COMMONWEALTH INSTITUTE OF BIOLOGICAL CONTROL

REPORT

AN ASSESSMENT OF THE OCCURRENCE AND POTENTIAL OF NATURAL ENEMIES OF *MIKANIA* SPP. IN THE NEOTROPICS

Final Report (May 1978 - March 1981)

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Gordon Street, Curepe

TRINIDAD, W.I.

SUMMARY

The natural enemies of *Mikania micrantha* in the Neotropics were investigated. The wide range of phytophagous insects associated with *M. micrantha* in the New World which are not found in the Old World may explain why *M. micrantha* is an aggressive weed in the latter, but of little importance in the former. The thrips, *Liothrips mikaniae* was examined in some detail and shown to be host specific. Subject to confirmatory tests in a receiving country, it is recommended for introduction into S.E. Asia. Other species which are probably host specific and merit further studies include the eriophiid mite *Acalitus* sp., the seed-feeding weevil *Apion luteirostre*, the flower midge *Neolasioptera* sp., the inflorescence inhabiting lace bugs *Teleonemia* spp., the cassids *Omoplata* spp. and the weevil *Pseudoderelomus baridiiformis*.

The Neotropical Region

Areas surveyed for *M. micrantha* and its natural enemies

1. TRINIDAD 2. TOBAGO 3. VENEZUELA: Guatapo National Park 4. Rancho Grande National Park 5. On road Maracaibo to Trujillo 6. Around Cordillera de Merida 7. COSTA RICA: Guapiles, Turrialba, San Isidro 8. PANAMA: Canal Zone & surrounds 9. COLOMBIA: Villetta & surrounds 10. Cali & surrounds to Buenaventura 11. ECUADOR: Santo Domingo de los Colorados & surrounds 12. Puyo & sourrounds 13. PERU: Talara 14. Iquitos 15. Pucallpa 16. Tingo Maria

Possible sources of *M. micrantha* introduced to Old World
17. MEXICO: Acapulco 18. PARAGUAY: Ascunsion

Suggested bases for further survey work
19. BOLIVIA: Santa Cruz 20. BRAZIL: Curitiba

CONTENTS

1. INTRODUCTION

Mikania is a large diverse genus of sprawling composit vines, whose centre of origin is undoubtedly neotropical. This project was principally aimed to study *M. micrantha* HBK, a native to tropical South and Central America, which has become a serious aggressive weed following its introduction to the Old World.

Due to confusion in the taxonomy of the weedy species of *Mikania* (Parker 1972) it was only recently realized how suitable the Old World *Mikania* problem was for the application of biological control. As Parker writes, until recently, the weedy *Mikania* of the Old World are considered to be one of two species: *M. cordata* or *M. scandens*. It is now established that *M. scandens* is restricted to North America, *M. cordata* is a native Old World species which generally is not an aggressive weed and that in nearly all cases the aggressive *Mikania* is the neotropical species *M. micrantha*.

M. micrantha is now documented principally as a weed of plantation crops such as tea, teak, rubber, oil palm, coconut (Parker 1972); Holm et al. 1977; Wirjahardja 1976). The large areas of plantation involved means the expenditure (or potential expenditure) on herbicides is enormous. Furthermore, the fact that most biocontrol of weeds successes have occurred in permanent (particularly pasture) situations rather than ephemeral (annual crop) situations argues strongly for the potential for biocontrol in (perennial) plantation situations.

A potential side benefit of this project is that biotic agents introduced to control *M. micrantha* are also likely to control the native, closely related and less aggressive weed *M. cordata*.

2. METHODS

In this section I wish to discuss briefly some features of the ecology of *M. micrantha* to facilitate the planning and undertaking of further studies.

In the Americas *M. micrantha* is distributed from Paraguay to Mexico. It reached Bogor, Indonesia from Paraguay as mentioned by Wirjahardja (1976), while I have heard from a botanist at CATIE, Costa Rica that it was introduced to Manila, Philippines from Acapulco, Mexico. Thus, the probable sources of the introduced material include both extremes of the range of *M. micrantha*. It is not impossible that *M. micrantha* differentiated into distinct races or strains at these extremes of its natural range. This should be borne in mind if introductions are made of a very highly host specific agent (e.g. *Acalitus* sp.).

In searching for *M. micrantha* throughout Trinidad (Cock 1979a, 1980b), and during survey visits (see Appendix 1 for details) to Central (Cock 1979c) and South America (Cock 1979b, 1980c) a picture has been built up of the habitats in which it normally occurs, and can most readily be found. *M. micrantha* is, as are most weeds, principally a species of disturbed situations, but it is normally only found in damp situations away from poor soil. The most rewarding sites in terms of number of natural enemies are at the edge of roads and tracks in forested regions, although swampy areas can also be productive.

A feature of the associated biotic agents noted throughout this survey is the difference between the species found in sunny and shaded situations. Natural enemy diversity and density of leaf feeding species is usually greater in shady situations. Cruttwell (1972) noted the same feature in the survey of natural enemies of the closely related composit *Chromolaena odorata* (= *Eupatorium odoratum*). She concluded that the heavy insect attack in shady situations prevented extensive colonization of *C. odorata* into such situations. Many of the

defoliating agents in such places are polyphagous species (e.g. Orthoptera, Phasmida).

One feature of the fauna of sunny situations is the variation in the numbers of insects to be found on *M. micrantha* in response to the time of day and weather conditions. Early in the morning, and throughout the day on overcast days, considerably more leaf feeding insects are found than during the hot (drier) part of the day. Although this does not seem to hold true for flower feeding insects, it can lead to a misleading view of the number of insects to be found on plants in sunny situations.

In Trinidad, flowering has been recorded as occurring in the dry season (December-April) (Cheesman 1940). In my experience, limited flowering can be found at any time of year, but is most extensive in the dry season. The flowering season is not as clear-cut as it is for *C. odorata* and offers the opportunity for some species to breed throughout the year, e.g. *Neolasioptera* sp. (Cecidomyiidae). The other common species of *Mikania* also have fixed flowering seasons: *M. vitifolia f. boliviensis* in September and *M. trinitaria* in January and February. Other species have not been found in flower sufficiently to determine their main flowering season - probably most flower in the dry season. The flowering of *M. vitifolia* in September offers the opportunity for some flower feeding species to alternate hosts and so have two generations a year instead of one. This may be so with *Apion luteirostre* (Apionidae) but has not been investigated.

When not in flower *Mikania* spp. are inconspicuous. Although it is possible (with practice) to spot *M. micrantha* from a moving car, the most reliable and productive method is to search on foot in likely areas. Because of their climbing habit, *Mikania* spp. are difficult to sample. The normal methods of

beating and sweeping are not usually possible, and on the few occasions when practicable, it was impossible to be sure whether the insects collected came from the vine or its associated vegetation. Besides this, there is the tendency for the vines to grow out of reach, and for the roots to be at some distance from the main growth. As *Mikania* grows in forested places which are usually on steep slopes (the flat land having been cleared of forest or the soil is too poor), or in swampy conditions, sampling difficulties are compounded. Accordingly, most collections were made by searching the growing plant in situ, and collecting insects individually.

For rearing the flower feeding insects it was found most convenient to collect flower masses in bags and take them back to the laboratory where they were put in wooden emergence boxes. Material continues to emerge for about two weeks. To obtain more information about the life histories and parasites of flower feeding species, individual flower heads were dissected. The larvae and pupae of the commoner species were distinguished and reared separately to obtain their parasites. Once the flower heads are dissected, the mortality amongst their inhabitants tends to be high even when kept in apparently suitable conditions.

Stem feeding insects were rare. Exit holes were occasionally found but extensive stem splitting yielded very little. As *M. micrantha* can grow from fragments, rooting at the nodes (Wirjahardja 1976), I have doubts as to the potential of stem boring species as biocontrol agents against this weed.

To effect control of *M. micrantha*, an agent which atacks the growing stems or a total defoliator would seem to be most suitable. Since *M. micrantha* produces enormous numbers of seeds, a high density of flower feeding insects would probably be necessary as well to achieve significant control.

3. STUDIES ON *LIOTHRIPS MIKANIAE* (THYSANOPTERA : PHLAEOTHRIPIDAE)

3.1. Introduction

In this section the detailed studies on *Liothrips mikaniae*, one of the most promising potential biological control agents, are reported. There is a precedent for using *Liothrips* spp. for the biological control of weeds - *L. urichi* Karny was shipped from Trinidad to Fiji and released to control *Clidemia hirta*. It rapidly became established, spread throughout the islands and effected control of *C. hirta*, at least in open situations (Simmonds 1933). Garcia (1980) has studied an undescribed species from *Baccharis microdonta* as a potential control agent for *B. halimifolia* in Australia. He found that it was specific to *Baccharis* spp. Indeed, when tested in Australia, it would not feed on *B. halimifolia*.

3.2. Taxonomy

Specimens collected from *M. micrantha* in Trinidad, Venezuela, Costa Rica and Colombia have been examined by Dr. J. Palmer of the British Museum (Natural History). She considers that this material, together with specimens from *Vernonia* and *Eupatorium* in Brazil form a species complex or are con-specific. Those collected from *Vernonia* in Brazil are referable to *L. vernoniae* Moulton. In his original description, Moulton (1933) states that the larvae are yellow (although in the key he says they are red), whereas the larvae from *M. micrantha* are red. Garcia (pers. comm.) who is familiar with *L. vernoniae* in Brazil writes that the larvae are in fact red. He also says that the species on *Vernonia* forms leaf galls; that on *M. micrantha* does not. In view of this, and the feeding tests described below, the two are considered distinct species. More recently, Dr. Palmer has examined the type of *Gynaikothrips mikaniae* Priesner and concludes that it is the species under consideration. The type material

was collected from *M. cordifolia* in Surinam (Priesner 1923).

3.3. Life history

The ova are yellow, rounded and elongate measuring 0.42 x 0.18 mm. The surface sculpture consists of raised white ovals arranged in rows. The eggs are laid on the surface of the leaves of the host plant and occasionally on the petiole. Although the leaf undersurface is preferred, the uppersurface is also used. Usually, the ova are laid against a vein or at the base of one of the leaf hairs. They take 12 - 14 days to hatch.

The larvae are bright red with black legs, head, tube and dorsal plates. There are two stages (I and II) which are similar. They feed on the undersurface of the leaf, often in small groups. Feeding causes a characteristic necrotic patch which dries out to leave a brown scar. When feeding occurs on young leaves, extensive distortion of the leaf occurs as it grows. The stage I and stage II larvae each last 4 or 5 days.

The prepupa and two pupal stages are a duller blotchy red with transparent extremities. The only obvious differences between the three stages are the progressive development of the antennae and wings. In the laboratory, the prepupa is formed amongst the larvae on the underside of the leaf. In the field, the mature larva must leave the plant to pupate, since prepupae and pupae were not collected. The prepupal and pupal stages are all mobile, but move little unless disturbed. The prepupal stage lasts a day and the two pupal ones for two or three days each.

The newly emerged adults harden for a day before they start feeding. Mating occurs readily. There is a pre-ovipositing period, normally of about 10 days, but occasionally as short as 5 days and sometimes as long as 14 days or more.

In laboratory cultures there was some indication that a large group of pre-ovipositing adults matures more rapidly than a small one, but this has not been properly investigated. The oviposition rate is low, not exceeding two or three eggs in 24 hours. Oviposition continues for several weeks. The total life cycle takes about 35 days from newly laid egg to egg-laying adult - longer than the 31 days found for *L. urichi* (Cook 1928), but less than that found for the *Liothrips* sp. on *Baccharis* (Garcia 1980).

3.4. Culture technique

Larvae, pupae and adults are conveniently kept in plastic tubs (e.g. 9.5 cm diameter x 3.5 cm deep) on detached leaves of *M. micrantha* which remain in good condition for two or three days when they should be replaced, the thrips being transferred with a paint brush. No extra moisture is needed. About 50 larvae or 30 - 40 adults can be kept on a large leaf in this way. Since thrips are good escape artists, care should be taken to make sure the containers are escape-proof.

As the prepupae and pupae are formed, the leaves on which they form are removed to a separate container and when they dry out a piece of moistened cotton wool is added. Since the eggs take 12-14 days to hatch, the leaves on which they are laid will not remain in good condition and very few larvae will be obtained if eggs are left on them. Therefore it is necessary to remove the eggs individually from the leaf with a blunt dissecting seeker under a low-power binocular microscope (e.g. 6x) and place them on moist filter paper in a petri dish. Losses due to breakage and other causes may be high (10 - 50%), but considerably less than those resulting from leaving the eggs on the leaves. The filter paper should be kept moist and when the eggs hatch the larvae must be transferred as soon as possible to fresh leaves.

3.5. Natural enemies

The following natural enemies have been encountered in Trinidad:-

3.5.1. *Tetrastichus gentilei* Del Guercio (= *T. thripophonus* Waterston) (Eulophidae). This species was originally described by Del Guerico as a prepupal parasite of *L. oleae* (Costa), the olive thrips (Del Guercio 1911). *T. thripophonus* Waterston was described and illustrated from material reared from prepupae of *L. urichi* in Trinidad (Waterston 1923), and placed as a synonym of *T. gentilei* by Domenichini (1965). *Tetrastichus tatei* Dozier from Puerto Rico is another synonym (Burks in Krombein et al. 1979). In addition to these type localities it is recorded from Florida and Fiji and described as cosmopolitan; other recorded hosts include *Gynaikothrips ficorum* (Marchal), *G. uzeli* (Zimmerman), *Hoplothrips pedicularius* (Haliday) and *Liothrips laureli* (Mason); the male is unknown and probably does not exist (Burks loc. cit.). All the host records found which specify the host stage, state that the prepupal stage is affected (Waterston 1923; Burks 1943; Bennett 1965).

In Trinidad, *T. gentilei* attacks the larvae of *L. mikaniae*. The mature larva becomes mummified on the leaf and turn a dirty white colour. The wasp emerges after 10 days or more. Simmonds (1933) records it as a rare parasite of *L. urichi* on *C. hirta*. In contrast, on *L. mikaniae* it can be common and levels of 40% parasitism have been found in the northern range of Trinidad. This species was also reared from *L. mikaniae* collected near Guapiles, Costa Rica. *T. gentilei* is an important natural enemy of pest species of thrips. For example it is one of the main natural controls of the olive thrips *L. oleae* around the Mediterranean (Del Guercio 1931). It has also been used in biological control, being released in Bermuda to control *Gynaikothrips ficorum* Marchal on *Ficus* spp., but establishment did not occur (F.D. Bennett in CIBC annual report 1963).

Although *T. gentilei* is not recorded from S.E. Asia, the wide distribution of this parasite is a major potential barrier to the success of *L. mikaniae* as a biocontrol agent.

3.5.2. *Thripsobromia liothripis* Barbes (Cecidomyiidae) was also described from Trinidad as a natural enemy of *L. urichi*. However, while it is reported as a common predator of *L. urichi* (Simmonds 1933), it has only rarely been encountered feeding on *L. mikaniae*. At the levels so far encountered it can only be considered of minor importance.

3.5.3. *Macrotracheliella laevis* Champion (Anthocoridae). The nymphs and adults of this species feed on the larvae (and if available prepupae and pupae) of *L. mikaniae*. It is recorded as a rare predator of *L. urichi* in Trinidad (Simmonds 1933) and as an occasionally common predator of *G. ficorum* in Brazil (Bennett 1965). It has been found regularly in association with *L. mikaniae* and, although in relatively low numbers, is probably capable of inflicting quite high mortality.

Simmonds (1933) also records a predatory mite *Hyletastes* sp. and a reduviid *Heniartes flavicans* F. as natural enemies of *L. urichi* in Trinidad but these were not encountered.

3.6. Literature on *Liothrips* spp. host range

Liothrips is a very large genus of phytophagous thrips. The available host records strongly suggest a narrow oligophagy or monophagy for individual species, but a very wide range of plant hosts for the genus as a whole. In Appendix 2, details are given of the 70 American species and the 119 host records found for the Old World. Many of these species, particularly those from the Oriential region are gall formers.

A number of plant species of economic importance are amongst the host plants of the genus, including the Sugar Apple, Avocado, Sweet Potato, Currants, Gooseberries, Lilies, Figs, Cinnamon etc. These or related species have been used in the feeding tests described in the next section.

3.7. Host specificity tests

Feeding tests were carried out with adults and stage I larvae.

3.7.1. Tests on adults

In the tests on adults, there were four replicates using 10 adults in each. The thrips were maintained upon *M. micrantha* until total oviposition reached a rate of five ova in 24 hours. They were then confined in an unventilated plastic tub (9.5 cm diameter x 3.5 cm deep) with a young fresh leaf or a piece of foliage of the test plant and a small pad of damped cotton wool. Test foliage was replaced as soon as it started to deteroriate. Mortality, number of thrips on test leaf, ova laid (on test plant and container) and feeding marks were recorded daily. After four days a leaf of *M. micrantha* was added, and observations continued until daily oviposition rate was half the number of adults present. The standard non-acceptance pattern was as follows:-

Day 1	Two or three thrips on leaf; 0,1,2 or 3 ova on leaf, similar or larger number on container; no feeding
Day 2-4	Two or three thrips on leaf; no more ova; no feeding; approximately 50% mortality by end of day 4
Day 5-6 or 7	All survivors on *M. micrantha* leaf; no ova; extensive feeding; no or very low mortality
Day 7 or 8	Oviposition recommences

The following plant species gave a result pattern as above:-

COMPOSITAE	*Ageratum conyzygoides, Synedrella nodiflora, Baccharis trinerva, Melanthera nivea, Vernonia cinerea, Helianthus annuus, Tridax procumbens, Bidens pilosa, Mikania scabra, M. hookeriana, M. vitifolia f. boliviensis, Tagetes sp., Chrysanthemum* sp., *Austroeupatorium inulifolium,Chromolaena odorata*
VERBENACEAE	*Tectona grandis* (teak), *Lantana camara*
EUPHORBIACEAE	*Manihot esculenta* (cassava), *Hevia braziliensis* (para rubber)
LEGUMINOSEAE	*Cajanus cajan* (pigeon pea)
MYRTACEAE	*Psidium guajava* (guava), *Eugenia malaccensis* (pomerac)
RUTACEAE	*Citrus sinensis* (orange)
SOLANACEAE	*Lycopersicon esculentum* (tomato), *Capsicum frutescens* (chilli pepper)
LAURACEAE	*Persea americana* (avocado), *Cinnamomum zeylanicum* (cinnamon)
MELASTOMACEAE	*Clidemia hirta*
CONVOLVULACEAE	*Ipomea* sp.
NYCTAGINACEAE	*Bougainvillea* sp.
MELIACEAE	*Swietenia macrophylla* (mahogany)
STERCULIACEAE	*Theobroma cacao* (cocoa)
RUBIACEAE	*Coffea arabica* (coffee)
ANNONACEAE	*Annona muricata* (soursop)

GRAMINAE *Saccharum officianarum* (sugarcane)

Different patterns of result were found as follows:-

PIPERACEAE *Piper marginatum*: in one replicate a small amount of feeding was seen; in two other replicates oviposition occurred on the second day.

COMPOSITAE *Parthenium hysterophorus*: four replicates gave the following results for the first four days:-

Rep.	No. on leaf	Ova	Lesions	Dead
1	4,3,6,2	2,2,1,0	0,0,1,3	0,0,0,1
2	0,0,9,3	1,3,0,0	0,0,10,2	0,0,0(6 escaped)
3	2,8,4,0	0,0,0,0	0,0,0,0	0,0,0,1
4	1,0,-,1	0,0,0,0	0,0,0,0	1,0,-,7

Thus replicate 4 follows the typical rejection pattern, as does replicate 3 apart from the low mortality. In replicate 1 oviposition continues to the third day and there is slight feeding, while in replicate 2 oviposition continues to the second day and there is moderate feeding on day 3, but most of the thrips escape on day 4.

Mikania cordifolia was not available when this set of tests was run. In a preliminary test, 10 adults which had not been checked for ovipositing fed extensively on *M. cordifolia* for four days, with negligable mortality, but no oviposition. They may have been in the pre-ovipositing phase. In a second test with two replicates of 10 ovipositing adults, a choice of leaves of *M. cordifolia* and *M. micrantha* was offered. Initially, the *M. cordifolia* leaves were older and in poorer condition; the *M. micrantha* however deteriorated more

rapidly and were changed on day 5 of a 7-day run.

Day	Number on *M.c.* ; *M.m.*	Ova on *M.c.* ; *M.m.*	Feeding on *M.c.* ; *M.m.*
1	0/9 ; 0/10	0/7 ; 0/11	-/+ ; -/+
2	2/5 ; 2/8	1/3 ; 0/15	-/+ ; -/+
3	4/1 ; 6/3	0/1 ; 2/8	-/+ ; -/+
4	5/1 ; 2;4	0/2 ; 0/2	-/+ ' +/+
5	4/1 ; 3/0	0/0 ; 1/0	-/+ ; +/+
6	0/6 ; 0/6	0/1 ; 0/1	-/+ ; +/+
7	0/6 ; 0/6	0/0 ; 0/3	-/+ ; +/+

These results show that *M. micrantha* is the preferred host plant, but that when it is in poor condition (days 4 and 5) *M. cordifolia* is acceptable for feeding, although only a small amount of oviposition occurred on it. When fresh *M. micrantha* is available oviposition resumes.

3.7.2. Tests on stage I larvae

Using containers similar to those of the adult tests, two replicates with 20 newly hatched stage I larvae gave the following results:-

	Day	1	2	3	4	5	6	7	8	9
			Number larvae stage I/II on leaf							
COMPOSITAE										
M.micrantha	A	20	18	18	16	-	1/8	dried out		
	B	20	18	18	16	-	3/11	"	"	
M.vitifolia f.*cryptodonta*	A	20	18	19	19	-	5/8	-	1/11	dried out
	B	20	20	20	16/2	-	0/13	-	0/6	" "
M.guaco	A	20	14	9	1	-	1/1	-	0/1	-
	B	20	14	7	1	-	0			
M.hookeriana	A	20	14	10	4	-	1	-	0	
	B	20	13	11	7	-	5	-	3	0
M.scabra	A	20	-	3	-	0				
	B	20	-	0						
A.inulifolium	A	20	5	2	-	1	-	0		
	B	20	8	4	-	0				
C.odorata	A	20	6	5	-	0				
	B	20	4	2	-	1	-	0		
S.nodiflora	A	20	3	5	1	-	0			
	B	20	4	5	0	-	0			
PIPERACEAE										
P.marginatum	A	20	2	5	2	-	0			
	B	20	9	6	1	-	0			

Apart from one individual on *M. guaco*, stage I larvae only reached the second stage on *M. micrantha* and *M. vitifolia* f. *cryptodonta*. This latter species was collected as seedlings from near the Morne Bleu Textel Installation growing near *M. micrantha* which had *Liothrips* sp. on it. No *Liothrips* were found on this *M. vitifolia* f. *cryptodonta*.

In view of the acceptance of *M. vitifolia* f. *cryptodonta* by stage I larvae and the rejection of *M. vitifolia* f.*boliviensis* by adults these forms and their acceptability should be investigated further as should the larval response to *P. hysterophorus* on which there was some adult feeding.

3.8. Discussion

The adult feeding tests have shown a very narrow range of plants suitable for feeding and oviposition. The larval tests, although not as extensive, suggest a slightly wider range of suitable hosts within the genus *Mikania*.

Before actually recommending *L. mikaniae* for release, there are a small number of other Compositae that ought to be tested, including *Stevia redaubundia* (a source of a saccharin substitute under trial in Malaysia) and *Chrysanthemum coronarium*. In view of the results to date there is no reason why this should not be done under quarantine conditions in a S.E. Asian receiving country.

4. STUDIES ON OTHER IMPORTANT NATURAL ENEMIES

4.1. *Acalitus* sp. (Acarina, Eriophyiidae) - Det. H.H. Keifer

This undescribed species appears to be host specific to *M. micrantha*. Feeding by the mites causes the plant to produce erineum patches - a hollow bump on the leaf with tangled transparent filaments in the hollow reminiscent of fungal hyphae. In Venezuela, these patches were noted as protruding mainly on the under surface of the leaf, whereas elsewhere they normally protrude on the upper surface. Material from Venezuela and Trinidad showing the different erineum patches was submitted to Mr. H.H. Keifer who stated that it probably all represented one, undescribed species. Since then, material has been collected from Costa Rica, Colombia, Ecuador and Peru.

The intensity of attack varies from negligible to intense. Erineum patches are often absent or represented by only one or two per leaf. At this level of infestation there is no apparent effect upon the plant. In contrast, on the edge of the Nariva Swamp in Trinidad and near Tingo Maria in Peru very heavy infestations particularly of the young leaves were found. In the former locality the infestation spread into the inflorescence. At this level extensive distortion and discolouring of the leaves, reduction of the internodal intervals of the growing shoots and reduced flowering resulted. Predatory (or scavenger) mites were observed quite commonly amongst the erineum patches.

Eriophiid mites are usually restricted to a single host plant. For example Cruttwell (1977) found two species specific to *C. odorata* and one specific to *A. inulaefolium*. Since erineum patches have been found on no other species of *Mikania* there seems every reason to think that this species is restricted to *M. micrantha*. Confirmatory tests planned for the recent season with potted plants positioned amongst the heavy infestations by the Nariva Swamp were prevented by the high water level in the swamp, caused by the relatively large amounts of rain during the early part of the dry season.

Subject to a small number of confirmatroy tests as planned above, this species is suitable for introduction. Obtaining stocks free of other mites and losses due to the time in shipment may present difficulties for this species.

4.2. *Teleonemia* sp. or spp. *prolixa* (Stal) or near (Heteroptera, Tingidae) - Det. M.S.K. Ghauri

Brown *Mikania* inflorescence feeding tingids have been found in Trinidad, Venezuela, Colombia and Ecuador. They are conspecific or close to *T. prolixa* (Stal). Champion (1897-1907) considered *T. prolixa* to be a variable species and

divided the material in the BM(NH) into three groups:-

1. compared with the type
2. var. a
3. var. b

Dr. Ghauri (pers. comm.) suggests that this may form a composite/complex of more than one species. He states that Trinidad specimens from *M. micrantha* and *M. vitifolia* are nearest to "var. b". Specimens from *M. micrantha* in Colombia are most distinct from any of the others, while material from *M. micrantha* in Venezuela and Ecuador is intermediate between Trinidad and Colombia material. There is a dark form/species found on *M. micrantha* and *M. trinitaria* in Trinidad previously referred to as *Teleonemia* sp. B, but Dr. Ghauri consideres that the dark colour may not prove a good character.

The distribution of *T. prolixa* given in Drake & Ruhoff (1965) extends from Argentina to Mexico and Jamacia, while the host plants recorded are *Cinchona* sp. (Drake & Poor 1938), *Lantana camara* (Monte 1939) and *Acacia riparia* (Drake & Ruhoff 1965). It was this apparently wide host range which caused the tingid to be dismissed as a potential biological control agent early in the project, when Trinidad material was determined as *T. prolixa* (Cock 1979a). The adults and nymphs have been found in the inflorescences of *M. micrantha*, *M. vitifolia*, *M. trinitaria* and *M. hookeriana*. They feed on the developing and mature flowers. Observations on sleeved tingids showed that their frass can be conspicuously mouldy on the flowers hindering or preventing opening, but sucking damage is not obvious.

During the course of the project this *Teleonemia* has not been seen on any plants except *Mikania* spp. *Lantana camara* in particular, has been examined several times. Thus it is possible that a complex of species are involved and this segregate may well be *Mikania* specific. In view of the successful use of

T. scrupulosa (Stal) for the biological control of *L. camara*, this species merits further investigation. However, as Dr. Ghauri points out it will be necessary first to revise the taxonomy of the group if not the genus (of 83 spp.) which would take a considerable effort.

4.3. *Desmogramma* spp. (Col., Chrysomelidae, Chrysomelinae) - Det. M.L. Cox

Three species of *Desmogramma* have been found on *Mikania* spp. during survey trips:- *D. conjugata* Stal, *D. bigaria* Er. and *D. bisbivittata* Stal. Of these *D. bigaria* and *D. bisbivittata* were each found once - the former as two adults and two larvae on *M. micrantha* on the south side of the Venezuelan Andes, and the latter feeding on *M. cordifolia* in Ecuador (nr. Banos). *D. conjugata* has been found more consistantly, albeit rarely, on *M. micrantha* in Central and South America but not Trinidad. It has been found as follows:-

1. Venezuela: six adults on *M. micrantha* growing amongst tall grass in waste space near Valera (Estado Trujillo). Previously reported as *D.* sp. nr. *conjugata*.
2. Colombia: adults and larvae on *M. micrantha* growing beside road in damp shaded coffee estate near Villetta (Cundinamarca).
3. Costa Rica: a single specimen was found on *M. micrantha* growing in the open on a fence by pasture near Sarchi. Reported previously as *Doryphora glaucovittata* Blanch. Two larvae which probably belong to this species were found on *M. micrantha* in a forest clearing near Turrialba, but not successfully reared.

From the material collected in Venezuela, about 25 ova were obtained, glued to leaves or the sides of the container. They were yellow, oval and about 25 mm long. The larvae are typical of Chrysomelinae with a large, shiny grey, bulbous abdomen and the head and thorax brown. They fed readily on leaves of

M. micrantha. Pupation was in the soil, and two F adults were obtained.

The larvae of *D. bigaria* had a redder abdomen. The resultant adults when offered a choice of *M. micrantha, B. pilosa* and *C. odorata* restricted their feeding to *M. micrantha*.

No host records have been found for this group and it is possible that some species are restricted to *Mikania* spp. The fact that the subfamily includes successful biocontrol agents (**Chrysolina** spp. on St. John's Wart *Hypericum*) and pests (the Colorado potato beetle, *Leptinotarsa decimlineata* Stal) suggests that a species specific to *Mikania* spp. would have potential as a biocontrol agent. Unfortunately, the species are rare and not found in Trinidad. It would be necessary to spend some time based on mainland South America in order to carry out the necessary studies. Other potential biocontrol agents available in Trinidad should be studied first.

4.4. *Physimerus* spp.(Col., Chrysomelidae, Halticinae) - Det. M.L. Cox

A complex of species occurring on *Mikania* and *Eupatorium* is involved here. Only one species, *P. pygmaeus* Jacoby, has been identified from Trinidad and that has only been collected from *M. micrantha*. Specimens found feeding on the very young, tender leaves of seedlings of *M. hookeriana* v. *platyphylla* have not yet been determined but are probably this species. Five species were obtained from Venezuela - one from *Eupatorium* (sensu lato) sp., two from *M. micrantha* and two from both *M. micrantha* and *M. cordifolia*. Material from Colombia and Peru collected off *M. micrantha* has been determined as *P. pygmaeus*. None was obtained from Central America, although Blackwelder (1957) records *P. pygmaeus* from Mexico and Panama.

The adults of *P. pygmaeus* feed on the young leaves of *M. micrantha* in Trinidad. Under laboratory conditions they will destroy the growing shoots. This beetle is, however, not common and insufficient numbers could be obtained to undertake adequate feeding tests or to establish breeding colonies in the laboratory. Eggs were obtained once; they are small, yellow and oval and are laid on the under suface of the leaf. Although these ova failed to hatch, the oviposition site initially suggested that the larvae feed openly on the leaves. However, the fact that no larvae have been found make it more likely that this species follows the rest of the subfamily in having root feeding larvae.

The few feeding tests undertaken showed that the adults will feed readily on *M. micrantha,* refuse *C. odorata* and will sometimes feed on *Bidens pilosa* (at the base of the leaves and on the petioles). This is another species which should be investigated further, should the more obvious biocontrol agents not succeed.

4.5. *Omoplata* spp. (Coleoptera, Chrysomelidae, Cassidinae) - Det. T.G. Vazirani and M.L. Cox

Two species of *Omoplata* have been found on *Mikania* spp.: *O. marginata* L. and *O. quadristillata* Boh. Both are probably host specific to *Mikania* spp., but neither is a very promising biocontrol agent.

O. marginata has been found in two forms; one from Trinidad with orange elytra (and also seen in the collection of the University of Maracay, Venezuela), and the other from Peru with translucent pale yellow elytra. It is recorded from French Guyana, Brazil, Bolivia and Paraguay (Blackwelder 1957) without indication of the elytra colour. It has been collected with larvae on *M. micrantha* in Trinidad, and on *M. cordifolia* in Peru.

The eggs are pale brown, long, thin and upright and are laid in small clusters often amongst the inflorescence. The larvae and pupae are typical of Cassidinae. A tachinid pupal parasite, *Hyalomyodes triangulifer* (Loew.) was reared once in Trinidad. *O. marginata* is not a common species, having been found only in two localities in Trinidad during the project.

O. quadristillata is recorded from Costa Rica and Nicaragua by Blackwelder (1957). Adults and larvae of *O. quadristillata* were found quite commonly around Turrialba, Costa Rica on *M. micrantha* and *M. cordifolia*. No preference was shown for either species but *Mikania* sp. (?*vitifolia*) was refused. Offered a choice of *M. micrantha*, *M. cordifolia*, *Bidens* sp. and *Sonchus* sp.(all Compositae) the adults frequented and fed on the *Mikania* spp. only. No oviposition took place in captivity. Three specimens of the solitary pupal parasite *Brachymeria russelli* (Chalcididae) were reared. A single tachinid puparium was obtained from one larva, but it failed to emerge.

Neither of these species seem particularly promising biocontrol agents, but merit further consideration if the more obvious species prove unsuitable or unsuccessful.

4.6. *Apion luteirostre* Gerst. (Col., Apionidae) - Det. D. Kissinger and M.L. Cox

This is a species whose larvae develop within the flowers of *M. micrantha* and is considered potentially useful as a biocontrol agent. Cruttwell (1972, 1973) studied *Apion brunneonigrum* B.B. in Trinidad as a potential control agent for *C. odorata*. She found this species restricted to *C. odorata* and *C. ivaefolium* and recommended it for introduction to Asia and Africa to control *C. odorata*. In all her collections from *Eupatorium* (s.l.)and other weeds, she did not obtain *A. luteirostre*.

Blackwelder (1957) records *A. luteirostre* from Guatemala and gives *acarinum* Sharp from Venezuela and *argentinum* B.B. from Argentina as synonyms. On the survey trips I have obtained it as follows;-

Trinidad: common and widespread, reared from flowers of *M. micrantha* and *M. vitifolia* only

Venezuela: one specimen from flowers of *M. micrantha* near Caja Seca, north of Los Andes in Estada Merida

Colombia: one specimen from flowers of *M. micrantha* from Cauca Valley

Peru: one specimen on vegetative *M. micrantha* from near Tingo Maria

There are no host records for this species. Other species of the very large genus *Apion* are associated with a wide variety of plants. They usually restrict their larval host plant to one or a few closely related species, although the adults will feed on a wider range of related plants and, in a few species, on unrelated plants. Thus, some of the legume feeders in temperate climates will, in spring, be found on a variety of trees - perhaps reflecting a shortage of their normal hosts due to the early season.

The life history is as follows. The egg is laid in the unopened capitula. To do this, the female weevil bites a hole through the bracts and the egg is then laid in the open area above the developing florets, often glued to the inner surface of the bracts. The larva initially feeds among the petals, stigma and stamen and moves down to feed on one or more of the developing achenes or seeds. The amount of damage varies, but it is likely to prevent the production of any seed from the attacked capitula. The pupa is formed within the capitula - sometimes within a single achene and sometimes in the area eaten out from several achenes. The newly emerged adult is lighter in colour than mature specimens and the ovaries of the female are undeveloped. When mature, the weevil is dark with brown legs.

The inter-relationship of *M. micrantha* and *M. vitifolia* in the adult development has not been examined. There may be two main generations a year, using *M. vitifolia* (whose main flowering time is September) and *M. micrantha* (main flowering time January - March) alternately. Alternatively, single generation biological races may be developing, using principally only one species. Since the flowering seasons are not very clear-cut and are somewhat variable, I suspect that there may well be more than one generation per year and if flowers are available the females will feed on these and mature their ovaries at any time of year.

Two parasites, the eulophid *Horismenus ?aeneicollis* and the pteromalid *Zatropis* sp. have been reared from larvae of *A. luteirostre* in Trinidad. *H. ?aeneicollis* is a general parasite, having been reared from pupae of the tephritid *Xanthaciura insecta* in *M. micrantha* flowers and from the larva of the hispid *Sceloenopla* sp. in its mine in *M. trinitaria* leaves.

To establish the normal host range of *A. luteirostre* in Trinidad flowers from a variety of Compositae were collected and held in emergence boxes to obtain adults of the insects feeding within them. The species collected and held in this way are:-

Mikania micrantha	-	many collections
M. vitifolia f. *boliviensis*	-	" "
M. vitifolia f. *cryptodonta*	-	once
M. trinitaria	-	many collections
M. guaco	-	once
M. hookeriana	-	"
M. scabra	-	"
Chromolaena odorata	-	several collections

Austroeupatorium inulaefolium	-	several collections
Ageratum conyzygoides	-	once
Vernonia cinerea	-	several
V. scorpioides	-	twice
Neurolaena lobata	-	several collections
Bidens *pilosa*	-	" "
Parthenium hysterophorus	-	" "
Pluchea odorata	-	once
Baccharis trinerva	-	"
Helianthus annuus	-	several collections
Melanthera nivea	-	" "
Emilia sonchifolium	-	once
E. coccinea	-	"
Wedelia trilobata	-	several collections
Synedrella nodiflora	-	" "

Only *M. micrantha* and *M. vitifolia* produced *A. luteirostre*. On the survey trips no specimens were obtained from *M. cordifolia*, although flowers of that species were held for emergence several times. Thus the data from these collections show a narrow oligophagy in this species.

A limited number of feeding tests were undertaken with newly emerged adult *A. luteirostre*. These were not completed due to a scarcity of flowering material (from which to obtain weevils) during the recent dry season. Tests were done using plastic tubs 9.5 cm diameter x 3.5 cm deep. A sprig of young leaves of the test plant was kept fresh by putting the stem into a small vial of water and blocking the neck with cotton wool. Ten weevils were used in each test and four replicates lasting 48 hours each were made for each test species:-

M. micrantha	-	many puncture holes in all replicates
M. vitifolia	-	-do-
M. hookeriana	-	many puncture holes in only replicate done
M. ?cordifolia	-	-do-
M. scabra	-	many puncture holes in one replicate out of four
B. pilosa	-	many puncture holes in one replicate, a few in second and none in third
C. odorata	-	no feeding in any replicates

Obviously, these adult feeding tests need to be extended, but are sufficiently promising to merit further work. In conclusion, the larval host plant appears to be narrowly restricted within the genus *Mikania* while the adults will feed on a wider range of hosts. Whether the adult potential host range will prove too wide to be acceptable, has yet to be established.

4.7. *Pseudoderelomus baridiiformis* Champ. (Col., Curculionidae) - Det. C.O'Brian and M.L. Cox

This species was very common in the flowers of *M. micrantha* in the dry season of 1979, but was less frequent during the 1980 and 1981 dry seasons. It has been collected in Trinidad, Tobago, Venezuela, Colombia and Ecuador. Champion (1910) recorded it from Mexico, Belize and Guatemala when describing the species, and this information is repeated by Blackwelder (1957). No published host records have been found although the adults of three species of *Derelomus* (which belongs to the same tribe, Derelomini of the Erirhininae) are recorded attacking the flowers of the palms in Brazil (Silva et al., 1968). Specimens of a similar species determined as genus near *Pseudoderelomus* were obtained from flowers of a *Mikania* sp. indet. near Villetta, Colombia.

The adults of *P. baridiiformis* have been obtained mainly from the flowers of *M. micrantha* , but also from *M. trinitaria* and *M. vitifolia,* twice from *Chromolaena odorata* and once from *Neurolaena lobata*.

The adult burrows into the flowers until only the tip of the elytra shows or it is completely out of sight. It then feeds on the petals, stamen and stigma and prevents seed production from that capitula. This type of damage can be common and occasionally reaches levels of 25%.

The life history has not been elucidated yet. It was thought that the larvae fed in the flowers, but I have been unable to rear anything except *Apion luteirostre* from the curculionid larvae found in the flowers. Attempts to breed *P. baridiiformis* by confining it on flowers of growing plants using cloth bags were unsuccessful. Investigations should continue with this species.

5. ANNOTATED LIST OF PHYTOPHAGOUS INSECTS FOUND ON *MIKANIA* SPP.

THYSANOPTERA

PHLAEOTHRIPIDAE (Det. J. Palmer)

Liothrips mikaniae Priesner - see section 3.

HEMIPTERA - HOMOPTERA

ALEYRODIDAE (Det. D.J. Williams)

Aleurotrachelus trachoides Back was found on *M. micrantha* in Venezuela and Costa Rica.

Aleurotrachelus sp. was found on *M. micrantha* and a different species on *M. hookeriana* in Trinidad.

APHIDIDAE (Det. J.H. Martin)

Aphis citricola gp. occurs in the inflorescences of *M. micrantha* in Trinidad and was found in the same situation on *M. micrantha, M. cordifolia* and *M.* sp. in Colombia.

Aulacorthum solani (Kltb.) was also collected from the inflorescence of *M. micrantha* in Colombia.

Uroleucon ambrosiae gp. collected from *M. cordifolia* and *Eupatorium* sp. in Colombia.

MEMBRACIDAE (Det. M.S.K. Ghauri)

Bolbonota pictipennis Fairm has been found with its nymphs on *M. micrantha* in Venezuela and once (unconfirmed) in Peru. I have not found it in Trinidad on *M. micrantha* although Cruttwell found it on *C. odorata*. I have found this (or a close species) on *Piper hispidum* in Trinidad.

Cyphona sp. indet. occurs on a wide variety of plants including *Mikania micrantha* in Trinidad.

C. trifida (Fabr.) occasionally on *M. micrantha* in Trinidad.

Echenopa sp. occurred on *C. odorata* with nymphs and on *M. micrantha* in Colombia. (*E. concolor* Fairm was found on *Eupatorium* sp. in Venezuela).

E. ferruginea Wlk. was found with nymphs on *M. cordifolia* in Colombia.

Enchophyllum dubium Fowler was found on *M. cordifolia*, and by Cruttwell on *C. odorata*, in Costa Rica.

Entylia sp. from *M. micrantha, M. cordifolia* and *Clibadium* sp. in Venezuela is very close to *E. sinuata*, if not conspecific. Cruttwell collected an *Entylia* sp. from *C. odorata* in Trinidad which is also very close to *E. sinuata*. I found an *Entylia* (apparently different to the other Venezuelan specis above) on *Eupatorium* sp. in Venezuela.

Gen. et sp. indet. occurred quite commonly together with its nymphs on *Mikania micrantha* in the Northern Range of Trinidad. Also collected by Cruttwell on *C. odorata* in Trinidad.

Micrutalis binaria Fairm. is found associated with *M. micrantha* regularly, and recorded from *M. trinitaria* and *M. vitifolia* in Trinidad. It is part of the regular association of insects on *M. micrantha* on the hills around the Cauca Valley, Colombia.

Itoplophorion hebes (Walk) once on *M. micrantha* in Colombia.

?Polyrhyssa sp.with nymphs on *M. micrantha* in Colombia.

Spongophorus amyoti Met. & Wd.was collected once on *M. cordifolia* in Costa Rica.

S. guerini Fairm.was collected on *M. micrantha* once in Trinidad and once in Colombia. Cruttwell obtained several specimens on *C. odorata* in Trinidad.

Stictolobus rubra(Linn.) on one occasion on *M. micrantha* in Trinidad. Also once on *C. odorata* by Cruttwell.

Trichaetipyga infantilis Ball with nymphs on *M. micrantha* in Colombia.

The remaining families of Homoptera are not considered to be more than casual or polyphagous and are listed below for completeness.

CERCOPIDAE (Det. M.S.K. Ghauri)

Mahanarva sp.	*M. micrantha*	Colombia,Trinidad
Sphenorhina rubra (Ginn.)	"	Costa Rica

CICADELLIDAE (Det. M.S.K. Ghauri)

Agallia sp.	*M. micrantha*	Venezuela
" "	*M. cordifolia*	Costa Rica
" "	*M. micrantha*	Colombia
Agrosoma cruciata (Signoret)	*M. cordifolia*	Costa Rica

A. placetis Medler	*M. cordifolia*	Costa Rica
Allogonia induta (Fowler)	*M. micrantha*	" "
Baleja flavoguttata (Latreille)	"	" "
Caldwelliola caucana Young	"	Colombia
Chlorogonalia coeruleovittata (Sign)	"	Venezuela, Costa Rica
Chlorotettix sp. *?curvidens* Osborn	"	Costa Rica
Draculocephala soluta Gibson	"	Colombia
D. sp.	"	"
Erythrogonia areolata Signoret	"	Costa Rica
Gypona sp.	"	Trinidad
Haldorus sp. *?furcatus* Caldwell	"	Costa Rica
Hortensia similis (Walk)	"	Colombia
Macunolla ventralis (Signoret)	"	Costa Rica, Colombia
Microgoniella tristicula (Melichar)	"	Colombia
M. sp.	*M. cordifolia*	"
Oncometopia nigricans	"	Costa Rica
Pleisiommata sp.	*M. micrantha*	Colombia
Pseudometopia latifascia Walk.	"	Trinidad
Siboria festana Young	"	Venezuela
Sibovia sp.	"	Costa Rica
Stehlikiana novemnotata (Leth.)	*M. cordifolia*	Venezuela
Strangallia sp.	*M. micrantha*	Colombia
Xerophloea viridis (Fabr.)	"	Venezuela
X. sp.	*M. cordifolia*	Colombia
CIXIIDAE (Det. M.S.K. Ghauri)		
Pintalia sp.	*M. micrantha*	Venezuela

CLASTOPTERIDAE (Det. M.S.K. Ghauri)		
Clastoptera sp.	*M. micrantha*	Colombia
COCCIDAE (Det. M.S.K. Ghauri)		
Parasaissetia nigra (Nietn.)	"	Venezuela
DELPHACIDAE (Det. M.S.K. Ghauri)		
Caenodelphax tepae (Fowler)	"	Costa Rica
DERBIDAE (Det. M.S.K. Ghauri)		
?Anotia sp.	"	Venezuela
FLATIDAE (Det. M.S.K. Ghauri)		
Flatorminis sp.	"	"
PSEUDOCOCCIDAE (Det. D.J. Williams)		
Phenacoccus grenadensis Gr. & Lg.	"	"
Planococcus gp.	"	Colombia
Puto barberi (Ckll)	"	"
Puto sp.	"	Venezuela

HETEROPTERA

PENTATOMIDAE

Sphaerocoris obliquus Germ occurred on the inflorescences of *M. micrantha* in Trinidad. Collected once on *C. odorata* by Cruttwell.

Symphylus ramivitta Walk. was found on the flowers of *M. micrantha* and *M. trinitaria* in Trinidad and on flowers of *M. micrantha* in Colombia. It is commoner than *Sphaerocoris obliquus* on *Mikania* flowers.

The following were also recorded from *Mikania* spp. but are not considered to be in a regular association with any of the genus:-

Edessa sp.	*M. micrantha*	Trinidad
Euschistus crenator (Fabr.)	*M. micrantha* *Desmodium*	Venezuela Colombia
E. sperculus Stal	*M. micrantha*	Trinidad
Proxys sp.	"	Venezuela
P. victor	"	Trinidad

LYGAEIDAE

Neacoryphus circumseptus (Stal) fed upon *M. cordifolia* in Venezuela.

Ochrostomus poeyi (Guerin) was found on the inflorescence of *M. cordifolia* in Colombia and (?) on *M. trinitaria* in Trinidad.

Ochrostomus sp. was found on *M. micrantha* in Colombia and(possibly a species) in Trinidad.

Xyonysius sp. nr. *ementitus* (Dist.) was found on *M. micrantha* flowers in Venezuela. This species may also be present in Trinidad, but determinations are not yet available.

Xynonysius inaequalis (Ulher) was not uncommon on flowers of *M. micrantha* in Trinidad.

The following are probably casual specimens:-

Oncopeltus varicolor (Fabr.)	*M. micrantha*	Trinidad
Pachybrachius sp.	"	"

TINGIDAE

Leptocysta sexnebulosa (Stal) was found with nymphs on *M. micrantha* in Venezuela on *M. micrantha* and *M. cordifolia* in Colombia and (unconfirmed) on *M. cordifolia* in Peru.

Teleonemia sp. or spp. *prolixa* Stal or near - see Section 4.2.

The following single specimens are most probably casual:-

Corythuca fuscomaculata	*M. micrantha*	Colombia
Gargaphia nigrinervis Stal	*M. cordifolia*	"
Leptobrysa decora Drake	*M. micrantha*	"
Vatiga illudens (Drake)	"	Trinidad

MIRIDAE

Horcias signatus Dist. was part of the regular association on leaves of *M. micrantha* around the Cauca Valley, Colombia.

Pycnoderes incurvus (Dist.) occurs with its nymphs on the under side of leaves of *M. micrantha* in Trinidad. *Pycnoderes* sp.(?p) was found in similar situations in Costa Rica, Colombia and Ecuador. Extensive puncture damage was observed associated with this species in Ecuador. It was similar but not as extensive as some damage seen in Colombia with no associated causative agents.

Rhinacloa subpallicornis Knight and 'gen. et sp. indet.' from *M. micrantha* inflorescence in Trinidad.

The following are most probably casual:-

Collaria oleosa(Dist.)	*M. micrantha*	Venezuela
Dagbertus olivaceus (Reut.)	" flowers	Colombia
Eccritotarsus nigrocruciatus Stal	"	"
Garganus gracilentus (Stal.)	"	Venezuela
Halticus	*M. cordifolia*	Colombia
Horcias plagosus	*M. micrantha*	"

The remaining Heteroptera recorded are also probably casual:-

CYDNIDAE		
Acrotmetus schulzii (Fabr.)	*M. micrantha*	Trinidad
Microcompsus daldorfii (Fabr.)	"	"
Nothocoris sp. *?marginicollis* Horv.	"	"
COREIDAE		
Hyalymenus sp.	*M. micrantha*	Colombia
Stenocoris sp. *?americana* Ah.	"	Venezuela
Vilga sp. nr. *acanthion* Dall	"	Trinidad
LARGIDAE		
Acinocoris sp. *?calidus* (Fabr.)	*M. micrantha*	Trinidad
Largus sp.	"	Venezuela
Stenomacra marginella (H.S.)	"	Colombia
PYRRHOCORIDAE		
Dysdercus collaris Blote	*M. cordifolia*	Colombia

DIPTERA

CECIDOMYIIDAE (Det. K.M. Harris and R.J. Le Gagné)

Alycaulus sp. (spp?) *?mikaniae* Rubsaamen. These are gall formers of the stem, petiole, leaf base and veins of *M. micrantha*. The number of species has yet to be elucidated. The species galling the leaf veins is most probably *A. mikaniae*. Specimens have been obtained from petiole galls in Costa Rica and Peru, while all gall types are found in Trinidad. Parasitism of these gall forming cecidomyiids is generally high and parasites include *Torymus* sp. (Torymidae), *Tetrastichus* sp. not in BMNH (Eulophidae), *Synopeas* sp. (Platygastridae),

Aphanogmus (Ceraphronidae), *Eurytoma* sp. (Eurytomidae) all from Trinidad.

Dasineura sp (?spp.) were reared from *M. micrantha* and *M. cordifolia* flowers in Colombia.

Lestodiplosis sp. is a species with predatory larvae, occasionally found in flowers of *Mikania* spp. in Trinidad.

Neosalioptera sp. has been reared in large numbers from flowers of *M. micrantha* and *M. vitifolia* in Trinidad. The larvae are yellow and the puparia transparent and elongate, becoming red as they develop. This and/or another species of the genus were reared from flowers of *M. micrantha* and *M. cordifolia* in Colombia. In both localities they are quite heavily parasitized by a sexually dimorphic *Tetrastichus* sp. Although almost certainly *Mikania* specific, the individual larvae do very little damage, normally feeding between the achenes and scarring the surface only. Seed viability tests would be needed to demonstrate whether this was of any significance.

TEPHRITIDAE (Det. R.H. Foote)

Urophora sp. nr. *aerea* Hering has been reared from *M. micrantha* and *M. trinitaria* in Trinidad, but it is not very common.

Xanthaciura insecta Loew. The larvae of this species develop within a variety of composit flowers in Trinidad. They are white with yellow-orange fat bodies; the puparia is translucent white with black spiracles. Recorded hosts include *M. micrantha, M. vitifolia, Aspilia verbesinoides, Neurolaena lobata* and by Cruttwell from *C. odorata* and *Ageratum conyzygoides*. The eulophid *Horismenus* sp. *?aeneicollis* has been reared from this species several times, as a pupal parasite.

AGROMYZIDAE (Det. K.A. Spencer and K.M. Harris)

Calcomyza mikaniae Spencer forms an upper leaf surface linear, becoming

blotch, mine on *M. micrantha* and *C. odorata*. The mines are seldom common and heavily parasitized by *Opius* spp. (2) (Braconidae) in Costa Rica, ?*Alophomyia* sp. (Eulophidae) in Trinidad, *Moneucoilia* sp. (Eucoilidae) in Colombia and *Tropideucoila* sp. (Eucoilidae) in Trinidad. *C. mikaniae* has been found in Trinidad, Costa Rica (?) and Colombia (?).

LAUXANIIDAE (Det. R.M. Miller)

Physoclypeus sp. and *Sapromyza sororia* Walliston. are probably saprophagous secondary invaders of rotting tissue in the flowers of *M. micrantha*. They have both been reared in Trinidad.

MILICHIIDAE (Det. K.M. Harris)

Prob. *Desmometopa m-nigrum* Zetterstedt. is also considered to be saprophagous in decaying flowers of *M. micrantha* in Trinidad.

LEPIDOPTERA

ACRAEIDAE (Det. M.J.W. Cock)

Actinote pellenia Hubner normally feeds on *A. inulaefolium* which it regularly defoliates. Occasionally it is found on *M. micrantha* feeding on the inflorescences. In view of the devastation this species can cause to *A. inulaefolium* , a strain adapted to *M. micrantha* would have potential as a biocontrol agent.

Actinote anteas Doubleday has only been found on *M. vitifolia* f. *boliviensis* in Trinidad. The Central American form however, feeds on *C. odorata*.

ARCTIIDAE (Det. J.D. Holloway)

Dysschema tricolor Sulzer was reared from a group of orange and black, hairy larvae found feeding on *M. micrantha* near Valera, Venezuela. Similar larvae

collected in Ecuador were not successfully reared. The species known as *D. tricolor* in Trinidad has somewhat different markings and has not been found on *M. micrantha*. This species is recorded from *Vernonia* in Brazil and probably feeds on a variety of low plants.

COCHYLIDAE (Det. J.D. Bradley)

Phalonidia multistrigata Wals. is a species with flower feeding larvae reared only in Trinidad. It has been reared from *M. micrantha, M. trinitaria, M.* sp., *M. vitifolia* f. *boliviensis, Neurolaena lobata* and by Cruttwell from *C. odorata*. Probably, it feeds on a wide selection of Compositae.

GELECHIIDAE (Det. J.D. Bradley)

Onebala tegulella Wals. has a black and white leaf rolling larva. It has been reared from *M. micrantha* in Trinidad and Costa Rica. The larvae of this or a similar species has been found on *M. vitifolia* f. *bolivensis* in Trinidad but not successfully reared.

Recurvaria sp. is another common species whose larvae feed on Compositae flowers. In Trinidad it has been reared from *M. micrantha, M. vitifolia* f. *boliviensis, M. trinitaria, Aspilia verbesinoides, Neurolaena lobata* and by Cruttwell from *C. odorata* and *E. iresinoides*.

GEOMETRIDAE (Det. J.D. Bradley and J.D. Holloway)

Chloropteryx languescens Warr. or *glauciptera* Hamps. - these names may be synonyms. The larvae feed on the flowers of *M. micrantha, M. vitifolia, C. odorata* and probably other Compositae. Only reared in Trinidad.

Eupithecia spp. These species also feed as larvae on the flowers. Species 'A' is smaller with a series of linear markings and a cell spot - it has been reared from *M. micrantha, M. vitifolia, M. trinitaria* and by Cruttwell

from *C. odorata*. Species 'B' is larger with a white tornal spot on the forewing and a faint line of white spots before termen. It has only been reared from *M. vitifolia* (and perhaps from *C. odorata* by Cruttwell). Both have only been reared in Trinidad. A braconid *Rogas* sp. was reared from an undetermined *Eupithecia* larva on *M. vitifolia* in Trinidad.

GRACILLARIIDAE (Det. J.D. Bradley)

Phyllonoryctor sp. was reared once from a leaf mine of *M. cordifolia* in Colombia and once from a leaf mine of *M. scabra* in Trinidad.

Acrocerops sp. was reared once from a blotch leaf mine of *M. scabra* in Trinidad.

LYCAENIDAE (Det. J.D. Holloway)

Thecla myrtillus Cr. (*Rekoa palegon* auct) feeds as a larva on a variety of composit flowers. It has been reared from *M. vitifolia* f. *boliviensis*, *M. micrantha*, *Vernonia cinerea*, *C. odorata* and by Cruttwell from *C. odorata* and *E. iresinoides*.

LYONETIIDAE (Det. J.D. Bradley)

?Buccalatrix sp. Two species were reared from blotch leaf mines of *M. cordifolia* in Colombia.

Note - Lepidopterous leaf mines of Gracillariidae and Lyonetiidae are uncommon on *Mikania* spp. and always heavily parasitized.

NOCTUIDAE (Det. J.D. Bradley)

Perigea cupentia Cr. and *Platysenta sutor* Gn. These two polyphagous species have been reared from larvae found on *M. micrantha* in Trinidad.

NYMPHALIDAE (Det. J.D. Holloway)

Tegosa similis Higgins (=*Phyciodes liriope* Auct.). Higgins has revised this group, and this revision with the new names *Tegosa* and *similis* is published in 1981 as a BM(NH) publication. This species has been reared from gregarious larvae found on *M. micrantha* in Trinidad and Colombia. While it is quite likely that this species is specific to *Mikania* spp. it is not considered a very promising potential biological control agent.

PTEROPHORIDAE (Det. J.D. Bradley)

Adaina bipunctata Moschl is another species whose larvae feed on the inflorescence of various Compositae. In Trinidad it has been reared from *M. micrantha* and by Cruttwell from *C. odorata* and *E. iresinoides*.

PYRALIDAE (Det. J.D. Bradley)

Lamprosema distincta Kaye has been reared from leaf rolling larvae on *M. micrantha* in Trinidad, Costa Rica and Panama. An undetermined agathid parasite was obtained from pre-pupa in Trinidad.

Pycnarmon levinia Cr. has larvae which feed between leaves of *M. micrantha* and has been reared from material collected in Panama and Colombia. Although this species occurs in Trinidad, it has not been reared from *M. micrantha*.

Epipagis mopsalis Walk. was reared once from a leaf rolling larva on *M. micrantha* in Trinidad. It is an uncommon species at light.

Piesmopoda flavicans Zeller was also reared once from a collection of *M. trinitaria* flowers in Trinidad. It too is uncommon at light.

RIODINIDAE (Det. J.D. Holloway)

Calephelis sp. prob. *iris* Stdgr. has been reared from larvae collected on

M. micrantha and once on *M. vitifolia* f. *boliviensis* in shady situations in Trinidad. The adults are not rare in such situations, and have often been seen where no *Mikania* occurs, suggesting that other hosts may be used.

Calephelis sp. ?*laverna* G&S. This species is close to the previous one in all stages. It has been reared from larvae on *M. micrantha* in Colombia and Trinidad. Parasitized larvae collected near Valera, Venezuela are probably of this species. The parasites were *Apanteles* sp. *glomeratus* group (Braconidae) and had a ceraphronid hyperparasite *Aphenogmus fijiensis* (Ferriere). In Trinidad this species is more commonly associated with *C. odorata*, and the larvae are to be found on plants growing in sunny situations.

Emesis nilus Feld was reared from larvae collected on *M. micrantha* near Turrialba, Costa Rica. A braconid pupal parasite *Rogas* sp. was also obtained.

TORTRICIDAE (Det. J.D. Bradley)

Argyrotaenia sp. ?*phaleropa* Meyr. and *Amorbia* sp. ?*decerptana* Zell. were both reared once from leaf rolling larvae found on *M. micrantha* in Colombia.

Polychrosis ?*carduana* Busck has been reared only in Trinidad from flowers of *M. micrantha* and *M. vitifolia* f. *boliviensis*.

XYLORYCTIDAE (Det. J.D. Bradley)

Catareta sp. was reared once from a stem boring larva collected in Venezuela.

COLEOPTERA

NITIDULIDAE (Det. R. Madge)

Camptodes communis Er. has been found in flowers of *M. vitifolia* in Trinidad.

Conotelus sp. and *Cryptarcha* sp. nr *atomaria* Sharp are sometimes common on the flowers of *M. micrantha* in Trinidad.

CERAMBYCIDAE (Det. M.L. Cox)

Adetus consors Bat. was found once feeding upon a stem of *M. micrantha* in Venezuela.

CHRYSOMELIDAE (Det. M.L. Cox and T.G. Vazirani)

CRIOCERINAE

The following are probably casual or polyphagous:-

Lema dorsalis Ol.	*M. micrantha*	Colombia, ?Trinidad
L. plumbea Chev.	"	Colombia, Costa Rica, ?Trinidad
L. maculifrons Clark	?"	Costa Rica
Lema sp.	*M. vitifolia*	Colombia

MEGALOPODINAE

Megascelis aerea Lac. on *M. vitifolia* in Colombia is probably a casual record.

CRYPTOCEPHALINAE

Most of the species recorded were found feeding in the flowers of *Mikania* spp. With the possible exception of *Pachybrachys reticulata* (Fab.) on *M. micrantha* in Venezuela, none are considered to be truly associated with *Mikania* spp.

Griburius batesi Kirsch	*M. micrantha*	Peru
Lexiphanes sordidulus (Suffr.)	*M. cordifolia* flowers	Colombia
L. jacobyi (Clav.)	*M. micrantha*	Colombia
Monachulus sp.	" flowers	Ecuador
M. juvencus (Ol.)	" "	Trinidad
Monachus spp. (3)	" "	Venezuela

CHLAMISINAE

Exema complicata Jacoby occurred regularly on *M. micrantha* in Trinidad (larvae also found), Costa Rica, Colombia and Peru. Cruttwell found and reared this species on *C. odorata* in Trinidad.

Chlamisus sp. nr. *globicollis* (Lac) and *C.* sp. nr. *inconspicua* (Jacoby) were recorded once from *M. micrantha* in Peru and *M. scabra* in Trinidad respectively.

EUMOLPINAE

Most of the following are casual flower feeders, as adults. None are considered to be truly associated with *Mikania* spp.

Agbalus sp.	*M. micrantha*	Venezuela
Colaspis flavicornis (F.)	"	Trinidad
C. inconstans (Lefer.)	"	Trinidad, Colombia, Costa Rica (generally common on many plants)
C. lebasi Lef.	"	Colombia
Glyptoscelis aeneipennis Baly	"	Trinidad
Myochrous bryanti Blake	"	"
Nodonota spp.	"	Peru, Venezuela, Costa Rica
N. atra	"	Colombia
N. exilis (Er.)	"	Trinidad
N. irazuensis (Jac.)	"	Costa Rica
N. lefevrei (Jacoby)	"	Trinidad, Costa Rica, Colombia
	Pteridium	
Sphaeropsis championi Lef.	*M. micrantha*	Trinidad
S. humeralis Lef.	" ,*M.* sp.	Colombia
Typophorus nigritus (F.)	"	Trinidad, Venezuela (generally common on many plants)

CHRYSOMELINAE

Desmogramma spp. See section 4.3.

Doryphora spectabilis Baly was found once on *M. cordifolia* in Costa Rica and was probably casual.

GALLERUCINAE

The following are considered to be casually associated with *Mikania* spp.

Coelomera cajennensis (F.)	*M. micrantha*	Peru
Diabrotica sp.	"	Venezuela
	legume vine	
?D. sp.	*M. micrantha*	Trinidad
D. elegantula Baly	"	Colombia
D. quadrivittata (Latr.)	"	Costa Rica
Gynandrobrotica bella Baly	"	Colombia
G. gestroi (Baly)	"	Peru
Metrobrotica geometrica (Er.)	"	"
Synbrotica delicula (Er.)	"	"

HALTICINAE

Hermaeophaga sp. nr. *nitidicollis* Jac. collected off leaves of *M. micrantha* in Colombia and Ecuador.

Longitarsus sp. nr. *amazonus* Baly was part of the regular association of species on *M. micrantha* around the Cauca Valley, Colombia. Also found in Peru.

L. sp. nr. *trapensis* Jacoby was found on *M. micrantha* and *C. odorata* in Maracas Valley, Trinidad. Cruttwell (1972) discusses this species.

Oedionychus trinidadensis Bowd was found feeding extensively on *M. micrantha* in the Nariva Swamp, Trinidad.

Physimerus pygmaeus Jacoby and other *Physimerus* spp. - See section 4.4.

The remaining Halticinae determined are not reliably associated with *M. micrantha*:-

Aphthona sp. nr *diversa* Baly	*M. micrantha*	Venezuela
Asphaera sp. nr. *limitata* Harold	"	Peru
A. nigrofasciata Jac.	"	Costa Rica
A. nobilatata (F.)	"	" ,Panama
	M. vitifolia	Trinidad
A. subfasciata Clark	*M. micrantha*	"
A. transversofasciata Jac.	"	Costa Rica(several found on *M. micrantha* but would not feed in captivity)
Chaetocnema sp.	"	Colombia
C. horni Jac.	"	Costa Rica
Crepidodera sp.	" flowers	Colombia
Epitrix spp. (4)	"	Costa Rica, Peru, Venezuela
Homophoeta acquinoctalia L.	"	Colombia
Longitarsus chontalensis Jac.	"	Costa Rica
Longitarsus sp.	"	Venezuela
Nephrica fulvicomis Jacoby	" and non-composit vine	Peru
Oedionychus decemguttatus (F.)	*M. micrantha*	Ecuador
O. inseptus Harold	"	Peru
Paleaothona sp.	"	Venezuela
Rhinotmetus sp.	"	Peru
Systena clarki Jacoby	"	Costa Rica
S. dilatipennis Jac	"	Venezuela
S. s-litara	"	Costa Rica, Peru
Varicoxa ustulata (Har.)	"	Costa Rica

HISPINAE

Oxychalepus anchora (Chap.) found on *M. micrantha* in Colombia and Venezuela almost certainly strayed from adjacent legume vines.

Pentispa sp. found on *M. micrantha* in Venezuela.

P. explanata (Chap.) was collected once on *M. micrantha*. Cruttwell found this species regularaly on *C. odorata* in Trinidad.

Sceloenopla sp. is a leaf miner of *M. micrantha* and *M. trinitaria* only found in Trinidad. It is probably specific to *Mikania* spp. The adults feed on the leaves leaving typical hispid leaf scars. A larval parasite *Horismenus ?aeneicollis* (Eulophidae) has been obtained. Since it is generally a scarce species, no work has been done on it. At large densities it would have potential as a biocontrol agent but can only be considered a long shot.

CASSIDINAE

Omoplata marginata L. and *O. quadristillata* Boh. - See section 4.5.

Pseudomesophalia flavofenestrata Boh. was found on *M. cordifolia* in Venezuela.

P. blanda / Cyrtonota coalita (Boh.) was found in *M. cordifolia* in Ecuador.

P. spp. (6) have been found on *M. micrantha* and *M. cordifolia* in Trinidad and Venezuela. Some of these are probably correctly associated with *Mikania* sp.

Agroiconota (=Metriona) judaica (F.) has been found on *M. micrantha* in Trinidad and Peru. This species may be associated with *Ipomea* spp.

Ctenochira cumulata Boh.	*M. micrantha*	Costa Rica
Cyphomorpha sp. nr. *cavata* (Boh.)	"	Venezuela
Metriona sp.	"	Colombia
Metriona erratica (Boh.)	*M. cordifolia*	"
M. propinqua (Boh.)	*M. micrantha, Ipomea* sp.	Costa Rica

Polychalma multicava (Latr.)	*M. micrantha*	Colombia

All are probably casual.

APIONIDAE (Det. M.L. Cox)

Apion luteirostre Gerst. - See section 4.6.

Apion sp. was reared occasionally from *M. micrantha* and *M. vitifolia* in Trinidad. Similar to *A. luteirostre*, it is pale brown in colour but not to be confused with teneral *A. luteirostre* which are paler and more transulent than the adults.

CURCULIONIDAE (Det. M.L. Cox)

Pseudoderelomus baridiiformis Champ. and genus nr. *Pseudoderelomus* are discussed in section 4.7.

Rhodobaenus bicinctus Chev. has been found on *M. micrantha* and *A. inulaefolium* in Trinidad. It appears to match *R.* sp. found regularly by Cruttwell on *C. odorata* which is probably a normal host plant.

The following have been collected from flowers of *Mikania* spp. but never reared from them. They are probably general (?composit) flower feeders as adults.

Baris aerea (Boh.)	*M. micrantha*	Trinidad
Baris sp. A	"	"
Baris sp. B	"	Colombia
Centrinaspis crucifer (Champ)	"	Venezuela
C. ferrugineus Hust.	"	Colombia
C. lentiginosus (Boh.)	"	Costa Rica, Colombia
C. lineellus (Lec)	"	Costa Rica
C. perscillus (Gyll)	"	Trinidad
C. picumnus (Herbst)	"	Trinidad, Peru, Venezuela

C. quadrivittatus (F)	*M. micrantha*	Trinidad
C. sp. A	*M. cordifolia*	Colombia
C. sp. B	"	"
C. sp. C	*M. vitifolia*	Trinidad
Centrinus suturellus (Chev.)	*M. micrantha*	Colombia
Derelomus sp.	" , *M.trinitaria*	Trinidad
Genevra sp. nr. *leucostigma* (Champ)	"	Colombia
G. sp. nr. *biplagiatus*	"	Ecuador
Geraeus sp. nr. *simulater* (Champ)	"	Colombia
Limnobaris aeraria Champ.	*M. trinitaria* *M. micrantha*	Trinidad Colombia, Ecuador
Madarellus maculatus Solari	*M. micrantha*	Venezuela
Nicentrus lineicollis (Boh)	"	Costa Rica, Colombia, Ecuador
	Mikania sp.	Peru
N. parensis Casy	"	Peru
Parisochoenus expositus Champ.	*M. trinitaria*	Trinidad
Phyllotrox sp. nr. *inconspicus* Champ.	*M. micrantha*	Colombia
P. suturalis Boh.	"	Ecuador
P. sp.	"	Peru
Pseudobaris abrupta (Champ)	"	Trinidad
P. diversa (Champ)	"	"
P. sp. nr. *diversa* (Champ)	"	Colombia
P. dividua (Champ)	*M. cordifolia* *M. micrantha*	Costa Rica Ecuador
P. sp. nr. *dividua* (Champ)	*M. micrantha*	Trinidad
P. sp. nr. *octonotata* Champ.	"	Colombia
P. sp. A	"	Trinidad

P. sp. B	*M. vitifolia*	Trinidad
P. sp. C	*M. micrantha*	Peru

The following species were collected from leaves of *Mikania* spp. but are thought to be casual or polyphagous.

Brachyomus clavipes Kusch.	*M. micrantha*	Venezuela
Catolethrus longulus (Boh.)	"	Peru
Cleistolophus similis Chev.	"	Costa Rica
Conotrachelus sp. nr. *leucostictus* Boh.	"	Venezuela
Ileomus mucorcus (L.)	"	Trinidad
I. sp. A	"	"
I. sp. B?	"	Peru
Lechriops infimus (Boh.)	"	Costa Rica
Lixus apterus Champ	"	Costa Rica
Microhyus sp. nr. *pallidisetis*	*M. cordifolia*	Venezuela
Mimographus sp.	*M. micrantha*	Colombia
Promecops sp.	"	Peru

6. DISCUSSION AND CONCLUSIONS

In the Neotropics, *Mikania micrantha* is not a significant weed, whereas in S.E. Asia it is. The probable explanation lies in the range of natural enemies attacking it in the New World which do not occur in the Old World.

While it is not impossible that one of these natural enemies is the principal cause of this difference, no obvious candidate stands out, and it is more likely that the effects of several species combine to control *M. micrantha*.

Accordingly, several of the most promising potential biocontrol agents should be examined, and a start has been made in this project. Factors to be considered in assessing a species' potential include mode of feeding, mobility, adaptability, fecundity, longevity, voltinism, parasitism and predation. The species with great reproductive potential due to high fecundity and/or longevity and/or multivoltism are clearly to be preferred. The damage caused to the plant must be significant and relevant - e.g., feeding on young leaves and growing points is much more damaging than feeding on old, mature leaves. The potential control agent should be able to maintain itself on a low population density of the weed, and to this end mobility is a desirable trait. Mobility and adaptability can be assessed by examining the distribution of the species in its natural habitat. A species found in all situations (including newly created ones) is to be preferred to one restricted in distribution (e.g. to shady situations in forests). A high incidence of specialized as opposed to generalized parasitism and predation in the natural Neotropical habitat can be considered an asset. A species freed of its specialist natural enemies should enjoy a greatly increased reproductive potential, while one subject to little generalist parasitism or predation in the New World may have less chance of suffering from generalist natural enemies in the Old World.

Apart from these factors the problems of breeding and transporting the potential biocontrol agents have to be considered. Clearly, a species with a robust stage, preferably non-feeding, of long duration will be easier to transport than one without. Also, it is clear that if another member of the genus of the candidate species has been previously used for biocontrol with success, then that species can be considered more promising.

To consider some of the potential control agents in these terms, the following table has been constructed.

Species	Reproductive potential	Voltinism	Natural enemies	Damage	Genus used before	Dispersal	Distribution	Comments
Liothrips mikaniae	.	+	-+	+	+	Sunny situations, easily overlooked	T, CR, C, P	Main parasite *T. gentilei*. Known from Old World, otherwise a good bet.
Acalitus sp.	+	+	?	+	.	Everywhere	T,V,C,E,P,CR	Good potential
Apion luteirostre	-	1 or 2	+	+	-	"	T,V,C,P	*A. brunneonigrum* used for control of *E. (C.) odoratum* - no useful results reported
Neolasioptera sp.	++	+	+	?-	.	"	T	If damage to seed test is sufficient to prevent germination - of great potential
Lamprosema distincta	.	+	+	-	.	Widespread	T	*Blepharomastix ebulealis* is quite closely related. Successfully introduced to Hawaii; it gave no useful results
Physimerus pygmaeus	?.	?+	.	+	.	Shady forest	T, V, C, P	
Teleonemia sp.	+	+	?+	?	+	Everywhere	T, V, C, P	Apparent damage not great but success of *T. scrupulosa* against *Lantana camara* suggests it could be worthwhile
Desmogramma spp.	-	?	?	+	.	Scarce	V,C,E,P,CR	
Omoplata spp.	-	?	+	.	.	"	T,V,CR	
Pycnoderes spp.	.	?+	?	?+	.	Shady situations	T,CR, C,E	Technical difficulties great
Alycaulus sp.	?-	?+	++	-	.	Widespread	T, CR, P	Probably not important
Tegosa similis	.	+	?	+	.	"	T, C, ?V	Probably predation prone
Pseudoderelomus baradiiformis	?	?+	?	+	.	"	T,V,C,E,P	Life history not established

In the above table + indicates a good trait (high reproductive potential, multivoltinism, natural enemies recorded from Neotropics, significant feeding damage and a co-generic species used with success in biocontrol previously) while - indicates a drawback (low reproductive potential, monovoltinism, natural enemies found in Old World, non significant feeding and co-generic species used unsuccessfully in biocontrol previously) and . implies some intermediate state. The abbriviations T(Trinidad), V(Venezuela), CR(Costa Rica), C(Colombia), E(Ecuador), P(Peru) are used for the distribution.

Liothrips mikaniae is the principal species investigated during this project. Feeding tests show it to be specific to *Mikania* spp. and it is recommended for introduction to S.E. Asia subject to some confirmatory tests on Compositae not readily available in Trinidad (e.g. *Stevia redaubandia* and *Chrysanthemum coronarium*). Although *Acalitus* sp. nov. is almost certainly species-specific, some confirmatory tests should be carried out in Trinidad. In view of the apparent failure of *Apion brunneonigrum* to control *C. odoratum*, *A. luteirostre* is not too promising, however, the data accummulated strongly suggest a narrow oligophagy for *A. luteirostre*. Further tests to delimit the adult host range are needed. *Neolasioptera* sp. is most probably specific to *Mikania* spp.; in view of the high density at which it sometimes occurs, it could usefully be investigated further to see if it causes significant damage. If none of the above prove effective, there are other species such as those in the table which merit consideration and, if suitably host specific, trial.

Survey trips to Central and South America have covered much of the range of *M. micrantha* but Bolivia and Brazil have not been covered (see map after summary). Brazil in particular would merit a survey trip.

Thus, further work on this weed is needed ,and the possibilities for biocontrol are reasonably promising.

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APPENDIX 1 DETAILS OF SURVEY TRIPS UNDERTAKEN FOR THIS PROJECT

Country	Dates	Preliminary report	Updated Report
Venezuela	17.iv. - 5.v.1979	Cock 1979b	Appendix 1 in Cock 1980b
Costa Rica	1-22.vii.1979	Cock 1979c	Appendix 2 " " "
Panama	22-29.vii.1979		
Colombia	14.xi.-7.xii.1979	Cock 1980a	Appendix 3 " " "
Ecuador	19-29.vi.1980	Cock 1980c	
Peru	29.vi.-29.vii.1980		

APPENDIX 2. LITERATURE ON *LIOTHRIPS* SPP. HOST RANGE

The American species of *Liothrips* are:

Species	Locality	Host
L. ampelopsidis (Moulton 1927)	Colorado	
L. anonae Moulton 1933	Brazil	*Anona squamosa* (Anonaceae)
L. atennatus Priesner 1933	Mexico	"Guayaba-Busch"
L. araliae Hood 1935	Panama	*Polyscias (Nothopanax) guilfoylei* (Araliaceae)
L. atricolor DeSantis 1950		Unknown
L. avocadis Hood 1935	Panama	*Persea americana* (Avocado) (Lauraceae)
L. barronis Hood 1936	"	*Conosteigia speciosa* (Melastomaceae)
L. bibbyi Watson 1923	Mexico	*Sphaeralcea cuspidata* (Malvaceae)
L. bispinosus Hood 1938	Panama	Unknown
L. bondari Moulton 1933	Brazil	*Myrtus* (Myrtaceae)
L. brasiliensis Moulton 1933	"	'a legume', *Ipomea batatas* (sweet potato) (Convolvulaceae)
L. brevicornis (Hood 1913)	USA	*Sassafras albidum* (Lauraceae)
L. brevitubus (Moulton 1929)	Mexico	
L. buffae (Hood 1908)	USA	
L. caryae (Fitch 1856)	"	In *Phylloxera* galls on Hickory
L. castanea Hood 1915	"	Chestnut
L. citricornis (Hood 1915) = *L. flavoantennis* Watson 1916	" USA	Hickory, wild grape, Cornus *Viburnum* (Caprifoliaceae), oak, basswood, (*Tilia americana*) (Titiaceae)
L. claripennis Moulton 1933	Brazil	Unknown
L. colimae Moulton 1929	Mexico	"
L. cordei Moulton 1933	Brazil	*Serjania* sp. or *Paullinia* sp. (Sapindaceae)
L. cordiae Hood 1935	Panama	*Cordia nitida* (Boraginaceae) *Casearia sylvestris* (Flacourtaceae)
L. corni Moulton 1926	USA	*Cornus california* v. *pubescens* (Comaceae)

L. debilis (Hood 1925)	USA	
L. dendropogonis Watson 1938	"	Spanish Moss
L. dentifer (Hood 1912)	"	
L. distinctus Moulton 1938	Brazil	Unknown
L. dumosa (Moulton 1907)	"	*Prunus ilicifolia* (Rosaceae) (not *Quercus dumosa*)
L. epimeralis Hood 1938	Peru	*Byrsonima spicata* (Malpighiaceae)
L. eremicus Cott 1956	USA	*?Pinus cembroides* (Pinaceae)
L. floridensis Watson 1913	"	
L. fuscus (Morgan 1913)	"	?Spice-bush
L. gaviotae (Moulton 1929)		*Adenostoma fasciculatum* (Rosaceae)
L. guerci Moulton 1929	Mexico	?Oak
L. ichini Hood 1949	Brazil	*Schinus terebinthifolius* (Anacardaceae)
L. ilex (Moulton 1907)	USA	*Photinia arbutifolia* (Rosaceae)
L. laureli (Mason 1922)	"	Laurel and Camphor
L. lepidus Cott 1956	"	?oak
L. leucogonis Hood 1915	"	Oak, *Ostrya virginiata* (Carpinaceae)
L. mendesi Moulton 1933	Brazil	Unknown
L. mexicanus Crawford 1910	Mexico	In oak galls of *Fagus* sp.
L. mikaniae Priesner	Surinam	*Mikania cordifolia* (Compositae)
L. montanus (Hood 1913)	Canada	Currants and gooseberries
L. muscorum Watson 1926	USA	
L. ocellatus Hood 1980	"	In moss and in galls on black walnut
L. penetralis Hood 1935	Panama	*?Trichilia* sp. (Meliaceae)
L. perseae Watson 1923		*Persea americana* (avocado) (Lauraceae)
L. peruviensis Moulton 1933	Peru	Unknown
L. piger (Hood 1925)	USA	
L. priesneri Bianchi 1968	Guatemala	*Persea american* (avocado) (Lauraceae)
L. pruni (Hood 1912)	USA	?cherry bark

L. rotratus (Hood 1927)	USA	
L. russelli (Hood 1925)	"	Virginia creeper
L. salti Moulton 1933	Colombia ?Banana	
L. sambuci Hood 1913	USA	?Elder, *Sambucus*
L. seini	Santo Domingo	
L. seticollis Karny 1912	Paraguay, Brazil	Given by Moulton as *Vernonia* sp. (this is probably a mis-spelling of *Vernonia*) (Compositae)
L. similis Bagnall 1910	Venezuela	Unknown
L. tessariae Hood 1915	Peru	*Tessaria* sp. (Compositae)
L. tridentatus (Shull 1909)	USA	
L. tupac Hood 1938	Peru	Unknown
L. umbripennis (Hood 1909)	USA	Oak
L. unicolor Moulton 1933	Brazil	Unknown
L. urichi Karny	Trinidad, Guyana	*Clidemia hirta* (Melastomaceae)
L. usitatus (Hood 1927)	USA	
L. vaneeckei Priesner 1920	Cosmopolitan	Lily bulbs (Liliaceae)
L. varicornis Hood 1912	Mexico, USA	*Photinia arbutifolia* and (other) (Malvaceae)
L. versicolor (Moulton 1929)	USA	
L. vigilax Hood 1938	Peru	Unknown
L. xanthocerus	USA	A desert species
L. zeteki	Panama, Honduras	Unknown

Priesner (1968) recently expanded the genus to include many Old World species of the genus *Gynaikothrips*. Doubtless some of the American species (including *L. mikaniae*) will also have to be moved.

The recorded host plants of Old World species include:-

L. acuminatus Priesner 1968	Leaf galls on *Piper* sp. (Piperaceae)
L. adulticornis (Karny 1915)	Leaf rolls of *Gnetum latifolium* (Gnetaceae)
L. aemulans Priesner 1968	Leaf gall of *Piper arcuatum* (Piperaceae)
L. acquilus Ananthakrishnan & Jagaidish	Galls of *Eugenia* sp., (Myrtaceae)
L. africanus Vuillet	Galls of *Guiera senegalensis* (Combretaceae)
L. annulifer Priesner 1968	*Elatostema sesquifolium* (Urticaceae)
L. anogeissus Priesner	Galls of *Anogeissus leiocarpus* (Combretaceae)
L. assimilans Priesner 1968	Leaf gall *Elatostema* sp. (Urtacaceae)
L. associatus Ananthakrishnan & Jagadish	Hom galls of *Schefflera racemosa* (Araliaceae)
L. astutus Priesner 1968	Leaf gall of *?Scindapsus* (Aracaceae)
L. ater Ananthakrishnan & Jagadish	Galls of *Piper* sp. (Piperaceae)
L. baccati Priemer 1968	Leaf gall of *Piper baccatum* (Piperaceae)
L. bosei Moulton 1928	Galls of *Mallotus philippinensis* (Euphorbiaceae)
L. brevitubus Karny	-do-
L. callosae Priesner 1968	*Ficus callosa* (Moraceae)
L. chaviceae Karny	Galls of *Piper retrofractus* (Piperaceae)
L. claripennis (Karny 1914-16)	Leaf rolls *Salacia oblongifolia* (Celastraceae), *Bruguiera* sp. (Rhizophoraceae) and *Meudinella* sp. (Melastomaceae)
L. cognatus (karny 1915)	Leaf rolls/galls of *Medinilla* spp. (3) (Melastomaceae) and *Ardisia javanica* (Myrsinaceae)
L. collustratus Priesner 1968	Galls of *Elatostema strigosum* (Urticaceae)
L. comparandus Priesner 1968	Leaf gall of *Fagraea fastigata* (Potaliaceae)
L. confusus Priesner 1968	*Piper* sp. (Piperaceae)
L. convergens Priesner 1968	*Fagraea obovata* (Potaliaceae)
L. crassipes Karny 1912)	Leaf galls of *Piper nignum, P. bettle* (Piperaceae)

L. cuspidatae Priesner 1968	*Ficus cuspidata* (Moraceae)
L. daetymon (Karny 1923)	In leaf gall on *Eugenia* sp. *(?polyantha)* (Myrtaceae)
L. dampfi Karny 1921	*Tamarix gallica*
L. devriesi (Karny 1928)	Leaf gall of *Elatostema sesquifolium* (Urticeae)
L. digressus Ananthakrishnan 1971	Galls of *Loranthus* sp.
L. dissochaetae Priesner 1968	*Dissochaeta gracilis* (Malastomaceae)
L. dux Priesner 1968	Leaf gall of *Elatostema sesquifolium* (Urticeae)
L. elaeocarpi Priesner 1968	?Flowers of *Elaeocarpus* sp. (Elaeocarpaceae)
L. elatostemae Priesner 1968	In a cecidomyiid gall of *Elatostema sesquifolium* (Urticeae)
L. emulatus Ananthakrishnan 1976	Galls of *Schefflera* sp. (Araliaceae)
L. esakii (Takahashi)	Galls of *Ficus retusa* (Moraceae)
L. eugeniae Priesner	*Eugenia* sp. (Myrtaceae)
L. exiguus Priesner 1968	Leaf gall of *Piper* sp. (Piperaceae)
L. extractus Priesner 1968	Leaf gall of *Vitis lanceolaria* (Vitidaceae)
L. fagraeae Priesner 1968	Leaf gall of *Fagraea obovata* (Potaliaceae)
L. ficarius (Priesner	Galls of *Ficus benjaminus* (Moraceae)
L. flavitibia (Moulton)	Galls of *Mallobus philippensis* (Euphorbiaceae)
L. fragilis Ananthakrishnan 1976	Galls of *Schefflera* sp. (Araliaceae)
L. fraudulentus Priesner 1968	In horn galls *Schefflera* sp. (Araliaceae)
L. fumicornis Priesner 1968	Leaf gall of *Piper* sp. (Piperaceae)
L. fumipennis (Karny 1913)	Leaf galls *Poikilospermum (=Conocephalus) suaveolens* (Urticaceae)
L. gracilis (Karny 1913)	Leaf rolls of *Planchonia* sp. also on *Barringtonia spirata* (Barringtoniaceae)
L. gynopogoni Priesner 1968	"galls" *Alyxia (=Gynopogon) reinwardtii* (Apocynaceae)
L. gynosporiae Priesner	Galls of *Maytenus senegalensis* (Celastraceae)

L. habitator	Galls of *Ficus* sp. (Moraceae)
L. heptapleuri (Karny 1913)	Leaf galls of *Schefflera elliptica* and *S. odorata* (Araliaceae)
L. heptapleuricola Takahashi	Galls of *Schefflera* sp. (Araliaceae)
L. heptapleurinus Priesner	-do-
L. hradecensis Uzel 1895	Galls of *Macaranga* sp. (Euphorbiaceae)
L. indicus Ananthakrishnan 1972	Wrinkled leaves of *Maytenus*
L. ingratus Priesner 1968	Leaf gall *Elatostema* sp. (Urticaceae)
L. inquilinus Ananthakrishnan & Jagadish 1967	Galls of *Eugenia* sp.(Myrtaceae)
L. insidiosus Priesner 1968	*Piper* sp. (Piperaceae)
L. interlocatus (Karny 1926)	In psyllid galls in *Terminalia* leaves (Combretaceae)
L. jacobsoni Priesner	Galls of *Schefflera* sp. (Araliaceae)
L. jasmini Priesner 1968	In leaf gall of *Jasminum* sp. (Oleaceae)
L. jogensis Ananthakrishnan & Jagadish 1967	*Flacourtia* sp. (Flacourtaceae)
L. karnyi (Bagnall)	Marginal leaf galls of *Piper nigrum* (Piperaceae)
L. kawanai (Moulton 1928)	*Piper* spp. (3) (Piperaceae), *Smilax* spp. (Smilacaceae)
L. kiriti Ramakrishna 1928	Mango leaf *M. senegalensis*
L. kolliensis Ananthakrishnan	Indet (Urticaceae)
L. latro Priesner 1968	Leaf gall *Ardisia* sp. (Myrsiaceae)
L. liliaceae (Priesner)	Galls of *Smilax* sp. (Smilacaceae)
L. litoralis (Karny 1912)	Leaf gall of *Fagraea litoralis* (Polaliaceae)
L. longiceps (Karny 1915)	Leaf gall *Piper recurvum* (Piperaceae), *?Ficus benjamina* (Moraceae)
L. longicollis (Karny)	Galls of *Ficus punctata* (Moraceae)
L. longicornis (Karny 1915)	Marginal leaf rolls of *Ficus punctata* (Moraceae)
L. loranthi Priesner 1968	Leaf galls *Loranthus schultesii* (Loranthaceae)

L. machilus Ananthakrishnan & Varadarasan 1978 Leaf galls of *Machilus macranthes*

L. macropanacis Priesner 1968 On *Macropanax concinnum* and in horn galls *Schefflera polybotrya* (Araliaceae)

L. malabaricus Ananthakrishnan & Jagadish 1967 Galls of *Macaranga* sp. (Euphorbiaceae)

L. melaleucae Girault Galls of *Malaleuca leucodendron* (Myrtaceae)

L. miniati Priesner 1968 Leaf galls of *Piper miniatum* (Piperaceae)

L. minys Ananthakrishnan 1972 Galls of *Jasminum* sp.

L. mirabilis (Schmutz) Galls of *Piper* sp (Piperaceae) and *Pavetta hispidula* (Rubiaceae)

L. morindae Ananthakrishnan & Muraleedharan 1974 Leaves of *Morinda* sp.

L. mucronis Ananthakrishnan & Jagadish 1967 Galls of *Mallotus philippinensis* (Euphorbiaceae)

L. nanus Ananthakrishnan Galls of *Jasminum* sp. (Oleaceae)

L. nerviseguus (Karny 1915) Leaf galls *Poikilospermum (=Conocephalus) suaveolens* (Urticaceae)

L. nigripes (Karny 1916) Leaf rolls *Eugenia* sp. (Myrtaceae)

L. oculatus Priesner 1968 Leaf gall of *Lasianthus purpurea* (Rubiaceae)

L. omphalopinus Priesner 1968 Leaf gall of *Omphalopus fallax* (Melastomaceae)

L. pallicrus (Karny 1913) *Vitis lanceolaria* (Vitidaceae)

L. pallipes (Karny 1913) *Piper* spp. (4) (Piperaceae)

L. piperinus Priesner Galls of *Piper futokasura* (Piperaceae)

L. polybotryae Priesner 1968 Horn halls of *Scheffleria polybotrya* and *S. scandens* (Araliaceae)

L. polyosminus Priesner 1968 Leaf gall *Polyosma ilicifolia* (Escalloniaceae)

L. postocularis Priesner Galls of *Maytenus senegalensis* (Celastraceae)

L. praetermissus Priesner 1968 Leaf gall of *Fagraea litoralis* (Polaliaceae)

L. racemosae Priesner 1968 *Fagraea racemosa* (Polaliaceae)

L. ramakrishnae Ananthakishnan & Jagadish Galls of *Schefflera racemosae* (Araliaceae)

L. rectaginis Karny Galls of *Vernonia eleagnifolia* (Compositae)

L. retrofracti Priesner 1968 Leaf galls of *Piper retrofractum*(Piperaceae)

L. retusus Ananthakrishnan	Horn galls of *Schefflera* sp. (Araliaceae)
L. reynvaanae Priesner 1968	Leaf gall of *Piper* sp. (Piperaceae)
L. rhaphidophorae Priesner 1968	Leaf rolls of *Rhaphidophora foraminifera* (Aracaceae)
L. rubiae Priesner 1968	Leaf galls *Rubia cordifolia* (Rubiaceae)
L. sarmentosi Priemer 1968	Leaf gall of *Piper sarmentosum* (Piperaceae)
L. schefflerae Priesner 1968	Leaf gall *Schefflera scandens* (Araliaceae)
L. siamensis (Karny 1923)	In leaf galls of *Dipterocarpus alatus* (Dipterocarpaceae)
L. simillans (Karny 1915/16)	Leaf galls *Tetrastigma pergamaceum* (Vitidaceae)
L. spectabilis Ananthakrishnan	Leaf galls of *Loranthus* sp. (Loranthaceae)
L. strigosus Ananthakrishnan & Jagadish 1968	Galls of *Cinnamomum* sp. (Lauraceae)
L. styracinus Priesner 1968	*Styrax* sp. (Styracaceae)
L. suavis Priesner 1968	*Elatostema strigosum* (Urticaceae)
L. subtilis Ananthakrishnan	Galls of *Schefflera* sp. (Araliaceae)
L. takahashii (Moulton 1928)	*Ficus refusa, F. benjamina* (Moraceae)
(?) *L. taurus* (Karny 1915)	Leaf galls *Poikilospermum (=Conocephalus) suaveolens* (Urticaceae)
L. tetrastigmae Priesner 1968	Leaf galls *Tetrestigma mutabile* (Vitidaceae)
L. tibialis Priesner	Galls of *Piper* sp. (Piperaceae)
L. tristis Karny	Galls of *Litsea chinensis* (Lauraceae)
L. trybomii (Karny)	Galls of *Aporosa microcalyx* (Euphorbiaceae)
L. variabilis Ananthakrishnan & Jagadish 1967	Galls of "Pepper"
L. viticola (Karny 1913)	Leaf gall *Vitis lanceolaria* (Vitidaceae)
L. vitivorus (Priesner 1935)	*Vitis* sp. (Vitidaceae)
L. willcocki Priesner	Galls of indet. Simarubaceae.

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