INSECT HERBIVORES ASSOCIATED WITH SPECIES OF SOLANUM (SOLANACEAE) IN NORTHEASTERN ARGENTINA AND SOUTHEASTERN PARAGUAY, WITH REFERENCE TO BIOLOGICAL CONTROL OF WEEDS IN SOUTH AFRICA AND THE UNITED STATES OF AMERICA

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INSECT HERBIVORES ASSOCIATED WITH SPECIES OF *SOLANUM* (SOLANACEAE) IN NORTHEASTERN ARGENTINA AND SOUTHEASTERN PARAGUAY, WITH REFERENCE TO BIOLOGICAL CONTROL OF WEEDS IN SOUTH AFRICA AND THE UNITED STATES OF AMERICA

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ABSTRACT

Solanum mauritianum Scopoli and *Solanum sisymbriifolium* Lamarck are major exotic weeds in South Africa, while *Solanum viarum* Dunal is similarly problematic in the United States of America. All three species are native to northeastern Argentina and southeastern Paraguay, where they were surveyed for natural enemies in February 1998. Insect agents for *Solanum* weeds have a tendency to extend their host ranges to include non-target *Solanum* species, in particular cultivated eggplant (*S.melongena* L.), during laboratory trials, making it difficult to promote their release. To facilitate the interpretation of such results, other native and cultivated *Solanum* species that grew in close proximity to the target species were also surveyed to give an indication of the insects' field host ranges. During the survey period, 19 insect herbivore species were recorded on *S.mauritianum*, while 8 species were recorded on each of *S.sisymbriifolium* and *S.viarum*. Based on the insects' occurrence, abundance and damage to their target weeds, and their absence on other non-target *Solanum* species, several natural enemies that warrant further investigation were identified. These include 5 species associated with *S.mauritianum* and 2 species associated with each of *S.sisymbriifolium* and *S.viarum*. With rare exceptions, these insects were normally associated with a single host species and none attacked cultivated eggplant.

Key Words: host range, natural enemies, *Solanum mauritianum*, *Solanum sisymbriifolium*, *Solanum viarum*, weed biocontrol

RESUMEN

Solanum mauritianum Scopoli y *Solanum sisymbriifolium* Lamarck son importantes malezas exóticas en Sudáfrica, mientras que *Solanum viarum* Dunal tiene el mismo status en Estados Unidos de América. Las tres especies son nativas del noreste de Argentina y sudeste del Paraguay, donde una búsqueda de enemigos naturales fue llevada a cabo en febrero de 1998. En ensayos de laboratorio, los insectos estudiados para control biológico de *Solanum* tienen una tendencia a extender su rango de hospedadores a otras especies del género, en particular *S.melongena* L.(berenjena), lo que dificulta obtener permisos de liberación. Por ello, en el estudio se incluyeron berenjena y otras especies nativas de *Solanum*, lo cual proveyó una indicación del rango real de plantas hospederas. Durante el estudio, 19 especies de insectos herbívoros fueron obtenidos en *S.mauritianum*, 8 especies en *S.sisymbriifolium* y 8 en *S.viarum*. Basado en la presencia, abundancia y daño infligido a las malezas en estudio y su ausencia en otras especies de *Solanum*, se identificaron nueve especies que ameritan futuros estudios. En la mayoría de los casos estas especies fueron halladas sobre una única planta hospedadora y en ningún caso se las encontró en berenjena.

South American species of *Solanum* L. (Solanaceae) include weeds of agricultural and environmental importance in South Africa and the United States of America. Two species, *Solanum mauritianum* Scopoli (bugweed, woolly nightshade) and *Solanum sisymbriifolium* Lamarck (wild tomato, sticky nightshade), were targeted for biological control in South Africa (Olckers 1999, Olckers et al. 1999), while a third, *Solanum viarum* Dunal (tropical soda apple), was targeted in the USA (Medal et al. 1996, 1999). All three species are native to northeastern Argentina, southern Brazil, Paraguay and Uruguay. During February 1998, a trip to northeastern Argentina and southeastern Paraguay was undertaken by scientists from Argentina, South Africa and the USA for the purpose of recording and collecting promising natural enemies of *S.mauritianum*, *S.sisymbriifolium* and *S.viarum*.

Biological control programmes against *Solanum* weeds have been complicated by introduced insect agents feeding on non-target conge-

neric species during quarantine evaluations (Olckers 1999, Olckers et al. 1999). Although these agents feed exclusively on *Solanum* species and are unable to utilize other solanaceous genera, cultivated eggplant (*S.melongena* L.) and certain native *Solanum* species are particularly susceptible to feeding by these agents, ensuring difficulties in promoting their release. These concerns are aggravated by revelations that in the USA, nearly all native plants that have become hosts for biocontrol agents belong to the same genus as the target weed (Pemberton 2000). In an attempt to collect information on the field host ranges of candidate agents for *S.mauritianum*, *S.sisymbriifolium* and *S.viarum*, all native *Solanum* species encountered during the trip were surveyed for insect herbivores. Efforts were also made to locate and examine eggplant cultivations growing in close proximity to natural populations of all three target weed species.

In this paper, we report on the insect herbivores associated with native *Solanum* species and cultivated eggplant in northeastern Argentina and southeastern Paraguay. Comments on the suitability of potential biological control agents for *S.mauritianum*, *S.sisymbriifolium* and *S.viarum* are made in the light of these observations.

Materials and Methods

Field observations and collections of insects associated with *S.mauritianum*, *S.sisymbriifolium* and *S.viarum* were made during a 7-day survey of native *Solanum* species and cultivated eggplant, encountered at several sites in northeastern Argentina and southeastern Paraguay, from 15-21 February 1998. Some 23 localities and 8 plant species were surveyed (Table 1).

At each locality, natural stands of plants were scanned for ectophagous herbivores and damaged stems, flowers and fruit were dissected to observe endophagous species. Since no specific sampling protocol was followed, collecting times varied at each locality, with more time spent at sites where the plant populations supported rich insect faunas. The phenological stages of the 8 *Solanum* species surveyed at the 23 sites were very similar in that, with few exceptions, the populations were flowering.

Table 1. Localities in Argentina and Paraguay where different species of *Solanum* were surveyed for insect herbivores.

Date	Site #	Localities (province)	Map reference	*Solanum* species[1]								
		Argentina										
15/02/98	1	Nr Gualeguaychu (Entre Rios-ER)	33.16S 58.42W						si			
15/02/98	2	Nr Concordia (ER)	32.03S 58.15W						si			
16/02/98	3	Nr Alvear (Corrientes- CO)	29.07S 56.38W			ma						
16/02/98	4	Alvear (CO)	29.05S 56.32W						si			vi
16/02/98	5	Nr Santo Tomé (CO)	28.34S 56.03W	at	fa							vi
16/02/98	6	Nr Gobenador Virasoro (CO)	28.07S 56.03W		fa	ma						
21/02/98	7	Nr Ituzaingo (CO)	27.33S 56.33W			ma						
17/02/98	8	Nr Posadas (Misiones- MS)	27.30S 55.51W			ma	me		si			
21/02/98	9	Nr Posadas (MS)	27.24S 55.58W						si			vi
17/02/98	10	Nr Gobenador Roca (MS)	27.14S 55.21W		fa	ma	me		si		ss	vi
18/02/98	11	Nr Capiovi (MS)	26.57S 55.05W		fa							vi
18/02/98	12	Nr Tres de Mayo (MS)	26.40S 54.46W			ma						
18/02/98	13	Nr Monte Carlo (MS)	26.36S 54.44W						si			vi
18/02/98	14	Monte Carlo (MS)	26.29S 54.40W			ma						
19/02/98	15	Eldorado (MS)	26.24S 54.39W			ma						vi
19/02/98	16	Nr Puerto Esperanza (MS)	26.01S 54.35W			ma						vi
19/02/98	17	Nr Iguazu Falls (MS)	25.40S 54.29W			ma						
21/02/98	18	Colonia Benitez (Chaco)	27.18S 58.59W			ma						
		Paraguay										
20/02/98	19	Juan O'Leary	25.25S 55.22W		fa			pa				vi
20/02/98	20	Nr Juan O'Leary	—					pa				vi
20/02/98	21	Nr Santa Rita	25.50S 55.06W			ma			si			vi
20/02/98	22	North of Encarnacion	—			ma						vi
20/02/98	23	North of Pirapo	—			ma						

[1]at = *S.atropurpureum*, fa = *S.fastigiatum*, ma = *S.mauritianum*, me = *S.melongena*, pa = *S.palinacanthum*, si = *S.sisymbriifolium*, ss = *Solanum* sp., vi = *S.viarum*.

Insect species that were deemed to be 'common' were present at 20% or more of the localities where a particular *Solanum* species was surveyed. By contrast, 'abundant' species were those that were found in high numbers when encountered, but were not necessarily common. Voucher specimens of plants and insects are lodged in the collections of the South American Biological Control Laboratory (United States Department of Agriculture, Buenos Aires, Argentina) and the Cedara Weeds Laboratory (Plant Protection Research Institute, Hilton, South Africa).

RESULTS

Insects Associated with *Solanum mauritianum*

Nineteen insect herbivore species were associated with *S.mauritianum* (Table 2) at the 14 sites where this species was surveyed (Table 1). Of these, at least 10 species were previously collected on this plant (Neser et al. 1990). While 11 of the 19 species were also recorded on other *Solanum* species, 8 were recorded on *S.mauritianum* only (Tables 2 and 3). Eight herbivore species were considered to be common, of which 6 species were abundant at the sites.

On the basis of their incidence, abundance, resultant damage and observed host ranges, 5 of these herbivore species are considered to have potential as biocontrol agents (Table 3). These include the leaf-mining flea beetle *Acallepitrix* sp. nov. (Chrysomelidae), stem-boring weevils *Collabismus notulatus* Boheman and *Conotrachelus* prob. *squalidus* Boheman (both Curculionidae) and flower-feeding weevils *Anthonomus morticinus* Clark and *A.santacruzi* Hustache (Curculionidae). The former two species are uncommon and occur in low numbers, while the latter three species are common and mostly occur in high numbers when encountered (Table 3). The two *Anthonomus* species are morphologically very similar and were collected together at one locality. Despite the recovery of *A.santacruzi* on *Solanum fastigiatum* Willd. at one site, the high levels of floral damage inflicted has necessitated that this species warrants further investigation. All 5 candidate agents were imported into quarantine in South Africa at the conclusion of this trip (Olckers 1999).

Other species that were common, abundant, or both, but were not considered as potential biocontrol agents include the stem-boring beetle *Nealcidion bicristatum* (Bates) (Cerambycidae), an unidentified species of Membracidae, a species of *Nezara* (Pentatomidae), the lace bug *Corythaica cyathicollis* (Costa) (Tingidae), the leaf-mining moth *Acrolepia xylophragma* (Meyrick) (Acrolepiidae) and the flower-feeding beetles, *Nycterodina* sp. (Chrysomelidae)and *Carpophilus* sp. (Nitidulidae) (Table 3). Reasons for this include broad field host ranges (e.g. *C.cyathicollis*), reported pest status (e.g. *N.bicristatum*), broad host ranges in quarantine (e.g. *A.xylophragma*) and insufficient information on the damage inflicted (e.g. Membracidae, *Carpophilus* sp.) (Olckers 1999).

A notable exception from the herbivore fauna was the leaf-sucking lace bug *Gargaphia decoris* Drake (Tingidae) which was released in South Africa against *S.mauritianum* (Olckers 1999, 2000). This insect was imported following a single collection made near the Iguazu Falls (MS) in 1995, but was not observed in the same area during this trip and may thus be a rare species.

Insects Associated with *Solanum sisymbriifolium*

Eight insect herbivore species were recorded on *S.sisymbriifolium* (Table 2) at the 8 sites where this species was surveyed (Table 1). Four of these species are polyphagous (e.g. *Diabrotica speciosa* Germar) while the sap-sucking *Amblyophallus maculatus* Funkhonser (Membracidae) was associated with several other *Solanum* species (Table 3). Of the remaining 3 species, the unidentified species of Miridae was only recorded on *S.sisymbriifolium*, while the leaf-feeding tortoise beetle *Gratiana spadicea* (Klug) and flower-feeding weevil *Anthonomus sisymbrii* Hustache were also recorded on *S.viarum*, at one site where this species grew in close proximity to *S.sisymbriifolium*.

Five herbivore species were common and two of these were abundant at the sites (Table 3). *Gratiana spadicea* was the most common, abundant and damaging herbivore and was recovered at all 8 sites. The only species of importance from a biocontrol perspective were *G.spadicea* and *A.sisymbrii*, since there is insufficient information on the damage caused by the Miridae. Because these surveys were focused primarily on *S.mauritianum* and *S.viarum*, none of these insect species were imported into quarantine in South Africa at the conclusion of this trip.

Insects Associated with *Solanum viarum*

Eight insect herbivore species were associated with *S.viarum* (Table 2) at the 12 sites where this plant was surveyed (Table 1), of which 6 species were previously collected on this plant (Medal et al. 1996). While 6 herbivore species were recorded on other species of *Solanum*, 2 species were collected on *S.viarum* only (Table 2). Of the latter species, the leaf-feeding tortoise beetle *Metriona elatior* Klug (Chrysomelidae) appears to be host specific while the fruit-boring moth *Neoleucinodes elegantalis* Guenee (Pyralidae) is reported to attack tomato crops (Medal et al. 1996). Another tortoise beetle, *Gratiana boliviana* Spaeth, may also be suitably host specific, despite the collection of a single specimen on *Solanum palinacanthum* Dunal at one site where this species grew in close proximity to *S.viarum*.

TABLE 2. INSECT HERBIVORES ASSOCIATED WITH SPECIES OF *SOLANUM* IN ARGENTINA AND PARAGUAY.

Insect species	Mode of attack	Host plants[a]							
		at	fa	ma	me	pa	si	ss	vi
Coleoptera									
Chrysomelidae									
Acallepitrix sp. nov.	Leaf miner			x					
Colaspis sp.[b]	Leaf feeder			x	x				
Diabrotica speciosa[b,c]	Leaf & flower feeder			x	x		x		
Epitrix prob. *parvula*[b]	Leaf & root (?) feeder			x	x		x		
Gratiana boliviana[c]	Leaf feeder					x			x
Gratiana spadicea	Leaf feeder						x		x
Gratiana sp. 1 (yellow adult)	Leaf feeder		x						
Gratiana sp. 2 (orange adult)	Leaf feeder		x		x				
Gratiana sp. 3 (green adult)	Leaf feeder		x		x				
Metriona elatior[c]	Leaf feeder								x
Nycterodina sp.	Flower feeder	x	x	x					
Platyphora quadrisignata	Leaf feeder		x						
Cerambycidae									
Nealcidion bicristatum[b]	Stem borer			x					
Curculionidae									
Anthonomus morticinus	Flower feeder			x					
Anthonomus santacruzi[b]	Flower feeder		x	x					
Anthonomus tenebrosus	Flower feeder							x	
Anthonomus sisymbrii	Flower feeder						x		x
Collabismus notulatus	Stem borer (?)			x					
Conotrachelus prob. *squalidus*[b]	Stem borer			x					
Unidentified sp. 1	Flower feeder			x					
Unidentified sp. 2	Flower feeder		x						
Nitidulidae									
Prob. *Carpophilus* sp.[b]	Flower feeder			x					
Hemiptera									
Fulgoridae									
Unidentified sp.	Sap sucker			x					
Membracidae									
Amblyophallus maculatus[c]	Sap sucker			x	x		x		x
Unidentified sp.[b]	Sap sucker		x	x					
Miridae									
Unidentified sp.	Sap sucker						x		
Pentatomidae									
Nezara sp.	Sap sucker			x	x		x		
Tingidae									
Corythaica cyathicollis[b,c]	Sap sucker	x	x	x	x				x
Lepidoptera									
Acrolepiidae									
Acrolepia xylophragma	Leaf miner		x	x					
Gelechiidae									
Unidentified sp.	Flower feeder		x						
Nymphalidae									
Mechanitis lysimnia[b,c]	Leaf feeder				x		x		x
Pyralidae									
Neoleucinodes elegantalis[b,c]	Fruit borer								
Unidentified families									
Species 1	Leaf cutter		x	x	x			x	
Species 2	Leaf miner				x				
Total number of species		2	12	19	11	1	8	2	8

[a]Host plants: at = *S.atropurpureum*, fa = *S.fastigiatum*, ma = *S.mauritianum*, me = *S.melongena*, pa = *S.palinacanthum*, si = *S.sisymbriifolium*, ss = *Solanum* sp., vi = *S.viarum*.
[b]Previously collected on *S.mauritianum* (Neser et al. 1990).
[c]Previously collected on *S.viarum* (Medal et al. 1996).

Four herbivore species were common during this trip, namely *G.boliviana*, *M.elatior*, *A.maculatus* and the defoliating butterfly *Mechanitis lysimnia* Fabricius (Nymphalidae) (Table 3). All except *M.elatior* were abundant when encountered. A few specimens of *G.spadicea* and *A.sisymbrii*, which are normally associated with *S.sisymbriifolium*, were collected on *S.viarum* on one occasion (see above). At this site some flowerbuds of *S.viarum* contained larvae of *A.sisymbrii*, suggesting that this plant may be an alternative host for the weevil. The congeneric *Anthonomus* cf. *tenebrosus* Boheman which was previously collected on *S.viarum* (D.E.G., unpublished data), was not recovered on the plants during this survey. However, 3 specimens identified as *A.tenebrosus* were collected on an unidentified species of *Solanum* (see below).

On the basis of their incidence, abundance, damage levels and observed host ranges, only *G.boliviana* and *M.elatior* are important from a biocontrol perspective. Both species were collected for further studies in the laboratory in Argentina and the USA.

Insects Associated with Other *Solanum* Species

The most common of the remaining *Solanum* species was *S.fastigiatum* which was surveyed at 5 sites (Table 1). Of the 12 insect herbivore species observed on this plant (Table 2), most were also collected on other *Solanum* species. Species that were only recorded on *S.fastigiatum* included a tortoise beetle (probably a species of *Gratiana*), the leaf beetle *Platyphora quadrisignata* (Germar) (both Chrysomelidae) as well as an unidentified weevil (Curculionidae) and moth (Gelechiidae), both of which fed on the flowers. The most notable observation was the recovery of several specimens of *A.santacruzi* on flowers of *S.fastigiatum* at one site in Paraguay. This species is normally associated with *S.mauritianum*, but has also been recorded on *Solanum granuloso-leprosum* Dunal (Clark & Burke 1996), a species very closely related to and often confused with *S.mauritianum* (Kissmann & Groth 1997).

Three other *Solanum* species, *S.atropurpureum* (Schrank), *S.palinacanthum* and an unidentified species, were surveyed at only one or two sites (Table 1). The only noteworthy insects recorded on these (Table 2) were a single specimen of *G.boliviana* on the foliage of *S.palinacanthum* and 3 specimens of *A.tenebrosus* on the flowers of the unidentified *Solanum*.

Insects Associated with Eggplant Cultivations

Eggplant is not cultivated extensively in the areas surveyed and only 2 cultivations, that were untreated with pesticides and in close proximity to *S.mauritianum* (2 sites), *S.sisymbriifolium* (2 sites) or *S.viarum* (1 site), were located (Table 1). Eleven insect herbivore species were recorded on the crop (Table 2), although most of these occurred at low, undamaging levels. Species that caused the most damage were the lace bug *C.cyathicollis* and leaf-feeding flea beetle *Epitrix* prob. *parvula* (F.), both of which are recorded as pests of eggplant (Silva et al. 1968). In addition, the membracid *A.maculatus* and defoliating butterfly *M.lysimnia*, which were previously reported to cause significant damage to *S.viarum* (Medal et al. 1996), were also observed to attack the crop.

The most important observations on eggplant were the absence of several insects with biocontrol potential, despite their presence on natural host plants that were in close proximity (within 20m) to the cultivations. These species include *A.santacruzi*, *A.morticinus*, *C.* prob. *squalidus*, *C.notulatus* (all on *S.mauritianum*), *G.spadicea* (on *S.sisymbriifolium*) and *G.boliviana* (on *S.viarum*).

Discussion

The surveys confirmed the unsuitability of some of the insect species that were previously introduced into quarantine for screening as biocontrol agents. *Corythaica cyathicollis* and *N.bicristatum* were the first candidate agents imported for *S.mauritianum* in South Africa, but were rejected before tests were initiated because of published host records implicating several families of plants (Silva et al. 1968, Olckers 1999). The broad host range and pest status of *C.cyathicollis* was confirmed by these surveys and by preliminary trials in the USA, where it was evaluated as an agent for *S.viarum* (J. C. M., unpublished data). Although *N.bicristatum* was only collected on *S.mauritianum* during these surveys, adults have been reared from larvae collected in the stems of *Sambucus australis* Cham. & Schlecht. (Caprifoliaceae) in Buenos Aires Province (Di Iorio et al. 1998) which, being outside the range of *S.mauritianum* in Argentina, confirms that this species is polyphagous. The broad host range of *A.maculatus*, another candidate agent for *S.viarum*, during laboratory trials in the USA (J. C. M., unpublished data), was confirmed by its recovery on several non-target *Solanum* species including cultivated eggplant. None of the above mentioned species will thus be considered for release in South Africa or the USA.

Despite the findings that 58% and 75% of the *S.mauritianum* and *S.viarum* faunas, respectively, were also collected on other species of *Solanum*, the surveys suggested that at least 5 candidate agents for *S.mauritianum* and 2 for *S.viarum* warrant further investigation. Of the potential agents for *S.mauritianum*, the flower-feeding weevil *A.santacruzi* and leaf-mining flea

TABLE 3. INCIDENCE, ABUNDANCE AND FIELD HOST RANGE OF INSECT HERBIVORES ASSOCIATED WITH *SOLANUM MAURITIANUM*, *SOLANUM SISYMBRIIFOLIUM* AND *SOLANUM VIARUM* IN ARGENTINA AND PARAGUAY. (* = SPECIES THAT HAVE POTENTIAL AS BIOCONTROL AGENTS)

Insect species	Incidence (abundance)[a]			Site # (Table 1)[b]											Host range[c]	
	S. mauritianum	*S. sisymbriifolium*	*S. viarum*													
Foliage																
Acallepitrix sp. nov.*	7.1 (++)	—	—	18											1	
Colaspis sp.	7.1 (++)	—	—	3	8	10									2	P
Diabrotica speciosa	7.1 (++)	37.5 (++)	—	1	2	3	10								3	P
Epitrix prob. *parvula*	14.3 (++)	12.5 (++)	—	8	10										3	P
*Gratiana boliviana**	—	—	84.6 (+++)	5	9	10	11	13	15	16	19	20	21	22	2	
*Gratiana spadicea**	—	100.0 (+++)	7.7 (+)	1	2	4	8	9	10	13	21				2	
*Metriona elatior**	—	—	46.2 (++)	13	15	16	20	21	22						1	
Nealcidion bicristatum	35.7 (+++)	—	—	6	14	15	17	21							1	P
*Collabismus notulatus**	14.3 (++)	—	—	7	8										1	
Conotrachelus prob. *squalidus**	57.1 (+++)	—	—	3	8	10	12	14	15	16	21				1	
Unidentified Fulgoridae	14.3 (++)	—	—	14	21										1	
Amblyophallus maculatus	7.1 (++)	12.5 (++)	30.8 (+++)	3	4	5	8	10	11	13					4	
Unidentified Membracidae	28.6 (++)	—	—	7	8	10	14	15							2	
Unidentified Miridae	—	37.5 (+++)	—	1	2	4									1	
Nezara sp.	21.4 (+++)	12.5 (++)	—	8	10	12	16	17							3	P
Corythaica cyathicollis	14.3 (+++)	—	7.7 (++)	5	6	8	10	11	21						5	P
Acrolepia xylophragma	21.4 (++)	—	—	3	5	7	18								2	
Mechanitis lysimnia	—	50.0 (++)	23.1 (+++)	1	2	4	8	10	11	13					3	P
Lepidopteran leaf cutter	7.1 (++)	—	—	8	10	11	17								4	
Flowers																
Nycterodina sp.	21.4 (+++)	—	—	5	6	8	10	11	12	19					3	
*Anthonomus morticinus**	50.0 (+++)	—	—	6	8	10	14	21							1	
*Anthonomus santacruzi**	35.7 (+++)	—	—	7	8	12	15	17	18	19	23				2	
*Anthonomus sisymbrii**	—	25.0 (++)	7.7 (+)	2	4										2	
Unidentified Curculionidae	7.1 (+)	—	—	3											1	
Prob. *Carpophilus* sp.	14.3 (+++)	—	—	8	21										1	
Fruit																
Neoleucinodes elegantalis	—	—	7.7 (++)	9											1	P

[a]Incidence is reflected by the number of localities where the insects occurred (as a percentage of the total number of localities where each plant species was surveyed). Abundance is a reflection of the average insect population levels, where + = very few individuals found, ++ = low numbers of individuals and +++ = high numbers of individuals.

[b]Includes sites where the insects were recorded on hosts other than the three target species reported here.

[c]Number of hosts recorded during this survey; P = polyphagous species that are known to attack plants from other genera of Solanaceae or from families other than Solanaceae.

beetle *Acallepitrix* sp. nov. are currently undergoing host-specificity tests in South Africa (Olckers 1999), while the second flowerbud weevil, *A.morticinus*, is under evaluation in Brazil. Similar evaluations on the leaf-feeding tortoise beetles *M.elatior* (Medal et al. 1999) and *G.boliviana* (Medal et al. 2001) in Argentina, Brazil and the USA have been concluded. Permission for the release of both *M.elatior* and *G.boliviana* in the USA has been sought, but has been delayed pending further investigation. By contrast, permission to release *A.santacruzi* and *Acallepitrix* sp. nov. in South Africa has not yet been sought because of feeding on non-target *Solanum* species in quarantine (T.O., unpublished data), necessitating that further work in South America be carried out to elucidate the agents' field host ranges.

Although the surveys were largely focused on *S.mauritianum* and *S.viarum*, observations on *S.sisymbriifolium* confirmed the importance of two natural enemies. The leaf-feeding tortoise beetle *G.spadicea* was the most common, abundant and destructive species, while the flower-feeding weevil *A.sisymbrii* was less common and abundant but is potentially very damaging because of its ability to reduce fruit set. *Gratiana spadicea* was released in South Africa for the biocontrol of *S.sisymbriifolium*, despite feeding on eggplant and 8 native South African *Solanum* species during quarantine evaluations (Olckers et al. 1999). Collections of the beetle on only two host plants during this survey and the absence of attacks on eggplant, provide some support for the decision to release this agent. *Anthonomus sisymbrii* has also been considered for introduction into South Africa (Olckers et al. 1999) and these surveys support this conclusion.

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REFERENCES CITED

CLARK, W. E., AND H. R. BURKE. 1996. The species of *Anthonomus* Germar (Coleoptera: Curculionidae) associated with plants in the family Solanaceae. Southw. Entomol. Suppl. No. 19: 1-114.

DI IORIO, O. R., H. A. CORDO, G. A. LOGARZO, AND D. E. GANDOLFO. 1998. Cerambycidae (Coleoptera) root and stem borers in living plants from Argentina: a bibliographical review and new host plant records. G. it. Ent.: 9: 73-95.

KISSMANN, K. G., AND D. GROTH. 1997. Plantas Infestantes e Nocivas. Tomo 3, 2 Edição. BASF, São Paulo, Brasil. 683 pp.

MEDAL, J. C., R. CHARUDATTAN, J. J. MULLAHEY, AND R. A. PITELLI. 1996. An exploratory insect survey of tropical soda apple in Brazil and Paraguay. Florida Entomol. 79: 70-73.

MEDAL, J. C., R. A. PITELLI, A. SANTANA, D. GANDOLFO, R. GRAVENA, AND D. H. HABECK. 1999. Host specificity of *Metriona elatior*, a potential biological control agent of tropical soda apple, *Solanum viarum*, in the USA. BioControl 44: 421-436.

MEDAL, J. C., D. SUDBRINK, D. GANDOLFO, D. OHASHI, AND J. P. CUDA. 2001. *Gratiana boliviana*, a potential biocontrol agent of *Solanum viarum*: quarantine host-specificity testing in Florida and field surveys in South America. BioControl 46 (In press).

NESER, S., H. G. ZIMMERMANN, H. E. ERB, AND J. H. HOFFMANN. 1990. Progress and prospects for the biological control of two *Solanum* weeds in South Africa, pp. 371-381, *In* E.S. Delfosse [ed.], Proceedings of the 7th International Symposium on Biological Control of Weeds, March 6-11, 1988, Italy, Istituto Sperimentale per la Patologia Vegetale Ministero dell'Agricoltura e delle Foreste, Rome, Italy. 699 pp.

OLCKERS, T. 1999. Biological control of *Solanum mauritianum* Scopoli (Solanaceae) in South Africa: a review of candidate agents, progress and future prospects, pp. 65-73. *In* T. Olckers, M.P. Hill [eds.], Biological Control of Weeds in South Africa (1990-1998). Afr. Ent. Mem. 1. 182 pp.

OLCKERS, T. 2000. Biology, host specificity and risk assessment of *Gargaphia decoris*, the first agent to be released in South Africa for the biological control of the invasive tree *Solanum mauritianum*. BioControl 45: 373-388.

OLCKERS, T., J. H. HOFFMANN, V. C. MORAN, F. A. C. IMPSON, AND M. P. HILL. 1999. The initiation of biological control programmes against *Solanum elaeagnifolium* Cavanilles and *S. sisymbriifolium* Lamarck (Solanaceae) in South Africa, pp. 55-63, *In* T. Olckers, M. P. Hill [eds.], Biological Control of Weeds in South Africa (1990-1998). Afr. Ent. Mem. 1. 182 pp.

PEMBERTON, R. W. 2000. Predictable risk to native plants in weed biological control. Oecologia 125: 489-494.

SILVA, A.G.D'A., C. R. GONÇALVES, D. M. GALVÃO, A. J. L. GONÇALVES, J. GOMES, M. D. SILVA, AND L. DE SIMONI. 1968. Quarto catálogo dos insetos que vivem nas plantas do Brasil seus parasitos e predatores. Parte 2-1 tomo, insetos, hospedeiros e inimigos naturais. Ministério da Agricultura, Departemento de Defesa e Inspeção Agropecuaria, Rio de Janeiro, Brasil. 622 pp.