Insects help clear weed-infested waters

About 20 years ago the pretty blue flowers of water hyacinth first made their appearance in the Gingham Watercourse, one of the network of channels through which the Gwydir River flows just downstream of the New South Wales town of Moree. At that time nobody took the plant seriously, but by 1975 some 10 000 ha of wetlands had become clogged by water hyacinth, together with a bulrush known as cumbungi.

This infestation was alarming enough in itself, since by blocking the watercourses in this particularly flat area the weed was preventing flood waters from draining from local agricultural and pastoral land, and at the same time drastically reducing the flow to properties bordering the Gingham Watercourse downstream. However, the Gwydir River is part of the Darling River system, and it became clear that water hyacinth washed out during floods could well pass down the river and finally infest the entire Murray–Darling system — a daunting prospect indeed.

Water hyacinth is regarded as the world's most troublesome water weed. Coming originally from South America, it now causes very serious problems in the warmer parts of North America, Africa, Asia, and Australia. It is one of more than 100 species of plants considered to be water weeds in Australia, and one of the seven or so that create the greatest problems.

Of these seven, the following five originally came from overseas: water hyacinth (Eichhornia crassipes), salvinia (Salvinia molesta), alligator weed (Alternanthera philoxeroides), water lettuce (Pistia stratiotes), and Canadian pondweed (Elodea canadensis). The remaining two, which are natives of this continent, are hydrilla, or water thyme (Hydrilla verticillata), and floating pondweed (Potamogeton tricarinatus).

Controlling water weeds may well cost the country as much as $6 million each year. If the aliens in particular are permitted to spread further into our inland waterways, irrigation ditches, and reservoirs, this figure could rise considerably.

Man-made problem

Water plants capable of making a nuisance of themselves usually require two conditions in which to thrive — slow-moving or still water, which may also need to be shallow (depending on the plant), and a plentiful nutrient supply. Unfortunately, major engineering works like reservoirs and irrigation or flood control schemes often provide such still or slow-moving waters, and fertilizers applied to crops and pastures provide nutrients that wash into inland bodies of water. Thus, water weed control often becomes an unwanted additional running expense to water engineering developments.

The enhanced supply of nutrients from agriculture is presumably a fact of life, which will usually have to be lived with. However, in two recent cases — where hydrilla had become a problem in Lake Moondarra at Mount Isa, Qld, and alligator weed had choked the Georges River near Liverpool, N.S.W. — nutrient levels were being raised by sewage being discharged into the water. Obviously, in such cases the nutrient supply can be reduced — albeit at a considerable cost. Normally, however, local authorities have to fall back on weed cutting or using herbicides, both of which are costly and usually only short-term in their effects.

Nevertheless, weed control costs can be lessened if features that discourage weed growth are incorporated into the design of water engineering schemes.

Biological control

The fact that the most aggressive water weeds are aliens may permit use of another control method that in the long run will be considerably cheaper than cutting or using herbicides. This technique is biological control, an approach that has, until recently, been little used against water weeds.

Biological control involves using natural enemies of a pest plant (or animal) to reduce its population to an acceptable level. Dr Ken Harley at CSIRO's Long Pocket Laboratories near Brisbane has for several years now been introducing insects that attack water hyacinth, salvinia, and alligator weed. Some have already been released, and these appear to be causing considerable damage to water hyacinth and alligator weed.

To date, much of the research into biological control of water weeds has been done by scientists of the United States Department of Agriculture (U.S.D.A.). Dr Harley began his program in 1975 and, until recently, he has been borrowing the results of the American research by concentrating his attention on insects for water hyacinth and alligator weed that have already been introduced into southern parts of the United States.

People continue to spread water hyacinth — mainly by throwing plants from their backyard fish-ponds into nearby streams, rivers, or swamps.
Not a crop or pasture, but water hyacinth clogging a natural lagoon in south-eastern Queensland.

However, agents selected for the North American environment may not be suited to the rather different Australian one. So the CSIRO Division of Entomology (the Division that employs Dr Harley) has established a Biological Control Unit at Curitiba in Brazil. Staff based there are investigating water hyacinth, alligator weed, and salvinia over their South American range.

World’s worst water weed

Water hyacinth is a notorious floating weed that, in its native South America, is largely controlled by a combination of natural enemies and flooding each year in the rivers in which it lives. It has spread throughout the tropics and sub-tropics of the rest of the world since the 1890s. It was first noticed in Brisbane, Sydney, and Grafton about 1894, and its attractive flowers and its ability to grow easily in garden ponds have ensured that people spread it rapidly around the country.

By the turn of the century, water hyacinth had already become naturalized in coastal areas of Queensland and New South Wales, and by 1939 it was growing in both Victoria and South Australia. It has now been recorded as growing successfully in every State or Territory here, with the exception of Tasmania. (Although introduced in Tasmania, it has not yet succeeded in becoming established there.)

People continue to spread water hyacinth — mainly by throwing plants from their backyards fish-ponds into nearby streams, rivers, or swamps. It was only recorded in the Darwin area about 10 years ago, and more recently a new outbreak was reported near Wagga, N.S.W. So far, all outbreaks in southern New South Wales, Victoria, and eastern South Australia are thought to have been eradicated. However, in the warmer areas to the north, eradication would now be impossible.

Water hyacinth produces seeds, and seedlings may be important for re-colonization of areas from which the plant has been cleared. However, its phenomenal growth rate and its vegetative reproduction system account for much of the build-up in infested localities. For example, studies in Louisiana, U.S.A., showed that one plant there produced 248,181 daughter ones in 90 days, which means that the number of plants doubled every 5 days.

Controlling the weed is made more difficult by the fact that it regenerates prolifically from fragments of stems. Water hyacinth will tolerate a wide range of environmental conditions, including frosts — it will not be killed unless the upper parts of the under-water rhizomes become frozen.

Weevil from the United States

Dr Harley and his colleagues began their aquatic weed control program in January 1975, when they imported from the U.S.D.A. laboratories in Florida a South American weevil called Neochetina eichhorniae. This weevil had successfully attacked water hyacinth in Florida, Louisiana, and nearby States. Studies at the quarantine facilities of the CSIRO Long Pocket Laboratories confirmed the American experience that the insect would confine its attacks to water hyacinth, and it was approved for liberation the following June.

The weevil has now become established on numerous water hyacinth infestations along the eastern coasts of Queensland and New South Wales. It is encouraging that some plants in the infestations along the central Queensland coast had been killed only 2 years after the weevil was first released. However, Dr Harley points out, it will be several years before the effectiveness of N. eichhorniae as a control agent can be fully assessed.

Dr Harley does not expect this weevil by itself to satisfactorily control water hyacinth over its whole Australian range. Instead, he expects that it will be necessary to release a number of insect species, each of which will attack the plant in a different way, and each of which will be adapted to slightly different circumstances.

A second insect, a moth called Sameodes albiguttalis, has now been imported from the Florida laboratories of the U.S.D.A., rechecked for its specificity for water hyacinth, and released. Already it has established itself on the weed over much of its expected range in Queensland and New South Wales.

Notoriety on Kariba Lake

Salvinia is a more recent arrival in Australia than water hyacinth. It shares with the latter phenomenal powers of regeneration and growth. In the laboratory it has been known to double its biomass in 3½ days. This sterile water-fern achieved particular notoriety during the 1960s when mats occupied some 1000 sq. km of the surface of Lake Kariba. The infestation of this artificial lake, which is located between Zambia and Rhodesia, occurred shortly after the Kariba dam was completed.

This little weevil, Neochetina eichhorniae, has been killing water hyacinth successfully since its introduction in 1976.
The troublesome species is *Salvinia molesta*, which seems to have a very limited range in its native south-eastern Brazil. This particular species was first recorded as a weed in 1943 in Sri Lanka. It now occurs in Africa, India, Sri Lanka, south-eastern Asia, Fiji, New Zealand, and Australia.

Some 20700 adult beetles were liberated at various alligator weed infestations along the Georges River.

It was first recorded in this country in the Brisbane area in 1953. Since then it has spread over an area rather similar to that occupied by water hyacinth. The fern has not yet caused any problems in the Murray-Darling system, but it has been seen near Deniliquin in southern New South Wales, and in Adelaide. It also occurs in the vicinity of Darwin, and at Gove in the Northern Territory.

Dr Harley and his colleagues began looking for natural enemies of salvinia from the laboratory at Curitiba, Brazil, early in 1978. To date, a weevil has been imported for evaluation.

Another South American

Like water hyacinth and salvinia, alligator weed originated in the tropics and subtropics of South America. It was first recorded in North America, in Florida, in 1894, and in Indonesia as early as 1895. By 1906 it was growing in New Zealand, but the plant wasn't recorded in Australia until the mid 1940s.

To date, alligator weed has not spread through the tropics and subtropics as fast as its two compatriots, perhaps because people don't favour it in aquaria or in garden ponds. But it seems to be able to establish itself readily in new environments, so it must be considered as being a potential threat to warm inland waters all over the world.

In a survey carried out in 1975, Dr Harley found that, in Australia, alligator weed occurs only in New South Wales, in three areas. The worst infestations are in the Georges River near Sydney, and close by Williamtown near Newcastle. However, the third infestation, near Holbrook, has been viewed with considerable apprehension since it poses a threat to the irrigation systems on the Murray and Murrumbidgee Rivers.

Like water hyacinth and salvinia, it spreads down river systems mainly by pieces being broken off and swept downstream (the flowers do not seem to yield seeds). Infestations usually begin from plants that become rooted in the banks of lakes, streams, or canals. With favourable conditions of temperature and nutrition, the plant grows outwards from the banks and forms a floating mat, which is rapidly replaced if swept away by floods or killed with herbicides. Infestations limit the use that can be made of the water, and generally reduce its quality.

Successful start

Dr Harley and his colleagues began their biological control program for alligator weed in June of 1976 when they imported from the U.S.D.A. laboratories in Florida the alligator weed flea-beetle. It was first released 6 months later.

Vast numbers have been released — early in the summer of 1977–78, for example, 20700 adult beetles were liberated at various alligator weed infestations along the Georges River, and beetle populations have risen rapidly.

Already, mats of much-weakened alli-
Gator weed have been washed away by floods or have merely sunk. Beetles surviving on small pockets of weed have been controlling regrowth this last summer.

Dr Harley and his colleagues have now also introduced a moth, which was first released during the summer of 1977–78. He is optimistic that these insects will keep floating infestations of alligator weed under control.

Unfortunately, alligator weed also grows on dry land, and the two insects liberated so far do not attack it under these circumstances. Such populations on dry land thus constitute a large reservoir from which the weed may be spread to uninfested regions. Already turf from near Williamtown, which may have contained alligator weed, has been sold elsewhere, and livestock may also carry it to clean areas. For this reason the staff of the CSIRO Biological Control Unit in Brazil is looking for agents that will control the weed on land.

Try fish?

Biological control need not always involve using insects or even plant diseases. Troublesome Canadian pondweed and hydridilla seem particularly unpromising candidates for control using such agents because they always remain completely submerged. Even so, biological control of these water weeds should not be entirely ruled out. A herbivorous fish called the white amur, or Chinese grass carp, is being investigated in several countries. In particular, it has been shown to have a considerable potential for controlling hydrilla in southern parts of the United States, where this Australian weed poses a very serious problem.

The white amur prefers certain submerged weeds, but it could only be introduced following demonstrations that such a fish would not attack useful plants. In any case, other ecological consequences, such as its effects on other fish and other forms of water life, would need to be checked out very carefully.

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More about the topic


Dealing with plant or animal pests using biological control has many advantages over using pesticides or mechanical means, of which the most important are that:

- once it has succeeded it is more or less permanent, so it's cheaper in the long run
- it affects only the target pest
- it doesn't pollute the environment

However, no doubt because of its more spectacular successes, the method is the subject of a number of popular misconceptions.

Perhaps the most commonly held of these is that biological control is an alternative means of eradicating pests. It isn't. The method does not seek to totally annihilate weeds or animal pests, it aims at permanently reducing their numbers to a level that we can tolerate. Thus prickly pear still grows in Queensland despite the fact that the little moth Cactoblastis cactorum very successfully controlled it nearly 50 years ago. But nowadays the cactus rarely becomes plentiful enough to be regarded as a pest. Small populations of the moth remain on the pockets of prickly pear that survive, ready to attack any flare-ups.

If successful control agents can be found, this situation should apply equally well with water weeds like water hyacinth, salvinia, or alligator weed, or with any other plant or animal pest. Thus, in the long run, biological control becomes by far the most economical method.

Another major misconception is that biological control will always be quick. Biological control is usually remembered for the spectacular speed of its successes — it took only a few seasons for prickly pear and the most common strain of skeleton-weed to be controlled after the release of suitable control agents. Usually the results will be much slower in coming. A period of several or even many years may elapse before the introduced control organisms have increased sufficiently in numbers and range to begin controlling infestations of a pest.

The philosophy behind biological control is, of course, simple. In their natural state plants (and animals) occur in population densities that remain in balance with the rest of the biological community. Gross disturbance of that community may upset the balance, with the result that some plants become extinct, while others become most dominating.

Agriculture causes just such a disturbance, and the successful but unwanted plants that grow and compete with the crops or pasture plants are, of course, weeds. The most extreme case of disturbance occurs when a fast-reproducing plant or animal is removed from its place of origin and introduced to another continent.

Under these circumstances the biological checks that limited this organism are completely removed and it will rapidly multiply wherever circumstances permit.

The Australian landscape is littered with examples of exotic plants that have been introduced and then become weeds — prickly pear, skeleton-weed, lantana, gorse, and Paterson's curse (salvation Jane) are but a few examples, and the explosion of rabbit numbers in Australia last century showed very clearly how an animal can become a pest once constraints on its breeding have been removed.

Such pests seldom cause problems in their countries of origin, so something, or more often several things, is keeping them in check. If some of these checks are living organisms (like insects, or diseases caused by fungi or viruses) it may be possible to use them to control the pest in the country where it has become a nuisance.

This may sound simple, but an effective biological control program involves considerable amounts of research. To begin with it is essential that the controlling agent should confine its attention to the target pest, and also essential to make sure that it will not attack crops or other valuable plants. Also, an organism that attacks the particular pest in its place of origin won't necessarily do so effectively in its new home. The environmental conditions may be different in the two places, and although the pest may thrive, its introduced enemies may not. Thus careful evaluation is needed to make sure that the introduced organism is suited to the environmental conditions of the new country. Even organisms that have successfully controlled weeds in one country after introduction there may not succeed under the different conditions prevailing in another — like Australia. (Sometimes the converse may apply — an insect that has little effect on the target pest in its place of origin may thrive on the weed away from its own enemies in the new country.)

As may be expected, introduced control organisms are usually more effective if they can breed quickly, and distribute themselves rapidly. By the time a plant has become a troublesome weed, infestations will nearly always be covering large areas. Control organisms are therefore released in as many localities as possible, and left to spread themselves.

In summary: organisms that confine their attacks to the target pest, breed rapidly, and originate from an environment similar to the one into which they will be released have a good chance of being successful biological control agents.