Abstract  Bitou bush, *Chrysanthemoides monilifera* subspecies *rotundata*, is a native of South Africa, used extensively in Australia as a sand stabilising plant and for revegetation of coastal areas mined for mineral sands. It has now become a serious environmental weed in eastern Australia, primarily of conservation areas, where it significantly reduces biodiversity. This importance has been recently recognised with the listing of *C. monilifera* as a Weed of National Significance. A biological control program against *C. monilifera* was approved in 1987 and agent releases commenced in 1989. To date, five species of insects have been released on bitou bush and additional species are under investigation. Of these insects, bitou tip moth, *Comostolopsis germana* and bitou seed fly, *Mesoclanis polana* have been the most successful. Biological control is a long term program and will not eradicate the host plant. An integrated approach appears to be the best option for long-term sustainable control. The Cooperative Research Centre for Weed Management Systems is coordinating studies on integrated control of bitou bush which include the use of biological control agents together with strategic herbicide applications, fire and revegetation techniques.

THE PROBLEM

Bitou bush, *Chrysanthemoides monilifera* subspecies *rotundata* (DC.) T. Norl., is a competitive environmental weed of South African origin. It is primarily restricted to areas of summer rainfall (Parsons and Cuthbertson 1992) and infests coastal areas of southern Queensland, New South Wales (NSW) and Lord Howe Island. There is also a localised infestation at Menindee Lakes, NSW. In NSW it is common in areas north of Sydney and occurs south to the Victorian border.

Bitou bush was first recorded in Australia from Stockton near Newcastle in 1908 (Weiss et al. 1998) where it appears to have been an accidental introduction in ships ballast. From 1946 to 1968 bitou bush was used as a sand stabilising plant and to revegetate coastal areas mined for mineral sands. The capacity of bitou bush to invade native vegetation was then recognised and its recommendation for coastal planting was withdrawn. However, by 1976 bitou bush was naturalised along much of the NSW coast. Aerial surveys of the NSW coastline were conducted by the NSW National Parks and Wildlife Service in 1981 and 1982. These indicated that bitou bush was distributed along approximately 60% (645 km) of the coast and was the dominant species along 230 km. Since these surveys its range has expanded and it has been predicted that bitou bush has the potential to spread and occupy over 90% of the NSW coastline by 2010. Over approximately two thirds of this area it could completely dominate and eventually displace most of the existing native vegetation.

The importance of bitou bush was officially recognised in early 1999 by both the NSW National Parks and Wildlife Service who listed it as a key threatening process under the Threatened Species Conservation Act 1995 and by the Commonwealth of Australia who listed it as a Weed of National Significance under the National Weeds Strategy 1997.

Bitou bush is largely an environmental weed as it is easily controlled by stock grazing and cultivation. It is primarily restricted to non-agricultural areas such as national parks, forests, coastal dune ecosystems and other recreational land. In invaded vegetation, significant reductions in biodiversity can occur. In the past, physical and chemical control and fire have been used to reduce infestations and limit spread of bitou bush. These traditional techniques are limited in their use for bitou bush control for a number of reasons. Physical control techniques are extremely labour intensive and can usually only target small areas. They are thus highly suitable for areas of high conservation significance. Herbicides have proven to be extremely effective for broad scale bitou bush control (Toth et al. 1996). However, there a number of situations where they are not suitable, such as in the presence of rare or threatened flora. Fire is also not suitable for all areas because ecosystems such as coastal dunes and rainforests are not fire adapted. These techniques need to be
repeated annually if they are to run down the existing soil seed banks. Because of these limitations another solution is required.

**BIOLOGICAL CONTROL: THE ANSWER?**

A biological control program against *C. monilifera* (which includes bitou bush and boneseed, a closely related subspecies) was approved by Standing Committee On Agriculture in 1987. Surveys in South Africa have indicated that there are more than 100 species of phytophagous insects associated with the *Chrysanthemoides* species complex (Scott and Adair 1990). Eighteen of these species were identified as having potential for the biological control of *C. monilifera* and five species have so far been released on bitou bush: bitou tip moth, *Comostolopsis germana* Prout; black boneseed beetle, *Chrysolina* sp. 1; painted boneseed beetle, *Chrysolina* sp. 2; bitou tortoise beetle, *Cassida* sp. and bitou seed fly, *Mesoclanis polana* Munro.

Of the above five insects there have been some successes and some failures. *Chrysolina* sp. 1 and *Chrysolina* sp. 2 have each been released at several sites along the NSW coast. Neither species has established at any of these sites. Releases of *Cassida* sp. are continuing on the NSW North Coast and populations are persisting at some of these sites. The Australian ant fauna is particularly large and diverse (Shattuck 1999) and the larvae of these leaf-feeding beetles appear to be particularly prone to predation by ants and spiders (R.H. Holtkamp and R.J. Adair pers. obs.). This factor may have been important in limiting their potential as biological control agents.

The other two species have been significantly more successful. *C. germana* has been released at over 70 sites in NSW. It is now established along most of the NSW coast and it is believed that this insect has spread throughout all bitou bush infestations although its numbers are still increasing in some areas. In many areas, it is having a significant impact on flowering and seed production of bitou bush. Experiments are currently under way to quantify the impact of *C. germana*. Preliminary results indicate populations in excess of 400 larvae/m² can occur. High population levels have reduced seed production by over 50% at some sites.

*M. polana* was first released in very low numbers in August 1996 at Iluka Bluff and Dunbogan. Since then, nine releases have been made on the NSW North Coast. By August 1998, *M. polana* had been found from near Fraser Island in Queensland to Tathra in southern NSW, a total of over 1200 km of coastline (Edwards et al. 1999). Over much of this area, population levels are extremely high and reductions in seed production of 50% are common. Further experiments on this species are continuing.

Research on establishing or introducing additional biological control agents is continuing. Another species of seed feeding fly, *M. magnipalpis* has been released onto boneseed in Victoria and South Australia. This insect is also suitable for release onto bitou bush, especially on the NSW South Coast and future plans include its continuing redistribution.

Agents currently undergoing quarantine evaluation are a leaf feeding moth, *Tortrix* sp., an eriophyiid mite, *Aceria neseri* and a rust fungus, *Endophyllum osteospermi* (Doidge). Host specificity testing of *Tortrix*’ sp. is now complete and an application for its release will shortly be submitted. By the end of this year we should know if *Tortrix*’ sp. has been approved for release. The other two agents are a little further down the track but will hopefully be available for release early in the new millennium.

**DISCUSSION**

Biological control will not eradicate bitou bush. At best biological control will reduce this weed to a minor component of invaded vegetation. The answer for long term control of bitou bush would appear to be an integrated weed management (IWM) approach using strategies such as biological control, physical removal, herbicides and fire. Studies on IWM are currently being coordinated by the Cooperative Research Centre for Weed Management Systems. Any integrated program which incorporates biological control will have to ensure that sufficient agents remain following other forms of treatment for re-establishment of biological control agent populations.

It is also essential that revegetation of disturbed habitat using native and preferably endemic species occurs quickly to prevent the niche previously occupied by bitou bush being colonised by bitou bush seedlings or by another weed species. Because of the importance of revegetation there will always be a place for hand removal and rehabilitation work carried out by volunteer groups in areas of high conservation significance where other control techniques may not be suitable.

Assuming approval is granted for the release of the remaining biological control agents under investigation and that they subsequently establish, we believe...
that by early in the new millennium we will have in place an effective, complementary suite of insects, mites and pathogens for land managers to utilise as part of an IWM program for bitou bush.

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REFERENCES


