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Natural enemies of balloon vine *Cardiospermum grandiflorum* (Sapindaceae) in Argentina and their potential use as biological control agents in South Africa

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Abstract. Exploratory field surveys of the natural enemies associated with balloon vine *Cardiospermum grandiflorum* Swartz, an environmental weed in South Africa, Australia and other countries, were conducted in northern Argentina from 2005 to 2009. The surveys included other plant species in the genus *Cardiospermum* and other native Sapindaceae, permitting an assessment of the distribution and host range of the natural enemies. Seventeen phytophagous insects in five orders and ten families, and two fungal pathogens were found. The nature of the potential agents' damage, their field distribution and abundance, and the results of preliminary host-specificity testing indicated that the seed-feeding weevil *Cissoanthonomus tuberculipennis* (Coleoptera: Curculionidae) and the fruit-galling midge *Contarinia* sp. (Diptera: Cecidomyiidae) were the most promising biological control agents for *C. grandiflorum* outside of its native range.

Key words: host range, foreign exploration, emerging weed, *Cissoanthonomus tuberculipennis*, *Contarinia* sp.

Introduction

Balloon vine *Cardiospermum grandiflorum* Swartz (Sapindaceae) is a perennial, woody climber that occurs naturally in tropical Africa, Asia, and South and Central America. In the Americas, its distribution extends from Southern Mexico to Argentina (Cowan, 1983; Ferrucci, 1991; BRAIN, 1997; Ferrucci, 1998; PIER, 2006). Introduced into many tropical areas of the world as an ornamental garden creeper, balloon vine has become an invasive weed in Australia, the Cook Islands, Hawaii, New Zealand and South Africa (Meyer, 2000; Henderson, 2001; Carroll *et al.*, 2005; GISD, 2005; USDA-NRCS, 2009).

Balloon vine was declared an invasive environmental weed in various regions of Australia and South Africa soon after its discovery in the 1920s and 1930s, respectively (Carroll *et al.*, 2005; WESSA, 2006). It is known that some weeds have a latent period following introduction before a slight ecological adaption enables them to become

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invasive (Binggeli, 2001; Groves, 2006). Changes in biotic or abiotic factors, as well as human activities and perception and adaptive evolution are explanations for some observed time lags (Binggeli, 2001; Lee, 2002). It is only during recent years that balloon vine has begun to display signs of invasiveness in South Africa, and consequently has been one of the 'emerging' weeds targeted for biological control in South Africa since 2003 (Olckers, 2004).

Balloon vine is widely distributed in five South African provinces: Gauteng, Mpumalanga, Limpopo, KwaZulu Natal, Eastern Cape and neighbouring countries (Henderson, 2001). Also considered a 'transformer' weed, balloon vine forms dense infestations, competing with and smothering indigenous plants in forest margins, watercourses and urban open spaces in subtropical regions (Henderson, 2001; GISD, 2005; WESSA, 2006). Although the plant re-grows from root fragments, it reproduces mainly by seeds, which are dispersed inside floating capsules by the wind and along waterways (GISD, 2005; WESSA, 2006). Control methods used against balloon vine include stalk immersion and foliar spray with herbicides and hand pulling of roots and seedlings (BRAIN, 1997; WESSA, 2006). However, these control practices are highly labour intensive, expensive and unsustainable as the plant coppices aggressively when cut back, requiring follow-up monitoring and treatments. In addition, due to its ability to grow along watercourses and natural habitats, balloon vine is difficult to control chemically or mechanically, which makes it an ideal candidate for biological control (Zimmermann and Neser, 1999; Olckers, 2003, 2004).

The use of biological control on an emerging weed is regarded as a cost-effective strategy as the resources required to curb its spread are likely to be significantly less than those required when it has become a fully fledged weed (Zimmermann and Neser, 1999; Olckers, 2003, 2004). As part of this strategy, the Agricultural Research Council, Plant Protection Research Institute, Pretoria, South Africa and the United States Department of Agriculture, Agricultural Research Service, South American Biological Control Laboratory, Hurlingham, Argentina, initiated a co-operative biological control programme on balloon vine in January 2005. Previous studies conducted in the Neotropics indicated that balloon vine and its congeners are attacked by a suite of insect natural enemies (Carroll and Loye, 1987; Carroll, 1988). Recent surveys conducted in previously unexplored northeastern Argentina indicated that balloon vine populations there harbour new natural enemies. In this paper, we present a prioritized list of natural enemies associated with balloon vine and other *Cardiospermum* species in their native range, with information on their biology, distribution and host plants. We also discuss their potential as biological control agents against balloon vine in South Africa and elsewhere in the world.

Materials and methods

Exploration and field host range

Extensive exploratory surveys on *C. grandiflorum* and other selected Sapindaceae were conducted along the main roads in the provinces of Chaco, Corrientes, Formosa, Jujuy, Misiones and Salta, in northern Argentina from January 2005 to April 2009 (Fig. 1). Forty sites were surveyed during the 4-year period, and most of the sites were scouted twice per year. Balloon vine occurring mainly along the natural forest edges and roadsides were scouted. Adult insects were collected by hand directly from the plants, while immature stages imbedded inside leaves, flower buds and fruits were transported to the laboratory in Buenos Aires, and reared to adulthood. In addition, leaves, stems and fruits of balloon vine and other Sapindaceae species were visually inspected for fungal pathogens. The infected material was collected from the field and preserved in a plant press for subsequent use at the laboratory.

Organisms that were found were considered 'rare' when present at less than 10% of the sites, 'occasional' at 10–30% of the sites or 'common' at more than 30% of the sites. Similarly, the abundance per site was ranked as ' + ' ($\leq$10 individuals), '++' (11–30 individuals) and '+++' ($>$30 individuals). Organisms collected/reared were sent to taxonomists for identification or description of new species.

Natural enemies were prioritized according to their perceived potential to control balloon vine. The criteria used included their apparent host specificity as determined from field observations, published records, and information provided by entomologists and pathologists on specific groups of insects and pathogens. Some species were investigated further in the laboratory to determine their host specificity and potential impact on *C. grandiflorum*. Sympatric populations of *Cardiospermum corindum* L., *Cardiospermum halicacabum* L. and *C. halicacabum* var. *microcarpum* (Kunth) Blume were also inspected, together with other closely related species within the Sapindaceae such as *Paullinia elegans* Cambessèdes, *Serjania fuscifolia* Radlkofer, *Serjania glabrata* Kunth, *Serjania laruotteana* Cambessèdes, *S. marginata* Casaretto, *S. meridionalis* Cambessèdes, *Urvillea chacoensis* Hunziker, *Urvillea ulmacea* Kunth and *Urvillea uniloba* Radlkofer. Voucher specimens of the plants and organisms collected were deposited

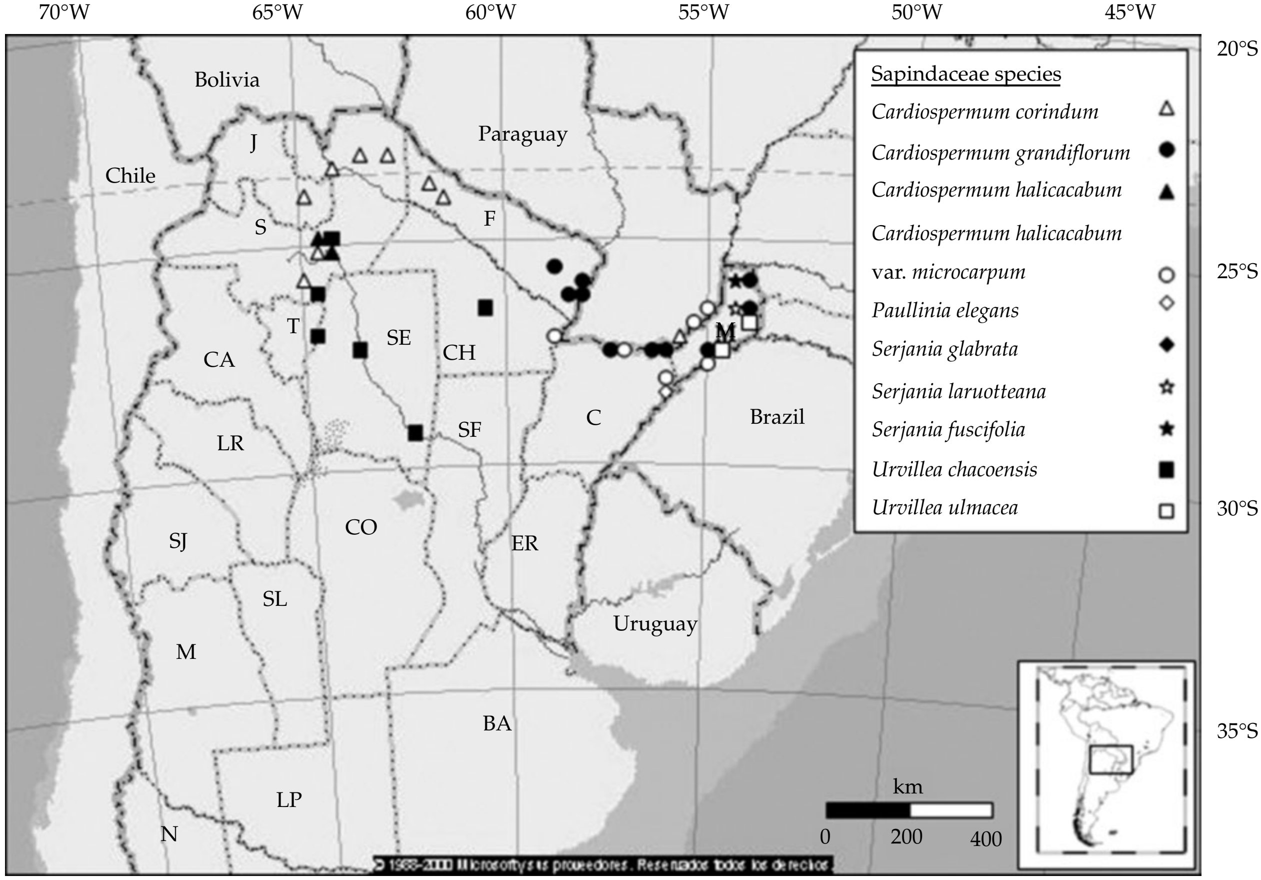

Fig. 1. Main collecting sites of natural enemies of *Cardiospermum grandiflorum* and other Sapindaceae in northern Argentina. CH, Chaco; C, Corrientes; F, Formosa; J, Jujuy; M, Misiones; S, Salta; SE, Santiago del Estero; T, Tucumán; BA, Buenos Aires; ER, Entre Ríos; CO, Córdoba; SL, San Luis; SJ, San Juan; SF, Santa Fe; CA, Catamarca; LR, La Rioja; M, Mendoza; N, Neuquén; LP, La Pampa. This figure was created using Atlas Mundial Encarta 2001 (Microsoft).

at the SABCL and at the Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina.

Preliminary host-specificity testing of selected agents

Out of 11 natural enemies (two pathogens and nine insects) found on *C. grandiflorum* in the field, three (all insects) were further subjected to preliminary host-specificity tests in the laboratory. These included *Gargaphia* sp. (Hemiptera: Tingidae), *Cissoanthonomus tuberculipennis* Hustache (Coleoptera: Curculionidae) and *Chlorostrymon simaethis sarita* (Skinner) (Lepidoptera: Lycaenidae).

The sap-sucking lace bug *Gargaphia* sp. was subjected to adult no-choice oviposition tests in quarantine in South Africa. Plants tested included *C. grandiflorum*, *C. corindum* and *C. halicacabum*, a wide range of other Sapindaceae, and some crop species of economic importance in South Africa (Table 1). Each test plant was placed separately in a gauze-covered cage (0.55 × 0.55 × 0.95 m) for 10 days with six pairs of newly emerged adult bugs. The experiment was replicated four times, with each plant representing one replicate. After 10 days, each plant was examined for leaf damage and eggs deposited.

The seed-feeding weevil *C. tuberculipennis* was subjected to preliminary adult no-choice and paired-choice oviposition tests in Argentina. Oviposition was evaluated on *C. grandiflorum*, *C. corindum* and *C. halicacabum* var. *microcarpum* under controlled environmental conditions (25 ± 1 °C; 60–80% RH; 16 h light-8 h dark) using 1- and 3-l gauze-covered plastic containers for no-choice and paired-choice trials, respectively (Table 2). Five to ten soft green fruits (1–2 cm long) excised from each test plant were exposed to eight adults for 72 h. Moistened tissue paper was placed at the bottom of each container to delay desiccation of the fruits. The number of eggs deposited was recorded.

The seed-feeding butterfly *C. simaethis sarita* was subjected to adult no-choice oviposition tests in South Africa on *C. grandiflorum*, *C. corindum* and

Table 1. Plant species on which *Gargaphia* sp. was tested for adult feeding, oviposition and nymphal survival in no-choice tests

Plant species	Leaf feeding damage level[+] (mean ± SE)	Number of eggs laid (mean ± SE)	Number of newly emerged nymphs (mean ± SE)
Sapindaceae			
Cardiospermum grandiflorum	3 ± 0.1	315 ± 14.5	260 ± 12.3
Cardiospermum halicacabum	3 ± 0.2	195 ± 10.3	135 ± 11.7
Cardiospermum corindum	3 ± 0.2	37 ± 5.6	15 ± 3.1
Allophylus decipiens	0	0	0
Dodonaea angustifolia	0	0	0
Paullinia pinnata	0	0	0
Pappea capensis	0	0	0
Fabaceae			
Phaseolus vulgaris (bean)	3	59 ± 8.1	33 ± 4.9
Pisum sativum (pea)	0	0	0
Convolvulaceae			
Ipomoea batatas (sweet potato)	1	0	0

[+] Level of feeding damage: none, 0; slightly damaged, 1; moderately damaged, 2; severely damaged, 3.

C. halicacabum. Fruit clusters, each containing approximately ten young fruits, were inserted by their stalks into a 400 ml flask full of water and placed inside a cage (0.5 × 0.5 × 1.0 m) constructed of a fine gauze material. Three pairs of adults were confined with the fruits for 10 days, and the fruits were inspected for oviposition. Eggs were kept until hatching, and emerging larvae were reared to adulthood on seeds of the same plant species. This experiment was repeated four times.

Results and discussion

Fungal pathogens

Puccinia arechavaletae Spegazzini (Uredinales: Pucciniaceae): this rust fungus was locally abundant throughout the wetter northeastern range of balloon vine in Argentina. It causes severe disease symptoms on *C. grandiflorum*, attacking the leaves, stems and fruits under natural conditions. *P. arechavaletae* has also been recorded on *C. halicacabum* var. *microcarpum*, *C. corindum*, as well as on other Sapindaceae plant species in tropical America (Farr and Rossman, 2009), but recent studies in South Africa have shown that host-specific strains do occur (A. Fourie *et al.*, unpublished data). In general, rust fungi are host specific and are often used as weed biological control agents (Charudattan, 2001, 2005; Morin *et al.*, 2006). *P. arechavaletae* is an autoecious microcyclic rust, producing only teliospores and basidiospores. This is an added benefit with respect to host specificity, since it completes its life cycle on a single host. Preliminary results have suggested that the rust has good potential as a biological control agent for balloon vine in South Africa.

Phyllachora rimulosa Spegazzini (Phyllachoraceae): this tar spot fungus was found developing on the leaves, stems and fruits of balloon vine. It was described on *Eugenia* sp. (Myrtaceae) in Costa Rica (Spegazzini, 1919), and its presence on *C. grandiflorum* constitutes the first record for this species in Argentina (Cecilia Carmarán, personal communication). The Phyllachoraceae are widely distributed in the tropical regions of the world affecting different host plants, but without producing much damage (Cecilia Carmarán,

Table 2. Preliminary host range testing of *Cissoanthonomus tuberculipennis* in Argentina

Tested plants	Replicates	No. of eggs (mean ± SE) No-choice test	No. of eggs (mean ± SE) Paired-choice test
Cardiospermum corindum	2	1.5 ± 0.5	
Cardiospermum grandiflorum	2	6.5 ± 0.5	
C. corundum			0
C. grandiflorum	1	—	7
Cardiospermum halicacabum var. *microcarpum*			0
C. grandiflorum	5	—	7 ± 0.8

personal communication). Hodges (1988), searching for natural enemies of *Psidium cattleianum* Sabine (Myrtaceae) in Brazil, reported the presence of the congener *Phyllachora subcircinans* Spegazzini, but did not recommend it as a biological control agent because of insignificant levels of damage on its host. Considering this information, of the related species *P. subcircinans,* and the existence of *P. arechavaletae*, an apparently more effective pathogenic fungus of balloon vine *P. rimulosa* is not being considered for further studies.

Insects

In total, 17 phytophagous insects were found associated with *C. grandiflorum* and other Sapindaceae species in northern Argentina within the orders Hemiptera (two species), Coleoptera (five species), Lepidoptera (six species), Diptera (one species) and Hymenoptera (three species) (Table 3). *C. tuberculipennis*, *Contarinia* sp. (Diptera: Cecidomyiidae) and *Moodnopsis* sp. nr *perangusta* Dyar (Lepidoptera: Pyralidae) were found exclusively on *C. grandiflorum*.

Leaf feeders

Gargaphia sp.: the surveys indicated that this leaf-sucking lace bug was one of the most common natural enemies of balloon vine, occurring almost everywhere within the geographic range of the host plant. Egg batches are mostly deposited on the abaxial surface of the leaf. Nymphs and adults feed primarily on the underside of the leaves, causing severe chlorosis. Although *Gargaphia* sp. was found mainly on *C. grandiflorum*, further tests conducted in South Africa indicated a wider host range, attacking important plant species outside the Sapindaceae (Table 1), notably the common bean, *Phaseolus vulgaris* L. (Fabaceae). Because of its wide host range, further studies on *Gargaphia* sp. are not recommended.

Seed feeders

Cissoanthonomus tuberculipennis: this weevil was found on *C. grandiflorum* throughout its geographical range in Argentina. Adult weevils are brown to grey in colour, approximately 5 mm in length, have prominent tubercles on the elytra, and the fore femora are greatly enlarged with a large ventral spine. Eggs are inserted inside the young green fruits (±1 cm long), and the larvae feed on the immature seeds inside the developing fruits. Greenish-blue pupae are found attached to the inner wall of the ripening fruit. Up to two adult weevils emerge from the ripening, well-developed pods. Adults were often found feeding on flower buds and flowers. Under laboratory conditions, adults fed on seeds of young fruits and on leaves when they were deprived of flower buds, flowers or fruits. In preliminary no-choice and paired-choice tests, *C. tuberculipennis* females laid more eggs on *C. grandiflorum* and only a few on other *Cardiospermum* species (Table 2). However, the present field surveys and studies by Clark (2006) and Clark *et al.* (2007) suggested that *C. grandiflorum* is the only natural host of *C. tuberculipennis*. Aspects of the biology of *C. tuberculipennis* such as the longevity of adults (up to 4 months in controlled laboratory conditions), short generation times (approximately 40 days) and the severe feeding damage by larvae and adults suggest that this weevil has excellent potential as a biological control agent for balloon vine.

Chlorostrymon simaethis sarita: this ‘hairstreak moth’ occurs throughout Central and South America, from Mexico to Argentina (Nicolay, 1980). We found it feeding on seeds of *Cardiospermum* and *Urvillea* species (Table 3). Larvae were reported inside the pods of *C. corindum* in Baja California, Mexico (Brown, 1983). Round greenish-blue eggs are laid singly on the surface of the young fruit. Larvae bore through the papery fruit walls to reach the immature seeds. The larva is voracious, devouring all of the three seeds within a fruit before completing its development. The larva exits the empty fruit to pupate on the ground. During preliminary adult no-choice tests, this butterfly laid more (28 ± 8.4) eggs on *C. grandiflorum* compared with 8 ± 1.4 and 4 ± 1.1 laid on *C. corindum* and *C. halicacabum*, respectively. The highest percentage of surviving larvae that developed to adults was on *C. grandiflorum* (100%), followed by *C. halicacabum* (75%) and *C. corindum* (70%). Although the damage on the target weed *C. grandiflorum* was high, Pratt and Ballmer (1991) reported a wide host range of this butterfly, which included species of the Fabaceae. Because of its wide host range, *C. simaethis sarita* is not recommended as a candidate biological control agent for *C. grandiflorum*.

Moodnopsis n. sp. near *perangusta*: this moth was found for the first time feeding on *C. grandiflorum*. Host plants for the six described *Moodnopsis* spp. are unknown (Robinson *et al.*, 2009). In most cases, a single yellowish-white larva destroyed all three seeds within a pod. Pupation takes place inside a silk cocoon that remains attached to the inner walls of one of the three pod partitions. The grey-brown coloured adults (wingspan: 2–2.3 cm) emerge from the dry mature fruits. Although our surveys indicated that *C. grandiflorum* was the only natural host of this moth, larvae were recently found inside young fruits of a closely related species *C. corindum* in an open-field

Table 3. Natural enemies recorded on balloon vine *Cardiospermum grandiflorum* and other Sapindaceae in northern Argentina

Natural enemies	Natural host	Attack site or mode	Stages collected[1]	Frequency of collection[2] and abundance[3]	Specificity index[4]
Fungal pathogens					
Uredinales					
Pucciniaceae					
Puccinia arechavaletae Spegazzini	*C. grandiflorum* Sw. *Cardiospermum corindum* L. *Cardiospermum halicacabum* var. *microcarpum* (Kunth) Blume	Leaves/stems/fruits		C	**
Phyllachoraceae					
Phyllachora rimulosa Spegazzini	*C. grandiflorum* Sw.	Leaves/stems		C	*
Insects					
Hemiptera					
Tingidae					
Gargaphia sp.	*C. grandiflorum* Sw. *Serjania glabrata* Kunth	Leaf feeder	E; N; A	C/+++	*
Rhopalidae					
Jadera spp.	*C. grandiflorum* Sw. *C. corindum* L.	Seed feeder	N; A	C/+++	***
Coleoptera					
Curculionidae					
Cissoanthonomus tuberculipennis Hustache	*C. grandiflorum* Sw.	Seed feeder	E; L; P; A	C/+++	****
Achia affinis Hustache	*Serjania fuscifolia* Radlk.	Seed feeder	L; A	R/+	—
Achia ancile Burke	*Serjania laruotteana* Cambess.	Seed feeder	L; A	R/+	—
Achia boliviana Clark & Burke	*Urvillea chacoensis* Hunz.	Seed feeder	L; A	R/+	—
Achia urvilleae Clark & Burke	*Urvillea ulmacea* Kunth	Seed feeder	L; A	R/+	—
Lepidoptera					
Elachistidae					
Stenoma or *Antaeotricha* sp.	*Paullinia elegans* Cambess.	Fruit feeder	L	O/++	—
Hesperiidae					
Pellicia hersilia Hayward	*Serjania glabrata* Kunth	Leaf tier	L	Uncertain	—
Lycaenidae					
Chlorostrymon simaethis sarita (Skinner)	*C. grandiflorum* Sw. *C. corindum* L. *Cardiospermum halicacabum* L. *Cardiospermum halicacabum* var. *microcarpum* (Kunth) Blume *U. chacoensis* Hunz. *U. ulmacea* Kunth	Seed feeder	E; L; P; A	C/+++	*
Pyralidae					
Phycitinae					
Moodnopsis near *perangusta* Dyar	*C. grandiflorum* Sw.	Seed feeder	L; P	C/++	***

Table 3. (continued)

Natural enemies	Natural host	Attack site or mode	Stages collected[1]	Frequency of collection[2] and abundance[3]	Specificity index[4]
Epipaschiinae					
Apocera zographica (Dyar)	*C. grandiflorum* Sw.	Leaf tier	L	O/++	****
Tortricidae					
Platynota xylophaea Meyrick	*C. grandiflorum* Sw.	Leaf tier	L	R/++	****
Diptera					
Cecidomyiidae					
Contarinia sp.	*C. grandiflorum* Sw.	Fruit galls	L; P	C/+++	****
Hymenoptera					
Eulophidae					
Lisseurytomella flava (Ashmead)	*C. grandiflorum* Sw. *C. corindum* L. *Cardiospermum halicacabum* L. *Cardiospermum halicacabum* var. *microcarpum* (Kunth) Blume *U. chacoensis* Hunz.	Seed feeder	L; P	C/+++	**
Oxypracetus sp.	*S. fuscifolia* Radlk.	Seed feeder	L; P	Uncertain	—
Tetrastichus urvilleae De Santis	*Urvillea uniloba* Radlk.	Seed feeder	L; P	Uncertain	—

[1] A, adult; E, egg; L, larva; N, nymph; P, pupa.
[2] R, rare; O, occasional; C, common.
[3] Abundance: +, ≤10 individuals; ++, 11–30 individuals; +++, >30 individuals.
[4] Specificity index (calculated for those natural enemies that include *C. grandiflorum* as a natural host): *, host range exceeds Sapindaceae; **, host range restricted to Sapindaceae; ***, host range restricted to *Cardiospermum* species; ****, host range restricted to *C. grandiflorum* only.

experiment currently in progress in Argentina (F. Mc Kay *et al.*, unpublished data). However, further observation revealed that none of *Moodnopsis* n. sp. larvae completed development on this plant species. Therefore, the narrow field host range displayed and the level of damage exerted by this moth on the target weed justify further screening as potential biocontrol agent.

Lisseurytomella flava Ashmead (Hymenoptera: Eulophidae: Tetrastichinae): varying numbers of larvae (5–30) of this phytophagous wasp were found feeding on green seeds in immature fruits of *C. grandiflorum* and other Sapindaceae at several localities (Table 3), causing deformation of the seeds and possibly inhibiting their viability. Pupation takes place inside the pods and the adults emerge from the mature dehiscing pods. Two other microhymenoptera, *Tetrastichus urvilleae* De Santis (Eulophidae: Tetrastichinae) and *Oxypracetus* sp. (Eulophidae: Tetrastichinae) were found on the Sapindaceae species: *U. uniloba* Radlkofer and *S. fuscifolia* Radlkofer, respectively. So far, records in Argentina indicate that the host range of *L. flava* is restricted to species of *Cardiospermum* and *Urvillea*, the two closely related genera within the tribe Paulliniae (Ferrucci, 1991).

Gall formers

Contarinia sp.: this gall midge was found damaging young fruits of *C. grandiflorum* at many sites, resulting in fruit deformation and destruction of seeds. The colour of the galls changes progressively from green in the early instars (0.5 cm in diameter) to greenish-brown at maturity (1.5 cm in diameter), during which the orange larvae exit the gall and drop onto the ground to pupate. To rear the adults, the mature galls were cut from the plant and placed in a plastic jar containing wet peat moss at the bottom. During the first day, midge larvae were observed exiting the gall and eventually burrowing into the soil to pupate. Adult emergence was recorded 2–3 weeks after the emergence of larvae from the galls. Unfortunately, high levels of parasitism by several hymenopteran wasp species including *Oomyzus sokolowski* Kurdjumov (Eulophidae) and *Idiomacromerus* sp. (Torymidae) and *Torymus* sp. (Torymidae) prevented the rearing and evaluation of this species in the laboratory. There are no host records of gall midges associated with either Sapindaceae or *Cardiospermum* species in North and South America (Gagné, 1989, 1994). So far, our field surveys indicate that *C. grandiflorum* is the only natural host of this gall midge. Because of its narrow field host range and the potential impact on reproductive capacity of *C. grandiflorum*, this gall midge appears to be a suitable biological control agent for this invader. Therefore, further host-specificity tests on this midge are strongly recommended.

Conclusions

Considering that balloon vine is an emerging weed that reproduces mainly by seeds, it seems that fruit- and seed-feeding agents like the weevil *C. tuberculipennis* and the midge *Contarinia* sp. would be more effective as biological control agents and should be prioritized for further studies. Indeed, our field surveys showed that seed-feeding agents are the most common and damaging agents and probably the key factors that regulate the abundance of balloon vine in its native range. Because there are no conflicts of interest associated with the control of balloon vine in South Africa, biological control may include agents that attack feeding niches other than fruits or seeds (e.g. leaves and stems). However, seed-attacking agents have played an important role in the long-term management of alien plant species, especially in reducing the cost of follow-up control operations (Neser and Kluge, 1986; Zimmermann, 1991; Moran *et al.*, 2004). It is therefore conceivable that seed feeders would be effective in curbing the spread of an alien invader such as balloon vine. Because *C. tuberculipennis* and *Contarinia* sp. are highly damaging and also displayed host ranges that are restricted to *C. grandiflorum*, they seem to be the best candidates for biological control of balloon vine in South Africa and elsewhere. It is strongly recommended that the two insects be subjected to further host-specificity tests.

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