Biological Control of Cape ivy Project
2004 Annual Research Report

prepared by Joe Balciunas, Chris Mehelis, and Maxwell Chau, with contributions from Liamé van der Westhuizen and Stefan Neser

Flowering Cape ivy overgrowing trees and native vegetation along California's coast near Bolinas

United States Department of Agriculture - Agricultural Research Service
Western Regional Research Center - Exotic & Invasive Weed Research Unit
800 Buchanan St., Albany, California 94710
(510) 559-5975 FAX: (510) 559-5982

Executive Summary

by Dr. Joe Balciunas

This is our first attempt at an 'electronic' report, and most of you will receive our Annual Report for 2004 as PDF attachment to an email. We hope that this will make our report more easily accessible, since you may chose to store it on your hard disk.

We made solid progress during 2004 towards our goal of completing our host range testing of our two most promising potential biological control agents for Cape ivy. We overcame a summertime 'crash' of our laboratory colonies, and by year's end had strong colonies of both the gall fly, *Parafreutreta regalis*, and the stem-boring moth, *Digitivalva delaireae*. By the end of 2004, we had tested more than 80 species of plants, and neither of our candidate agents was able to complete development on anything other than their Cape ivy host.

The single dark cloud has been the continuing downturn in external funds to support our Cape ivy research, especially that conducted by our cooperators in Pretoria, South Africa. While we have managed to maintain a small research effort there, our cooperators are no longer assisting us in our host range evaluations.

By mid-2005, we hope to have completed our host-specificity testing. Then, we will collate our results, and prepare a formal 'petition' seeking permission to release both of these agents in the field. The complex and lengthy approval process for obtaining permission to release a herbivorous agent is outlined in Section V.B of this report.

As always, if you have any questions or comments, don't hesitate to contact me.

List of Staff and Cooperators

USDA Staff:
Joe Balciunas, Project Leader (Jan. 1, 1996 to present)
Chris Mehelis, Biological Science Technician (April 28, 1998 to present)
Maxwell Chau, Biological Science Technician (March 1, 1999 to present)
Eve Lednicky, Biological Science Technician (July 7, 1999 to present)

PPRI Staff at Reitondale (Pretoria) in South Africa:
Stefan Neser, Principal Investigator
Liamé van der Westhuizen, Agricultural Research Technician
Yogie Kistensamy, Nursery Manager

Cooperators:

Academy of Sciences – St. Petersburg, RUSSIA
Bonsell Reserve, Oceanside, CA
Bureau of Land Management – Fort Ord
California Dept. of Food & Agriculture (CDFA)
California Dept. of Transportation (CalTrans)
California Invasive Plant Council (CalIPC, formerly, California Exotic Pest Plant Council)
California Native Plant Society (CNPS)
California State Parks and Recreation
California Polytechnic State University, San Luis Obispo
East Bay Regional Park District (EBRPD)
Golden Gate National Recreation Area
National Park Service – Redwood National Park
Plant Protection Research Institute – Pretoria, SOUTH AFRICA
Rio Pedros Reserve, Carmel, CA
Stansell, Veva – Forest Service (retired)
Univ. of California – Berkeley
Univ. of California – Davis
USDA-ARS, Reno, Nevada
USDA-ARS, Fresno, California
USDA-ARS, Frederick, Maryland
USDA-Forest Service, Siskiyou National Forest
Washington State Univ.
Wits University – Johannesburg, SOUTH AFRICA

List of Acronyms and Abbreviations

List of Acronyms

APHIS	Animal and Plant Health Inspection Service (an agency of USDA)
ARS	Agricultural Research Service (an agency of USDA)
BCDC	Biological Control Documentation Center
CA	California
Cal- IPC	California Invasive Plant Council (formerly, California Exotic Pest Plant Council)
CNPS	California Native Plant Society
CSIRO	Commonwealth Scientific and Industrial Research Organization
EA	Environmental Assessment
EIS	Environmental Impact Statement
EIW	Exotic & Invasive Weed Research Unit, USDA-ARS, Albany, California
FWS	US Fish and Wildlife Service
FONSI	Finding Of No Significant Impact
GGNRA	Golden Gate National Recreation Area
PPRI	Plant Protection Research Institute (an agency of the Agricultural Research Council of the Republic of South Africa)
PPQ	Plant Protection and Quarantine (a section within APHIS)
SPRO	State Plant Regulatory Official
TAG	Technical Advisory Group for Biological Control of Weeds
T&E species	Threatened and Endangered species
USDA	United States Department of Agriculture

List of Generic Abbreviations

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

Table of Contents

List of Tables

List of Figures

I. Introduction

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

Cape ivy (also known as German ivy), a vine native to 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 it 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, such as Big Basin, Hearst San Simeon, Mt. Tamalpias, Van Damme, and Jughandle, are heavily impacted as well. U.S. Forest Service lands along the Big Sur coast are also frequently heavily infested, 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 through 2004)

Dr. Balciunas made his first trip to South Africa, the native home of Cape ivy, early in 1996, to attend an international symposium. After the symposium ended, he visited five South African herbaria, and collated the collection records from the pressed Cape ivy specimens at these institutions. 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).

The Cape Ivy Biocontrol Project began in 1998, and since then, Dr. Balciunas, the project leader, has made four additional visit to South Africa. On each visit, he spent 4-5 weeks with our South African cooperators, reviewing their results, participating in field studies, and jointly planning the research for the following year. During the first two years, our South African cooperators, Beth Grobbelaar and Stefan Neser, collected over 230 species of plant-injuring insects from Cape ivy (Grobbelaar *et al.*, 2003).

Six of the most promising of these insects were selected for further research. These included: *Diota rostrata* (Arctiidae) - a defoliating caterpillar; *Digitivalva delaireae* (referred to as *Acrolepia* new species in earlier reports) – 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.

By mid-2000, three of these six insects had been dropped from further consideration, and the focus of the last five years of research in South Africa has been to assist us in a collaborative effort to evaluate the host range of the three most promising insects: *Digitivalva delaireae*, *Diota rostrata* and *Parafreutreta regalis*. This phase of research has been led by Dr. Stefan Neser, and his assistant Liamé van der Westhuizen. They were able to establish laboratory colonies of these three Cape ivy insects, and have compiled valuable information on the biology and life history of these three insects, and developed rearing techniques. They have also nearly completed their portion of the host range evaluations of our top three candidate biocontrol agents. They confirmed that the moth *Diota rostrata*, whose caterpillars sometimes spectacularly defoliate Cape ivy patches, has several other hosts, and will not be safe enough for release here. They have also confirmed the safety of *Digitivalva delaireae*, and *Parafreutreta regalis*.

Since 1997, the California Invasive Plant Council (Cal-IPC [formerly, California Exotic Pest Plant Council]) and the California Native Plant Society (CNPS), have raised funds ($11,000-$65,000 annually) to assist our USDA-ARS project on the biological control of Cape ivy. We have used these contributions to support research in South Africa. The poor state of California's economy has caused a severe decline in contributions to the Cape ivy project no additional funds were received in 2003 or 2004 from any California state agency. Accordingly, we scaled back research in South Africa the last two years, and anticipate continuing a much-reduced research effort there during 2005.

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

Parafreutreta regalis (Diptera: Tephritidae) was described in 1940 by Munro, and identified as a potential agent for the biological control of Cape ivy during insect surveys in South Africa in 1998-99. An adult *Pa. regalis* (Figure 1) is about the size of a housefly or slightly smaller. Females lay eggs inside the nodes or growing tips of Cape ivy vines. The maggots cause Cape ivy to grow a spherical gall, about a ½-inch in diameter (Figure 1), within which they complete their life cycle, before adult flies emerge from the gall. 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 (windows) at bottom left.

Dr. Balciunas brought back the first gall flies to the US from South Africa in January, 2001. We started our colony in our quarantine laboratory from a subsequent shipment of these flies in August 2001. Our colony has since produced six to seven generations in each of three last three years.

A. Host range evaluations

During the past four years, the research at our Albany facility, as well as in Pretoria, has concentrated on evaluating the safety of some of the insects discovered during surveys in South Africa. Safety is the primary concern for those involved in releasing herbivorous insects from overseas. It is in everyone's best interest that the insects are narrowly host-specific – that once released and established, they will not cause significant damage to native, cultivated, or desirable ornamental plants. The host-specificity of candidate insects is typically determined by exposing the insects, in cages in the laboratory, to an array of potential host plants, then noting which of these (if any) are suitable as hosts. Traditionally, these laboratory host range evaluations are comprised of "no-choice tests" (sometimes called "starvation tests) where 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, we designed another testing protocol. Essentially, these tests (that we call "no-choice/ host added") are a multi-plant, no-choice trial, to which, at the beginning of the fourth day, a Cape ivy plant is added. The procedures 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% Mountain Dew®) was placed in the center of the cage. We then released four female-male pairs of flies into the cage. After 72 hours, we placed a Cape ivy plant into the center of the cage. Our initial oviposition studies showed that 70% of female *Parafreutreta* have begun to oviposit by this time. Seven to ten days after the start of the test (depending on the number of flies still alive after seven days), the test was ended and the remaining flies recovered. Plants were watered as necessary, and observed nearly daily for signs of gall formation. If no galls had formed after 60 days, or if the plant died earlier, 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" trials, and were very similar to those conducted in Albany. Three or four test plants of roughly similar size were placed in a cage (0.56m x 0.56m x 0.6m) 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. After another three days of exposure, the flies were removed, while the plants were left in the cage and gall development monitored. At both locations, we attempted to test each plant species five times.

Table 1 summarizes the plants, number of repetitions, and galls formed on the "no-choice/ host added" tests that we and our cooperators in South Africa have completed through December 2004. Only the results from trials that produced galls on the control plant (Cape ivy) are included. Appendix A provides the complete, detailed results for each of these trials in Albany and Pretoria.

Table 1. Plant species evaluated by USDA and PPRI for *Parafreutreta regalis* oviposition and development (2001 through 2004).

Tribe	Species tested (including Cape ivy)	Location of test	# of reps.	Mean # of galls per test
Family Araliaceae				
	Hedera canariensis Willd.	Albany	5	0
	Hedera helix L.	Albany	5	0
Family Asteraceae				
Subfamily Asteroideae				
Anthemideae	*Achillea millefolium* L.	Albany	5	0
	Artemisia californica Less.	Albany	5	0
	Schistostephium cf. heptalobum (DC.) Oliv. & Hiern	Pretoria	5	0
Astereae	*Baccharis pilularis* DC.	Albany	5	0
	Erigeron glaucus Ker-Gawl.	Albany	5	0
	Grindelia sp.	Albany	5	0
	Symphyotrichum chilense (Nees) G.L. Nesom	Albany	5	0
Calenduleae	*Calendula officinalis* L.	Albany	5	0
Eupatorieae	*Ageratina adenophora* (Spreng.) King & H.E. Robins	Pretoria	6	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	5	0
	Mikania capensis DC.	Pretoria	9	0
Gnaphalieae	*Anaphalis margaritacea* (L.) Benth. ex. C.B. Clarke	Albany	5	0
	Gamochaeta sp.	Albany	2	0
Helenieae	*Eriophyllum staechadifolium* Lag.	Albany	5	0
	Madia elegans D. Don ex Lindl.	Albany	6	0
	Tagetes sp.	Albany	5	0
	Tagetes minuta L.	Pretoria	5	0
Heliantheae	*Bidens formosa* (Bonato) Schultz-Bip.	Pretoria	5	0
	Coreopsis sp. *cv*.	Pretoria	5	0
	Dahlia pinnata cv. Cav.	Pretoria	6	0
	Galinsoga parviflora Cav.	Pretoria	5	0
	Helianthus annuus	Pretoria	6	0
	Helianthus tuberosus L.	Pretoria	9	0
	Rudbeckia sp. *cv*.	Pretoria	5	0
	Zinnia elegans cv. Jacq.	Pretoria	5	0
Plucheae	*Pluchea odorata* Cass.	Albany	3	0
Senecioneae	Subtribe Blennospermatinae			
	Blennospema nanum (Hook.) Blake	Albany	5	0
Senecioneae	Subtribe Senecioninae			
	Cineraria cv "butterfly"	Pretoria	8	0
	Cineraria deltoidea Sond.	Pretoria	5	0
	Cineraria saxifraga DC.	Pretoria	9	0

	Delairea odorata Lem.	Albany	58	5.7
		Pretoria	69	5
	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	9	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		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	4	0
	Packera macounii (Greene) W.A. Weber & A. Löve	Albany	5	0
	Pseudogynoxys chenopodioides Kunth	Albany	5	0
	Senecio angulatus L. f.	Pretoria	7	0
	Senecio articulatus (L.) Sch. Bip	Pretoria	5	0
	Senecio blochmaniae Greene	Albany	5	0
	Senecio brachypodus DC.	Pretoria	6	0
	Senecio deltoideus Less.	Pretoria	5	0
	Senecio flaccidus Less.	Albany	5	0
		Pretoria	5	0
	Senecio glastifolius L. f.	Pretoria	5	0
	Senecio helminthioides (Schultz-Bip.) Hilliard	Pretoria	6	0
	Senecio hybridus Regel	Albany	5	0
	Senecio jacobaea L.	Albany	5	0
	Senecio macroglossus DC.	Pretoria	5	0
	Senecio oxyodontus DC.	Pretoria	9	0
	Senecio oxyriifolius DC.	Pretoria	6	0
	Senecio pleistocephalus S. Moore	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	5	0
Senecioneae	Subtribe Tussilagininae			
	Lepidospartum latisquamum S. Wats.	Albany	5	0
	Luina hypoleuca Benth.	Albany	5	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
	Centaurea melitensis L.	Albany	1	0
	Cynara scolymus L.	Pretoria	5	0
Lactuceae	*Cichorium intybus* L.	Albany	5	0
	Lactuca sativa L.	Pretoria	5	0
	Picris echioides L.	Albany	5	0
Mutisieae	*Adenocaulon bicolor* Hook.	Albany	5	0
Vernonieae	*Vernonia missurica* Raf.	Albany	6	0

Family Aristolochiaceae			
Aristolochia californica Torr.	Albany	1	0
Family Brassiceae			
Brassica oleracea L.	Pretoria	5	0
Lepidium latifolium L.	Albany	5	0
Raphanus sativus L.	Pretoria	5	0
Family Campanulaceae			
Campanula muralis	Albany	5	0
Lobelia erinus L.	Albany	5	0
Family Chenopodiaceae			
Beta vulgaris subsp. *cicla* (L.) Koch	Pretoria	5	0
Family Cucurbitaceae			
Marah fabaceus (Naud.) Naud. ex Greene	Albany	5	0
Zehneria scabra (L. f.) Sond.	Pretoria	5	0
Family Rosaceae			
Frageria chiloensis (L.) P. Mill.	Albany	5	0
Family Ranunculaceae			
Clematis lingusticifolia Nutt.	Albany	5	0
Family Vitaceae			
Vitis californica Benth.	Albany	5	0

In Albany, we've conducted 58 trials (each with four test plants) so far, that showed a positive control (galls formed on Cape ivy), while in Pretoria, 69 trials (each with 3-5 test plants) have showed a positive control. Between the two locations, we have tested 88 species, and have not found any sign of gall development or *Pa. regalis* damage to any species other than *Delairea odorata*, thereby confirming this fly's exclusive preference to Cape ivy.

The South African host range testing for this insect is complete. For Albany, in 2005, we plan to conduct a few more "no-choice/ host added" trials several species already tested, so that at a minimum, each species is tested five times. We will then compile our results and begin the lengthy process of obtaining federal and state approval to release this fly in California [see Section V. B].

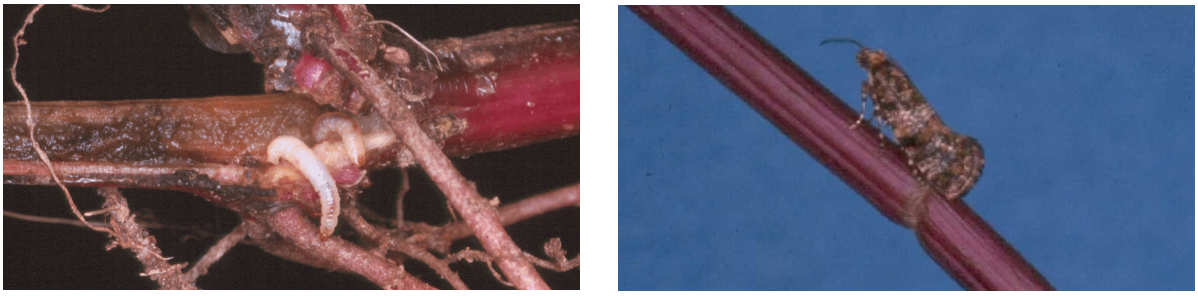
III. The Cape ivy stem boring/leaf-mining moth, *Digitivalva delaireae*

A. Observations, Biology, and Life History

The Cape ivy stem boring 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 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.

Digitivalva delaireae is a tiny moth (usually about ¼-inch in length). Adults (Figure 2, right) seem to be quiescent during daylight hours, but appear quite active at dusk. We have seldom observed moths mating. Females oviposit single opaque eggs on both sides of Cape ivy leaves, on stems, and stipules, and sometimes on the petiole. Tiny caterpillars (Figure 2, left) hatch out and tunnel within the leaves and stems, leaving distinctive "mines" in the leaves. Newly hatched caterpillars on the leaves usually bore down through the leaf petiole, and then bore inside the stem of Cape ivy. In our laboratory, most of the mined leaves, and many of the bored stems die, and sometimes the entire Cape ivy plant is killed. Mature larvae exit the stems and leaf mines, and crawl around on the ground, before pupating in small, flattened, silken pupal cases. It is during this stage that we collect the mature larvae (also called pre-pupae) and pupal cases from the floor of our cages, then use the emerging adults for our tests and colonies.

Figure 2. *Digitivalva delaireae* larvae (left) and newly-emerged adult (right). (Photos by E. Grobbelaar)



Dr. Balciunas hand-carried the first *Digitivalva delaireae* to our quarantine in Jan. 2001. From subsequent shipments, we started a colony in Oct. 2001. In 2002, we had seven generations of this multivoltine moth, six generations in 2003, and another six generations in 2004. In Sept. of 2004, due to concerns about the lack of genetic diversity, we requested and received another shipment of *Digitivalva* from our cooperators. The shipment of 40 pupae arrived on Nov. 8th but unfortunately only 11 moths (five females and six males) emerged from these pupae. Most of these adults were feeble and died within a few days of emergence, so it is doubtful that they contributed to our colony. We plan to request another shipment from our South African cooperators in 2005.

In 2003 and 2004, we studied two aspects of oviposition of *Di. delaireae*: the pre-oviposition period and net fecundity. The pre-oviposition period – the time from when the female

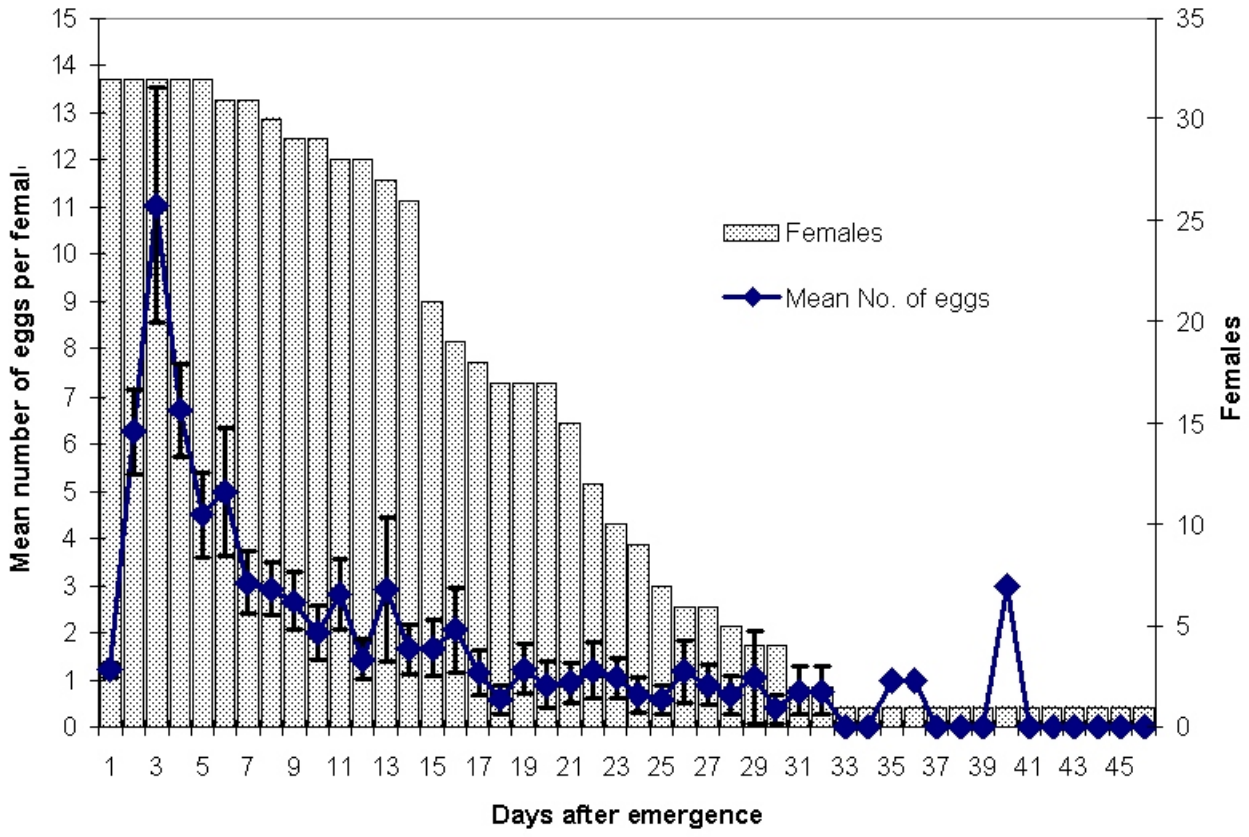
emerged from the gall to when it would first oviposit – was determined in 2003. We collected newly emerged females (within 1-2 hours of emergence) and placed them with two males (usually slightly older) in a plexiglass tube (dimensions: 26 cm height, 14.5 cm diameter). The top and bottom of the tube were covered with mesh to contain the flies and allow air exchange. A 13-18 cm cutting of a Cape ivy vine, was placed in tube with its end embedded in moistened oasis foam. After 24 hours (always in the late afternoon), we examined the cutting for eggs. If no eggs were found, we replaced the Cape ivy vine segment and continued dissections daily, at 8:00 and 16:00 hrs., until the first eggs were discovered.

We completed 30 of these tests. Most of the females (70%) oviposited between 24 to 72 hours. Furthermore, most of the females (82%) oviposited during daytime hours.

After initial oviposition was discovered, we continued to dissect and replace the Cape ivy vines on an almost daily basis to determine the oviposition rate and net fecundity (total number of eggs oviposited by one female). We did this until the females died. The number of eggs laid during a multi-day period was averaged to obtain a daily rate. If a female escaped or was damaged, her results were discarded, and another test was started.

We completed 32 of these tests and determined the mean lifetime fecundity to be 51.3 eggs per female (SE ± 5.79, range: 11 to 141 eggs). The oviposition rate increased for a week, then decreased over the next two weeks (Figure 3). No eggs were laid after 24 days, although a few females lived for four weeks.

Figure 3. The mean number (± SE) of eggs oviposited daily by *Digitivalva delaireae* females during their lifetimes.



When counting the eggs during the pre-oviposition and net fecundity study, we noted the location of the oviposition for 31 of the moths. Interestingly, of the 1457 *Di. delaireae* eggs, 71% were oviposited on leaves, 23% on stems and stipules, and 6% on petioles.

Since we followed the lives of female moths from birth to death during our oviposition studies, we were able to estimate their longevity. Of the 32 females in the study, the longevity of 15 could be accurately determined (the other 17 died over the weekend). Of these 15, the mean longevity was 16.2 days (SE=1.84, range 7-31). In 2002, our South African cooperators preformed a preliminary study of the longevity of *Di. delaireae*. They found the average female longevity to be 7.3 days (n=8, range 3-10 days).

B. Host range evaluations

We continued host range testing *Di. delaireae* in Albany and Pretoria through 2004. Some new plant species were tested, and other trials were run to test each plant five times. The protocols for the *Digitivalva* "no-choice/ host added" tests are identical to those for the gall fly, *Pa. regalis*.

The results of the successful "no-choice/ host added" trials completed in Albany and in South Africa are summarized in Table 2, while Appendix B provides detailed results of each trial conducted in Albany and Pretoria.

Table 2. Plant species evaluated by USDA and PPRI for *Digitivalva delaireae* oviposition and development (2001 through 2004)

Tribe: Subtribe	Species tested (including Cape ivy)	Location of test	# of reps	# 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				
Anthemideae	*Achillea millefolium* L.	Albany	6	0
	Artemisia californica Less.	Albany	6	0
	Schistostephium cf. heptalobum (DC.) Oliv. & Hiern	Pretoria	6	0
Astereae	*Baccharis pilularis* DC.	Albany	2	0
	Bellis sp.	Pretoria	5	0
	Erigeron glaucus Ker-Gawl.	Albany	6	0
	Grindelia sp.	Albany	5	0
	Symphyotrichum chilense (Nees) G.L. Nesom	Albany	5	0
Calenduleae	*Calendula officinalis* L.	Albany	5	0
Eupatorieae	*Ageratina adenophora* (Spreng.) King & H.E.	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	5	0
	Mikania capensis DC.	Pretoria	4	0
Gnaphalieae	*Anaphalis margaritacea* (L.) Benth. ex C.B. Clarke	Albany	6	0
	Gamochaeta sp.	Albany	2	0
Helenieae	*Eriophyllum staechadifolium* Lag.	Albany	5	0
	Madia elegans D. Don ex Lindl.	Albany	6	0
	Tagetes sp.	Albany	5	0
	Tagetes minuta L.	Pretoria	5	0
Heliantheae	*Bidens formosa* (Bonato) Schultz-Bip.	Pretoria	2	0
	Dahlia pinnata Cav.	Pretoria	3	0
	Galinsoga parviflora Cav.	Pretoria	5	0
	Helianthus annuus L.	Pretoria	3	0
	Helianthus tuberosus L.	Pretoria	5	0
	Rudbeckia sp. *cv.*	Pretoria	5	0
	Zinna elegans cv. Jacq.	Pretoria	5	0
Senecioneae: Blennospermatinae	*Blennosperma nanum* (Hook.) Blake	Albany	6	0
Senecioneae: Senecioninae	*Cineraria cv.* "butterfly"	Pretoria	5	0
	Cineraria deltoidea Sond.	Pretoria	5	0
	Cineraria saxifraga DC.	Pretoria	6	0
	Delairea odorata Lem.	Albany	53	53
		Pretoria	57	57
	Erechtites glomerata (Desf. ex Poir.) DC.	Albany	5	0
	Euryops chrysanthemoides (DC.) B. Nordenstam	Pretoria	6	0
	Euryops pectinatus (L.) Cass.	Albany	5	0
		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
	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 chenopioides Kunth	Albany	5	0
	Senecio angulatus L. f.	Pretoria	5	1
	Senecio articulatus (L.) Sch. Bip	Pretoria	6	0
	Senecio blochmaniae Greene	Albany	5	0
	Senecio brachypodus DC.	Pretoria	5	1
	Senecio deltoideus Less.	Pretoria	5	0

	Senecio flaccidus Less.	Albany	5	0
		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	2
	Senecio oxydontus DC.	Pretoria	5	1
	Senecio oxyriifolius DC.	Pretoria	5	0
	Senecio pleistocephalus DC.	Pretoria	5	1
	Senecio serratuloides DC.	Pretoria	5	0
	Senecio tamoides DC.	Pretoria	5	1
	Senecio triangularis Hook.	Albany	5	0
	Senecio vulgaris L.	Albany	5	0
	Senecio sp. (unidentified)	Pretoria	5	0
Senecioneae: Tussilagininae	*Lepidospartum latisquamum* S. Wats	Albany	5	0
	Luina hypoleuca Benth	Albany	5	0
	Petasites frigidus (L.) Fries	Albany	5	0
Subfamily Cichorioideae				
Arctoteae	*Arctotheca calendula* (L.) Levyns	Pretoria	6	0
Cardueae	*Carthamus tinctorius* L.	Albany	5	0
	Cynara scolymus L.	Pretoria	5	0
Lactuceae	*Cichorium intybus* L.	Albany	5	0
	Picris echioides L.	Albany	5	0
Mutisieae	*Adenocaulon bicolor* Hook.	Albany	5	0
Vernonieae	*Vernonia missurica* Raf.	Albany	5	0
Family Aristolochiaceae				
	Aristolochia californica Torr.	Albany	2	0
Family Brassicaceae				
	Brassica oleracea L.	Pretoria	5	0
	Lepidum latifolium L.	Albany	5	0
Family Chenopodiaceae				
	Beta vulgaris subsp. *cicla* (L.) Koch	Pretoria	5	0
Family Cucurbitaceae				
	Marah fabaceus (Naud.) Naud. ex Greene	Albany	6	0
	Zehneria scabra (L. f.) Sond.	Pretoria	5	0
Family Rosaceae				
	Frageria chiloensis (L.) P. Mill.	Albany	5	0
Family Campanulaceae				
	Campanula muralis	Albany	5	0
	Lobelia erinus L.	Albany	5	0
Family Ranunculaceae				
	Clematis lingusticifolia Nutt.	Albany	2	0
Family Vitaceae				
	Vitis californica Benth.	Albany	2	0

Out of the 110 "no-choice/ host added" trials completed in Albany so far, 53 showed a positive control (oviposition and development on Cape ivy) and their results are shown in Table 4. In these 53 trials, we have had hundreds of female and male *Digitivalva* moths emerge from Cape ivy, but have found no development or signs of infestation on any of the other 46 species of test plants.

In South Africa, 41 plant species have been tested. A total of 69 trials have been completed: 57 showed a positive control (oviposition and development on Cape ivy), while five 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. In addition, two *Senecio macroglossus* test plants showed more damage. Despite some tunneling in non-host species *Digitivalva* is still regarded as a very promising biological control candidate. Host range tests should be completed in 2005.

IV. Other studies during 2004

A. *Cercospora* pathogen

In 2002, 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. More information on this pathogen can be found in our 2002 Biological Control of Cape ivy report (Balciunas et al. 2002)

In late 2004, a sample of this pathogen was sent to USDA-ARS plant pathologist Dana Berner in Frederick, MD for a species identification. Dr. Berner has not yet identified this pathogen, but at this point believes there are actually two pathogens. If either of these pathogens shows pormise as a potential biocontrol agent, Dr. Berner will conduct the required host-specificity tests at the Fort Dietrick Plant Pathogen Quarantine Facility in Frederick, MD. In that case, we would assist Dr. Berner by supplying many of the plants that need to be tested.

B. Studies in Cape ivy biology

The inflorescences ("heads") of most species of *Senecio*, along with its close relatives, are usually composed of two types of florets: outer ligulate ("ray") florets surrounding central discoid ("disk") florets. Cape ivy is different in that each head is composed entirely of disk florets. Each of these florets is capable of producing a seed. Our interest in quantifying the damage of flower-feeding insects led us to investigate how many seeds might be produced. We soon noted an anomaly in the literature. The original discription of Cape ivy by Lemaire (1844) noted 12 florets per head. However, several authoritative texts, both in USA (Barkley, 1993) and abroad (Blood, 2000) give the number of disk florets per head as 20-40, or 15-40.

During 2003, we began to quantify the number of florets per head of Cape ivy flowers from various regions by collecting Cape ivy seed heads from a variety of locations around the world. We dissected the inflorescences of *Delairea odorata* that had been collected at five locations in South Africa, one in Australia, one in Hawaii, and one in California. The florets in each head were counted. In each inflorescence, the number of florets ranged from 8-14, with a mean number of 10.6 florets from all 43 inflorescences at the seven locations – far less than what has been reported in the recent literature.

This year, we continued these investigations by collecting heads at four sites in sites in California, after the Cape ivy had flowered in early 2004. From each collection, 100 flowers were randomly selected and dissected, except for Wildcat Canyon where only 85 mature heads could be collected. Table 3 shows the results of our 2004 studies. Our 2004 results confirmed our 2003 results, with means between 10.95 and 11.67 florets at the four San Francisco region sites.

Table 3. Number of Cape ivy florets / inflorescence collected during 2004 from four sites near San Francisco, California.

Location	No. of inflorences dissected	Mean florets / inflorescence (range)
San Bruno Mountain (Feb. 11, 2004)	**100**	**11.67 (10-14)**
Tilden park (Feb. 10, 2004)	**100**	**11.29 (9-13)**
Bolinas (Jan. 26, 2004)	**100**	**11.48 (10-13)**
Wildcat Canyon (Feb. 13, 2004)	**85**	**10.95 (7-13)**

Interestingly, none of the 4000+ florets examined from the four sites contained viable seeds. In 2005, we plan to examine Cape ivy flowers from the same sites to determine if viable seed production varies from year to year.

C. *Chaetorellia succinea* no-choice oviposition tests on purple starthistle

In the summer of 2004, while hiking on the weekend in the Contra Costa county, Dr. Balciunas noticed some *Centaurea* spp. plants which appeared similar to yellow starthistle, only with pink flowers. He keyed this plant out to be *Centaurea iberica* – which has been reported in the San Francisco bay area, though only in a few locations. Because of its phylogenetic relationship, and similarity in appearance to yellow starthistle, we decided to determine if the accidentally released fly – *Chaetorellia succinea* would develop on this plant.

With seeds we procured from the CDFA, we were able to grow plants with heads of appropriate size, and then started two no-choice tests on these plants. Our testing protocol was the same one we used for our other no-choice tests of plants from the tribe Cardueae (see 2001-2002 annual report.

We tested six female and male pairs of newly emerged flies (1-3 days old) by confining them in metal screen cages (122 x 91.5 x 91.5 cm) with two *Cent. iberica,* each with several mature closed heads appropriate for oviposition and development. Tests were run for 14 days to allow sufficient time for *Ch. succinea* oviposition, and development on Cardueae heads. Confined flies were supplied a nutrient source of 50 % Mountain Dew © soda (Coca-Cola© Company).

After 14 days, flies were removed from the test. To determine that the *Ch. succinea* were ovipositional, with the surviving flies, we ran the control portion of these tests by exposing the surviving flies to two yellow starthistle plants (with a similar no. of heads as the *Cent. iberica* previously used) for another 14 days. After each portion of the test the plants involved in that portion were held for 3 weeks to allow *Ch. succinea* to complete development, and were monitored for adult emergence. After this, the heads were removed and kept for 1-2 more weeks, then dissected to verify the presence or absence of *Ch. succinea*.

Although we found no sign of larval development on the heads of the *Cent. iberica*, we were concerned that the plants were not actually *Cent. iberica* but *Cent. calcitrapa* – purple starthistle because of their similarity in appearance. Upon head dissection, the identifying feature that distinguishes *Cent. iberica* from *Cent. calcitrapa* – *Cent. iberica* has seeds with pappus – was absent on the seeds from the heads we had tested. We had actually tested *Cent. calcitrapa*, rather that *Cent. iberica*.

We intend to test *Cent. iberica* for *Ch. succinea* development, when we are able to obtain seeds or plants. Below (Table 4) is an updated table of our no-choice tests for *Ch. succinea* development on plants from the Cardueae tribe, including the two tests we ran in 2004 with *Cent. calcitrapa*.

Table 4. Larval infestation rates to test plants in the tribe Cardueae and paired yellow starthistle controls exposed to *Chaetorellia succinea* adults under no-choice conditions.

Test		*Ch. succinea*		Test Plant				Yellow starthistle Control				
Test No.	Test duration (days)	Population	n	[a] Species	Total heads	No. of heads infested by *Ch. succinea*	Infested heads /	n	Total heads	No. of heads infested by *Ch. succinea*	Infested heads /	Fisher Exact test two tailed *P* value
CH-26-99	22	WC	5	*Carthamus baeticus* (Boiss. & Reuter) Nyman	8	0	0	4	15	10	2.5	<.001***
CH-31-99	22	WC	10	*Carthamus baeticus*	22	0	0	6	13	7	1.17	<.001***
CH-6-01	14	WC	3	*Centaurea americana* Nutt.	4	1	0.33	5[b]	17	6	1.2	.503
CH-7-01	14	WC	4	*Centaurea americana*	5	2	0.5	2	6	4	2.0	.105
CH-8-01	14	WC	6	*Centaurea americana*	3	0	0	5	10	7	1.4	.009**
CH-20-99	21	RB	5	*Centaurea calcitrapa* L.	48	0	0	5	38	11	2.2	<.001***
CH-1-04	14	WC	6	*Centaurea calcitrapa* L.	30	0	0	3	24	23	7.67	<.001***
CH-2-04	14	WC	6	*Centaurea calcitrapa* L.	30	0	0	4	19	19	4.75	<.001***
CH-12-00	14	Var.	8	*Centaurea cyanus* L.	30	0	0	4	12	7	1.75	<.001***
CH-14-00	14	SB	10	*Centaurea cyanus*	38	0	0	6	13	5	0.83	<.001***
CH-19-01	14	WC	3	*Centaurea diffusa* Lam.	34	0	0	2	19	3	1.5	<.001***
CH-10-00	14	Laf.	5	*Centaurea maculosa* Lam.	10	0	0	3	6	4	1.33	<.001***
CH-9-01	14	WC	4	*Centaurea melitensis* L.	46	7	1.75	2	12	4	2.0	.006**
CH-10-01	14	WC	6	*Centaurea melitensis*	51	2	0.33	3[b]	24	8	2.67	<.001***
CH-15-01	14	WC	6	*Centaurea melitensis*	28	3	0.5	1	12	4	4.0	.002**
CH-2-01	14	WC	12	*Centaurea rothrockii* Greenm.	4	0	0	2	25	14	7.0	.090
CH-2-02	14	WC	6	*Centaurea rothrockii*	3	0	0	4	15	10	11.1	.069
CH-1-00	21	WC	10	*Centaurea sulphurea* Willd.	12	4	0.4	9	10	5	0.56	.680
CH-3-00	21	Ione	10	*Centaurea sulphurea*	8	2	0.2	6	29	14	2.33	.277
CH-6-00	21	Ione	6	*Centaurea sulphurea*	6	0	0	6	12	8	1.33	<.001***
CH-5-96	63	RC	12	*Cirsium brevistylum* Cronq.	38	0	0	12[c]	274	113	9.42	<.001***
CH-1-99	35	NV	9	*Cirsium brevistylum*	6	0	0	4	9	4	1.0	.064
CH-11-00	14	Laf.	8	*Cirsium brevistylum*	3	0	0	7	17	9	1.29	.102
CH-3-01	14	WC	5	*Cirsium hydrophilum* var. *vaseyi* (A. Gray) J. Howell	6	0	0	3	11	2	0.67	.171
CH-7-00	14	Ione	6	*Cirsium occidentale* var. *candidissimum* (E. Greene) J.F. Macbr.	5	0	0	2	13	4	2.0	.097
CH-16-00	14	Var.	6	*Cirsium occidentale* var. *candidissimum*	3	0	0	5	23	8	1.6	.167
CH-5-00	21	Ione	3	*Cirsium ochrocentrum* A. Gray	1	0	0	2	11	2	1.0	1.000
CH-17-00	14	WC	4	*Cirsium ochrocentrum*	1	0	0	2	19	7	3.5	.551
CH-30-99	21	WC	6	*Silybum marianum* (L.) Gaertner	5	0	0	5	17	5	1.0	.165
CH-32-99	21	WC	7	*Silybum marianum*	3	0	0	4	17	8	2.0	.126

[a] *Ch. succinea* populations: (all reared from yellow starthistle except RC, flies swept from yellow starthistle) RC – Rancho Cordova, Sacramento County, CA. NV – Washoe Co., Nevada. RB – Red Bluff, Tehama Co., CA. WC – Wildcat Canyon, Contra Costa Co., CA. Ione – Ione, Amador Co., CA. Laf. – Lafayette, Contra Costa Co., CA. Var. – Various, multiple locations of the previous six sites, CA. SB – Sutter's Butte, Butte Co. CA.

[b] In the CH-5-96 test, the YST control test was run simultaneously with *Ch. succinea* no-choice oviposition / development tests on *Cir. brevistylum* using different flies. Consequent tests used flies surviving no-choice oviposition / development tests in post YST control tests.

[c] No female *Ch. succinea* adults survived the test plant portion of the test. Yellow starthistle control data was derived from pooling yellow starthistle control data from each test run before and after the test without a yellow starthistle control.

** $P < 0.01$, *** $P < 0.001$; Fisher's exact test of proportion of infested vs. non-infested heads per female*10.

V. Future Plans

A. Research planned for 2005

Our efforts, both in Albany and Pretoria, will be directed to completing the host range testing of *Parafreutreta regalis* and *Digitivalva delaireae*. We will then compile this data, and begin the lengthy process of obtaining regulatory approval for release [see Section B below]. We will also begin selecting our release sites, and establish relationships with agencies and individuals that might assist us in the pre-release and post-release evaluations at these sites.

No further research on other South African insects is planned at this time. Instead, we will concentrate on beginning research on the pathogen that kills leaves (and sometimes entire vines) in South Africa. Our ARS colleagues located at Foreign Plant Disease Laboratory in Ft. Detrick, Maryland have agreed to assist us in a portion of the planned research for this *Cercospera* species.

We will also continue our studies into the basic biology of Cape ivy, especially flowering and seed viability. We are also still trying to find colleagues interested in assisting us in molecular studies into Cape ivy's origin and distribution.

B. The next step: obtaining approval for release

Barring unforeseen delays, during 2005, I anticipate beginning the process of obtaining permission for release for the Cape ivy gall fly, *Parafreutreta regalis*, and possibly also for the Cape ivy stem-boring moth, *Digitivalva delaireae*. There are substantial differences in the approval processes for biocontrol agents targeting insect pests, compared with those targeting weeds. Approval for release of an overseas insect (usually a parasitoid) to control an insect pest is primarily done at the state level, and is straightforward and relatively quick. However, releasing a herbivorous insect to control a weed has always been considered more risky. As a result, gaining approval for release of a new weed biological control agent is a complex and lengthy process (see diagram in Figure 4) that involves an advisory panel and an array of federal agencies. The entire approval process takes at least a year, and sometimes much, much longer.

By mid-2005, we plan to take the first step in this process and submit a "petition" requesting release of the Cape ivy gall fly to the Technical Advisory Group for Biological Control of Weeds (**TAG**). This advisory panel currently has 16 members (plus the Chair and Executive Secretary) from 12 federal agencies, as well as representatives from Canada, Mexico, the National Plant Board, and the Weed Science Society [for more information, visit http://www.aphis.usda.gov/ppq/permits/tag/].

The petition for TAG is prepared in a special format, and contains a summary of what is known about the proposed agent, as well as our research into its host range and safety. The taxonomy of the target weed, and a summary of its impact is also included in the petition. TAG members review the petition, and make their recommendation to the TAG chairman. Prior to making a recommendation, some TAG members may send the petition to internal and external experts for their comments. The TAG chair summarizes the comments from the TAG members, and then prepares a recommendation to USDA-APHIS Plant Protection and Quarantine Agency

(**PPQ**). Not infrequently, TAG will indicate that additional information is required before it can recommend approval.

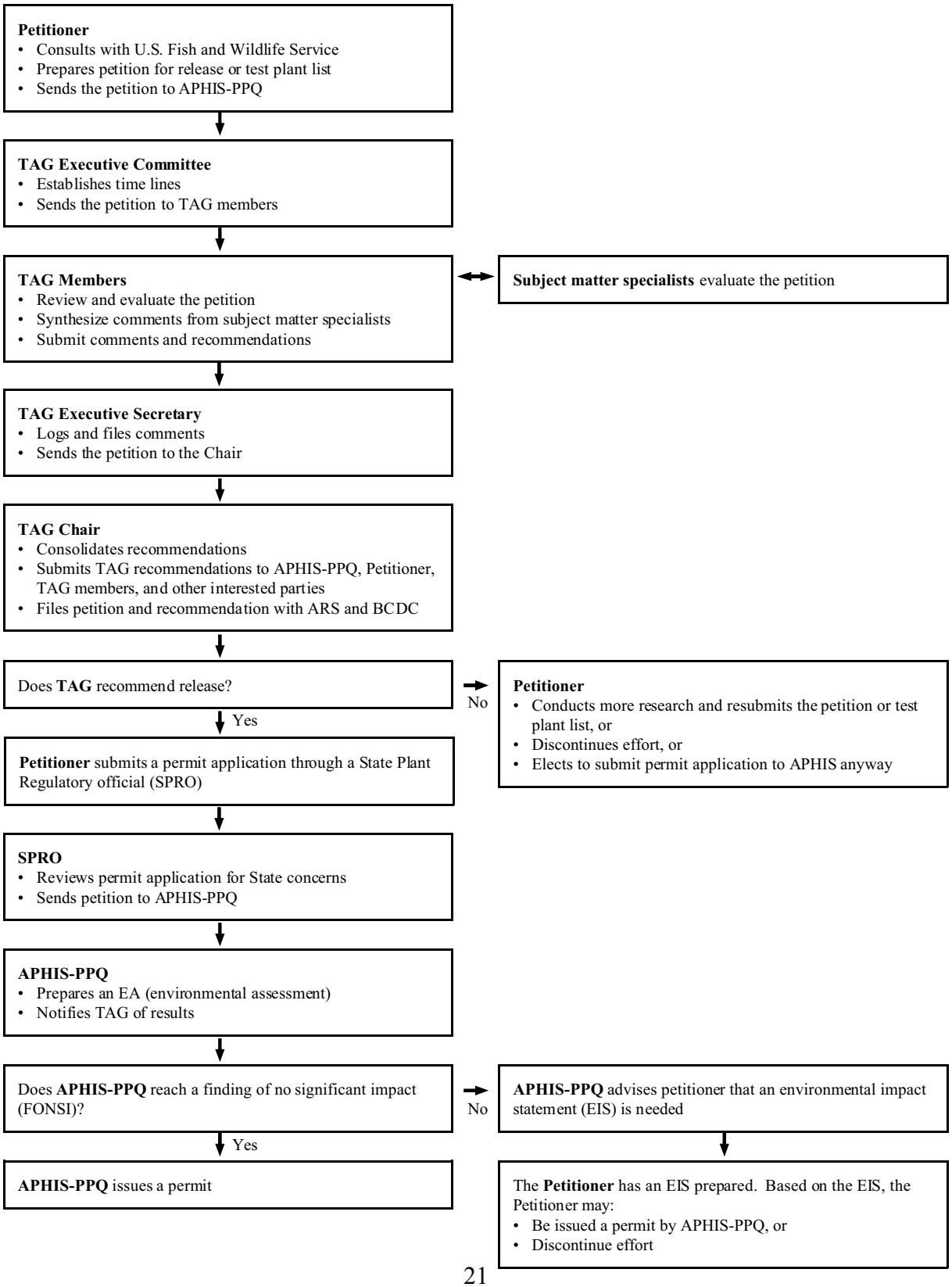
TAG's recommendation is not binding on PPQ, but, in practice, has great influence on PPQ's decision to issue a release permit. If TAG recommends release, I will then seek approval from the State (California) through the State Plant Regulatory Official (**SPRO**). If California also approves, PPQ prepares an Environmental Assessment (**EA**), using the information presented in our petition. This EA is circulated to other agencies, with the mandatory consultation with US Fish and Wildlife Service (**FWS**), being the most critical. FWS must provide their opinion if the release of the weed biocontrol agent might impact a federally-listed Threatened and Endangered (**T&E**) species. If they reach a finding of no significant impact (**FONSI**), PPQ will issue a release permit. As mentioned earlier, this complex approval process can easily require one year.

However, if FWS feels there might be an impact on a T&E species (and release of the agent is still desired), a full Environmental Impact Statement (**EIS**) must be prepared. After receiving the EIS, FWS must consent to allowing the impact to the T&E species. With FWS approval, PPQ then issues a release permit. Preparing the EIS, and securing approval from FWS is very time-consuming – 5 to 10 years might be required if the EIS process is triggered.

Another potential obstacle to approval is that this approval process is currently being overhauled. A large portion of the staff of USDA-APHIS, including PPQ, was transferred to the recently created Department of Homeland Security. Many critical vacancies were created in the PPQ staff that handles the approval process, and most have not yet been filled. In addition, a post- September 11, 2001 review of potential biosecurity threats, found PPQ oversight and monitoring of importation of overseas organisms to be problematic. As a result, PPQ is in the process of changing these procedures. New regulations covering importation of organisms were issued in November 2003. But many of these were almost immediately "postponed" pending further modification. At this point, we still don't have the final regulations.

Although I remain hopeful that our thoroughly tested agents will be approved for release in 2006, it is possible that this complex and changing approval process will require more time.

Figure 4. Flowchart diagramming the approval process for release of weed biological control agents (from TAG Reviewer's Manual)



C. Funding shortfalls

While USDA-ARS provides the bulk of the funds for our project, supplementary external funds have funded most of the research in South Africa. External funds also accelerated our research in Albany by providing most of the salary for an additional technician here, allowing us to test two foreign insect species simultaneously in our quarantine.

However, the enormous decrease in external funding that began in 2001-2002, has slowed development and evaluation of Cape ivy agents. California's fiscal crisis has led every state agency to terminate their contributions to the Biocontrol of Cape ivy Project. This includes CalTrans' annual $25,000 that provided most of the support for one of my assistants here. The contributions ($5,000 - $15,000) from California State Parks & Recreation, as well as from individual parks, have also dried up. Fortunately, I continue to receive full support from USDA-ARS, but the decline in external funds has caused us to drastically scale back the supporting research in South Africa, and could slow down the evaluation of agents here in California. Since additional funds for research in South Africa during 2005 are likely to be minimal, we scaled back research there during 2003, in an attempt to stretch currently allocated funds into 2005 and beyond. By doing so, we are hopeful that we will be able to maintain at least a part-time effort in South Africa during 2005.

VI. Other activities and publications

A. Articles published issued or submitted since January 1st, 2004

Balciunas, J. 2004. Are mono-specific agents necessarily safe? The need for pre-release assessment of probable impact of candidate biocontrol agents, with some examples. pp. 252-257 *in:* Proceedings of the XI International Symposium on the Biological Control of Weeds. CSIRO Entomology, Canberra, Australia. (log #150889)

Balciunas, J. 2004. Cape ivy, Delairea odorata (previously, Senecio mikanioides). pg. 441 *in*: E. Coombs, J. Clark, G. Piper, and A. Cofrancesco (eds.) Biological Control of Weeds in the United States. Oregon State University Press, Corvallis, Oregon. (log #161994)

Balciunas, J. 2004. Delairea odorata Lemaire. Crop Protection Compendium, 2004 edition. CABI. http://www.cabi.org/compendia/cpc/

Balciunas, J. 2004. Four years of 'Code of Best Practices': Is biocontrol of weeds less risky, and receiving greater acceptance? pp. 258-260 *in:* Proceedings of the XI International Symposium on the Biological Control of Weeds. CSIRO Entomology, Canberra, Australia. (log #150886)

Balciunas, J. and E. Coombs. 2004. International Code of Best Practices for classical biological control of weeds. pp. 130-136 *in*: E. Coombs, J. Clark, G. Piper, and A. Cofrancesco (eds.) Biological Control of Weeds in the United States. Oregon State University Press, Corvallis, Oregon. (log #146080)

Young, Clements, Pitcairn, **Balciunas**, Enloe, Turner, Harmon. (submitted) Germination-temperature profiles for achenes of yellow starthistle. Weed Technology.

Uygur, Sibel; Smith, Lincoln; Uygur, F. Nezihi; Cristofaro, Massimo, and **Balciunas, Joe.** 2004. Population densities of yellow starthistle (Centaurea solstitialis) in Turkey. Weed Science 52: 746-753.

Uygur, Sibel; Smith, Lincoln; Uygur, F. Nezihi; Cristofaro, Massimo; **Balciunas, Joe.** (2005?) Field assessment in land of origin of host specificity, infestation rate and impact of Ceratapion basicorne (Coleoptera: Apionidae), a prospective biological control agent of yellow starthistle. BioControl.

B. Selected meetings and travel by Dr. Joe Balciunas

2004 Balciunas Meetings and Travel

Jan 27-29	Denver	Attend "Benefits and Risks of Biological Control Workshop". Present invited talk "Benefits of the Code of Best Practices".
Feb. 1-3	Greenbelt MD	Attend ARS "Critical Issues on Biological Control Workshop".
Feb. 4-7	Greenbelt MD	Attend ARS "CRIS Update" Workshop
Feb. 11	San Pablo	Serve as judge at Contra Costa County Science Fair
Mar. 25	San Francisco	Serve as judge at the San Francisco Bay Regional Science Fair
Jul. 8	Albany	Present poster "Biological Control of Cape Ivy" at "Sextennial WRRC-PGE Poster Session".
Jul. 22 -25	Mineral CA	Complete Jepson Herbarium training course on"Flora of Lassen National Park"
Oct. 5-7	Alta, UT	Attend W-1185 Annual meeting
Oct 7-10	Ventura, CA	Attend annual CAL-IPC Symposium; present poster "Progress towards Biological Control of Cape Ivy"
Dec. 3	Big Sur	Invited to attend "Big Sur Multi-Agency Meeting" and presented talk "Biological Control of Cape Ivy and Other Coastal Weeds".
Dec 7-9	Corvalis OR	Attend Biennial "Oregon Noxious Weed Symposium" and present invited talk "Importance of the Code of Best Practices"
2004		Continued to serve as an "Activity Leader" for the San Francisco Bay chapter of the Sierra Club. During 2004, led 10 hikes in the San Francisco bay area that helped to familiarize participants with native plants, and the invasive weeds that are displacing them.

References cited in the report

Balciunas, J. K., C. N. Mehelis, and M. Chau. 2002. Joe Balciunas Research Report (January 2001 through March 2002), USDA, Albany, CA. 56 pp.

Balciunas, J. K., C. N. Mehelis, and M. Chau. 2003. Joe Balciunas Research Report (April 2002 through December 2002), USDA, Albany, CA. 36 pp.

Barkley, T. M. 1993. *Senecio*: groundsel, ragwort, butterweed. *In:* James C. Hickman (ed.) The Jepson Manual: Higher Plants of California. University of California Press, Berkeley, California. pp. 336-342.

Blood, K. 2001. Environmental Weeds: A field guide for SE Australia. CH Jerram & Associates. Mt. Waverley, Victoria, Australia. 228 pp.

Grobbelaar, E., J. K. Balciunas, O. Neser, and S. Neser. 2003. South African insects for biological control of *Delairea odorata.* pp. 16-28 *in:* Proceedings, Cal-IPC Symposiums, 2000, 2001, 2002. M. Kelly (ed.), Concord, CA.

Gaedike, R., and M. Krüger. 2002. *Digitivalva* (*Digitivalva*) *delaireae* sp. n. (Lepidoptera: Acrolepiidae), a potential biological control agent for *Delairea odorata* (Asteraceae). African Entomology. 10: 357-360.

Haselwood, E. L., and G. G. Motter, (eds.). 1983. Handbook of Hawaiian Weeds, second edition. Honolulu, HI: University of Hawaii Press.

Jacobi, J. D., and F. R. Warschauer. 1992. Distribution of six alien plant species in upland habitats on the island of Hawai'i. pp. 155-188 *in*: Alien Plant Invasions in Native Ecosystems of Hawai'i: Management and Research. C. P. Stone, C. W. Smith, and J. T. Tunison (eds.). Honolulu, HI: University of Hawaii Cooperative National Park Resources Studies Unit.

Lemaire, C. 1844. *Delairea*, ad synantheras genus novum spectans. *In:* M. Milne-Edwards, MM. AD. Brongniart, and J. Decaisne. Annales des Sciences Naturelles. Fortin, Masson et C^{ie}, Libraires-Éditeurs, Paris. pp. 379-381.

Munro, H. K. 1940. Further South African gall-forming Trypetidae (Diptera) with descriptions of new species. Journal of the Entomological Society of Southern Africa. 3: 76-87.

Wagner, Warren L., Derral R. Herbst, and S. H. Sohmer. 1990. Manual of the Flowering Plants of Hawai'i, Volume 1. Honolulu, HI: University of Hawaii Press.

Appendicies

Due to the length of the appendicies, they have been placed in separate files. Please refer to the appendix file for summaries of test data for our two Cape ivy biological control agents.

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

Appendix B. ***Digitivalva delaireae*** **host range tests**