

BIOLOGICAL CONTROL OF *LANTANA* IN AUSTRALIA

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INTRODUCTION

In Australia *Lantana camara* L. is a serious pest from Cape York (15° S lat.) south to Jervis Bay (35° S lat.). The climate of the infested region varies from tropical, with high summer rainfall (up to 4,000 mm per annum), to sub-tropical with a mean annual rainfall of approximately 1,000 mm distributed relatively uniformly throughout the year. Inland the limit of distribution approximates the 750 mm isohyet in the south and the 1,000 mm isohyet in the northern wet tropical region. Distribution is further influenced by soil type.

There are 30 or so taxa of *L. camara* naturalised in Australia but to date only nine have assumed pest proportions. All pest taxa occur in Queensland and two in New South Wales (Smith, unpublished data). All except the widespread Common Pink taxon are toxic to cattle (Seawright, 1965 and unpublished data). All Australian lantanas are thought to have originated in Mexico, Central or South America (including the Caribbean) but the majority appear to be cultivars and it has not been possible to determine the populations from which they were derived.

The pest taxa vary in flower colour, growth habit, chemical components, in suitability as hosts for species specific insects and in several other ways. This broad variation between taxa coupled with their extensive establishment in climatically diverse areas has produced a complex situation requiring a range of biological control organisms if effective control is to be achieved. The problem is in marked contrast to that which attained in Hawaii. There three taxa are naturalised but the bulk of the infestation is due to one taxon and climatic conditions throughout the range are much less varied. In the simpler Hawaiian situation introduced insects have brought lantana under control over much of its range. However these insects have been relatively ineffective in Australia.

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ORGANISMS INTRODUCED FOR CONTROL

Insects introduced prior to 1965

Insects introduced into Australia prior to 1965 are listed in Table 1.

TABLE 1
Insects introduced into Australia prior to 1965 for biological control of
Lantana camara

Species	Date introduced	Status
<i>Ophiomyia lantanae</i> (Froggatt)	1914, 1917	May cause some reduction in seeding. Minor importance.
<i>Platyptilia pusillidactyla</i> (Walker)	No record	Minor importance.
<i>Epinotia lantana</i> (Busck)	1914, 1917	Minor importance.
<i>Eutreta xanthochaeta</i> Aldrich	1914, 1971	Not established.
<i>Thecla agra</i> Hew.	1914	Not established.
<i>Teleonemia scrupulosa</i> Stål	1935, 1969, 1972	Major importance.
<i>Syngamia haemorrhoidalis</i> Guén.	1956	Minor importance.
<i>Catabena esula</i> (Druce)	1956, 1957	Minor importance.
<i>Diastema tigris</i> Guén.	1956, 1957	Not established.

As is evident from the dates of importation there were three phases of activity, 1914-17, 1935 and 1956-57. The seed fly *Ophiomyia lantanae* (Froggatt) and the tip borer *Epinotia lantana* (Busck) are well established and quite numerous but exert little or no controlling influence on lantana. The lace wing bug *Teleonemia scrupulosa* Stål is seasonally very abundant and causes considerable damage to some taxa but not others. Plants may be fully defoliated and when attack coincides with a period of climatic conditions adverse to the plant severe dieback or death may result. However the controlling influence of this tingid is substantially reduced as population levels are depressed by abnormally cold or wet conditions, and by failure to develop damaging populations on the important Common Pink taxon.

The moths *Syngamia haemorrhoidalis* Guén. and *Catabena esula* (Druce) occasionally become locally abundant but rarely cause any lasting damage.

Insects introduced 1965 to date

The fourth and current phase of activity in biological control of lantana in Australia began in 1965. Insects which have been introduced during this phase are listed in Table 2.

TABLE 2

Insects introduced into Australia 1965 to date for biological control of
Lantana camara

Species	Date introduced	Status
<i>Hypena strigata</i> (Fabricius) (African strain)	1965, 1966	Indistinguishable from Australian strain with which it interbreeds. Probably established. Minor importance.
<i>Uroplata girardi</i> Pic	1966, 1972	Major importance.
<i>Octotoma scabripennis</i> Guérin	1966, 1972	Major importance.
<i>Plagiohammus spinipennis</i> (Thoms.) (Jalapa strain)	1966	Minor importance.
<i>Leptobyrsa decora</i> Drake	1969, 1972	Liberations throughout Queensland and N.S.W. Not known to be established.
<i>Teleonemia elata</i> Drake	1969	Liberated Queensland and N. S. W. Not known to be established.
<i>Teleonemia harleyi</i> Froeschner	1969, 1970	Liberated. Not known to be established.
<i>Teleonemia prolixa</i> (Stål)	1972, 1973	In quarantine.

In addition a further attempt has been made to establish the gall fly *Eutreta xanthochaeta* Aldrich and the gene pool of *Teleonemia scrupulosa* has been increased by introduction of material from localities scattered over its extensive indigenous range (Table 1).

The majority of the insects listed in Table 2 are still being liberated and it is too soon to evaluate their long-term effects. However the two hispine beetles *Uroplata girardi* Pic and *Octotoma scabripennis* Guérin established readily, have increased to exceedingly high populations in several favourable regions of Queensland and are having a severe impact on the weed. In several areas lantana is now rapidly receding and is being replaced by more desirable plants. These hispines have not attained their full potential as control agents and are still increasing in population and distribution. They attack all pest taxa and are undoubtedly the most effective control agents yet established in Australia.

The cerambycid stem borer *Plagiohammus spinipennis* Thomson proved amenable to mass rearing using a synthetic culture medium (Harley & Wilson 1968, Hadlington & Johnston, in press). This appears to be the first occasion on which an insect with a life-cycle of nearly a year has been mass reared on a synthetic diet. In Australia this beetle has not increased appreciably in the field but may assume greater importance during periods of particularly favourable climate or when lantana is suffering from attack by other organisms.

The effectiveness of the tingids *Teleonemia elata* Drake, *T. harleyi* Froeschner and *T. prolixa* (Stål) will be limited due to their specialized behaviour. The Pink-edged Red taxon of *L. camara* is the main host of *T. elata*; the Common Pink taxon being less suitable. Both *T. harleyi* and *T. prolixa* are primarily flower feeders and have quite interesting behavioural adaptations which appear to ensure survival of these species during periods of little flower production.

The tingid *Leptobyrsa decora* Drake has been introduced from two climatically dissimilar regions in Peru and Colombia. The Peruvian and Colombian collections appear to be distinct genotypes but although hundreds of thousands have been liberated in diverse habitats in Australia establishment remains uncertain. It is interesting to note here that the Peruvian genotype has established at two sites in Hawaii. *L. decora* breeds prolifically under insectary conditions and within its native range, it causes very severe damage to all pest taxa of *L. camara*, and in Peru and Colombia it also occurs on other *Lantana* species. It appears to have attributes predisposing it as a highly successful biological control agent. To date it has not been possible to determine just why it has not established in Australia but general predators and, in the south, cool winters seem to play a role.

INTERDISCIPLINARY STUDIES

From the foregoing it is clear that biological control of the *L. camara* complex in Australia is a very difficult undertaking. Recently it has been possible to coordinate the work of several research groups in an interdisciplinary approach to the problem.

Taxonomy

An understanding of the taxonomic relationships of a naturalized weed and the plant in its indigenous range is essential if any biological control programme is to be pursued efficiently and effectively. In the case of lantana this was also essential to a proper understanding of its status as a toxic plant.

Studies by the late L. S. Smith, Botany Division, Department of Primary Industries, Queensland, which were completed after his death by his wife, have shown that there are approximately 30 taxa in the *L. camara* complex in Australia. Some of these occur only in cultivation but nine occur in pest proportions and are

responsible for the very serious weed problem which this plant poses in Australia. An intensive search throughout the indigenous range of *L. camara* and in world herbaria failed to locate any of the taxa naturalized in Australia. The only lead was a specimen resembling the Common Pink taxon in a German herbarium. Mr. Smith's work has been invaluable in sorting out and enabling recognition of the Australian taxa but has not, as was originally hoped, indicated their origin within the plant's extensive natural range. It is now postulated that the Australian taxa are cultivars, possibly developed in Europe from material collected in the Americas. As reproduction is apomictic any cultivars produced would breed true and could increase to pest proportions in Australia and other countries where they were introduced as horticultural plants. Descriptions and a key of the taxa naturalized in Australia are in preparation.

Toxicity to livestock

Lantana poisoning is known to account for the death of approximately 1000 to 1500 cattle per annum and is regarded as one of the most important poisonous plants in coastal Queensland. Its toxicity has been recognised for many years but until recently reports have been confused due to variation in the toxicity of morphologically similar taxa. Toxicity studies by A. A. Seawright (1965), Department of Veterinary Preventative Medicine, University of Queensland, coupled with the work of Smith have now clarified the situation. Of the nine pest taxa all except one, the Common Pink taxon, are toxic and of the other 21 taxa most, if not all, are toxic. The toxin and its mode of action are currently being investigated by A. A. Seawright, and J. A. Lamberton and his colleagues.

Phytochemistry

Phytochemical studies by J. A. Lamberton and N. K. Hart, Division of Applied Chemistry, CSIRO, K. E. Murray and B. H. Kennett, Division of Food Research, CSIRO and C. W. Ford, Division of Tropical Agronomy, CSIRO have added a further dimension to comparative studies of the Australian and American taxa and are enabling rapid progress towards recognition of fractions biologically active either as toxins or in influencing the behaviour of biological control agents. Again the complexity of the task is increased by the variety of taxa and, particularly in regard to insect behaviour, by the variety of organisms and behaviour patterns involved. This is a challenging field and components, which it is hoped eventually to characterise, should constitute keys to some very interesting biological activities.

Insect Behaviour

Mr. L. A. J. Radunz (1971), Department of Entomology, University of Queensland, has studied the relationships of *Teleonemia scrupulosa* to several lantana taxa and is currently studying the behaviour and reasons for the specificity of *Octo-*

toma scabripennis. He is working in close cooperation with myself and with Lambertson and his colleagues. Several components of *L. camara* have been found to elicit biting or feeding. Although it is too early to give any indication of what these substances may be, they do not appear to be related to the toxic components.

Ecology

To date documentation of the establishment, spread and effects on the weed of introduced insects has been limited to qualitative observations. However techniques for quantitative assessment of these factors have been used in a study of the interaction of a complex of established control agents with three pest taxa of *L. camara* in an experimental planting at Brisbane. In this study comparisons were made between insect populations and damage caused to plants treated with insecticides and to untreated plants. The results are presently being analysed but are complicated by the fact that the insecticide applications did not give as high a degree of protection as was desired. Quantitative ecological studies which are now being undertaken by C. D. Brickhill, Darling Downs Institute of Advanced Education, Queensland, should provide much valuable information on factors influencing insect populations, effects on the weed and the ecology of infested regions.

The understanding of the lantana problem in Australia has improved greatly as a result of these interdisciplinary studies. However much remains to be accomplished before the problem is solved. Surveys conducted by the Division of Entomology, CSIRO, in Mexico, Central and South America in 1969 and 1972 indicated a large untapped reservoir of potential biological control agents, and a station has been established in Brazil to study these at first hand.

Current Programme of Exploration and Importation

In Australia at the present time the greatest need is for organisms which will attack the Common Pink taxon of *L. camara* and which can withstand cool winters and periods of drought. Keeping these requirements in mind the Division of Entomology, CSIRO, decided to establish a field station at Curitiba, Brazil (lat. 26° south). Curitiba is central to a region of very diverse topography and climatic types and is believed to contain a wide variety of taxa of *L. camara* and related *Lantana* spp. It is anticipated that systematic exploration of the region will yield several organisms for control of *L. camara* in Australia. The station was established at the end of June this year with John A. Winder as Entomologist-in-charge. It is possible that a second station to seek insects suited to more tropical environments may be established by the Department of Lands, Queensland, in Central America.

Preliminary selection and study of the specificity of organisms will be done in Curitiba. Detailed studies of biology, of suitability to lantanas naturalized in

Australia, of host specificity and of climatic conditions likely to limit performance of the organism in the field will be made in quarantine in Australia.

The prospects for effective biological control of *L. camara* are good. It is seven decades since organisms for its control were first sought by Koebele in Mexico but it is only recently that the search has been extended by Division of Entomology, CSIRO, to cover the extensive native range of the plant and only now that a station has been established in the Americas for full time research of the problem.

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