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The phytophagous organisms associated with *Lantana* L. species in Jamaica and their potential use as biological control candidates of weedy varieties of *Lantana camara* L. (Verbenaceae) in South Africa

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Abstract

Baars J-R, Hill MP. 2010. The phytophagous organisms associated with *Lantana* L. species in Jamaica and their potential use as biological control candidates of weedy varieties of *Lantana camara* L. (Verbenaceae) in South Africa. Entomotropica 25(3): 99-108.

The West Indies lies within the natural range of *Lantana* species (Verbenaceae) but few searches have been completed in this area looking for potential classical biological control agents. A survey for potential candidates for the biocontrol of the weedy varieties of *L. camara* was conducted mainly on *L. urticifolia* in Jamaica. A total of 46 sites were sampled across the island where *Lantana* plants were common with at least 10 plants occurring in close proximity. Collections were focussed on phytophagous organisms collected using a beating tray and those with endophagous stages reared from inflorescence, seed and leaf samples. Twenty one species of phytophagous insects and mites were collected on *L. urticifolia* during the survey. Eight were considered to induce significant damage and warrant consideration. Of the species encountered during the survey seven species have been released as biocontrol agents in the past, four have recently been released on the weedy forms of *Lantana* and one has been rejected for release in Africa. The phytophage assemblage on *L. urticifolia* in Jamaica is considered relatively small in comparison to the species lists available for adjacent continents, and Jamaica is thus not the most suitable area for surveys for additional biocontrol candidates of *Lantana.*

Additional key words: Biocontrol, *Lantana urticifolia*, natural enemies, weed control.

Resumen

Baars J-R, Hill MP. 2010. Organismos fitófagos asociados a especies de *Lantana* L. en Jamaica y su uso potencial como candidatos para el control biológico de variedades nocivas de *Lantana camara* L. (Verbenaceae) en Suráfrica. Entomotropica 25(3): 99-108.

Las islas del Caribe están dentro del área de distribución natural de las especies de *Lantana* (Verbenaceae). Sin embargo se han realizado pocas búsquedas en esta zona por potenciales agentes clásicos de control biológico. Un inventario de candidatos potenciales para el control biológico de variedades nocivas de *L. camara* se realizó fundamentalmente sobre *L. urticifolia* en Jamaica. Se muestrearon 46 sitios en la isla donde las plantas de *Lantana* eran comunes, con al menos diez plantas ocurriendo en proximidad. La colecta se enfocó en organismos fitófagos usando una sábana de golpe, aquellos con fases endófagas fueron criados de muestras de inflorescencias, semillas y hojas. Veintiún especies de insectos y ácaros fitófagos fueron colectados sobre *L. urticifolia* en este muestreo. Ocho se consideran que pueden causar suficiente daño como para tomarlas en consideración. De las especies encontradas en el muestreo, siete han sido liberadas en el pasado como agentes biocontroladores, cuatro han sido liberadas recientemente para el control de las formas nocivas de *Lantana*, y una ha sido rechazada para

su liberación en Africa. Los organismos fitófagos de *L. urticifolia* en Jamaica se consideran relativamente pocos cuando los comparamos con las listas de especies disponibles para los continentes cercanos. Por lo tanto Jamaica no es el área más idónea para la búsqueda de candidatos para el control biológico de *Lantana.*

Palabras clave adicionales: control biológico, control de malezas, *Lantana urticifolia*, enemigos naturales.

Introduction

The West Indies falls within the natural range of *Lantana* species (Palmer and Pullen 1995), and should therefore be a source of potential natural enemies for biological control of *Lantana camara* L. sensu lato in areas of the world where it is an invasive alien species. However, with the exception of a few natural enemies collected in Cuba (Krauss 1962) and Trinidad (Stegmaier 1966; Harley and Kassulke 1973, 1974), there is no comprehensive list of the phytophagous organisms associated with *Lantana* species from this region. The collection of promising candidate biocontrol agents during an opportunistic survey in Jamaica in 1994 (Stefan Neser, personal communication) has stimulated interest in more detailed searches in this region. Further collections from Jamaica resulted in the importation of *Falconia intermedia* (Distant) (Hemiptera: Miridae) and *Longitarsus* spp. into South Africa as candidate biological control agents (Baars et al. 2003; Simelane 2005).

The genus *Lantana* occurs naturally in South, Central and southern parts of North America, where surveys for potential biocontrol agents for *L. camara* have been confined to species in the section *camara*. Surveys conducted on the closely related species, namely *L. tiliaefolia* Cham. and *L. glutinosa* Poepp. from Brazil (Winder and Harley 1982, 1983), and *L. camara*, *L. hirsuta* Mart. and Gal., *L. urticifolia* Mill. and *L. urticoides* Hayek from Central and North America (Palmer and Pullen 1995; Krauss 1962), have largely been the source of natural enemies released as biocontrol agents on the weedy forms of *Lantana* referred to as *L. camara* sensu lato or *L. camara* hort. However, the *Lantana* species from which the biocontrol candidates were collected in the country of origin was not consistently recorded in the literature and is largely unknown (Day and Neser 2000, Day et al. 2003a). Recent assessments of biological control programmes emphasise the need for additional phytophagous organisms to offer better control of *Lantana* varieties (Baars and Neser 1999, Broughton 2000, Baars 2003, Baars and Heystek 2003, Day et al. 2003a, 2003b, Zalucki et al. 2007).

This paper reports on a short-term survey of the phytophagous organisms associated with *Lantana* species (chiefly *L. urticifolia*) in Jamaica, and aims to determine the scope for candidate biocontrol agents and direct future exploratory searches in the West Indies and continental America.

Materials and Methods

The phytophagous organisms associated with *Lantana* species were sampled throughout the island of Jamaica (Figure 1). Plants were sampled in the growth season (July 1999) at 46 sites, which included roadsides, riparian zones, arable land borders and natural vegetation. Sites were selected where *L. urticifolia*, the dominant species of *Lantana* in Jamaica, was common, with at least 10 plants in close proximity. A minimum of 10 plants were inspected for damage and abundance of individuals, and two to three sections of each plant were shaken above a beating tray. Where possible, at least 20 each of damaged flowers and green, mature and dry seed heads were collected per site. Endophagous species collected from inflorescences, seeds samples and leaves were reared through for

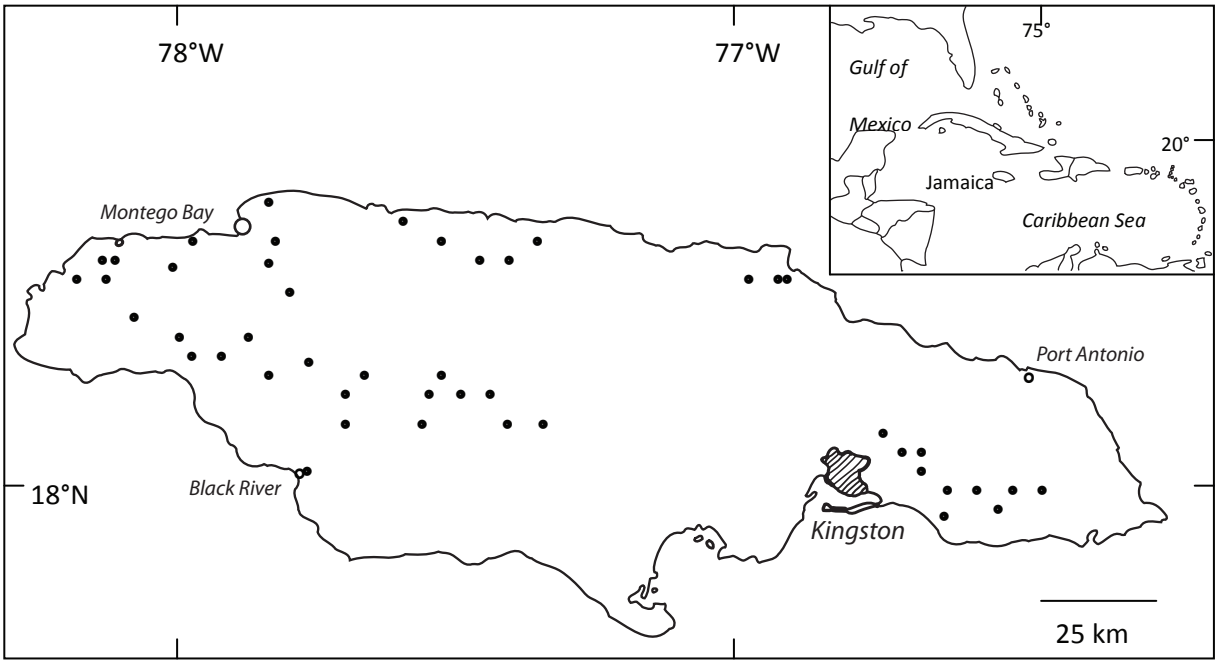

Figure 1. The sites sampled (•) during a survey of the phytophagous organisms associated with *Lantana* species (chiefly *Lantana urticifolia*) in Jamaica.

identification. All specimens identified were lodged at the South African National Collection (SANC, ARC-Plant Protection Research Institute) in Pretoria, South Africa. Field observations were also made on congeneric and other related species (Verbenaceae) and only provide an indication of potential non-target impacts. Species richness estimators were applied to determine if the species collected were representative of the regional species pool on *L. urticifolia* at the time of the survey. Data were analysed using the diversity programme EstimateS (Version 7.5) (Cowell 2005). The observed species accumulation (MaoTau) and the two richness estimators were applied, namely Chao1 and Chao 2.

Results

Phytophagous organisms in Jamaica

Twenty-one species of phytophagous insects and mites were collected on *L. urticifolia* in Jamaica (Table 1). Of these eight were considered to be damaging to plant growth and/or flower and fruit production (Table 1).

Aceria lantanae (Cook) (Acari: Eriophyidae) and *Falconia intermedia* (Miridae) were consistently the most abundant species (Table 1), with the flower-galling mite, *A. lantanae*, occurring at more than 80 % of the sites. Mite infestations varied considerably in size between sites, from a few infested flowers with numerous undamaged flowers and seeds present, to almost all of the flowers heavily galled. At most of the sites old galls were still attached to plants, indicating that infestations persisted on individual plants over time. Heavily galled plants were sparsely stemmed, and had little evident growth vigour. High population levels of the leaf-sucking lantana mirid, *F. intermedia*, occurred at approximately half of the sites and mostly in high numbers, causing severe leaf chlorosis.

The adults and larvae of the leaf-chewing flea beetle, *Omophoita albicollis* Fabricius (Chrysomelidae), caused typically large 'shot

Table 1. Phytophagous organisms associated with *Lantana urticifolia* in Jamaica, including their frequency of occurrence and biocontrol potential (*).

Order/ Family	Natural enemy species[a]	Mode of attack	No. sites[b]
Acari			
Eriophyidae	*Aceria lantanae* (Cook)	Flower gall former	38*
Coleoptera			
Chrysomelidae	*Omophoita albicollis* Fabricius	Leaf chewer	18*
	Longitarsus spp. (2170; 2156)	Root feeder/ Leaf chewer	24*
Heteroptera			
Miridae	*Falconia intermedia* (Distant)	Leaf sucker	23*
	Teleonemia prob. *scrupulosa* Stål (2167)	Flower and leaf sucker	36*
Tingidae	*Teleonemia* prob. *harleyi* Froeschner (2174)	Flower and leaf sucker	43*
	Teleonemia sp. (2165)	Flower sucker	14
	prob. *Corythaica* sp. (2180)	Leaf sucker	4
Homoptera			
Ortheziidae	*Orthezia insignis* Browne	Stem sucker	5
Flatidae	Unidentified sp. (2176)	Stem sucker	9
Cicadellidae	Unidentified sp. 1 (2139)	Stem sucker	4
	Unidentified sp. 2 (2137)	Stem sucker	2
Diptera			
Agromyzidae	*Ophiomyia lantanae* (Froggatt)	Fruit borer	26
	Ophiomyia camarae Spencer	Leaf miner	15*
	Calycomyza sp.	Leaf miner	24
Lepidoptera			
Crambidae (= Pyralidae)	*Salbia haemorrhoidalis* Guenée	Leaf chewer and binder	18*
Tortricidae	*Epinotia lantana* (Busck) (= *Crocidosema lantana* Busck)	Fruit and flower receptacle feeder, and shoot tip borer	8
	Platynota rostrana Walker	Unknown	1
Pterophoridae	*Oxyptilus* sp. (Walker) (2188)	Flower, fruit and seed chewer	1
Geometridae	*Leptostalis* sp. (2182; 2184; 2193; 2194; 2200)	Leaf chewer	9
Lycaenidae	*Strymon bazochii* Godart	Flower and fruit chewer	2

a Accession numbers (AcSN) of the undetermined species are given in parentheses and lodged in the South African National Collection, Pretoria.
b Number of sites at which the organism was present, out of 46 sites sampled.
* Severity of damage to plant growth and or flower and fruit production considered significant to warrant further consideration.

holes' in the leaves. Larvae were seldom collected and adult feeding on the shoot tips was usually limited, with damage restricted to a small proportion of the leaves.

The populations of the leaf-tying moth, *Salbia haemorrhoidalis* Guenée (Crambidae) were relatively low (Table 1) and although characteristic damage was regularly encountered, the impact on the leaves was limited. Where larvae were abundant, the damage to leaves was considerable and the plants were visibly stressed.

The two sap-sucking lace bugs, *Teleonemia* prob. *scrupulosa* Stål and *T.* prob. *harleyi* Froeschner (Tingidae), fed predominantly on the leaves, but also on the flowers. These two species were consistently associated with *L. urticifolia* at the sites sampled (Table 1) and where population levels were high, the leaf damage was severe.

The small 'shot-holes' which typify the feeding damage caused by adults of the root-boring flea beetles, was regularly encountered at several sites (Table 1). The small number of specimens that could be collected was identified as *Longitarsus bethae* Savini and Escalona 2005 (Chrysomelidae), but other species may well be present in the area. Three endophagous flies, *Ophiomyia lantanae* (Froggatt), *O. camarae* Spencer, and *Calycomyza* sp. (Agromyzidae), were considered to be 'rare' in abundance (Table 1). The larvae of the seed fly, *O. lantanae*, fed on the fleshy ectocarp of the seeds, and also occasionally bored into and pupated in the flower receptacles. The larvae of the leaf-miner, *O. camarae*, tunnelled into the mesophyll tissue and main veins of leaves, causing characteristic 'herring-bone' leaf mines. Larvae of the second leaf miner, *Calycomyza* sp., caused 'blotch' mines on leaves that usually damaged less than 25% of the leaf surface. As very few specimens were reared through in the laboratory and sent for identification, these may be the species *Calycomyza lantanae* (Frick) (Agromyzidae), which is known to cause these blotch mines in Central America (Palmer and Pullen 1995) on leaves and has been released as a biocontrol agent on *Lantana* (Baars and Neser 1999).

Another two lace bugs, *Teleonemia* spp. and *Corythaica* spp. (Tingidae), and the scale insect, *Orthezia insignis* Browne (Ortheziidae), were collected at several sites (Table 1), but the damage caused to the flowers, leaves and shoots respectively was considered negligible at the time of the survey, with no signs of shoot tips wilting.

Five other species of Lepidoptera were collected (Table 1), of which the larvae of *Epinotia lantana* (Busck) (Tortricidae) caused the most damage to plants. Larvae of *Oxyptilus* spp. (Pterophoridae) only damaged a few flowers per inflorescence, leaving the undamaged flowers to mature and fruit to develop.

Three other stem-sucking homopteran species were collected at relatively few of the sites (Table 1) and with the exception of the flatid planthopper, which was rated as 'frequent' at some sites, these species had a low abundance. Only adults of these three species were observed feeding on the stems of the plants, with no signs of the immature stages.

Host range analysis

In addition to surveying *L. urticifolia*, several other species of *Lantana* and Verbenaceae were surveyed where possible (Table 2). *Aceria lantanae* and *Falconia intermedia* were abundant on the *L. camara* variety native to Jamaica, while the ornamental *L. camara* variety (similar in appearance to the weedy forms in South Africa) supported a phytophagous fauna that was similar to that on *L. urticifolia*. *Lantana trifolia* L. showed minimal feeding damage by adults of *O. albicollis* and larvae of *S. haemorrhoidalis*. None of the natural enemies recorded on *L. urticifolia* were collected on any of the other related species occurring in the vicinity, which included *Lantana reticulata* Pers., *Lantana angustifolia* Mill., *Verbena* prob. *bonariensis L.* and *Priva* sp..

Sampling assessment

The species richness estimation was conducted on the taxa encountered during the field survey excluding the species reared from the flowers and seeds. Flower heads and fruits were placed in emergence containers and mortality could not be estimated and may result in bias in the species richness estimations. The species omitted from the analysis include *Platynota rostrana* Walker (Tortricidae), *Oxyptilus* spp., *Strymon bazochii*

Table 2. Phytophagous natural enemies on *Lantana urticifolia*, and their presence on related plant species (Verbenaceae) occurring at the same sites.

Related plant species	Natural enemies on *L. urticifolia*	*n*[a]	Natural enemies on related plant[b]	Damage intensity
Lantana camara L. (native species)	*F. intermedia* *A. lantanae*	1	*F. intermedia* *A. lantanae*	Damage similar to that on *L. urticifolia*
Lantana camara sensu lato/hort. (ornamental variety)	*F. intermedia* *O. albicollis* *T.* prob. *scrupulosa* *T.* prob. *harleyi*	2	*F. intermedia* *O. albicollis* *T.* prob. *scrupulosa* *T.* prob. *harleyi*	Damage similar to that on *L. urticifolia*
Lantana trifolia L.	*A. lantanae* *F. intermedia* *O. albicollis* *Longitarsus sp.* *T.* prob. *scrupulosa* *T.* prob. *harleyi* *S. haemorrhoidalis*	14	*O. albicollis* (1) *S. haemorrhoidalis* (1)	Limited damage on nearby plants Damage on isolated leaves; plant entwined with *L. urticifolia*
Lantana reticulata Pers.	*A. lantanae* *F. intermedia* *T.* prob. *harleyi*	2	None	-
Lantana angustifolia Mill.	*F. intermedia* *T.* prob. *scrupulosa* *T.* prob. *harleyi*	2	None	-
Verbena prob. *bonariensis*	*F. intermedia* *O. albicollis* *E. lantana*	2	None	-
Priva sp.	*F. intermedia* *T.* prob. *scrupulosa* *T.* prob. *harleyi*	1	None	-

a The number of sampled sites where the related plant species was present.
b The value in parentheses indicates the number of sites at which the observation was made.

Godart (Lycaenidae), and *O. lantanae*. Due to the lack of confirmed identifications the cicadellids were combined and treated as a single taxon in the analysis.

The observed species richness curve indicates that there was a small number of phytophogous taxa associated with *L. urticifolia* in Jamaica (Figure 2). The curve reaches an asymptote indicating that most of the taxa in the regional species pool were recorded during the survey (Figure 2). There were only a few new taxa collected after about 15 sampling sites (Figure 2). Both richness estimators Chao 1 and Chao 2 reach an asymptote (Figure 2), indicating that the species collected were likely to represent the species present on *L. urticifolia* during the time of sampling.

Discussion

The two most damaging and abundant phytophagous organisms collected in Jamaica were the flower-galling mite, *A. lantanae*, and the lantana sap-sucking mirid, *F. intermedia*. The large flower-galls induced by the mite may act as metabolic sinks (Baars and Neser 1999), but primarily reduce seeding. The large populations of the *Lantana* mirid, and the severe damage observed in the field indicate its potential as a biocontrol agent. Other natural enemies that

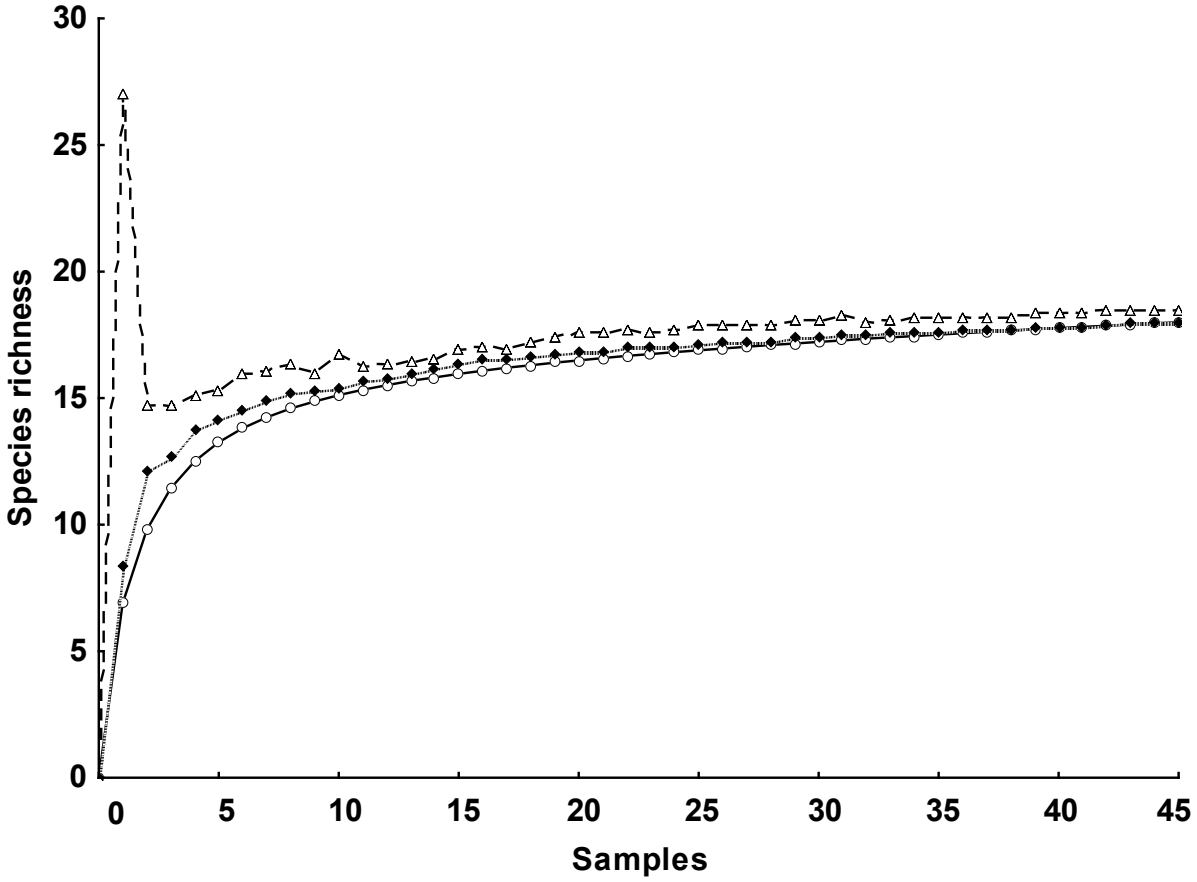

Figure 2 Species richness estimation of the phytophagous organisms collected on *Lantana urticifolia* in Jamaica. Observed curve (Mao Tau) (solid line with circles) based on collections made at 46 sampling sites, and Chao 1 (dotted line with diamonds) and Chao 2 (dashed line with triangles) richness estimators calculated using EstimateS (Cowell 2005).

were damaging include the two tingids, *T.* prob. *scrupulosa* and *T.* prob. *harleyi*, and the leaf-tying moth, *S. haemorrhoidalis*. Although population levels of *O. camarae* were relatively low during the survey, the larvae promote leaf abscission and are thus suitably damaging. However, leaf miners on *Lantana* are likely to recruit generalist parasitoids in countries of introduction (Baars 2003; Baars and Heystek 2003). The impact of the larvae of the root-boring flea beetle, *Longitarsus* spp., on field plants was difficult to assess, but adult field populations were relatively abundant. Several unidentified *Longitarsus* species have been imported to South Africa from Central America (Baars and Neser 1999), and laboratory studies on *L. columbicus columbicus* Harold and *Longitarsus* sp. (from Jamaica) indicate that the larvae can cause severe damage to rootlets (Baars 2001; Simelane 2005).

The mode of attack of *C. lantanae* and *O. albicollis* causes little damage to plants, and any significant impact caused by these candidates would depend on extremely high population levels. The negligible impact and low occurrence of the two tingids, *Teleonemia* sp. and *Corythaica* sp., excluded them from further consideration. The host specificity of the unidentified homopteran species is questionable, as no immature stages were observed on any plants, suggesting that these species may require alternative hosts to complete their life cycle.

The spatial distribution of the sampling sites over the range of *L. urticifolia* in Jamaica and the relatively quick decline in the accumulation of species with increasing numbers of samples suggested that the list of phytophagous species is representative of the regional species pool. Due to the short time span of the survey (7 days), and possible seasonal differences in the phytophage assemblage, new species are likely to be encountered. However, the lack of abrupt seasonal changes supports the notion that large seasonal changes in the phytophage assemblages are unlikely. Seasonal changes in the abundance levels of species are certain to occur and may affect the priority assigned to some species in this survey. The results of the survey are by no means exhaustive, and phenological studies on certain of these natural enemies may be warranted, but in the pursuit for new natural enemies as candidate biocontrol agents further surveying efforts would be better invested in continental America. Of the twenty one species recorded on *L. urticifolia* in Jamaica, fourteen also occur in North America (Palmer and Pullen 1995), and six occur in Brazil (Winder and Harley 1983). On continental America there are also several other congeneric natural enemy species and the species pool recorded to be associated with *Lantana* species is considerably more diverse. The relatively small number of endemic natural enemy species in Jamaica suggested that it was an unlikely centre of endemism for *Lantana* species. The theoretical model rarefraction curve described by Müller-Schärer et al. (1991) is comparable to the observed species-accumulation curve obtained during the survey in Jamaica. Müller-Schärer et al. (1991) argue that such a species-accumulation curve suggests that the regional species pool consists of natural enemies that are common and widespread.

It is now widely accepted that host specificity screening of natural enemies under laboratory conditions can result in candidate biological control agents displaying artificially wide host ranges (Baars and Neser 1999; Baars 2003). Therefore, surveys and open-field trials in the native range of candidate biocontrol agents, provide additional insight into the range of plant species that are likely to be accepted under natural conditions. These observations have proven to be useful in several biocontrol programmes (Maddox and Sobhian 1987; Clement and Cristofaro 1995; Balciunas et al. 1996). As this survey was conducted over a short period the lack of non-target damage does not provide sufficient evidence that these natural enemies encountered may be host specific. However, the association of some species, like *F. intermedia* with the ornamental *L. camara* sensu lato/*L. camara* hort. is noteworthy as the development of ornamental varieties has been implicated in the poor performance of biocontrol agents released. The lack of severe damage on related verbenaceous species during the survey may suggest that field based trials may be useful in future. Particularly for agents, like *O. albicollis* that was considered damaging, but was rejected as a result of laboratory based trials (Williams and Duckett 2005).

Several of the candidate biocontrol agents present in Jamaica have either been established, or are being considered for release in countries like South Africa and Australia. The agents previously released include *T. scrupulosa*, *O. lantanae*, *C. lantanae*, *S. haemorrhoidalis*, *L. pusillidactyla*, *E. lantana*, and *O. insignis* (Cilliers and Neser 1991, Julien and Griffiths 1998, Anonymous 1999, Baars and Neser 1999, Day and Neser 2000). Although in some circumstances a selection of these species seem to contribute to suppressing *Lantana* the control is not adequate (Baars 2003, Baars and Heystek 2003, Day et al. 2003a, 2003b). Other agents like *Aceria lantanae*, *F. intermedia*, *O. camarae* and *L. bethae* have been recently released in South Africa (Similane 2002; Baars et al. 2003; Alan Urban personal communication). Those being evaluated for release include species of

Leptostalis. The leaf-feeding beetle, *O. albicollis*, has been rejected as a biocontrol agent (Baars and Neser 1999; Williams and Duckett 2005). The tingid, *T. harleyi*, was released in Australia (Harley and Kassulke 1973), but although it was reported as established (Julien and Griffiths 1998) it is considered to have failed to persist in the field (Day et al. 2003b). This species is not recommended for introduction, however, the use of additional tingid species is still considered to be a viable option in South Africa (Baars 2002). The majority of the species recorded in Jamaica considered as potential candidate agents have been, and are in the process of being employed or evaluated as biocontrol agents. With the exception of only a few species, some of which did not warrant further consideration during the survey, Jamaica does not seem like a good area to invest future biocontrol surveying efforts. Unless specific aspects of species already recorded on *Lantana* require investigation surveys are better done elsewhere, probably on the nearby continental America.

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