Mimosa pigra threatens Kakadu

Leaves of the giant sensitive plant, *Mimosa pigra*, have the startling ability to close up quickly when touched, which is the plant's most obvious distinguishing feature. (Indeed its small cousin *Mimosa pudica* is frequently found in school biology laboratories because it can perform the same trick.)

But, aside from illustrating the fact that sensitivity to touch and rapid movement are not the exclusive preserve of animals, why is *M. pigra* special?

The reason is that it has recently spread over large areas of the 'Top End' of the Northern Territory in dense stands in which almost nothing else grows. In doing so, it has replaced unique communities of native plants and their dependent animals. It now threatens the World-Heritage-listed Kakadu National Park.

The woody, prickly weed, which grows in thickets up to 6 metres tall, originated in central America, but now exists in Africa and South-East Asia, as well as Australia. It prefers a tropical climate with distinct wet and dry seasons, such as the Top End experiences. It probably first came to Darwin some time last century, most likely to the Botanic Gardens where it might have been deliberately planted as a curiosity because of its sensitivity to touch. Although it 'escaped' from the gardens, it lingered in the Darwin region causing little problem for nearly a hundred years.

Sudden spread

Now, however, the plant has established itself in an arc spanning 450 km from the Moyle River in the west to Arnhem Land in the east, with the worst infestation on the Adelaide River (see the maps). It covers about 45 000 ha, and its devastatingly successful march across the landscape seems likely to continue for some time.

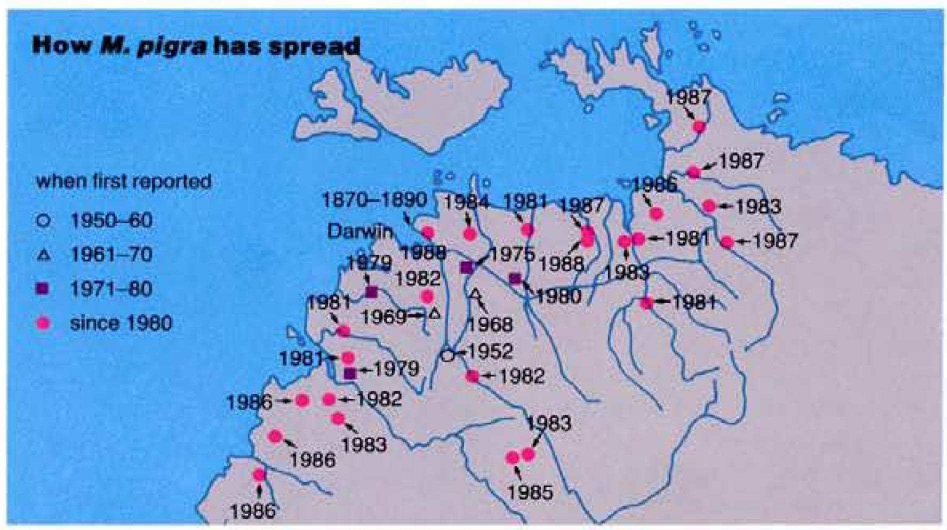
Research by Dr Mark Lonsdale of the CSIRO Division of Entomology's Darwin unit and his colleague Dr Wendy Forno, in collaboration with Mr Ian Miller of the Northern Territory Department of Primary Industry and Fisheries, has clarified the nature of the problem posed by the weed and may, the scientists hope, eventually lead to its control by biological means.

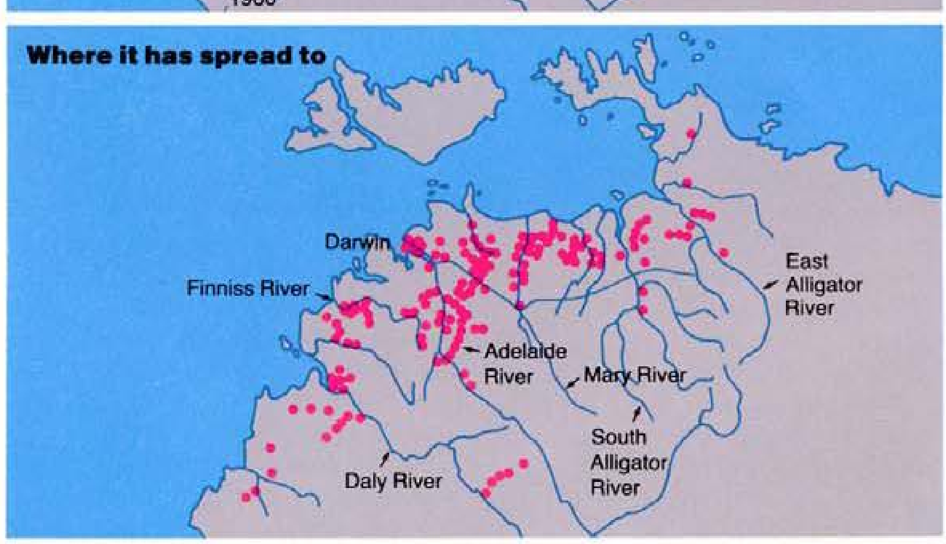
But first, why did giant sensitive plant remain 'harmless' for so long after its initial introduction? And what triggered its sudden, rapid spread? It seems that another introduced 'disaster', the water buffalo, gave it a helping hand. So too did unusually severe flooding in the mid 1970s.

Huge herds of feral water buffalo (themselves introduced earlier last century) were for years overgrazing the sedgelands in the area, especially on the floodplains of the Adelaide River. The animals ate and trampled virtually all the vegetation; any plant that, by being inedible to buffalo, could establish itself in those parts would therefore face no competition. It seems that no fast-growing native plant had the right adaptations to profit from this heavy destructive grazing, but prickly and unpalatable *Mimosa pigra* proved 'just the ticket'.

A feature important to the weed's success is that its seeds remain viable in water and can float. Once it had reached the Adelaide River township in the 1950s it had only to wait until an opportunity occurred for it to spread far and wide. This came with the big floods of the 1970s, when the seeds were carried throughout the floodplain and colonised the mud-churned land devastated by the buffaloes.

Under the right conditions, *M. pigra* grows quickly — at the rate of about 1 cm a day! It can also withstand droughts, so the





Although introduced in Darwin last century, *Mimosa pigra* did not begin its destructive spread until relatively recently. The first map charts its spread and the second shows where it had been reported to April 1988.

The hardy plant can tolerate very dry conditions, as well as the wet.

M. pigra (foreground) invades the understorey of a paperbark swamp.

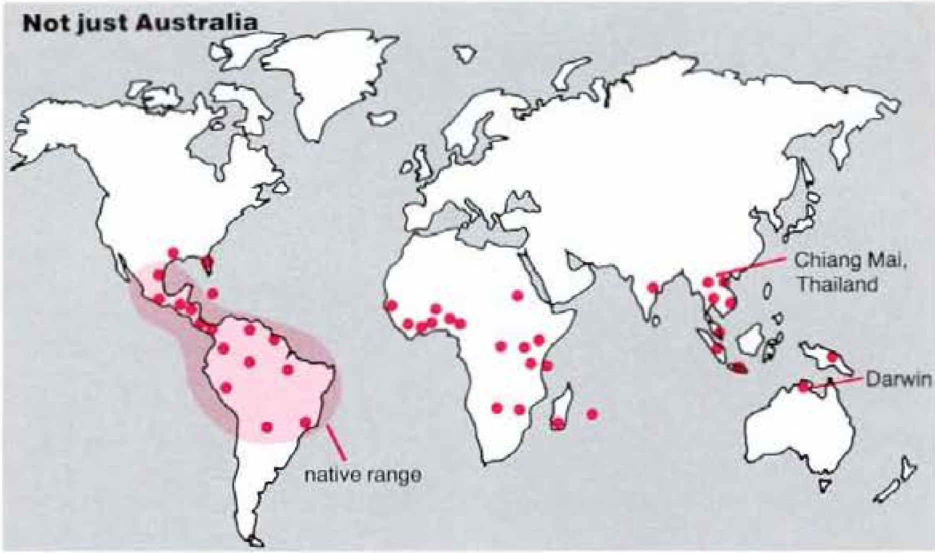
Mimosa pigra in flower — pretty but menacing.

6-month dry season, although slowing its growth rate and thinning its canopy, does not kill it. Equally, the almost permanent flooding of the 'wet' presents no problems — the weed can grow aerial roots. Consequently, once it had reached the floodplains its success was assured, and now its spread continues each year; and in wetter years with greater flooding its seeds are transported even further.

Giant sensitive plant has other features useful to a weed. If it is chopped down it will easily resprout from the stump. The plants mature quickly and can set seed in their first year of growth — and vast quantities of seed, too! Dr Lonsdale and Divisional colleague Dr Ken Harley, in collaboration with Mr John Gillett of the Territory Department, investigated the seed-production potential and the longevity of seeds in two infested sites.

They found that seed populations in the soil under the thickets in 1986 measured about 8500 per sq. m at one site and about 12 000 per sq. m at another. They also discovered that the life span of a seed depends greatly on its depth in the soil. For example, half of a seed population was no longer viable after 99 weeks spent 10 cm down in a light clay soil, whereas just 9 weeks was the half-life for seeds at a depth of 1 cm in a heavier cracking clay.

Regular heating and cooling — the soil surface temperature can range from about 25 to 70°C — causes expansion and contraction of the hard seed-coats of *Mimosa* species, eventually making them crack, which breaks their dormancy. The deeper in the soil a seed may lie, the less extreme is the temperature range it experiences. The scientists found that seeds buried deeper than 10 cm cannot successfully germinate, but they can remain viable for long periods.



The distribution of *M. pigra* around the tropics.

Even if all the adult plants were removed from an area, such seeds, if brought to the surface by cultivation or the actions of animals, could start an infestation afresh. If a mere handful of seeds per sq. m were to germinate, the resulting plants — with their rapid growth rates and early maturation (it takes as little as 6 months from germination to flowering) — would form dense stands, and start copious seed production all over again. This means that total eradication of giant sensitive plant will be very hard to achieve.

Since 1985, when *Ecos* last reported on the problem, the area lost to thickets of this weed has increased more than fivefold. Kakadu National Park has four full-time staff assigned to its monitoring and 'eradication'. (For immediate control, each plant is sprayed with a herbicide or manually removed.) Their vigilance has meant that every eruption in the park has so far been contained and the weed does not yet have a permanent foothold there.

Why the worry?

But how damaging to the native environment is giant sensitive plant, and how should we respond to it? Dr Lonsdale, and Dr Dick Braithwaite and Mr John Estbergs, of the CSIRO Division of Wildlife and Ecology, have investigated its effects on native plants and animals. To do this, they sampled the flora and fauna in an area on the Adelaide River that it had infested for 5 years, in another site on the Finniss River where it had been present for 3 years and was still completing its invasion, and in similar areas that had remained free of it. As well as conducting censuses of animals and plants, they measured how much light passed through the weed thickets to the

Why do they do it?

People have long been fascinated by plant movement; Venus fly-traps, whose flowers snap shut on insects feeding within them, and the small *Mimosa pudica* are popular favourites. But despite considerable study scientists still do not fully understand the mechanisms of, or the reasons behind, the sensitivity of *Mimosa* plants to particular stimuli and their movements.

The compound leaves of various *Mimosa* species are sensitive not only to touch, but also to heat, electricity, certain chemicals, and wounding. Moreover, the plants fold their leaves at night in response to a 'biological clock'.

At the base of each leaflet, and where the leaf stalk joins the stem, are small swellings called pulvini, in which cells swell in response to the movement of potassium ions into them.

An initial stimulus appears to be transmitted outwards in the plant, activating many pulvini within a few seconds. What happens resembles in many respects the conduction of the nervous impulse in animal nerve cells. A wave of electrical excitation sweeps along a line of cells, brought about by movements of ions across the membrane. Each cell then needs to pump out ions before it can be triggered again. As a result, the opposing leaflets in the compound leaf promptly fold up, and then whole leaves and stems droop.

Scientists have suggested various explanations for why a plant should bother with this sort of sensitivity: perhaps the drooping of leaves allows raindrops (heavy enough to initiate the response) to reach the roots easily rather than splashing off leaves. Secondly, in a heavy rainstorm, the response may lower the plant's profile and allow it to 'bend with the wind' more readily and so prevent damage. Thirdly, in dry, gusty conditions (again sufficient to trigger the response) leaf closure could reduce the loss of moisture — an idea that Dr Lonsdale favours. Finally, the sudden response may startle animals about to browse on the plant, and expose its prickles to them. We may not like it, but we have to admire the way this plant keeps its secrets!

ground, and compared this with readings from the native vegetation.

They found that, whereas 75% of the incident light passed through the canopy of a stand of paperbarks (*Melaleuca* species), only 26% made it through to illuminate the ground flora if giant sensitive plant also spread its canopy beneath the trees. Sedgeland sites, which carry no trees, received 100% of the sunlight in the absence of the weed, but only between about 60 and 80% if it was present.

These measurements represent the situation during the dry season when the weed has a relatively sparse canopy. During the wet, a lush thicket may prevent 90% of the incident light from reaching the ground! In this case it's not hard to see why the researchers also found that the denser the thicket grew the fewer were the tree seedlings beneath it.

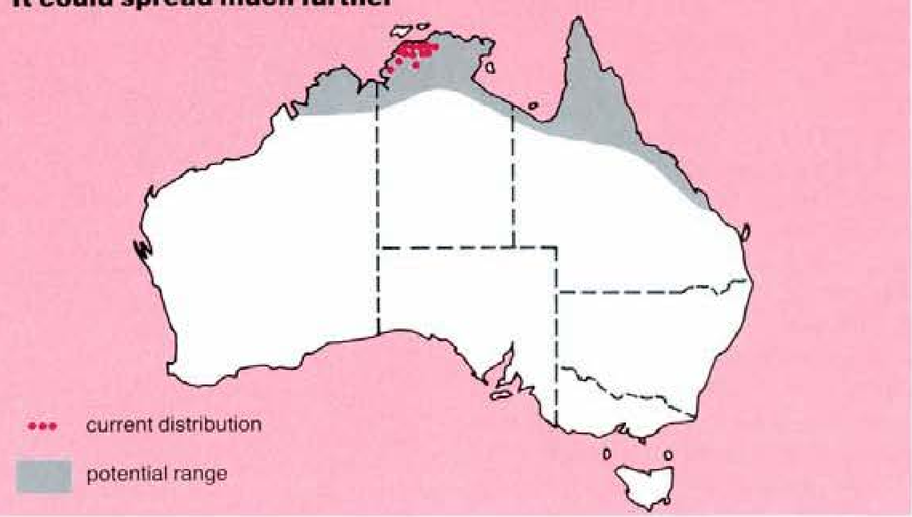
They also discovered that the species richness of the grassy layer declined as the density of giant sensitive plants increased. Not surprisingly, censuses showed that such increases, due to the crowding out of other plant species, had a very bad effect on animals requiring an abundant grass cover or a high diversity of woody plants. Birds have suffered the most: ducks, egrets, jabirus, and magpie geese like an open sedgeland with a variety of grasses — they find the weed's impenetrable thickets simply uninhabitable.

Similarly, the scientists found that few lizards live in the weed-dominated areas. By contrast, some small mammals appear in greater abundance in these sites — and for a previously rare species of dunnart times have never been so good (for more on this, see the adjacent box). It's not hard to see why: small mammals are well protected in thickets of giant sensitive plant. Predatory birds flying overhead cannot see them, and the clump of above-ground roots at the base of the stems provides an ideal home in which to shelter.

However, small mammals will only benefit where the weed occurs in patches from which they can make forays into the surrounding vegetation for food. Once it establishes as a large blanket then these mammals will also find it impossible to live there.

The survey revealed that the presence of giant sensitive plant did not affect the densities of water buffalo and amphibians. However, Dr Lonsdale believes that the numbers of these animals would probably decline in the future, because increases in the area of wetland choked by the weed will make it harder for them, too, to find suitable food.

It could spread much further



Work by Mr Ian Miller shows the theoretical possible distribution of *M. pigra* in Australia according to climate. Dots mark its actual distribution.

So, for the ecosystems of a very special and relatively unspoilt part of the country, giant sensitive plant is most definitely a cause for considerable worry. And not only does it threaten biological diversity; the important pastoral industry in the region is also concerned about it. The weed can take over pastures, hinder mustering, and prevent access. Buffaloes are now farmed, but *M. pigra* pays back the 'helping hand' they gave it during its establishment by eventually rendering areas unsuitable for them. Moreover, scenic billabongs, popular with tourists and those who like fishing, lose all their appeal when surrounded by impenetrable spiky thickets that grow across them, leaving open only the deepest water in the centre.

Kakadu

Unfortunately, the future may bring worse troubles. Kakadu National Park, an area of great biological significance and importance to the tourism industry, is under severe threat. From an examination of the vegetation types present, and with their

Helping hand for a small animal

The little native mammal *Sminthopsis virginiae* — a type of dunnart — occurs in small numbers over a large part of northern Australia. Biologists believed it to be uncommon throughout its range. For example, in the Northern Territory there were only 34 records of its existence prior to 1986; and Dr Dick Braithwaite of the CSIRO Division of Wildlife and Ecology caught only two individuals during the 21 600 'trap-nights' of an exhaustive fauna survey in the native vegetation of Kakadu National Park.

But all notions about the abundance of this shrew-like marsupial changed during a 3-day period in September 1986. Just 624 trap-nights brought to light 19 individuals in the wetlands of the Finniss River, and nearly all of these were found just inside the newly weed-dominated former sedgeland.

Before this study, conducted by Dr Braithwaite, Dr Lonsdale, and their assistants, the animal's presence was mainly associated with the palm-like tree *Pandanus spiralis*, which has a 'skirt' of dead leaves and covers the ground nearby with prickly fronds. The early European explorers reported that this tree was much more common than today, and formed dense thickets. But the trampling, browsing water buffalo changed all of this, and the scientists believe that the ensuing loss of *Pandanus* thickets caused the present scarcity of *S. virginiae*.

At the same time, the buffalo helped with the establishment of giant sensitive plant. Today, its thickets simulate some of the protective features that the *Pandanus* species once offered to dunnarts. The research suggests that the new colonist offers an excellent habitat for *S. virginiae*, provided suitable foraging areas with a grassy understorey are present nearby. If it eventually colonises these areas too then this little Australian native may return to its previous rarity.

The rarity of *Sminthopsis virginiae* (Marsupialia: Dasyuridae) in relation to natural and unnatural habitats. R.W. Braithwaite and W.M. Lonsdale. *Conservation Biology*, 1987, **1**, 341–3.

knowledge of giant sensitive plant's biology, Dr Lonsdale and Dr Braithwaite estimate that a major invasion could leave 29% of the park's 13 000 sq. km covered by this alien weed. The 29% at risk includes sedgelands, paperbark forest, monsoon forest, and the woodland around rivers, streams, and billabongs. In a further 54% — comprising open forest, woodland, and shrubland — the prickly weed would become common although not the dominant feature. In only 17% — essentially sandstone woodland, spinifex, and mangroves — would it fail to take hold.

The wetlands of the park, besides being its most vulnerable part, are its most important for the abundant bird life. The region already provides a refuge for species, such as the magpie goose, that have disappeared from southern Australia. During the dry season many birds congregate in small areas of the wetlands; any reduction in these is likely to bring about a collapse of the water-bird population.

Birds living in the paperbark and monsoon forests would also be affected as, once established in the relatively sunny understorey, giant sensitive plant would then shade out tree seedlings. Eventually, the remaining mature trees poking out from the thickets would die, and the whole area would be left to the weed. More bird species and flying foxes, which depend on this type of habitat, would then follow the decline of the water-birds.

But the story doesn't end there. The plant's invasion could lead to secondary consequences that may be as devastating as its initial takeover of the wetlands. For example, the flying foxes are major pollinators and seed distributors for many trees. A significant decline in their number could affect the long-term viability of these species.

Not only Kakadu is at risk. Mr Miller believes that the weed's essential climatic requirement is more than 750 mm of rain a year in a tropical setting. Theoretically, this puts a considerable area of our north at risk, including all of Cape York Peninsula, much of the Queensland coast, and the far north of Western Australia (see the map on page 7).

A pair of infrared aerial photos (where green shows as red) taken in 1975 and 1985 demonstrate the spread of *M. pigra* in the Adelaide River.

Any answers?

But *Mimosa pigra* is not yet established in Kakadu National Park, or anywhere beyond the Top End, and maybe we can prevent its spread to new areas. Biological control offers the best prospect. *Ecos* 45 reported on the release of the *Chlamisus* beetle, which feeds on the species' shoots. Unfortunately, the insect's population has not exploded and, although it still persists in small numbers in the field, it has had no detectable effect on the vigour and spread of the plant.

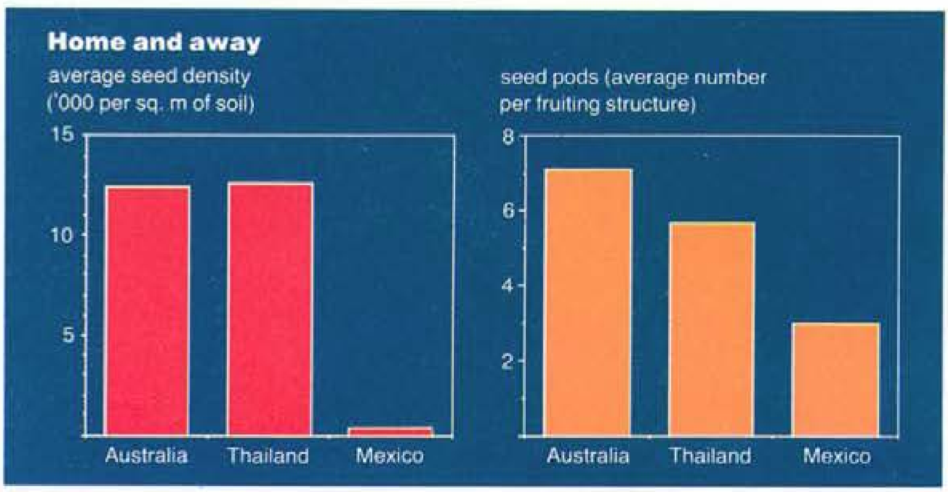
In general, the weed appears to be low in palatability for higher animals, and no Australian insects are known to eat it in any quantity. Its seeds are removed by ants and some vertebrates but, owing to its enormous seed production, this has little impact on its spread. Clearly, we need to look in the plant's home to find its Nemesis.

Biological control investigations by CSIRO started in 1979. Since 1984 a collaborative research program involving CSIRO, the Northern Territory government, the National Biological Control Centre in Thailand, and the Australian Centre for International Agricultural Research (ACIAR) has concentrated on studies of the plant and its predators in Mexico.

More than 200 species of insects and several fungi attack *M. pigra* in its home range. Indeed, so avid are these predators and parasites that plants there differ considerably from those in Thailand and Australia. Dr Lonsdale and Mr Ricardo Segura (also of the Entomology Division, but based in Mexico) found that *Mimosa pigra* was larger and far more productive in Australia than in its homeland. For example, the number of seeds in a pod here ranged from 14 to 26, whereas in a Mexican pod the range was 5–20. Similarly, the number of pods borne on a branch rose as high as 27 here, and averaged seven, yet there it reached a maximum of only eight and averaged three.

All of this fecundity conspires to produce a huge bank of seeds in the soil in Australia — an average of about 12 000 per sq. m in some areas, whereas in Mexico the figure was only 118. In Thailand the introduced plants were not quite as productive as in the Northern Territory, but considerably more so than in Mexico.

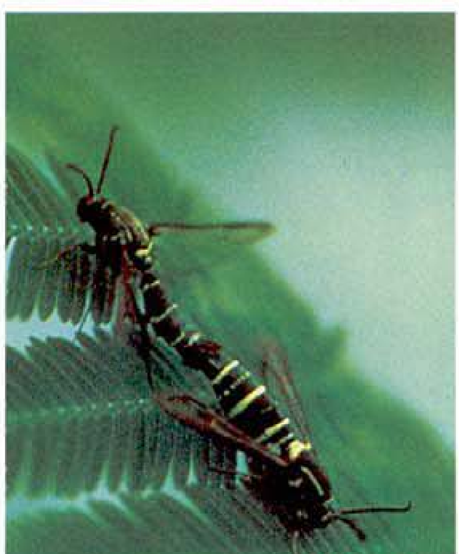
Naturally, in its homeland *M. pigra* is not a nuisance; it is an insignificant-looking minor part of the local flora. Despite that,



***M. pigra* is much less productive where it comes from (represented by data from Mexico) than in Australia and Thailand.**

The innocuous-looking adult of *Neurostrota gunniella*, a potential biological control agent.

The larva of *N. gunniella* eats out the inside of the plant's stems.



The adults of another *Mimosa pigra* predator, *Carmenta mimosa*, mate on the plant. Biologists hope that many more matings will take place to build up a sizeable predator population.

the scientists have not proved a definite causal connection between the large number of predators and pathogens and the poor state of the weed there; to do that they would need to remove some or all of the offending insects and fungi and watch the result. However, it seems likely that an important link does exist, and for that reason two stem-boring moths from Mexico were released in Australia, after exhaustive testing, in March 1989.

The larvae of both tunnel in the stems and cause these to die. One of the moths, *Neurostrota gunniella*, has already established itself and has spread out from its release site to a radius of 3 km. Inspection of giant sensitive plants along a 6-km transect by Mr Colin Wilson of the Northern Territory Department of Primary Industry and Fisheries revealed that from 60 to 90% of all stems were infested. However, Dr Lonsdale and Dr Forno don't yet know what effect this is having on the plants, and are currently measuring their seed output as an indicator of their state of health. It's possible that the caterpillar's burrow will kill young single-stemmed seedlings, and present research is also assessing how often this happens.

Other possible control agents are seed- and flower-feeding weevils, also from Mexico, which Dr Forno and her team are currently testing for their host-specificity in the Division's Brisbane laboratories.

Two species of fungi are known to damage the weed severely in Mexico. One grows on stems and leaves and causes premature leaf fall, while the other attacks branches, main stems, and seed-pods as well as leaves, and causes cankers on the stems that in turn lead to ringbarking and the eventual death of the plant. In their native range both fungi have their own problems — in the form of other fungi that parasitise them — but if introduced here without those natural enemies they would no doubt have an even greater effect on the weed. Scientists in Mexico and Britain are currently studying the host-specificities and life cycles of these fungi.

Recently, the Commonwealth government announced a major injection of new funds ($1·25 million over 3 years) for further research aimed at combating the spread of giant sensitive plant through effective biological control agents. For the sake of large areas of our tropical wilderness, and the tourists who flock to see it, we can only hope that, even if complete eradication is out of the question, at least some control can be exercised over this 'sensitive' menace.

Roger Beckmann

More about the topic

Alien vegetation and native biota in tropical Australia: the impact of *Mimosa pigra*. R.W. Braithwaite, W.M. Lonsdale, and J.A. Estbergs. *Biological Conservation*, 1989, **48**, 189–210.

Litterfall in an Australian population of *Mimosa pigra*, an invasive tropical shrub. W.M. Lonsdale. *Journal of Tropical Ecology*, 1988, **4**, 381–92.

Seedling mortality in *Mimosa pigra*, an invasive tropical shrub. W.M. Lonsdale and D.G. Abrecht. *Journal of Ecology*, 1989, **7**, 371–85.

The biology of Australian weeds. 20. *Mimosa pigra* L. W.M. Lonsdale, I.L. Miller, and I.W. Forno. *Plant Protection Quarterly*, 1989, **4**(3), 119–31.

Sensitive plant invades the north. M.L. Considine. *Ecos* No. 45, 1985, 10–11.