Biological Control of Cape ivy
Joe Balciunas Research Report
(April 2002 through December 2002)

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Executive Summary
by
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Welcome to the 2002 Annual Report for the Cape Ivy Project. Since our 2001 Annual Report included the first quarter [Jan.-Mar.] of 2002, this report covers the final nine months [Apr.- Dec.] of 2002. Once again, we have combined the progress reports of our South African colleagues who are assisting us on this project, into one Annual Report.

During 2002, our research, both at Albany and in South Africa, focused on developing the first two biocontrol agents for Cape ivy. Fortunately, our laboratory colonies of both the Cape ivy gall fly, *Parafreutreta regalis*, and the Cape ivy stem-boring moth, *Digitivalva delaireae,* were productive this year, and as a result we made excellent progress in testing their host ranges. Our planned testing of *Parafreutreta* is nearing completion [see Section II], and if we can obtain the last few test plant species, should be finished during the first half of 2003. Likewise, testing of *Digitivalva* moths advanced well during 2002 [see Section III], and, optimistically, might be completed by the end of 2003.

The minute caterpillars of *Digitivalva* cause extensive damage to Cape ivy. In our laboratory, they frequently kill most leaves and many stems, and occasionally entire plants. If our tests confirm the safety of *Digitivalva*, and we are able to obtain permits for its release, this moth should become an excellent biocontrol agent.

The impacts from the galls of *Parafreutreta* flies are more subtle. Since even an agent whose feeding is restricted to Cape ivy might have unpredictable impacts on ecosystem foodwebs, I wanted to prove that these galls do negatively impact this vine. During 2002, I conducted two trials measuring the impacts of two different densities of *Parafreutreta* flies on both small and medium sized Cape ivy plants [see Section II C]. In both cases the reduction in biomass and structure of the vines was readily evident, and statistically different from ungalled plants. Although these galls will probably not directly kill the Cape ivy, they deserve continued consideration as biocontrol agents.

During 2002, I made my fifth visit to South Africa, and spent the month of May reviewing progress there, and planning future research [see Section I B]. During this visit, I was able to launch new sub-projects that investigate a promising flower-feeding beetle [see Section IV], as well as pathogen that we frequently find damaging the leaves of Cape ivy in South Africa [see Section V]. We were also able to finally obtain identification of an orange-colored rust that we occasionally observe damaging Cape ivy in California and Oregon.

Due to the excellent progress during 2002, by mid-2003, we hope to prepare and submit a petition requesting field release of the *Parafreutreta* gall fly in California. This petition is just the first step in a long regulatory process, but barring set-backs, we are hopeful of releasing our first insects during 2004.

While we made excellent scientific progress during 2002, the funding picture was far less satisfactory. Due to new priorities for funding agencies and the continued poor economy in California, the external funds that we received this past year was cut nearly in half, and early indications are that they will be even lower during 2003. Since the Cape ivy research in South Africa is primarily supported by these external funds, if this shortfall is sustained, it will mean a drastic cutback on the amount of research there. This will slow the testing of current agents, as well as the development of additional agents for controlling Cape ivy.

April 2002 through December 2002 Research Report

prepared by Joe Balciunas, Chris Mehelis, and Maxwell Chau, with contributions from Liamé van der Westhuizen, Lin Besaans, and Maryna Serdani

Research presented in this report was performed under the guidance of Dr. Joe Balciunas.

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Unauthorized publication of results prohibited: the results in this report are preliminary and tentative. In order to prevent the spread of out-of-date or inaccurate information, this report should not be

quoted or cited without verifying accuracy with Dr. Joe Balciunas, Research Leader, Exotic & Invasive Weed Research Unit, USDA - ARS - Western Regional Research Center.

List of Acronyms and Abbreviations

List of Acronyms

ARS	Agricultural Research Service (an agency of USDA)
APHIS	Animal and Plant Health Inspection Service (an agency of USDA)
CA	California
CalEPPC	California Exotic Pest Plant Council
CDFA	California Department of Food and Agriculture
CINWCC	California Interagency Noxious Weed Coordinating Council
CNPS	California Native Plant Society
CSIRO	Commonwealth Scientific and Industrial Research Organization
EBCL	European Biological Control Laboratory, USDA-ARS
EIW	Exotic & Invasive Weed Research Unit, USDA-ARS, Albany, California
FY	Federal Fiscal year (Oct. 1 to Sept. 30)
IPM	Integrated Pest Management
MD	Maryland
NRA	National Recreation Area
PPRI	Plant Protection Research Institute (an agency of the Agricultural Council of the Republic of South Africa)
TAG	Technical Advisory Group for Biological Control of Weeds
USDA	United States Department of Agriculture
WRRC	Western Regional Research Center - USDA - Albany, California

List of Generic Abbreviations

Del.	*Delairea* ivy
Di.	*Digitivalva* moths
Pa.	*Parafreutreta* flies
Sen.	*Senecio* plants

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I. Introduction

A. Cape ivy (*Delairea odorata*, prev. *Senecio mikanioides*)

Cape ivy (also known as German ivy), a native of South Africa, has recently become one of the most pervasive and alarming non-native plants to invade the coastal areas of the western United States. Botanically, this plant is a member of the sunflower family (Asteraceae), and, in the U.S., is still frequently referred to by its old name, *Senecio mikanioides*. However, its accepted scientific name is now *Delairea odorata.* A recent survey in California (Robison *et al.* 2000) reports Cape ivy infestations from San Diego to southern coastal Oregon. Cape ivy is spreading in riparian forests, coastal scrubland, coastal bluff communities, and seasonal wetlands. Though the species prefers moist, shady environments along the coast, there are increasing reports of infestations from inland riparian locations. This vine has the potential to cause serious environmental problems by overgrowing riparian and coastal vegetation, including endangered plant species, and is potentially poisonous to aquatic organisms (Bossard 2000).

Cape ivy has become the highest-ranked invasive species problem in the Golden Gate National Recreation Area (GGNRA). GGNRA spent a $600,000 grant over three years for Cape ivy control efforts. California State parks along the coast are heavily impacted as well. These include Big Basin, Hearst San Simeon, Mt. Tamalpais, Van Damme and Jughandle. U.S. Forest Service lands along the Big Sur coast are heavily impacted, as are other public and private lands along the coast.

Cape ivy was introduced into the Big Island of Hawaii around 1909 and has become a serious weed in a variety of upland habitats there, between 200 and 3000 meters elevation. (Jacobi and Warshauer 1992). Two reports (Haselwood and Motter 1983, Jacobi and Warshauer 1992) state that in the Hawaiian Islands this vine is restricted to the Big Island. However, Wagner *et al.* (1990) state that it is also sparingly naturalized on Maui.

B. Overview of collaborative research in South Africa (1996 to 2003)

On his first trip to South Africa during 1996, Dr. Balciunas completed a thorough study of South African Cape ivy herbarium records. These records were used to locate Cape ivy sites for future surveys and to develop a distribution map of Cape ivy in South Africa (Balciunas *et al.*, in press). Since 1997, the California Exotic Pest Plant Council (CalEPPC) and the California Native Plant Society (CNPS), have raised funds to assist our USDA-ARS project on the biological control of Cape ivy. Together, CalEPPC and CNPS have been successful in raising $30,000-65,000 annually. We have used these contributions to support research in South Africa, the native home of Cape ivy, and we have been fortunate enough to obtain the services of Dr. Stefan Neser, a world-renown biological control specialist, as well as several talented younger, South African scientists for this project.

Almost every year, Dr. Balciunas spends 4-5 weeks with our South African cooperators, reviewing their results, participating in field studies, and jointly planning the research for the following year. In Aug. of 1998, during the first year of collaborative research there he joined our South African cooperators, and participated in a 3000 km survey, led by Beth Grobbelaar and Stefan Neser, that visited most of the Cape ivy sites in the country, and collected the natural enemies that attacked it. Over 230 species of plant-injuring insects were collected at these sites (Grobbelaar *et al.*, in press).

Six of the most promising of these insects were selected for further research. These included: *Diota rostrata* (Arctiidae) - a defoliating caterpillar; *Digitivalva* new species – a stem boring/leaf mining moth caterpillar; *Parafreutreta regalis* (Tephritidae) - a stem galling fly; an unidentified leaf mining Agromyzid fly; and two species of Galerucine leaf beetles (Chrysomelidae) - which feed on leaves as adults or larvae. During the second year (April 1999 to March 2000), our South African team tried to collect these six insects on relatives of Cape ivy growing at these sites. More than a dozen close relatives of Cape ivy were repeatedly examined, but only one of the six insects, the arctiid moth - *Diota rostrata*, was collected on anything other than Cape ivy, and so it appears that at least five insects are very host-specific to Cape ivy.

The focus of the past three years of research in South Africa (April 2000 to March 2003) was to evaluate the host range of these promising insects. This phase of research has been led by South African weed biocontrol specialist, Dr. Stefan Neser, and his assistant Liamé van der Westhuizen. They were able to establish laboratory colonies of two Cape ivy insects: *Digitivalva delaireae*, and *Parafreutreta regalis*. In addition, Joanna Wing, a USDA-sponsored graduate student at Wits University in Johannesburg, studied the biology of the arctiid moth, *Diota rostrata*. Neser and van der Westhuizen also compiled valuable information on the biology and life history of these three insects, and developed rearing techniques.

In May of 2002, Dr. Balciunas made his 5th trip South Africa. He began the trip, by participating in the 30th Annual Biological Control of South African Weeds Workshop. While attending the workshop, Dr Balciunas was able to enlist the assistance of several South African plant pathologists from Stellenbosch. One helped identify the golden-orange rust that we frequently observe on Cape ivy in California and Oregon [see Section V.B]. Even more exciting, Dr. Maryna Serdani agreed to try to isolate and identify the pathogen that Dr. Neser and I had commonly encountered at many South African Cape ivy sites. This pathogen causes brown lesions on the leaves of Cape ivy in South Africa. Dr. Serdani's report on her findings is presented in Section V.A.

After the workshop, Dr. Balciunas met with Stefan Neser and Liame van der Westhuisen and reviewed their research progress during the past year. Their results are summarized in this report. Dr. Balciunas then accompanied Dr. Neser and Mrs. Lin Besaans on a two week trip to Kwazulu-Natal, and East and West Cape Provinces. The focus of this field trip was to investigate the insects that attack Cape ivy flowers. Our timing was good, and we found flowers at nearly every Cape ivy site we visited in these three provinces. The most widespread and consistently collected insect feeding on Cape ivy flowers were the larvae of a phalacrid beetle. Mrs. Besaans plans to assist us in research on this beetle, and to earn her Masters degree [at Rhodes University, Grahamstown] in the process. Her summary of her research on these beetles comprises Section IV of this Report.

Thus, during Year 5 of research in South Africa, we maintained our excellent team in Pretoria, and added a sub-project on flower feeding insects [Rhodes University] as well as a sub-project on pathogens [PPRI, Stellenbosch]. This assures that we will not only continue to maintain optimal research progress, but also that all potential biological control agents will be evaluated. Unfortunately, the poor economy in the United States has led to a dramatic drop in contributions to the Cape Ivy Biocontrol Project [see Executive Summary]. Since these external funds are required for the research in South Africa, if this funding shortfall continues, we will be forced to dramatically scale down the research in South Africa, thereby slowing down the development of additional agents for Cape ivy.

II. The Cape ivy gall fly, *Parafreutreta regalis*

The gall fly, *Parafreutreta regalis* (Figure 1), is a multivoltine fruit fly (family Tephritidae) that appears to specialize on Cape ivy. The female *Parafreutreta*, about the size of a housefly, generally lays eggs in the nodes or growing tips of Cape ivy vines. The little maggot that hatches causes Cape ivy to grow a spherical gall, about a ½-inch in diameter, within which the maggot completes its life cycle. These galls sometimes inhibit further elongation of that stem, although side shoots are usually produced.

Figure 1. *Parafreutreta regalis* adult on Cape ivy gall. Note emergence holes at bottom left.

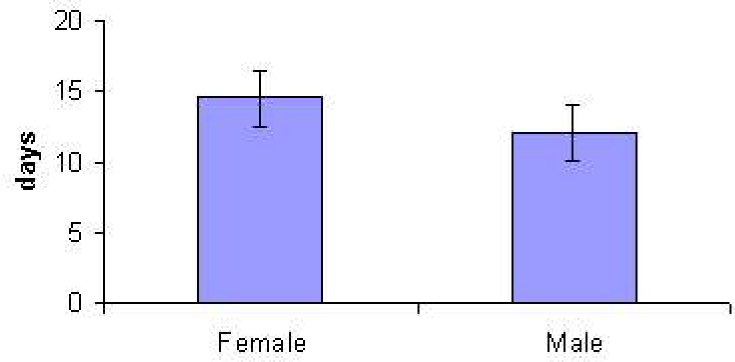
We continued to keep a colony of *Pa. regalis* in our quarantine laboratory throughout 2002 for host range testing and studies on the flies biology. In August, we began to see increased mortality of adults followed by reduced fecundity, and it seemed our colony was destined to die off. We submitted samples to ARS insect pathologist Joel Siegel who ruled out microsporidia, bacteria, and fungi, but thought the colony might be infected with a virus. However, in Sept. the colony made a comeback, since then we have had no problems with our fly colony.

A. Life history studies

Currently, very little is known about the biology and life history of *Parafreutreta regalis*. We attempted to determine the average survival rate of males and females kept at a constant temperature (20 °C) in a Conviron model No. E7 growth chamber with a consistent regime of light (16:8 light:dark).

Male and female pairs of newly emerged (within one day) *Pa. regalis* adults were kept in plexiglass tubes (26cm height, 14.5cm diameter) covered with plastic mesh inside the growth chamber. A nutrient source - 5% honey (with a small amount of yeast hydrolysate) and 95% water, was supplied to the flies as needed. Except for weekends and holidays, these longevity tests were checked daily. Dead flies were removed, kept as voucher specimens, and replaced with another fly of the same sex. Results are shown in Figure 2.

Figure 2. Mean longevity of *Parafreutreta regalis* adults (n=62). Error bars indicate the standard error. The differences are not statistically significant.



Pa. regalis flies are realtively short lived (about 12 days), with males (n=32) surviving an average of 12.1 days, while females (n=30) lived for 14.5 days. These differences were not statistically significant (Student's T-test: t=0.974, df=61, p=0.334).

In preliminary observations, we have noted that females are ovipositional soon after emergence. In a few instances, oviposition on Cape ivy by *Pa. regalis* was seen as early as 24 hours after emergence, although more often, oviposition was within 48 hours of emergence. We had planned in 2002, to complete a study determining the mean time (hrs.) at which *Pa. regalis* females become oviparious and at what time during their life they oviposit the most and least eggs. Due to problems with the colony, we were unable to complete these life history studies, but hope to do so during 2003.

B. Host range evaluations

During the past 24 months, the research at our Albany facility, as well as in Pretoria, has concentrated on evaluating the safety of some of the insects discovered during the first two years of surveys in South Africa.

Safety is the primary concern for those involved in releasing herbivorous insects from overseas. Everyone wishes to feel confident that the insects are narrowly host-specific – that once they are released and established, they will not cause significant damage to native plants, crops, or desirable ornamental plants. The degree of host-specificity of candidate insects is usually determined by exposing the candidate insects, usually in cages in the laboratory, to an array of potential host plants, and then noting which of these, if any, are also suitable as hosts. Traditionally, these laboratory host range evaluations are comprised of "no-choice tests" [sometimes called "starvation tests] in which the known host (in this case Cape ivy) is not present in the cage, and of "choice tests" where the target host is present. Due to the short longevity of *Parafreutrata* adults, another testing protocol was used.

Essentially, these tests (that we call "no-choice/host added") are a multi-plant, no-choice test, to which, after three days, a Cape ivy plant is added. The procedures we used in Albany [our collaborators in Pretoria used nearly identical protocols] are as follows: a metal screen cage (122 x 91½ x 91½ cm) was set up in our quarantine laboratory greenhouse with four different plant species, one in each corner. A source of sugar water (50% Mt. Dew [a soda produced by

Coca Cola Co.] and 50% water in a shell vial with a wick) was placed in the center of the cage. We released four female-male pairs of flies into the cage.

Three days later, we placed a Cape ivy plant into the center of the cage. Four days after that (seven days after the start of the test), we ended the test. Flies were recovered and preserved as voucher specimens. All plants were held and observed daily, for signs of gall formation. If no galls had formed after 60 days we dissected the stems looking for signs of *Parafreutreta* damage, then disposed of the plants.

The host range tests of *Pa. regalis* conducted in Pretoria were also no-choice/host added tests, and were very similar to those conducted in Albany. Three or four test plants of roughly similar size were placed in a cage (5.6cm x 5.6cm x 6.0cm) with four pairs of newly emerged flies for three days. Flies were provided with a honey and yeast solution. On day four, the control, a Cape ivy plant of similar size, was added to the cage. After another three days of exposure, the flies were removed and plants were left in the cage and gall development monitored. These trials were replicated five times for each test species.

Table 1 summarizes the plants, number of repetitons, and galls formed on the no-choice/host added tests we and our cooperators in South Africa have completed through December 2002. Appendix A provides a complete list of our *Parafreutreta* tests.

Table 1. USDA and PPRI *Parafreutreta regalis* host range evaluations (2001 through 2002).

Tribe	Species tested	Location of test	# of reps.	Mean # of galls
Family Araliaceae				
	Hedera canariensis Willd.	Albany	5	0
	Hedera helix L.	Albany	5	0
Family Asteraceae				
Subfamily Asteroideae				
Anthemideae	*Schistostephium cf. heptalobum* (DC.) Oliv. & Hiern	Pretoria	4	0
Astereae	*Symphyotrichum chilense* (Nees) G.L. Nesom	Albany	3	0
Calenduleae	*Calendula officinalis* L.	Albany	1	0
Eupatorieae	*Ageratina adenophora* (Spreng.) King & H.E. Robins	Pretoria	5	0
	Ageratina riparia (Regel) King & H.E. Robins	Pretoria	5	0
	Ageratum houstonianum Mill.	Pretoria	5	0
	Campuloclinium macrocephalum (Less.) DC.	Pretoria	5	0
	Chromolaena odorata (L.) King & H.E. Robins	Pretoria	1	0
	Mikania capensis DC.	Pretoria	5	0
Gnaphalieae	*Anaphalis margaritacea* (L.) Benth. ex. C.B. Clarke	Albany	3	0
Helenieae	*Eriophyllum staechadifolium* Lag.	Albany	2	0
	Tagetes sp. L.	Albany	4	0
	Tagetes minuta L.	Pretoria	4	0
Heliantheae	*Bidens formosa* (Bonato) Schultz-Bip.	Pretoria	5	0
	Coreopsis sp. *cv*. L.	Pretoria	5	0
	Dahlia pinnata cv. Cav.	Pretoria	4	0
	Galinsoga parviflora Cav.	Pretoria	4	0
	Helianthus annuus cv. 8751	Pretoria	1	0
	Helianthus annuus cv. 3037	Pretoria	4	0
	Helianthus tuberosus L.	Pretoria	5	0
	Rudbeckia sp. *cv*. L.	Pretoria	5	0

	Zinnia elegans cv. Jacq.	Pretoria	4	0
Senecioneae	Subtribe Senecioninae			
	Cineraria cv “butterfly”	Pretoria	4	0
	Cineraria deltoidea Sond.	Pretoria	5	0
	Cineraria lobata L’Herit.	Pretoria	5	0
	Delairea odorata Lem.	Albany	28	5.6
		Pretoria	47	5.0
	Erechtites glomerata (Desf. ex Poir.) DC.	Albany	5	0
	Euryops pectinatus (L.) Cass.	Albany	5	0
		Pretoria	5	0
	Euryops chrysanthemoides (DC.) B. Nordenstam	Pretoria	5	0
	Euryops subcarnosus DC.	Albany	5	0
	Mikaniopsis cissampelina C. Jeffrey	Pretoria	5	0
	Packera bolanderi (Gray) W.A. Weber & A. Löve	Albany	5	0
		Pretoria	4	0
	Packera breweri (Burtt-Davy) W.A. Weber & A. Löve	Albany	5	0
	Packera ganderi (T.M. Barkl. & Beauchamp) W.A. Weber & A. Löve	Albany	3	0
	Packera macounii (Greene) W.A. Weber & A. Löve	Albany	5	0
	Pseudogynoxys chenopodioides Kunth	Albany	5	0
	Senecio angulatus L. f.	Pretoria	5	0
	Senecio blochmaniae Greene	Albany	5	0
	Senecio brachypodus DC.	Pretoria	5	0
	Senecio deltoideus Less.	Pretoria	5	0
	Senecio flaccidus Less.	Albany	4	0
		Pretoria	5	0
	Senecio glastifolius L. f.	Pretoria	1	0
	Senecio helminthioides (Schultz-Bip.) Hilliard	Pretoria	5	0
	Senecio hybridus Regel	Albany	5	0
	Senecio jacobaea L.	Albany	5	0
	Senecio macroglossus DC.	Pretoria	5	0
	Senecio oxyodontus DC.	Pretoria	5	0
	Senecio oxyriifolius DC.	Pretoria	5	0
	Senecio pleistocephalus S. Moore	Pretoria	5	0
	Senecio tamoides DC.	Pretoria	5	0
	Senecio triangularis Hook.	Albany	5	0
	Senecio vulgaris L.	Albany	4	0
	Senecio sp. (unidentified)	Pretoria	5	0
Senecioneae	Subtribe Tussilagininae			
	Lepidospartum latisquamum S. Wats.	Albany	3	0
	Luina hypoleuca Benth.	Albany	4	0
	Petasites frigidus (L.) Fries	Albany	5	0
Subfamily Cichorioideae				
Arctoteae	*Arctotheca calendula* (L.) Levyns	Pretoria	5	0
Cardueae	*Carthamus tinctorius* L.	Albany	6	0
	Cynara scolymus L.	Pretoria	2	0
Lactuceae	*Lactuca sativa* L.	Pretoria	4	0
Mutisieae	*Adenocaulon bicolor* Hook.	Albany	5	0

Vernoneae	*Vernonia missurica* Raf.	Albany	intend to test	-
Family Brassiceae				
	Brassica oleracea L.	Pretoria	4	0
	Raphanus sativus L.	Pretoria	4	0
Family Chenopodiaceae				
	Beta vulgaris subsp. *cicla* (L.) Koch	Pretoria	4	0
Family Cucurbitaceae				
	Zehneria scabra (L. f.) Sond.	Pretoria	5	0

Since March, 12 new species have been tested, and still no gall development was found on any species other than *Delairea odorata* confirming the host specificity of *Parafreutreta regalis*. So far, we and our Pretoria cooperators have run 75 no-choice/host added tests with *Pa. regalis* that showed a positive control – galls developed on the Cape ivy, thus confirming that indeed the flies used in the test were ovipositional. None of the other 67 species of test plants exposed during these 55 tests showed any sign of *Pa. regalis* oviposition. We have not found galls or any sign of *Pa. regalis* damage on any plants other than the Cape ivy host. In Albany, we also conducted 23 tests that did not show a positive control, while in Pretoria, 10 tests were also conducted that did not have a positive control. We plan to conduct more no-choice/host added tests on more related plant species to confirm *Pa. regalis*' apparent restricted host range.

C. Impact assessment of probable damage by *Parafreutreta regalis*

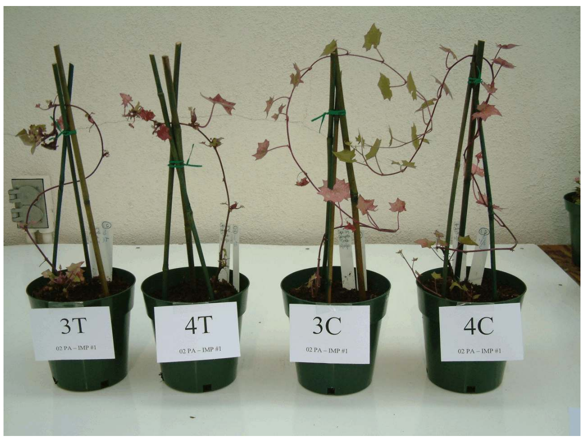
Although *Pa. regalis* readily oviposit and develop galls on Cape ivy, we are concerned that these galls may not significantly impact Cape ivy plants. Even a "safe" biological control agent that is completely restricted to its target weed, may cause unforseen changes to the ecosystem, especially if the populations of the agent build up to high levels, without causing a corresponding decrease to the target weed. This has already been documented for two other tephritid gall flies that was released to control spotted knapweed, *Centaurea maculosa* (Pearson *et al*. 2000). These researchers found that the extremely abundant galls on knapweed were changing the behavior and populations of deer mice, that had learned to feed on the abundant overwintering larvae of *Urophora affinis* and *Urophora quadrifasciata* inside the galls. Thus, Dr. Balciunas would not request release of *Pa. regalis,* even though it would not damage any other plant than Cape ivy, unless he felt that the damage to Cape ivy might reduce the invasiveness of this vine. Therefore, he set out, prior to its release, to demonstrate that this fly has the potential to depress populations of Cape ivy.

Dr. Balciunas designed and performed two trials to determine if *Pa. regalis* galls reduce the fitness of Cape ivy plants. Both trials, in each of which six Cape ivy plants were exposed to two different densities of gall-forming flies, were conducted in our quarantine laboratory, . A similar number of Cape ivy plants were used as controls in each trial and great care was taken to insure that the control plants were similar in size and number of leaves to the plants exposed to the flies.

On Christmas eve 2001, he initiated the first impact assessment trial to determine if *Parafreutreta* galls reduce the biomass or height of Cape ivy plants. The first trial was conducted in plexiglass cages with small Cape ivy plants exposed to high densities of flies (10 pairs of flies per plant). In three of the cages, he maintained 10 pairs of *Parafreutreta,* adding flies when necessary, and with the remaining two cages [with two Cape ivy plants each] serving as controls. Aphids quickly became a problem, and all 10 plants needed to be examined daily, and the aphids crushed.

In the second trial, he used larger plants in larger screen cages with a low density (2 pairs/plant) of flies. In each trial, the test Cape ivy plants were exposed to gall flies for approximately two months. During that time, galls formed on all six of the exposed plants in each trial. In both the first (high density) trial and second (low density) trials, the galled vines exhibited visible stunting (Figure 3).

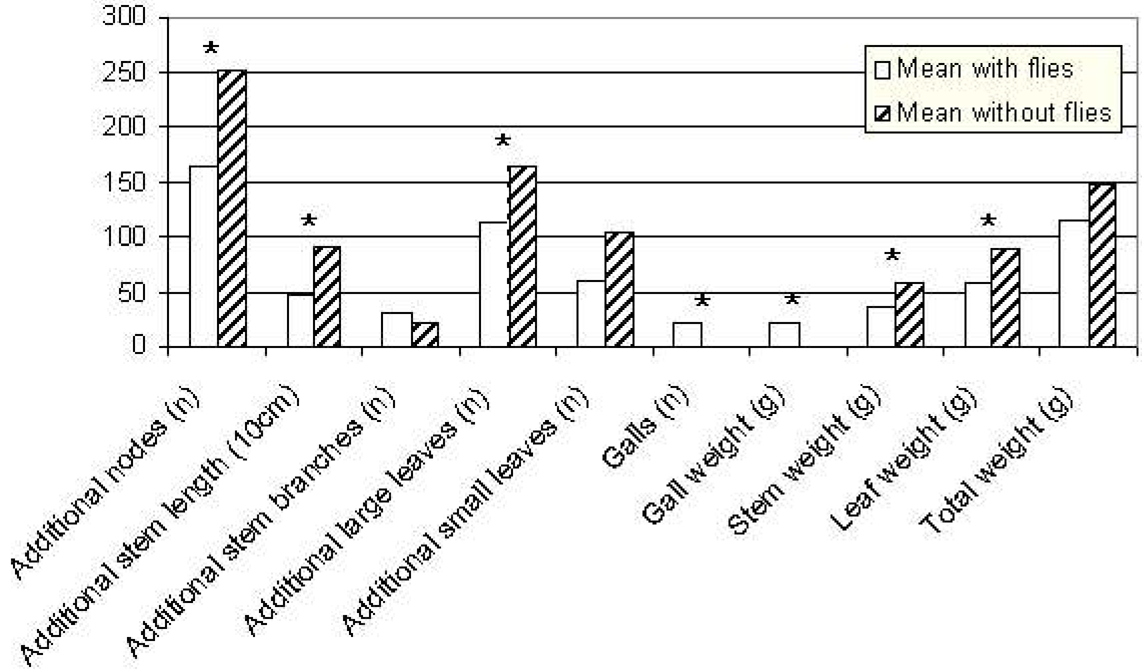
Figure 3. *Parafreutreta regalis* impact assessment trial results. (Left) The high density trial; small Cape ivy exposed to 10 pairs of flies on left and unexposed control on right. (Right) The low density trial with Cape ivy exposed to two pairs of flies on the left, unexposed Cape ivy on the left.

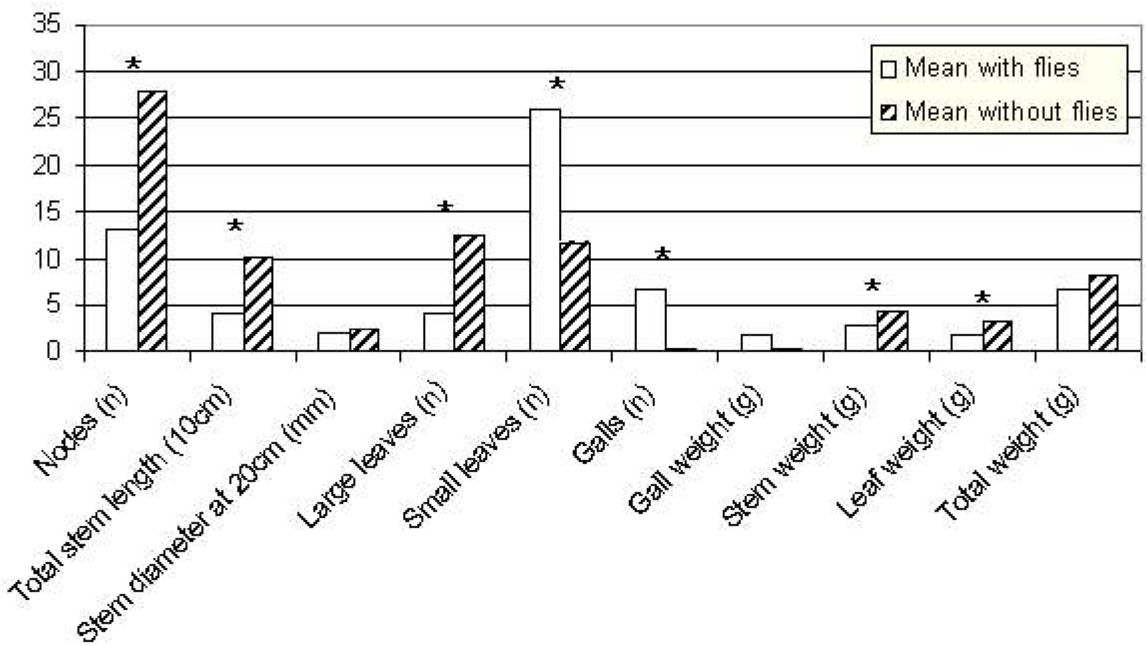


Once each trial was ended, we weighed and measured the plants, and statistically confirmed the apparent difference between plants with galls, and those without. Our analyses confirmed that the galled Cape ivy plants were statistically shorter, with fewer nodes and smaller leaves in each trial (Figure 4).

These two trials confirm that the galls resulting from the South African fly *Parafreutreta regalis* reduce the growth of Cape ivy. Therefore, if this fly is released and successfully establishes in California, it should contribute to reducing the negative impacts of this invasive vine. The results of these two trials have been submitted for publication in the journal: Biological Control: Theory and Application in Pest Management.

Figure 4. Bar graphs depicting the differences between Cape ivy plants exposed to *Parafreutreta regalis* flies (top: high density trial, bottom: low density trial) and similar control plants not exposed flies. (* P < 0.05, Student's T-test)

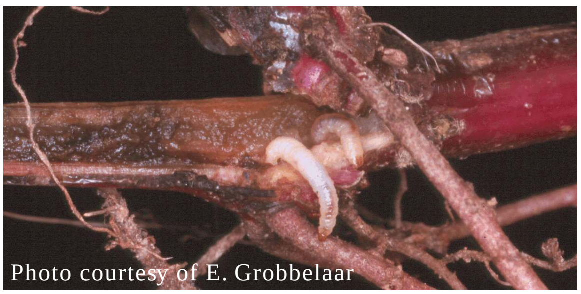




III. The Cape ivy stem boring/leaf-mining moth, *Digitivalva delaireae*

The *Digitivalva* moth (initially identified as *Acrolepia* new species) was discovered during our surveys in South Africa, and is new to science. This moth was described in 2002 by Gaedike and Kruger as *Digitivalva* (*Digitivalva*) *delaireae*. It is one of the most widely distributed of Cape ivy natural enemies, and it has been collected at nearly all our Cape ivy sites in South Africa. This small moth (less than ¼-inch in length) (Figure 5, right) lays eggs within a leaf of Cape ivy. Tiny caterpillars (Figure 5, left) hatch out and tunnel within the leaves, leaving distinctive, narrow "mines". Some of the caterpillars bore down through the leaf petiole, and then bore inside the stem of Cape ivy. In the lab, most of the mined leaves, and many of the bored stems die, and sometimes the entire Cape ivy plant is killed.

Figure 5. *Digitivalva delaireae* larvae (left) and adult (right).



A. Life history studies

1. USDA research on *Digitivalva* in Albany, CA

In preliminary observations studying the oviposition of *Digitivalva*, we have noted that females are ovipositional soon after emergence. They oviposit single opaque eggs on each side of the Cape ivy leaves and sometimes on the petiole. We also noted that in a no choice situation females will oviposit on safflower and *Petasites frigidus* leaves. In a few instances, oviposition on Cape ivy by was seen as early as 24 hours after emergence, although more often, oviposition was seen within 48 to 72 hours of emergence. We plan in 2003, to determine when *Digitivalva* females become ovipositional and when they oviposit the most of their eggs.

2. PPRI research on *Digitivalva* in South Africa (by Liamé van der Westhuizen)

Our tests in South Africa on the biology of *Digitivalva* were run as follows: A single pair of *Digitivalva* was released into a ventilated honey jar that was placed over a small, newly potted *Delairea* cutting (6-8 leaves per plant). The adults were supplied with a 5% honey solution. Each trial was replicated 8 times. Three days after exposure, the adults were removed and the plants closely examined for eggs or any signs of mining.

The data that was collected were not as consistent as I would have liked it to be, but it did reconfirm existing knowledge. On average male and female longevity was found to be 8.23 days (n=8, 4-10 days) and 7.25 days (n=8, 3-10 days) respectively, eggs started hatching after 14 days and 50% of the females deposited eggs within the first 3 days. The plants were not expected to sustain the feeding larvae and no data was collected on female fecundity.

During the previous cycle problems were encountered with stabilizing the *Digitivalva* culture which delayed the progress with host specificity testing. It was suspected that too high temperatures experienced especially during the peak of summer (November - January), was the main contributing factor. Adjusting the wind flow through the glass house as well as covering the glass house with a 50% shade net solved this problem. Another factor that might have contributed to the low egg laying of females is the number of females per cage. The number was reduced even further to a maximum of 5 females per cage. To date the measures taken seem to have a positive effect in providing a continuous flow of adults.

B. Host range evaluations

We continued no-choice/host added testing in Albany with *Digitivalva delaireae* through 2002. The protocols for the *Digitivalva* no-choice/host added tests were virtually the same as the no-choice/host added tests for *Pa. regalis*: a metal screen cage (122 x 91½ x 91½ cm) was set up in our quarantine laboratory greenhouse with four different plant species, one in each corner. A source of sugar water (50% Mt. Dew [a soda produced by Coca Cola Co.] and 50% water in a shell vial with a wick) was placed in the center of the cage. We released four female-male pairs of moths into the cage. The moths used were young, always within two days of emergence as adults. Three days later, we added a *Delairea* plant into the center of the cage. Seven to ten days after the start of the test (depending on the number of moths still alive after seven days), the test was ended by removing all remaining live moths, and recovering the dead moths. Plants were watered as necessary, and held for observation.

We checked the Cape ivy and non-target plants daily for signs of *Digitivalva* infestations. When it was apparent that plants were infested, we isolated these plants and collected pupae and adults that emerged from these plants. Plants with no apparent infestation, after sixty days, were dissected the plants to look again for signs of infestation and dead larvae before discarding them.

Digitivalva multi-choice/host added trials were also conducted in South Africa according to similar protocols. Three to four test plants of roughly similar size were placed in a cage (0.56m x 0.56m x 0.6m) with four pairs of young adults for three days. A 5% honey solution was provided and plants were watered regularly. On day four, the control, *Delairea odorata*, was included in the trial. After another three days of exposure, the adults were removed and plants were left in the cage where they were monitored for any signs of mining. All the trials will be replicated 5 times.

The results of the no-choice/ host exclusion tests completed in Albany and in South Africa are summarized in Table 2, while Appendix B provides a complete listing of each test. Out of the 49 no-choice/host added tests completed in Albany so far, 27 showed a positive control (oviposition and development on Cape ivy). We have had 219 *Digitivalva* moths emerge from Cape ivy, and have found no development or signs of infestation on any of the 52 species of non-target test plants. We plan to continue evaluating this moth via our no-choice/host added test protocols until we have completed five replicates per test plant.

In South Africa, 28 plant species have been tested, but not all the plant species have been replicated 5 times. A total of 25 tests have been completed: 20 showed a positive control (oviposition and development on Cape ivy), while 5 did not. Single leaves were found to have been mined on *Senecio angulatus*, *Sen. brachypodus*, *Sen. oxyodontus, Sen. pleistocephalus* and *Sen. tamoides*. The mines were very small and very short. It seems as though the larva left the leaf shortly after entry, and no further damage could be detected. As for *Senecio macroglossus*, two test plants showed more damage. Both plants have been placed in a cage and will be monitored. This discovery calls for further investigation in the form of no-choice trials, focusing mainly on related *Senecio*.

Despite the odd occurrence of some tunneling in non-host species *Digitivalva* is still regarded as a very promising biological control candidate. Host range tests will be continued during phase 6 as well as studies on the effect of *Digitivalva* on host plants in different growth phases.

Table 2. USDA and PPRI *Digitivalva delaireae* host range evaluations (2001 through 2002).

Tribe	Species tested	Location of test	# of reps	# w/ *Di.* infestation or damage
Family Araliaceae				
	Hedera canariensis Willd.	Albany	5	0
	Hedera helix L.	Albany	5	0
Family Asteraceae				
Subfamily Asteroideae				
Asterae	*Symphyotrichum chilense* (Nees) G.L. Nesom	Albany	2	0
Calendulae	*Calendula officinalis* L.	Albany	intend to test	-
Eupatorieae	*Ageratina riparia* (Regel) King & H.E. Robins	Pretoria	1	0
	Ageratum houstonianum Mill.	Pretoria	3	0
	Campuloclinium macrocephalum (Less.) DC.	Pretoria	1	0
	Chromolaena odorata (L.) King & H.E. Robins	Pretoria	1	0
	Mikania capensis DC.	Pretoria	4	0
Gnaphalieeae	*Anaphalis margaritacea* (L.) Benth. ex C.B. Clarke	Albany	3	0
Helenieae	*Tagetes* sp. L.	Albany	6	0
	Eriophyllum staechadifolium Lag.	Albany	3	0
Heliantheae	*Bidens formosa* (Bonato) Schultz-Bip.	Pretoria	2	0
	Helianthus annuus L.	Pretoria	1	0
	Helianthus tuberosus L.	Pretoria	2	0
	Rudbeckia sp. *cv*. L.	Pretoria	1	0
Senecioneae	Subtribe Senecioninae			
	Cineraria deltoidea Sond.	Pretoria	2	0
	Cineraria lobata L'Herit.	Pretoria	5	0
	Delairea odorata Lem.	Albany	27	27
		Pretoria	20	20
	Erechtites glomerata (Desf. ex Poir.) DC.	Albany	5	0
	Euryops chrysanthemoides (DC.) B. Nordenstam	Pretoria	3	0
	Euryops pectinatus (L.) Cass.	Albany	5	0
		Pretoria	1	0
	Euryops subcarnosus DC.	Albany	5	0
	Mikaniopsis cissampelina C. Jeffrey	Pretoria	4	0
	Packera bolanderi (Gray) W.A. Weber & A. Löve	Albany	5	0
	Packera breweri (Burtt-Davy) W.A. Weber & A. Löve	Albany	6	0

	Packera ganderi (T.M. Barkl. & Beauchamp) W.A. Weber & A. Löve	Albany	1	0
	Packera macounii (Greene) W.A. Weber & A. Löve	Albany	5	0
	Pseudogynoxys chenopodioides Kunth	Albany	5	0
	Senecio angulatus L. f.	Pretoria	5	0
	Senecio blochmaniae Greene	Albany	5	0
	Senecio brachypodus DC.	Pretoria	1	0
	Senecio deltoideus Less.	Pretoria	2	0
	Senecio flaccidus Less.	Albany	5	0
		Pretoria	1	0
	Senecio hybridus Regel	Albany	5	0
	Senecio jacobaea L.	Albany	4	0
	Senecio macroglossus DC.	Pretoria	3	0
	Senecio oxydontus DC.	Pretoria	2	0
	Senecio oxyriifolius DC.	Pretoria	1	0
	Senecio pleistocephalus DC.	Pretoria	5	0
	Senecio tamoides DC.	Pretoria	5	0
	Senecio triangularis Hook.	Albany	5	0
	Senecio vulgaris L.	Albany	5	0
	Senecio sp. (unidentified)	Pretoria	2	0
Senecioneae	Subtribe Tussilagininae			
	Lepidospartum latisquamum S. Wats	Albany	1	0
	Luina hypoleuca Benth	Albany	2	0
	Petasites frigidus (L.) Fries	Albany	5	0
Subfamily Cichorioideae				
Arctoteae	*Arctotheca calendula* (L.) Levyns	Pretoria	2	0
Cardueae	*Carthamus tinctorius* L.	Albany	5	0
Mutisieae	*Adenocaulon bicolor* Hook.	Albany	5	0
Vernoneae	*Vernonia missurica* Raf.	Albany	intend to test	-
Family Chenopodiaceae				
	Beta vulgaris subsp. *cicla* (L.) Koch	Pretoria	1	0
Family Cucurbitaceae				
	Zehneria scabra (L. f.) Sond.	Pretoria	3	0

IV. Phalacrid beetles (by Lin Besaans)

During May 2002, Joe Balciunas and two researchers from PPRI in South Africa conducted a survey of *Delairea odorata,* throughout its natural distribution, in search of a seed feeding insect. A phalacrid beetle (Figure 6, right), provisionally identified as a species of *Olibrus*, was found to be common at all sites. This small beetle (approximately 2 mm in length) lays eggs between the florets of Cape ivy. Tiny larvae (Figure 6, left), almost invisible to the naked eye, hatch out and chew their way into the florets. Early instar larvae feed on pollen and, in so doing, frequently damage or destroy the stamens which effectively sterilizes the florets. Later instars burrow to the bottom of the floret where they eat the ovaries. Prepupal larvae fall to the ground and pupate in the soil. Owing to the fact that this beetle appears to be new to science, it is not yet clear whether it is univoltine. Preliminary specificity tests conducted in the field indicate that it is fairly host specific. However, until all the insects which have been reared from various asteraceous plants have been positively identified, this is not certain.

Figure 6. Larvae (left) and adult (right) phalacrid beetles on Cape ivy flowers.

Once it was established that there was indeed a seed-feeder, floral material was collected regularly and dissected to assess the impact of the insect on the plant. A primary site was selected in Plettenberg Bay where, for the remainder of the floral period (April – August), a random sample of 20 capitulum was collected weekly and dissected. Additional collections were done on at irregular intervals at sites in Wilderness, Hogsback and the Addo Elephant Park.

The site at the Addo Elephant Park is of special significance since it is an arid area and provides an important comparison with the other sites – all of which occur in areas with a more temperate climate. During the period May 2002 to February 2003, approximately eight field-trips were undertaken to the Addo Elephant Park. At each visit, a small sample of capitula were collected randomly from the site. The capitula were dissected in the laboratory and the presence of eggs, larvae and/or larval damage recorded. For host-specificity purposes, all asteraceous plants flowering in the vicinity of *Del. odorata* (notably *Cineraria lobata* and *Senecio linifolius*) were examined for beetles and/or larval damage.

Dissections of floral material revealed a positive link between the flowering phenology of Cape ivy and insect activity. To facilitate sampling, a floral index was developed and the duration of the various floral stages determined by tagging inflorescences and recording their development. Beetle larvae were reared on severed plant material to establish the number of larval instars and their duration. Pre-pupal larvae were provided with a pupation medium and the pupal duration recorded.

The floral genera *Cineraria, Delairea, Mikaniopsis and Senecio* are closely related and, since it is important that any potential biocontrol agent has a narrow host range, these plants and all other flowering asteraceous plants found growing in the vicinity of stands of *Del. odorata* were tested. Adult beetles were collected from the plants and larvae dissected from flowers were reared to adults. All adults were then accessioned at the National Collection of Insects in Pretoria for identification. Samples of floral material tested were collected, pressed and submitted for identification to the Selmar Schonfeld Herbarium at the Albany Museum, Grahamstown.

Dissections of plant material revealed that insect activity is closely aligned with the flowering phenology of the plant. Thus, to facilitate sampling, a floral index was developed which describes the developmental stage of the flowers at any particular time (Table 3).

Table 3. The flowering stages of *Delairea odorata*.

Bud/Flower Stage	Description of floral stage
B1	First signs of budding, inflorescences little more than nodules.
B2	Buds within the sub-inflorescences are rounded and packed tightly together.
B3	Individual capitula are separating from one another, florets elongating, first signs of yellow may be visible through involucral bracts. Significant stage with regard to oviposition.
B4	Yellow tubular florets beyond involucral bracts. Eggs and/or neonate larvae frequently present.
F1	Florets beginning to open, forming trumpets with elongated styles. Early instar larvae may be present.
F2	All florets in the capitulum have opened, style branches bent back to expose stigmatic surfaces. Later instar larvae may be present.
F3	Post anthesis – florets discoloured and shrivelled. Seeds not ripe, involucre intact. Final instar larvae may be present.
S1	Dehiscent - involucral bracts have burst, ripened seeds dispersed or being dispersed. Final instar larvae exit-holes frequently visible on locules.

A. Biology and impact

A phalacrid beetle, provisionally identified as *Olibrus* sp.#1 was found to be common in flowers of Cape ivy at all the sampled sites. Dissections of floral material collected from the various sites revealed eggs, larvae and distinct signs of larval damage.

The genus, *Olibrus*, or ‘shining flower beetles’, is fairly large and widespread. All members of the genus are associated with asteraceous flowers where adults feed on pollen and larvae feed and complete their life cycle inside the flower heads (Steiner 1984).

Adults usually lay a single, ovoid, translucent egg on B4 florets on the inner side of the capitulum. The neonate larva chews into the floret where it feeds on pollen grains, whereas later instar larvae feed on the ovaries. Larvae always feed downwards with the head towards the receptacle. By feeding on pollen, early instar larvae cause dehydration and shrivelling of the floret which then fails to open. Also, while feeding on pollen, larvae frequently damage or destroy the style. Thus, during their development, larvae effectively sterilize individual florets in a number of ways. Firstly, by causing shrivelling of the floret the stigmatic surfaces are not exposed; secondly by possible destruction of the style; and, thirdly by destroying the ovaries.

Larvae move between capitula, thus development is not necessarily completed within a single capitulum. Pre-pupal larvae usually chew an exit hole through the involucral bracts before dropping to ground to pupate. Preliminary observations indicate that pre-pupal larvae remain dormant in the soil, pupate only briefly, and that beetles may remain in the soil after eclosion. Debris collected by sifting through pupation medium indicates that the larvae may form a cocoon prior to pupation. Adults emerge within 31 days but this can be considerably longer since emergence appears to be triggered or delayed by the floral stage of the plant.

Preliminary field testing indicates that phalacrids are restricted to those members of the Asteraceae whose flowers contain pappus, the silky hairs attached to the racemes of many asteraceous plants and which aid in seed dispersal. Larvae frequently disclose their presence in flowers by the formation of a distinct ‘phalacrid tuft’ composed of a combination of frass, florets and pappus which is pushed up and beyond the surface of the floral disc.

Mortality of larvae collected in the field is fairly high, and is probably the result of parasitism. In addition, a number of parasitoids have been reared from pre-pupal phalacrid larvae. These have been accessioned at the National Collection of Insects for identification. Throughout the course of this study, no other seed-feeding insects were encountered on *Del. odorata*.

B. Host specificity

Host specificity testing was conducted in the field on an opportunistic basis. Beetles were collected from all flowering asteraceous plants growing in the vicinity of *Del. odorata* and submitted for identification. Flowers were dissected and larvae reared to adults for identification. The following plants have been tested so far:

Senecio angulatus

This plant frequently grows in close proximity to *Del. odorata* and, except for a short flush of flowers during November and December, flowers simultaneously with *Del. odorata*. Adults collected on this plant plus larvae collected from flowers and reared to adults appear, superficially, to be identical to those found on *Del. odorata*. However, larval feeding behavior and feeding damage on the two plants is different. Specimens have been accessioned at the National Collection of Insects, Pretoria, for identification and, initial indications are that they may well be different species.

Senecio ilicifolius L., Senecio elegans, Arctotheca calendula, Cineraria lobata.

Phalacrid adults and larvae were found on the above plants but do not resemble the species found on *Del. odorata* and *Sen. angulatus*. Adults collected and larvae obtained from flowers and reared to adults have been accessioned at the National Collection of Insects, Pretoria.

Taraxicum officionale, Chrysanthemoides monilifera, Felicia echinata (provisional ident.).

Neither phalacrid larvae nor adults were found on any of these plants.

V. Pathogens

A. *Cercospora*, a pathogen on Cape ivy in South Africa (by Maryna Serdani)

Delairea odorata Lem. (Cape ivy) is a widespread, aggressive invader in the coastal and riparian areas of California in the United States. This pest vine is native to South Africa, where one is most likely to find a successful biocontrol agent for the weed. Several insect species have been targeted as biocontrol agents against *Del. odorata*, but no work has so far been done with fungal pathogens.

Recently, large circular lesions were noticed on leaves of *Del. odorata* in the Eastern Cape Province of South Africa and diseased leaves sent to ARC-PPRI, Weeds Pathology Division in Stellenbosch, Western Cape Province. Isolations from these lesions revealed an aggressive fungal pathogen, preliminary identified as a *Cercospora* sp. Fungi belonging to this genus are well known to cause leaf spots on a variety of plant species, but are also known to be mostly host-specific, which makes it an ideal candidate for biological control.

Figure 7. A Cape ivy leaf lesion (left) caused by *Cercospora* sp. (right).

Altogether 6 single-spored (pure) cultures of this fungus were isolated from three different locations in South Africa, namely Global Village, Helderberg and Dragon's Peak Park. Fungi were induced to sporulate on a special growth medium and used to inoculate *Del. odorata* plants (received from PPRI in Pretoria), using a spore suspension (1×10^6/ml) brushed onto marked leaves. Three leaves per plant were marked with a string and inoculated by applying the spore suspension by brush. Three plants per isolate were inoculated in this way, and nine uninoculated plants were used as controls. Results were monitored on a weekly basis and results noted. After 4 weeks, all plants started to turn purple (starting from the vines and extending as spots on leaf laminas) making monitoring very difficult. Plants were subsequently moved to a more shaded area (sun-filtering gauze tunnel) and uninoculated plants soon recovered. Inoculated plants were severely stressed with leaves rapidly turning brown and dying off. The reason why leaves did not develop the same circular lesions as in the field, probably has to do with the inoculum load used during inoculations, which does not occur in nature. Inoculated leaves were rated according to disease severity on a scale of 1-5, with 1 being 0% disease and 5 being 100% of leaf diseased (dead) (Table 4). After 8 weeks, all isolates scored a majority of 5. Plants did not however die off completely as only selected leaves were inoculated, but were severely diseased in a short period of time.

Table 4. Disease severity of marked leaves on *Delairea odorata*, caused by the 6 different isolates of *Cercospora* sp.

Location	Plant	Symptoms*	Average
Dragon's Peak Park 1	1	5, 5, 5	4.7
	2	5, 5, 5	
	3	5, 5, 2	
Dragon's Peak Park 2	1	5, 5, 5	4.8
	2	5, 5, 5	
	3	5, 4, 4	
Plettenberg Bay 1 (Global Village)	1	5, 5, 5	4.8
	2	5, 5, 5	
	3	5, 5, 3	
Plettenberg Bay 2 (Global Village)	1	5, 5, 5	5
	2	5, 5, 5	
	3	5, 5, x	
Helderberg 1 (Plett)	1	5, 5, 5	4
	2	5, 5, 5	
	3	2, x, x	
Helderberg 2 (Plett)	1	5, 5, 5	4.3
	2	5, 5, 3	
	3	2, x, x	
Control	1	1, 1, 1	1
	2	1, 1, 1	
	3	1, 1, 1	

***Rating system:** **1**=0% lesions; **2**=25% lesions; **3**=50% lesions; **4**=75% lesions; **5**=100% lesions
x = these leaves could not be rated due to insect damage and were left out of calculation of average values

This experiment will be repeated in December 2002 during which whole plants as well as selected leaves will be inoculated. It is clear that these isolates show good potential as biocontrol agents of *Del. odorata* and that further experiments will reveal more about disease development.

B. Rust on Cape ivy and other *Senecio* plants in California

For several years we have infrequently observed an orange-colored rust damaging leaves of Cape ivy in California, mainly during the fall and winter months. In the past, we had sent this rust to different cooperators but none were familiar with this rust or were unable to make an identification.

In 2002, Joe traveled to South Africa, but was unable to find this rust on Cape ivy, and neither he or our cooperators from PPRI had ever noticed it on South African Cape ivy during previous surveys. During this trip, Joe met with Alan Wood - a plant pathologist who agreed to identify the rust. Upon Joe's return to the U.S. we were unable to provide Alan with Cape ivy leaves infected with rust, but found a similar appearing rust on the leaves of *Senecio triangularis* growing near where we once had rust-infected Cape ivy.

We sent these leaves of *Sen. triangularis* to Alan who identified this rust as *Colesoporium occidentale*. Later in the summer, a cooperator in Oregon found this rust on Cape ivy leaves. We supplied these leaves to Alan, and to Markus Scholler - the director of the Arthur and Kriebel Herbaria at Perdue University. Both agreed that the rust was *Colesporium*. Markus informed us that in fact, Alan was using an older system and that currently all *Coleosporium* rust on Asteraceae species are now incorporated in *Coleosporium tussilaginis*.

We have no plans to study this rust, but have contacted Bill Bruckart at the USDA-ARS in Fredrick, MD who may choose to examine this rust as potential biocontrol agent.

Figure 8. *Coleosporium tussilaginis* rust on a *Senecio breweri* leaf.

VI. Other potential biocontrol agents (by Liamé van der Westhuizen)

A. *Diota rostrata* (Lepidoptera: Arctiidae) moth tests in South Africa

During two years, our South African colleagues have extensively tested a third insect, the Cape ivy defoliating moth, *Diota rostrata*. The hairy caterpillars of this moth are voracious feeders, and in South Africa, we frequently encounter patches of Cape ivy where most the leaves are either totally missing or only small tatters remain.

Earlier in the year, several plant species were tested to see whether or not *Diota* would oviposit on them and accept them as hosts. The preliminary data from these oviposition tests seemed to indicate that female *Diota* moths prefer *Sen. oxyodontus* for oviposition to all other species used in the trial. This may be an indication that *Delairea odorata* was not the primary host of the *Diota rostrata* population ("Kirstenbosch culture") used in the trial.

A more detailed analysis will be put forward as soon as the final replicate was completed. However, the *Diota* culture originating from Kirstenbosch became infected with microsporidia forcing us to destroy the whole culture. This will delay the completion of the last replicate of the oviposition trial. New material will be collected from Kirstenbosch at a later stage but for now it has been decided to collect material from *Diota odorata* from the Addo National Park in the Eastern Cape. The aim will be to establish if the *Diota* collected in Addo will have a stronger preference for *Delairea* than their Kirstenbosch counterparts which seemed to prefer *Senecio oxyodontus*, from which they had been collected.

B. Stem-boring flies (Agromyzidae)

We tried to establish a culture of the agromyzid flies at Rietondale. *Delairea* stems were collected in Wilderness in the Eastern Cape and placed in emergence boxes. During a four week period 35 adults presumed to belong to the same species were placed in cages in the glass house with potted *Delairea odorata* plants. Unfortunately no offspring was obtained, possibly because we did not provide the flies with enough direct light required for mating and egglaying.

C. *Liperodes* c.f. *tibialis*

No new adults of the galerucine chrysomelids of which the larvae may be root feeders of Cape ivy, were reared in the last two years from potted plants exposed late 2000, over a long period (until all the adult beetles disappeared) to actively feeding adults. It is possible that *Delairea odorata* may not be a larval host of these beetles, and we have not conducted further observations that will have to be made near the only site where adults have been collected, if work on this beetle is to be pursued.

VII. Other activites and publications

A. Publications issued or submitted

Balciunas, J. 2002. Coping with Cape ivy. Biocontrol News and Information. 23: 65-67.

Balciunas, J. (In press). Enhancing Successful Biological Control of Weeds by Expanding and Improving Overseas Research. pp. 1-7 *In* Denslow, J.E., Hight, S.D., and Smith, C.W. (eds.), Proceedings, Hawaii Biological Control Workshop. Pacific Cooperative Studies Unit, University of Hawaii, Honolulu.

Balciunas J. (In press). International Code for Best Practices for Classical Biological Control of Weeds. pp. xx-xx *In* Clarke, J., Coombs, E., and Cofrancesco, A. (eds.), Biological Control of Weeds in North America, U.S. Forest Service.

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B. Selected meetings and travel by Dr. Joe Balciunas (April through Dec. 2002)

May 5-7	Vaalwater	Attend 30th annual South African Biocontrol of Weeds workshop; present talk on update on biocontrol of *Delairea*
May 3- Jun 7	South Africa	Review research progress during year 4 by South African collaborators; spend two weeks in the field at various South African sites initiating a new sub-project to discover and develop flower-feeding Cape ivy insects; brief U.S. Embassy officials on the Cape Ivy Project: prepare plan of or Year 5 research in South Africa.
Aug 15-16	Davis	Attend UC BioControl III Conference; inspect new quarantine building under construction near campus
Sept 28	Carmel	Present invited talk "Biological Control of Cape ivy" to Garrapata Creek Association meeting
Oct 1-3	Boulder, CO	Attend W-185 Annual meeting

Oct 11-12	Sacramento	Attend annual CALEPPC Symposium; present invited talk "Update on Biological Control of weeds in California"; co-moderate Cape Ivy Breakout session
Oct 21	Berkeley	Attend CNPS Funding Partnership Conference and present poster "Biological Control of Cape Ivy"
Nov 17-20	Ft. Lauderdale	Attend Annual Entomological Society of America meeting; present paper "Predicting Impact of potential agent prior to release"; co-moderate Biological Control session; serve as judge for student presentations on biological control

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Appendicies

Appendix A. USDA *Parafreutreta regalis* no-choice/host added tests

Test No.	Non-target test plants	Dates	Oviposited on	Notes
PA-1-1004	*Euryops pectinatus* *Packera macounii* *Senecio blochmaniae* *Senecio triangularis*	4-26 to 5-3 2001	Cape ivy	3 females alive when CI added (4-30), 1 female alive at end of test. **CI had 3 galls**, 2 dissected 7-31: 1st had 1 pupal case (PC), 2nd had 1 dead pupa, 3rd had *Pa.* dmg
PA-2-1004	*Senecio blochmaniae* *Packera macounii* *Senecio hybridus* *Senecio triangularis*	4-27 to 5-4 2001	Cape ivy	3 females alive when CI added (5-1), 1 female alive at end of test. **CI had 2 galls**, 1 dissected 7-31: it had 2 PC
PA-3-1004	*Euryops pectinatus* *Packera bolanderi* *Senecio blochmaniae* *Senecio triangularis*	4-30 to 5-7 2001	nothing	2-3 females alive when CI added (5-3), no females alive at end of test.
PA-4-1004	*Euryops pectinatus* *Packera macounii* *Senecio blochmaniae* *Senecio hybridus*	4-30 to 5-7 2001	nothing	4 females alive when CI added (5-3), 2 females alive at end of test.
PA-5-1004	*Euryops pectinatus* *Packera bolanderi* *Packera breweri* *Senecio flaccidus*	5-8 to 5-15 2001	nothing (Rydin Rd.)	2 females alive when CI added (5-12), no females alive at end of test.
PA-6-1004	*Euryops pectinatus* *Euryops subcarnosus* *Packera bolanderi* *Sen triangularis*	7-9 to 7-16 2001	nothing (Rydin Rd.)	2 females alive when CI added (7-12), no females alive at end of test.
PA-7-1015	*Adenocaulon bicolor* *Hedera helix* *Packera bolanderi* *Senecio confusus*	8-22 to 8-29 2001	nothing (Rydin Rd.)	3 females alive when CI added (8-25), 1 or 2 females alive at end of test.
PA-8-1015	*Adenocaulon bicolor* *Erechtites glomerata* *Euryops subcarnosus* *Hedera helix*	8-22 to 8-29 2001	Cape ivy (Garrapata Ck.)	4 females alive when CI added (8-25), 2 or 3 females alive at end of test. **CI had 4 galls**, 3 dissected 11-5: 1st had 1 PC, 2nd had 3 PC, 3rd had 2 PC and 2 dead adults
PA-9-1015	*Adenocaulon bicolor* *Erechtites glomerata* *Packera bolanderi* *Senecio confusus*	8-22 to 8-28 2001	nothing	4 (?) females alive when CI added (8-25), all females escaped before end of test.
PA-10-1015	*Erechtites glomerata* *Euryops subcarnosus* *Senecio blochmaniae* *Senecio confusus*	8-22 to 8-27 2001	nothing (Rydin Rd.)	2 females alive when CI added (8-25), no females alive at end of test.

PA-11-1015	*Adenocaulon bicolor* *Erechtites glomerata* *Euryops subcarnosus* *Senecio confusus*	8-27 to 9-4 2001	Cape ivy (Rydin Rd.)	4 females alive when CI added (8-30), 2 females alive at end of test. **CI had 7 galls**, 5 split 11-5: 1st had 3 PC, 2nd had 1 dead adult, 3rd had 3 PC, 4th had 1 PC, 5th had *Pa.*dmg; 1 split 11-29: it had 5 PC and 1 dead pupa
PA-12-1015	*Erechtites glomerata* *Euryops subcarnosus* *Senecio flaccidus* *Senecio triangularis*	8-28 to 9-4 2001	Cape ivy (Garrapata Ck.)	4 females alive when CI added (8-31), 3 females alive at end of test. **CI had 7 galls**, 4 dissected 11-5: 1st had 8 PC, 2nd had 2 PC and 1 pupa, 3rd had 1 PC, 1 pupa and 1 dead adult, 4th had 4 PC
PA-13-1015	*Erechtites glomerata* *Hedera helix* *Packera bolanderi* *Senecio flaccidus*	8-29 to 9-5 2001	nothing (Rydin Rd.)	4 females alive when CI added (9-1), 2 females alive at end of test.
PA-14-1015	*Adenocaulon bicolor* *Euryops subcarnosus* *Packera macounii* *Senecio flaccidus*	8-29 to 9-5 2001	Cape ivy (Rydin Rd.)	4 females alive when CI added (9-1), 1 female alive at end of test. **CI had 6 galls**, 2 dissected 11-5: 1st had 3 PC, 2 pupae and 1 dead adult, 2nd had 5 PC, 1 pupa and 1 dead adult *Adenocaulon* had possible *Pa.* damage
PA-15-1015	*Adenocaulon bicolor* *Euryops subcarnosus* *Packera macounii* *Senecio flaccidus*	9-5 to 9-12 2001	nothing (Garrapata Ck.)	4 females alive when CI added (9-7), 3 females alive at end of test.
PA-16-1015	*Euryops subcarnosus* *Packera macounii* *Senecio confusus* *Senecio flaccidus*	9-12 to 9-19 2001	Cape ivy	4 females alive when CI added (9-14), 3 females alive at end of test. **CI had 1 gall**, 1 gall dissected 11-29: it had 2 PC
PA-17-1015	*Adenocaulon bicolor* *Senecio blochmaniae* *Senecio confusus* *Senecio flaccidus*	9-17 to 9-24 2001	Cape ivy (Garrapata Ck.)	4 females alive when CI added (9-20), 3 females alive at end of test. **CI had 4 galls**, 4 dissected 11-29: 1st had 2 PC, 2nd had 1 dead pupa, 2 live females and 1 live male, 3rd had 5 PC, 4th had 4 PC
PA-18-2015	*Euryops pectinatus* *Hedera helix* *Senecio blochmaniae* *Senecio confusus*	10-15 to 10-22 2001	Cape ivy (Rydin Rd.)	4 females alive when CI added (10-18), 2 females alive at end of test. **CI had 5 galls**
PA-1-3015	*Hedera canariensis* *Euryops pectinatus* *Packera bolanderi* *Senecio hybridus*	1-10 to 1-17 2002	Cape ivy (Rydin Rd.)	4 females alive when CI added (1-13), 2 females alive at end of test. **CI had 3 galls**, 1 dissected 4-10: it had 7 pupal cases, 2 dissected 4-24: 1st had 1 dead pupa, 2nd had 1 PC

PA-2-3015	*Hedera canariensis* *Euryops pectinatus* *Packera bolanderi* *Senecio hybridus*	1-14 to 1-22 2002	nothing (Garrapata Ck.)	4 females alive when CI added (1-17), 1 female alive at end of test.
PA-4-4015	*Packera breweri* *Packera ganderi* *Petasites frigidus* *Senecio blochmaniae*	3-4 to 3-11 2002	Cape ivy (Garrapata Ck.)	3 females alive when CI added (3-7), 1 females alive at end of test. **CI had 3 galls**, 2 dissected 6-17: 1st had 1 dead pupa and 2 PC, 1 dissected 6-27: it had 1 pupa
PA-5-4015	*Packera bolanderi* *Packera ganderi* *Packera ganderi* *Senecio hybridus*	3-7 to 3-14 2002	Cape ivy (Garrapata Ck.)	4 females alive when CI added (3-11), 2 females alive at end of test. **CI had 10 galls**, 10 dissected 6-3: 1st had 3 dead pupa, 2nd had 2 dead pupa and 15 PC, 3rd had 2 dead pupa, 4th had 1 dead pupa and 3 PC, 5th had *Pa.* damage, 6th had 3 dead pupa and 9 PC, 7th had 2 PC, 8th had 4 PC, 9th had 1 dead pupa and 1 PC, 10th had 1 dead pupa and 2 PC
PA-6-4015	*Luina hypoleuca* *Packera breweri* *Senecio vulgaris* *Senecio jacobaea*	3-11 to 3-18 2002	Cape ivy (Garrapata Ck.)	3 females alive when CI added (3-14), 3 females alive at end of test. **CI had 13 galls**, 13 dissected 6-3: 1st had 9 PC, 2nd had 4 PC, 3rd had 3 PC, 4th had 5 PC, 5th had 2 PC, 6th had 3 PC, 7th had 1 dead pupa and 3 PC, 8th had 3 PC, 9th had 5 PC, 10th had 4 PC, 11th had 3 PC, 12th had 1 PC, 13th had 2 PC
PA-8-4015	*Luina hypoleuca* *Packera breweri* *Senecio vulgaris* *Senecio jacobaea*	3-18 to 3-25 2002	Cape ivy (Garrapata Ck.)	3 females alive when CI added (3-21), 3 females alive at end of test. **CI had 11 galls**, 2 dissected 5-29: 1st had 9 PC, 2nd had 1 dead pupa and 7 PC; 9 dissected on 6-3: 1st had 5 PC, 2nd had 7 PC, 3rd had 2 PC, 4th had 5 PC, 5th had 1 dead pupa and 3 PC, 6th had 2 PC, 7th had 6 PC, 8th had 3 PC, 9th had 3 PC
PA-10-5015	*Hedera canariensis* *Luina hypoleuca* *Petasites frigidus* *Senecio jacobaea*	4-11 to 4-19 2002	Cape ivy (Garrapata Ck.)	2 females alive when CI added (4-15), 1 female alive at end of test. **CI had 4 galls**, 2 dissected 6-25: 1st had 1 dead pupa and 3 PC, 2nd had 1 PC; 2 dissected 6-28: 1st had 1 larvae, 2nd had 1 larva, 1 pupa
PA-11-5015	*Hedera helix* *Luina hypoleuca* *Petasites frigidus* *Senecio jacobaea*	4-15 to 4-22 2002	nothing (Garrapata Ck.)	3 females alive when CI added (4-18), 1 female alive at end of test.

PA-12-5015	*Euryops pectinatus* *Hedera helix* *Senecio hybridus* *Senecio triangularis*	4-18 to 4-29 2002	nothing (Garrapata Ck.)	1-3 females alive when CI added (4-22), no females alive at end of test.
PA-13-5015	*Carthamus tinctorius* *Hedera helix* *Petasites frigidus* *Senecio triangularis*	4-25 to 4-29 2002	n/a	test aborted due to high *Pa*. mortality rate
PA-14-5015	*Carthamus tinctorius* *Hedera helix* *Petasites frigidus* *Senecio triangularis*	4-29 to 5-6 2002	nothing (Garrapata Ck.)	3-4 females alive when CI added (5-2), no females alive at end of test.
PA-15-5015	*Carthamus tinctorius* *Hedera helix* *Petasites frigidus* *Senecio triangularis*	5-3 to 5-13 2002	Cape ivy (Garrapata Ck.)	2 females alive when CI added (5-7), 1 female alive at end of test. **CI had 6 galls**, 5 dissected 7-10: 1st had 2 PC, 2nd had 3 PC, 3rd had 1 dead pupa and 3 PC, 4th had 2 PC, 5th had 1 dead pupa and 2 PC; 1 dissected 8-26: it had 2 dead adults and 1 PC
PA-16-5015	*Carthamus tinctorius* *Packera bolanderi* *Packera ganderi* *Senecio hybridus*	5-6 to 5-14 2002	Cape ivy (Garrapata Ck.)	3 females alive when CI added (5-9), 3 females alive at end of test. **CI had 1 gall**, it was dissected on 8-12 and had 3 dead adults
PA-17-5015	*Carthamus tinctorius* *Erechtites glomerata* *Hedera helix* *Luina hypoleuca*	5-7 to 5-15 2002	Cape ivy (Garrapata Ck.)	4 females alive when CI added (5-10), 1 female alive at end of test. **CI had 10 galls**, 3 dissected on 6-28 only had *Pa*. dmg; 4 were dissected on 7-11: 1st had 3 PC, 2nd had 1 live female and 1 PC, 3rd had 4 pupa, 4th had 3 pupa and 2 PC; 2 were dissected 8-6: 1st had 8 PC, 2nd had 1 dead female and 2 dead pupa; 1 dissected 8-13: it had 1 pupa and 3 PC
PA-18-5015	*Carthamus tinctorius* *Erechtites glomerata* *Hedera helix* *Senecio blochmaniae*	5-16 to 5-24 2002	Cape ivy (Garrapata Ck.)	4 females alive when CI added (5-20), 1 female alive at end of test. **CI had 5 galls**, 2 were dissected 8-21: 1st had 6 PC, 2nd had 4 PC; 2 were dissected 8-27: 1st had 1 dead adult and 1 dead pupa, 2nd had *Pa*. dmg
PA-19-5015	*Euryops pectinatus* *Hedera helix* *Packera bolanderi* *Packera macounii*	5-17 to 5-24 2002	Cape ivy (Garrapata Ck.)	3 females alive when CI added (5-21), 1 female alive at end of test. **CI had 5 galls**, 1 dissected 8-26: it had 7 PC; 4 dissected 8-27: 1st had *Pa*. dmg, 2nd had 3 dead adults, 3rd had 5 dead adults, 4th had 2 dead pupa

PA-20-5015	*Carthamus tinctorius* *Euryops pectinatus* *Senecio triangularis* *Tagetes sp.*	5-28 to 6-6 2002	nothing (Garrapata Ck.)	4 females alive when CI added (5-31), no females alive at end of test.
PA-21-5015	*Hedera helix* *Packera bolanderi* *Packera breweri* *Tagetes sp.*	6-3 to 6-10 2002	Cape ivy (Garrapata Ck.)	3 females alive when CI added (6-6), no females alive at end of test. **CI had 3 galls**, 3 were dissected 8-13: 1st had 3 PC, 2nd had 3 PC, 3rd had 1 dead female and 6 PC
PA-22-5015	*Hedera helix* *Petasites frigidus* *Senecio flaccidus* *Tagetes sp.*	6-6 to 6-12 2002	nothing (Garrapata Ck.)	2 females alive when CI added (6-10), no females alive at end of test.
PA-23-5015	*Adenocaulon bicolor* *Luina hypoleuca* *Senecio jacobaea* *Tagetes sp.*	6-10 to 6-17 2002	nothing (Garrapata Ck.)	3 females alive when CI added (6-13), no females alive at end of test.
PA-24-5015	*Hedera helix* *Petasites frigidus* *Senecio flaccidus* *Tagetes sp.*	6-11 to 6-17 2002	nothing (Garrapata Ck.)	2 females alive when CI added (6-14), no females alive at end of test.
PA-25-5015	*Senecio confusus* *Senecio jacobaea* *Senecio vulgaris* *Tagetes sp.*	6-17 to 6-21 2002	Cape ivy (Garrapata Ck.)	4 females alive when CI added (6-17), no females alive at end of test. **CI had 3 galls**, 2 dissected 9-6: both had *Pa*. dmg
PA-26-5015	*Hedera helix* *Packera breweri* *Senecio flaccidus* *Tagetes sp.*	6-17 to 6-27 2002	nothing (Garrapata Ck.)	2 females alive when CI added (6-21), no females alive at end of test.
PA-27-5015	*Hedera helix* *Packera bolanderi* *Petasites frigidus* *Tagetes sp.*	6-18 to 7-1 2002	nothing (Garrapata Ck.)	3 females alive when CI added (6-21), no females alive at end of test.
PA-28-5015	*Carthamus tinctorius* *Euryops pectinatus* *Senecio triangularis* *Senecio vulgaris*	6-20 to 7-1 2002	nothing (Garrapata Ck.)	3 females alive when CI added (6-24), no females alive at end of test.
PA-29-6015	*Adenocaulon bicolor* *Senecio hybridus* *Senecio jacobaea* *Senecio vulgaris*	7-10 to 7-19 2002	nothing (Garrapata Ck.)	4 females alive when CI added (7-15), no females alive at end of test.

PA-30-6015	*Adenocaulon bicolor* *Hedera helix* *Senecio jacobaea* *Senecio vulgaris*	8-5 to 8-13 2002	Cape ivy (Garrapata Ck.)	3 females alive when CI added (8-8), no females alive at end of test. **CI had 5 galls**, 5 dissected 10-15: 1st had 3 PC, 2nd had 3 PC, 3rd had 3 PC, 4th had *Pa.* dmg, 5th had 5 PC
PA-31-8015	*Carthamus tinctorius* *Euryops pectinatus* *Petasites frigidus* *Senecio hybridus*	11-19 to 11-26 2002	Cape ivy (Garrapata Ck.)	2 females alive when CI added (11-22), no females alive at end of test. **CI had 10 galls**,
PA-32-8015	*Lepidospartum latisquamum* *Senecio triangularis* *Symphyotrichum chilense* *Tagetes sp.*	11-21 to 12-2 2002	Cape ivy	4 females alive when CI added (11-25), no females alive at end of test. **CI had 15 galls**, 7 dissected 1-27-03: 1st had 2 PC, 2nd had *Pa.* dmg, 3rd had 2 pupa, 4th had 1 pupa, 5th had 1 pupa, 6th had *Pa.* dmg, 7th had *Pa.* dmg
PA-33-8015	*Anaphalis margaritacea* *Lepidospartum latisquamum* *Symphyotrichum chilense* *Tagetes sp.*	11-26 to 12-3 2002	Cape ivy (Garrapata Ck.)	2 females alive when CI added (11-29), no females alive at end of test. **CI had 6 galls**,
PA-34-8015	*Anaphalis margaritacea* *Lepidospartum latisquamum* *Symphyotrichum chilense* *Tagetes sp.*	11-26 to 12-3 2002	nothing (Rydin Rd.)	2 females alive when CI added (11-29), 1 female alive at end of test.
PA-35-8015	*Anaphalis margaritacea* *Eriophyllum spicatum* *Lepidospartum latisquamum* *Symphyotrichum chilense*	11-29 to 12-6 2002	nothing (Garrapata Ck.)	4 females alive when CI added (12-2), 3 females alive at end of test.
PA-36-8015	*Anaphalis margaritacea* *Calendula officinalis* *Eriophyllum spicatum* *Lepidospartum latisquamum*	12-2 to 12-10 2002	Cape ivy (Garrapata Ck.)	3 females alive when CI added (12-5), 2 females alive at end of test. **CI had 1 gall**,

PA-37-8015	*Anaphalis margaritacea* *Carthamus tinctorius* *Eriophyllum staechadifolium* *Symphyotrichum chilense*	12-2 to 12-10 2002	Cape ivy (Garrapata Ck.)	* test started w/ 3 females and 5 males 3 females alive when CI added (12-5), 2 females alive at end of test. **CI had 4 galls**,

Appendix B. USDA *Digitivalva delaireae* no-choice/host added tests

Test No.	Test type	Non-target test plants	Dates	Oviposited on	Notes
DI-1-2001	C	*Packera bolanderi* *Packera macounii*	4-23 to 5-2 2001	Cape ivy	1 DI alive at end of test.
DI-2-2001	C	*Senecio triangularis*	4-24 to 5-7 2001	nothing	1 DI alive at end of test.
DI-3-3001	C	*Packera bolanderi*	6-14 to 6-21 2001	nothing	no DI alive at end of test.
DI-4-3001	NC	*Senecio triangularis*	6-15 to 6-22 2001	nothing	4 DI alive when CI added (6-19) 2 DI alive at end of test.
DI-5-3001	NC	*Senecio flaccidus*	6-18 to 6-25 2001	nothing	5 DI alive when CI added (6-22) 3 DI alive at end of test.
DI-6-3001	NC	*Senecio blochmaniae*	6-18 to 6-25 2001	Cape ivy	4 DI alive when CI added (6-22) 4 DI alive at end of test.
DI-7-3001	NC	*Petasites frigidus*	6-18 to 6-25 2001	nothing	4 DI alive when CI added (6-22) 2 DI alive at end of test.
DI-9-3001	NC	*Packera macounii*	6-20 to 6-28 2001	nothing	5 DI alive when CI added (6-25) 5 DI alive at end of test.
DI-10-1018	NCHA	*Euryops subcarnosus* *Hedera helix* *Senecio confusus* *Senecio triangularis*	11-13 to 11-26 2001	Cape ivy (Rydin Rd.)	7 DI alive when CI added (11-16) no DI alive at end of test. 2♀ & 2♂ adults emerged from CI
DI-11-1018	NCHA	*Euryops pectinatus* *Euryops subcarnosus* *Packera macounii* *Senecio hybridus*	11-13 to 11-26 2001	Cape ivy (Rydin Rd.)	7 DI alive when CI added (11-16) 4 DI alive at end of test. 4♀ & 3♂ adults emerged from CI
DI-12-1018	NCHA	*Euryops pectinatus* *Hedera helix* *Packera bolanderi* *Senecio confusus*	11-14 to 11-26 2001	Cape ivy (Rydin Rd.)	7 DI alive when CI added (11-20) 2 DI alive at end of test. 2♀ adults emerged from CI
DI-1-2018	NCHA	*Packera macounii* *Senecio hybridus* *Senecio jacobaea* *Senecio triangularis*	1-14 to 1-23 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (1-17) 1 DI alive at end of test. 4♀ + 5♂ adults emerged from CI
DI-2-2018	NCHA	*Packera breweri* *Packera macounii* *Senecio jacobaea* *Senecio triangularis*	1-28 to 1-31 2002	nothing (Garrapata Ck.)	5 DI alive when CI added (1-31) 3 DI alive at end of test.
DI-3-2018	NCHA	*Packera breweri* *Senecio confusus* *Senecio hybridus* *Senecio jacobaea*	2-5 to 2-13 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (2-8) 5 DI alive at end of test. 4♀ + 6♂ adults emerged from CI

DI-4-3018	NCHA	*Euryops pectinatus* *Euryops subcarnosus* *Packera breweri* *Packera macounii*	3-18 to 3-28 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (3-21) 4 DI alive at end of test. 17♀ + 14♂ adults emerged from CI
DI-5-3018	NCHA	*Hedera canariensis* *Luina hypoleuca* *Senecio jacobaea* *Senecio triangularis*	3-22 to 4-1 2002	nothing (Garrapata Ck.)	8 DI alive when CI added (3-26) 1 DI alive at end of test.
DI-6-3018	NCHA	*Luina hypoleuca* *Packera bolanderi* *Packera breweri* *Senecio vulgaris*	3-25 to 4-3 2002	nothing (Garrapata Ck.)	8 DI alive when CI added (3-29) 2 DI alive at end of test.
DI-7-3018	NCHA	*Luina hypoleuca* *Packera bolanderi* *Packera ganderi* *Senecio vulgaris*	3-28 to 4-5 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (4-1) 3 DI alive at end of test. 3♀ + 4♂ adults emerged from CI
DI-8-3018	NCHA	*Luina hypoleuca* *Senecio blochmaniae* *Senecio jacobaea* *Senecio vulgaris*	4-4 to 4-12 2002	nothing (Garrapata Ck.)	5 DI alive when CI added (4-8) 3 DI alive at end of test.
DI-9-3018	NCHA	*Luina hypoleuca* *Petasites frigidus* *Senecio blochmaniae* *Senecio jacobaea*	4-5 to 4-16 2002	nothing (Garrapata Ck.)	7 DI alive when CI added (4-9) 1 DI alive at end of test.
DI-10-3018	NCHA	*Carthamus tinctorius* *Erechtites glomerata* *Hedera canariensis* *Packera bolanderi*	5-13 to 5-21 2002	Cape ivy (Garrapata Ck.)	6 DI alive when CI added (5-16) 1 DI alive at end of test. 2♀ + 2♂ adults emerged from CI
DI-11-4018	NCHA	*Carthamus tinctorius* *Erechtites glomerata* *Hedera canariensis* *Packera bolanderi*	5-13 to 5-21 2002	nothing (Garrapata Ck.)	6 DI alive when CI added (5-16) 1 DI alive at end of test.
DI-12-4018	NCHA	*Carthamus tinctorius* *Packera macounii* *Senecio blochmaniae* *Senecio triangularis*	5-14 to 5-22 2002	nothing (Garrapata Ck.)	7 DI alive when CI added (5-17) 1 DI alive at end of test.
DI-13-4018	NCHA	*Carthamus tinctorius* *Euryops pectinatus* *Hedera helix* *Senecio blochmaniae*	5-21 to 5-28 2002	nothing	* CI not added to test 1 DI alive at end of test.
DI-14-4018	NCHA	*Carthamus tinctorius* *Erechtites glomerata* *Hedera canariensis* *Tagetes sp.*	5-21 to 5-29 2002	nothing (Garrapata Ck.)	6 DI alive when CI added (5-24) 1 DI alive at end of test.

DI-15-4018 NCHA	*Erechtites glomerata* *Hedera helix* *Senecio blochmaniae* *Tagetes sp.*	5-24 to 6-4 2002	Cape ivy (Garrapata Ck.)	7 DI alive when CI added (5-28) 1 DI alive at end of test. 6♀ + 5♂ adults emerged from CI
DI-16-4018 NCHA	*Euryops pectinatus* *Euryops subcarnosus* *Senecio triangularis* *Tagetes sp.*	5-24 to 6-3 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (5-28) 2 DI alive at end of test. 5♀ & 7♂ adults emerged from CI
DI-17-4018 NCHA	*Carthamus tinctorius* *Hedera helix* *Senecio blochmaniae* *Tagetes sp.*	6-4 to 6-10 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (6-7) no DI alive at end of test. 1♀ adult emerged from CI
DI-18-4018 NCHA	*Euryops pectinatus* *Euryops subcarnosus* *Petasites frigidus* *Senecio flaccidus*	6-10 to 6-17 2002	nothing (Garrapata Ck.)	7 DI alive when CI added (6-13) no DI alive at end of test.
DI-19-5018 NCHA	*Adenocaulon bicolor* *Hedera helix* *Packera breweri* *Senecio confusus*	7-9 to 7-17 2002	Cape ivy (Garrapata Ck.)	6 DI alive when CI added (7-12) 1 DI alive at end of test. 1♀ & 1♂ adults emerged from CI
DI-20-5018 NCHA	*Hedera helix* *Packera breweri* *Petasites frigidus* *Senecio flaccidus*	7-23 to 8-5 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (7-26) 1 DI alive at end of test. 2♀ adults emerged from CI
DI-21-5018 NCHA	*Adenocaulon bicolor* *Packera breweri* *Petasites frigidus* *Senecio flaccidus*	7-23 to 7-31 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (7-26) 1 DI alive at end of test. 1♀ & 2♂ adults emerged from CI
DI-22-5018 NCHA	*Adenocaulon bicolor* *Hedera helix* *Packera breweri* *Senecio flaccidus*	7-29 to 8-7 2002	Cape ivy (Garrapata Ck.)	7 DI alive when CI added (8-1) 1 DI alive at end of test. 2♀ & 5♂ adults emerged from CI
DI-23-6018 NCHA	*Carthamus tinctorius* *Euryops pectinatus* *Senecio hybridus* *Senecio vulgaris*	9-3 to 9-11 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (9-6) no DI alive at end of test. 1♀, 1♂, and 2 unsexed adults emerged from CI
DI-24-6018 NCHA	*Carthamus tinctorius* *Euryops subcarnosus* *Senecio flaccidus* *Senecio hybridus*	9-16 to 9-25 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (9-19) no DI alive at end of test. 1♀ & 3♂ adults emerged from CI
DI-25-6018 NCHA	*Hedera canariensis* *Packera bolanderi* *Senecio flaccidus* *Senecio vulgaris*	9-17 to 9-25 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (9-20) no DI alive at end of test. 7♀ & 3♂ adults emerged from CI

DI-26-6018 NCHA	*Packera bolanderi* *Packera macounii* *Senecio triangularis* *Senecio vulgaris*	9-23 to 10-1 2002	nothing (Garrapata Ck.)	8 DI alive when CI added (9-26) no DI alive at end of test.
DI-27-6018 NCHA	*Adenocaulon bicolor* *Packera macounii* *Senecio triangularis* *Senecio vulgaris*	9-26 to 10-7 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (9-30) 1 DI alive at end of test. no adults emerged from CI
DI-28-6018 NCHA	*Luina hypoleuca* *Packera macounii* *Senecio blochmaniae* *Senecio vulgaris*	9-20 to 10-8 2002	Cape ivy (Hawaii)	8 DI alive when CI added (10-3) no DI alive at end of test. 1♂ adult emerged from CI
DI-29-6018 NCHA	*Adenocaulon bicolor* *Hedera canariensis* *Petasites frigidus* *Senecio blochmaniae*	10-1 to 10-7 2002	nothing (South Africa)	4 DI alive when CI added (10-4) no DI alive at end of test.
DI-30-7018 NCHA	*Carthamus tinctorius* *Petasites frigidus* *Senecio blochmaniae* *Senecio confusus*	10-28 to 11-5 2002	Cape ivy (Garrapata Ck.)	* test started with 5♀ & 3♂ 8 DI alive when CI added (10-31) 2 DI alive at end of test. 3♀ & 4♂ adults emerged from CI
DI-31-7018 NCHA	*Packera bolanderi* *Petasites frigidus* *Senecio jacobaea* *Tagetes sp.*	10-29 to 11-7 2002	nothing (Garrapata Ck.)	8 DI alive when CI added (11-1) 2 DI alive at end of test.
DI-32-7018 NCHA	*Adenocaulon bicolor* *Petasites frigidus* *Senecio blochmaniae* *Tagetes sp.*	10-31 to 11-13 2002	Cape ivy (Garrapata Ck.)	7 DI alive when CI added (11-4) 2 DI alive at end of test. 6♀ & 8♂ adults emerged from CI
DI-33-7018 NCHA	*Erechtites glomerata* *Hedera canariensis* *Senecio jacobaea* *Senecio triangularis*	11-4 to 11-13 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (11-7) 2 DI alive at end of test. 8♀ & 8♂ adults emerged from CI
DI-34-7018 NCHA	*Erechtites glomerata* *Eriophyllum staechadifolium* *Senecio jacobaea* *Symphyotrichum chilense*	11-5 to 11-13 2002	nothing (Garrapata Ck.)	7 DI alive when CI added (11-8) 1 DI alive at end of test.

DI-35-7018	NCHA	*Anaphalis margaritacea* *Erechtites glomerata* *Eriophyllum staechadifolium* *Symphyotrichum chilense*	11-8 to 11-18 2002	Cape ivy (Garrapata Ck.)	7 DI alive when CI added (11-12) 1 DI alive at end of test. 8♀ & 6?♂ adults emerged from CI
DI-36-7018	NCHA	*Carthamus tinctorius* *Petasites frigidus* *Senecio confusus* *Symphyotrichum chilense*	11-13 to 11-19 2002	nothing (Garrapata Ck.)	7 DI alive when CI added (11-16) no DI alive at end of test.
DI-37-7018	NCHA	*Eriophyllum staechadifolium* *Petasites frigidus* *Packera bolanderi* *Symphyotrichum chilense*	11-13 to 11-20 2002	nothing (Garrapata Ck.)	8 DI alive when CI added (11-16) no DI alive at end of test.
DI-38-7018	NCHA	*Erechtites glomerata* *Eriophyllum staechadifolium* *Symphyotrichum chilense* *Tagetes sp.*	11-13 to 11-21 2002	Cape ivy (Garrapata Ck.)	7 DI alive when CI added (11-16) 1 DI alive at end of test. 9♀ & 11♂ adults emerged from CI
DI-39-7018	NCHA	*Anaphalis margaritacea* *Erechtites glomerata* *Hedera canariensis* *Senecio triangularis*	11-19 to 11-26 2002	Cape ivy (Rydin Rd.)	7 DI alive when CI added (11-22) 1 DI alive at end of test. 8♀ & 4♂ adults emerged from CI
DI-40-7018	NCHA	*Anaphalis margaritacea* *Eriophyllum staechadifolium* *Lepidospartum latisquamum* *Senecio jacobaea*	11-21 to 11-29 2002	Cape ivy (Garrapata Ck.)	8 DI alive when CI added (11-25) no DI alive at end of test. 1♀ & 1♂ adults emerged from CI
DI-41-7018	NCHA	*Anaphalis margaritacea* *Eriophyllum staechadifolium* *Lepidospartum latisquamum* *Senecio jacobaea*	11-21 to 11-29 2002	nothing (Garrapata Ck.)	5 DI alive when CI added (11-25) no DI alive at end of test.

DI-42-8018	NCHA	*Eriophyllum staechadifolium* *Lepidospartum latisquamum* *Senecio jacobaea* *Symphyotrichum chilense*	12-23 to 12-30 2002	nothing (Garrapata Ck.)	7 DI alive when CI added (12-26) no DI alive at end of test.
DI-43-8018	NCHA	*Lepidospartum latisquamum* *Senecio jacobaea* *Symphyotrichum chilense* *Vernonia missurica*	12-23 to 12-30 2002	nothing (Garrapata Ck.)	6 DI alive when CI added (12-26) 1 DI alive at end of test.