Finding a pattern to plant invasions

Driving along the Hume Highway near Albury in New South Wales, the curious motorist will notice whole paddocks carpeted with the brilliant purple flowers of the weed Paterson's curse (alias salvation Jane). Whether a curse to graziers or a boon to bee-keepers, the weed, like others in Australia, is of interest to a CSIRO scientist who is looking for a pattern to the way plant immigrants have established themselves in the country.

Most of us have objections — on either economic or aesthetic grounds — to weeds such as Paterson's curse. Can similar plant 'invasions' be prevented in future? Dr Richard Groves, of the CSIRO Division of Plant Industry in Canberra, believes that the history of plant introductions to Australia could reveal a pattern that would assist authorities in screening out potential weeds. He has reviewed the published opus of research on the topic, in order to better understand the process of plant 'naturalization'.

Dr Groves' recent research has been in the ecological control of skeleton weed (*Chondrilla juncea*), a pest of wheat crops that came from Mediterranean countries. Some success in controlling this weed has been achieved through the release of a fungus and a gall mite that attack it in its Mediterranean home range.

Skeleton weed and Paterson's curse are only two of the estimated 1500 introduced plants that now have a place in Australia's check-list of 15 000 to 20 000 vascular plants. What's more, many plants that we regard as 'indigenous' — such as the coastally distributed sea-rocket — may not have evolved here but have arrived before the advent of man, by a process of long-distance dispersal via birds, winds, or the sea.

Strangely enough, the Aborigines appear to have brought no new plants into the country when they arrived tens of thousands of years ago. Only much later did people first bring plants. From 1700 until the beginning of this century, the Macassan fishermen from the South Celebes gathering beche-de-mer or trepang camped on the beaches of northern Australia to gather this delicacy for trade with the Chinese. Their travel rations included tamarind fruit. Trees from the seeds established around these camp sites and have since spread further afield.

European man brought the first mass imports of plants to Australia. When the boat came in during the early days of settlement, it often brought with it a range of crop and pasture plants and ornamentals (including Paterson's curse). Joseph Banks' list of plants to be shipped from Britain to the colony in 1798 included 'hops, olives, carribs, lemon grass, spring grass, cactis, ginger, strawberries, camphor, vines, apples, pears, peaches, nectarines, mulberries, walnuts, chestnuts, filberts, quinces, pruient plums, oakes and willows, mint, lavender, tarragin, sage, savoury laurel, cammomile and wormwood'.

We know that some of these plants and assorted seeds survived the voyage out. Dr Groves is surprised that so few species in the vast inventory of imports have become naturalized, and that even fewer have become weeds. Naturalization occurs when colonizing plants multiply and spread from their point of introduction to a country. Many plants remain in the colonizing state and don't succeed in flourishing in the wild — garden plants are an example.

The process of plant naturalization has yet to stop. It is proceeding at a rate of from four to six species a year, and shows no sign of slowing down.

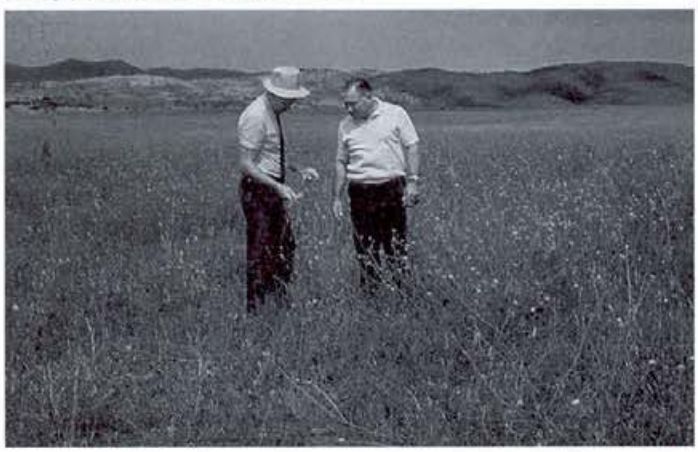
Dr Groves estimates that, for every 100 species that have been introduced, only about 10 have successfully colonized new environments and, of these, perhaps five have become naturalized. Further, perhaps one or two of those five species have gone on to become weeds — that is, to inconvenience man in some way. Dr Groves believes that, if we knew more about the stages of this filtering process, we could limit the number of plants reaching 'weed' status by identifying, and then keeping out, plants with the potential to become weeds.

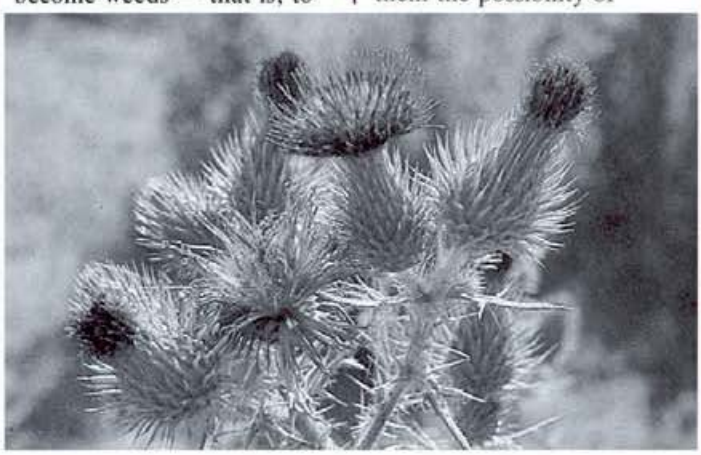
During the introduction phase, plants may get into the country at more than one point. For example, it appears that early settlers deliberately introduced Paterson's curse to Australia a number of times in the nineteenth century as an ornamental plant. Then, in the late nineteenth century, it became naturalized in two areas — one near Albury in southern New South Wales and the other near Gladstone in South Australia. Later, the same thing happened at a third location in the south-west of Western Australia. The plant's present widespread southern distribution radiated from these three isolated locations.

Not only has Australia's flora been invaded from the outside — internal invasions have also occurred, with man's help. The Cootamundra wattle, a native of south-eastern New South Wales, is now naturalized around Melbourne and Adelaide as well. Another south-eastern Australian *Acacia* species — *A. dealbata* — has found a second home across the Nullarbor: it was introduced into south-western Australia for mining area re-afforestation.

Such migrations bring with them the possibility of

Skeleton weed (left) and thistles belong to a family containing many colonizers, the Asteraceae.





Paterson's curse, brought to Australia as an ornamental.

hybridization between species. Already, Cootamundra wattle has hybridized with several naturally occurring *Acacia* spp. in different areas of Victoria and South Australia. A question raised by Dr Groves is whether this 'homogenization' of native plants will produce invasive natural hybrids with the potential themselves to become weeds.

He was particularly interested in finding out whether a set of characteristics that identifies potential weeds — an 'invasive syndrome' — exists for plants. From his review, he concluded that no one suite of invasive characteristics can be identified. However, he did put his finger on certain 'predisposing factors' that increase the chances of a plant becoming an invader.

One of the most important of these is taxonomic position. For example, if a plant belongs to the family Asteraceae, beware. The Asteraceae include thistles, skeleton weed, bitou bush, and sunflower. Most commonly, they stay around as flat rosettes of leaves throughout the year, sending up a stem in spring. In Victoria, of the 88 plants identified as noxious, 27 belong to the Asteraceae — 15 of these are thistles. Other families containing a large share of noxious plants are the Amaranthaceae and the Brassicaceae.

The next thing to look at is whether a plant is a colonizer in its country of origin. If so, it is more likely to become invasive in a new country. For instance, in southern Europe, skeleton weed inhabits the sandy beds and banks of river flood plains, making it an ideal colonizer of cereal-growing areas — on regularly disturbed sandy soils — in Australia.

Plants with seeds that have hooks and barbs can also spread easily. Two American *Xanthium* spp. — Noogoora burr (*X. occidentale*) and Bathurst burr (*X. spinosum*), weeds of eastern Australian grazing lands — have seeds with hooked spines to attach to animals and birds. Another predisposing factor for plant invaders is the ability of seeds to remain dormant for long periods, germinating only when the conditions are most favourable for the plant. This is a characteristic of most of the Mediterranean plants that have invaded southern Australia.

The reproductive strategy used by invading plants can be a factor in their success. In particular, plants that can reproduce both sexually and vegetatively have an advantage. As well as producing seeds, skeleton weed can multiply from buds on both the root and the shoot. The notorious salvinia water fern has been able to spread rapidly in Australia and New Guinea by simply breaking itself up into 'clones'.

Currently 20 genera of plants and a further 66 species are on the list of plants prohibited entry by the Plant Quarantine Branch of the Australian Department of Primary Industry. Many of these are already established weeds in parts of the country.

Dr Groves hopes that quarantine authorities will consider the types of predisposing factors he has identified when producing future prohibited lists. And he suggests the emphasis should change from plants that have already established here to those that have not yet arrived. A species of the thistle genus *Carduus*, found in Mediterranean countries, has not made its mark here, but its biology includes predisposing factors outlined by Dr Groves. A candidate for prohibited entry?

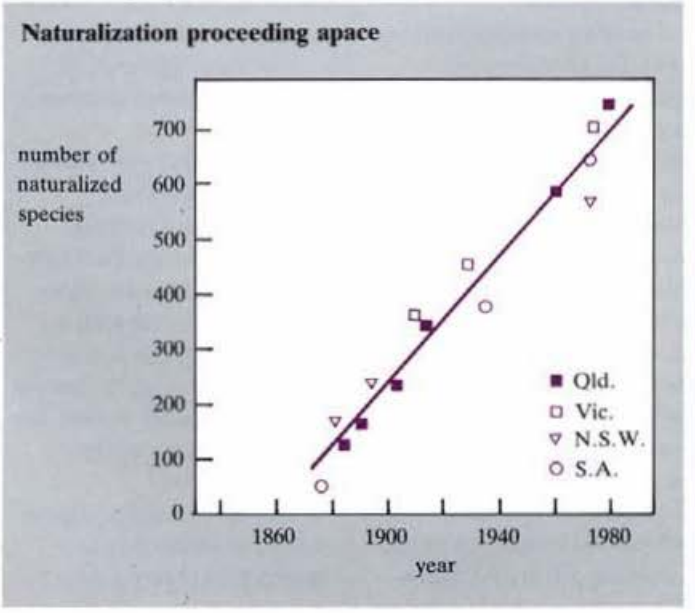
Plants from the European *Hieracium* genus are relatively unknown in Australia. Yet several species have become major weeds of pasture lands and mountain regions in North America and New Zealand. Again, the genus exhibits predisposing factors for invasion: it is one of the Asteraceae, and it can reproduce both by seeds and vegetatively.

As for the control of plants already here, scientists could alert plant control authorities on the basis of their predictions of how plants will grow and develop in particular environments.

Dr Groves hopes that, in future, more effort will be channelled into modelling the spread of plants. This will answer questions about which are most likely to enter Australia, which introduced plants will become naturalized, what the rate of spread will be, and what impact they may have on Australian ecosystems.

Mary Lou Considine

The number of introduced plants that have become naturalized has risen rapidly over the last 100 years.



Plant invasions of Australia: an overview. R. H. Groves. In 'Ecology of Biological Invasions in Australia', ed. R. H. Groves and J. Burdon. (Australian Academy of Science: Canberra, in press.)