage mimosa in a cost-effective manner. A suite of proven, effective, safe and readily reared biological control agents is available and the prospect of this suite being augmented with new and useful agents is promising. A range of on-ground treatments, including high and low-tech methods, has been developed. These are increasingly being integrated into comprehensive programs. Based on these methodologies and ongoing research, strategic approaches have been developed to implement programs on property, catchment or regional scales. These strategies and treatments can be easily transferred, with considerable cost savings compared to their development, to those countries that have relatively recently taken on the mimosa management challenge. Part of this transferral will require the taking into account of cultural, technological and resource issues, and management experiences, in the new region (refer to Thi *et al.* 2004, Hong Son *et al.* 2004, Marambe *et al.* 2004).

Strategic, integrated management programs that provide cost-effective management can now be implemented at a range of scales. These programs will be based on a suite of widely established and abundant biological control agents that will provide cheap, long-term management (Paynter 2004). Other methods such as herbicides (Wingrave 2004, Chopping 2004, Searle 2004) and mechanical control (Chopping 2004, Thi *et al.* 2004, Searle 2004), including biomass fuel generation (Presnell 2004) and fire (Thi *et al.* 2004, Searle 2004), can be used to control high-priority outbreaks, where the prospect of eradication or reduction in mimosa populations to a level where other land uses are possible (including biodiversity protection or restoration) is technically feasible, and within the long-term resources available.

In the short term, the integration of biological control and other control methods will need to ensure that the establishment and spread of agents is unhindered. It has been demonstrated (Paynter and Flanagan 2004) that once agents are widespread they will reinvade treated areas and some species can be favoured by the presumably higher nutritional value that seedlings and regrowth has over the larger woody mature plants.

Implementing strategic, cost-effective integrated management programs has taken several decades to achieve in northern Australia. Based on this work (Paynter and Flanagan 2004), this situation could be achieved much sooner in those countries that want to commence such a program in the 21st century.

References

Chopping, C. 2004. *Mimosa pigra* at Peter Faust Dam, Proserpine, Queensland. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 102–105. CSIRO Entomology, Canberra, Australia.

Harley, K.L.S., Gillett, J.D., Winder, J., Forno, I.W., Segura, R., Miranda, H. and Kassulke, R.C. 1995. Natural enemies of *Mimosa pigra* and *M. berlandieri* (Mimosaceae) and prospects for biological control of I. *Environmental Entomology* **24,** 1664–1678**.**

Heard, T.A. and Segura, R. 2004. Agents for biological control of *Mimosa pigra* in Australia: review and future prospects. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 127–140. CSIRO Entomology, Canberra, Australia.

Hennecke, B.R. 2004. The prospect of biological control of *Mimosa pigra* with fungal pathogens in Australia. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 117–121. CSIRO Entomology, Canberra, Australia.

Hoskins, M. and Rea, N. 1999. Biological control agents of *Mimosa pigra* and their release history. Canberra, Australia, *CSIRO Entomology Technical Report* No. 83.

Hong Son, N., Van Lam, P., Van Cam, P., Thi Thanh, D.V., Van Dung, N., Duc Khanh, L., and Forno, I.W. 2004. Preliminary studies on control of giant sensitive *Mimosa pigra* in Vietnam. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 110–116. CSIRO Entomology, Canberra, Australia.

Julien, M.H. and Griffiths, M.W. 1999. *Biological Control of Weeds. A World Catalogue of Agents and Their Target Weeds*. Fourth Edition. CAB International, Wallingford, UK, 233 pp.

Marambe, B., Amarasinghe, L., Silva, K., Gamage, G., Dissanayake, S. and Seneviratne, A. 2004. Distribution, biology and management of *Mimosa pigra* in Sri Lanka. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 85–89. CSIRO Entomology, Canberra, Australia.

Lonsdale, W.M. and Farrell, G. 1998. Testing the effects on *Mimosa pigra* of a biological control agent *Neurostrota gunniella* (Lepidoptera: Gracillaridae), plant competition and fungi under field conditions. *Biocontrol Science and Technology* **8**, 485–500.

Ostermeyer, N. 2000. Population density and distribution of the biological control agent *Carmenta mimosa* on *Mimosa pigra* in the Adelaide and Finniss River catchments of the Northern Territory, *Plant Protection Quarterly* **15**, 46–50.

Paynter, Q. 2004. Evaluating *Mimosa pigra* biological control in Australia. In:*Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 141–148. CSIRO Entomology, Canberra, Australia.

Paynter, Q. and Flanagan, G.J. 2004. The integrated control of mimosa. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 158–163. CSIRO Entomology, Canberra, Australia.

Presnell, K. 2004. The potential use of mimosa as fuel for power generation. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 68–72. CSIRO Entomology, Canberra, Australia.

Samouth, C. 2004. *Mimosa pigra* infestation and current threat to wetlands and floodplains in Cambodia. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 29–32. CSIRO Entomology, Canberra, Australia.

Searle, T. 2004 Mimosa management a case study – Melaleuca Station. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 154–157. CSIRO Entomology, Canberra, Australia.

Suasa-ard, W., Sommartya, P. and Jaitui, S. 2004. Evaluation of seed-feeding bruchids, *Acanthoscelides* spp., as biological control agents for *Mimosa pigra* in Thailand. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 122–125. CSIRO Entomology, Canberra, Australia..

Thi, N.T., Triet, T., Storrs, M. and Ashley, M. 2004. Determining suitable methods for the control of *Mimosa pigra* in Tram Chim National Park, Vietnam. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 90–95. CSIRO Entomology, Canberra, Australia.

Triet, T., Kiet, L.C., Thi, N.T.L. and Dan, P.Q. 2004. The invasion by *Mimosa pigra* of wetlands of the Mekong Delta, Vietnam. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 45–51. CSIRO Entomology, Canberra, Australia.

Van Rangelrooy, D.S. and Wilson, C.G. (1994) The biological control of *Mimosa pigra*. *The Australian Entomological Society 25th Annual General Meeting and Scientific Conference*, Adelaide 24–28 September 1994, pp. 82–83.

Wilson, C.G. and Flanagan, G.J. 1991. Establishment of *Acanthoscelides quadridentatus* (Schaeffer) and *A. puniceus* Johnson (Coleoptera: Bruchidae) on *Mimosa pigra* in northern Australia. *Journal of the Australian Entomological Society* **30**, 279–280.

Wingrave, S. 2004. Herbicides and their application for the control of mimosa in the Northern Territory. In: *Research and Management of* Mimosa pigra (eds Julien, M., Flanagan, G., Heard, T., Hennecke, B., Paynter, Q. and Wilson, C.), pp. 96–101. CSIRO Entomology, Canberra, Australia.