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Nature's weapons in the war on weeds

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It has been fifty-two years since publication of the last scientific book on biological weed control in Australia. This makes *Biol* *Biological Control of Weeds in Australia* – published just ahead of the fiftieth anniversary of Rachel Carson's *Silent Spring* – a timely and valuable contribution to the field of environmental management.

Biological Control of Weeds in Australia. Edited by Mic Julien, Rachel McFadyen and Jim Cullen. CSIRO Publishing, 2012, hardback and ebook, ISBN: 9780643099937, AU $180.00.

When left to itself, Nature manages populations brilliantly. The food-chain hierarchy includes predatory and parasitic organisms that regulate populations of herbivores. In turn, herbivores regulate plant populations.

Over time, we humans have learnt to exploit natural mechanisms of predation and parasitism to our advantage. We use them to manage populations of organisms such as pests, weeds, using those predators and parasitoids that utilise them.

The introduction of the South American cactus moth (*Cactoblastis cactorum*) to regulate exploding populations of the introduced prickly pear (*Opuntia* spp.) in the 1920s is an Australian example of the brilliantly successful use of biological management.

The use of chemicals to regulate pest populations took off in the 1940s, with the discovery that DDT can be a powerful weapon in the management of pestiferous insects (e.g. mosquitoes). However, by the 1960s, the environmental consequences of DDT and similar chemicals were becoming apparent. The effects of unintentional pesticide permeation into natural systems were elegantly articulated by Rachel Carson in her groundbreaking book *Silent Spring* in 1962.

The pioneering idea of biological control is based on the premise that we can use host-specific, specialist organisms to regulate populations of organisms considered by us as ‘unwanted’. The term ‘biological control’ was first used by Harry Scott Smith in 1919[1], although it would be more appropriate to refer to this practice as ‘biological management’. Carl Barton Huffaker (1914–1995) is another key name to be remembered in this context.

Despite the longer time-frames involved relative to chemical control, biological management of pests and weeds has gained prominence as a strategy to reduce harmful impacts on the environment.

Unfortunately, the early success of prickly pear management was followed in the 1930s by the ill-fated introduction of the cane toad (*Bufo marinus*) to regulate populations of the native cane beetle (*Dermolepida albohirtum)*, which had been devastating Australian sugar cane crops.

Unlike the South American cactus moth, which is a specialist herbivore insect (feeding only on plants of a particular genus or species), the cane toad is a generalist. The cane toad is, of course, now a major pest across large tracts of northern Australia.

Since the introduction of the cane toad, improvements in our understanding of the biology of several predatory and parasitic arthropods have enabled us to successfully use generalist organisms as biological management agents.

Given this background, ***Biological Control of Weeds in Australia*** comes at the right time. The preceding volume on a similar theme by Frank Wilson[2] appeared more than fifty years ago. It is both amazing and worrying that Wilson’s volume referred to only a dozen weeds – obviously of high importance then – whereas the present volume refers to 83 species.

Close to fifty world specialists have contributed to the book. Each chapter covers the taxonomy and developmental biology of one identified weed, along with its life history and details of the biology of potential control candidates (arthropods and fungi). Wherever relevant, a distribution map is included.

The editors have included details of conflicts of interest, which are emerging as major social issues. Conflicts of interest arise under different circumstances: for example, when a potential agent has a tendency to spread beyond the target weed species, or when people have found a weed to be of some use in specific circumstances.

Credit: CSIRO/scienceimage

The discussion about conflicts of interest around the weed, mother-of-millions (*Bryophyllum delagoense*), brings to mind another dynamic example of conflict of interest. In Ranathambore National Park – a tiger reserve in central western India – conflicts of interest surround the management of the exotic perennial *Prosopis juliflora*, an invasive weed across many regions of India. At least four groups of people have competing interests in *P. juliflora*[3], rendering its management at the park messy.

Thankfully, in Australia, legislation governing the introduction of biological management agents includes precautionary measures that address potential conflicts of interest.[4]

Another impressive feature of *Biological Control of Weeds in Australia* is the inclusion of distribution maps developed using CLIMEX (climate and population modelling software). These maps predict the potential expansion ranges of the nominated weed in Australia.

The use of multi-pronged strategies employing a range of arthropods to manage perennial weeds (augmentative biological control) offers exciting insights. The book includes a chapter on augmentative biological control of the paperbark *Melaleuca quinquenervia*. This

Australian native was introduced into Florida (USA) in the 1900s and is now a serious environmental weed in many regions of USA. The strategy uses a sap-sucking bug (*Boreioglycaspis melaleuca*), a leaf-chewing weevil (*Oxyops vitiosa*), and a stem gall-inducing fly (*Lophodiplosis trifida*) to collectively inflict considerable damage to the paperbark tree. Reading this, we were reminded of the work of Helmut Zwölfer and his colleagues on effective partitioning of resources and sharing guilds by different arthropod species in the 1970s and 1980s[5].

This large book is well executed, with easily readable prose and elegant supportive illustrations. As an example of the book's strengths, we point to elements of the chapter by Dhileepan and McFayden on the management of parthenium weed (*Parthenium hysterophorus*). Parthenium weed is a major problem in Queensland's rangelands and summer cropping areas, imposing a significant economic burden on the pastoral industry. The chapter includes a section on searches made in South America – the original distribution sites of this weed – for possible management agents. Also discussed are the successes and failures of various Australian management trials using arthropod and microbial agents. A highly useful 'evaluation' section should help policy-makers and funding agencies in making decisions about biological management programs.

Credit: © John Hosking/State of NSW through Department of Trade and Investment, Regional Infrastructure and Services

We were, however, disturbed to see the inconsistent use of 'biological control' and 'biocontrol'; use of one term would have been better. One of us (Anantanarayanan Raman) who has worked on the biology and ecology of gall-inducing arthropods for decades found the use of the term 'galler' discomforting.

For postgraduates, we would have liked to see a chapter outlining the basic techniques used in biological management and research. This could have included details of host-specificity tests; criteria for short-listing an organism as a potential biological management agent; and an explanation of different computational models used to select localities for exploring an agent and measuring its performance.

These oversights are, however, minor. In all, this book is a valuable contribution to Australian biological science and to the future development of eco-sensitive, sustainable landscape-management programs. Given that securing chapters from 50 world specialists is never an easy task, we congratulate the editors on organising a useful volume, which will no doubt remain a valuable resource for as long as the Frank Wilson volume of the 1960s.

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1 Smith HS (1919) On some phases of insect control by the biological method. *Journal of Economic Entomology* **12**: 288–292.

2 Wilson F (1960) *A Review of the Biological Control of Insects and Weeds in Australia and Australian New Guinea*, Commonwealth Agricultural Bureau, Farnham Royal, United Kingdom.

3 Dayal V (2007) Social diversity and ecological complexity: how an invasive tree could affect diverse agents in the land of the tiger. *Environment and Development Economics* **12**: 553–571.

4 CSIRO (2011) ***Safeguarding Australia: steps in a weed biological control program.***

5 For example: Zwölfer H (1979) Strategies and counterstrategies in insect population systems competing for space and food in flower heads and plant galls. *Fortschritte der Zoölogie* **25**: 331–353.