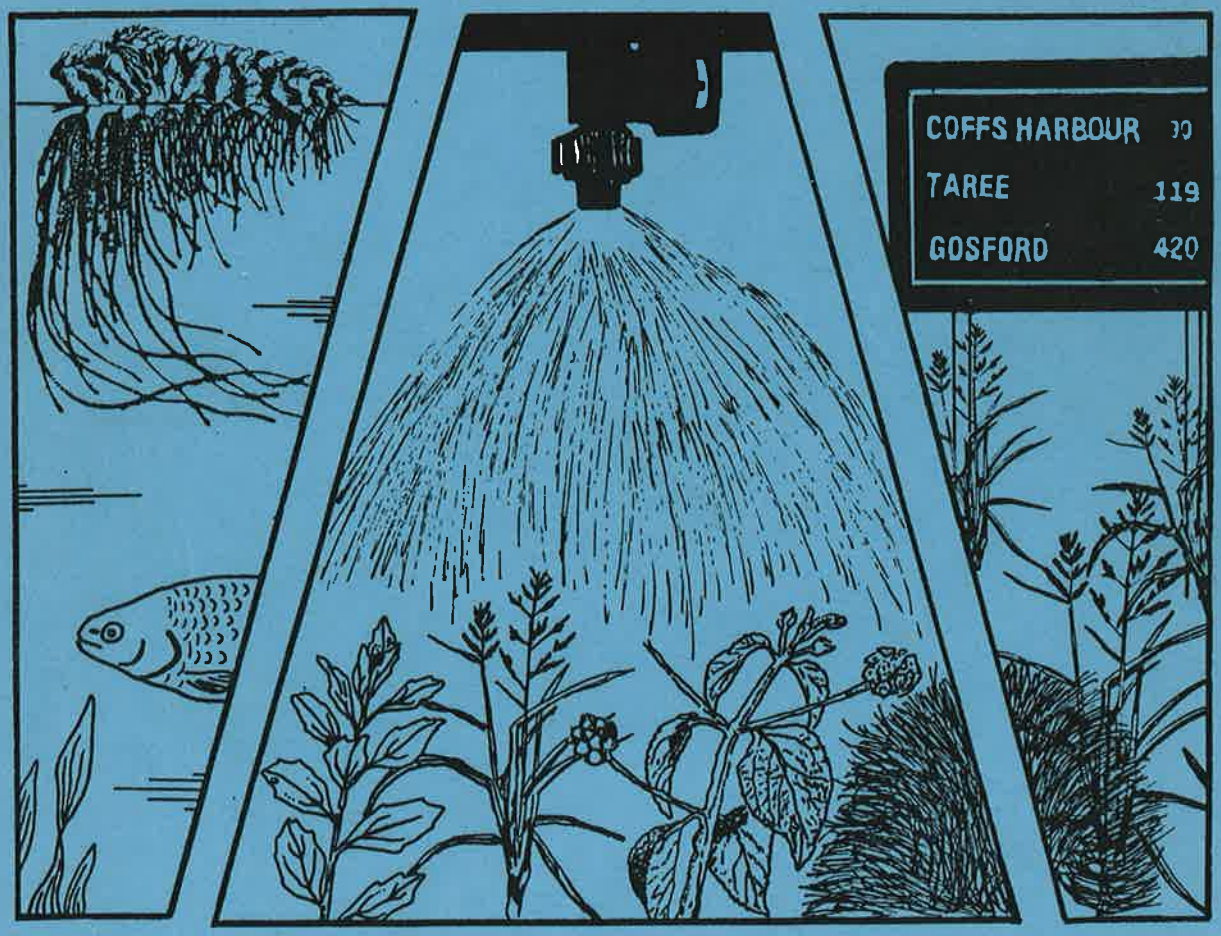
FOURTH BIENNIAL NOXIOUS PLANTS CONFERENCE

Hawkesbury Agricultural College, Richmond

29th June – 3rd July 1987

Conducted by

Department of Agriculture New South Wales



Weed management – Rural and Urban

Department of Agriculture New South Wales

PROCEEDINGS OF THE FOURTH BIENNIAL NOXIOUS PLANTS CONFERENCE

HAWKESBURY AGRICULTURAL COLLEGE,
RICHMOND. N.S.W.

29th JUNE - 3rd JULY, 1987

Edited by R. E. A. Dyason

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ACKNOWLEDGMENTS

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PROGRAM

MONDAY, 29TH JUNE, 1987

8.30 am	Late registrations
9.15 am	Welcome: Cr. David King, Chairman, Hawkesbury River County Council
9.30 am	Opening Address: Hon. Janice Crosio M.P., Minister for Local Government
10.00 am	**MORNING TEA**
10.30 am	Noxious Plant Control Management in NSW Dr. Leon Smith, Principal Agronomist (Weeds)
11.00 am	Weeds and the Environment Laurie Greenup, Director of Pesticides and Environmental Studies
11.30 am	Noxious Plant Control in South Australia David Creeper, Regional Advisor, Pest Plants & Vertebrate Pests Commission
12.00 am	Invasiveness of Weeds Dr. Richard Groves, Principal Research Scientist, CSIRO
12.30 pm	**L U N C H**
1.30 pm	Legal Procedures In Regard to Noxious Plant Control Alan Russell, Chief Legal Officer, Department of Agriculture
3.00 pm	**AFTERNOON TEA**
3.30 pm	Legal Procedures (continued)
Night	**Evaluation of Noxious Weeds Awareness Week**

TUESDAY, 30TH JUNE, 1987

8.45 am	Urban Weed Initiatives Derek Brown, Noxious Plants Advisory Officer, Tamworth
9.15 am	Weeds and Human Health Dr. Diana Bass, Department of Allergy, Royal North Shore Hospital
10.00 am	**MORNING TEA**
10.30 am	Urban Weed Dilemna Dr. Marilyn Fox, Royal Botanic Gardens, Sydney
11.00 am	A Councils Initiative in Controlling Community Pest Plants Murray McCafferty, Ku-ring-gai Municipality

11.45 am	The History of the Introduction of Weeds Into Australia Professor Peter Michaels, University of Sydney
12.30 pm	**L U N C H**
1.30 pm	The Development of Herbicides Ken Watson, Research Leader, Dow Chemicals
2.00 pm	The Disposal of Herbicides Dr.Harley Wright, State Pollution Control Commission
2.30 pm	The Safe and Effective Application of Herbicides Greg Stores, Combined Chemicals
3.00 pm	**AFTERNOON TEA**
3.30 pm	The Aims & Objectives of the NSW Weed Society Geoff Jacobs, Du Pont (Australia) Ltd.
3.45 pm	Woody Weed Control Jim Dellow, Special Agronomist (Weeds), Orange
4.15 pm	Urban Weeds on the Move Dr. Leon Smith, Principal Agronomist (Weeds)
4.45 pm	Problems Associated With the Use of Herbicides In or Near Water Chris Ripper, Field Officer, Weeds, Department of Water Resources
Night	**Noxious Plants Officers Association meeting**

WEDNESDAY, 1ST JULY, 1987

8.30 am	New Products and New Uses for Old Products Short talks by various chemical companies on recent developments
9.30 am	Safety Equipment
10.00 am	**MORNING TEA**
10.30 am	**FIELD DAY**

- Commercial exhibits: safety equipment
  spray equipment
  cultural equipment for weed control
  weed wipers, gas gun
- Selected council weed spray vehicles
- Weed display
- Weed information and identification centre
- Spray calibration demonstration (continuous throughout day)
- Video tape screenings on aspects of weeds and their control
- Spraying demonstrations

THURSDAY, 2ND JULY, 1987

8.30 am	Biological Control Policy in NSW Robert Dyason, Noxious Plants Advisory Officer, Grafton
9.00 am	Management Practices Des Thwaites, Des Thwaites and Associates
10.00 am	**MORNING TEA**
10.30 am	Communication and Publicity Alan Batchelor and Tom Braz, Regional Media Officers
11.30 am	Fireweed Brian Sindel, University of Sydney
12.00 noon	Management Practices (continued)
12.30 pm	**L U N C H**
1.30 pm	St. Johns Wort and Pasture Establishment Dr. Malcolm Campbell, Principal Research Scientist, Orange
2.00 pm	Spiny Burrgrass Control Utilising Rhodes Grass Dave Richards, Weeds Inspector, Castlereagh Macquarie County Council
2.20 pm	The Latest Developments in Biological Control Dr. Ernest Delfosse, Senior Research Scientist, CSIRO, Canberra
3.00 pm	**AFTERNOON TEA**
3.30 pm	Innovative Uses of Goats for Weed Control Terry Mitchell, Special Livestock Officer (Goats), Dubbo
4.15 pm	The Latest Developments in the Biological Control of Paterson's Curse Dr. Ernest Delfosse, Senior Research Scientist, CSIRO, Canberra
4.45 pm	Noxious Plant Control in New Zealand Fred Marsh, Guest Weeds Officer from New Zealand
Night	**Conference Dinner**

FRIDAY, 3RD JULY, 1987

8.30 am	Dodder Hugh Milvain, Noxious Plants Advisory Officer, Yanco
9.00 am	Parramatta Grass Ken Hayes, Weeds Inspector, Coffs Harbour Shire Council
9.15 am	The Introduction of Blackberry Rust Jim Cherry, Chief Weeds Officer, Central Northern County Council
9.30 am	The Registration of Herbicides Harvey Baker, Registrar of Pesticides

10.00 am	**MORNING TEA**
10.30 am	The Variation in Application Rates Between Various Operators Spraying Woody Shrubs Max McMillan, Special Agronomist (Weeds), Glen Innes
11.00 am	Latest Developments in Alligator Weed Legislation Ken Bunn, Weeds Officer, Port Stephens Shire Council
11.15 am	Parthenium Weed Update Derek Brown, Noxious Plants Advisory Officer, Tamworth
11.45 am	Conference Evaluation.
12.30 pm	C L O S E

NOXIOUS PLANT CONTROL MANAGEMENT IN N.S.W.

L. W. Smith

Department of Agriculture
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INTRODUCTION

The pressures from changing social attitudes, from community interest groups, for more accountability and better performance makes it imperative for us to stop, think and carefully assess our current methods and policies for noxious plant control.

With a better informed and educated public and an ever broadening environmental lobby, together with additional all-encompassing legislation affecting many activities, it is essential for everyone to update, revise and plan all aspects of their noxious plant control management programmes.

The following guidelines for conducting noxious plant control programmes have been produced by the Noxious Plants Advisory Committee to enable local government authorities to operate and plan better noxious plant control programmes and to relate these to an overall total land protection policy to help preserve the land for future generations.

GUIDELINES

1. In order that Council carry out an effective noxious plant control programme it should:

   (i) adopt a noxious plant policy statement (sample copy attached as Appendix I) and circulate to all ratepayers;

   (ii) employ a full-time Weeds Inspector (Noxious Plants Inspector) directly responsible to Council or a single department of Council;

   (iii) ensure that the Noxious Plants Inspector has adequate facilities and the full support of Council;

   (iv) provide for adequate training and updating of all Council officers involved in controlling noxious plants;

   (v) establish a special Weeds Committee within Council to monitor and advise on Council's noxious plants policies;

   (vi) adopt a special planned programme of noxious plant control over a full 12 month period (see Noxious Plants Control Plan/ Programme - Appendix II);

   (vii) liaise with the community by communicating with groups of concerned citizens i.e. Ratepayers Associations etc. about the control programmes and policies;

(viii) carry out advisory activities or publicity to enhance the landholder's understanding of his responsibilities under the Act;

(ix) carry out a proper and appropriate policing and enforcement programme on both private and public lands;

(x) be aware of the assessment procedures used to evaluate the progress of local government control programmes (Appendix III).

2. Council should also be aware of the following:

(i) the role of the Noxious Plants Advisory Committee (see Policy Statement produced annually by the NPAC for details);

(ii) that several other Acts of Parliament impinge on the area of noxious plant control and need to be considered when any programme is undertaken. These include:

Pesticides and Allied Chemicals Act, 1978
Public Health Act, 1902 (Hazardous Pesticide Regulations)
Drug Misuse and Trafficking Act, 1985
State Pollution Control Commission Act, 1970
Clean Waters Act, 1970
Soil Conservation Act, 1938
Environment Planning and Assessment Act, 1979

(iii) that noxious plant grants are made to local government authorities, Pastures Protection Boards and Trusts to assist with control of noxious plants on Crown Land and to carry out their responsibilities under the Local Government Act.

(iv) the role of the Department of Agriculture and its advisory services for assisting with their programmes (see Appendix IV).

(v) the value of cooperation and coordination of noxious plant control activities with other authorities in their area.

(vi) the reasons for declaration of plants as being noxious and the criteria used to evaluate declaration (Appendix V).

APPENDIX I

EXAMPLE OF COUNCIL NOXIOUS WEEDS POLICY

1. INTRODUCTION

The Council's objective is to eradicate or control all noxious plants within the Shire.

Every landholder (urban and rural) or person(s) leasing or renting properties i.e. all owners/occupiers of land, is obliged under the Local Government Act, 1919 (Section 472), to take reasonable and effective measures to eradicate noxious plants from the land.

As financial resources for noxious plants control are limited, Council has to:

(a) Aim to obtain maximum landholder cooperation and participation in the effective implementation of the weed control programme, and

(b) Place greater emphasis on those weeds likely to cause greatest economic loss, either because of their widespread presence or ability to spread rapidly in the future.

Each year the Council applies to the Noxious Plants Advisory Committee for a Government Grant to supplement Council funds for noxious plants control work.

2. ADOPTED POLICY OF COUNCIL

(a) To eradicate or control all noxious plants on Council owned and public lands thereby setting an example to landholders.

(b) To determine the degree of noxious plant infestation within the Shire by regular inspections of all lands and to determine a programme for the eradication or control of such noxious plants.

(c) To achieve the object with the closest cooperation with the landholder in the first instance, otherwise by use of its legal powers.

(d) To carry out the policy in close liaison with the District Agronomist and other officers of the Department of Agriculture.

(e) To maintain the Council plant and equipment at a high standard of efficiency.

(f) To assist landholders by spraying noxious plants on private land at the landholder's expense.

(g) To encourage and assist the establishment of trial plots and use of chemicals in close cooperation with officers of the Department of Agriculture, manufacturers and landholders.

(h) To maintain a priority list of noxious plants and to review such priority list annually.

3. **WORK METHODS**

Council's method of implementing control will consist of:

(a) Inspection, interview where possible and written report advising the presence of specific weeds, control methods, areas to be treated and a suitable time to effect control measures.

(b) If the subsequent inspection shows no action has been taken, a Section 473 Notice, under the Local Government Act, is served. Failure to comply with this notice results in Council instituting legal proceedings for non-compliance and/or the issue of a Section 474 Notice, under the Local Government Act after which Council may enter onto the property and carry out the work at the landowner's expense.

4. **ON FARM**

(a) Council will aim to progressively reduce noxious weeds, by the active cooperation and participation of landholders, in the development of practical, reasonable and effective whole farm plans for noxious weed control.

(b) Properties with large infestations will require an ongoing plan, designed with consultation with the landowner, and District Agronomist, which will initially require a base area to be cleaned, subsequent years will require maintenance of clean areas plus additional undertakings until the property is satisfactory.

5. **RESOURCES**

At present Council employs:

(a) One Weeds Officer who is available for inspection and consultation purposes.

(b) A spray operator, operating a modern fully equipped spray unit to control noxious weeds on Council land. This unit is available for small contract work only, on a "BREAK EVEN COST BASIS".

Landholders may contact Council's Weeds Officer for information regarding private contract work.

For the inaccessible and heavily infested areas Council's Weeds Officer assists landholders to organise aerial group spraying programmes (annually or when required) by helicopter or fixed wing aircraft.

Council supplies registered chemicals for contract work and group spraying programmes, at Council's bulk purchase price plus oncosts.

6. PRIORITY LIST

Listed in order of priority are the problem noxious plants:

1. Serrated Tussock
2. Blackberry
3. African Love Grass
4. St. John's Wort
5. Paterson's Curse

APPENDIX II

COUNCIL NOXIOUS PLANT CONTROL PLAN/PROGRAMME

Effective and economical programmes of noxious plant control must be carefully planned from the start. The planning process must include:

(i) assessment of the problem (identify major weeds and extent of infestations);

(ii) planning of the control work (decide what method of control is to be used, when control should be carried out, physical or equipment requirements);

(iii) the execution or implementation of the plan in the field (carrying out of actual work);

(iv) evaluate results of work carried out and modify as necessary to maintain a satisfactory level of control.

Consultation with appropriate persons or advisory bodies is necessary at all stages of planning.

The actual method of control adopted will depend on many factors including the situation in which the weed occurs, the cost of treatment, the available resources etc. However, the use of integrated weed control systems in all programmes is to be highly recommended.

This system utilises all suitable techniques and methods in as compatible a manner as possible to maintain the weed below economic levels.

The continuous use of one control method is likely to lead to tolerant or resistant weed flora and thus the use of a series of separate but mutually compatible and supportive methods each of which puts a different pressure on the weed population is necessary.

Continual spraying of noxious weeds on roadsides usually leads to a change in weed flora and the need for further sprays. However, after initial removal of weeds, replacement with desirable non weedy species will cut costs and be more environmentally acceptable.

The Council's programme plan should:

(a) list objectives of the programme;

(b) list noxious plants declared for the area in priority of control;

(c) prepare maps of all known infestations of the noxious plants of the area (originals and annual overlays);

(d) develop a long term control plan of action (5, 7, 10 years) involving a total land management strategy for the local government area;

(e) overall strategy should involve all methods of control (sprays, cultural, mechanical, biocontrol and environmental) and ensure that

all safety requirements have been observed.

(f) an update of the programme and plan should be carried out annually;

(g) provisions should be made for liaison, support, cooperation with other interested groups and neighbouring councils;

(h) special regard needs to be made for publicity and community awareness about noxious plants and to enhance landholder understanding of his responsibilities;

(i) outline to landholders (in policy statement) attitude and mode of operation of council also assistance available from Council;

(j) provide for proper financial accountability of the costs involved in the programme.

APPENDIX III

GUIDELINES FOR ASSESSMENT OF COUNCILS

COUNCIL

1. Understand the need to develop a balanced long term programme to control noxious plants (5 years).

2. In conjunction with long term programmes, formulate and carry out effective yearly programmes which would need to be reviewed annually.

3. Look to develop a total land management strategy for control of noxious plants in conjunction with a spray programme and be able to integrate other methods such as a biological control system into existing programmes.

4. Have a proven ability in the operation of Local Government accounting procedures and recognise its financial responsibilities and commitment to control serious noxious plants beyond the $: $ concept.

5. Recognise the need for a Weeds Department/Section within Council and have good facilities and equipment for use by the Weeds Officer and staff. The Department/Section reports direct to Council.

6. Ensure that the Weeds Officer receives adequate training and continued update training at all times.

WEEDS OFFICER (NOXIOUS PLANTS OFFICER)

1. Has a sound knowledge of the Noxious Plants of his area and the various Acts which are relevant to the control of noxious plants.

2. Show initiative and responsibility in noxious plant control programmes within Council area.

3. Is prepared to adopt new approaches to noxious plant control and integrate them into the total programme.

4. Be competent in his job and approach to the ratepayer by securing good public relations for control of noxious plants.

THE COUNCIL/WEEDS OFFICER

1. Does Council support the Weeds Officer and recognise the need for his services and private land policy?

2. Has the Weeds Officer adequate office and record facilities and is he available to the general public to answer inquiries?

3. Are Council and Weeds Officer willing to cooperate with neighbouring Councils and managers of Crown Land to control noxious weeds on a watershed or community basis?

APPENDIX IV

THE ROLE OF THE NSW DEPARTMENT OF AGRICULTURE

While it is the responsibility of the Department of Local Government to administer the Local Government Act, and other administrative matters, the Department of Agriculture executes a more active role. It is the function of the Department of Agriculture to provide and allocate to Councils all State Government grant funds for noxious plant control, advise on all management and technical matters for noxious plant control and to provide biological control and research expertise.

An advisory service is provided to Councils and landholders through the District Agronomists, Noxious Plants Advisory Officers and the Pesticides Inspectors.

District Agronomists are resident district advisory officers who provide the local agronomic expertise, their districts cover between 1-2 shire areas. They are available to provide local assistance at all times.

Noxious Plants Advisory Officers are regional advisory officers who provide a direct service to Local Government and Pastures Protection Boards for noxious plant control. These officers are located at Cowra, Dubbo, Leeton, Tamworth and Grafton; each officer has a regional responsibility.

Inspectors (Pesticides Act) are regional officers with an advisory/ regulatory responsibility. The officers advise on all the aspects and requirements of the Pesticides Act 1978. They are responsible to see the Act is properly implemented and can initiate regulatory action when necessary.

The Noxious Plants Advisory Committee is responsible for advising the Minister for Local Government and the Minister for Agriculture on all matters relating to noxious plant control. This Committee meets regularly and undertakes visits to various parts of the State. The committee is not in a position to make detailed inspections of individual councils nor to make regular visits.

Noxious Plants Advisory Officers are employed by the N.S.W. Department of Agriculture to promote the control of noxious plants and have the responsibility of acting as field officers for the Committee. They provide contact between the Committee and organisations, particularly councils, involved in noxious plant control. The Noxious Plants Advisory Officers have the responsibility of maintaining contact with the various organisations and reporting to the Committee.

The Noxious Plants Advisory Officers are responsible for:

(1) Visiting councils and any other organisations receiving government grant funds and assessing all aspects of their noxious plant control programmes.

(2) Assessing the noxious plant control grant applications submitted by councils and other bodies receiving government grant funds and making recommendations to the Noxious Plants Advisory Committee in regard to each application.

(3) Provide technical and management advice on weeds to councils and other bodies.

(4) Promote the coordination of noxious plant control programmes and cooperation between the various organisations concerned.

(5) Provide training for staff involved in noxious plant control.

(6) Organise and conduct conferences, schools and other activities for members and staff of organisations involved in noxious plant control.

APPENDIX V

DECLARATION OF NOXIOUS PLANTS

Tradition has been that, providing it doesn't adversely affect the neighbours, all owners/occupiers of land can make their own decisions on whether to control weeds and if so the amount of control to be achieved. Some weeds, however, have a significant detrimental effect on production or the environment and in these circumstances it is considered desirable in the general interest that each and every individual carry out certain control activities. This interference with the rights of individuals to make their own decisions requires legislative authority. Local Government authorities as representatives of communities have this responsibility through the Noxious Plants Provisions (Part XXII) of the Local Government Act. The weeds for which action is required are designated "Noxious Plants".

Note: Other States are now designating these plants as "declared" or "pest" plants.

Plants are declared as noxious plants by the Minister for Local Government acting on the advice of the Minister for Agriculture.

It is the responsibility of the Noxious Plants Advisory Committee to decide if the threat posed by a weed is sufficient for it to be proclaimed under the Act as a "Noxious Plant". The Act does not stipulate the criteria to be used in making decisions.

However, certain criteria have been established by the Committee to assist in decision making and these are:

Need: That the plant is likely to spread from its present situation to other properties of average management where it is expected to cause serious harm and economic loss from its effect on man, domestic animals, crops and pastures: or to otherwise degrade land and ecosystems.

Means: That means, both reasonable and enforceable, are available to kill the plant, to bring it under effective control and limit its spread.

Intent: That there is a firm intention by the council to enforce control according to the noxious plant provisions of the Local Government Act (1919).

Benefit: That a worthwhile benefit to the community can be reasonably anticipated from enforced control with the methods available.

An element of judgement must enter into decisions relating to declaration and for this reason it is difficult to set down a list of firm criteria against which a plant can be evaluated. It is possible, however, to list the sort of information and evidence that will assist the Committee in making decisions:

(1) Evidence to show the plant causes or has the potential to cause serious economic loss to people or harm to the environment.

(2) Information on the distribution and abundance of the plant.

(3) Evidence that effective and practical control measures are available.

(4) Evidence to show that action taken under the Act is expected to be effective and result in progress being made.

(5) A description of the programme of control or eradication proposed for the district.

(6) An assurance that there is a firm intention to initiate, maintain and if necessary enforce the activity required under the programme.

The review of noxious plant lists for the whole State or individual council areas would normally be held every four years. However, the Noxious Plants Advisory Committee will consider at its June meeting each year any additional requests for declaration.

WEED INVASIONS

R. H. Groves

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About 10% of Australia's total of 20 000 plant species are introduced. In some areas, however, the proportion of introduced plants can be much higher than this average figure. For instance, for the Sydney area there are more than 400 species of introduced and about 1 500 native plants. Of course not all these introduced plants are weeds; perhaps less than a quarter fit into the weedy category.

When Aborigines arrived in Australia more than 40 000 years ago they do not seem to have brought seeds or other plant propagules with them. Although there is no evidence from this pre-European period for plant introduction, immigrants arriving subsequently certainly have introduced plants and some of these have become weeds eventually.

The first record of an introduction leading to an 'invasion' is that associated with the annual visits of Macassans who came to Australia's northern shores from the South Celebes to collect the marine animal called trepang or beche-de-mer. These Macassans took dried trepang back to the Celebes to trade with the Chinese. For up to 200 years from about 1700 the Macassans camped on the beaches of northern Australia. On their voyages they brought large quantities of tamarind fruit with them for their own diet. The first known plant to arrive and establish and become naturalised in Australia was thus the tamarind. Although it has never become a weed, tamarind is now spreading naturally and its presence can no longer be used by archeologists to indicate former Macassan campsites (Macknight 1976).

Accurate historical records of plant introductions since European settlement in 1788 date from the first comprehensive botanical reconnaissance of the Australian coast conducted by Robert Brown during Matthew Flinders' voyage of circumnavigation. By 1804, Brown had noted 29 species of introduced plants collected at Sydney, including such well known weeds as Plaintain (*Plantago major*), Storksbill (*Erodium moschatum*), and Winter grass (*Poa annua*) (Maiden 1916). So began the invasion process for plants; it has continued ever since. Plants have been introduced, sometimes accidentally (e.g. Skeleton weed), sometimes deliberately (Paterson's curse), sometimes with Victorian English nostalgia for 'home' (e.g. Gorse) and sometimes with a blend of European nostalgia and arrogance (e.g. the continued spread of Blackberry by Von Mueller in the late nineteenth century). Since European settlement, the number of introduced species that have become naturalised in four Australian States (South Australia, Victoria, New South Wales and Queensland) has increased linearly with time (Specht 1981). This process is continuing at a rate of from four to six species a year (Figure 1). We now have a quarantine service of high competence yet how long will it take to reduce the number of plants added to the naturalised flora of New South Wales each year as a result of its actions? By looking more closely at the invasion process and the factors which make for invasiveness we may be able to reduce the number of weed invasions in the future.

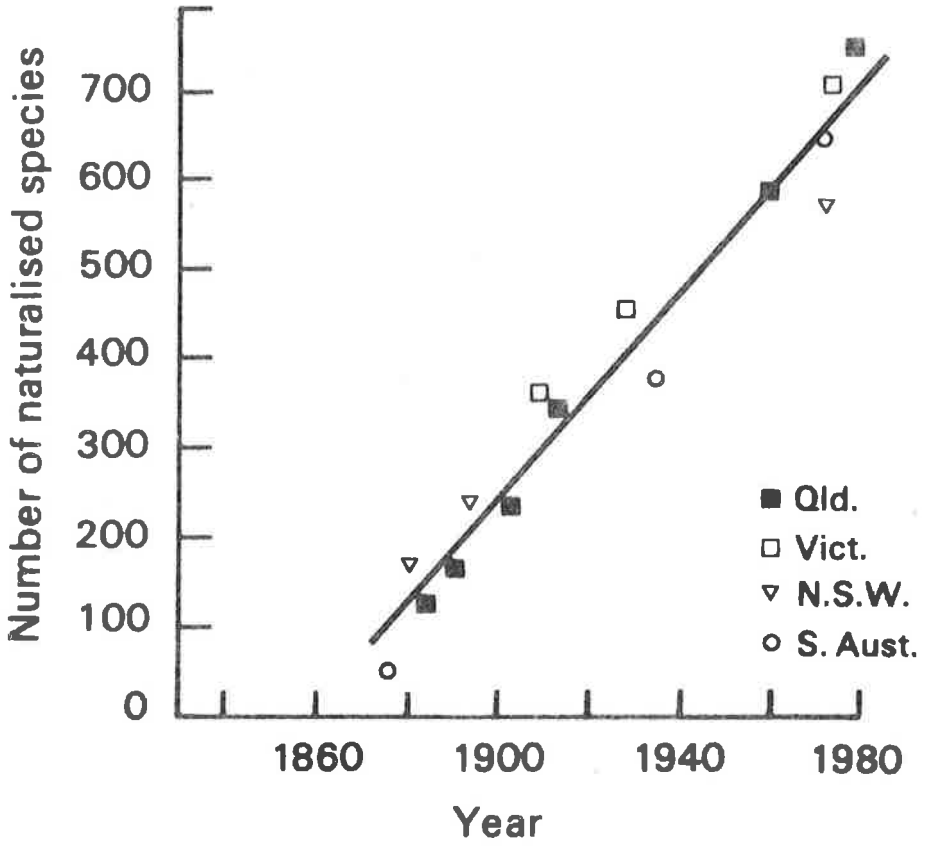

Figure 1. Number of naturalised plant species in the four Australian States of Queensland, Victoria, New South Wales and South Australia 1870-1980 (Figure 14 of Specht 1981).

INVASIONS

There are three main stages in the invasion process: namely, introduction, colonisation and naturalisation. Many plants have been introduced to Australia. Some have failed to regenerate and establish; others have established successfully, formed self-perpetuating populations (the colonisation phase) and gone on to become permanent components of the naturalised flora. Numerically, the order of loss may be that for every 100 species introduced, perhaps only 10 will successfully colonise new environments and only 5 of these will eventually become naturalised. Of these 5 naturalised species, perhaps only 1 will become a weed in that it will interfere with human activities in some way.

Whilst we know very little about the numerical aspects of invasions in any region, we do know that the introduction stage in the overall process can be complex. Let us consider Paterson's curse, a colorful herb of Mediterranean origin, which is now widespread in southern Australia and considered to be a nuisance by most graziers. The plant has also been introduced to South Africa, California and New Zealand. In Australia it was introduced deliberately a number of times in the nineteenth century as an ornamental (Piggin 1977). Kloot (1982) has claimed on the basis of both literature and herbarium records that it became naturalised (cf. introduced) in southern

Australia in the late nineteenth century in two separate areas - one near Albury and the other near Gladstone in South Australia - and later at a third area in southwest Western Australia. The present almost continuous distribution of the plant in southern Australia comes from these separate and previously isolated sites from which it has spread subsequently.

Some of the major weeds of Australian agriculture have had similarly complex invasion histories, for example Soursob (Michael 1964). Thus the invasion of weeds is often complex in space and time and involves, for some ornamental plants at least, multiple introductions of material which may already be genetically diverse in their region of origin, as seems to be the case for Paterson's curse.

PLANT GEOGRAPHY

Australia's weeds have come from many parts of the world - those in northern Australia coming predominantly from both temperate and other tropical regions and those in southern Australia from temperate and Mediterranean-climate regions of the world, especially Europe. Of 578 plants naturalised in Queensland, 33% came from tropical regions and 40% came from Europe, Western Asia and North Africa. Furthermore, there was little change in these proportions according to region of origin between an initial survey in 1883 and one made in 1959, although the absolute numbers of introduced species had increased substantially. The 654 species naturalised in South Australia were grouped according to their origins; most (32%) came from the Mediterranean region and from Europe and Western Asia (Table 1), with a significant but smaller proportion (13%) coming from the Cape Province of South Africa. Generally, plants which have successfully invaded Australia seem to have come from areas of similar climate, although the Queensland example shows that where the people came from also influences where the weeds come from.

Table 1. The origin of species introduced to South Australia (Table 24 of Specht 1972).

Region	Monocots	Dicots	Total
Mediterranean region	47	161	208
Europe and Western Asia	45	194	239
South Africa	34	50	84
Cosmopolitan	15	35	50
South America	6	29	35
North America	3	26	29
Southeast Asia	2	7	9
Total	152	502	654

Currently, within Australia, there seems to be an increasing exchange of plant species between different regions, but this refers more to movement of some native plants than to weeds.

In return for these plants coming in to Australia, some Australian plants have themselves become invaders of other countries. Apart from the indigenous woody plants such as Eucalypts, Casuarinas and Acacias, several

herbaceous Australian plants have also become invasive in other regions. *Vittadinia triloba*, a composite, is native to southeastern Australia and is now naturalised in the upper Waitaki valley and central Otago regions of the South Island of New Zealand (Williams 1980). The New Zealand native congener (*V. australis*) never forms such extensive colonies as *V. triloba* but is more widespread throughout New Zealand. Kloot (1985) mentions five southern Australian herbs which are now naturalised in Europe and recorded as 'wool adventives' although some were also introduced deliberately to Europe for horticultural purposes. With the increasing export trade in live sheep to Western Asia the chances for invasion of a number of other Australian plants, especially herbs, to such semi-arid regions perhaps may increase in the future.

CHARACTERISTICS OF WEEDS

Seeds arrive at a new site with certain inherent characteristics which previously enabled their successful survival and continued reproduction at their original site. Is there an 'invasive syndrome' for plants? The answer seems to be that there is not, although there do appear to be several predisposing factors which act either alone or together to increase the chance of a plant becoming invasive as a weed. I shall discuss some of these factors giving Australian examples.

Plant family

Certain groups of plants have become more invasive in most regions than other taxonomic groupings. In southern Australia, for instance, of the 88 plants identified as noxious in Victoria by Parsons (1973), 27 belong to the Daisy family, of which 15 are thistles. Of the 63 plants identified as noxious or secondary plants in Tasmania, 16 belong to the Daisy family, of which 8 are thistles (Hyde-Wyatt and Morris 1980). Despite problems associated with the legal definition of 'noxiousness', species from certain taxonomic groupings, such as the Daisies (for total numbers) and the Crucifers and Amaranths (on a proportional basis), are more likely to be invasive, at least in regions of temperate climate.

Climate

If a plant finds itself transported to a climate similar to that of its region of origin it may be better able to colonise and spread rapidly. For instance, Bitou bush (*Chrysanthemoides monilifera* ssp. *rotundata*) is naturally distributed on dunes on the east coast of southern Africa, a region with markedly summer-incident rainfall. The closely related Boneseed (*C. monilifera* spp. *monilifera*) replaces Bitou bush the further west one goes along the southern coast of South Africa, as the rainfall becomes progressively more winter-incident. These two subspecies have been introduced to southeastern Australia where they are presently distributed in relation to rainfall incidence in a pattern similar to that in southern Africa. Bitou bush is confined to the east coast of New South Wales and southern Queensland, whilst Boneseed occurs mainly inland of Bitou bush in New South Wales and along the southern coastline of Victoria. Whether Bitou bush has reached its southern climatic limit in Australia is still uncertain, since it has been in Australia only since about 1908. However, the similarity of climate (rainfall incidence) for its distribution in eastern South Africa and eastern Australia suggests that it may already have done so.

Ecological status

If a plant is a 'coloniser' in its country of origin, it seems more likely to become invasive in its new country. One of the habitats of Skeleton weed in southern Europe is on sandy beds and banks of river systems periodically disturbed by floods. It is thus a plant which on entering Australia was well adapted to a regime of regular disturbance in the form of cultivation of sandy soil for cereal growing. It rapidly became a major economic problem of the Australian cereal industry. Spiny Emex (*E. australis*) from South Africa is another pioneering species in its native region which has also become a major weed of regularly disturbed soils in southern Australia.

Dispersal characteristics

Allied to the pioneering status of some invasive plants in their native region is the fact that invaders often have fruits which are morphologically adapted to disperse efficiently. Such plants are more likely to be moved around accidentally by wind or by birds or grazing animals on or in their products and thus arrive at a 'new' site. Noogoora and Bathurst burrs, with their numerous hooked spines on fruits, are perhaps the most obvious examples of plants introduced accidentally to Australia having this characteristic. Both species are widespread in eastern Australia where they are weeds of grazing lands. Fruits of Noogoora burr are also water-dispersed, thereby spreading the species along the inland river systems of central eastern Australia, where the species is common.

Seed dormancy

Many invasive plants show some level of seed dormancy, the effect of which usually is to spread the time for germination and establishment; the chances for effective colonisation are thereby increased. In fact, very few instances of the absence of seed dormancy are known for the group of Mediterranean plants which so successfully have invaded other regions of Mediterranean-type climate, including southern Australia. The type of dormancy may be morphological (e.g. hard seeds in legumes) or physiological (e.g. after-ripening in grasses) or it may be a complex combination of the two.

Genetic systems

Inbreeding annuals or some perennials are commonly represented on lists of invasive plants although it is difficult to generalise because weeds display a wide range of evolutionary pathways.

Mode of reproduction

Once a seed has arrived at a new site it is advantageous to be able to reproduce rapidly and enter the colonisation stage of invasion. Plants having the ability to produce large numbers of seeds or those having both sexual and asexual (vegetative) modes of reproduction are advantaged. As an instance of the latter, Skeleton weed reproduces both from seed and asexually from buds on both the basal shoot and the root system. The weed is well placed thereby to become a dominant plant in frequently disturbed habitats as well as to invade new sites. An extreme but by no means uncommon case among

invasive plants is provided by the water fern Salvinia and by Soursob, both of which reproduce only vegetatively.

On the evidence available I suggest that plants having at least some of these seven characteristics may more easily reach new sites and/or more readily compete with and eventually become dominant over plants which have evolved at that site. The invasion will be complete if the invading plant causes the extinction of the former occupant of the site. To prevent this extreme event happening is the task of the land manager, whether he or she be a quarantine official, a weeds ecologist, a farmer, a national park ranger or a noxious plants advisory officer. Therein lies the challenge for the future.

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WEEDS AND HUMAN HEALTH

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It is important to first define what an allergy is and secondly to define what I mean by a weed because this is likely to be very different to your definition of the term "weed".

Allergy is a state of altered reaction to a substance where there has been a previous exposure.

My brief to talk about weeds and human health, gives me some license in defining a weed. I will adopt the philosophy of Humpty Dumpty in Lewis Carroll's *Through the looking-glass*, who said "When I use a word [....] it means just what I choose it to mean ... neither more nor less". Therefore a weed is any plant that causes allergies. Not only is it a plant growing in the wrong place, but that it grows at all!

20% of the population react adversely in various ways to substances which have no apparent ill effect on the normal people. For the purpose of this discussion I will confine my talk to two of several different types of allergy.

The first type of allergy is characterized by symptoms such as one or more of the following: sneezing; itching of the nose and eyes and often the roof of the mouth; intense watering of the nose and eyes; and nasal blocking. Asthma is a more serious problem and can occur as an immediate result of pollen exposure where cause and effect are quite obvious, or as a late reaction where the association of symptoms and exposure are not so clear cut, and the relationship of cause and effect not realised. The following slides of respiratory function will illustrate this point. Late onset asthma presents a similar picture to "industrial or occupational" asthma, which indeed it is. Wheezing may start many hours after exposure, for instance during the night after slashing/clearing or harvesting during the day. Wheezing, cough and shortness of breath will tend to increase in severity over a number of nights following daily exposure and then, symptoms improve after week-ends with the first day after return to work being relatively asymptomatic. Increasing disability ensues as more consecutive days are worked. This sequence is repeated until a point comes where asthma persists at week-ends and symptoms are only relieved by holiday or prolonged sick leave. The ultimate event, if exposure persists, is that symptoms are not relieved by holidays or sick leave and permanent asthma results.

The message is to be aware of the pattern. Make sure that you make your doctor aware of the pattern. The treatment is avoidance as well as medication.

This type of allergy is diagnosed by means of skin prick testing when small amounts of the suspected agent are pricked through the top layer of skin. If

the reagent meets sensitized or previously primed "mast" cells, histamine is released from the cell producing an itchy lump denoting a positive test that demonstrates that allergy exists. This can be confirmed by a blood test called RAST (Radioallergosorbent test) which estimates circulating antibodies to specific allergens.

The second type of allergy is from skin contact with certain plants or chemicals and causes a rash which occurs later. The prime example is contact sensitivity to Rhus tree (*Toxicodendron succedaneum*). This type of allergy is generally tested by placing a small amount of suspected material on the skin, leaving the test material applied for 48 hours, and subsequently observing the skin 48 hours after removal of the test material. Redness and blistering demonstrates sensitization.

Hayfever was first recognised as a single disease in 1819 when an English physician John Bostock described his own symptoms to the London Medical Society in a paper entitled "*Case of a Periodical Affection of the Eyes and Chest*".

The cause of this type of allergy was first described in 1873 by Charles Blackley whose publication "*Experimental Researches on the Causes and Nature of Catarrhus aestivus*" was a culmination of more than ten years' observation and experiments into the causes of hayfever. He demonstrated beyond doubt the role of pollen as the cause of this dis-ease. He was led to this conclusion after having an attack of acute hayfever following exposure to a vase of dried grasses left in his room by his children at a time of year when he did not normally experience symptoms. Charles Blackley subsequently collected over 80 different pollens and tested himself with dried, fresh and extracts of pollen. He came to the conclusion that pollen of grasses were the ones that caused him most trouble.

The majority of patients who have symptoms from weeds are primarily affected by grass pollen and therefore I have put at the top of the list introduced pasture species, with rye grass *Lolium perenne*, having pride of place. It has been estimated that 1 hectare of unmown or ungrazed Rye grass releases an estimated 210 kg of pollen in one flowering season. Rye grass is distributed world wide and W.H.O. studies have defined the allergenic molecular weight fractions within the pollen grain. This electrophoretic procedure enables us to examine other grass and weed pollen structure and perhaps one day, with genetic engineering you may be able to breed non allergenic high yielding pastures, thus pleasing everyone.

In order to cause allergic symptoms most plants need to be wind pollinated and growing in vast quantities over a wide area. The classic example of this is Ragweed in the United States, where there are thousands of people who have seasonal hayfever and asthma for six weeks during the clearly defined flowering period and then have no further problems until the following year. Our local species of Ragweed (*Ambrosia artemisiifolia*) I understand, grows in great profusion in Northern New South Wales, especially in the Kyogle district. It flowers during April-May causing hayfever in sensitive sufferers. So far there have been no documented cases of asthma but it will only be a matter of time before Ragweed asthma occurs. Sporadic growth occurs in the Western Division and Hunter Valley, but so far, not enough to cause allergic symptoms.

Parthenium weed (*Parthenium hysterophorus*) is a native of Argentina, Mexico, West Indies and Southern States of U.S.A. It was recognised as a problem weed in India in 1977, having been accidentally introduced in 1956. A steady increase in hayfever in Bangalore associated with the increase of Parthenium prompted a study where it was found that 44% of all airborne pollen in June and July was Parthenium pollen. Skin prick tests with an extract of Parthenium pollen gave positive tests in 40% of all hayfever sufferers and all these patients had symptoms between July-October. The Indian study suggests that Parthenium like Ragweed, may be a potential source of hayfever and asthma in Australia. So far there are no reported cases of hayfever due to Parthenium pollen but it is possible that some of the late asthmatic responses reported after slashing in Parthenium weed infested areas in Queensland may be caused by exposure to Parthenium pollen.

There are a number of weeds that cause seasonal allergic rhinitis and the most well known is Plantain (*Plantago lanceolata*) and this is widely distributed both in the country and in cities where it is a well recognised volunteer in gardens and on nature strips. Each plant produces a lot of pollen and the grains are quite characteristic. The pollination season varies with geographical location and small quantities of pollen are present throughout the year in New South Wales and Queensland but the amount increases between September and Christmas. It does not appear to be an aggressive invader like Patersons Curse (*Echium plantagineum*) which was introduced by farmer Paterson into his garden, at Cumberoona near Albury in 1880. It surely escaped and is known to sensitise grass sensitive patients from other cities within two to three years of initial exposure after moving to Albury. As you are aware this weed is not only taking over the countryside but is now appearing in our major cities.

The Mesquite or Honey Locust Tree (*Prosopis julieflora*), a common tree of south western United States covering 71 000 million acres of land in Texas and Oklahoma in 1952, was considered relatively unimportant allergenically at that time. This tree was planted extensively in Kuwait in 1951 at the same time as *Chenopodium album* which was introduced to stabilise sand dunes, when water became abundantly available, and Bermuda couch grass was sown for lawns. Prior to the mid 1950s asthma was not considered a problem. In 1978 10% of the population were said to be suffering from asthma.

Results of skin prick tests (% of 756 asthmatics)

Prosopis (honey locust, mesquite)	74%
Chenopodium album (lamb's quarters)	62%
Cynodon dactylon (bermuda couch grass)	54%
Feathers	22%
Animal fur/dander	6%
Various foods	2.5%
Dust mite	1.5%
Moulds	0.8%

These results show a very high incidence of pollen sensitivity and most attacks of asthma occurred between March and October when abundant pollen is encountered as well as more severe dust storms.

It appears that it takes approximately 20 years for deliberately introduced species to proliferate sufficiently to cause allergic disease. I understand that the Mesquite tree has been seeded in the western division and I would like to know when this was done and if you can give me any idea approximately how many trees there are around such places as Broken Hill, Wilcannia, Cobar and Bourke.

However, not all introduced weeds cause severe allergies and it appears that both large and small leaved Privet (*Ligustrum lucidum* and *Ligustrum sinense*) which have a bad reputation among hay fever sufferers, are not in fact strongly allergenic. In a pilot study at the Royal North Shore Hospital we asked for volunteers who thought they were allergic to privet to be skin prick tested both with a commercial extract of privet pollen and an extract made from freshly collected local pollen. We demonstrated that half of the volunteers had positive skin tests but only one of fifteen showed a significant level of circulating antibodies on RAST testing. So at this stage we have not been able to confirm that Privet causes allergy. We have yet to determine whether it is the perfume which is acting as an irritant rather than the pollen acting as an allergen.

These weeds cause little problem in comparison with the aggressive opportunists such as Ragweed in United States and Wall Pellitory (*Parietaria judaica*) in Mediterranean countries and now in Sydney.

The patient, who first drew my attention to *Parietaria* as a cause of her severe hayfever between the months of September and March, presented in 1983. She said that an elderly lady who lived next to her told her that this plant was the cause of her hayfever. The weed was identified at the Herbarium but she did not bring the plant with her. I had no testing agent for it and all other grass, tree and weed skin tests were negative. Her symptoms improved during the winter but she arrived back in September 1984 bringing the weed with her. I pricked some of the small floret into her skin and she had a huge response with a large red spreading lump on her arm. Now, was this due to an irritant effect of the hairy plant or was it allergenic? The allergic reaction was able to be confirmed by RAST testing using a disc obtained from Europe.

Parietaria judaica was recorded at the Herbarium in 1901, the first sighting being at Woolloomooloo. It is thought that the seed probably arrived on a ship load of Italian marble. This plant colonised in the North Sydney-Kirribilli area and residents have remarked how quickly it has spread in the past ten years. There have been positive sightings as far west as Kurrajong and Penrith, south at Coledale and north at Dural. It is spreading in the eastern suburbs as well as city and inner western suburbs. The majority of symptomatic patients live in the municipalities of North Sydney, Mosman and Lane Cove where growth is dense. A few patients live in Warringah Shire between Manly and Pittwater and recently patients living in eastern, city and inner western suburbs have been identified as *Parietaria* sensitive. It is difficult to say whether this is due to the rapid spread or to increased publicity encouraging people to be tested. We have identified approximately 80 patients with positive skin prick tests and high levels of circulating antibodies. Of those at least 75% have severe symptoms.

The average length of exposure before symptoms occur is three to four years and the main age group affected is in the third and fourth decade. Treatment

consists of antihistamines and/or nasal, and eye drops and asthma sprays if indicated. Patients can also be effectively desensitized by *Parietaria* vaccine injections.

This weed has apparently taken far longer than 20 years to cause symptoms, in fact it has taken nearly 80 years to recognise it as a cause of allergy. However, it should be remembered that it was not deliberately seeded but brought in as a contaminant and has spread because of soil perturbation brought about by urban development. It is interesting to see that four years ago there was little *Parietaria* in the grounds of Taronga Park Zoo but since the upgrading of amenities with much soil disruption the weed is spreading very nicely.

It has been demonstrated that pollination occurs throughout the year but the major pollen peak is between September and December. there is a secondary lower peak in February and it is of interest to see that the same pattern occurs in Italy in their spring and autumn months. The pollen does not travel far and most exposure occurs from plants growing in the immediate vicinity of the home. The whole plant is covered by fine hairs; seeds stick to clothing, animal hair, earthmoving equipment and cars and are dispersed by man. There is local spread as you can see from these slides caused by water run off on the relatively steep hills in North Sydney. This weed grows well in crevices of rocks and old sandstone walls which have weathered providing cool damp conditions for growth.

One square metre of plants produce 250 000 seeds and it is only by repeated use of appropriate herbicide and handweeding before seed set that eventual control will be gained. I must add a note of caution about removal of the weed; a number of patients have developed asthma for the first time after pulling out *Parietaria*. They have exposed themselves to a massive inhalation of pollen by the explosive dehiscence of the anthers which is characteristic of the Urticaceae group. Once triggered the asthma continues and requires constant treatment.

So far this weed has not spread beyond the Sydney area. One would have expected it to be found in Newcastle and Wollongong but so far it has not been sighted. The reason for this is not clear to me. State herbariums have records of sightings in Melbourne, Freemantle and the Adelaide hills. The indigenous species Smooth Nettle (*Parietaria debilisis*) is recorded at Jenolan and Yarrangobilly Caves and grows in damp and shady places. Although it grows too sparsely to cause allergic symptoms we would like to obtain some flowering plants to compare the pollen with that of *Parietaria judaica*.

It seems that our allergenic plants originate overseas. The following list shows some other allergenic weeds known to have caused allergies in limited areas where density of growth is high.

Careless weed	(*Amaranthus palmerii*)	North America
Lamb's Quarters	(*Chenopodium album*)	Europe
Dock	(*Rumex acetosella* and *Rumex crispus*)	Europe
Capeweed	(*Arctotheca calendula*)	Africa
Coreopsis	(*Coreopsis lanceolata*)	North America

Contact allergy

Rhus tree (*Toxicodendron succenadeum*), the most well known cause of severe contact dermatitis and systemic illness, has recently been declared a noxious weed. While easily recognised in autumn when the leaves turn a glorious red it is not easy to recognise hanging over a garden wall when the leaves are green.

Cauliflower or Pill flower (*Helichrysum diosmifolium*) has recently been described by Dr. R. McMahon, a member of the R.N.S.H. Department of Allergy, as another plant causing a severe contact allergy. This is commonly found in coastal areas but has also been reported on the eastern edge of the Condobolin-Tullamore and Barellan districts.

Although hardly a weed, Paper Bark or Broad-leaved Tea-tree (*Melaleuca quinquenervia*) can also cause contact dermatitis and this can be aggravated by tea-tree oil widely used in herbal cosmetics.

The cultivar *Grevillea Robyn Gordon* frequently causes a contact dermatitis and I see no reason why native *Grevilleas* should not also, however, I do not know of any reports.

Stinging nettle (*Urtica urens* and *Urtica incisa*) and *Parietaria judaica* as well as the Stinging Nettle Tree (*Dendrocnide excelsa*) all cause an immediate very painful rash and swelling due to plant chemicals and is not a true allergy.

I have mentioned a few of the weeds which we know cause allergies in Australia. I have also discussed some that are documented overseas. If these weeds proliferate here allergies are going to follow. It is only a matter of time, and the time interval appears to be approximately 20 years for deliberately seeded plants and 80 years for accidental seeding.

You are in a fortunate position because almost certainly you will be the first to hear of adverse reactions to plants and you will also be the first to identify these weeds. We feel that we can benefit from your observations and knowledge and would welcome greater interaction between our two disciplines.

I wish to acknowledge the help of Dr. Brian Baldo, Kolling Institute, Royal North Shore Hospital in the preparation of skin testing extracts and RAST testing and my son David Bass who has elucidated the growth habits and distribution of *Parietaria judaica*.

URBAN WEED DILEMMA

Dr. Marilyn D. Fox

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Sydney. 2000

INTRODUCTION

The Oxford dictionary defines a dilemma as "a logical or actual position presenting only a choice between two or more unwelcome alternatives". In its most simplistic form the urban weed dilemma represents a choice between accepting more weed species and greater weed cover, or meeting the considerable community cost of preventing or minimising the the impact of such weeds. However, the urban weed dilemma is not simple, it is multifaceted. In 1984 Adamson, addressing the same topic, concentrated on one of these facets: "how to keep native vegetation within giant urban areas". His paper saw the dilemma only from the perspective of the remnant bushland. It is, however, a weed dilemma and interfaces with native vegetation only in such remnants. There are many other niches available to weeds apart from bushland although most community and scientific concern focusses on the bush.

THE PERCEIVED VALUES OF URBAN BUSHLAND

1. Positive

   - Aesthetic, breathing space, pleasant vista, etc.
   - Educational, used by local schools, tertiary institutions, community groups such as S.G.A.P.
   - Recreational, picnics, bushwalking, photography, etc.
   - Scientific, reference areas for natural bushland, some new species, rare species, etc.
   - Natural habitat for both animals (vertebrate and invertebrate) and plants.
   - Catchment protection.

2. Negative

   - A dumping ground for car bodies, garden refuse, unwanted pets, garbage, etc.
   - Harbours vermin (animal weeds) - true if already used as a garbage dump.
   - Harbours undesirable people, escaped prisoners, vagrants, etc.

- Used for stormwater discharge, corridors for sewerage, power and drainage lines.

- Exploiting urban bushland for bush rock, firewood and native plants.

FUTURE TRENDS

Looking to the future one may ask are there going to be more weed species? Such new species could come from the ranks of the currently naturalised species or from new introductions. Are the existing weeds going to become more dominant, more abundant and troublesome? Affirmative answers to both questions will doubtless have impacts on our remaining urban bushland. Affirmative answers will also lead to higher community cost just to maintain the status quo or, even greater cost to regenerate areas already weed-infested.

In terms of new weeds, we are still receiving new species that become naturalised, (Figure 1) and of these some will prove troublesome.

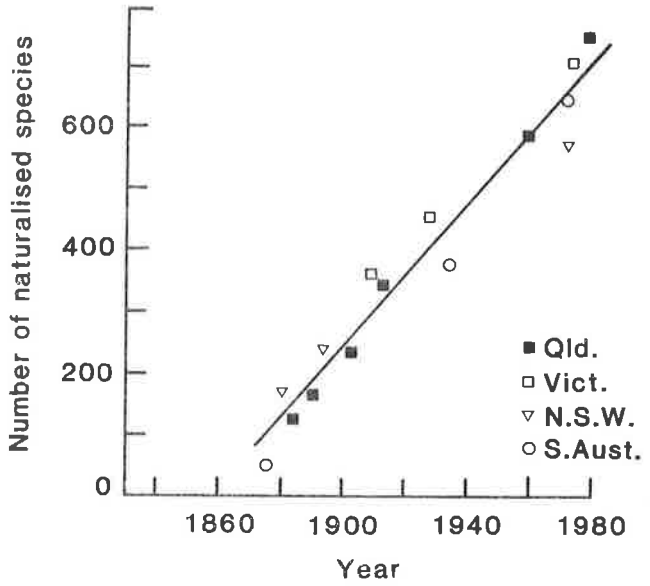

Figure 1. Increasing numbers of naturalised plant species in four Australian states for the period 1870-1980 (Specht 1981).

TYPES OF DISTURBANCE

The evidence strongly supports the hypothesis that there is no weed invasion without disturbance (Fox and Fox, 1986).

Railway vs urban development

While there is continued disturbance weeds will continue to prosper. Figure 2 conveys a number of important aspects of weed invasion into bushland and the role played by the nature of the disturbance. The data were collected from a number of creek lines in Ku-ring-gai Chase National Park downslope of the railway line and of suburban development (Cooper and McRae, pers. comm.). There is a general trend for the highest numbers of species to be close to the disturbed edge and to decrease with distance from the disturbance. However, the weeds influence can penetrate up to 2 km along such creeks.

The contrast between the railway and urban development is striking. The railway represents almost a "one-off" disturbance with little recurrent disturbance. By contrast there is much greater continuing run-off from urban developments plus many more sources of weed seed and other propagules. The result is many more weeds and they are spread further along the creek lines downslope from residential areas than they are from the railway disturbance.

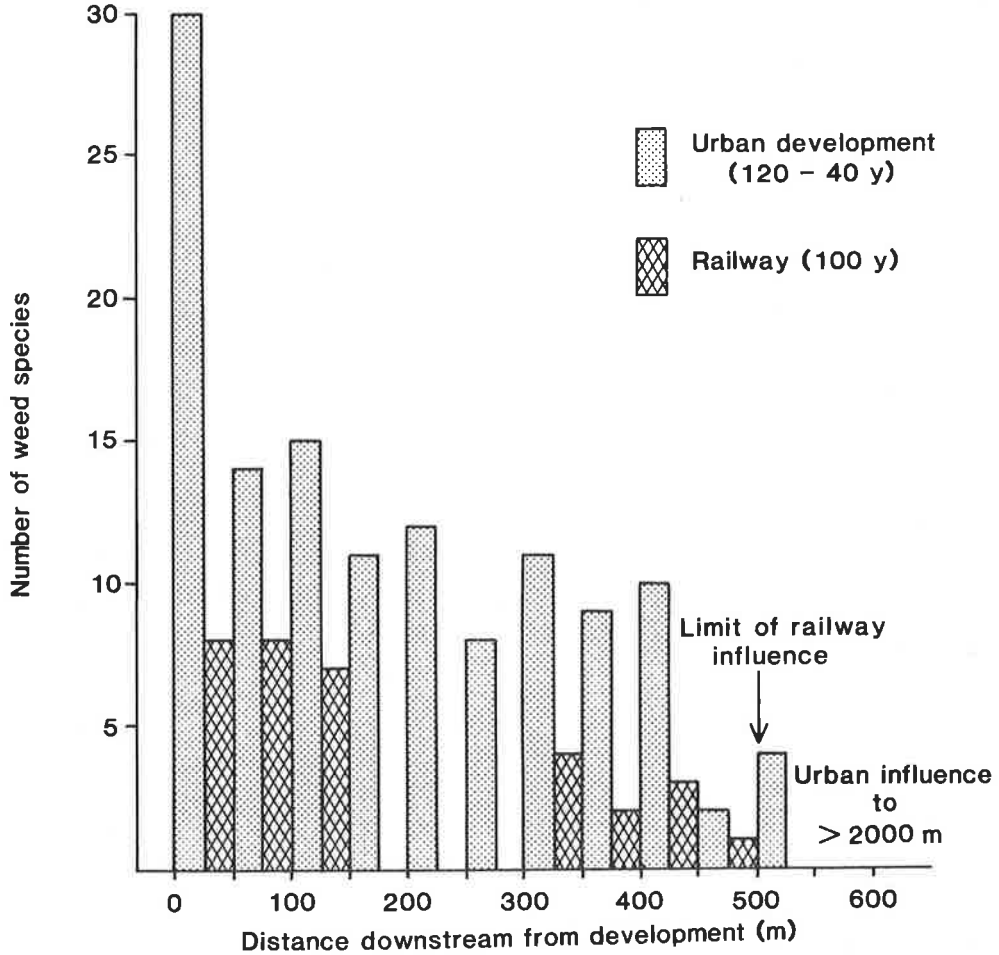

Figure 2. Number of weed species encountered away from two disturbances (data from an unpublished report by Cooper and McRae). There are fewer weed species associated with the railway and their influence does not extend as far down the creek lines.

Urban runoff

Runoff from all urban areas is one of the most insidious forms of disturbance but has a massive cumulative impact. Such runoff is highly enriched in plant nutrients (Blaxell, 1980; Wright, 1986), in particular in phosphorus. As a result soils receiving such runoff are both moister and richer than natural soils. Soil phosphorus levels are critical in determining the distribution of vegetation types (Beadle, 1954, 1962). If the levels are changed, particularly if they are elevated by enriched stormwater, then the vegetation of the affected soil will change. Clements (1983) has measured the phosphorus levels of a number of soils from sites that are infested with weeds and from matched natural bushland sites. Figure 3 summarises some of her findings.

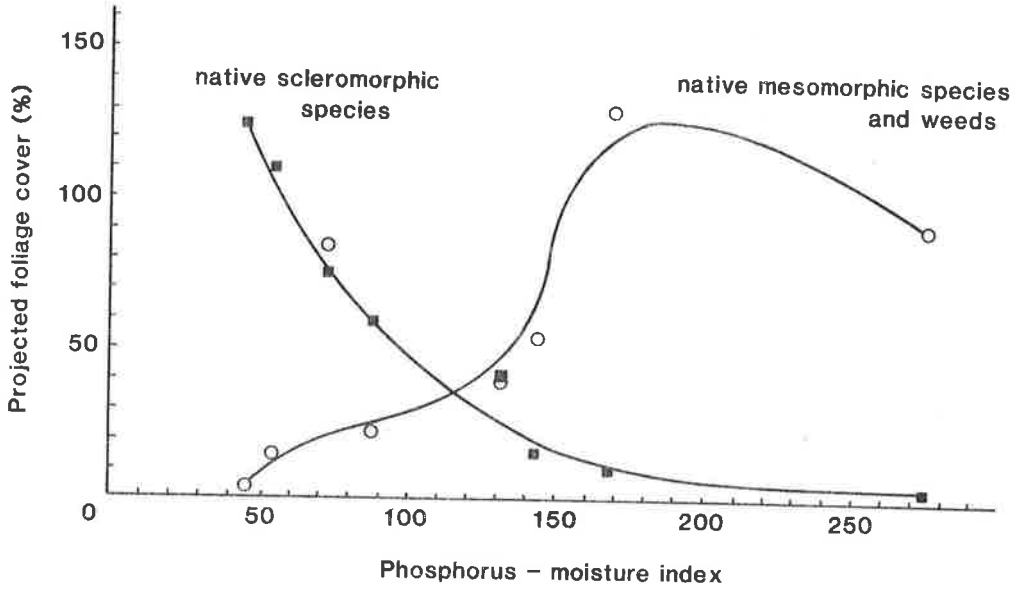

Figure 3. Reduction in cover of native schleromorphic species with increasing phosphorus-moisture index and increase in mesomorphic species (from Clements 1983).

The amount of cover of plant species adapted to higher phosphorus and more moist soils increases along the phosphorus-moisture axis. Such plants are mesomorphic native species and some weeds. The native species are shrubs and small trees such as *Pittosporum undulatum* (Sweet Pittosporum) and *Acmena smithii* (Lilli Pilli). More significant is the reduction in cover of the scleromorphic native species. These species have adapted to the low nutrient content of soils such as those derived from Hawkesbury sandstone. In other words, as soils become rich in phosphorus and moister from urban runoff, there is a shift in the type of vegetation from the scleromorphic native species (= dry sclerophyll vegetation) to more mesic species (either native or weeds).

Other factors also promote this change in species composition. Fire is the principal one. In small patches of urban bushland fire is commonly suppressed and so vegetation that would have experienced more frequent fires, probably in summer, is now rarely burnt and the same shift to more mesic (often fire-sensitive) species occurs.

Figure 4 is also based on Clements' measurements but emphasises the accompanying shift in species composition. The bar figures at the top of the figure give the mean (+/- standard error, and range) phosphorus content of both shale and sandstone soils, and from weedy sites and natural bushland. Hawkesbury sandstone soils subject to urban runoff are raised to phosphorus levels similar to the richer shales, while the enriched shale soils approach the phosphorus levels of some rainforest soils. With such increases in the soil phosphorus there are considerable alterations in the floristic composition of the vegetation, both from native species that require the higher levels and particularly from introduced weed species.

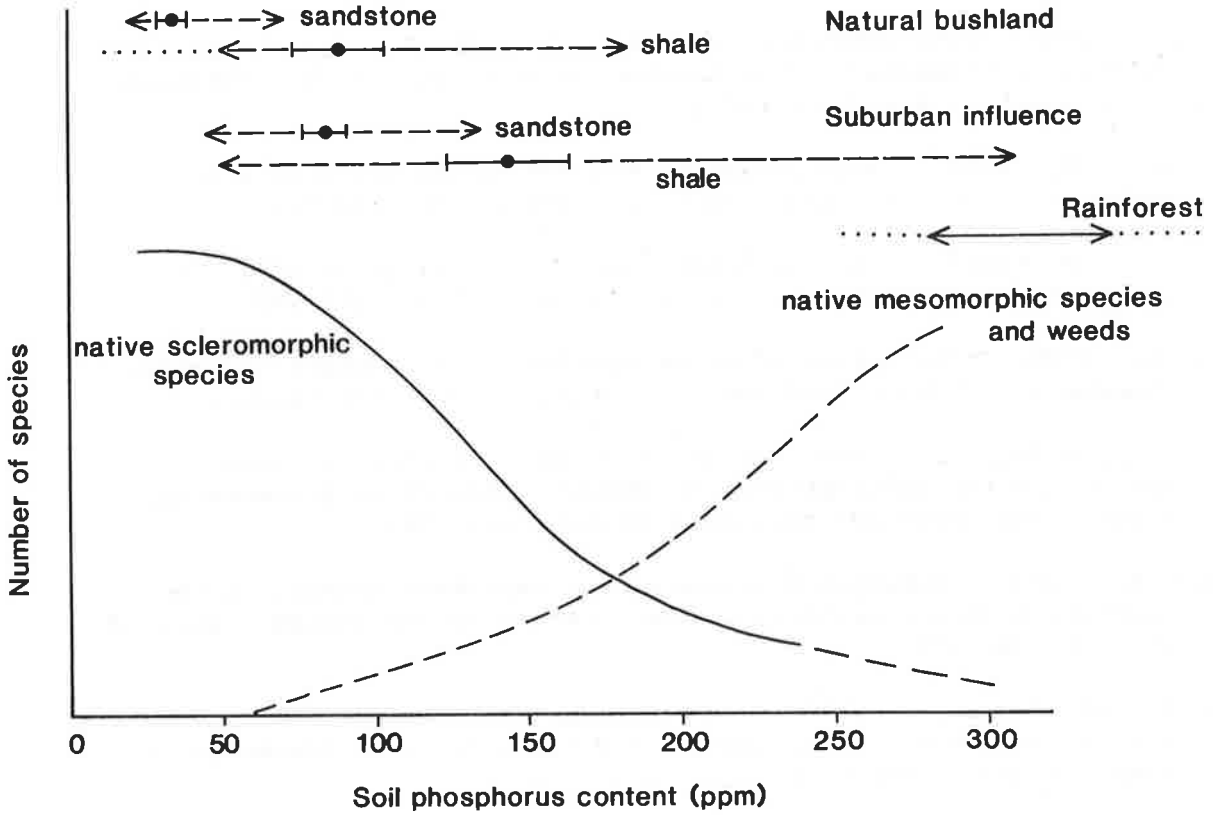

Figure 4. Soil phosphorus levels (mean, standard error and range) for natural bushland on sandstone and shale compared to similar soils influenced by suburban development (from Clements 1983), and typical range for rainforest sites. There is a reduction in richness of native scleromorphic species with increasing soil phosphorus content and associated increase in mesomorphic species.

CONCLUSION

1. Presuming that a community view of the positive values of urban bushland prevails, then increasingly there will be community pressure to retain its natural character.

2. Accepting that the weeds and disturbances which promote their spread are integral parts of urban life then the solution to the "urban weed dilemma" is to minimise weed spread by adopting appropriate means of dispersing urban runoff (see e.g. Bliss *et al.*, 1983) public education about garden refuse, etc.

3. The cost of these measures will have to be borne by the public via increased cost of new housing developments, and increased council rates to cover educational and weeding programs.

ACKNOWLEDGEMENTS

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THE DEVELOPMENT OF HERBICIDES

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INTRODUCTION

The development of a new herbicide, or any other pesticide, is a complex, lengthy and expensive procedure. The usual time taken from synthesis of a new molecule to marketing of the first kilogram or litre is about ten years with an estimated cost of US$30 million, excluding the cost of a manufacturing plant which may cost another US$50 million if existing facilities cannot be utilised.

When you consider that the patent protection for a new product in Australia at present is only 16 years a company must be certain of recouping the development cost in six years plus making a profit to produce the funds to develop further new products and to pay the cost of developing products that do not reach the market. It has been estimated that for every 10 000 compounds synthesised only one will be marketed. There is a general consensus in the industry that for a product to be commercially viable it must generate a minimum of US$50 million in sales per year worldwide. In the United States it is unlikely that development of a new herbicide would continue unless it was shown to have application in maize, soybeans, cotton or wheat; application in other crops would be regarded as a bonus but not of critical importance.

THE DEVELOPMENT PROCESS

The procedure for development of a new pesticide involves the interrelation of a number of functions: chemistry research, manufacturing, legal and patent, formulation research, biology research, toxicology, analytical, sales and technical service and of course, management to co-ordinate the whole process. Figure 1 shows in diagrammatic form the way in which the various functions are involved during the ten year development programme. You will note that at various stages decisions have to be made whether to continue the programme or drop it.

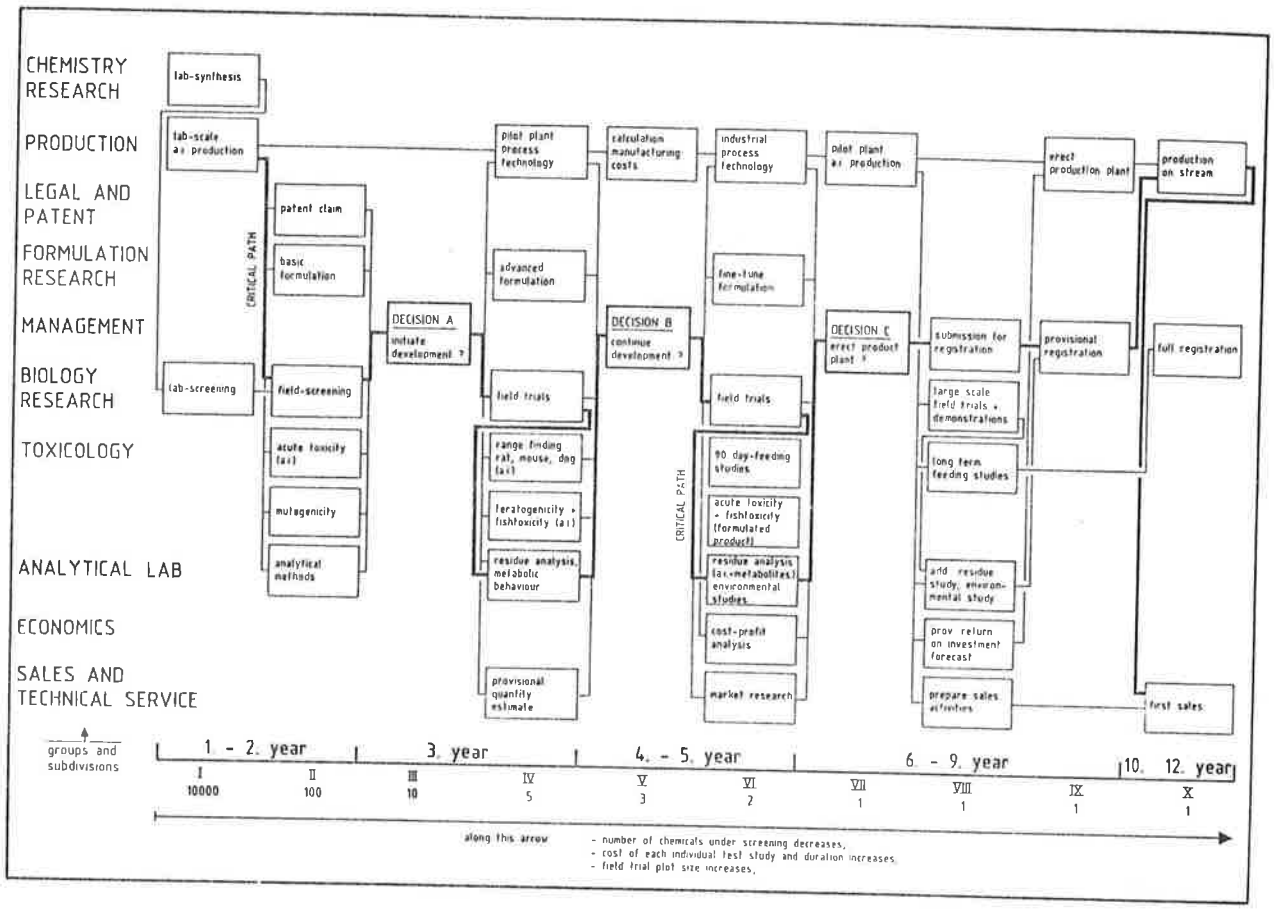

Figure 1. Diagrammatic representation of steps in the development of a herbicide.

Briefly the contributions of the various functions are as follows:

CHEMISTRY RESEARCH

First of all the molecule must be synthesised. In the past the synthesis of compounds was largely empirical in the hope that if you synthesised enough new molecules one of them was bound to show useful biological activity. Today the procedure is much more sophisticated with computer modelling of molecules, improved knowledge of the physiology of plants and their enzyme systems.

BIOLOGICAL RESEARCH

The compound must be screened in the laboratory for biological activity and in the case of herbicides, against a range of representative weeds. If phytotoxicity is demonstrated on important weeds then selectivity in a range of crops must be ascertained. If selectivity is not demonstrated and the weed spectrum is broad, the compound may have potential in the non-crop industrial vegetation control area. If the new compound passes the laboratory screen it can then proceed to field scale testing which, for a successful new herbicide, will continue through the ten year development

programme ending up with farmer demonstration plots. Only about 10% of compounds screened in the laboratory pass through to field testing.

LEGAL AND PATENT

To protect the invention of a new compound patents must be filed throughout the world. The patent must clearly establish that the product is unique and does not contravene any existing patent.

FORMULATION RESEARCH

Formulation chemists have to develop a formulation of the compound that is stable both in the concentrated form and when diluted. Suitable containers must also be identified. The usual requirement is that it must be demonstrated that the formulation in the unopened container will be stable for a minimum of two years.

TOXICOLOGY STUDIES

To protect the user of the product and consumers of produce treated with it, a comprehensive range of toxicology tests must be carried out on the active constituent and the formulated product. Table 1 shows the man-months required to carry out the basic toxicology tests required. Fig. 2 shows in a little more details the tests required and the various laboratories involved in these tests. Toxicology testing is undoubtedly the most expensive aspect of pesticide development today and is likely to increase further as regulatory requirements grow. Toxicology studies commence very early in the development programme and continue over a period of eight years or more. Any adverse findings can result in even the most biologically active pesticide being dropped from development. The toxicology testing of agricultural chemicals is just as rigorous as for drugs other than for the clinical testing in human subjects required for the latter.

Table 1.

Test	Man-months of effort
Acute Oral LD50 In Mammals	0.26
Inhalation LC50	0.37
Eye Irritation	0.1
Skin Irritation	0.1
30-Day Feeding Study	3.7
90-Day Feeding Study	11.0
2-Year Feeding Study	50.9
30-Day Inhalation Study	7.0
90-Day Inhalation Study	18.8
2-Year Inhalation Study	109.5
Teratology	5.1
Reproduction	30.8
Mutagenesis Studies	3.7
Metabolism Studies	13.9

ENVIRONMENTAL TESTING

Very comprehensive testing is carried out to determine whether the product will have any adverse effect on the environment. Data must be produced to determine the fate of the chemical and its metabolites in plants, animals, soil and water. Tests are also carried out to determine the toxicity of the chemical to birds, mammals, fish, marine and freshwater organisms, soil organisms including earthworms and insects. The trend is for more environmental data to be required by regulatory authorities and it would appear that the cost of these studies will soon equal or exceed that of toxicology testing.

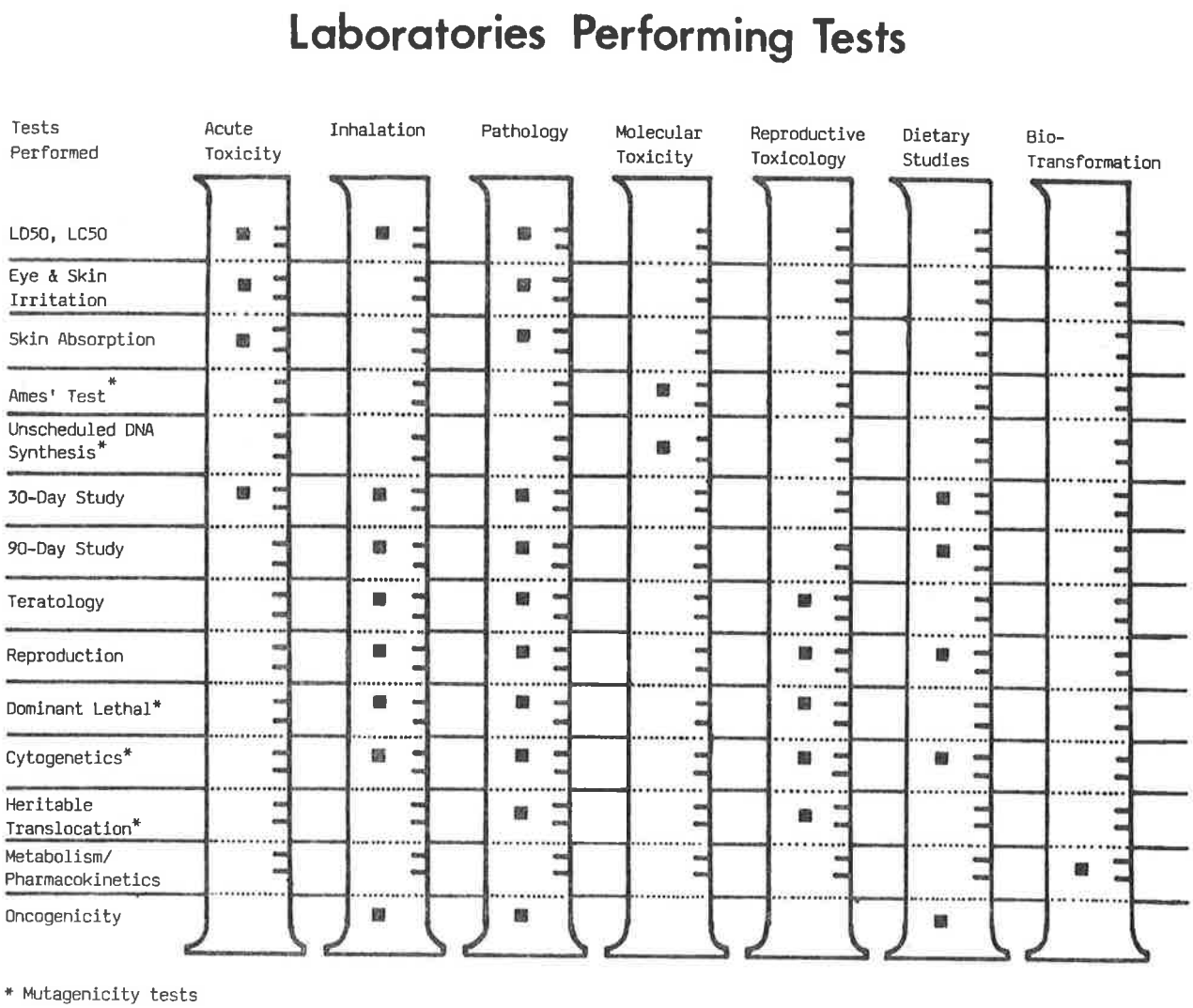

Figure 2. Laboratory type, and tests performed on herbicides under development.

RESIDUES

Plants treated with the product must be analysed to determine the level of residues of the chemical and its metabolites that remain in the various parts of the plant. These residue studies are used to determine maximum residue limits for particular crops and to establish withholding period, where necessary, in order to reduce residue levels. Residue levels are related to acceptable daily intake of the chemical and if too high in a particular species may prevent registration of the product for that particular crop. Residue trials require as much planning and effort as efficacy trials.

PROCESS RESEARCH AND MANUFACTURING

After the molecule has been synthesised at laboratory bench level, usually producing only a few grams of chemical, for the initial laboratory screening, it is then necessary to scale up to pilot plant production in order to provide enough chemical for field and toxicology testing. Products may be dropped at this stage because they prove to be too difficult or too expensive to make on a commercial scale.

When pilot plant production has been shown to be practical and the costs appear satisfactory a decision has to be made on whether a new production facility has to be designed and built or if existing facilities can be utilised.

ECONOMICS

As stated earlier all the above activities may cost US$30 million over a period of ten years. It is essential that as soon as the biological activity is known and the basic production costs are established that the size of the potential market be determined. If the product cannot show cost/benefit advantages over existing products it may well be dropped from development. Many excellent herbicides have not made it to market because of unsatisfactory economics.

MANAGEMENT

The function of management is to co-ordinate the whole programme and to make the critical decisions as to whether the project should continue or should be dropped at any stage. Obviously the earlier a project is stopped the less money is spent but there is always the possibility you may have dropped a product that would have been as successful as Roundup, Hoegrass, or Glean.

CONCLUSION

In spite of all the constraints outlined new herbicides continue to be developed and marketed. New herbicides are likely to be used at lower rates than the older products and will be environmentally safe and relatively non-toxic to the user. Wide scale use of a specific herbicide can cause a shift in weed flora resulting in loss of effectiveness thus requiring its replacement by a new product. The recent discovery of resistant strains of annual rye grass to a range of herbicides demonstrates the continuing need for new herbicides with novel activity.

PESTICIDE WASTE DISPOSAL

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State Pollution Control Commission

1. INTRODUCTION

Herbicides are an important tool for controlling noxious plants both in agriculture and in other land management areas including public parks and reserves, national parks and forests, and rights of way for railways and roads. Inevitably some wastes and residues are generated together with large numbers of containers that have to be disposed of. While the interest of this conference will be in appropriate disposal methods for herbicides, the discussion here will include the broader area of pesticides generally (including herbicides, insecticides, etc).

Comprehensive guidelines for the disposal of pesticide wastes and containers have been recently approved by the State Pollution Control Commission (SPCC) and are attached. These are believed to be the first comprehensive and official pesticide disposal guidelines in NSW. Prior to this the Agricultural and Veterinary Chemicals Association's (AVCA) "Disposal of Pesticides and Unwanted Containers" provided practical information about the disposal of pesticide wastes.

Until recently, NSW legislation did not readily provide for regulatory control of the disposal of pesticides. Pesticides are regulated by a number of Acts of parliament:

- Poisons Act;
- Public Health Act (Hazardous Pesticides Regulations);
- Dangerous Goods Act; and
- Pesticides and Allied Chemicals Act.

However, none of these Acts really offers a convenient way of controlling the disposal of pesticides and their containers.

The Environmentally Hazardous Chemicals Act (EHCA) was established with the purpose of providing controls on environmentally hazardous chemicals and wastes, and provides for the restoration of contaminated sites. The Act is administered by the SPCC. It has the power to impose controls on waste pesticides and their containers.

Officers of the Department of Agriculture and the SPCC had been considering the problem of pesticide wastes and containers for some time. The advent of the EHC Act in 1985 then provided an appropriate means for providing formal controls on pesticide wastes or containers.

Accordingly, the SPCC announced that it would make an assessment of pesticide wastes including containers, and submissions were invited from interested persons and organizations. Consideration of the submissions in conjunction with the current technical literature led to the publication of "Assessment of Pesticide Wastes, including Containers", together with approved disposal procedures in the form of two sets of guidelines - one for the home occupier,

the other for the commercial user.

The assessment report found that there were a number of treatment options that were not yet available or sufficiently developed such that they could be incorporated in guidelines or statutory controls at this stage.

The SPCC noted the need for treatment and disposal facilities to be established throughout the State so that pesticide wastes can be disposed of properly and effectively. The provision of such facilities and some related issues for the effective regulation of waste disposal was seen to require further development and liaison. For that purpose the SPCC established a subcommittee of its Hazardous Chemicals Advisory Committee to develop these details and ensure establishment and operation of the facilities.

Some future possible developments that are technically feasible but were not included in the Guidelines because they have not yet been sufficiently developed for use in NSW, are:

- Degradation Drains
- Soil treatment beds
- Evaporation ponds
- Public receiving depots for containers and pesticides
- Inspections and certification to ensure proper washing before leaving at a public depot.

The development of some of these options should be of particular interest to local councils who currently have difficulties with these issues and stand to benefit from the provision and operation of suitable facilities, procedures and policies.

2. OUTLINE OF THE GUIDELINES FOR DISPOSAL OF PESTICIDE WASTES

The basic provisions of the Guidelines are briefly summarised here. The Guidelines will be available at the conference.

Disposal of Waste Unused Concentrate

In general, the more dilute a pesticide is, the less hazard it poses to the environment. Hence, the environment is most at risk from the disposal or spillage of pesticide concentrate. Whenever possible, pesticide concentrate should be used for its intended purpose, thereby obviating the need to dispose of it. Unused pesticide at the end of a season might be retained for use in the following season, given to another user, or returned to the manufacturer. Should it become necessary to dispose of the concentrate this must be done in a secure landfill. The Metropolitan Waste Disposal Authority (MWDA) operates secure landfill facilities for liquid wastes from the Sydney Region at Castlereagh.

Cleanup of Spillage/Concentrate Storage Area

Should pesticide concentrate be accidentally spilled, the spillage should be immediately contained and absorbed using dry soil or an inert absorbant. The herbicide-contaminated absorbant should then be disposed of in a secure landfill. To facilitate cleanup, the herbicide concentrate should be stored and prepared on a surface which is impervious to pesticides and which is

bunded to prevent escape of any spillage. An adequate supply of absorptive material should be kept on hand for use in the event of a spill.

Disposal of Tank Residues

Excess pesticide remaining in the spray tank once a task is completed presents less of a hazard to the environment than the spray concentrate does. Ideally, the excess herbicide will be used on a similar task at the first opportunity. Should this be not possible, the waste herbicide may be disposed of by burying in a safe spot away from plants and watercourses. Procedures and specifications are being developed for improved methods of disposal in soil.

Disposal of Empty Containers

Empty pesticide containers should be thoroughly rinsed and the rinsings added to the spray vat. The container, minus its cap, should be punctured in several places and crushed, then buried in a controlled landfill of the type operated by the MWDA at several locations around Sydney.

3. FACILITIES AND PROCEDURES TO BE DEVELOPED

3.1 Further Requirements

There are some pesticide disposal procedures recommended in the current Guidelines and others additionally recommended in special cases, which while safe if done properly, are not ideal.

These situations include:

- recommendations to bury diluted pesticides particularly from commercial users,

- recommendations for surface application of excess pesticide sprays - particularly herbicides

- codisposal: ie the burial of pesticides at council landfill waste depots.

While these procedures can be done safely they require suitable sites and reasonable skills and judgement. Quite understandably a lot of people when given such advice are uneasy about using such methods - particularly on their properties - and they look for other disposal routes. The subcommittee will look at these options to determine if and when they are safe, and to develop satisfactory specifications.

3.2 Alternative Pesticide Disposal Options

Most of the pesticides that are used today are organic chemicals, that is to say they contain carbon. Burning is a convenient way of getting rid of organic pesticides because all of them are combustible.

It is generally accepted that a high temperature incinerator which has been specially designed for handling hazardous wastes and chemicals, is the best way to burn organic wastes. The main disadvantages of high temperature

incinerators are that disposal costs are high and importantly there is strong local public opposition to proposals for their installation - based on the NIMBY syndrome - Not In My Back Yard. At present there is no high temperature incinerator generally available for pesticide waste destruction in Australia.

It is possible that pathological incinerators could be used to destroy selected pesticide wastes (e.g. strychnine). However, there may be organizational difficulties associated with their exploitation.

In the absence of an incinerator, there are a number of practical disposal methods that can be developed and refined for safe use in NSW.

It is generally appreciated that virtually all naturally produced organic chemicals (the vast array that make up plants and animals) are biodegradable, ie they are consumed by organisms and broken down to simple, harmless constituents. It is not so well appreciated that the major proportion of synthetic organic chemicals are also biodegradable. Moreover, all organic chemicals, even those that are not biodegradable, when exposed to air and sunlight will also eventually degrade to simple harmless constituents such as carbon dioxide and water.

A number of procedures are available using these degradation processes for the safe disposal of organic pesticides, but they are not suitable for inorganic pesticides containing heavy metals, eg arsenic or mercury.

These procedures include:

- Degradation Drains
- Soil Treatment Beds
- Evaporation Ponds
- Codisposal

3.2.1 Degradation Drains

Degradation drains exploit the absorptive capacities and the micro-flora and -fauna of soils to degrade pesticide wastes. Pesticides are prepared on a concrete pad. Waste washings, rinsings and spillages from the pad run into the degradation drains - several parallel leach lines that can be from 12-30 m long. The wastes flowing down the degradation drains percolate into the soil where microbial degradation occurs. After five or so years' use, it was found in a facility in the USA, that pesticide residues could not be detected in the soil more than 45 cm away from the lines. It is significant that ground water quality and populations of soil arthropods were not adversely affected.

Degradation drains appear to be suitable for small farms and orchards. Specifications are needed before their use can be tested and recommended.

3.2.2 Soil Treatment Pits

These are large concrete pits or bins that are filled to a depth of about 1 m

with alternating layers of soil and gravel (thickness of each bed about 300 mm). The University of Iowa built two pits; one 8 m x 3 m, the other 14 m x 7 m; they were used for the disposal of pesticide wastes arising from the operation of the University farm.

Periodic chemical analyses of water and soil from the beds showed that there was no buildup of pesticides, and what pesticides were present were strongly adsorbed onto the soil. It is believed that the latter fact prevented evaporative losses and hence air pollution.

Plastic lined pits of varying designs have also been used successfully in parts of California over periods of 4-8 years.

The major disadvantage of soil treatment beds is that they cost money to build, especially the concrete type. The advantages of treatment are ease of construction and operation, with little or no maintenance.

Soil treatment beds should appeal to the large users of pesticides, such as cotton growers and aerial spraying companies, for getting rid of their wastes and residues.

If treatment beds were set up at selected public garbage depots they could be used by various people to dispose of pesticides.

3.2.3 Evaporation Ponds

Evaporation ponds or pits are generally lined with an impervious material such as concrete or heavy gauge plastic sheet. Clay lined ponds may be satisfactory, but noting that they can not be totally impermeable, their safe use will be dependent on locality and the nature of pesticides to be disposed of.

Evaporation pits or ponds are easy to operate. Dilute pesticide wastes are added as and when necessary. Concentrated wastes, though, should be diluted to working strength before pouring into the pit. Hydrolysis, oxidation, biodegradation and photolysis are processes that degrade the organic pesticides in the pond. Further, the pesticides evaporate into the atmosphere where they are rapidly and considerably diluted. Subsequently, airborne pesticides are eventually broken down by sunlight into harmless products.

The advantages of evaporation pits or ponds are that they are reasonably inexpensive to build and cost little or nothing to operate and maintain. Possible disadvantages are that they may present an occupational health problem, particularly to sensitive individuals and have nuisance value if foul smelling pesticides are evaporating. Moreover there is a potential risk to wildlife that may settle on, or drink at, such a pond.

The ponds need to be designed and operated so that they do not overflow with heavy rain, ie. a net loss from evaporation needs to be maintained. In high rainfall areas, a cover would be needed, but it should be positioned so that it does not impede the evaporation and dispersal processes. In low rainfall areas, the cover would not generally be needed.

A number of evaporation ponds or pits are being used successfully in the

drier regions of New South Wales.

3.2.4 Codisposal

Codisposal is the disposal of industrial wastes, including pesticides, with ordinary municipal putrescible waste. It was the common way of disposing of industrial wastes in Sydney until the late 60's, and because of inadequate controls and inappropriate design, operation and management, pollution problems with leachate were not uncommon.

Not suprisingly, some government authorities have reservations about codisposal because of the potential problems. There is now a much better understanding of appropriate landfill disposal practices, and codisposal is becoming better understood, and accepted in some situations. The potential for codisposal of selected pesticide wastes in appropriate quantities at appropriate landfill disposal depots warrants further development so that specifications be written for making this a safe practice under carefully specified conditions.

3.2.5 Security

Because of the potential danger from pesticides, evaporation ponds and soil treatment beds would have to be properly fenced and covered to prevent access from unauthorized people, children, domestic animals and wildlife. This requirement would be particularly important, where public access is possible. Therefore, appropriate security would need to be specified and implemented.

3.3 Containers

Pesticide users generate large numbers of containers that need to be satisfactorily recycled or disposed of. The guidelines specify that empty containers are to be triple rinsed, and the outside washed too. The disposal of properly washed pesticide containers at disposal depots is not hazardous. Disposal is essentially required for good housekeeping - ie aesthetic purposes.

Two hundred litre drums are fairly expensive and a number of companies find it economically worthwhile, in cities at least, to collect and recondition them for resale. The recycling and reconditioning of containers is not generally favourable where there are small quantities and sizes of container, or long distances involved. A possible solution to this problem would be to have centralized collecting points where pesticide users could leave their empties; major agrochemical sales outlets or local council garbage depots could be suitable in some instances.

Before unwanted pesticide containers are to be left at a waste disposal deopt, either for disposal or especially for recycling, it is most desirable that there is some form of assurance or check to ensure that the containers are satisfactorily clean - this is clearly necessary for the safety of those that may still be involved with the containers.

4. CONCLUSION

The SPCC's guidelines for disposal of pesticide wastes and containers now provide formally approved safe means of disposal of these wastes.

Further useful procedures and facilities are being developed so that there is a greater choice and availability of safe and practical disposal and recycling avenues for these materials.

APPENDIX I

GUIDELINES FOR THE HOME OCCUPIER FOR THE DISPOSAL OF SURPLUS PESTICIDES, HERBICIDES AND LIKE, CONTAINERS, SPRAY AND SPILLS

INTRODUCTION

These guidelines relate to pesticides which includes insecticides, herbicides, fungicides and some other chemicals.

Pesticides are useful chemicals, but they may harm humans, pets or plants or the environment generally, if they are not handled with great care. This applies also to disposal of surplus pesticides, containers, spray and spills.

The Pesticides and Allied Chemicals Act requires the home occupier to read the container label and to follow its instructions regarding use and disposal. These guidelines are to assist the home occupier in safe disposal procedures.

A. SAFETY PRECAUTIONS

- Use the same personal precautions in disposal operations as are recommended on the label for handling and use. In any case, it is advisable to use rubber or PVC gloves.

- If pesticide is spilled on the skin, it should be removed at once following the directions on the label. If clothing becomes contaminated, remove it immediately and have it washed separately from other clothes.

B. MINIMIZE THE DISPOSAL PROBLEM

- Before buying pesticides identify or forecast the pest(s) and decide whether pesticides are the most effective control procedure.

- Seek advice regarding the least hazardous recommended pesticide(s) and buy only enough for one season.

- When using:
  - mix only enough for the application
  - use up all the pesticide prepared
  - when rigid pesticide containers (tins, glass or plastic bottles) become empty, rinse three times with water and put rinsings in sprayer. Either spray over the same or similar area as is, or make up to full strength with pesticide from a fresh container and use as recommended. If this is not convenient, dispose of rinsings as under E.

DO NOT rinse out non-rigid pesticide containers (bags).

C. DISPOSAL OF SURPLUS PESTICIDES

1. If possible, use the surplus for purposes shown on label.

2. Offer pesticide to neighbours and friends provided that the container is sound, the label is intact and the product usable.

3. If the pesticide is new and unopened, request the supplier to take it back. Normally, there is no expiry date on pesticides.

4. If 1 to 3 do not apply and the surplus material is 200 g or 200 mL or less, wrap up the container in several layers of newspaper and tie around it as a package. Then place package in a plastic bag, fold it up and place in garbage container. Limit this to once per collection. Alternatively, the wrapped container may be left at the garbage depot face with the rest of the household garbage. Do not leave it with the depot attendant.

5. If the surplus is greater than under 4, obtain advice from the local council health surveyor, the Metropolitan Waste Disposal Authority in the Sydney area, or from the State Pollution Control Commission.

6. If the container is leaking liquid, place it in a larger metal, rigid plastic or glass container, pack all around it with soil, sand, powdered chalk, diatomaceous earth (from pool filter) or similar inert material (but not sawdust), and seal. If the container is losing powder place it in a larger similar container or rigid container and close it. Then dispose of container as under 4 or 5 depending on the amount.

7. Pending disposal, the surplus pesticides should be held in a secure cool place.

   DO NOT leave out surplus pesticides for pick-up in special houshold waste collections.

   DO NOT burn surplus pesticides in open fires or incinerators or bury them in urban areas.

   DO NOT dispose of to stormwater or sewerage system.

D. DISPOSAL OF PESTICIDE CONTAINERS

8. Rigid containers and bags should be treated as under 4 or 5.

9. Aerosol containers (a maximum of one per collection) may be placed directly in garbage container; it should be wrapped well.

   DO NOT re-use pesticide containers for pesticides or for other purposes, e.g. to hold water and other substances or as plant containers.

   DO NOT place aerosol cans in the incinerator.

   DO NOT puncture aerosol cans.

   DO NOT leave empty pesticide containers for special household waste collections or leave out or deliver glass or plastic containers for bottle collections.

E. DISPOSAL OF EXCESS SPRAY AND RINSINGS

10. If there is room in the garden, excess pesticide (except herbicides) or fungicide spray (not surplus concentrate) or rinsings (see B) may be poured into a hole at least 15 cm deep as far as possible away from plants and neighbours. Allow it to soak in, then fill up hole.

11. For disposal of excess herbicide, or other pesticides not in 10, spray (not surplus concentrate) or rinsings obtain advice from the local council health surveyor, the Metropolitan Waste Disposal Authority or the State Pollution Control Commission.

DO NOT store unused pesticide spray in non-pesticide containers especially drink or other food containers: this is particularly dangerous.

DO NOT leave out surplus spray for council pick-up.

DO NOT dispose of excess herbicide spray in the garden.

DO NOT pour pesticide concentrate into toilets sinks, drains (sewage and stormwater) and gully traps.

F. SPILLS

13. Keep children and pets away.

14. Put on rubber or PVC gloves.

15. If the spill is a powder, any top portion not contaminated, e.g. by soil or dust, may be returned to the container using a disposable plastic spoon. Gently scrape the remainder onto stiff paper using the spoon, or a piece of stiff cardboard or stiff plastic, and transfer all to a plastic bag including the spoon. Treat as under 4. As a last resort (e.g. if the spill is on a carpet), the area can be cleaned with a vacuum cleaner that has a disposable bag. Immediately after use, the bag should be put in the garbage bin. If the vacuum cleaner smells afterwards, vacuum up one of the absorbents listed under 17. Wash gloves under the garden tap or in the laundry tub.

16. If liquid pesticide as spray or concentrate is spilt onto an absorbent surface such as soil or sand, scoop up the contaminated material, transfer to plastic bag or rigid container and treat as under 4.

17. If liquid pesticide is spilt onto a solid surface, e.g. floor, walls or furniture, remove splashes with rags or absorbent tissues. Transfer these to a plastic bag or rigid container and treat as under 4. If necessary, more may be removed with dampened rags or absorbent tissues. It may be preferable to treat the furniture outside. Larger amounts on the floor may be contained and absorbed with a non-reactive agent such as sand, talcum powder, diatomaceous earth (as used in swimming pool filters), vermiculite, whiting or powdered chalk. Sawdust may be used for a spray but not for a

concentrate. Then scrape up as under 15 using also a vacuum cleaner if required. These actions may not remove sufficient of the spill, in which case lightly dampen the area with water and repeat the process. If the smell persists it may be advisable to seek advice from the authorities, especially if it occurs inside the house, or to contact a professional cleaning service.

USEFUL TELEPHONE NUMBERS

State Pollution Control Commission	(02) 265-8888
Metropolitan Waste Disposal Authority	(02) 412-1388
Department of Agriculture	(02) 217-6666

APPENDIX II

GUIDELINES FOR THE COMMERCIAL USER FOR THE DISPOSAL OF SURPLUS PESTICIDES, CONTAINERS, SPRAY AND SPILLS

INTRODUCTION

The commercial user is regarded as a self-employed or an employed person or an organization that uses pesticides for commerical purposes, and may accumulate large quantities of surplus pesticides or containers or be involved in pesticide spills that require disposal.

Commercial users should be aware already that some pesticides may adversely affect health or the environment if they or their containers are not disposed of correctly. Accordingly, such users have a major responsibility to become informed of accepted disposal practices and to follow them.

The purpose of these guidelines is to inform the commercial user of correct disposal procedures and to provide a range of effective options to meet the various situations and legal requirements under which commercial users operate. Optimum disposal procedures vary according to factors such as the person or persons responsible, the location and availability of public disposal facilities and the nature of the pesticide. The disposal of small quantities and containers used in a household situation are also dealt with in Guidelines for the Home Occupier.

It should be noted that pesticides includes insecticides, herbicides, fungicides and some other chemicals, and that not only insecticides may be hazardous and require correct disposal.

Commercial users should be familiar with the law relating to disposal. The Poisons Act states that no person shall dispose of or use a poison (which includes most pesticides) so that it will constitute a danger to the public.

The Pesticides and Allied Chemicals Act requires that label recommendations be followed in disposing of a pesticide. Regulation 123 of the Public Health Act has strict requirements for the disposal and handling of spillages of pesticides declared hazardous because they are specially dangerous to health. Disposal facilities and procedures are the responsibility of local councils, the Metropolitan Waste Disposal Authority and the State Pollution Control Commission.

If more than one person is responsible for use and disposal or for different phases of disposal, effective communication is essential between them particularly down the line of operations to ultimate disposal.

A. SAFETY PRECAUTIONS AND EQUIPMENT

- Commercial users should be thoroughly familiar with safety precautions, including protective clothing and equipment. Some product labels provide directions for use that are broadly applicable to disposal.

- Australian Standard AS2507 Section 4.6 provides a guide to protective clothing that should be available for disposal operations, and Section 6.5.2.3 lists suitable equipment.

  Generally, operators should wear at least a boiler suit buttoned up at the wrists and throat, impervious gloves and impervious footwear. A washable hat, eye protection and respirators may be indicated.

- For pesticides declared hazardous under the Public Health Act (the Hazardous Pesticides Regulations) it is compulsory to provide the described protective clothing and equipment.

- If skin, eyes or clothing come in contact with a pesticide, see the label. If the label does not give directions (it may be damaged) wash the affected area with soap and water. Wash eyes with copious amounts of water. Remove any contaminated clothing immediately. If necessary, contact a doctor or the Poisons Information Service (02) 51-0466).

B. MINIMIZE THE DISPOSAL PROBLEM

Before buying pesticides:

- Identify or forecast the pest(s).

- Where applicable, decide if pesticide treatment is the most effective control procedure.

When buying:

- Choose the least hazardous recommended pesticide.

- Buy only enough for one season.

When using:

- Mix only enough in the sprayer or mix tank for the job at hand - or if practicable slightly less, so that the exact amount can then be mixed to finish off;

- Mix over a concrete or impervious area so that any spillage can be readily collected;

- Use up all the pesticide prepared for any single application;

When rinsing:

- When non-combustible or rigid plastic pesticide containers become empty, rinse several times with small portions of the diluent (usually water) and put in the sprayer, mix tank or a holding container for the next spray batch for use that day. Obtain the rinsing water from a tank or reticulated water supply not by dipping the container in a natural body of water.

Follow these steps:

1. At final emptying, drain the container for at least 30 seconds after the liquid stream reduces to drops;

2. Part fill with water* to about 1/8 to 1/4 of its volume;

3. Replace closure;

4. Shake or roll and tumble;

5. Drain into the sprayer, mix tank, or holding container, and continue for 30 seconds as for Step 1;

6. Repeat steps 2 to 5 twice, but before draining the last (i.e. third) rinse, puncture the container's rim next to the spout and drain from puncture;

7. If the residue appears difficult to shift from the container, add about 1 ml of detergent per L volume of container, and re-rinse;

8. Cross out all labels, but do not make them unreadable.

9. Retain container(s) for disposal preferably in an enclosure that is secure against unauthorized entry.

The steps above apply to all normal sizes including 200 L, though some operators may use a special flushing procedure with a lance.

If the rinsings cannot be used, particularly as a result of action 7, dispose of them as described under E.

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*Oil-based formulations: rinse out with an oil or solvent as per the steps above and dispose of as under E.

C. DISPOSAL OF SURPLUS PESTICIDES

There are three major options:

1	2	3
Pass on for use by others	**Take to disposal facility or site**	**Dispose in safe spot**
***Sell/give to someone else** ***Return to supplier or manufacturer**		
(1) It is essential that the label is intact and the product is still usable.	(1) Some garbage depots will accept limited quantities.	This requires careful site selection and disposal procedures (see below) and should be used if options 1 and 2 are not available. Disposal in a safe spot can be managed in two main ways: (1) Burial (2) Surface application.
(2) Suppliers and manufacturers will not consider partly-used product and may not accept unopened containers because of expense and concern over tampering.	(2) A collection site is for transfer of surplus to a special disposal site such as a secure landfill or a high temperature incinerator. Such sites are not generally available, but the Metropolitan Waste Disposal Authority may be prepared to accept limited quantities of waste pesticides in the Sydney area.	

Burial

First it is necessary to select a suitable site for surplus pesticides (and containers). This must be away from settled areas, and the following criteria should be followed:

- the site should be well away from people (homes, shops, schools, recreation areas and roads), agriculture (crops, livestock yards, fodder, grain and produce), and watercourses.
- the site should be used solely for pesticides and containers, and no other future uses should be expected.
- the site should be clearly marked and fenced.
- the soil surface should be level, and the soil porous so that the pesticides will mix or sink in and not run off.
- the site should be selected to minimize access of pesticide effluent

to the water table, wells and watercourses, and erosion.

. if residual herbicides are to be disposed of beware of nearby trees.

Two procedures may be used at the disposal site:

Disposal procedure (1)

1. Construct a disposal pit or trench at least 0.5 m deep and as large as needed.

2. Spread at least one bag of hydrated (slaked) lime over the bottom.

3. Dilute pesticide to spraying strength.

4. Pour into pit.

5. Fill in with soil and build up a mound to encourage runoff of rain from the surface.

Disposal procedure (2)

Additional insurance against the escape to the environment of certain pesticides can be obtained by encapsulating them in Portland cement before burial. A simple procedure is available from the State Pollution Control Commission. The procedure is desirable for pesticides that persist in the environment such as organochlorines (both insecticides and herbicides) and metallics (arsenic, cadmium, mercury, zinc).

Surface application

Pesticides that are used in agriculture may be disposed of by applying them on the recommended crop at the recommended rate if appropriate and safe, or onto another safe area of unused land but this should not occur shortly after a normal application. An additional precaution is to dilute them to below the recommended rate.

Great care has to be exercised in choosing the pesticides to be disposed of in this way and it is advisable to avoid pesticides and herbicides that are highly persistent. Advice is available from the State Pollution Control Commission and the Department of Agriculture.

It may be necessary to isolate the area from livestock for at least two weeks.

Precautions

1. Do not dispose of any type of surplus pesticide down the toilet;

2. Generally it is not considered safe to dispose of surplus pesticides by burning them.

D. DISPOSAL OF PESTICIDE CONTAINERS

Check as far as possible that the pesticide has been rinsed from rigid containers (glass, tin, moulded plastic), particularly as the person disposing of the container may not be the same as the person who used its contents. If the container has not been rinsed, deal with it as under A. It is not advisable to rinse bags as this is difficult to perform safely. Before disposal, small containers may be stored in larger containers marked for this purpose.

The major disposal options for empty containers are as follows:

Combustibles (Paper, plastic bags and cardboard)	Non combustible (Metal, glass and moulded plastics)	
	Small metal, glass and moulded plastic	**Large metal**
Burn in safe spot	**Bury in safe spot**	**Pass on for re-use or recycling to:**
1. Permissable only in remote places (so that the smoke will not go over residents, roads, waterways, valuable trees, crops, or livestock), and subject to the Clean Air Act. 2. Beware of burning containers with residues of volatile herbicides, e.g. 2,4-D and 2,4,5-T as they may drift and cause harm. 3. Keep away from smoke. 4. Ensure that the fire is as hot as possible to achieve maximum combustion of residues.	1. This spot may be the same as or similar to that described under C 2. Glass: remove cap, break crush, bury. 3. Metal or plastic: remove bung or cap, pierce sides, squash, bury. Squashing may be by means of a hammer, mechanical compressor, tractor or earthmoving equipment. 4. Non-combustible containers may be fired before burial if fuel available. to remove traces of pesticides. Metal containers should stay red hot for at least five minutes. **Take to disposal facility or collection site** 1. This may be provided by employer or government operating singly or together on a regional basis. Before disposal, remove caps and either pierce sides or crush container. The State Pollution Control Commission can provide directions (Environmental Guide WD2)* for the construction of facilities. 2. Most councils will accept bags and rinsed containers at tips.	* Drum reconditioner * Supplier * Scrap metal merchant * Manufacturer 1. These options usually apply to 200 L drums; other containers are uneconomic or impractical. 2. Generally manufacturers are reluctant to accept empties because of handling costs and risk of contamination.

*Environmental Criteria for Landfill Waste Disposal in New South Wales.

It should be noted that, under the Hazardous Pesticides Regulations, it is an obligation to dispose of a container made of paper, cardboard or any other material that is not impervious to the pesticide, within 48 hours of removing the pesticide.

Precautions

1. Do not leave glass or plastic pesticide containers at community collection (recycling) centres unless there is special provision.

2. Never use or convert containers for other purposes, e.g. holding water, feed, or use as raft floats. Suitable containers may however be used for temporary containment of pesticide wastes and spills.

3. Never dispose of aerosol containers or closed or unpunctured containers in a fire. Do not puncture aerosol containers.

E. DISPOSAL OF EXCESS SPRAY OR RINSINGS

Generally a commercial user should be sufficiently skilled not to have excess spray. If excess occurs, there should be very little and in any case it is less of a potential threat to the environment than concentrate. The same applies to rinsings or equipment washings. The disposal options are as follows (excess spray 1 to 4, rinsings 2 to 4):

1. Keep for future use	**2. Take to disposal facility or collection site**	**3. Use at recommended rate or less**	**4. Dispose of to ground**
This is risky because of settling out and breaking of emulsions.	1. This may be provided by the employer or government agency. 2. It is not advisable to pour the spray into a public tip as others may come into contact with it.	1. If safe to the environment, apply excess as it is, or further diluted according to standard recommendations, over an isolated area. 2. Particular care is needed with herbicides which should preferably be diluted.	Use the same or similar pit as described under C - Disposal procedure 1 in cases where the excess or rinsings can be readily transported.

Rinsings or washings from equipment may occur at a site where they are most conveniently allowed to run and be hosed into a collection sump or drain for collection or drainage to an impermeable floodfree evaporation basin. Operators who regularly generate rinsings, may find it worthwhile to place or allow these to run into, a concrete tank that promotes evaporation and decomposition. The State Pollution Control Commission is

developing construction and operating details that will be formalised soon.

F. SPILLS

The appropriate procedure for dealing with spills depends upon the responsibilities of those concerned, location, quantity and hazardous nature of the spill, and the surface on which it falls.

Commercial users, either as a body or individuals, should already know about the nature of the pesticide, and should have all the necessary protective clothing (see section A) and ancillary equipment for handling and using the pesticides and disposing of all but major spills.

First actions

1. Keep vehicles, bystanders and animals away.

2. Attempt to identify the pesticide, plus any emergency directions on the label.

3. Decide whether outside assistance is needed (see obtaining help).

Leaking containers

1. Position them so that leaking is lessened or stopped.

2. Leaking containers may be placed in suitable oversize containers or plastic bags (special oversize drums exist for holding 200 L drums). Wrapping up in appropriate plastic sheeting may be suitable. If practicable decant or shovel the contents into another container.

3. If possible, transfer temporarily to a suitable secure location.

4. Dispose of as indicated under C, options 2 or 3.

Spills on Soil

1. Powders

   Scoop up any uncontaminated top portion and return it to the container if it is intact, for use later. Then scoop (and brush) up the remainder together with underlying soil. Transfer to an open-head waste drum, close it, and label. If the powder tends to blow away, lightly moisten it and place all powder and soil in a waste container. Dispose of as under C, options 2 or 3.

2. Liquids

   For emulsifiable concentrates, or sprays of persistent insecticides, herbicides, or metallic pesticides dig up the soil as far as possible to the limit of penetration and transfer to a clearly-marked open-head waste drum. Fill in the hole with fresh soil. Dispose of the

waste as under C, options 2 or 3.

For sprays of other pesticides, wash the spillage further into the soil with copious quantities of water. Cover over the area with at least 10 cm of fresh soil.

For oil formulations, act as for emulsifiable concentrates.

Spills on Hard Surfaces (clay-pan, pathway, road, concrete floor)

1. Powders

Scoop up any uncontaminated portion and return it to the container for use later. Then scoop and brush up the remainder into an open-head waste drum. If there is any difficulty in recovering the material, and if it is in a vulnerable location which could threaten health (warehouse) or the environment (nearby trees), lightly cover the spill area with an absorbent such as dry soil, sand, talcum, agricultural lime (calcium carbonate), hydrated lime, dolomite, vermiculite or diatomaceous earth (as used in pool filters). Sweep the absorbent into the powder and into a heap. Transfer to a waste container. If the material is highly hazardous to health, lightly dampen down the area with water and cover with hydrated lime. Transfer to a waste container and label it as such. Dispose of as under C, options 2 or 3.

In a factory or warehouse it may be feasible to further spread with lime, and after 1 hr wash the material down into a sump and transfer the washings to a container.

2. Liquids

Surround the spill to prevent it spreading further, and to absorb it, with any of the absorbents used for powders. But do not use sawdust as it may catch alight. Then handle as for powders.

Concentrates have a high capacity to penetrate certain hard but porous surfaces such as concrete, and to produce a surface that is potentially toxic to human health. This applies particularly to certain organochlorines and organophosphates. In such cases an additional clean-up may be desirable: spray the area with a 50/50 mixture of laundry bleach and water, cover with hydrated lime for about an hour and then remove. If the area is likely to be contacted by foodstuff containers, pets or bare feet, the authorities should be contacted for advice. It may be necessary to remove part of the surface or cover it with an impermeable coating.

Household Situations (floor boards, concrete, floor coverings).

It is not expected that large amounts of pesticide will be spilled in a household because they are neither needed nor acceptable on safety grounds. But even relatively small spills can produce a surface that is hazardous to humans and pets, or cause an unpleasant smell.

1. Powders

The same general principles apply as for hard surfaces. However, more care has to be exercised in choosing an absorbent. Thus soil, sand, and lime should not be used indoors whereas they may be acceptable on the floor of a garage or workshop. Small amounts may be vacuumed provided that the vacuum cleaner has a bag that can be readily disposed of without contaminating the equipment. The cleaner should be decontaminated by vacuuming up some clean absorbent.

Further traces of pesticide may be removed by dampening the area lightly with water, working in further absorbent, allowing to dry, and removing it.

2. Liquids

Follow the general directions for powders in the household.

Oil Concentrates

Pesticide formulations that do not contain emulsifiers and do not mix with water require some special treatment. Containment and absorption is similar to that for emulsifiable concentrates. However, if further clean-up is required the spill area should have detergent worked into it. Then add water and absorb as above.

Final Disposal of Contained Spill

See C, options 2 or 3.

Obtaining Help

If the spill is in a public place particularly a road, and help is needed, the following actions may be appropriate (not necessarily in the order given):

1. Keep bystanders and traffic away - it may be necessary to get assistance on the spot. (A notice or barrier would assist.)

2. Call or have the Fire Brigade or Police called without the spill being deserted.

3. Attempt to minimise leaking from containers if this can be done safely.

4. Attempt to contain and absorb the spill if this can be done safely - see section F.

5. No smoking - warn bystanders if necessary.

6. Stay upwind if necessary.

The Fire Brigade is responsible for clean up of spills, and the Police for crowd and traffic control. The Fire Brigade should have all the necessary information and equipment. Department of Main Roads or local council personnel provide sand or soil and clean-up machinery for a large spill. Pesticides, particularly residual herbicides, should not be hosed

off roads into surrounding vegetation or watercourses.

Decontamination of persons, clothing and equipment

The commercial user should be informed as to the decontamination measures appropriate to a given situation and to the toxicity of the pesticide. If the recommended protective measures are followed, the chances of contact between the pesticide and the body are minimized, and hence immediate personal decontamination measures are unlikely to be needed. If the clothing is contaminated by a hazardous pesticide, it should be removed immediately and transferred to a holding container (Hazardous Pesticides Regulations). Immediately wash affected skin with soap and water. Shower if necessary. Wash or have clothing washed separately from non-contaminated clothes.

If there is no emergency situation, clothing including underwear, should be washed at frequent intervals or when obviously contaminated. But if a hazardous pesticide is being disposed of, the clothing and protective equipment are to be placed in a holding container as soon as the operation is concluded, or at the end of each day.

Shower.

If the clothes or equipment become grossly contaminated it may be desirable to handle them with clean gloves.

It may be desirable to dispose of grossly contaminated items of clothing or equipment which should be held temporarily in a drum.

Items that are retained may need to be washed according to S.4.6.2 of AA 2507 as follows:

(a) Protective equipment. Soak in 5 per cent soda ash solution for at least 24 h. Thoroughly rinse with water and dry. Test gloves for holes by filling with water and squeezing.

(b) Other equipment. For shovels, etc. soak in 5 per cent soda ash separate from the protective equipment for at least 24 h. Thoroughly wash with water containing detergent, rinse and dry.

(c) Overalls, clothes, etc. Soak in 5 per cent soda ash solution for at least 24 h and then launder in the normal way.

USEFUL TELEPHONE NUMBERS

State Pollution Control Commission	(02) 265-8888
Metropolitan Waste Disposal Authority	(02) 412-1388
Department of Agriculture	(02) 217-6666

ALTERNATIVE APPLICATION METHODS FOR HERBICIDE CONTROL OF WOODY WEEDS

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Orange

There is a range of alternatives for herbicide application for the control of woody plants. The use of high volume, spot spraying application of herbicides, particularly to larger woody weeds can pose specific problems, i.e.

- a larger volume of herbicide mixture is required
- damage to non-target species is more likely (less selective)
- risk of spray drift from volatile herbicides

and - high cost application equipment (sprayers) and difficulty of access of this equipment,

all provide distinct disadvantages; particularly for urban weed control.

In this paper I will briefly discuss two alternative herbicide application techniques which have been successfully used to control privet (*Ligustrum sinense*) on the central coast.

Due to the situations in which woody weeds such as privet grow, a selective and simple application technique had to be devised. Overall high volume spot spraying is not considered a satisfactory alternative due to the problems mentioned earlier.

Two methods of application were trialled at Gosford in Autumn 1983 using both the "cut stump" and "basal bark" application techniques. The stem injection and "frill cut" methods were found impractical due to the inaccessible nature of the massive number of stems and suckers of the privet bushes.

METHOD OF APPLICATION

Basal bark application involves the application of the herbicide mixture to the lower portion of the trunk or stems of the plant i.e. usually from ground level to a height of 30 cm. The herbicide mixture can be applied with a paint brush or low pressure pneumatic hand-held sprayer.

The "cut stump" technique is more labour-intensive and involves the applying of the herbicide mixture immediately with a paint brush or swab to the stump after cutting as close to ground level as possible usually with a chain saw. The cut stump treatment although generally the more reliable of the two techniques has the distinct disadvantage of having to dispose of massive amounts of plant material following the lopping.

Table 1. Percent kill of privet using basal bark and cut stump application treatment at Gosford. Treatments applied Autumn 1983.

Percent kill of privet		
Herbicide treatments		12 months after treatment
Control - untreated	—	0%
Roundup [R] + water (1: 2)	Cut stump	95%
	Basal bark	97%
Garlon [R] + distillate (1: 10)	Cut stump	89%
	Basal bark	46%

The "cut stump" treatment gives more reliable results. This technique has been observed to give good control of both species of privet, Cotoneaster, and Pyracantha (firethorn). Surprisingly some species such as Oleander appear difficult to control by this method. There appears a great variation in species susceptibility and new situations should be trialled before undertaking large areas.

URBAN WEEDS ON THE MOVE

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Haymarket. 2000.

Pampas Grass	(*Cortaderia selloana*)
Rhus Tree	(*Toxicodendron succedaneum*)
Pellitory	(*Parietaria judaica*)
Temple Plant	(*Gymnocoronis spilanthoides*)

These plants have recently been declared noxious plants.

Temple plant, Pampas grass and Rhus tree have been declared noxious plants statewide while Pellitory has been declared noxious only in Mosman municipality.

Temple plant is a plant which has escaped from aquariums at two sites in the State and grows mainly in dams and swampy areas. It is hoped to eradicate this plant before it spreads further. An information sheet with coloured photographs of the plant will be distributed to councils shortly.

Pampas grass and Rhus tree are weeds mainly found in urban and coastal areas. Rhus may cause skin irritations particularly when coming in contact with the sap or bark. It is in the same family as poison ivy.

Pampas grass is invading urban parks and bushland areas and in New Zealand invades urban areas and is a major weed of forests. A major reason for declaring it noxious is to prevent further introduction of material and varieties from New Zealand and other overseas sources.

The two plants have in the past been planted as ornamental species, but are now no longer available or recommended as garden plants.

When removing Rhus tree, be careful. The sap of the plant is capable of causing severe and painful skin irritation and rashes. The plant is best cut down and dug out, but the material should not be burnt due to the irritant nature of the plant.

Extreme caution should be exercised when handling Rhus material due to the skin allergy problem.

It is suggested that landholders or occupiers of land where Rhus and Pampas grass are growing be given 12 months to remove them. After that time people will be liable for prosecution. This is to enable councils to publicise the recent declarations and give people time to carry out control measures.

The other declaration - Pellitory, is a plant which can cause allergies. It looks like a type of stinging nettle and feels sticky to touch. Infestations are particularly heavy in the North Sydney and Mosman areas as well as in the commercial part of Sydney and the Eastern Suburbs. Further declaration will depend on the success of control in the Mosman area and the continued spread.

There are currently two excellent information sheets available on Rhus and Pampas grass. In the near future Agfacts will be available.

FIREWEED - A PROFILE

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University of Sydney. 2006.

Farmers in coastal areas of New South Wales consider fireweed to be their worst weed of pastures. This is just one of the findings from my present research work on the ecology and control of this weed.

CURRENT CONTEXT

There are at least four reasons why fireweed has such a high profile at this particular time and they are as follows:

(i) Although thought to be a native of Australia for so long, the common weed referred to as fireweed, was discovered only in 1980 to be an introduced species. It originates in south-eastern Africa and Madagascar (Michael 1981). Fireweed (*Senecio madagascariensis*) was previously confused with one of our native species of plants *Senecio lautus*. It is important therefore to be able to distinguish between the two, particularly since the native does not generally behave in a weedy manner and does occur in areas where fireweed is not expected to grow (Sindel 1986).

(ii) There has been a severe lack of research on fireweed in Australia and very few published accounts of it exist. No doubt this is partly due to it being considered a native until only recently.

(iii) Recent reports have confirmed its toxicity to cattle (Walker and Kirkland 1981; Kirkland *et al* 1982). It has the potential to cause poor growth and death of livestock.

(iv) In 1983 following a long drought fireweed exploded in many parts of coastal New South Wales. And the weed continues to spread into new areas, particularly along the south coast.

These four factors then have led to a renewed interest in the ecology and control of this weed.

THE WEED ITSELF

Why is it called fireweed?

Possible explanations for this include its bright yellow colour and fire-like appearance when covering a large area; the suggestion that it can cause spontaneous combustion in lucerne hay; its appearance soon after bushfires; and the possibility that when eaten it causes burning of the cow's throat and intestinal tract. However, the most common explanation is its ability to "spread like wild fire".

What is its distribution?

The earliest known record of fireweed in New South Wales was from Raymond Terrace in the Hunter Valley in 1918 (Nelson 1980). It was in the Hunter Valley that it first became prominent in pastures and from there spread to the north coast and throughout many parts of coastal New South Wales (Green 1953). It is now especially abundant in the Richmond, Manning and Hunter Valleys, in the County of Cumberland and between Wollongong and Berry on the south coast. It is also known to occur as far south as Bega and in south-eastern Queensland (Sindel 1986). While the weed does primarily infest the coastal river valleys, distribution does extend into the northern and southern Tablelands and an isolated occurrence exists further inland at Dubbo in the Western Plains Zoo.

The potential distribution of fireweed in Australia is not known, but in view of its rapid spread in recent years, it can be expected, I believe, to occupy areas much larger than at present.

What are its identifying features?

Fireweed is a bush, or herb, most often erect and much branched, up to about 60 cm tall. Its leaves are alternate on the stem, sessile (without a stalk) and variable in shape. The flower heads are canary yellow and when mature contain "seeds" of three colours i.e. light brown, dark brown, and green. These are from 1.5 to 2.5 mm long and have 9 to 10 bands of short hairs on them. The number of involucral bracts or phyllaries is a major distinguishing characteristic and is 20 or 21. The number of ray florets (commonly called "petals") is usually 13 but this can vary. Sindel (1986) gives a key which allows for simple differentiation between fireweed (*S. madagascariensis*) and the more common representatives of the native *S. lautus* species.

What is its life cycle?

Fireweed is a short-lived perennial plant which behaves most commonly as an annual. While it is capable of growing and reproducing during a large part of the year flower intensity is greatest at the beginning of spring with another flush occurring in the middle of autumn (Verona *et al* 1982).

At the moment when seed is released from the flower head nearly all of it is viable and ready to germinate. It has been estimated that an average fireweed plant may produce 9000 viable seeds. Seedlings develop rapidly with plants producing flowers six to ten weeks after emergence. It is the dispersal of large amounts of seed in the wind that is considered to be the major factor responsible for the rapid spread of the weed over large areas and long distances (Watson *et al* 1984).

FIREWEED SURVEY

In order to assess the impact of fireweed on agriculture and the likely success of various control techniques, I conducted a survey in 1985 of 780 dairy farmers and beef cattle graziers in coastal areas of New South Wales. This was done by means of a mail questionnaire. I chose eight areas for the survey (see Figure 1) and randomly selected farmers in each from lists

supplied by various dairy co-operatives and District Agronomists and from other lists in the Yellow Pages of the local telephone directories. The way the farmers were selected allowed a comparison of the fireweed situation between each of the eight areas amongst dairy farmers and also a comparison of the situation on dairy farms and other grazing properties in the five areas where fireweed has been established for the longest period of time. This latter comparison was relevant because some observers believe that fireweed is a greater problem on the more undulating and less intensive grazing properties than on the intensively farmed river flats. The survey also acted as a springboard for making decisions regarding future fireweed research.

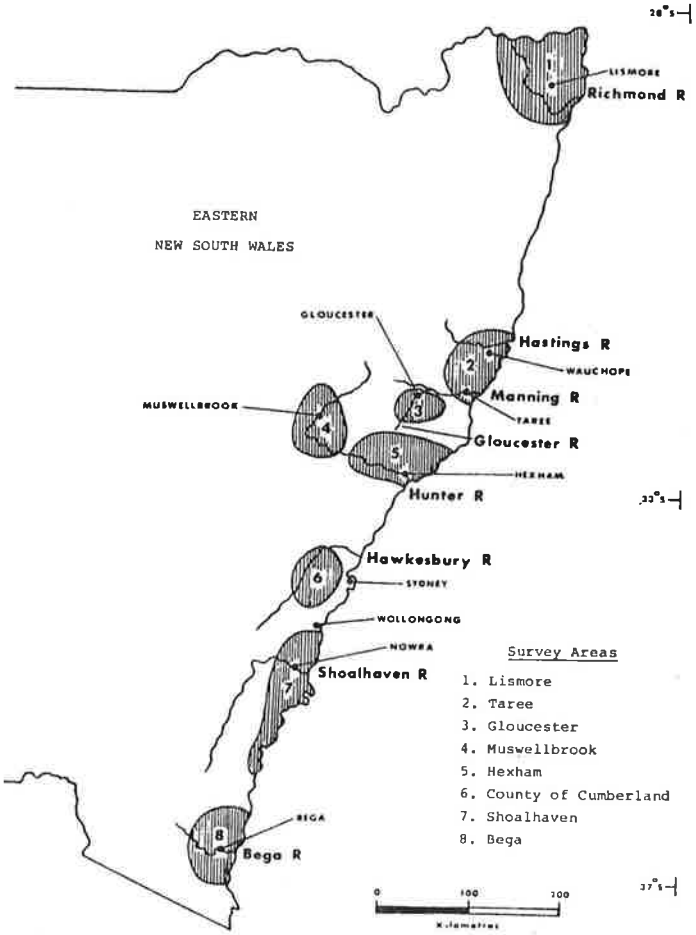


Figure 1. Areas sampled in the fireweed survey.

The 74 per cent response to the questionnaire was very pleasing and highlighted the concern farmers have about this weed. The salient results of the survey are as follows:

1. Fireweed was present on 90 per cent of respondents' properties and of these less than ten per cent considered it under control. It is therefore widespread in the areas surveyed.

2. 29 per cent of respondents with fireweed observed its arrival on their properties within the last five years, 58 per cent within the last ten years and 86 per cent within the last 20 years. Fireweed then is

spreading rapidly and the number of farms it infests in New South Wales has more than doubled since the mid 1970's.

3. As to the size of the fireweed problem, 19 per cent of farmers with fireweed considered it no problem, 36 per cent a minor problem, 33 per cent a moderate problem and 12 per cent a major problem.

4. When asked for what reasons did they consider it a problem on their property, respondents gave the replies as shown in Table 1. The fact that fireweed is such a conspicuous weed was reason enough for nearly half of them.

Table 1. Major reasons why fireweed is considered a problem by farmers.

Reason	Percentage of total replies
Looks bad	45%
Poisons stock	4%
Causes poor growth of stock	4%
Competes with crops or pasture	57%
Prevents stock grazing amongst it	30%
Occurs in pasture or crops used for hay or silage	24%

5. Notably four per cent of respondents believed it had been or is currently causing poisoning of stock and four per cent poor growth of stock. However, cattle tend not to eat fireweed. So how does this poisoning occur? Some cattle I believe must inadvertently graze some fireweed, presumably in its younger stages. Perhaps more importantly though, under conditions such as drought or very heavy infestations, cattle are forced to eat it despite its unpalatability. Overall it is prudent to consider fireweed to be of potential danger to grazing cattle.

6. 24 per cent of respondents had fireweed in pasture or crops used for hay or silage. Because it remains poisonous in these forms and it may be more difficult for the cattle to be selective in their feeding, this situation is also potentially dangerous.

7. 57 per cent of respondents claimed that fireweed reduced crop or pasture productivity and 30 per cent the available grazing area. This is not surprising considering that I have observed densities as high as 5000 plants/sq. m. Because fireweed tends to be seasonal, respondents believed that productivity was reduced much more in bad fireweed years than in normal years.

8. Over 80 per cent of respondents with fireweed attempt one or more forms of control. They spend on average an estimated 56 hours and $152 per year on it. This amounts to some hundreds of thousands of man-hours and dollars spent on fireweed control each year in New South Wales.

9. As to the frequency with which various control methods are used hand-weeding and slashing are most common while herbicides and grazing with sheep or goats are least common.

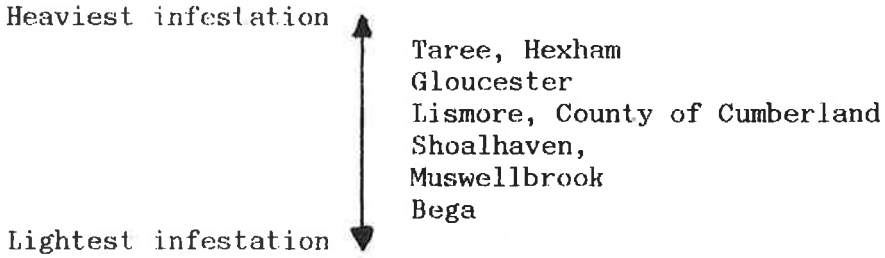
The level of success achieved with hand-weeding was variable, as shown in Table 2. One disillusioned respondent suggested that "pulling out fireweed is like emptying the ocean using a bucket with a hole in it". Neither slashing nor cultivation were considered by many respondents to be highly successful in controlling fireweed, however, moderate success was achieved using either method. Herbicides can give good control but due to their expense are not used very extensively. Sheep and goats are much less susceptible to fireweed poisoning (Bull 1955) and were found to be very successful. However, they are not without their difficulties. One respondent who tried using goats said that "controlling the goats was as bad as the fireweed". Promoting competitive pastures was considered to be as effective in control as herbicides and this result is very encouraging.

Table 2. Percentage success for the major methods of fireweed control.

Control method	Level of success		
	Low	Moderate	High
Pulling out by hand	37%	29%	34%
Slashing	41%	46%	13%
Cultivation	33%	54%	13%
Herbicides	22%	37%	41%
Grazing with sheep or goats	11%	22%	67%
Promoting competitive pasture	21%	37%	42%

10. A comparison of the responses of dairy farmers with other graziers revealed no significant difference in the occurrence of fireweed nor the magnitude of the problem. However, the conditions which favoured the growth of fireweed did vary, as did some of the methods of control. So while fireweed is not necessarily worse on less intensive properties the characteristics of the problem may be different.

11. The level of fireweed infestation varies between localities and if we were to rank the areas from heaviest to lightest infestation the ranking would be as follows:



Farmers, however, do not necessarily perceive the importance of fireweed

in this same order. For example, a large number of respondents considered it a major problem in the Shoalhaven area, where for the most part, it occurs only in small amounts. Of special concern there, as well as in other areas is the potential for infestations to increase.

12. A general comment made by a number of respondents was that public land and neighbours properties where fireweed is allowed to grow unchecked can prevent successful control on a particular individual's land. These places effectively act as seed banks for reinfestation.

FUTURE RESEARCH

It was previously mentioned that 57 per cent of respondents believed that fireweed was reducing pasture or crop productivity. Because it would be very difficult for farmers to give precise and accurate figures for such reductions, experiments designed to determine these losses for different levels of infestation need to be undertaken, and this is one aspect of research that I am presently involved in.

Fireweed was also seen to be spreading rapidly and I suggested that for this reason it has not yet reached its potential distribution in Australia. It would be very helpful to know just where fireweed is likely to spread to and what factors limit its distribution, for example, does frost? This is another line of investigation which I plan to pursue.

It is obviously most important, however, to direct research effort at strategies for fireweed control. The success attributed to competitive pastures in the survey was said to be very encouraging. This is because they alone, I believe, offer long term control. The other methods such as hand-weeding, slashing, cultivation, herbicides and grazing with sheep or goats, offer only a short term solution and because of the mobility of fireweed seed, provide opportunities for reinvasion. Thus the effectiveness of a range of pasture species for the control of fireweed needs to be properly evaluated. An integrated approach to fireweed control is desirable with pasture improvement as its basis.

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TELEVISION SKILLS

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ENVIRONMENT

You should have an idea of the environment that makes you feel comfortable and helps you to communicate smoothly, e.g. in your office, in the paddock.

Television studios are foreign territory to most of us and except in the case of panel discussions or group appearances, can be unnerving. If you must record your presentation at the studio, try to visit it beforehand or arrive early to get the feel of the place.

In the case of a news interview or interview for a program, if it is recorded on your territory and you are surrounded by familiar objects, you will feel less nervous and a more confident presentation will result.

DRESS IS IMPORTANT

You will lose credibility if you are overdressed. Conversely, if your clothing is obviously dirty and untidy this may, to some people, reflect your personal standards and may damage the image of your organisation.

Don't wear bright colours or clothes with fine patterns as these may cause distracting strobing effects on the camera.

Clothing that blends into the environment where the segment is being recorded and does not compete visually with the information that you are presenting will help viewers to concentrate on you and your message. Bone, tan and light brown shades are generally safe for television.

WATCH TV

Pick the people who perform well and work out why they appeal to you. Isolate the elements of the image they project, e.g. clarity of speech, honesty, pleasant appearance.

PRACTISE

Practise packaging and presenting your information out loud until you can cover it all in a neat and uncluttered manner. You will find that with time you will develop your own style and it will become easy for you to mould new information into that style.

PREPARATION

Before the interview begins, spend some time talking to your interviewer, set a friendly atmosphere but firmly state what you do and do not want to talk about. You are the talent and should maintain equal control of the discussion. If the interviewer begins to carry the interview beyond the limits that you have outlined do not carry on the interview. Stop any response before it leaves your mouth. You must remain in control.

EYE CONTACT

Ignore the camera. It is an observer of your conversation and if you shift your eye contact from the interviewer to the camera, you immediately change the role of the audience from observation to being the focal point of your presentation - a distracting situation that can make viewers uncomfortable. Eye contact between interviewer and interviewee is extremely important. It generates trust and establishes a valuable line of communication.

DEMONSTRATIONS

Use simple demonstrations or props to illustrate your point, but make sure that you are well rehearsed.

STAY STILL

Don't sway backwards and forwards while you are on camera. Many people find comfort in rocking or swaying as they speak. This makes it hard work for the cameraman to keep good picture composition and it is distracting in the end product.

IDENTIFY YOUR COMMUNICATION ZONE

Some people who may be articulate and well rehearsed in a subject can lose their ability to communicate if the interviewer works from an uncomfortably close distance.

Watch yourself and see how far you stand from people in groups or crowds. If you feel threatened by an interviewer, ask him to step back a bit.

BE COMFORTABLE

If the sun in your eyes is making you squint, or the site does not suit you, ask to move. You will probably find that no one is greatly inconvenienced and it may just be the difference between a good performance and a nerve wracking disaster.

Be sure at all times during spring or summer (inside or out) to wear personal insect repellent on your hands, face and arms, (also legs if you are wearing shorts or a skirt). If you begin to say something that is irrelevant, stop. Videotape is reusable and it is quite normal to do three or four .... or more takes for one good interview.

BIOLOGICAL CONTROL POLICY IN NEW SOUTH WALES

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INTRODUCTION

The last ten years have seen a substantial increase in the number of noxious weeds subject to biological controls in New South Wales. This rapid progress has stimulated controversy and confusion over whether biological control of noxious weeds can be regarded as a satisfactory means of control or eradication, both in terms of the practicalities of controlling the weed and in terms of the Local Government Act.

Landowners frequently ask the Department of Agriculture and local council weeds inspectors: "Why do we have to keep controlling our weeds (by herbicide spraying or chipping) when this magnificent bug is doing such a good job of control?" If that question is answered in terms sufficient to convince the questioner that some effort on their part is still required to control the weed, the next question is usually: "If I spray my weeds will the bugs all die out because nothing is left for them to eat?"

Such questioning of the need or even desirability of conventional control techniques coupled with a genuine or feigned acceptance of the immediate efficacy of recently-released biological controls has stimulated the Department of Agriculture's attempt to develop policy guidelines for the control of noxious weeds by biological means. If biological control was allowed to run its course, whether "effective" or not, and encourage the abandonment of conventional and costly weed control practices, there is a grave risk that noxious weed control would suffer in the long term.

Hence, an accommodation of noxious weed control by biological means needs to be made within the current noxious weed control system and there is an obvious need to formalise its role so a flexible and unambiguous determination of the acceptability of biological control can be made on a weed-by-weed and property-by-property basis.

CURRENT SITUATION

In comparison with the number of weed species present in New South Wales, the number of noxious weeds which have biological control available is relatively small. The current situation is that there are 16 noxious weeds with biological control available:

Alligator weed	Skeleton weed
Water hyacinth	Blackberry
Water lettuce	St. John's wort
Salvinia	Gorse
Bathurst burr	Spiny emex
Noogoora burr	Perennial ragweed

Groundsel bush	Creeping ragweed
Crofton weed	Red lantana

This excludes the cacti, of which there are nine species in two genera, all of which are subject to biological control.

Unfortunately, only three of the sixteen weeds listed above have levels of biological control which may be considered sufficient to render conventional control unnecessary and then only in some situations. In the case of all three weeds, conventional control is still required in the many situations where biological control is ineffective. This ineffectiveness may be due to:

* climatic conditions being unsuitable for the control agent

* control agents are not effective on certain varieties of the weed

* growth habits and rates of the weed are unsuitable for biological control.

The three weeds which in some situations have acceptable levels of biological control are:

(i) **Water hyacinth.** Biological control levels have risen steadily on the North Coast since the first N.S.W. releases in 1977. High levels of control are being obtained in some situations, especially in enclosed anabranches, farm dams and billabongs. However, chemical and/or mechanical control is still required at least in flood mitigation channels and on the Gingham Watercourse and other waterways where the objective is total eradication. Biological control is not generally satisfactory south of Kempsey.

(ii) **Alligator weed.** Biological control is effective in aquatic, but not terrestrial situations, where it presents a major problem.

(iii) **Skeleton weed.** The rust pathogen has been effective on only one of three biotypes of this weed. The two unaffected biotypes still require chemical control and are spreading onto land vacated by the third.

It is important to stress that biological control of weeds can eventually be extremely successful and the removal of weeds from the noxious list should be an objective of biological control programmes.

Control of the cacti in New South Wales is an example of enlightened integrated weed control. Biological control insects for cacti are widespread and effective, but Prickly Pear Destruction Commission operatives still use herbicide extensively on infestations which are not controlled effectively by biological agents. This flexibility of approach must be embraced in the control of noxious weeds.

BIOLOGICAL CONTROL ON PRIVATE PROPERTY

Of the 13 plants on which the effects of biological control would be insignificant except in isolated situations, the acceptability of biological control as a satisfactory control technique in terms of the Local Government Act must be very low. Only when effects such as reductions in area of

infestation, plant density, seed production or rate of spread occur, does biological control become acceptable. A cut in reproductive potential is probably the most critical determinant of acceptability of biological control on private property. If the reproductive potential of a noxious weed is reduced to a level such that its threat potential to neighbouring property is negligible, then the control must be considered acceptable.

Landowners must realise that their responsibility to control noxious weeds does not end on the day that the bugs arrive. It is asking far too much of any biological agent to expect it to gain immediate control. Conventional control should be continued normally in areas where biological control has not penetrated or has had only a minimal effect.

Occasionally there are difficulties in the early stages of releases. A small number of organisms, fresh from being bred in hothouse conditions, has only a tenuous hold on survival. There is a need to avoid weed eradication at the immediate release site, so that sufficient weeds are present for the agents to multiply.

But what of the practicalities of biological control in the general run of council weed control work? The Department of Agriculture has developed guidelines which will help councils make the right decisions about individual noxious weeds in their area. Each weed control authority must assess their own situation - no two areas will have similar circumstances. These guidelines are arranged in a chronological progression from initial realisation of the need to have biological control, to eventual success or failure.

SUGGESTED GUIDELINES FOR USING BIOLOGICAL CONTROL ON NOXIOUS WEEDS

1. Councils should support where appropriate and on the basis of informed advice, the introduction of biological control for their major noxious weeds.

2. Councils should realise that biological control is environmentally safe, more so than chemical control.

3. Other control techniques including chemical control should never be abandoned in favour of a potential biological control - the degree of control obtained from an agent will vary between locations and may not work in some areas. It is important to continue other controls even if biological control is going to be introduced, especially in areas where the weed is at a maintenance or control level of infestation. Biological control is only one of the available tools and should be integrated into control strategies accordingly. The "panacea mentality" must be strongly opposed.

4. Biological control releases are almost invariably ineffective in the first years following release. Normal acceptable control methods must be the only option for satisfying Sec. 473 notices until the success of the agents is proven.

5. Councils must be active and vocal in encouraging Government landholders and land managers who are not bound by the Local Government Act to employ biological agents as a control technique for noxious weeds on

land under their jurisdiction.

6. Weed infestations which have low, ineffective burdens of biological control should still be subject to conventional control techniques to satisfy landowners' statutory responsibilities.

7. The critical determinant of effectiveness of biological control is seen as the removal of the spread threat of the weed to adjoining properties, or in other words, the reduction of reproductive potential to very low levels.

8. Once the weed's reproductive potential is reduced to very low levels, then councils can use their discretion in deciding whether biological control will satisfy a Sec. 473 notice.

9. Council should, ideally, judge whether biological control is satisfactory on a property-by-property and weed-by-weed basis. Flexibility of approach will be necessary. Rigid policies will eventually turn to the Council's disadvantage.

10. It must be pointed out that since the inception of biological control in Australia early this century, only three weeds to date have reached the status of satisfactory control levels, not requiring the service of Sec. 473 notices. Dozens of weeds are controlled biologically, but their reproductive potential remains unacceptably high.

VARIETIES, BIOLOGY AND CONTROL OF ST JOHN'S WORT

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1. VARIETIES

In 1929 St John's wort collected in New South Wales, Victoria and South Australia was identified at Royal Botanical Gardens, Kew, U.K., as *Hypericum perforatum* var. *angustifolium* or narrow-leaved St John's wort. As a result it was generally accepted that there was only one variety of St John's wort in N.S.W. However, more recently, differences noted between plants of St John's wort (J. Everett, botanist, National Herbarium, Sydney; W.L. Ryan, noxious plants officer, Mid-Western County Council, Mudgee) suggest that more than one variety is present in N.S.W. The main varieties that occur in Europe are broadleaved (northern Europe - U.K.), narrow-leaved (southern Europe - Spain, North Africa) and intermediate hybrids. To investigate whether these varieties occur in N.S.W. seeds were collected from plants at various locations in N.S.W., grown in a common environment at Bathurst, and observed over time.

1.1 Differences between varieties

Growth characteristics. Observations made between 1985 and 1987 revealed the existence of two groups of plants in N.S.W.: the broad-leaved variety (Duntryleague, Bloomfield short) characterised by broad leaves, early flowering, shortness, thick stems and large capsules and the narrow-leaved variety (Captains Flat, Adelong, Mudgee short and tall, Tuena) characterised by narrow leaves, late flowering, tallness, thin stems and small capsules (Table 1).

Table 1. Characteristics of St John's wort collected from different locations in N.S.W. The first 3 characteristics are means of 1985 and 1986; the latter 2 were measured in 1985.

St Johns wort	Leaves# Width	Leaves# Length	Leaves# Proportions	Flowering in early Dec.	Height at full flower	Stem* diam.	Capsule size
	mm	mm		%	cm	mm	mm
Duntryleague	12.6	23.8	1:2	85	57	6.2	8.0 x 2.1
Bloomfield short	11.8	22.8	1:2	85	61	5.6	7.5 x 2.0
Captains Flat	9.3	28.0	1:3	50	86	4.9	6.7 x 1.9
Adelong	9.2	29.4	1:3	33	77	4.7	5.6 x 1.8
Mudgee short	9.1	26.4	1:3	78	69	4.2	6.3 x 1.8
Mudgee tall	8.8	31.6	1:4	18	90	4.4	7.2 x 1.8
Tuena	8.1	27.5	1:3	13	77	4.2	7.0 x 2.0
Mean coefficient of variation (%)	5.0	7.2					

#Central 6 leaves on main flowering stem. *Just below the 6 leaves measured.

Broad leaves were 10 to 14 mm in width and narrow leaves 7 to 10 mm. Leaf measurements are not made in Europe, the distinction between varieties being based on leaf proportions (width:length), broad being 2:1 and narrow up to 6:1 which confirms the classification of groups made above.

Based on the characters in Table 1, there were no consistent groups in the narrow-leaved varieties. However some other characters may help distinguish between narrow-leaved "varieties". For example, the Mudgee tall variety had a strong maroon colour on: young buds (giving them an orange appearance); the top branches bearing buds (only the top of the branches was maroon, the underside was green); and sepals enclosing the bud. Only one other "variety" had maroon sepals and none had strong maroon on buds and top stems.

Other characters that may be used to differentiate between varieties include: colour of foliage (light to dark green); colour of the flowering stem (pink to light green); and distance between branches on flowering stems. Many characteristics appear common to all "varieties" (Campbell 1986*a*).

Germination. Large differences were found (Campbell 1985) in the germination of seeds of plants from 5 locations (Table 2).

Table 2. Germination (%) of seeds of St John's wort collected from 5 locations in N.S.W.

Location	Month of collection in 1984	Germination in 41 days
Tuena	April	81 a#
Coolah	April	49 b
Mudgee short	January	46 b
Captains Flat	May	17 c
Duntryleague	May	12 c

#Values not followed by a common letter differ $P < 0.05$.

1.2 Cytology

Whether there are genetic differences (number of chromosomes) between varieties is being investigated. However the chromosones are so small that accurate counts have not been made yet.

1.3 Electrophoresis

It is possible to distinguish between varieties of plants by electrophoresis. Again this is proving difficult and further investigations are needed.

1.4 Hypericin

Attempts are being made to determine whether varieties contain different levels of hypericin (the poisonous principle) but, as there is no method available for chemical analysis of hypericin, investigations will be long term. If a variety contains low hypericin then it may not be a weed.

1.5 Consequences

If there are a number of varieties in N.S.W. it could mean differences in

susceptibility to herbicides or to biological control.

Figure 1. St. John's wort: a broad-leaved variety, Duntryleague (left), vs a narrow-leaved variety, Mudgee tall (right), at Bathurst in December 1986.

2. BIOLOGY OF ST JOHN'S WORT

Some important points from a recent review of the history and biology of St John's wort in Australia (Campbell and Delfosse 1984) follow:

Annual growth cycle: Erect stems that grow from the crown in late winter, flower in spring, die in autumn and persist standing for several years. Non-flowering stems initiate from the crown in late summer and die in late spring.

2.1 Types of stands

Two types of stands have been observed (Clark 1953):

(1) Large crowns well spaced 12 to 37/m^2, 3 or more years old, having a relatively large number of stems, rarely suckering, growing on deep soil and easy to kill.

(2) Small crowns ranging from 12 to 124/m^2, growing on stony dredgings and shallow soils in forests, that have fewer and smaller stems than (1). Few crowns are more than 3 years old. The lateral roots develop numerous crowns attached to the same root system. These plants frequently sucker and are

hard to kill.

2.2 Germination

Germination of new seeds (1 to 6 months old) is restricted by high temperatures (20° to 30°C), darkness and a chemical inhibitor in the capsule (Table 3). Germination of old seeds (9 years) was only restricted by the inhibitor. The effect of the inhibitor and high temperature was overcome, respectively, by washing seeds in water and by reducing the temperature to 15°C (Table 3). Thus germination is favoured by rain to wash away the inhibitor, cool temperatures and bare ground to allow the seed to receive light (Campbell 1985).

Table 3. Germination of seeds of St John's wort from day 0 to 48 at 20°/30°C (16h/8h) with half the treatments in light and half in dark; and from day 49 to 87 at constant 15°C with all treatments in light, (Campbell 1985).

	% germination on: Day 48	Day 87
Old seed*		
washed	68 a#	74 a#
unwashed	46 b	57 b
New seed*		
washed	2 c	51 b
unwashed	2 c	32 c
Old seed*		
in light	64 a	71 a
in dark	58 a	67 a
New seed*		
in light	1 b	69 a
in dark	1 b	20 b

*Old seed, 9 years old. *New seed, 1 to 6 months old.
#Values not followed by a common letter differ $P < 0.05$.

2.3 Emergence and seedling growth

Seedlings of St John's wort are small (1-2 mm); they cannot emerge from a covering of more than 2 mm of soil and, as improved species grow much faster, the seedlings are easily smothered.

2.4 Harmful effects

In pastures St John's wort is a weed because it replaces useful vegetation. Grazing animals only eat it when feed is scarce; production losses are caused by animals losing condition, not by direct toxicity. However, fluid extract from wort injected into guinea pigs and dogs proved fatal; for a 7 kg dog 1 ml reduced blood pressure whilst 2 ml almost, and 5 ml immediately, paralysed the heart.

When plants are eaten weakly pigmented parts of the body become affected by 'wort dermatitis'. This is due to hypericin causing photosensitisation; there is no damage to the liver. Although black colouration in animals can

reduce photosensitisation ingestion still adversely affects behaviour of black sheep during shearing, dipping, and earmarking (intense irritation of the cut ear, the unmarked ear being unaffected). Surprisingly tailing or castration of black lambs had no ill effects.

Foliage is more toxic if injested at flowering than when young or dry (the weed is still harmful in hay). Physical contact alone has no ill effects.

2.5 Defoliation

Cutting has no effect on control but repeated defoliation, by hand or insect, can reduce density. Hand defoliation every 2 weeks from April to mid November or from August to early December resulted in 95% and 93% destruction of crowns in low and high density stands. Hand defolialtion from mid August to mid November or from early October to early December killed high density stands and reduced crown density of low density stands by 82%. Results indicated that St John's wort is particularly susceptible to defoliation in late spring when growth is most rapid (Clark 1953). Hand defoliation in a forest killed only 45% of crowns.

3. CONTROL OF ST JOHN'S WORT

Control of St John's wort can be achieved by replacing it with a competitive pasture followed by heavy grazing. Details of control techniques are recorded in Agfact P7.6.1 (Campbell 1986*b*).

3.1 Arable land

Cultivation alone or cultivation and cropping is not effective but cultivation and sowing a competitive pasture is effective. Ploughing in spring, cultivating 3 times in summer and sowing in autumn controlled the weed in 2 to 5 years. The ultimate aim is to establish a phalaris pasture that can be grazed heavily once established.

3.2 Non-arable land

Aerial application of subterranean clover seed with high rates of super-phosphate followed by heavy grazing has controlled the weed in some situations. However more permanent control has been achieved by applying herbicides after the autumn break (to kill all resident plants) then aerially applying seed of phalaris and subterranean clover with fertilizer (Table 4). Sometimes it is necessary to break up moss on the soil surface to obtain establishment. Again, long-term control depends on heavy grazing once the phalaris is established.

Table 4. Effect of herbicides (applied 11.5.73) and surface-sown pasture species (sown June 1973) on the control of St John's wort (Campbell *et al.* 1975).

Herbicide	% ground cover in May 1974		
	Sub. clover	Phalaris	Wort
Nil	21 ab#	2 d	47 c
2,4-D + 2,2-DPA	22 ab	20 c	27 b
2,4-D + 2,4,5-T + 2,2-DPA	15 b	24 bc	28 b
Picloram + 2,4-D	1 c	51 a	6 a
Glyphosate	31 a	37 b	6 a

#Values in columns not followed by a common letter differ $P < 0.05$.

3.3 Grazing

As it takes 1 or 2 weeks for the effects of St John's wort to appear and 3 to 6 weeks for animals to recover, a '2 weeks on and 5 weeks off' rotational system has allowed the weed to be grazed by adult sheep with little effect on their health. Merino wethers, at a heavy stocking rate, have been used to graze St John's wort after a fire. The sheep controlled the weed but had to be removed 2 weeks before shearing. Various flocks had to be used and any one flock could only be on the weed for 1 week during flowering.

Set stocking a lightly infested (15%) 80 ha non-arable paddock south of Orange during the dry years 1979-82 with Merino sheep at 2 to 8 d.s.e./ha virtually eliminated the weed (Campbell and Dellow 1984). The sheep killed mature plants by eating the foliage and pulling the crowns and roots 10-20 cm out of the soil. Control was assisted by aerial application of subterranean clover seed and superphosphate.

Black animals are resistant to the sunburn effects of St John's wort but high wastage of ewes and lambs as well as destruction of native pasture can occur as a result of heavy grazing pressure. Cattle are more effective than sheep in controlling the weed by grazing as they have less effect on the associated pasture and cause more physical damage to the weed. Santa Gertrudis cattle are more resistant to wort than Herefords.

St Johns wort is much more difficult to control by grazing on large paddocks (100 ha) than small paddocks especially if heavily infested.

3.4 Goats

Goats are more tolerant to St John's wort than sheep. On a large paddock near Coolah goats (6/ha) grazed much more wort than sheep in the next paddock. Goats graze the weed in summer and autumn mainly. However it is obvious that St John's wort is relatively unpalatable to goats. A combination of goats and cattle at Coolah resulted in goats controlling briar and blackberry which allowed cattle (Santa Gertrudis) to graze some wort, the combination preserving the associated pasture. A combination of sheep and goats would not be as successful because sheep destroy the pasture competition at high stocking rates.

3.5 Herbicides

Three herbicides have proved (Campbell *et al.* 1979) effective in killing St John's wort 2,4-D ester (in late spring), glyphosate (summer and autumn) and picloram + 2,4-D (all year, Table 5). For each herbicide to be effective St John's wort must be growing actively; if applied in dry conditions 2,4-D and glyphosate will defoliate the plant but it will recover.

Table 5. Effect of time of application of herbicides applied in 1976 on the control of St John's wort, measured in February 1978.

Herbicide and rate	kg/ha a.i.	Ground cover (%) of St John's wort sprayed in: February	May	August	November
2,4-D ester	3.4	46 b#	55 b	60 b	19 a
2,4,5-T	3.4	50 bc	71 b	82 c	47 b
2,4-D + 2,4,5-T (2:1)	3.4	66 c	35 a	68 bc	16 a
Picloram (5%) + 2,4-D ester(20%)	1.7	17 a	19 a	25 a	7 a
Glyphosate	1.7	14 a	16 a	78 bc	42 b
Control	-	76	76	77	78

#Values in columns not followed by a common letter differ $P < 0.05$.

Application of glyphosate before the autumn break gives best selective control in annual pastures. Glyphosate kills associated perennial pasture species which reduces its selectivity. However recent research (Campbell, unpublished data) shows that phalaris tolerates glyphosate provided it is heavily grazed before spraying (< 3% ground cover of green leaves). Problems of dust (on roadside wort), metals (Al, Fe, Ca) in water and insufficient spray coverage (wort should be sprayed to run-off despite some recommendations for low-vol application) restrict the scope of glyphosate.

2,4-D gives disappointing results unless applied to rapidly growing wort before flowering in October-November; it has proved successful when applied in a strong pasture, the pasture completing the kill.

Picloram + 2,4-D has reliably killed wort but it is costly and can kill trees even when applied as a spot spray.

3.6 New herbicides

Good kills of St John's wort have been reported with triclopyr in the Cowra Shire at 1:1000 in July, 1:900 in August, 1:800 in September, 1:700 in October, 1:600 in November and 1:500 in December. Triclopyr is highly volatile and can kill susceptible trees and crops. There is a need to test the effectiveness of triclopyr and other newer herbicides (e.g. metsulfuron) in controlled experiments.

3.7 Biological control

A review of the history of biological control of St John's wort in Australia is given in Campbell and Delfosse (1984). *Chrysolina* beetles and larvae control St John's wort quite effectively in some years but it often regrows

in following years when insect activity is upset by environmental conditions. CSIRO is continuing to investigate control with insects and, recently, an aphis (*Aphis chloris*) that has been released for the control of St John's wort in Canada and South Africa, has yielded promising results in Australia.

A practical method of fostering biological control is the repeated collection of *Chrysolina* spp (or other insect enemies) from populated St John's wort and transportation to unpopulated wort. An integrated approach using herbicides or grazing, after an attack by insects, to remove recovering wort could be effective. Naturally insect attack will be more successful if a phalaris-subterranean clover pasture is sown to replace the weed.

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RHODES GRASS FOR THE CONTROL OF SPINY BURRGRASS

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Spiny burrgrass has spread considerably in recent years and it is now one of this states more serious weeds. It is found on light soils throughout New South Wales from the coast to western areas, but it does not persist on heavier soils. There are numerous names used in different parts of the state to refer to spiny burrgrass including, Bohena beauty, innocent weed, gentle annie, field burr, sand burr and American burrgrass.

Two species *Cenchrus incertus* and *C. longispinus* are state wide declared noxious plants in NSW. Both are summer growing with *C. longispinus* being an annual while *C. incertus* can be either annual or perennial.

The plants can grow up to 60cm in height under favourable conditions, however, they are usually much shorter. Up to 30 burrs can be borne on each spike-like panicle and it is these burrs which constitute a serious problem.

The sharp, rigid, barbed spines can penetrate the mouths of stock or the feet of dogs. The burrs cause a very serious problem in wool, reducing its sale value and making the sheep difficult and painful to handle, particularly at shearing time. In extreme cases, the dense matt of sharp burrs in the wool can cause considerable discomfort to the sheep, not to mention people handling the animals such as farmers, shearers and shed hands, stock agents and abattoir workers. Shearing costs can be increased by 25% and the shearers may have to be supplied with protective clothing.

The increased mobility of farming activities and adverse seasonal conditions have been major factors contributing to the spread of spiny burrgrass in recent years. Travelling sheep, in particular, have been a major cause. There have been numerous reports from weeds officers that they have found spiny burrgrass growing around sheep carcases beside roads in areas that were otherwise free of the weed.

Although spiny burrgrass is not a strong competitor, it is well adapted to light soils and dry conditions, particularly where the soil has been disturbed. The lack of competition in this type of situation, often as a result of drought and/or increased areas of cultivation, has been a major factor in spiny burrgrass becoming established in more locations in New South Wales.

The Gilgandra/Coonamble district receives a relatively low annual rainfall and has large areas of light sandy soils which are ideal for spiny burrgrass. There are many timbered areas which are not worth clearing for cultivation. There has thus been a dramatic increase in the incidence of spiny burrgrass in the district in the last six years.

One Stock Agent contacted recently at a stock sale in Gilgandra said "Ten years ago, you knew which properties in the district had spiny burrgrass and

so you knew which sheep to treat with caution. Now over 75% of the sheep coming through these saleyards are infested and you must treat all sheep with caution".

Some graziers claim that spiny burrgrass provides useful grazing for stock under dry conditions when very little else will grow; however, its disadvantages far outweight its grazing value. Some land owners have gone out of sheep altogether, while others have altered their activities such as the time of shearing to retain their sheep enterprise.

There have been some claims from graziers that heavy grazing will control the weed; however, under practical conditions, it does not prevent the plants seeding, merely reducing the number of burrs and the height of the plant. This can reduce the degree of wool contamination but it definitely cannot be considered to be an effective control measure.

Spiny burrgrass plants are relatively easy to kill with various herbicides. Established spiny burrgrass plants are susceptible to herbicides such as glyphosate, MSMA and 2,2-DPA while emerging seedlings are susceptible to trifluralin and atrazine.

Herbicide control is not, however, a practical proposition for extensive agricultural areas due to the numerous germinations during the growing season and the lack of selectivity of the available herbicides. The lack of selectivity means that herbicide application will reduce what plant competition there is. Spiny burrgrass is a strong coloniser and bare ground situations such as produced by spraying with glyphosate are ideal for the establishment of spiny burrgrass, not to mention the cost of repeated sprays throughout the growing season.

The Castlereagh-Macquarie County Council has used atrazine, a pre-emergent herbicide, to control spiny burrgrass on roadside situations with fair results. Where the plants are already established at spraying time, a knockdown herbicide such as MSMA is added. However, this technique is not applicable to most on-farm situations and is becoming very costly.

Cropping programs have been effectively used further east incorporating the use of trifluralin and legumes in a rotation with grain crops. Unfortunately, this technique is not applicable to much of our area as the country could not stand up to repeated cultivation and cropping.

It was thus realised that the best means of control for much of our area would be to establish some form of pasture competiton. As spiny burrgrass is summer growing, it was evident that we would have to find a strong, drought resistant, summer growing pasture species.

The choice was narrowed down to a summer growing perennial grass,because lucerne does not provide enough competition in the summer while sub clover is a winter growing annual. Early work in the Coonamble district used buffel grass, a close relative of spiny burrgrass, with some reasonable results on better quality red soils. Buffel grass was not, however, suitable for the lighter acidic soils which are very common in the Gilgandra district.

Finding a suitable species for this area was not easy and in a trial planted on a sand ridge west of Coonamble some seven years ago to test various perennial grass species, there was very little establishment of any of the species sown.

The District Agronomist with the Department of Agriculture at Dubbo, Mr. Col Mullen, selected Rhodes grass as the most likely species to do well on the light sandy acidic soils in the Gilgandra/Dubbo district. In conjunction with the Castlereagh-Macquarie County Council, he planted a species trial on very sandy soil near Collie, west of Gilgandra in October, in 1983. The site selected was heavily infested with spiny burrgrass. A range of grass species was planted and the results, which are shown in Table 1, were recorded in March, 1984.

TABLE 1: Plant Counts of Spiny Burrgrass - Collie, 1984

Grass	Spiny Burrgrass Plants Number/Square Metre	
Pioneer Rhodes Grass	0.2	)
Gatton Panic	1.3	)
Kazangula Setaria	1.8	) *
Narok Setaria	1.9	)
Callide Rhodes Grass	2.8	)
Bambatsi Panic	5.0	
Nandi Setaria	5.5	
American Buffel	6.7	
Gayndah Buffel	8.7	
Control	8.7	

* Very small spiny burrgrass plants compared to large vigorous plants in other grass plots.

As can be seen, the best results were obtained with Pioneer Rhodes grass. The growing season was extremely dry, so the results were obtained under adverse conditions. These results are compatible with other experiences obtained by landowners in the district over the past three seasons, and despite dry summers, many successful Pioneer Rhodes grass pastures have been established.

For example, one farmer, also in the Collie district, planted Pioneer Rhodes grass in a 50 ha paddock which was severely infested with spiny burrgrass. Today, three years later, very little, if any, spiny burrgrass can be found anywhere in the paddock. This farmer now calls this paddock his "haystack" paddock because of the abundance of feed his stock obtain from the Rhodes grass.

At the present time Pioneer appears to be the most competitive and best adapted variety of Rhodes grass for this area. It has proven to be a drought

tolerant pasture reasonably palatable to sheep and cattle. The variety Callide has proved next best, with Samford proving inferior.

One of the problem areas in the district has been the Gilgandra Aerodrome which is on a sandy ridge on the edge of town. The use of herbicides was not feasible due to the high costs and the need to retain ground cover to control erosion and dust. The closeness of the residential area meant that removing the ground cover would create a serious dust problem from both wind and aeroplanes using the aerodrome. The Gilgandra Shire Council agreed to have the aerodrome, with the exception of the landing strip, sown down to Rhodes grass. This was carried out in October, 1985 with an excellent establishment being obtained, and the amount of spiny burrgrass was drastically reduced. The only significant infestations of spiny burrgrass on the aerodrome at the present time are where the Rhodes grass is not well established, such as the disturbed soil around the boundary where firebreaks have been graded.

A major concern of the County Council is the problem of spiny burrgrass along roadsides. The County approached Gilgandra Shire Council and the DMR about commencing a joint effort to plant Rhodes grass along road shoulders and adjoining areas infested with spiny burrgrass. This program has now started and excellent results have been achieved. An additional benefit will be a reduction in roadside erosion.

An expected advantage of this program is that selective herbicide spraying will be possible. Research carried out in Queensland has found that Rhodes grass is tolerant to MSMA (Robinson and Marley, 1980). It is envisaged that any spiny burrgrass that comes up in the planted areas can be sprayed with MSMA without any serious damage to the Rhodes grass.

These projects have generated considerable interest amongst landowners in the district and there is now a considerable increase in the sowing of Rhodes grass as a method of controlling what has been to many an uncontrollable weed. A very important bonus has been the grazing value of the Rhodes grass and thus the control measures have generated income rather than merely costing money.

Rhodes grass can be sown during the warmer months preferably September to November or late February - March. It should be sown shallow at about 1 kg per hectare. The seed is best sown through a combine mixed with the fertilizer to help it run. It should be dropped on top of the seedbed and covered with light harrows. Alternatively it can be sown through a roller drum seeder. It can be sown dry. Establishment appears to require some soil disturbance.

Ideally Rhodes grass should be sown with an annual legume such as sub-clover such as Nungarin, Dalkeith or Seaton Park, Serradella or Namoi Woollypod Vetch. Lucerne can also be included if the soils are not too acid. When February/March plantings are made mixtures containing some of these pastures can be sown with the Rhodes.

Where possible it is preferable that the spiny burrgrass seed reserves are reduced as much as possible before sowing down to these pastures. This can be achieved by a period of cropping using the herbicide trifluralin with winter crops such as lupins, wheat, cereal rye, barley or triticale and summer crops such as cowpeas.

Rhodes grass is not a problem when the paddock returns to cropping, as ploughing eliminates the grass for winter cropping. Also it does not appear to spread outside sown areas.

The experiences gained have definitely shown the value of using Rhodes grass pasture as a very effective method of spiny burrgrass control in the Gilgandra district. It should be noted, however, that Rhodes grass may not be the answer in all situations, and anyone contemplating using pasture competition should find out what species will grow well in their locality.

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LATEST DEVELOPMENTS IN CSIRO BIOLOGICAL WEED CONTROL PROGRAMS OF INTEREST TO NEW SOUTH WALES

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ABSTRACT

Nine biological weed control programs of interest to New South Wales are discussed. Two new strains of the skeleton weed rust fungus, both specific to the intermediate-leaf form of the weed, have been released, but are unsuccessful. A new strain of the skeleton weed gall mite specific to the intermediate-leaf form was released in early 1987 and is currently being evaluated. Large numbers of a flea beetle which attacks common heliotrope have been released and are being evaluated, and projects for three other agents are at various stages of development. For St. John's wort, an aphid species has been released, a foliage-feeder has recently been received in quarantine, and testing of a leaf-miner is nearly completed. New programs involving *Carduus* and *Onopordum* thistles have begun, and a weevil species for *Carduus* should be released in spring 1987. A promising weevil is being tested for spiny emex. The blackberry rust fungus is being cultured overseas for Victoria, while awaiting approval for release. The legal situation for Paterson's curse/salvation Jane is expected to be resolved in 1987.

PROGRAM UPDATES

Skeleton weed, *Chondrilla juncea* L. (Asteraceae)

The narrow-leaf form of skeleton weed has been controlled for over 15 years, primarily by stress caused by a strain of the rust fungus, *Puccinia chondrillina* Bub. & Syd. (Pucciniaceae) and the gall mite, *Aceria chondrillae* G. Can. (Acari: Eriophyidae) (Cullen 1985). Both of these agents are specific to the narrow-leaf form in the field. The intermediate- and broad-leaf forms are unaffected, and are spreading into areas formerly dominated by the narrow-leaf form.

Two new strains of the rust fungus have been released near Young, New South Wales (Delfosse *et al.* 1985). Both of these strains are specific to the intermediate-leaf form of the weed. One strain did not become established. The other strain persists at a low level, but does not attack stems of skeleton weed in summer, and is insufficiently virulent.

In January 1987 a new strain of the gall mite, located near Montpellier, France, was released at the Young site and also in the Australian Capital Territory. It is specific to the intermediate-leaf form, and is currently being evaluated. Experiments conducted in France on the effect of this strain on the Australian intermediate-leaf form indicate that it should contribute significantly to control of this form.

CSIRO's Biological Control Unit (based in Montpellier) is currently searching

for more effective strains of the rust fungus, a strain of the gall mite effective against the broad-leaf form of the weed, and a promising aphid species, *Chondrillobium blattnyi* Pintera (Homoptera: Aphidae).

Common heliotrope, *Heliotropium europaeum* L. (Boraginaceae)

Significant progress has been made on three of the four most-promising agents (Delfosse 1985) for this poisonous annual weed, and testing for the fourth candidate will begin next year.

Over 20 000 adult common heliotrope flea beetles, *Longitarsus albineus* Foudras (Coleoptera: Chrysomelidae), and many more larvae on plants infested in the laboratory, have been released at sites near Jugiong, Mathoura, Trangie and Young, New South Wales, Caniambo, Victoria, and in the Australian Capital Territory. Adults of this beetle feed on leaves, creating small "shot holes", and larvae feed on rootlets. Damage caused by larvae is greater than that caused by adults.

Testing has been completed of the common heliotrope weevil, *Pachycerus cordiger* Germar (Coleoptera: Curculionidae). It will be imported into quarantine in March 1987, and application will be made for its field release in spring 1987. Adults of this weevil feed on heliotrope foliage, and larvae feed on the root.

The most promising agent for common heliotrope is a rust fungus, *Uromyces heliotropii* Sredinski (Pucciniaceae). Testing of this agent is expected to be completed in 1988. The rust can prevent or greatly reduce seeding of the weed (Hasan 1985).

The fourth agent to be evaluated for biological control of common heliotrope is a bud-feeding moth, *Ethmia distigmatella* Erschoff (Lepidoptera: Ethmiidae). Caterpillars of this moth can reduce seeding of the weed. Host-specificity testing for the moth is expected to begin in 1988.

St. John's wort, *Hypericum perforatum* L. (Clusiaceae)

Several new agents are being considered for this weed.

A moth, *Anaitis efformata* Guenee (Lepidoptera: Geometridae), was released in 1982-4, but failed to become established due to predation (Briese 1987, Briese and Pullen 1987).

An aphid, *Aphis chloris* Koch (Homoptera: Aphidae), was released at several sites in 1986, and is currently being evaluated. Predation may be the limiting factor to its effectiveness, but populations at one field site each in New South Wales, Victoria and the A.C.T. are developing well.

Host-specificity testing of the gall mite, *Phyllocoptes hyperici* Liro (Acari: Eriophyidae), will be finished soon. This species deforms the weed, and appears to be a very promising potential agent. If, as indicated, it is specific to the weed, it could be introduced in mid-1987.

Testing of the moth, *Actinotia hyperici* Schiff. (Lepidoptera: Noctuidae), has been completed, and it was introduced into quarantine in Canberra in late February 1987. Application for its release has been made. Larvae of this

species feed on foliage of St. John's wort.

Testing of the moth, *Aristotelia morphochroma* Walsingham (Lepidoptera: Gelechiidae), should be completed by June 1987. If specific, application will be made for its importation and release in Australia. Larvae of this species mine the stems of the weed.

Nodding and slender thistles, *Carduus* spp. (Asteraceae)

Carduus thistles have been successfully managed by biological control agents and cultural methods in several countries. One of the main agents used is the seed head weevil, *Rhinocyllus conicus* Froelich (Coleoptera: Curculionidae) (Kok and Pienkowski 1985). This species was imported into quarantine in Canberra in late February 1987, and releases are planned for spring 1987. The CSIRO Divisions of Plant Industry and Entomology are conducting ecological studies of the weed at field sites in New South Wales.

Scotch and related thistles, *Onodordum* spp. (Asteraceae)

Onopordum spp. are mainly problem weeds in Australia. A new project has been approved to examine the weeds for their natural enemies in southern Europe, and import after testing and approval those which appear to be most promising. The first agents for *Onopordum* spp. could be imported in 1990-91.

Spiny emex, *Emex australis* Stein. (Polygonaceae)

Officers at the CSIRO Biological Control Unit in Cape Town have located a very promising weevil, *Rhytirrhinus inaequalis* Fabricius (Coleoptera: Curculionidae), which is very damaging to, and appears to be specific to, *Emex*. Host-specificity testing is currently being conducted, and the weevil will be introduced if found to be specific.

Blackberry, *Rubus fruticosus* L. agg. (Rosaceae)

In cooperation with the Montpellier Unit, host-specificity of the rust fungus, *Phragmidium violaceum* (C. F. Schultz.) Winter (Pucciniaceae), was determined by the Keith Turnbull Research Institute (KTRI), Department of Conservation, Forests and Lands, Victoria. If approved for release in Australia, the Unit, which has been multiplying 15 strains of the fungus every six months for several years to retain viability, will send the fungus to KTRI for quarantine clearance, mass-culture and field release.

Bitou bush/boneseed, *Chrysanthemoides monilifera* (L.) T. Norl. (Asteraceae)

The Cape Town Unit has begun to survey these weeds for their natural enemies. Already a good deal is known about this complex, and all indications are that there are several potential agents for these weeds. The KTRI will handle importations and releases once survey work and preliminary testing are completed by CSIRO. This is a Council of Nature Conservation Ministers-sponsored project involving funding from State National Park Services, the Soil Conservation Service of New South Wales and CSIRO.

Paterson's curse/salvation Jane, *Echium plantagineum* L. (Boraginaceae)

This program has been halted by legal injunction since 1980. Another paper in these Proceedings deals specifically with this project. In brief, there are eight approved agents for *Echium*, which attack the plant at every stage of growth. An Industries Assistance Commission Inquiry determined that the program would be in the national interest by a factor of at least 9:1, and that it should proceed. CSIRO has applied to the Supreme Court of South Australia to lift the injunction, and to two rural granting bodies for financial support. If the injunction is lifted the first biological control agent, the leaf-mining moth *Dialectica scalariella* Zeller (Lepidoptera: Gracillariidae), could be released in autumn 1987.

CONCLUSIONS

All current programs have resulted in finding potential biological control agents for each of the weeds. Given the nature and extent of attack by these agents, the potential for successful biological control of the weeds must be rated as high.

The main limiting factor to starting new projects and speeding up current projects is funding. For any new projects to begin, the "user pays" system is now encouraged; i.e., the rural sector which is predicted to benefit most from a successful program will have to fund it. This is sometimes justified. However, there are weeds without an identifiable primary potential beneficiary, and there are weeds whose control would yield a significant benefit Australia-wide. For these weeds funding arrangements are more complex, and increased Government support may be required.

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INNOVATIVE USES OF GOATS FOR WEED CONTROL

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INTRODUCTION

In recent years the ability of goats to control some economically important weeds has been highlighted at weeds and other conferences. More recently, the emphasis has been directed more toward goat production than plant management so as to increase the returns from goat enterprises.

During this time, the management of vegetative resources in 'sensitive' areas has received some attention. These sensitive areas include forests and major dam foreshores, and are areas where goats may not have been previously considered.

FORESTS: RADIATA

The New South Wales Forestry Commission used goats to clean-up the floor of a radiata forest near Orange during the 1970's. This was reported at the 1st Noxious Plants Conference by Edwards (1981). Since that time APM Forests have adopted a similar system in their Gippsland (Vic) forests. Little use of the technique has been made in New South Wales forests, although currently there are goats in a radiata forest near Guyra. The difficulties of fencing forests, the aversion of foresters to opening and closing gates and the low level of forest supervision during winters are all contributing causes to low adoption. A recent report (Browne, 1986) discusses the use of goats in a private radiata forest in Victoria.

CYPRESS PINE: PEAK HILL

Goats are being run in a cypress pine (*Callitris columallaris*) forest near Peak Hill. Regrowth of seedling cypress pine is a major management problem in these forests. With suitable rainfall a new cohort of seedlings will germinate. Their growth will compete with existing trees and reduce their growth. Although not ideal, only one thinning to about 6 m centres, is considered to be economic in cypress pine forests.

Rainfall that will germinate seedlings can occur at any time during the life of a forest. What is required is a system that controls the regrowth of cypress and the growth of other woody plants, leaves the selected trees to grow unimpaired and, if possible, generates income perhaps from agistment. At this stage, after two years, the goats appear to be achieving those objectives plus they are reducing the within forest fire risk and have increased visibility which allows easier management. If they prove to be sufficiently productive, they may even provide some income through agistment.

NATIVE FOREST: PILLIGA

The Forestry Commission has also put goats into a section of the Pilliga forest to assess their worth in helping to manage that forest. At this site, there are many scrub species growing that are either too dense or of low commercial value. It is hoped that goats will control these species and so allow the timber species to mature more rapidly and to clean up the forest floor so the within forest fire hazard is reduced and visibility is increased.

DAM FORESHORES

The foreshores of many major water storages in New South Wales are managed by the Soil Conservation Service. In managing these areas, their aim is to maintain a stable perennial pasture, so as to minimise erosion into the dams.

The newly completed Windamere dam near Mudgee has presented the Soil Conservation Service with a major problem. When they took it over it was carrying a heavy infestation of blackberry and other weeds plus a very healthy rabbit population. Additionally, the new road was built through some of the worst affected areas.

The Soil Conservation Service had a major dilemma; the site was highly visible, but it was also part of a catchment on which they wanted to preserve most, if not all, of the trees. They were reluctant to spray and so decided to try goats on a limited area. A program was designed that allowed their major policy issues to be addressed. After all, this was a Soil Consevation Service project and it has generally been thought that goats are the antithesis of conservation (the better informed of us, of course, know differently).

The goats entered the first paddocks during November, 1985. It was a big spring and the paddocks had not been stocked for about four months. As a result, there was a tremendous growth of weeds and desirable species alike. The goats took to the variegated thistles (*Silybum marianum*) before making any impression on the blackberry. However, after six weeks or so their effect on the blackberry was becoming noticeable. When that first summer was finished, the goats had cleared up virtually all the thistle, both variegated and Scotch (*Onopordum spp*), defoliated the purple top, decimated the *Datura spp*, defoliated all the briar to at least 1.5 m high and all blackberrry up to about 1.5 m had been trimmed back, with no new leaders.

At the end of the summer of 1985/86 the pasture had been uniformily eaten back, but not to the stage where the soil surface was bared. The combined effect of reduced blackberry cover and well eaten pasture insured the effectiveness of a rabbit control program that was subsequently conducted.

The goats were placed into another paddock for the following winter. This paddock had a very heavy cover of low growing blackberry. The goats ate a large amount of blackberry during winter, which is not a very common practice. In the subsequent spring and summer, a spectacular control has occured. The stocking rates used were lower in this area, but a very acceptable level of control has been achieved and goat management costs have been reduced due to lower drenching needs.

This demonstration has shown the Soil Conservation Service that goats can be used effectively to control some weeds in sensitive areas. In so doing, they have been able to reduce their weed control costs and avoid using herbicides beside a water storage or near trees that they wish to retain.

GENERAL

More producers on the tablelands are putting goats onto their farms to control weeds such as blackberry, as they are an effective alternative to herbicides. Others are putting them on to increase the return from other stock, while others are putting them on to diversify their income. Increased returns from other stock, that result from running goats, can be readily seen where thistles cause vegetable fault in wool. Control of thistles by goat grazing results in reduced vegetable fault and higher wool returns. Where a moderately heavy blackberry infestation restricted carrying capacity of cattle, goat grazing not only allowed more cattle to be carried but allowed the type of cattle carried to be changed from growing weaners to cows with calves at foot.

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CURRENT STATUS OF BIOLOGICAL CONTROL OF *ECHIUM*

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BACKGROUND AND LEGAL INJUNCTIONS

Echium plantagineum L., Paterson's curse/salvation Jane (Boraginaceae), was among a small group of introduced plants rated by the Australian Weeds Committee in 1971 as priority weeds for biological control (Delfosse and Cullen 1985). CSIRO investigated the natural enemies of *Echium* in part of its native range (Mediterranean Europe). Eight insect species were tested and found to be safe for introduction (Wapshere and Kirk 1977, Kirk and Wapshere 1979, Wapshere 1982, Vayssieres 1983, Vayssieres and Wapshere 1983). CSIRO imported the first four species (three beetles and a moth) from late 1979 to early 1980. Releases of the moth, *Dialectica scalariella* Zeller (Lepidoptera: Gracillariidae), were made in 1980 at three sites in New South Wales (near Blighty, Braidwood and Jugiong) (Delfosse *et al.* 1987). On 10 July 1980, two beekeepers and two graziers obtained an interim injunction from the High Court which prevented further releases. The injunction was remanded to the Supreme Court of South Australia.

Repeated attempts were made by CSIRO to resolve the conflict without risking a legal decision against biological control. Unfortunately, these attempts were unsuccessful, and CSIRO accepted a perpetual injunction on 23 June 1983, in the knowledge that changes in the legal status of biological control were foreshadowed. This meant that no further work on biological control of the weed could be undertaken in Australia until and unless there was a change in the *status quo*.

BIOLOGICAL CONTROL LEGISLATION, INQUIRIES AND SUPPORT

The world's first biological control legislation, the Biological Control Act 1984 (Commonwealth of Australia 1984), commenced on 22 November 1984. Under provisions of the Act, the Industries Assistance Commission (IAC) conducted an inquiry into whether *Echium* spp. should be targets for biological control. During this inquiry the IAC evaluated some 600 submissions from beekeepers, farmers, graziers, Government Departments, and others. The IAC recommended in their Final Report in September 1985 that the program would be in the national interest by a factor of about 9:1 (IAC 1985).

The Australian Weeds Committee, the Standing Committee on Agriculture and the Australian Agricultural Council then all recommended unanimously that the program be re-started.

Mr. Kerin, the Minister for Primary Industry, who is also the Commonwealth Biological Control Authority (BCA), declared on 3 March 1986 all *Echium* spp. as "target organisms" for biological control, and the eight insect species which CSIRO had proposed for release against *Echium* as "agent organisms" (Commonwealth of Australia 1986). Taken alone, the declarations do not

approve re-starting the program, but they are essential steps if final approval is eventually to be given. These declarations may be challenged by the Federal Council of Australian Apiarists' Associations, on the basis of "denial of natural justice".

Complementary State and Territory biological control legislation will ensure smoother operation of approved biological control programs. South Australia, New South Wales, Victoria and Tasmania have passed such legislation, and each has declared their legislation complementary with the other states and with the Federal Act. Western Australia and the Northern Territory have recently passed similar legislation (with complementarity to be declared soon) and Queensland should follow later this year. Complementary legislation will enable biological control to proceed faster in cases where no conflict of interest exists, and will provide mechanisms to resolve conflicts where they crop up.

ATTEMPT TO LIFT THE PERPETUAL INJUNCTION AND TO OBTAIN FUNDING

Late in 1986 CSIRO notified the plaintiffs of intent to apply to the Supreme Court of South Australia for lifting of the perpetual injunction. These applications have now been made. We believe that, following the IAC and BCA *Echium* Inquiries, the BCA declarations, and the passage of complementary legislation, a change in the *status quo* has been demonstrated. Should the perpetual injunction be lifted, the way would be clear to restart the program.

The IAC identified the livestock industry as the greatest potential beneficiary of a successful program. Therefore, last year we applied to the Australian Meat and Livestock Research and Development Corporation (AMLRDC) for financial support for the program. This was not approved, at least partly because the injunction had not been lifted by the time they met to decide on applications. We have emphasized to the Court that the injunction should be lifted in time for granting bodies to consider our applications for funding which would begin in July 1987, and have again applied to the AMLRDC, plus the Australian Wool Corporation (AWC). If the injunction is lifted, as is expected, funding will be the limiting factor in re-starting the progam fully. About $200 000 p.a., fully indexed, is required; this is about 2% of the estimated yearly costs due to *Echium*. CSIRO will re-start the program at a much reduced level even if grant funds are not forthcoming, but progress will necessarily be much slower.

Because of the uncertainties described above, it is impossible to predict when, or if, importation and release of agents will be made, or in which States the Division might operate a field program. If the program is re-started, we would, however, continue to cooperate closely with appropriate State groups by providing "starter colonies" of insects, guidance on release, field evaluation, etc.

THE FUTURE

In short, there are still quite a few uncertainties about this program. As a result of the legal action against CSIRO the biological control agents for *Echium* had to be destroyed in quarantine. Therefore, the first activity if approval and support were given would be to import the moth to Canberra, where it would spend a period in quarantine before being mass-reared for

field release. Because of the built-in delays in this procedure, it would take about 3-4 months to clear the moth from quarantine and mass-rear sufficient numbers to begin field releases. In other words, if approval and funding is received, and a colony of the moth is received from our overseas laboratory (which in itself could take up to several weeks, depending on availability of the moth in the field in Europe), an additional period of 3-4 months will be required before the moth could be released. This pre-release period could be even longer if the *Echium* plants in the field are unhealthy or in the wrong stage of development to allow the greatest chance of establishment of the moth. (However, due to the life cycle of the moth, the stage of *Echium* in the field would be expected to be less of an impeding factor for the moth than for the other agents, which are more closely reliant on particular growth stages of *Echium* being present at specific times in the field.)

Biological control is the only long-term, economically- and ecologically-satisfactory strategy for management of *Echium*; the IAC report also noted this. It should be appreciated that control would not be achieved overnight; it would take several years for the agents to build up to levels at which they would be effective. However, we believe that they would be successful ultimately.

Should you wish to express support for this program, you might consider writing to the two Rural Industry Research Councils which are most affected by *Echium* (the AMLRDC and the AWC), and their respective "peak" Councils, from which the Research Councils take advice on matters of most concern to their industry. Addresses for these groups are listed below.

A letter which quantifies the cost of *Echium* to you, the extent of infestations on your property or in your region, and reasons why you think the bodies should support the program, will carry more weight than a letter simply expressing support without giving specific details.

RURAL INDUSTRY RESEARCH COUNCILS

Australian Meat and Livestock
Research and Development
Corporation,
G.P.O. Box 4129,
SYDNEY. N.S.W. 2001.

Australian Wool Corporation,
Box H274, Australia Square,
SYDNEY. N.S.W. 2000.

PEAK COUNCILS

Sheepmeat Council of Australia,
P.O. Box E10,
QUEEN VICTORIA TERRACE. A.C.T. 2600.

Cattle Council of Australia,
P.O. Box E10,
QUEEN VICTORIA TERRACE. A.C.T. 2600.

Wool Council of Australia,
P.O. Box E10,
QUEEN VICTORIA TERRACE. A.C.T. 2600.

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IMPORTANCE AND CONTROL OF FIELD DODDER (*CUSCUTA* SPP.)

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Agricultural Institute,
Yanco.

SUMMARY

During the last four years increasing awareness of a yellow twining plant which was parasitising lucerne and a large number of other broadleaf plants has occurred throughout New South Wales, South Australia and Victoria.

This yellow twining plant was found to be Field or Golden Dodder (*Cuscuta campestris*) a native of North America. In the Namoi River valley of New South Wales a number of lucerne-producing properties have become unproductive because of the dodder. A similar situation is developing in South Australia along the Murray River downstream from Renmark. If no control of Field Dodder is attemped in south east Australia approximately $384 m of susceptible crops are at risk.

Currently in Australia, the use of herbicides and crop rotation management has been the only means of effective control available. But in some situations this practice is uneconomical because of the locality and size of the infestions. Two such situations are present in New South Wales, at Lake Brewster - 600 ha and Lake Victoria/Rufus River - 800 ha.

The use of biological control agents in these two localities would be a solution to the problem, but there are no biological agents in Australia at this time. There are potential biological agents in Pakistan, Hungary, and the USSR. The possible control agent is a weevil belonging to the genus *Smicronyx*. Care will be needed if introductions of this insect are attemped, to preclude the introduction of natural enemies of *Smicronyx* which have been found to limit the success of attempted biological control programmes in these countries. A detailed biology of Dodder is presented as a basis for recommending approaches to control which deals with management, chemical and biological control means.

INTRODUCTION

Field Dodder (*Cuscuta campestris*) is a native plant of North America and has been introduced to Australia and is found in many other countries of the world including India, Pakistan, Japan, USSR and Hungary.

Dodder has wide range of host plants in Australia. The host plants are; *Xanthium* spp., seedling Boxthorns, Wireweed, Prickly lettuce, Stinkwort, Docks, Cumbungi, and pasture plants such as lucerne, to which it is causing major production losses. Some vegetable crops in the past have been infected by the parasite.

The value of possible susceptible crops at risk is approximately $384 m.

The dodders are amongst the most common and serious obligate parasitic plants in the world. They gain nutrients from their various host by the means of a haustoria cell by which means they attach to the host plant.

Dodders belong to the botanical family Cuscutaceae. The genus *Cuscuta* is large with more than 100 species which are often very difficult to differentiate (Musselman and Sand 1984). In Australia, fourteen species occur either naturally or by introduction (Trounce 1986). One imported species has become endemic in eastern Australia. This species is Field or Golden Dodder (*Cuscuta campestris*, Yunck). *C. campestris* occurs mainly in New South Wales, Victoria and South Australia and has in the past been confused with *C. australis*.

Records at the Herbarium, Royal Botanic Gardens shows that Field Dodder is found in most areas of the state, while *C. australis* is limited in distribution to the coastal and tableland areas of the state north of Sydney.

In Australia, Dodders have been a major agricultural pest since early colonial days. To quote an 1867 report 'The introduced species (Dodder) is causing considerable injury to lucerne at Bathurst and other parts' (Trounce 1986).

A three state committee of which I am a member was established in April, 1985 with the aim 'To eradicate Dodder from the Murray River valley.' The committee comprises members of Noxious Plants authorities in New South Wales, Victoria and South Australia. To achieve this objective, the distribution and growth habit within New South Wales first had to be known. Once this was known, the control strategies using chemicals could be undertaken.

In overseas research, researchers have shown that selective herbicides which will control dodder without affecting the host plants are not available (Dawson 1984).

DISTRIBUTION IN SOUTH EASTERN AUSTRALIA AND ECONOMIC IMPACT

Distribution in south eastern Australia

There is no special climate requirement in south eastern Australia for the growth and survival of dodder.

It is capable of growth from the highland region of the Upper Murray River in south east New South Wales/north east Victoria to the lower flood plain of the Murray River.

New South Wales

In New South Wales, *Cuscuta campestris* have been recorded in ten geographic regions of the State. They are: north coast, central coast, northern tablelands, north west slopes, central west slopes, south west slopes, north west plains, south west plains, far south west plains and far north west plains.

There are 55 specimens held in the Herbarium at the Royal Botanic Gardens, Sydney, originating from the ten regions. The dates of collection range from June, 1913 to February, 1985. Most specimens held in the herbarium,

collected prior to May, 1977 were identified as *Cuscuta australis* but a 1977 review of these specimens has led to a reclassification to *C. campestris*.

Recorded host plants have varied over a wide range of dicotyledons; garden plants to field collections of *Bidens*, *Xanthium*, *Chenopodium*, *Verbena*, *Solanum*, *Polygonum*, *Rumex*, *Tribulus*, *Trifolium* and *Medicago*.

New infestations were recorded during 1986 at Yanco, Wellington, Bingara, Delungra, and Menindee, where host plants were *Xanthium* and *Polygonum* species. Dodder was previously unrecorded in these areas.

During 1983/84 and 1985/86 a state survey was made of Local Government areas (Milvain and Smith unpublished). Major infestations were recorded in the Manilla area on the flood plain of the Namoi river in 583 ha of lucerne grown for hay production. Infestations were also recorded at Forbes near 200 ha of seed producing lucerne, the 600 ha bed of Lake Brewster which is a storage area for irrigation water on the Lachlan river, and 800 ha at Lake Victoria/Rufus River, near the South Australian border on the Murray River.

There have been other areas throughout the State ranging in size from a few square metres up to 10 hectares. These have been controlled with applications of glyphosate, diquat, or amitrole. On the basis of observations made over a period of 12 months after treatment, the management strategy for these infestations has included changes in the cropping rotations with a shift from the dodder susceptible legume pastures to the non-susceptible winter cereals.

South Australia

Dodder is known to occur along the Murray river from Renmark to Blanchetown a distance of 160 km (pers. comm. I. Black).

The most heavily infested areas have been in the fruit growing districts from Renmark to Morgan and the adjoining lucerne growing areas. This has been of major concern to lucerne growers in the Riverland (pers. comm. I. Black).

There have also been outbreaks in the south east of the state which have been considered to be minor. The use of chemicals, amitrole and diquat, and burning for control to prevent further spread of the parasite has resulted in no other outbreaks in the area. It is evident that this control strategy has been successful.

Victoria

Infestations in this state are to be found along the full length of the Murray River and in isolated localities on the Ovens, Goulburn, and Loddon Rivers and their tributaries (pers. comm. L. Hoatson).

Cuscuta is a PRIORTY ONE PEST PLANT in Victoria and as such must be eradicated under the requirements of the Vermin and Noxious Plants Act (pers. comm. W. Parsons).

The levels of infestations of dodder in Victoria could be higher if it was not for a major *Xanthium* control programme undertaken along most rivers in the state.

The Economic Impact

The control of dodder in south eastern Australia is economically very important to agriculture.

Based on the values of production as shown in Table 1, a control programme could be benefical because if no control is used then the value of production would be greatly reduced.

The list of crops shown in Table 1 are possible susceptible crops which dodder could parasitise. Overseas experience has shown that vegetables such as tomatoes, peas, beans, and carrots are susceptible; legume crops such as faba beans, lucerne and some clovers or medics are susceptible; soybeans are a possible host species.

The value of crops which are at risk from dodder infestations in New South Wales, Victoria, and South Australia is $383.9 m. This value cost is taken from the production values that are produced annually by the Australian Bureau of Statistics. The figures shown in the table represent 1984/85 values.

Table 1. Production value of crops susceptible to dodder ($ million).

	States		
Crops	**N.S.W.**	**Victoria**	**South Australia**
Vegetables	78.2	131.1	68.8
Soybeans	13.9	0.1	0.0
Lucerne hay	29.0	11.1	7.3
Lucerne seed	1.0	0.1	4.9
Clover seed	1.1	1.1	3.3
Grain legume	6.7	18.2	15.0
Total	129.9	161.7	92.3

Total all states - $383.9 m

The individual states have placed dodder at a nil tolerance level as a contaminant of agricultural seeds and fodder.

The cost of control in the Murray/Murrumbidgee valley of New South Wales for a single treatment of known infestations with herbicides was estimated in 1985 at $16 300 (Milvain unpublished). The number of treatments required would be dependent on the seasonal conditions and the range of host plants available when the dodder germinated.

During 1985 and 1986 a major control programme was mounted by the South Australian Pest Plants Commission officers using diquat and amitrole as a means of control. The South Australian authorities during the 1985/86 summer estimated that the cost of chemical control of dodder was $100 000 (pers.

comm. I. Black). Based on the South Australian costs, the Victorian authorities estimate that their costs of control would be similar.

During the 1985/86 summer one Conservation, Forest and Lands region in Victoria expended over $40 000 on control of dodder with glyphosate and amitrole. The main area treated extended from Corryong to Corowa along the Murray River (pers. comm. L. Hoatson).

Concentrated control efforts in one Victorian region have been frustrated by the reluctance of other regional managers to commit funds, even in the face of compelling arguments for its control. Hence, the potential for reinfestation of chemically treated areas exists (pers. comm. L. Hoatson).

It is likely that the cost of control in the Murray/Murrumbidgee valley of New South Wales would be similar to that of the South Australian programme because of the large infestation at Rufus River and smaller infestations upstream in both river valleys. Also there are several large tracts of country which have yet to be inspected.

From the New South Wales experience in controlling other noxious plants, it has been found that for a control programme to be workable it needs to be carried out over at least 5 years to enable the use of chemical control and the implementation of farming system changes to a grass pasture or winter cereals. During the rotations with grass pasture or winter cereals, strict prevention of regrowth of broadleaf weeds, which allow subsequent reseeding by the dodder, is very important. During this period it could be necessary to respray with chemicals.

If this phase of management of dodder gives successful control, the lucerne pastures may be re-established with associated increase in cropping profitability. The success of such a control strategy will be dependent on the depletion of the parasite seed reserve in the soil.

DODDER BIOLOGY AND LIFE CYCLE

To be able to implement the necessary control measures, one needs to understand the biology and life cycle of the parasite. Knowledge of seed spread and plant growth and development are of paramount importance for any control programme to be undertaken.

The Plant

The name Dodder is derived from the Germanic 'dotter' or 'yolk of egg' which is the basic colour of the plant and is now used as a common name for all species belonging to the genus *Cuscuta* (Mahadevan 1983).

There is some dispute as to which family the genus belongs. Most taxonomists by tradition have placed it in Convolvulaceae, but Cronquist (1981), when listing the families to be covered in "Flora of Australia", has placed Dodder in the Cuscutaceae as distinct from the Convolvulaceae. The genus *Cuscuta* contains numerous species, all of which are obligate parasites that attach to the stems and leaves of a host plant (Dawson 1984).

Growth Habit

Dodder is a non-green, leafless, rootless, twining, flowering plant that parasitises other plants for nutrients, water and support (Mahadevan 1983). While it germinates from seed, roots do not develop and the plant has no connection with the soil. It consists exclusively of thread-like often yellowish vines partly coiled around the stems of its host and partly draped over it or hanging free.

Reaching a host is tantamount to survival in dodder and several features in its development enhance this ability. The absence of root growth and thus anchorage in the soil soon after the seeds have germinated reduces its expenditure of stored reserves and allows the seedling to be carried by wind or water. In the absence of expanding leaves, shoot growth is essentially the elongation of a cylinder, geometrically ideal for spanning distances while at the same time keeping surface area to a minimum and hence the loss of water by evaporation.

The tip of the shoot continues to grow by mobilising food and water towards itself from the older tissue behind. The dodder literally grows in front while dying behind. The tip can stay alive and grow for many days, increasing its chances of meeting a new host plant.

Method of Spread

Dodder propagates either from seed or vegetatively from broken-off segments of the vine that by chance come in contact with a fresh host plant.

The initiation of invasion is by the formation of haustoria, specialised cells that will penetrate the host plant tissue and allow the dodder to obtain the necessary nutrients. The production of a few coils usually triggers the development of haustoria which eventually establishes the supply line for the transfer of nutrients and water from the host.

Once established on a host plant, continued growth and spread is by vegetative means by way of contact with a new host plant and the fixation via the haustoria cells .

As with most twiners, dodder exhibits either equal growth around its cylindrical axis which yields a relatively straight vine or grows unequally allowing it to coil around and climb up a linear object such as a host plant.

Once this link has been established with the food supply from the host, normal growth will resume to seek out more host tissue.

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INTRODUCTION OF THE BLACKBERRY LEAF RUST (*PHRAGMIDIUM VIOLACEUM*)

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Friday, 24th February, 1984, was the day landowners who are plagued with blackberry started jumping up and down, because the long awaited blackberry leaf rust had been positively identified, by Dr. El Bruzzese, living on blackberry in Victoria. The rural press and media spread the news quickly, but the problem was no-one knew who released it and thus it was quickly named the illegal rust.

Blackberry has been a good candidate for rust because of the vast areas infested with this noxious plant in south east Australia. In NSW alone, more than 5.5 million ha of non-arable country is infested with blackberry of varying degrees. Cost for control (not eradication) which is done on a limited basis, is estimated at tens of millions of dollars, while losses from decreased production are at least $20 million. In the meantime, blackberry keeps spreading.

In 1976, a project to investigate the biological means of controlling blackberry in Australia was undertaken by the Keith Turnbull Research Institute, Victoria. Also a survey of suitable insects and pathogens was made by the Commonwealth Institute of Biological Control throughout Europe. Two agents were selected, a fungus *Phragmidium violaceum*, and a stem borer *Hartigia* spp.

From 1979 a Research Officer from the Keith Turnbull Research Institute was based at the CSIRO Biological Control Unit in Montpellier, France, to carry out selection and specificity trials on the rust fungus *Phragmidium violaceum.* This pathogen is active against the most widespread blackberry species (*Rubus procerus*) in Australia. *R. procerus* though, is only one of 23 species known in Australia. Five are native to Australia, nine are from European sources (mainly for hedge and wild fruit production) and nine are from American sources (for cultivated fruit production).

Since 1983, and as a direct consequence of problems associated with the release of bio agents for *Echium* spp. (Paterson's Curse), the wheels of scientific progress have been moving slowly, especially under new legislation and guidelines for the release of biological agents into Australia, so that finally legal releases of the blackberry leaf rust might be made in the summer of 1987/88.

However, following the news of the illegal release of the rust, and even on occasions prior to this event, plans were being made to go - somewhere - to find and bring back home this most sought after object. It doesn't matter where you go, but rumour has it that vehicles with ample room for storage of carefully pruned blackberry canes from the roadsides of Victoria, were soon returning to the blackberry regions of N.S.W. It appears that these carefully packaged samples were then sold off to cover the cost of hire car expenses and fuel costs.