SESSION 5.

SOME ASPECTS OF THE BIOLOGICAL CONTROL OF WEEDS IN AUSTRALIA

By Frank Wilson

The purpose of this contribution to the Weed Control Conference is to draw attention to a few of the principles and problems underlying work on the biological control of weeds in Australia, and to summarize the present position for the problems that are of particular current interest.

Australia has long had a special importance in relation to the biological control of weeds, especially because of the remarkable results of the work on prickly pear. More recently, arising out of interest abroad in Australian work on St. Johns Wort, we have seen the U.S.D.A. reverse its long-established and sceptical policy in relation to the biological control of weeds and to allow for the first time the introduction of phytophagous insects into continental U.S.A.

Nevertheless, objections to this form of weed control are still heard, though it usually takes the form now, not of questioning the feasibility of effective control by insects, but of claiming that such control relieves the pastoralist of the obligation to control weeds by pasture improvement. But this objection cannot apply to weeds for which chemical or mechanical control is used, or to those problems for which pasture improvement is not a solution, or to those terrains on which it is impracticable. We cannot ignore either that a farmer's resources, or economic circumstances, at times may not permit pasture improvement, however desirable in itself. A more balanced view is that biological control is one of several important means by which weeds may be controlled. When it is effective, it is certainly the cheapest form of control

Though comparatively few successes have been obtained (the most complete examples are perhaps prickly pear and Clidemia hirta) it has to be remembered that comparatively few attempts at the biological control of weeds have been made, and that in no problem have the possibilities been fully investigated. My personal opinion is that biologists have only begun to explore the potentialities of this form of weed control.

There are, of course, very few people engaged in this kind of work, and for this Australia, with the example of prickly pear before it, has singularly little excuse. Apart from questions of personnel, however, there are other impediments. The first is the difficulty in obtaining from agricultural authorities and agrostologists an unequivocal statement that the biological control of a weed is desirable. One can illustrate this by the difficulty with which a clear-cut statement was finally obtained on the status of Lantana in eastern Australia. Then again, Echium is apparently partly weed and partly a useful fodder plant in some areas or during droughts. Or sometimes the agrostologist suggests that, if a weed is brought under control by insects it may be replaced by a potentially more serious weed, as Lantana by Crofton weed. Perhaps the main impediment to undertaking the biological control of weeds is the inability to determine for any particular species whether its biological control is desired or not.

Another important difficulty is the question of the risks involved when introducing phytophagous insects. After passing through a phase in which we were considered abroad to be rash in introducing such insects at all, the tendency now is to criticise our conservatism in insect introductions. I have in mind, for example, the question of whether other insect species should be introduced against Noogoora burr. So far as C.S.I.R.O. is concerned, we are against anything in the nature of a gamble in this matter, because an error would adversely effect the development of the biological control method in general. We admit freely that we are likely to oppose the introduction of insects which, if introduced, might not prove economic pests. We do so because we cannot virtually guarantee that they will not become so. We take into account also that introduced insects may often become established at a comparatively low population density, and, though having no significant effect on the weed, might, at this same density, prove troublesome pests.

It is to be expected that no biological control solution will be found to many weed problems either because the associated insects have so little harmful effect on the weed (e.g., bracken), or because the insects are too polyphagous (e.g. blackberry). In particular, there are likely to be difficulties in finding suitable natural enemies for the control of weeds belonging to families of economic importance. On the other hand, if the biological control of a weed is desirable in the light of a satisfactory knowledge of its ecological background, and if the weed

W/5/11/2

is an exotic, preferably a perennial, and fairly isolated botanically from economic plants, there is a good prospect of finding natural enemies which can be introduced with safety.

In searching for such natural enemies, it is necessary to give considerable importance to climatic aspects of the problem, and to choose insects suitable for the climate of the area in which, it is hoped, they will control the weed. In this way, the chances are greatly increased that the insect numbers will fluctuate directly in accordance with food abundance, without the inhibiting effect of other important mortality factors.

We will now briefly review the present position in six weeds of current interest from the viewpoint of biological control.

(a) Hypericum perforatum L. (Hypericaceae) St. Johns Wort

W/5/W4/3

Current work on this weed by the C.S.I.R.O., Division of Entomology is concerned primarily with the establishment of a European gall-forming Cecidomyiid, Zeuxidiplosis giardi Kieffer. It was introduced in 1953 and appears to be well established already. This insect greatly restricts the growth of the attacked plants, and is able to increase in numbers with great rapidity because it has five or six generations a year. It is quite possible that it will prove of importance in the biological control of St. Johns wort in Australia.

The Chrysomelid beetles (Chrysomela quadrigemina and C. hyperici) continue to be distributed on a smaller scale to areas where they are not yet established. Probably these insects are now established in most of the important St. Johns wort areas in most States, and they often occur in very large numbers, at least intermittently. Where detailed field studies have been made in Victoria and New South Wales, it appears that the efficacy of the Chrysomelids is hampered by an unfavourable physical environment, the host's ability to recover from the severe damage caused by the insects, and the comparative slowness with which the insects repopulate recovering areas of the weed. It is possible that the results being obtained in other States are different from this, but apparently detailed field studies have not yet been made. So far as it is possible to make a generalization, it seems that despite the enormous Chrysomelid populations

that develop and the great damage they frequently cause to the host, the overall reduction of St. Johns wort has been very much less than is desirable.

Apart from Zeuxidiplosis giardi, there are other insect species which could be introduced if this were thought desirable.

(b) Heliotropium europaeum L. (Boraginaceae) Common Heliotrope

The possibility of the biological control of this weed was investigated because of its importance in toxaemic jaundice of sheep. There has been some doubt as to the origin of Heliotrope which has long been present in Australia, but Kew Herbarium considers that it may safely be taken to be a non-Australian species of Western Mediterranean origin, though the indigenous area of the species extends far into Asia.

Certain climatic characteristics of the Australian areas infested (having regard especially to the Murray Valley) were utilized to define the Mediterranean homoclimes of these areas, and it was concluded that special interest attached to areas of the Mediterranean region with approximately the following characteristics:

Temperature (°F)	Annual mean	60	(58-66)
	Amplitude	27	(20-30)
Rainfall (inches)	Annual	15	(10-22)
	Ratio wettest/driest 6 months	1.4:1	(1:1, 3.3:1)

Corresponding data for a large number of Mediterranean stations, showed that these conditions are most closely paralleled in parts of southern France, eastern Spain, eastern Greece, and coastal Algeria and Tunisia. All these areas, except Greece, were surveyed by C.S.I.R.O. in 1950, and a study made of the insect fauna associated with various species of Heliotropium. A study of the literature and information supplied by entomologists in Kenya, Sudan, and Eritrea has produced an extensive list of Heliotropium insects.

The species encountered during the field survey of the western Mediterranean were limited in number and none promise to be of value in the control of Heliotropium. A

W/5/W1114

flea beetle, Longitarsus albineus Foud. was by far the most abundant species but its immature stages were not observed on Heliotropium nor has subsequent study by the Commonwealth Institute of Biological Control discovered these immature stages. It seems probable, therefore, that the larvae attack some other host. Utetheisa pulchella L. is commonly regarded as the most important enemy of the weed in western Mediterranean Africa, but this moth already exists in Australia. None of the other species encountered seemed to be of importance. While the period spent in the field was brief, it seems unlikely that any really important enemies of the weed would have been missed. It is probable, therefore, that no effective insects suitable for introduction into Australia exist. Heliotropium europaeum is an annual and apparently, like Noogoora burr, has very few, if any, insects specific to it.

(c) Eupatorium adenophorum Spreng. (Compositae) Crofton Weed

American field work in Mexico on the natural enemies of this weed led to the discovery in 1946 of Procecidochares utilis Stone, a Tephritid fly, the larvae of which form multilocular stem-galls on Eupatorium adenophorum. The insect has four to five generations a year, and is entirely restricted to this species. Since its introduction into Hawaii in 1945, P. utilis has become established on several islands of the group, and in some areas has had a very marked effect on the weed. In 1951, C.S.I.R.O. decided that, subject to additional food tests being carried out in Hawaii, this insect should be introduced into Australia. The same conclusion was reached by the Queensland Department of Lands after a subsequent visit to Hawaii by Mr. A.P. Dodd and after discussions between the two organizations, a plant was drawn up for further host-restriction tests on P. utilis which were later carried out by the Queensland Department of Lands. After satisfactory conclusion of the tests, the insect was introduced into Queensland, where it is now well established. It has also been released in northern New South Wales.

It is too early to judge of the ultimate effects of this introduction. Should it prove inadequate, it is quite possible that other species could be introduced from Mexico. Dr. Krauss, of the Hawaiian Board of Agriculture and Forestry, considered that two Mexican

Trypetids which attack the flowers of Crofton weed, Xanthaciura connexionis Benj. and Trupanea actinobola (L.N.) would be safe for introduction. X. connexionis is known to attack only E. adenophorum and E. petiolarae, whilst T. actinobola was reared only from two wild composites as well as Crofton weed. Other species thought promising included Rhodobaenus sanguineus Gyll., a Curculionid stem borer. The total number of species which seemed worth further investigation was not large, but the indication is that there is a complex of insects associated with Crofton weed which includes several of very restricted host range.

(d) Xanthium pungens (Compositae) Noogoora burr

Investigations over a very extended period were made by Australian entomologists in America and India on the natural enemies of this important weed. A large number of insects were investigated, many of which caused considerable damage to the host plant and promised to be of value if established in Australia. However, food tests showed that these insects generally are not closely restricted in the plants they will attack. Consequently, though many species were imported into Australia, the only one released was Euaresta aequalis (Trypetidae), the burr-seed fly, which is the only species restricted to Xanthium. Though established for a decade in southern Queensland, this insect has proved of no importance in controlling the weed.

There has been much debate as to whether or not we should introduce Mecas saturnina and Nupserha antennata, two Cerambycid stem-borers, from U.S.A. and India respectively. Food tests show that these species might well attack Jerusalem artichoke, sunflower, and certain garden composites, but it is argued that this would be a minor matter compared with the control of Noogoora burr. Unfortunately, there is no guarantee, or even likelihood, that these species would control Noogoora burr. Under these circumstances, C.S.I.R.O. has been unable to recommend the importation of these insects, and it seems unlikely that the States not affected by the weed would approve the introductions.

At the request of the 38th Meeting of the Australian Agricultural Council, the Commonwealth Department of Health enquired of the Bureau of Entomology and Quarantine, U.S.D.A., concerning Mecas saturnina. In reply, they have been informed that this species attacks Jerusalem artichoke (Helianthus tuberosus) and Parthenium hysterophorus (an annual weed of the same genus as the rubber-producing plant

guayule) and that the extent of attack by Mecas on Noogoora burr is assumed to be very light. On the basis of this information the Department of Health feels it could not approve of the introduction of Mecas saturnina.

(e) Lantana camara L. (Verbenaceae)

Against this weed the seed-fly, Agromyza lantanae, and the leaf-bug, Teleonemia scrupulosa, have been established for a good many years with little effect. It has long been considered that many other insects could probably be introduced from Central America if the need for the biological control of Lantana were of sufficient importance. A reconsideration of this aspect of the problem by Queensland authorities led to their concluding that further introductions were very necessary. New South Wales also had some interest in the work being undertaken.

At the same time a proposal was made that various interested countries should finance work on Lantana in Central America, and C.S.I.R.O. and Queensland jointly financed the despatch of Mr. J. Mann, of the Department of Lands to collaborate in the expedition with Dr. N.H.L. Krauss of the Hawaiian Board of Agriculture and Forestry.

The expedition began in March 1953 and continued for almost a year. During that period, the explorers made collections of Lantana insects in Mexico, Florida, Cuba, Puerto Rico, Trinidad, Colombia, Panama, Guatemala, British Honduras, El Salvador, Honduras, Nicaragua and Costa Rica. The collections made have justified the expectation that the field work would discover more insect species associated with Lantana, some of which might well be of value in its control. Both Krauss and Mann were impressed by the evident ability of some of the species found to seriously damage the weed, and the results of the work may be anticipated with some optimism.

The expedition sent many species of Lantana insects to Hawaii to be cultured in quarantine and subjected to tests on their ability to attack economic plants, and permission has already been given for the release of some of these species in the Hawaiian islands. The more important of these species appear to be:-

(i) Plagiohammus spinipennis, a Cerambycid stem borer from Mexico and Costa Rica, which has not yet been approved for release.

(ii) Blepharomastix acutangulalis, a Pyraustid leaf-eating species from Mexico, which has been released.

(iii) Diastema tigris, a Noctuid leaf-feeder, from Panama, for which permission for release has just been given.

Other species, which may be less important, are:

(i) Octotoma scabripennis from Mexico, and O. plicatula (?) from Honduras, both these Chrysomelid leaf-miners having been released.

(ii) Teleonemia spp., Tingid leaf-feeding bugs, from Cuba, British Honduras, Trinidad and Brazil, have been released.

Two species which are giving trouble in propagation in Honolulu are:

(i) An undetermined beetle borer from Mexico.

(ii) A Hepialid stem-borer from Costa Rica and Mexico.

Other promising species were found which have not yet been propagated in Honolulu.

It can be seen from this account that the expedition produced a considerable amount of new material. However, the work is still at an early stage, and it is now for the Hawaiians to develop and establish the safe and effective species. Australia will re-enter the field when the importance of the various species has been established more clearly.

(f) Senecio jacobaea L. (Compositae) Ragwort

Attempts at the biological control of this weed were made, unsuccessfully, before the war. The problem is a serious one in parts of Victoria and Tasmania, and C.S.I.R.O. has received many requests from the Victorian Department of Lands for further work to be undertaken. It has been decided, therefore, to introduce from Europe, probably next year, Tyria jacobaeae (Arctiidae), a leaf-feeding caterpillar, and Pegohylemyia seneciella (Anthomyidae), which attacks the

capitula. These are two well-known ragwort insects. Tyria jacobaeae was liberated in South Gippsland between 1930 and 1937, but the species was not established, apparently because of predators, such as scorpion flies. It is also likely to be attacked by parasites of Nyctemera amica (Hypsidae) which is an Australian native species found on ragwort. Pegohylemyia seneciella has not previously been liberated in Australia.