PROC. V INT. SYMP. BIOL. CONTR. WEEDS, BRISBANE, AUSTRALIA, 1980: 603–7

RAGWORT, *SENECIO JACOBAEA*, IN VICTORIA AND RENEWED ATTEMPTS TO ESTABLISH THE CINNABAR MOTH, *TYRIA JACOBAEAE*, FOR ITS CONTROL

L. Schmidl[1]

ABSTRACT

The distribution of ragwort, *Senecio jacobaea* L., in Victoria, Australia, and the weed problems that ragwort presents are described. With the change of land use in recent years from agriculture to forestry over large areas of some of the worst ragwort infestations in South Gippsland and in the Otway Ranges, the nature of the ragwort problem has been considerably modified. Biological control in forest plantations will be important and some of the biological control agents can be expected to have better chances of survival and success under these conditions. The Cinnabar moth, *Tyria jacobaeae* L., has been introduced to Australia previously, but failed to become established. A review of earlier attempts to establish *T. jacobaeae* is given.

In the present attempt at controlling ragwort by biological means *T. jacobaeae* was introduced from Canada from apparently disease-free field material. The results of insectary breeding and field releases are described.

Work is also being conducted to establish the flea beetle, *Longitarsus jacobaeae* Waterhouse, in Victoria. Other investigations being undertaken by the *Commonwealth Institute of Biological Control* (C.I.B.C.) for the Department of Crown Lands and Survey include an evaluation of the curculionid, *Lixus punctiventris* Boh., and other possible agents for the control of ragwort.

RAGWORT IN VICTORIA

A plant of Euro-Asian origin, ragwort, *Senecio jacobaea* L. (Compositae), was introduced to Victoria between 1880 and 1890 and was recorded as a naturalized species in 1907 (Ewart 1907). The time of the introduction of ragwort coincided with the clearing of densely timbered hill country for agricultural settlement, which proved to have regrettable consequences in the not too distant future. It was in these newly cleared, remote hills that ragwort found a favourable environment. It soon became a serious weed problem and contributed to the failure of farming within a short period of time. Ragwort spread rapidly in southern Victoria and by 1907 it was proclaimed as a noxious weed.

The total area of ragwort in Victoria is 400 000 ha (Schmidl 1972), which includes farming land and forest and shrub land. Infestations range from very dense to the occasional isolated single plant. The most troublesome infestations are on the hill country of South Gippsland and the Otway Ranges which are situated, respectively, south-east and south-west of Melbourne. Both areas have similar topographical, botanical and climatic characteristics. The largest infestations are in South Gippsland's Strzelecki Ranges, which consist of steeply sloping hills with sharp ridges and slopes up to 40° inclination. The soils are dark brown, yellowish or red-brown loams, suitable for the absorption of large amounts of water. The average annual rainfall is from 760 to 1520 mm. The mean maximum temperatures in the centre of the ragwort areas of South Gippsland at Olsen's Bridge, latitude 38° 29' S, longitude 146° 19' E, are 23.5°C in January and 11.3°C in July and the mean minimum temperatures are 9.5°C in January and 1.8° C in July. Temperature extremes can reach a maximum of 40°C and a minimum of -6°C. The highest number of raindays is in August with a mean of 21 and the lowest in January with 10 while the

[1] Department of Crown Lands and Survey, Keith Turnbull Research Institute, P.O. Box 48, Frankston 3199, Victoria for the Vermin and Noxious Weeds Destruction Board.

mean rainfall ranges from 71 mm in January to 145 mm in August.

The Strzelecki Ranges originally supported wet sclerophyll forests consisting of *Eucalyptus regnans* F. Muell., *E. globulus* Labill., *E. rubida* Deane et Maiden, *E. obliqua* L. Her., *Acacia* spp. and a variety of understory plants. The entire area was cleared for farming in the latter part of the last century and in the early 1900s.

Due to adverse environmental and economic conditions and the invasion of ragwort, blackberry (*Rubus* spp.) and rabbits, farming became non-viable within 30 years. Records from three parishes with an area of 320 km^2 in the ragwort areas show that 148 properties totalling 11 500 ha had been abandoned by 1959. Serious efforts were made to control ragwort, but because of the necessity for annual treatment costing millions of dollars to the State authorities and to individuals, little permanent control was achieved.

Reforestation of these areas commenced 40 years ago and the rate has increased greatly in recent years. Under the circumstances this was the most realistic decision for the effective utilization of these areas. In the Strzelecki Ranges some 100 000 ha of former farmland has come under organized forest management and substantial areas have been planted to *Pinus radiata* D. Don. and *E. regnans* by the Forests Commission of Victoria and by private industry. This change in land use from agriculture to forestry modifies the ragwort situation and also has implications on its biological control.

In forest plantations, ragwort increases sharply during the land clearing, soil preparation and planting stages, which may take one to three years. In plantations of *P. radiata*, ragwort will be shaded out by the forest canopy by the time the trees are eight years old and, unless control measures are taken, infestations will then be present only on forestry roads, firebreaks and in clearings. The spread of ragwort to surrounding farmland is possible from the forest areas through seeds carried by wind, animals, vehicles and man.

Ragwort is a biennial plant, but often becomes a perennial when it is physically disturbed in the vegetative growth stage. This often occurs under farming conditions when the roots, crowns or stems are injured through grazing, cutting or other farming activities. Because of its production of large numbers of viable seeds which germinate readily, and its high rate of seedling establishment, ragwort spreads rapidly and reduces useful pasture production. Ragwort is a toxic plant containing pyrrolizidine alkaloids which affect grazing animals kept for long periods on infested pastures. Cattle usually avoid eating the plant. Therefore, cattle-grazed pastures in the ragwort area often become dominated by the weed.

On the inaccessible hill country, where ragwort is common, its effective control is difficult by conventional means and thus, biological control may be the more realistic approach. Many insects used for biological control are adversely affected by grazing, cultivation and by other farming activities. With the change of land use from agriculture to forestry, it is possible, that some of the species of insects may have better chances of survival in the relatively undisturbed forest situation.

Since 1929, a number of attempts have been made to establish the univoltine lepidopterous insect, *Tyria jacobaeae* L. (Lepidoptera:Arctiidae), in Victoria for the control of ragwort, but it was not until recent years that a program was adopted to investigate all possible agents for the biological control of this weed.

Introduction of *Tyria jacobaeae* to Victoria

T. jacobaeae is the most obvious of the insects damaging ragwort in Europe. The larvae feed on the aerial growth of the plant, causing damage to the foliage, stems and flowers. After attack by *Tyria*, the plants regenerate, but viable seed production is reduced.

Attempts to establish *T. jacobaeae* have a long history in Australia. The first introduction of a small number of *Tyria* was made from New Zealand by the *Council for Scientific and Industrial Research* (C.S.I.R.) in 1929. In the same program, further introductions of 33 800 pupae were made from England in 1935 and 1937 (Curry and Fyfe 1938). Disease adversely affected the larvae in the insectary rearings and only small numbers of adults, eggs and larvae were released in Gippsland and in the Otway Ranges. No progeny were recovered a year after release and it was concluded that the predatorial *Harpobittacus nigriceps* Selys (Mecoptera:Bittacidae), was responsible for the disappearance of the insects.

At the request of the Victorian Department of Crown Lands and Survey, the *Commonwealth Scientific and Industrial Research Organization* (C.S.I.R.O.) Division of Entomology recommenced the investigations into the biological control of ragwort in 1955. A total of 4000 pupae were introduced in 1955 from Italy and 57 000 from England, and in 1957 5000 pupae were introduced from England (Bornemissza 1966).

Some problems were experienced with the termination of the pupal diapause of the imported material while synchronizing the life cycle of the insect to the seasons of the southern hemisphere. Pupal mortality was high, resulting in a low (14 per cent) adult emergence.

Insectary breeding was a complete failure due to disease epidemics.

In the field, predatorial insects (tipulids, pentatomids and particularly *H. nigriceps*) caused losses, while ichneumonid parasitism also was observed. Mass rearing in the field was not successful due to nuclear polyhedrosis, which made the planned large scale field releases impossible. This work was continued by the Department of Crown Lands and Survey as an independent project and a batch of 13 000 pupae was imported from England in 1959. Although 55.8 per cent adults emerged, disease eliminated the entire field population in the larval stage within the first season (Schmidl 1972).

Of the number of biotic factors adverse to the establishment of *Tyria* in Australia, pathogenic organisms were the most damaging. These prevented the insectary and field rearings of large populations of the insect for field releases. In 1960, in an effort to obtain disease-free material for introduction, the author suggested a program which consisted of the collection of *Tyria* larvae from healthy colonies in different locations in Europe and the rearing of the material under stress conditions through one generation, before transferring the pupae to Australia. As a result, several introductions were made by the Department of Crown Lands and Survey through the C.I.B.C. European Station at Delemont, Switzerland, and short term establishment was achieved. The project was discontinued in 1964 due to lack of finance (Schmidl 1972).

It is recognized that, for the successful biological control of weeds, usually a number of interacting control organisms is necessary. Apart from *Tyria*, the only other insect introduced to Australia for the biological control of ragwort was the seed fly, *Pegohylemyia seneciella* Meade (Diptera:Muscidae), in 1956. It was released in South Gippsland, but failed to become established.

To further investigate the establishment of *Tyria*, and all possible aspects of

the biological control of ragwort, a research program was commenced by the Department of Crown Lands and Survey in 1975. *Tyria* pupae were introduced in November 1976 from Nova Scotia, Canada, from a reportedly healthy population free of nuclear polyhedrosis. Although high pupal mortality occurred during the artificially extended diapause period, due to mechanical failure in the environment chamber, and adult emergence was extremely low, the insects were successfully reared through to pupation in a quarantine insectary at Frankston in 1977. This contrasted with the failures in insectary rearing of earlier introductions.

Limited field releases of larvae of the second Australian generation were made at several sites in Gippsland in 1978. In the majority of these releases, the larvae were confined to the plants by cages which, however, did not entirely exclude predators and parasites. In the following spring (November 1979) a number of adults emerged at only one of the study areas. To build up the insect population, rearing of the second Australian generation continued in the insectary.

Further field releases of adults and larvae were made at four study sites in Gippsland and at one site in the Otway Ranges in November to December 1979 and January 1980. In the insectary rearing in 1979/80 the third Australian generation *Tyria* was reared on the host plant in a temperature controlled glasshouse insectary and, as a result, 6200 pupae were produced. No epizootics developed in the cultures throughout the rearing season in either the field or the insectary. However, some larval mortality occurred. The presence of cytoplasmic polyhedrosis and a nonoccluded virus (spherical) were, however, diagnosed (C. Reinganum, pers. comm.). The predatorial *Harpobittacus* was observed at some of the release areas and at one of the sites it was numerous.

DISCUSSION

The conventional methods for the control of ragwort include the use of herbicides, cultivation, cropping, and grazing management. However, the level of control obtained is usually inadequate, particularly in inaccessible hill country. Expenditure on ragwort control results in little or no appreciable return on farms which lack sound management. This gives little incentive to voluntary control of ragwort.

While reforestation of the hills, under the prevailing economical climate, is a sound approach, there is the danger of the spread of ragwort to the marginal and better farmland from the annual production of seed in the reforested areas. Because it is uneconomical to control ragwort in these areas by chemical means, biological control appears to be the most appropriate means of preventing this seed production.

The establishment of *Tyria* failed in the past because of antagonistic biotic factors and primarily because of highly pathogenic organisms. Some of these biotic factors remain, and will impose limitations to the establishment of *Tyria*. The successful rearing of the Canadian *Tyria* strain is, however, a significant break-through in the *Tyria* work in Victoria. The narrow genetic base of *Tyria* presently in Victoria is of some concern and from this viewpoint its adaptation to the local conditions will be carefully studied.

Investigation into *Tyria* is continuing and research work has also commenced with the flea beetle, *Longitarsus jacobaeae* Waterhouse (Coleoptera:Chrysomelidae), by the C.S.I.R.O. and the Department of Crown Lands and Survey. *L. jacobaeae* has already been introduced and released in Victoria.

A survey of the natural enemies of ragwort is being conducted in Europe by the C.I.B.C. for the Department of Crown Lands and Survey. The stem mining weevil *Lixus punctiventris* Boh. (Coleoptera:Curculionidae) and the moths *Epiblema costipunctana* Haw. (Lepidoptera:Tortricidae) and *Commophila aeneana* Hüb (Lepidoptera:Tortricidae) will be studied as possible biocontrol agents. Other insects, and also the rust, *Puccinia expansa* Link., will also be considered for the possible biological control of ragwort in Victoria.

REFERENCES

Bornemissza, G.F. (1966). An attempt to control ragwort in Australia with the cinnabar moth, *Callimorpha jacobaeae* (L.) (Arctiidae:Lepidoptera). *Aust. J. Zool.* 14:201–43.

Currie, G.A., and Fyfe, R.V. (1938). The fate of certain European insects introduced into Australia for the control of weeds. *J. Coun. Scient. Ind. Res. Aust.* 11:289–301.

Ewart, A.J. (1909). 'The Weeds, Poison Plants and Naturalized Aliens of Victoria.' (Government Printer:Melbourne.)

Schmidl, L. (1972). Studies on the control of ragwort, *Senecio jacobaea* L., with the cinnabar moth, *Callimorpha jacobaeae* (L.) (Arctiidae:Lepidoptera) in Victoria. *Weed Res.* 12:46–57.