The yellowing of these *Mimosa pigra* leaves (pictured in the plant's native home of Mexico) is caused by a natural fungus called *Phloeospora mimosae-pigrae*. The fungus was released in the Adelaide River flood plains in March as part of a suite of biocontrol agents programmed to attack *Mimosa pigra* year-round.
Six insects have been released so far in Australia as biological control agents for the prickly wetlands invader.
CSIRO entomologist Dr Wendy Forno makes twice-yearly visits to Mexico to select potential 'biocontrol' species. She says each of the agents released so far attacks a different part of the mimosa plant.
Scientists use a computer modelling program called CLIMEX to predict the weed's spread. They say it will probably take 10 years for the biocontrol program to have a significant effect.

Where will that pest go next?

A computer program that has helped scientists in Australia to plan strategies to control introduced species such as the cattle tick and *Mimosa pigra*, is now being used in more than 60 locations worldwide.

CLIMEX, developed at CSIRO's Division of Entomology in Brisbane, uses climate data and distribution patterns of plant and animal pests to predict their likely spread.

Dr Bob Sutherst, a chief research scientist at the division, says climate is the key factor affecting geographical distributions of about 80% of species.

The variables used in the CLIMEX model are maximum and minimum temperatures, rainfall and humidity. These are entered for the pest's native environment and for the area of study. Added to this is the geographical distribution of the pest in its place of origin and in countries where it has been introduced. From this information, CLIMEX calculates a growth index and a series of stress indices which, when combined with the growth index, produce an 'eco-climatic' index.

This indicates the potential for growth in a given environment and how likely it is that the species will be able to survive there in the long term. It predicts such things as how well the species will perform in both favourable and unfavourable conditions.

CLIMEX was used in the development of the biological control program now in place for one of Australia's worst environmental weeds, the prickly tropical American species, *Mimosa pigra*.

Mimosa out-competes grassland species and spreads rapidly by seed through waterways. In this way, the plant has invaded 800 square kilometres of the Northern Territory and become a threat to Kakadu National Park. It is particularly harmful to native birds as it destroys their breeding sites.

The control program for mimosa aims to establish a suite of biocontrol agents that attack the weed all year-round. Six agents have been released so far, one of which (a fungus) has reduced seed set by 60% in the Adelaide River flood plains. It is anticipated that additional control agents will be needed as the weed invades different climatic zones.

Predicting weed spread

To forecast the pattern of this invasion, scientists at the Division of Entomology first investigated the mimosa's native environment and identified its distribution limits. They then assessed the species' climate preferences in other countries. With this information, and a knowledge of Australia's climate, CLIMEX predicted the geographical limits of the weed's likely spread.

A knowledge of the pest being studied is important when interpreting the output from the program. For example, CLIMEX would predict that the cane toad could spread 200 km south if the annual temperature increased by 3°C. But knowledge of the cane toad's biology suggests this is unlikely, since the toad would be unable to move quickly enough to exploit a short-term climatic change in individually warm years. On the other hand, a pest like the buffalo fly could exploit such conditions to temporarily expand its range.

The CLIMEX package includes 2400 sets of meteorological data from around the world. It is generating a body of information which anyone can use.

'Once the climatic requirements of a species have been estimated with the CLIMEX model, they are captured in a series of equations,' Sutherst says.

'If we take on a consultation in China, for example, we can use that information before we visit to estimate what will happen to that species anywhere in the country. In this way CLIMEX reduces the amount of preparatory research work and the cost for a particular pest project.'

Sutherst says this type of modelling, which exploits the variation in climates of different geographical areas, is a field of ecology which has been neglected yet offers solutions to environmental problems.

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