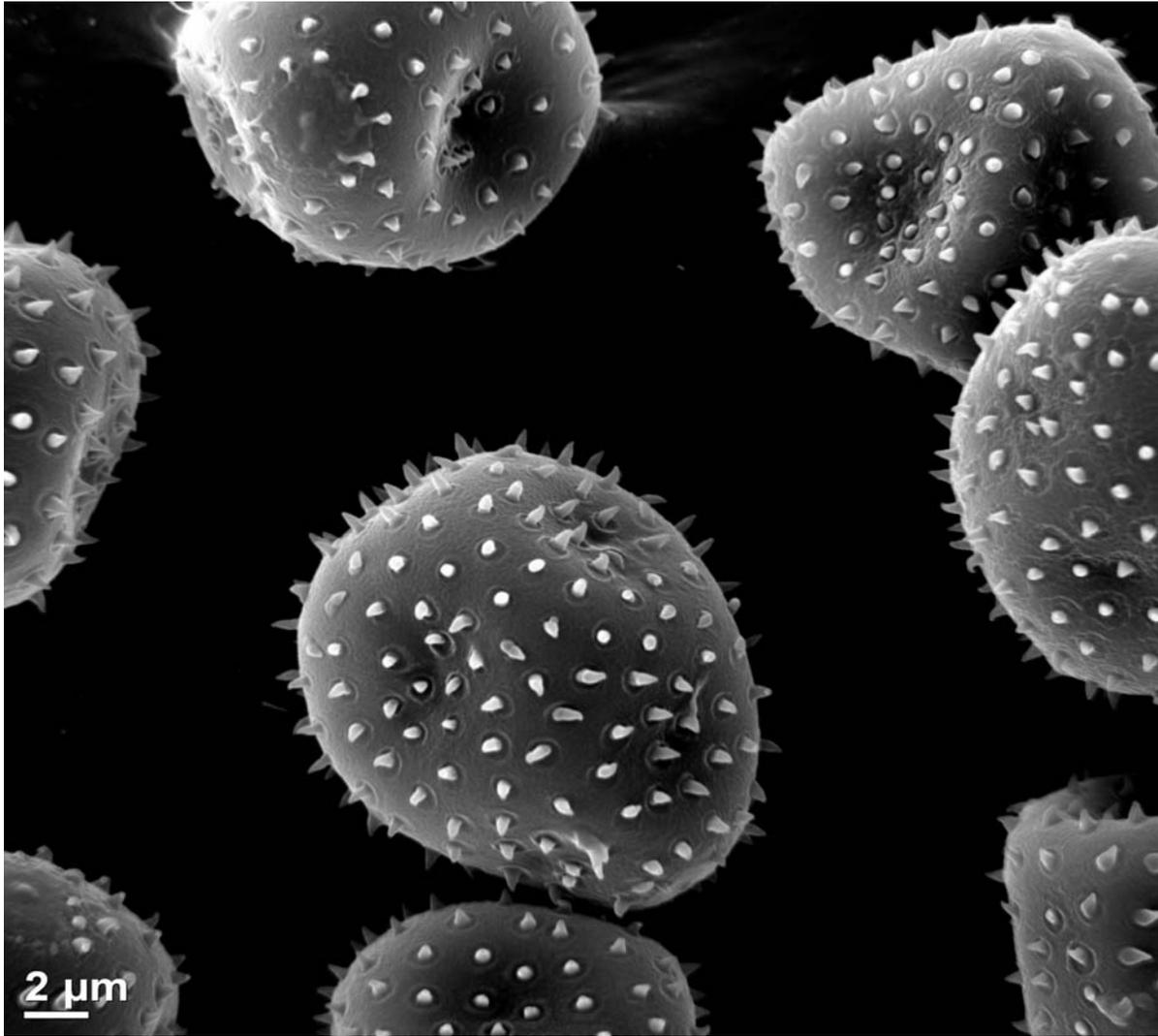


# PLANT PEST DIAGNOSTICS CENTER 2006 ANNUAL REPORT



**PLANT PEST DIAGNOSTICS CENTER  
2006 ANNUAL REPORT  
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Cover illustration: *Uromyces transversalis* (Gladiolus Rust) Urediniospores with characteristic recurved echination. Scanning Electron Micrograph by Cheryl Blomquist and Scott Kinnee, CDFA Plant Pest Diagnostics Center (PPDC).

# PLANT PEST DIAGNOSTICS CENTER

## 2006 ANNUAL REPORT

UMESH C. KODIRA, BRANCH CHIEF

### MISSION

To serve as a scientific and professional resource, providing timely and accurate plant pest diagnostics to our clients, with the aim of protecting California's agriculture and environment.

### VISION

To continually enhance our professional expertise as an internationally recognized scientific service and research center committed to meeting future scientific challenges to California's agricultural and environmental needs.

### VALUES

- **Leadership** in the field of plant pest diagnostics.
- **Excellence and Innovation** in science, technology, research and service.
- **Professional Integrity** in taking responsibility for the validity of work based on the best available and accepted scientific protocols.
- **Trust** established by practicing ethical conduct.
- **Empowerment** through an organizational culture that promotes delegation of authority, creativity, and celebration of accomplishments.
- **Mutual Respect, Cooperation and Communication** through partnerships and teamwork and the constructive exchange of ideas.

The Plant Pest Diagnostics Center (PPDC) also serves as a scientific resource and provides professional expertise to a number of clients including CDFA, the United States Department of Agriculture (USDA), other federal and state agencies, County Agricultural Commissioners, the University of California Cooperative Extension, the agriculture industry, and the public. Our scientists, technicians and support staff strive to provide excellence in service and leadership in plant pest diagnostics and biosystematics.

This annual report is a summary of accomplishments from 2006. It provides updates on projects and highlights critical areas of research and new methodology in diagnostics and is by no means inclusive of all work performed at the PPDC.

The staff of the PPDC continues to provide leadership in plant pest diagnostics and excellence in scientific service and research.

Following is a table representing the number of samples and specimens submitted to the laboratory in 2006. The sample numbers listed are not representative of the amount of time or labor required to complete any given sample diagnosis or specimen identification. Nor can sample numbers be compared among the different disciplines (labs) as a measure of workload. Note for example, that the number of plant taxonomy or seed samples does not reflect the number of actual identifications made for a given sample in these labs. It is common for a single plant or seed sample to require multiple identifications of all the material in a sample.

Thus a more accurate representation of the true workload for plant taxonomy and seed taxonomy would be several times these numbers. In a similar way, sample numbers alone do not differentiate between an insect identification that is an immediate recognition and identification, from one requiring lengthy study, possibly collaboration with other experts, or even a new published description. Likewise sample numbers of plant pathology do not differentiate those requiring only a simple, quick serological test, from a sample requiring days to weeks of culturing, microscopy, greenhouse testing, etc. in order to arrive at a diagnosis. And, of course, the same line of reasoning is true for Nematology samples as well.

<b>SAMPLES PROCESSED (4 YEARS)</b>				
<b>Labs / Programs</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>
Botany	3,284	1,008	1,000	1,474
Entomology*	36,146	45,000+	50,000+	50,000+
Nematology*	4,782	3,874	4,923	7,912
Plant Pathology*	88,233	109,398	103,451	87,434
Seed Science	3,067	6,923	3,166	5,791
<b>Total</b>	<b>135,512</b>	<b>166,203</b>	<b>162,540</b>	<b>152,611</b>
* Includes special projects				
Please note that the numbers cannot be compared among the different disciplines (labs/programs) as an accurate indication of workload.				

## **RESEARCH**

The scientists at the PPDC continue to do research and publish scientific papers as part of the mission of this branch. In the past year members of the PPDC published fifty-eight scientific papers. In addition, thirty-four posters and/or oral presentations were given at various professional meetings, seminars, and training workshops. A list of scientific publications and presentations for 2006 are included at the end of this report.

## **THE CALIFORNIA STATE COLLECTION OF ARTHROPODS**

The California State Collection of Arthropods, a significant resource of more than 1.5 million specimens, is utilized for comparative specimens in diagnostics by our staff and as a resource for scientists worldwide. The collection is maintained by the Entomology Lab, as an integral feature of the identification services provided to the citizens and business interests of the State, and to our peers and colleagues both nationally and internationally. Our staff has added more than 25,000 specimens to the collection this year, and an inventory of the species held is nearly complete, with over 40,000 species represented so far. As far as specimen usage, the CSCA issued 10 loans in 2006, representing nearly 5,000 specimens, and more than 25 visitors from the local, national, and international communities have come in to study our collections.

## SEMINAR SERIES

The Plant Pest Diagnostics Center seminar series began in 2004 to enable scientists to present research data and discuss on-going research and pest issues of general importance, and has continued throughout 2006 with enthusiasm and participation by many from within and outside of our branch. The speakers have included scientists from the PPDC, USDA, UC Davis, and visiting scientists from other universities and agencies. The focus of the seminar series has been to share information on any aspect of basic or applied research or diagnostics and includes invited speakers from other institutions. Dr. Gillian Watson, Associate Insect Biosystematist, coordinates the seminar series.

## STAFFING CHANGES

### NEW FACES AT THE CDFA PLANT PEST DIAGNOSTICS CENTER



Sergei Subbotin



Dean Kelch

**Dr. Sergei Subbotin** currently serves as an **Associate Plant Nematologist** in the PPDC Nematology laboratory. Dr. Subbotin is an expert in the molecular methodology for nematode identification, as well as for studies in the genetic diversity and phylogeny of nematodes. His particular research interest is in the systematics of cyst nematodes. In addition, Dr. Subbotin is accomplished in both scanning and transmission electron microscopy. He has been a Senior Researcher at the Institute of Parasitology of the Russian Academy of Sciences in Moscow, Russia, a Guest Professor at the Gent University in Gent, Belgium, and most recently an assistant nematologist at the Nematology Department of the University of California, Riverside. In addition, Dr. Subbotin serves as Chief Editor of the Russian Journal of Nematology.

**Dr. Dean Kelch** joined the PPDC in March, and currently serves as an **Associate Botanist** in the Botany Laboratory. An expert in California's native flora, Dr. Kelch's research interests

include the systematics of thistles and conifers, as well as the evolution and biogeography of seed plants using molecular methodology and computer-assisted phylogenetic analysis. Dr. Kelch's diverse and varied areas of expertise include seed plant evolution, native plant restoration, habitat delineation, as well as native and rare plant propagation. Most recently Dr. Kelch served as a visiting scholar, researcher, and lecturer at the University of California, Berkeley. Dr. Kelch has won numerous awards, grants, and scholarships to study various aspects of botany and systematics both in the United States and internationally.

**Dr. Riad Baalbaki** joined the PPDC in April of this year, and serves as an **Associate Seed Botanist** in the Seed Science Laboratory. A Seed Physiologist by training, Dr. Baalbaki received his education in seed science at Michigan State University. Prior to joining the PPDC seed science laboratory, he was an associate professor of plant science at the American University of Beirut, Lebanon, where he designed, set up, and managed the seed science laboratory. Dr. Baalbaki is a specialist in seed physiology including seed responses to stress factors, germplasm characterization, phytoremediation, and sustainable cropping systems. In his professional travels he has also served as a visiting scholar/scientist at Stanford University, Cornell University, the University of California at Davis, as well as with the USDA ARS in Riverside, CA.



Riad Baalbaki

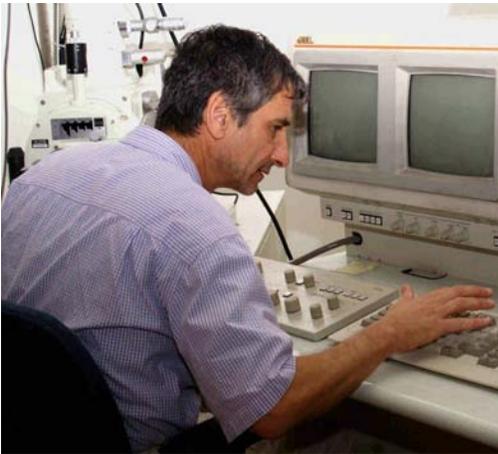


Suzanne Rooney Latham

**Dr. Suzanne Rooney Latham** joined the PPDC in December. Dr. Latham is an **Associate Plant Pathologist**, whose special expertise and experience in grape diseases is a welcome addition to the Plant Pathology Laboratory. A specialist in mycology, Dr. Latham's primary responsibilities include the diagnostics of plant diseases caused by fungal plant pathogens, and will likely spend a fair amount of time working on the *Phytophthora ramorum* project as well. Most recently Dr. Latham has been working as a Post-doctoral scholar at the University of California, Davis, conducting research on fruit diseases. This includes serving as the project leader of a research team on studies involving grape pathogens. During this same period, Dr.

Latham has also been serving as Professor of Biology at Solano Community College, in Fairfield, California. She also currently serves as a reviewer for the scientific journals *Plant Disease*, *Phytopathologia Mediterranea* and the *European Journal of Plant Pathology*.

**Tom Manos**, joined the PPDC Entomology Laboratory staff in March as an **Senior Laboratory Assistant**. Tom assists in the processing of samples for Glassy Wing Sharpshooter (GWSS) identification, including scanning electron microscopy. Most recently he had been part of the Microbial Data Program, assisting microbiologists in various lab functions such as media preparation and sample processing. Tom has a diverse background that includes working in a medical laboratory, doing medical transcription, information technology, and includes a 4-year term as an English language editor at the Central Translation Bureau of the Chinese government in Beijing. With a degree in philosophy from U.C. Berkeley, Tom's interests include art, metaphysics and travel.



Tom Manos



Marinell Soriano and Jun-Jun Estoque

**Marinell Soriano** and **Jun-Jun Estoque** joined the PPDC Plant Pathology laboratory as **Laboratory Assistants** working on the Sudden Oak Death (SOD) Project. Marinell heads up the SOD sample processing team, and is involved in the training of part time scientific aides who process SOD samples and prepare culture media. Jun-Jun works primarily in the ELISA laboratory conducting serological tests for *Phytophthora ramorum*, and occasionally assists with ELISA testing for other pathogens such as the Pierce's Disease pathogen, *Xylella fastidiosa*. Both Jun-Jun and Marinell have Bachelor's degrees in nursing.

## DEPARTURES

Dr. Samantha Thomas, left the Plant Pathology Laboratory in July to take a position with Seminis Vegetable Seeds as the Director of their Seed health Testing Program in Woodland, California. She had served as an Associate Plant Pathologist for 1 ½ years with the PPDC Lab.

Dr. Matthew Buffington left the Entomology Laboratory to take a position a Research Entomologist with USDA-ARS-Systematic Entomology Laboratory at the Smithsonian Institution, Washington, DC. He was a Postdoctoral Research for about a year with the PPDC Lab.

# BOTANY

## 2006 BOTANY LABORATORY STAFF

FRED HRUSA  
DEAN KELCH  
KEVIN DOWNING  
JOHANNA NAUGHTON  
YOSHIKO KINMONTH

The Botany Laboratory provides plant identification services, noxious weed distribution information, and biological support data to the County Agricultural Commissioners' offices, the general public, CDFA programs, and various other State and Federal agencies. These activities function to help prevent the introduction and spread of serious weed pests and to identify host plants of insects, plant diseases, and plant parasitic nematodes. Plant identification is an integral part of weed pest exclusion, detection, control, and eradication. It is also important to other units of the Department, such as the Animal Health & Food Safety Services, Inspection Services and to county departments of agriculture, which require prompt and accurate botanical information in pursuit of their goals. The Botany Laboratory herbarium (known internationally as the herbarium of the California Department of Agriculture, or simply the "CDA") currently contains approximately 40,000 specimens and has an active specimen exchange program with state, national and international herbaria. These specimens form the basis for ensuring accurate identification of plants new to or currently growing in California. Field investigations are also an essential part of the program; not only to collect specimens, duplicates of which form the nucleus of the exchange program and populate the collection itself, but also to evaluate such things as the environmental conditions influencing the presence of new or existing plant populations. Seventy-five percent of the counties submit 90% or more of their plant specimens to the Botany Laboratory/Herbarium CDA for identification or confirmation. The ability of the laboratory to assist field programs promptly and accurately has aided in pinpointing the distribution of the major weed pests in the State.

The Botany Lab has begun a long-term project to database the entire herbarium collection and make the data available on the web as part of the Consortium of California Herbaria, which provides plant specimen data from 18 different California herbaria. One-stop shopping for botanical information will revolutionize the ability of scientists to understand plant distribution and systematics in California. This outreach to other botanical institutions is an example of forming alliances with other organizations and increasing the use and relevance of the CDA Herbarium to the California community.

Dr. Hrusa and Dr. Kelch authored an article for the winter issue of *Noxious Times* (Winter 2007, Volume 8 number 4) entitled *Profile: CDFA Botany Lab* in which the colorful 80-year history of the CDFA Botany lab and herbarium is chronicled. In addition, the diverse functions of the PPDC Botany Lab are discussed, as well as a description of the various on-going research projects of both Dr. Hrusa and Dr. Kelch.

## GIANT DODDERS 2004-2006

G.F. Hrusa and Dean Kelch  
Botany Laboratory/Herbarium  
Plant Pest Diagnostics Center  
California Dept. of Food and Agriculture

The genus *Cuscuta* (dodder) comprises approximately 150 species of chlorophyll-less, often thread-like parasitic plants, which connect to a host via haustoria. They may be viewed from an evolutionary viewpoint as parasitic morning glories (Convolvulaceae), although they are often included in their own family, the Cuscutaceae.

Most, if not all dodders have orange to yellowish stems and are readily visible on their hosts. While the plants lack true leaves, small bracts are present in their place and these are colored the same as the stems. The flowers are generally white, but sometimes are almost colorless. Most are not agricultural weeds, and in California there are eight native species and three naturalized non-natives. All but the A-rated *Cuscuta reflexa* and *Cuscuta japonica* are given a “C” pest-rating by the CDFA because, although mostly native and not generally pestiferous, they can reduce crop yields if infestations become large.

The two A-rated species are part of a related group of dodders known as the “giant dodders”. These plants have distinctively thick stems, about the thickness of spaghetti pasta, and are not easily confused with the thin-stemmed native species.

### History in California

#### ***Cuscuta reflexa* Roxb.**

*Cuscuta reflexa* is native to southern Asia, ranging from Afghanistan to Yunnan, China, northern India to Ceylon and Java. It has been found only once in California; in 1969 a patch was found parasitizing an ivy planting on the University of California Los Angeles campus. Coincidentally a researcher working on *Cuscuta* occupied an office in the adjacent building, but denied any connection with the infestation. In any case, the infestation was eliminated and *Cuscuta reflexa* has not been found in California since.

#### ***Cuscuta japonica* Choisy**

In June 2004 a sterile specimen of a dodder with thick, spaghetti-like stems was submitted to the Botany Laboratory for identification. It was parasitizing a *Citrus* tree in a backyard planting in Redding, Shasta County. The plant was identified as possibly *Cuscuta reflexa*, based on it being a “giant dodder” but the determination was incomplete as mature flowers are necessary for conclusive identification in this genus. Consequently it was given a Q-rating.

Although several more sterile specimens were submitted over the next few months, it was not until October of 2005 that a specimen with fully developed flowers was received and identified as *Cuscuta japonica*. Native along the eastern Asian seaboard and Islands from Vladivostock and Amur to Yunnan, as an adventive it is established as a pest in the U.S. southeast. A specimen (R.D. Cobb s.n.) grown from seed collected from a plant parasitizing kudzu in 1958

and established on potato in Sacramento is in herbarium CDA, but the origin of this seed was not reported. A duplicate of the specimen submitted in October 2005 to the Botany Laboratory was sent to Mihai Costea, a specialist in *Cuscuta* systematics at the University of Guelph in Ontario Canada, who confirmed that it was *Cuscuta japonica*. At this point *C. japonica* itself received a Q-rating. In flower *C. japonica* is readily distinguished from the native North American species and *Cuscuta reflexa*. From our native species it is distinguished by its single style with two-lobed stigma. Native *Cuscuta* have two separate styles and unlobed stigmas. *Cuscuta reflexa* has a short style or no style at all, the two-lobed stigma is sessile or nearly so on the ovary, and the floral tube is longer than it is wide. In *Cuscuta japonica* the floral tube is wider than long or near parity. Sterile material is more problematic to identify. It was readily determined that the sterile specimens were not one of the native species. In the native taxa, the bracts subtending each node are elongated and free from the stem, while in *C. japonica* and *C. reflexa* the bracts are shortened into a small hood over the developing axillary bud and tightly appressed to the stem. These differences are illustrated in Figs. 1 and 2.

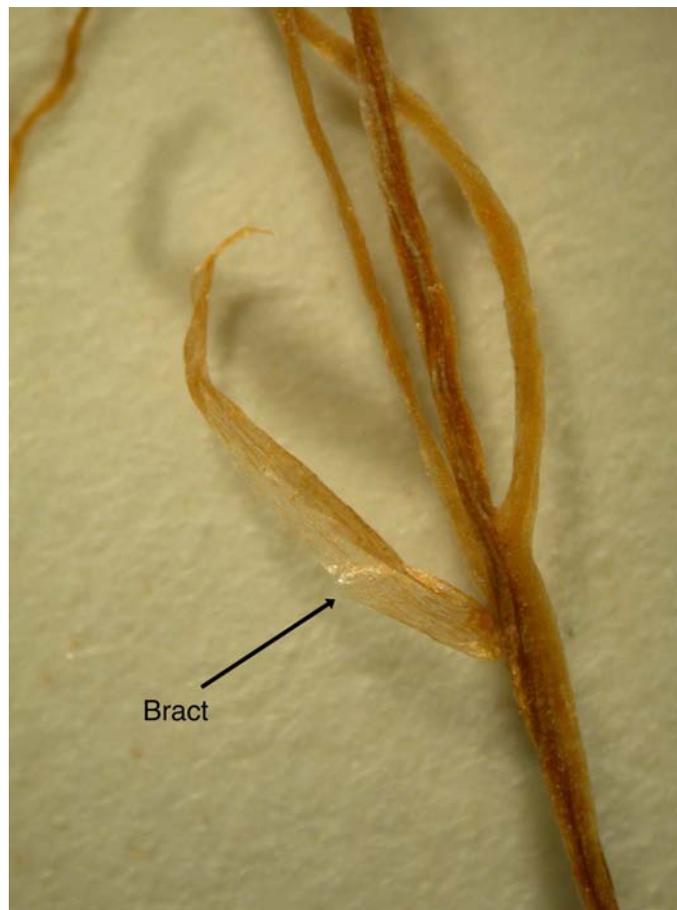


Figure 1. Free bract subtending the axillary bud of native North American *Cuscuta* spp.

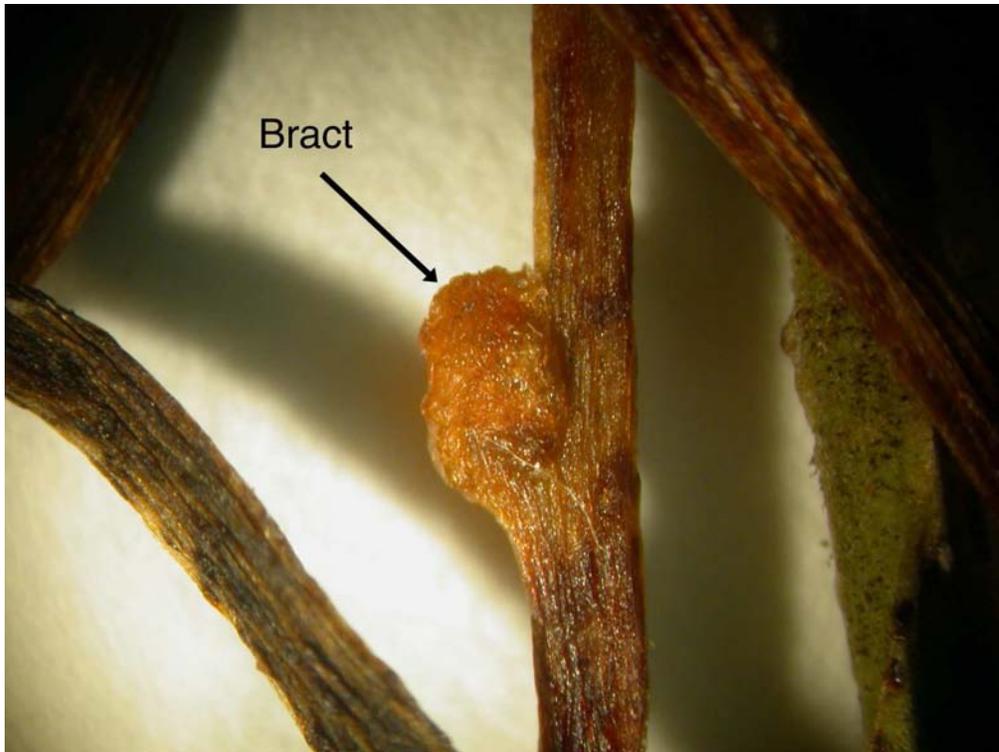


Figure 2. Shortened bract forming a small hood over the axillary bud of *Cuscuta japonica*.

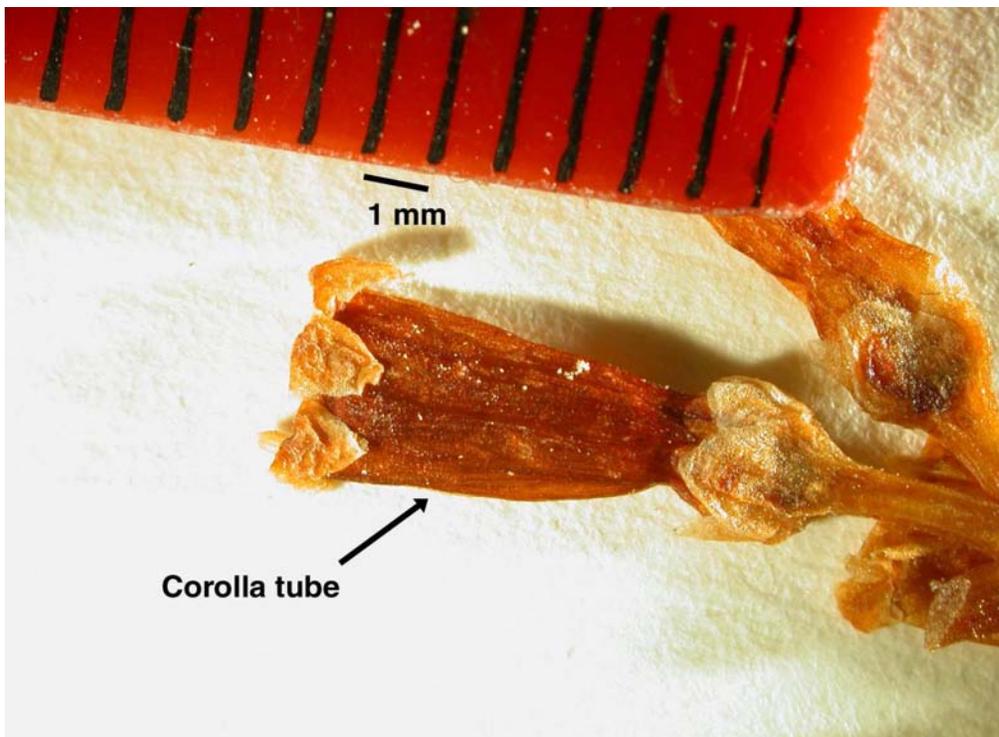


Figure 3. *Cuscuta reflexa* flower.

However, this characteristic was not able to differentiate *C. japonica* from *C. reflexa*. Figs. 3-6 illustrate *Cuscuta reflexa* and *C. japonica* floral parts.

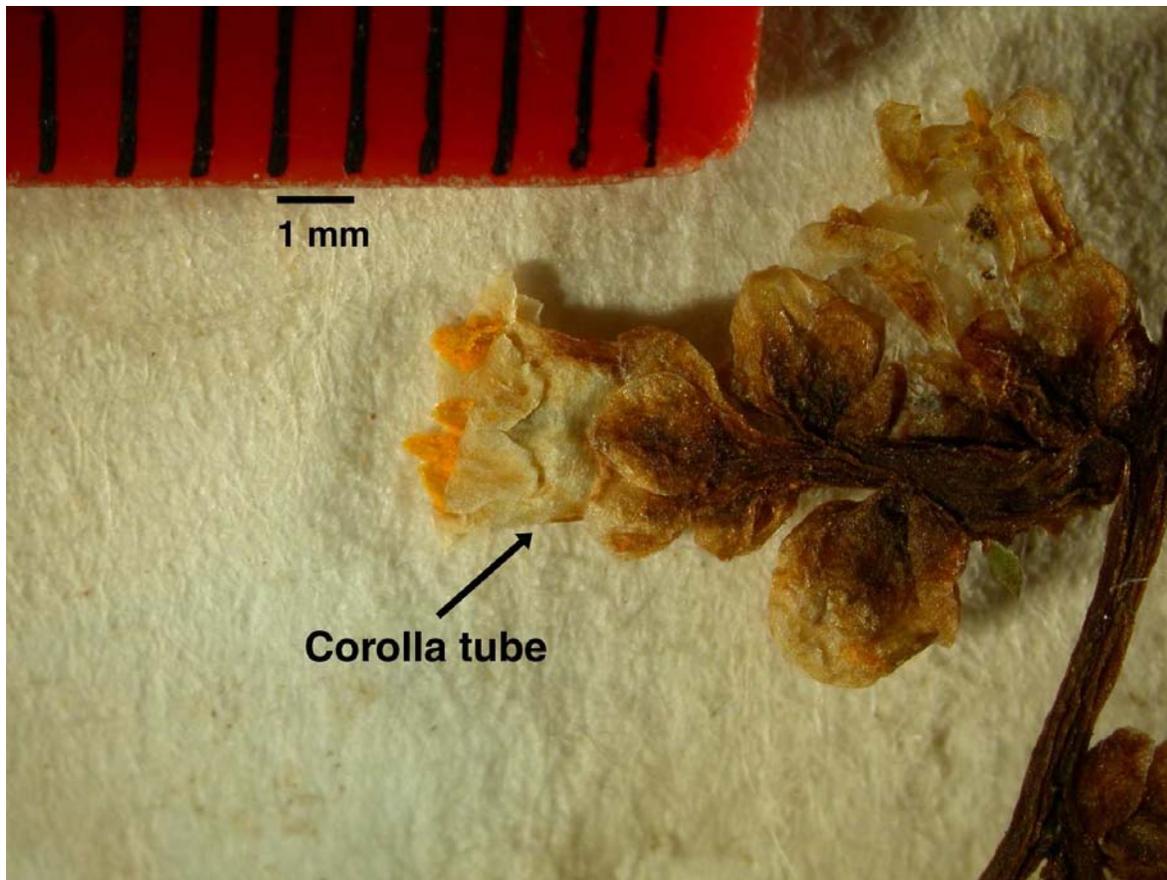


Figure 4. *Cuscuta japonica* flower. Note the relative shortness of the corolla tube in comparison to *Cuscuta reflexa*.



Figure 5. *Cuscuta japonica* flowers in situ. Photo by Fred Rinder, Fresno Co.

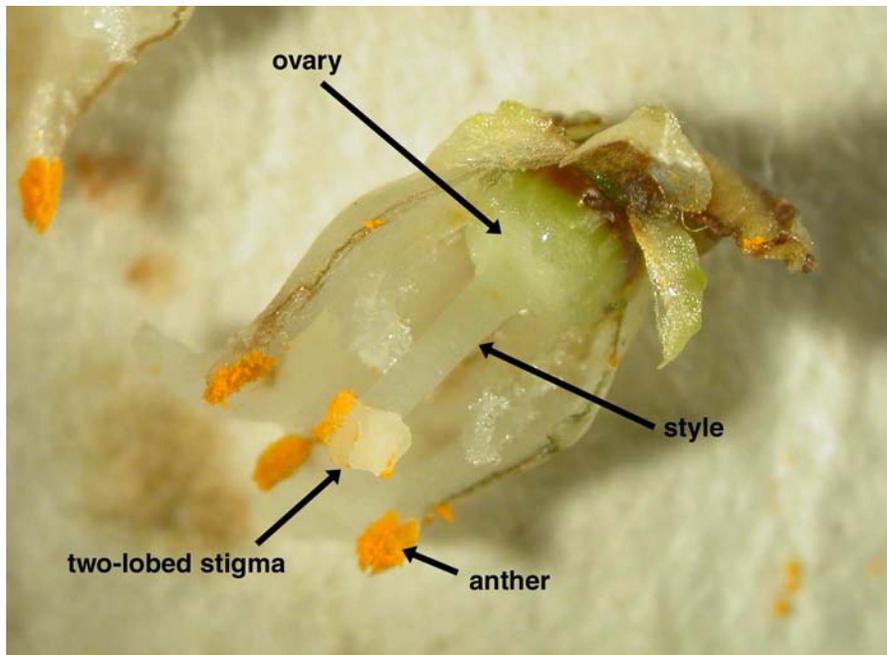


Figure 6. *Cuscuta japonica* flower after dissection.

Beginning in spring of 2006 the Botany Lab began to regularly receive specimens of this giant *Cuscuta*. These came from numerous counties, but were concentrated in Sacramento, Fresno, Merced and Contra Costa. All these specimens received during the early season were sterile and could not be confirmed as *Cuscuta japonica*

All specimens of giant dodder that were sterile were given the identification of *Cuscuta* cf. *japonica* and received a Q-rating as well.

### **Biology**

According to literature sources, *Cuscuta japonica* is an annual plant, that is, it lives, sets seed, and dies in a single season. It then germinates new individuals the following season and the life cycle is repeated. In California we have not yet seen seed form or mature on any individuals, and indeed, flowering occurs from about late October to mid-January in mild regions, leaving little time for seed to mature. If seed were to be formed and sexually reproducing populations established, difficulty of eradication or even control would be considerably increased. Control appears difficult in any case for the following reasons:

- 1) The plants grow rapidly and fragment easily. Small pieces are able to form haustoria and grow into large infestations.
- 2) In the absence of freezing weather the plants continue to grow indefinitely, not dying after a single season.
- 3) Small fragments are difficult to detect. Pulling material off a host is thus not likely to eliminate the infestation.
- 4) The plants do not desiccate rapidly. A specimen was left on a table in the Botany Laboratory for 3 weeks without a host. The stems became thinner, but when placed on a host rapidly formed new haustoria. This means that material can easily be transported alive without special treatment to prevent drying, and can form new infestations after being isolated for several weeks.
- 5) The plants become very large, and will cover entire trees. Removing all dodder material from an infested location is therefore difficult.
- 6) Wildlife, especially birds, move vegetative pieces into the tops of tall trees where infestations become established well beyond reach or even sight, making early detection almost impossible.
- 7) Human mediated dispersal appears responsible for most of the current infestations. Preventing purposeful movement will be very difficult unless voluntarily accomplished.

### **Reproductive Biology**

Although control or eradication may be difficult, as outlined above, if this dodder remains moved only through vegetative means there is hope of interrupting the dispersal flow. However, if seed were to form and sexual populations established, successful eradication would become unlikely, and even control would be much more difficult. The possibility that the late season bloom will prevent seed set in northern California does not guarantee that seed will not set in far southern California, indeed, the most threatened areas have not yet had *Cuscuta japonica* detected there. These areas include the humid coastal zones of Santa Barbara, Ventura, Los Angeles, Orange, and San Diego Counties where vegetative growth can continue year round and seed can form late into the winter season.

However, the likelihood that many or most of the *Cuscuta japonica* infestations in California are the result of human-mediated vegetative propagation suggests the possibility that these are largely one or a few clones and not different individuals. When specimens first arrived in the Botany Lab it was not known if *Cuscuta japonica* was self-fertile. If not self fertile, and the plants are mostly a single clone, or even regionally a single clone, seed production would be unlikely. A molecular test to determine how many clones are present in California awaits staff and materials, however, we decided to test directly whether these plants are self fertile, and if so, whether cross pollinations among specimens from different regions could enable seed set.

Self-pollinations were performed in fall of 2005. A *Cuscuta japonica* plant, which was received with flowers already developed, was placed on a host in the Meadowview greenhouse and allowed to establish. Pollen was transferred from flowers in one inflorescence to flowers in another. After several weeks it became clear that seed was not going to form; the flowers died and shriveled, the ovary did not enlarge at all, indicating fertilization had not been effected. In fall of 2006, more specimens were being received and two from different regions, one from Contra Costa County and one from Sacramento County, both with fully formed flowers, were placed on a host. Once established (only a few days) cross pollinations in both directions were made. One inflorescence did not set seed, and indeed, it disappeared (for unknown reasons) from the host plant several days after the pollinations were made, but the second set seed on a large number of flowers. Eventually, most fertilized ovaries did not fully mature, but several did form filled seeds. Figure 7 shows the maturing fruits; Figure 8 the mature capsule and Figure 9 a mature seed.



Figure 7. Artificially pollinated inflorescence of *Cuscuta japonica* with maturing fruits (capsules).

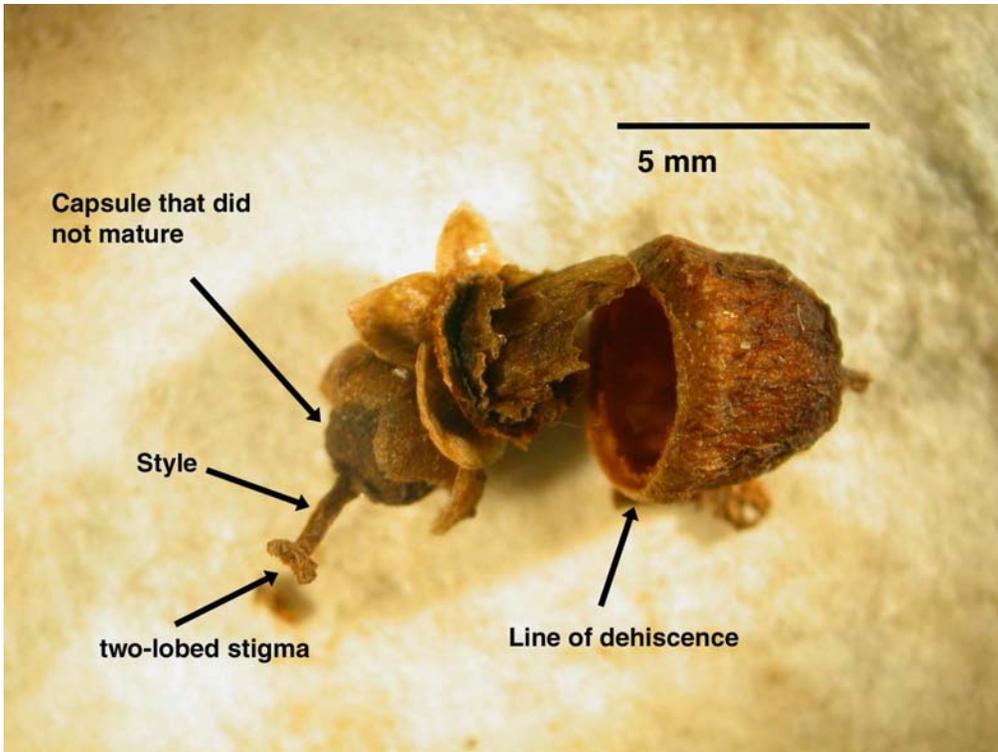


Figure 8. Mature capsule. *Cuscuta japonica* capsules dehisce around their circumference (circumcissile). Note the unfertilized capsule on the left shows the elongated style, and two-lobed stigma characteristic of *C. japonica*. Each mature capsule contains from 1 to 4 seeds. See also Fig. 6.



Figure 9. A *Cuscuta japonica* mature seed.

It would appear that seed set is indeed possible and that it is likely multiple clones comprise the infestations of this plant in California.

### **Adaptation**

Seed set does not guarantee sexual reproduction will occur. There are many factors that can influence survival between seed set and establishment of seedling individuals, none of which are specifically known for *Cuscuta japonica*. Moreover, it would appear that *Cuscuta japonica* is best adapted in humid climates. Not only is its native range a humid region, it is established as a pest in the most humid parts of the U.S. Within California, the Central Valley and San Francisco Bay Area, where *Cuscuta japonica* is established, are among the more humid regions in California, and it is possible that, although theoretically vulnerable, southern California, with its relatively dry air may not be optimum habitat for this taxon.

In addition, without a seed bank, cold conditions may prevent this plant from maintaining large populations purely by overwintering vegetation. It is not likely that coastal or low Valley habitats get cold enough on a regular basis to completely eliminate the plant from sheltered or other protected microclimates, but a hard frost, similar to that in winter 2006-7 may go a long way toward holding down major spread.

### **Conclusions**

The most dangerous aspect of *Cuscuta japonica* is its parasitic habit and large size. It actually behaves less like a weed and more like a plant pathogen, especially in its ability to survive vegetatively without a host and to spread by fragments. It has a wide host range as far as current observations suggest. Only monocots and perhaps Polygonaceae seem to resist haustorial establishment. Several common host plants are major agricultural crops. It apparently parasitizes Rosaceae easily; *Malus* (apple) and *Prunus* (plums, cherries, almonds, apricots and others) are common hosts, with *Vitis* (grape), and *Citrus* (oranges, lemons etc.) also utilized. Undoubtedly, many other horticultural and agricultural plants are potential hosts.

Its large size allows it, unlike any of the native dodders, to cover entire large plants and even full size trees. Figure 10 shows what can happen if *Cuscuta japonica* is allowed to grow uncontrolled. Observations by this laboratory have seen heavily infested trees that were near death, or dead. Cause and effect are not absolutely known, but the implication is that this parasite may have weakened those trees to the point where they could no longer survive.



Figure 10. The parasite *Cuscuta japonica* covering a 25 ft. tall tree at Grand & Branch Sts., Sacramento, in June 2006. Photo by Terra Irving, PPDC, CDFA.

*Cuscuta japonica* is believed by some to be a useful medicinal plant and this is the apparent source of our infestations; perhaps even those of the U.S. southeast can be traced largely to deliberate introductions as “alternative” medicine. The result is that *C. japonica* is now a pest in the U.S. southeast, and is becoming one in California. It has recently received considerable attention in the city of Houston where it has become established on the city’s street trees, causing tree decline and death, as well as being unsightly. For more information and pictures from Houston, see <http://www-aes.tamu.edu/mary/dodder/dodder.htm>.

# NEMATOTOLOGY

## 2006 NEMATOTOLOGY LABORATORY STAFF

JOHN CHITAMBAR  
KE DONG  
ROWENA DELEON  
RENE LUNA  
MIRASOL BALLESTEROS  
NATALIA BERTOTTI

DUANNA CHALLENGER  
CAROLINE DASALLA  
JENNIFER HAYNES  
DONNA IMES  
LATASHA PHIEFER  
CHRISTI SANCHEZ

The Nematology Laboratory provides diagnostic support for the protection of California's agricultural industry against economically important plant parasitic nematodes associated with plant disease. The state's agricultural industry could lose over \$600 million annually in crop losses if certain plant parasitic nematodes not known, or of limited occurrence in California would become widespread within the State. Based largely on the nematode diagnostic support provided by the Laboratory, government agencies are able to:

1. Provide nursery certification and standards of pest cleanliness.
2. Prevent the introduction and spread of regulatory significant pests.
3. Provide phytosanitary certification of foreign export commodities.

Support activities include nematode identification, evaluation of nematode related agricultural issues, training county and state personnel, and providing scientific consultations to state, county, and federal agencies, as well as, university, industry and the general public. The nematologists specialize in specific groups of nematodes and provide binomial identifications to species of economic, regulatory importance detected in samples. Nematode identifications are based primarily on morphological analyses, and may be supplemented with molecular analyses, biological assays, computer-aided identification programs, literature reviews and peer consultations. More than one nematologist confirms identifications of nematode species of quarantine significance. Complete sample and nematode diagnostic information is maintained in the Laboratory computer database, which is networked to county agricultural commissioners' offices. Training in regulatory nematology, nematode biology, diseases, sampling, sample handling, processing and preliminary nematode identifications (genus level) is provided to county and state personnel, as needed. Six out of 30 county agricultural departments have nematode processing capabilities that have been certified by the State Nematologist. In addition, nematologists are also responsible for conducting research, and, organizing and participating in professional meetings.

## **ANNUAL REPORT OF THE NEMATOLOGY LABORATORY**

John Chitambar, Ke Dong, Sergei Subbotin and René Luna

The Nematology Laboratory of the Plant Pest Diagnostics Center (PPDC) provides diagnostic support for the protection of California's agricultural industry against economically important plant parasitic nematodes associated with plant disease. Based largely on the nematode diagnostic support provided by the Laboratory, government agencies are able to:

- Provide nursery certification and standards of pest cleanliness.
- Prevent the introduction and spread of regulatory significant pests.
- Provide phytosanitary certification of foreign export commodities.

### **Laboratory Staff**

The Nematology Laboratory comprises three Nematologists, one Agricultural Biological Technician and a support staff of seven Scientific Aides. Dr. Sergei Subbotin joined the Laboratory as Associate Plant Nematologist in fall 2006. Scientific Aides comprise mainly of graduate and post-graduate students in Nematology or other biological science from the University of California, Davis.

### **Role and responsibilities**

The role and responsibilities of the State nematologists are mainly four-fold:

- Identification of plant parasitic nematodes in regulatory and survey samples. Diagnosis of nematode related agricultural problems.
- Professional consultations provided to state, federal, university, industry, commercial and private agency personnel.
- Training in nematode sampling, processing, and preliminary identifications provided to county and state personnel.
- Research in nematode taxonomy, methodologies, and other areas of regulatory nematology.

The Agricultural Biological Technician is responsible for the effective and timely management of the support staff, sample processing, data management and other related operations of the Laboratory.

### **Regulatory sample processing**

In order to meet the diagnostic responsibilities, the Laboratory support staff under the direct guidance of the biological technician, processes plant and soil samples that are routinely collected and sent to the Nematology Laboratory by County Agricultural and State personnel. Plant parasitic nematodes are microscopic and inhabit above and below ground plant parts as well as rhizosphere soil of plants, depending on the species and biology of the nematode involved. These samples are designated to Quarantine, Nursery, Commercial or Dooryard (residential) programs, and are sent as non-processed "raw" samples, or as processed samples of nematode suspensions preserved in two and one-half percent formaldehyde solution contained in vials. Approximately six counties have nematode sample processing facilities and

personnel trained and certified by the State Nematology Laboratory. The State Laboratory uses a combination of several scientific tests or procedures to extract nematodes from infested samples. Each of these procedures involves the use of large volumes of water, as nematodes are essentially aquatic animals requiring moisture for activity. The number of tests involved in extracting and preparing a collection of nematodes in clear water suspension for diagnostic evaluation is indication of the fact that the workload of the Nematology Sample Processing Laboratory cannot be entirely based on the number of samples processed.

During 2006 a total of 7,912 samples were diagnosed at the Laboratory. A breakdown of sample type per program is presented in Table 1. The bulk of quarantine samples include those entering the State through the External Quarantine for Burrowing and Reniform Nematodes program and those exported to other countries through the Quarantine Phytosanitary Certification Program. Samples in the former sub-program comprise collections made mainly from indoor decorative foliage plants sold at nurseries, while samples in the latter sub-program consists of mainly plant seeds processed and examined for targeted nematode species not wanted by importing countries. Most nursery samples of plants for sale by the grower comprised garlic (220 seed bulb samples), strawberries (879 foliage and root samples), grape and stone fruits (711 root and soil samples) collected through the State's Registration and Certification, and Nematode Control programs.

### Special surveys

**1. Statewide Nematode Survey:** This survey commenced in spring 2005 and continues through 2007. The project is funded by the National Cooperative Agricultural Pest Survey (CAPS) of the United States Department of Agriculture Animal and Plant Health Inspection Service (USDA-APHIS), and commonly known as the CAPS survey. The operational responsibilities of the project (sample collection) are conducted by the Pest Detection and Emergency Projects Branch (PDEP), while survey planning, sample processing and nematode diagnostics are conducted by the Nematology Laboratory, PPDB, of the California Department of Food and Agriculture (CDFA).

In 2006, 2,159 soil, root and foliage samples were processed by the Laboratory for the detection of 22 exotic and economically important target plant parasitic species. Each sample included at least 4 different nematode extraction procedures or tests thereby, resulting in a total of 8,636 tests. Nematode identifications were accomplished using morphological and molecular procedures. A separate report on the CAPS survey details the results of the project. With the exception of few target plant parasitic species already known in California, none of the target exotic species have been detected to date in the State's agricultural production sites.

**2. Potato Cyst Nematode Survey:** This survey commenced in fall 2006 and continues through spring 2008. The survey is in response to a request by the national potato industry to USDA for a nationwide survey per state following the detection of the potato cyst nematode, *Globodera pallida*, in a potato field in Idaho. The Idaho find marks the first occurrence of the high-risk nematode species in the United States and USDA holds a federal quarantine against the pest. The project is funded by USDA-APHIS, and is commonly known as the PCN survey. Sample collection was conducted by PDEP, while sample processing and nematode diagnostics were conducted by the Nematology Laboratory.

Survey of California's potato fields was based on 2006 acreage to seed and commercial production potatoes. In 2006, 39,618 acres in 642 fields were cultivated to production potatoes while seed potatoes were grown on 661 acres in 24 fields. According to the sampling protocol

established by USDA, ten percent perimeter acreage of each field was sampled for both types of potato. Only ten percent of all production fields per county were sampled whereas, all seed fields, or 100 percent, were sampled per county. Four samples were collected per acre and each sample comprised five pounds of soil, thereby, totaling more than 1,300 potato soil samples for the survey. 674 samples were processed and diagnosed in 2006.

To accommodate the processing needs for both PCN and CAPS surveys, an additional nematology laboratory was constructed in the annex building adjacent to the main Nematology Laboratory at PPDB. Samples were processed for the extraction of nematode cysts using a combination of the gravity sieving and sugar centrifugation techniques.

No potato cyst nematodes or cyst nematodes of any other species group were found in samples processed and diagnosed in 2006.

### **Significant detections**

Three "A" rated quarantine species were detected and included, the Awl nematode, *Dolichodorus heterocephalus* on imported *Ficus benjamina* in San Diego county, the Reniform nematode, *Rotylenchulus reniformis* on imported *Phoenix roebelenii* in San Joaquin County and the Citrus Sheath nematode, *Hemicycliophora arenaria* on lemon and grapefruit commercially grown in Imperial county. The Awl and Reniform nematode species are not established in California's agricultural soils. The Citrus Sheath nematode has been found in limited regions of Imperial County and is contained in those regions.

Two "B" rated nematode species, namely, the Columbia root-knot nematode, *Meloidogyne chitwoodi* and the Dagger nematode, *Xiphinema index* were detected. The former species was detected on commercially grown potato in Siskiyou County and the latter species was detected on commercially grown grape in Napa, Sonoma and Tulare counties. Both species are limited in their distribution within California and are potential economic threats to grape and potato industries.

A single detection of *Pratylenchus* sp. was given a "Q" rating based on an incomplete identification. The species was detected on quarantine imported *Ficus benjamina* in San Diego County and is currently under further diagnostic study.

**Table 1.** Total number of samples per program received by the CDFA Nematology Laboratory in 2006

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<b>Nematode Detection Program</b>	<b>No. of samples</b>
<b>Quarantine (<i>total</i>)</b>	<b>3,201</b>
- Incoming External Quarantine	2,687
- Border Station Interceptions	91
- Export Phytosanitary Certification	422
- Other	1
<b>Nursery (<i>total</i>)</b>	<b>1,845</b>
- Registration and Certification	1,101
- Nematode Control	711
<b>Commerical</b>	<b>2,833</b>
(Includes CAPS and PCN surveys)	
<b>Dooryard/Residential</b>	<b>33</b>
<b>Total</b>	<b>7,912</b>

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## CALIFORNIA STATEWIDE NEMATODE SURVEY PROJECT 2006 REPORT

Ke Dong, John Chitambar, Sergei Subbotin, Mohammed Alzubaidy, Magally Luque-Williams, Jennifer Romero, Kathy Kosta and Rene Luna

The vast diversity of crops cultivated in California readily provides a wide range of environments that favor many agricultural pests including plant parasitic nematodes. Such pests, whether domestic and exotic, have the potential to greatly reduce crop productivity, and adversely impact California economy and way of life. The Nematology Laboratory, Plant Pest Diagnostics Center (PPDC) and Pest Detection and Emergency Projects Branch (PDEP) of California Department of Food and Agriculture (CDFA) conducted a statewide nematode survey project that commenced spring 2005 and continues through 2007. The project was cooperative with the US Department of Agriculture Animal and Plant Health Inspection Service (USDA-APHIS) and funded by the National Cooperative Agricultural Pest Survey (CAPS) Program. The objective of this project was to obtain current information on the occurrence and distribution of economically harmful plant parasitic nematodes in the major cropping and nursery production areas of California. The target nematode species surveyed within California included 22 species listed below:

White tip of rice nematode, *Aphelenchoides besseyi*  
Wheat seed gall nematode, *Anguina tritici*  
Rice stem nematode, *Ditylenchus angustus*  
Potato rot nematode, *Ditylenchus destructor*  
Onion stem/bulb nematode, *Ditylenchus dipsaci*  
Potato cyst nematode, *Globodera pallida*  
Golden nematode, *Globodera rostochiensis*  
Cereal cyst nematode, *Heterodera avenae*  
Soybean cyst nematode, *Heterodera glycines*  
Mediterranean cereal cyst nematode, *Heterodera latipons*  
British root-knot nematode *Meloidogyne artiellia*  
Columbia root-knot nematode, *Meloidogyne chitwoodi*  
False Columbia root-knot nematode, *Meloidogyne fallax*  
Northern root-knot nematode, *Meloidogyne hapla*  
Javanese root-knot nematode, *Meloidogyne javanica*  
Pecan root-knot nematode, *Meloidogyne partityla*  
False root-knot nematode, *Nacobbus aberrans*  
Burrowing nematode, *Radopholus similis*  
Reniform nematode, *Rotylenchulus reniformis*  
Dagger nematodes, *Xiphinema* spp. (*bakeri*, *coxi*, *diversicaudatum*)

Sixteen species in the above list have never been detected in California's agricultural production sites, namely, the wheat seed gall nematode (*Anguina tritici*) rice stem nematode (*Ditylenchus angustus*), golden nematode (*Globodera rostochiensis*), potato cyst nematode (*G. pallida*), three cyst nematode species (*Heterodera avenae*, *H. glycines* and *H. latipons*), three root-knot nematode species (*Meloidogyne artiellia*, *M. fallax* and *M. partityla*), false root-knot nematode (*Nacobbus aberrans*), reniform nematode (*Rotylenchulus reniformis*) and three species of dagger nematode (*Xiphinema bakeri*, *X. diversicaudatum* and *X. coxi*). These exotic

nematode species could cause devastating losses to agricultural production and urban landscapes if they became established in California. Early detection of these pests is crucial for the eradication of incipient infestations. In addition, the survey also included economically important species, which are known to occur however, with a more or less limited distribution within California, namely, the white tip of rice nematode (*Aphelenchoides besseyi*), potato rot nematode (*Ditylenchus destructor*), stem and bulb nematode (*Ditylenchus dipsaci*), and stubby root nematode (*Paratrichodorus spp*), and three species of root-knot nematodes (*Meloidogyne chitwoodi*, *M. hapla*, *M. javanica*). The survey will provide information on the occurrence and distribution of target exotic and non-exotic nematode species within the State. This information will enable 1) the implementation of appropriate eradication and regulatory management strategies, 2) California growers to export agricultural commodities, 3) alert states to new pathways of prevention/management, given the detection of exotic nematode species, and 4) expand and strengthen existing databases at CDFA and National Agricultural Pest Information Service (NAPIS).

## **Materials and Methods**

### **Major Hosts**

Twenty-four major plant hosts were selected for the survey based on the host ranges of the target nematode species and the cultivation of the plants in California (Table 1). Acreages and field locations of selected host plants were determined per county from Agricultural Commissioners' pesticide permit records. Information obtained for each sampled field included, physical address of site, global positioning system (GPS) coordinates, crop cultivated, cropping history, pesticide use history and date of last fumigation. Only non-fumigated fields were sampled in the survey.

### **Sampling**

A minimum of 20 composite samples per host per county was collected. For counties with large production acreage, at least, 25 composite samples per host were recommended. Sampling was also encouraged in those counties not listed but known to be minor producers of survey plants. Field samples from plant hosts not listed in the Table 1, nevertheless cultivated as important crops in a given county, were also included in the statewide survey.

Sampling was performed near crop maturity in late summer/fall or during harvest or post harvest, depending on the crop. Soil, root, tuber and stem/foilage samples were collected from commercial fields, rows, and orchard plants depending on the target pest. For field and row crops, a composite sample comprised of 15 subsamples collected on a 120 x 120 ft grid, (50 paces) per 2-hectare unit. For fields less than 2 hectares, 15 subsamples were collected on an 85 x 85 ft grid (35 paces). For fields exceeding 2 hectares, more than one unit was sampled per field, depending on the total number of fields/acreage to be sampled within a county. A subsample comprised 50 ml soil and 20 ml feeder roots thereby, yielding a total sample volume of approximately 750 ml soil plus roots. Two tubers or bulbs and approximately, 100 ml stem and foliage were collected per subsample. Orchard trees samples comprised soil and roots collected from 10 randomly selected trees per 2 hectare or less unit. Field grown nursery stock was sampled on a 40 x 40 ft grid per acre with a collection of approximately, 50 ml soil and 30 ml roots per subsample or 800 ml total sample size. Nursery plants in containers, flats or fields, were sampled at 10 x 10 ft bench or frame space according to guidelines established in CDFA Nursery Integrated Pest Manual (NIPM item 7.1). Total soil and plant sample volumes were sent to the Laboratory for nematode extraction.

## Nematode Diagnosis

Nematodes were extracted from soil samples by gravity sieving, sugar centrifugation, and mist extraction techniques. Nematodes were extracted from plant tissue samples by chopping and mist extraction techniques. As a result, each sample yielded three to four separate test suspensions for nematode analyses: 1) direct microscopic examination of 250- $\mu$ m pore sieve residue for cysts and large vermiform plant parasitic nematodes, 2) resultant nematode suspension from sugar centrifugation for the extraction of sluggishly motile and other plant parasitic nematodes, 3) resultant nematode suspension from mist extraction for motile and endoparasitic root and soil nematodes and 4) resultant suspension from mist extraction for above ground or tuber plant parasitic nematodes.

Plant parasitic nematodes were identified using morphological and DNA analyses. Morphological identifications were made of water-mounted and glycerin-mounted nematode specimens, using scanning and compound light microscopes. Populations of certain nematode species were increased on carrot callus or potted tomato plants for further study as needed.

Second stage larvae of *Meloidogyne* spp. and *Heterodera* spp. initially identified and confirmed using a dissection microscope at a magnification of 250X, were further identified to the species level based on the size of DNA bands analyzed using PCR-RFLP tests. A minimum of 5 infective juveniles was analyzed from each sample for PCR diagnoses. In diagnostic tests for *Meloidogyne* spp. tests, the PCR amplification was conducted with primer set located in the COII and 16S ribosomal mitochondrial genes respectively (Powers and Harris, 1993; Stanton, *et al.*, 1997). The C2F3 primer (5' GGTC AATGTT CAGAAATTTGTGG 3') from Powers was chosen as up-stream primer, and the MRH106 from Stanton was used as down-stream primer (5' AATTTCTAAAGACTTTTCTTAGT 3'). The root-knot nematode species identifications were made by the size of amplification PCR (or PCR-RFLP) products. *M. arenaria* will develop a ~1,300bp product. The amplification products of approximately 1,800bp were further digested with *Hinf*I: *M. javanica* will not be digested; *M. incognita* will produce the 1400bp and 400bp fragments. For some *Meloidogyne* species when the amplification products were about 650bp, the PCR products were subjected to a *Dra*I digestion: if the digestion products were 258bp, 119bp, 40bp, 18bp, and 156bp, the species was *M. chitwoodi*. If the digestion products were 246bp, 198bp, 51bp and 103bp, the species was *M. hapla*. Since both *M. chitwoodi* and *M. hapla* were target species in this CAPS survey, an IGS region PCR test was further conducted to confirm the species (Wishart, *et al.*, 2002). In addition to the PCR tests, when root galls were available in some samples, *Meloidogyne* adult females were isolated for morphological and isozyme analyses as supplementary techniques for identification.

The ITS1 and ITS2 regions were used to differentiate species of *Heterodera* (Subbotin, *et al.*, 2000). Most *Heterodera* spp. yielded a single fragment of approximately 1060bp from the primer pair AB 28 (ATATGCTTAAGTTCAGCGGGT) and TW 81 (GTTTCCGTAGGTGAACCTGC). Only *H. schachtii* was detected in this survey, the PCR products were digested with restriction enzyme *Mva*I and the results from *H. schachtii* were seven fragments of 1010bp, 840bp, 760bp, 630bp, 220bp, 150bp, and 80bp.

## Results

A total of 2,159 CAPS survey samples were processed and diagnosed in 2006. In addition, 711 nematode samples from the CDFA's Nematode Control program, 881 Nursery Nematode Certification program samples and 422 Quarantine Phytosanitary samples of commodities for export collected from major agriculture crop and fruit trees cultivated in California's agricultural soils in 2006 were also included into the overall survey results. Seventy-eight nematode genus/species were detected in the 2006 survey (Table 2). Only five of the target nematode species, namely, *Ditylenchus dipsaci*, *Meloidogyne chitwoodi*, *M. hapla*, *M. javanica* and *Paratrichodorus* spp., already known to be present in California's agricultural production sites, were detected in the 2006 CAPS survey. Table 3 lists the plant hosts associated with these species in 2006, as well as the counties wherein the species have been detected according to CDFA-Nematology pest detection records 1989-2006.

Few "B" rated nematode species were detected in this survey (Table 2), for instance, the Columbia root knot nematode *Meloidogyne chitwoodi* was detected in Siskiyou County on potato. The California dagger nematode *Xiphinema index* was found in Butte, Napa, Sonoma, and Tulare counties. The Citrus Sheath nematode, *Hemicycliophora arenaria*, an "A" rated pest was detected in a lemon orchard in Imperial County. The nematode species is very limited in its distribution within the State and is currently contained or held within the infested areas. A "Q" rating was given to few *Heterodera* sp. and *Meloidogyne* sp. (Table.) pending complete diagnoses of the species. Those species are currently under further study. No other "A" or "Q" rated nematode species were detected in 2006, however the White-tip of rice nematode, *Aphelenchoides besseyi*, has been detected on paddy rice in Butte, Sutter and Yolo counties in 1997-2005 (CDFA-Nematology pest detection records).

Table 1. List of plant hosts sampled for the detections of 2006 survey target nematode species

<b>Major plant hosts</b>	<b>Target nematode species associated</b>
Alfalfa	<i>Ditylenchus dipsaci</i> , <i>Meloidogyne artiellia</i> , <i>M. fallax</i> , <i>M. hapla</i>
Apricot	<i>Meloidogyne javanica</i> , <i>Xiphinema</i> spp.
Barley	<i>Heterodera latipons</i> , <i>Meloidogyne artiellia</i> , <i>M. chitwoodi</i>
Bean (common)	<i>Heterodera glycines</i>
Broccoli	<i>Meloidogyne artiellia</i>
Cabbage	<i>Meloidogyne artiellia</i> , <i>Nacobus aberrans</i> , <i>Xiphinema</i> spp.
Carrot	<i>Meloidogyne fallax</i> , <i>Nacobus aberrans</i> , <i>Radopholus similis</i> , <i>Rotylenchulus reniformis</i>
Cauliflower	<i>Meloidogyne artiellia</i> , <i>Nacobus aberrans</i>
Cherry	<i>Meloidogyne javanica</i>
Citrus	<i>Radopholus similis</i> , <i>Rotylenchulus reniformis</i>
Cotton	<i>Rotylenchulus reniformis</i>
Cucumber	<i>Nacobus aberrans</i>
Daffodil/Narcissus	<i>Ditylenchus dipsaci</i>
Grape	<i>Meloidogyne javanica</i> , <i>Rotylenchulus reniformis</i> , <i>Xiphinema</i> spp.
Oats	<i>Ditylenchus dipsaci</i> , <i>Heterodera avenae</i>
Onion	<i>Ditylenchus dipsaci</i> , <i>Rotylenchulus reniformis</i>
Garlic <sup>a</sup>	<i>Ditylenchus dipsaci</i> , <i>Rotylenchulus reniformis</i>
Peach	<i>Meloidogyne javanica</i> , <i>Xiphinema</i> spp.
Plums	<i>Meloidogyne javanica</i>
Potato	<i>Ditylenchus destructor</i> , <i>Globodera pallida</i> , <i>G. rostochiensis</i> , <i>Meloidogyne chitwoodi</i> , <i>M. fallax</i> , <i>Nacobus aberrans</i>
Rice (paddy)	<i>Aphelenchoides besseyi</i> , <i>Ditylenchus angustus</i>
Rose	<i>Xiphinema</i> spp.
Sugar beet	<i>Heterodera latipons</i>
Strawberry <sup>a</sup>	<i>Meloidogyne hapla</i> , <i>Radopholus similis</i>
Walnut/pecans	<i>Meloidogyne partityla</i>
Wheat	<i>Anguina tritici</i> , <i>Heterodera avenae</i> , <i>Meloidogyne chitwoodi</i> , <i>M. fallax</i>

<sup>a</sup>Host plants included in CDFA's Quarantine Phytosanitary certification program

Table 2. Nematode Species Detected in the 2006 CAPS survey

Nematode Species	Number of Detections <sup>a</sup>	CA Pest Rate
<i>Criconema</i> sp.	21	D
<i>Criconemella curvata</i>	1	D
<i>Criconemella</i> sp.	34	D
<i>Ditylenchus dipsaci</i>	10	C
<i>Gracilacus idalimus</i>	1	D
<i>Gracilacus</i> sp.	1	D
<i>Helicotylenchus digonicus</i>	5	D
<i>Helicotylenchus dihystra</i>	48	D
<i>Helicotylenchus pseudorobustus</i>	25	D
<i>Helicotylenchus solani</i>	1	D
<i>Helicotylenchus paragirus</i>	12	D
<i>Helicotylenchus</i> sp.	27	D
<i>Hemicriconemoides californianus</i>	2	D
<i>Hemicriconemoides chitwoodi</i>	2	D
<i>Hemicriconemoides</i> sp.	3	D
<i>Hemicycliophora arenaria</i>	3	A
<i>Hemicycliophora biosphaera</i>	1	D
<i>Hemicycliophora sheri</i>	5	D
<i>Hemicycliophora</i> sp.	13	D
<i>Hemicycliophora striatula</i>	1	D
<i>Heterodera schachtii</i>	88	C
<i>Heterodera</i> sp. <sup>b</sup>	1	Q
<i>Hirschmanniella belli</i>	2	D
<i>Hirschmanniella</i> sp.	4	D
<i>Longidorus africanus</i>	3	C
<i>Macroposthonia (Mesocriconema) xenoplax</i>	392	D
<i>Meloidogyne arenaria</i>	8	C
<i>Meloidogyne chitwoodi</i>	1	B
<i>Meloidogyne hapla</i>	27	C
<i>Meloidogyne incognita</i>	43	C
<i>Meloidogyne javanica</i>	23	C
<i>Meloidogyne</i> sp. <sup>b</sup>	6	Q
<i>Merlinius brevidens</i>	42	D
<i>Merlinius microdorus</i>	1	D
<i>Merlinius</i> sp.	2	D
<i>Ogma</i> sp.	3	D
<i>Paratrichodorus minor</i>	2	D
<i>Paratrichodorus</i> sp.	22	D
<i>Paratylenchus baldaccii</i>	3	D
<i>Paratylenchus bukowinensis</i>	57	D
<i>Paratylenchus dianthus</i>	1	D
<i>Paratylenchus hamatus</i>	127	D
<i>Paratylenchus holdemani</i>	1	D
<i>Paratylenchus italiensis</i>	1	D
<i>Paratylenchus lepidus</i>	4	D
<i>Paratylenchus nanus</i>	1	D

Table 2. Nematode Species Detected in the 2006 CAPS survey (Continued)

<i>Paratylenchus neoamblycephalus</i>	21	D
<i>Paratylenchus similes</i>	3	D
<i>Paratylenchus</i> sp.	52	D
<i>Pratylenchus brachyurus</i>	9	C
<i>Pratylenchus neglectus</i>	185	D
<i>Pratylenchus penetrans</i>	19	C
<i>Pratylenchus scribneri</i>	28	D
<i>Pratylenchus</i> sp.	16	D
<i>Pratylenchus thornei</i>	79	D
<i>Pratylenchus vulnus</i>	83	C
<i>Quinisulcius capitatus</i>	7	D
<i>Rotylenchulus parvus</i>	1	C
<i>Rotylenchus robustus</i>	1	D
<i>Scutellonema brachyurus</i>	4	D
<i>Scutellonema clathricaudatum</i>	2	D
<i>Scutellonema conicephalum</i>	4	D
<i>Tylenchorhynchus agri</i>	1	D
<i>Tylenchorhynchus annulatus</i>	1	D
<i>Tylenchorhynchus aspericutis</i>	2	D
<i>Tylenchorhynchus ebriensis</i>	1	D
<i>Tylenchorhynchus elegans</i>	9	D
<i>Tylenchorhynchus goldeni</i>	5	D
<i>Tylenchorhynchus mashhoodi</i>	38	D
<i>Tylenchorhynchus microconus</i>	3	D
<i>Tylenchorhynchus nudus</i>	1	D
<i>Tylenchorhynchus oleraceae</i>	3	D
<i>Tylenchorhynchus penniseti</i>	1	D
<i>Tylenchorhynchus punensis</i>	1	D
<i>Tylenchorhynchus</i> sp.	128	D
<i>Tylenchulus semipenetrans</i>	142	C
<i>Xiphinema americanum</i>	291	C
<i>Xiphinema index</i>	14	B
No Plant Parasitic Nematode Found	2712	
Total Survey Sample Detections	4946	

<sup>a</sup>Sample Numbers include CDFA's Nematode Certification and Nematode control program data for 2006.

<sup>b</sup>Species under further study. Temporary rating assigned for incomplete identification.

Table 3. List of 2006 survey target nematode species detected in California's agricultural production soils (1989-2006)<sup>a</sup>

Common Name	Species	Counties	Pest Rating	Associated Host (2006)
White tip of rice nematode	<i>Aphelenchoides besseyi</i>	Butte, Sutter, Yolo	A	-
Potato Rot Nematode	<i>Ditylenchus destructor</i>	Contra Costa, Humboldt, Los Angeles, Marin, San Diego, San Francisco, San Luis Obispo, San Mateo, Santa Cruz	B	-
Stem and Bulb Nematode	<i>Ditylenchus dipsaci</i> <sup>b</sup>	Alameda, Alpine, Calaveras, Contra Costa, Del Norte, Fresno, Glenn, Humboldt, Imperial, Kern, Kings, Lassen, Los Angeles <sup>c</sup> , Madera, Marin, Mendocino, Merced, Modoc, Monterey, Napa, Orange, Plumas, Riverside, Sacramento, San Benito, San Diego, San Joaquin, San Luis Obispo, San Mateo, San Bernardino, Santa Clara, Santa Cruz, Siskiyou, Sonoma, Stanislaus	C	Alfalfa
Northern Root-Knot Nematode	<i>Meloidogyne hapla</i> <sup>b</sup>	Alameda, Colusa, Contra Costa, Fresno <sup>c</sup> , Glenn <sup>c</sup> , Imperial, Kern <sup>c</sup> , Los Angeles <sup>c</sup> , Marin, Tehama, Yolo, Sutter, Solano, Merced <sup>c</sup> , Modoc <sup>c</sup> , Monterey <sup>c</sup> , Orange, Riverside, San Bernardino, San Diego, San Francisco, San Joaquin, Santa Barbara, Santa Clara, Santa Cruz, Shasta <sup>c</sup> , Stanislaus, Tulare <sup>c</sup> , Ventura	C	Alfalfa, long, bean, potato
Javanese Root-Knot Nematode	<i>Meloidogyne javanica</i> <sup>b</sup>	Contra Costa, Fresno, Glenn, Imperial, Kern, Kings, Los Angeles, Madera, Merced, Napa, Orange, Riverside, San Bernardino, San Diego <sup>c</sup> , San Joaquin <sup>c</sup> , Stanislaus <sup>c</sup> , Sutter <sup>c</sup> , Tulare <sup>c</sup> , Ventura, Yolo <sup>c</sup>	C	Bean, lima bean, grape, peach, tomato,
Columbia Root-Knot Nematode	<i>Meloidogyne chitwoodi</i> <sup>b</sup>	Modesto, Monterey, Shasta, Siskiyou <sup>c</sup> , Tulare, Tuolumne	B	Potato
Stubby Root Nematode	<i>Paratrichodorus</i> spp. <sup>b</sup>	Widespread throughout California (including, Fresno, Imperial, Kern, Kings, Merced, Placer, San Joaquin, Shasta, Tulare counties) <sup>c</sup>	D	Alfalfa, apricot, cherry, lemon, orange, plum, potato, strawberry, walnut

<sup>a</sup> Includes 2006 survey and CDFG-Nematology pest detection records data

<sup>b</sup> Target nematode species detected in 2006 survey.

<sup>c</sup> Counties positive for target nematode species detected in 2006 survey.

## RESEARCH ON MOLECULAR DIAGNOSTICS AND PHYLOGENY OF NEMATODES

Sergei Subbotin

Sergei Subbotin's research is devoted to different aspects of molecular and traditional systematics of plant parasitic and entomopathogenic nematodes. The studies have been conducted in co-operation with many nematologists from different countries.

### Abstracts of papers published in 2006:

**Subbotin S.A., Sturhan D., Chizhov V.N., Vovlas N. & Baldwin J.G. 2006.** Phylogenetic analysis of Tylenchida Thorne, 1949 as inferred from D2 and D3 expansion fragments of the 28S rRNA gene sequences. *Nematology* 8: 455-474.

The order Tylenchida includes the largest and most economically important group of plant-parasitic nematodes. As plant parasites they have diverged to exploit all plant parts including foliage, flowers and seeds, but mostly they attack roots. The evolutionary relationships of 82 species of tylenchid and aphelenchid nematodes were evaluated by use of sequence data of the D2 and D3 expansion fragments of the 28S ribosomal RNA genes. The molecular data sets showed that the order Tylenchida comprises lineages that largely correspond to two suborders, Hoplolaimina and Criconematina, and other taxonomic divisions as proposed by Siddiqi (2000). Several significant results also derived from our study include: *i*) the basal position of groups that include entomoparasitic nematodes within tylenchid trees; *ii*) paraphyly of the superfamily Dolichodoroidea *sensu* Siddiqi (2000); *iii*) evidence for a *Pratylenchus*, *Hirschmanniella* and *Meloidogyne* clade; and *iv*) lack of support for widely held traditional placement of *Radopholus* within Pratylenchidae and placement of this genus within Hoplolaimidae or Heteroderidae. Sequences obtained from many agricultural important nematodes in this study can serve as a source for designing of specific probes for molecular diagnostics.

**Tanha Maafi Z., Sturhan D., Subbotin S.A. & Moens M. 2006.** *Heterodera persica* sp. n. (Tylenchida: Heteroderidae) parasitizing Persian hogweed (*Heracleum persicum* (Desf. ExFisch.) in Iran. *Russian Journal of Nematology* 14 171-178.

A new cyst-forming nematode, *Heterodera persica* sp. n., belonging to the Goettingiana group and parasitizing the umbellifer plant *Heracleum persicum* (Desf. ex Fisch.) is described from the Alborz Mountains in Iran. The new species resembles particularly *H. circeae*, *H. scutellariae* and *H. bergeniae*. The ITS sequences of rRNA distinguish *H. persica* sp. n. from other species in the Goettingiana group by at least 16 unique nucleotides.

**Chizhov V.N., Chumakova O.A., Subbotin S.A. & Baldwin J. G. 2006.** Morphological and molecular characterization of foliar nematodes of the genus *Aphelenchoides*: *A. fragariae* and *A. ritzemabosi* (Nematoda: Aphelenchoididae) from the Main Botanical Garden of the Russian Academy of Sciences, Moscow. *Russian Journal of Nematology* 14: 179-184

During surveys conducted in glasshouses in the Main Botanical Garden of the Russian Academy of Sciences several fern plants infected by the strawberry crimp nematode, *Aphelenchoides fragariae*, were found. Nematode infection produced water-soaked bands that become dark brown to black, usually between the leaf veins. Several plants of *Sambucus racemosa* attacked by the chrysanthemum foliar nematode *A. ritzemabosi* were found in an outdoor area. Morphological and morphometrical diagnostic characters and descriptions are given for *A. fragariae* and *A. ritzemabosi*. Differences in the 18S rRNA gene sequences allow a clear separation of these species from each other and from other *Aphelenchoides* species. The phylogenetic relationships of these species with other aphelenchids as inferred from analysis of the 18S-rRNA gene are presented and discussed.

Vovlas, N., Landa, B.B., Liebanas, G., Handoo, Z.A., Subbotin, S.A. & Castillo, P. 2006. Characterization of the cystoid nematode *Meloidoderita kirjanovae* (Nematoda: Sphaeronematidae) from South Italy. *Journal of Nematology* 38: 376-382.

The genus *Meloidoderita* comprises three valid species, including *M. kirjanovae*, *M. polygoni*, and *M. safrica*, which can be differentiated according to a combination of morphological and morphometrical characters. *Meloidoderita* females retain the eggs inside a hypertrophied uterus that becomes a protective and persistent cystoid sac after the nematode's death. At the first time in this work we analyzed two fragments of rRNA genes for *Meloidoderita*. The ITS-rRNA sequence clearly separates *M. kirjanovae* from the closely related species *M. polygoni*. The basal position of the genus *Meloidoderita* together with *Sphaeronema* within the Criconematina clade in this tree may indicate close relationships of these genera.

Phan, K.L., Spiridonov, S.E., Subbotin, S.A. & Moens, M. 2006. Four new species of *Steinernema* Travassos, 1928 with short infective juveniles from Vietnam. *Russian Journal of Nematology* 14: 11-29.

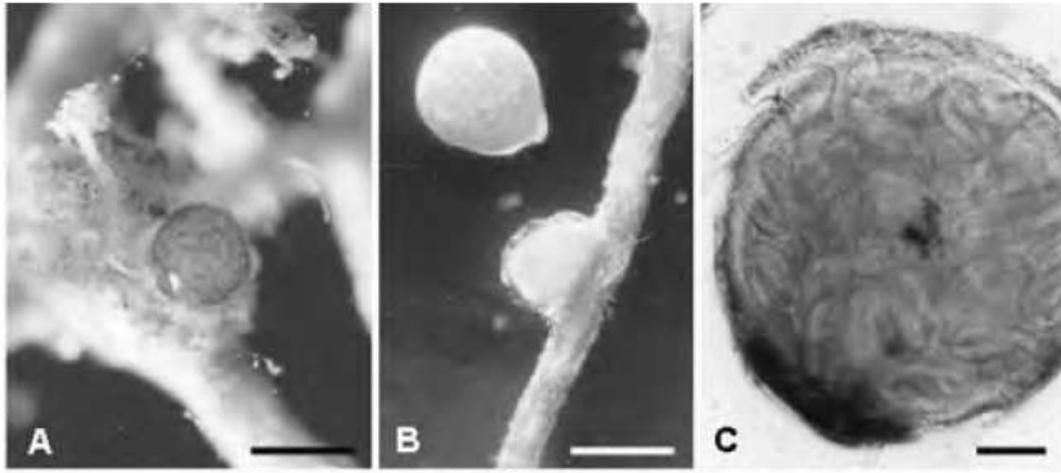
The four species of entomopathogenic nematodes: *Steinernema cumgarensense* sp. n., *S. eapokense* sp. n., *S. backanense* sp. n. and *S. sasonense* sp. n. with length of the infective juveniles less than 600  $\mu\text{m}$ . The IJ have lateral fields with four central ridges and two prominent marginal ridges. In addition to morphological and morphometrical features, four new species can be differentiated from each other and from closely related species of the 'carpocapsae-scaterisci-tami' group by characteristic sequences of their ITS-rRNA gene. The phylogenetic relationships within clade 'carpocapsae-scaterisci-tami' of the genus *Steinernema* with inclusion of these four species are presented.

#### **Other publications in 2006:**

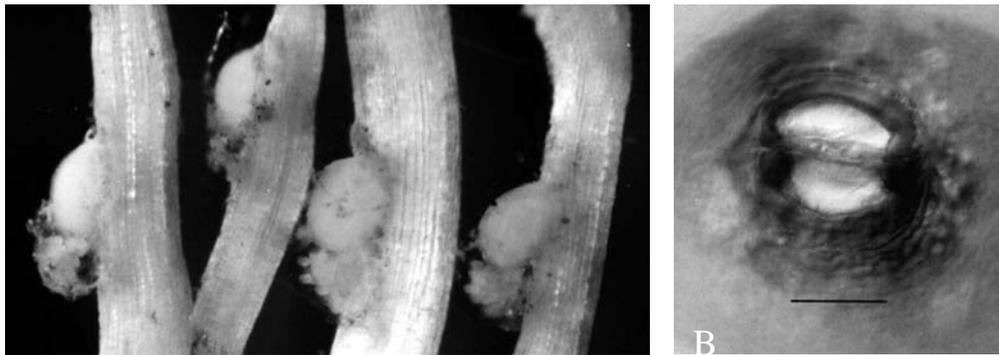
Chapters in Books:

**Subbotin S.A.** & Moens, M. 2006. *Molecular Taxonomy and Phylogeny*. Pp. 33-58 In Book: *Plant Nematology* edited by R. Perry and M. Moens. CABI, UK. 447 pp.

**Subbotin S.A.** 2006. [Molecular diagnostics of phytoparasitic nematodes using polymerase chain reaction]. Pp. 228-252. In Book: *Applied Nematology*, Moscow, Nauka. 352 pp.



Microphotographs of specimens of the cystoid nematode *Meloidoderita kirjanovae*. A-C: Cystoid bodies on mint root (from Vovlas *et al.*, 2006).



Microphotographs of cysts of cyst-forming nematode *Heterodera persicae*. A: White females parasitizing roots of Persian hogweed, B: Vulval plate of cyst (from Tanha Maafi *et al.*, 2006).



Symptoms on fronds of *Pteris cretica* infected with the strawberry crimp nematode *Aphelenchoides fragariae* (from Chizhov *et al.*, 2006).

## **SEED SCIENCE**

### 2006 SEED LABORATORY STAFF

RIAD BAALBAKI  
JIM EFFENBERGER  
DEBORAH MEYER, SUPERVISOR  
DON JOLEY  
PAUL PETERSON  
ELAINE HARRIS  
JOHANNA NAUGHTON  
EVELYN RAMOS  
CONNIE WEINER  
CHRIS FERNANDEZ  
AARON LANGENBECK  
CINDY CHEA  
JEANETTE DELEON  
ROWENA DELEON  
DEVIKA DUTT  
NOSA IHEGIE  
JULIA SCHER (USDA)

## SEED LABORATORY

### Responsibilities

- Provide identification and quality assessments of agricultural, vegetable, flower, native and weed seed.
- Substantiate label information on seed lots in the marketplace.
- Prevent introduction and dissemination of noxious weed pests via contaminated seed lots moving into California.
- Provide required seed quality and phytosanitary testing for seed export.
- Serve as a repository for seed and fruit specimens and associated literature used for morphological identification.
- Serve as a resource of scientific expertise in seed identification, seed physiology and seed quality assessment for the Department and the seed industry.

### Background

The Seed Laboratory identifies and evaluates seed samples and other plant propagules submitted by Department representatives (primarily through the Pest Exclusion Branch), seed producers and distributors, commercial and private laboratories, other state and federal agencies, academic institutions and private citizens. The laboratory is considered an impartial authority and information provided is often utilized in resolving contract disputes among seed trade parties.

The Seed Laboratory consists of two sections (Seed Taxonomy and Seed Physiology) and the majority of the samples required processing through both sections of the laboratory. In the Seed Taxonomy Laboratory, scientists identify seed, fruit and other plant propagules; examine quarantine and border stations samples for contamination by noxious weed pest propagules; evaluate the quality of seed lots for labeling purposes; examine seed lots in the marketplace for component label integrity; and inspect feed mill samples for weed seed contaminants. The Seed Physiology Laboratory scientists perform germination and viability evaluation of seed lots for labeling purposes; examine seed lots for germination label integrity; determine viability of weed seed contaminants for feed mill approval; and perform biochemical and seed vigor assessment procedures to detect structural damage of the seed that may result in seedling abnormalities indicating the potential for crop failure in the field.

Seed Laboratory scientists conduct research, either individually or in cooperation with scientists from other laboratories, to improve methods for laboratory testing of seed. Many of the methods used throughout North America today are the result of such work.

In addition to required academic degrees, scientists in the Seed Laboratory have obtained professional certifications in the field of seed technology through the following organizations: the Association of Official seed Analysts (AOSA), the Society of Commercial Seed Technologists (SCST) and the International Society of Seed Technologists (ISST).

## 2006 SEED LABORATORY SAMPLE WORKLOAD

The staff of the Seed Laboratory of the Plant Pest Diagnostics Center consists of five Seed Botanists, two Agricultural Biological Technicians, one Senior Laboratory Assistant and additional support from temporary, part-time Scientific Aides. During 2006, approximately 65 percent of the workload consisted of seed quality assessment testing, seed/fruit identification and professional consultations, 25 percent was devoted to laboratory quality assurance (i.e., equipment maintenance and calibration, database entry, document preparation, database management, Q.A. system development, seed herbarium curation, etc.) and 10 percent was devoted to professional enhancement activities (i.e., research, professional meeting attendance, workshop and seminar presentations, professional organization committee work, etc.).

### Types of Samples Processed by the Seed Laboratory

The numbers of samples processed and tests completed during 2006 for each sample type are indicated in Table 1. The percentages of tests completed for each sample type are shown in Figure 1. The types of samples routinely processed by the Seed Laboratory include:

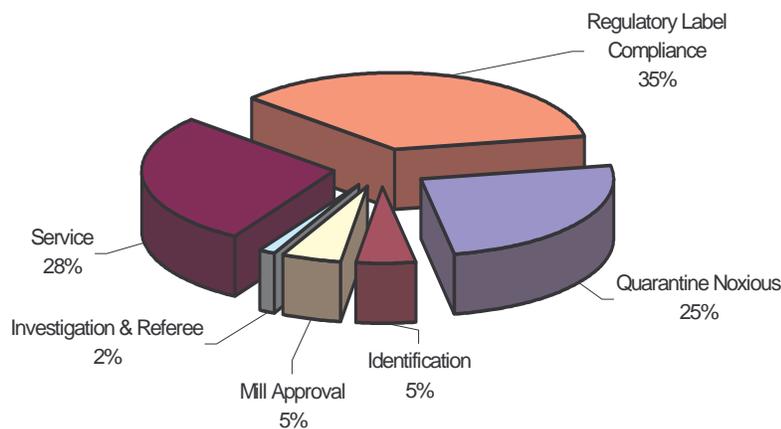
- **Quarantine** – Tests on quarantine samples require examination of a minimum of 25,000 seed units from each submitted sample to detect the presence of noxious weed seeds. Quarantine samples are drawn from seed lots moving across state and county lines and are an important part of the pest exclusion programs.
- **Regulatory** - Tests on regulatory label compliance samples include a noxious weed seed examination of 25,000 seed units, a purity analysis on 2,500 seed units, and a germination test of 400 pure crop seed, from each submitted sample to determine label integrity. Laboratory procedures used for these tests are those prescribed in the Federal Seed Act. The noxious weed seed examination is similar to that of a quarantine test. The purity analysis determines the physical composition of a seed sample and consists of separation of the pure crop seed kind or kinds (in the case of mixtures of 2 or more species) under consideration from the following contaminants: inert matter, other crop seeds and weed seeds. The components are reported as percentages based on weight, and all contaminating species are identified. The germination test estimates the percentage of normal seedlings a seed lot can produce. Four hundred seed units are planted on various types of artificial media, and are subjected to various environmental conditions deemed appropriate for the species being tested, in an effort to determine the number of normal seedlings produced under optimum conditions. Laboratory results from the noxious weed seed examination, purity analysis, and germination test are compared to the seed lot label; if the results are determined to be out of tolerance with the seed lot label, appropriate action is taken by State regulatory officials under the Nursery, Seed and Cotton Program.
- **Service** – Tests on service samples include examinations similar to those described for regulatory tests, as well as specialized tests based on client needs. Service samples are processed on a fee for service basis. The test results are reported directly to the client on certificates of analysis and are confidential. These types of documents are the basis for seed commerce throughout the world. Laboratory procedures used in service testing follow those prescribed in the Federal Seed Act, the Association of Official Seed Analysts Rules for Testing Seed, the International Seed Testing Association Rules for Seed Testing and the Canadian Methods and Procedures for Testing Seed. Results of these tests may also be used for resolving contractual disputes.

- **Feed Mill Approval** – To prevent the spread of weed seeds throughout the state, feed mill certification is dependent upon devitalization of all weed seed contaminants in livestock feed. This is usually achieved when seeds that will be used as feed (e.g., oats, wheat, corn, barley, etc.) are subjected to one or more treatments, such as high temperature, crushing or grinding. Feed mill approval tests include the removal, identification and viability determination of all weed seed found in processed livestock feed samples.
- **Identification** - These samples include identifications of specimens submitted to the laboratory by border stations, counties, other government agencies, commercial seed laboratories, medical doctors, veterinarians, archaeologists and other researchers. These identifications are not only critical in preventing the spread of hazardous weeds, but are often necessary for expediting importation and exportation of agricultural products, are required as evidence in criminal court cases, are necessary for medical and veterinary diagnoses of poisoning cases and provide valuable information for researchers in a variety of scientific fields.

**Table 1.** Total number of samples processed and tests completed by the Seed Laboratory in 2006 for each sample type. Each sample received may require more than one test.

Type of Sample	# Samples completed	# Tests completed
Quarantine Noxious	1448	1448
Identification	260	294
Mill Approval	98	281
Investigation & Referee	91	91
Service	608	1616
Regulatory Label Compliance	688	2061
TOTALS	3193	5791

**Figure 1.** The percentages of tests completed by the Seed Laboratory in 2006 for each sample type. Pie areas represent percentages of the numbers of samples completed, not the time required to complete each type of sample.

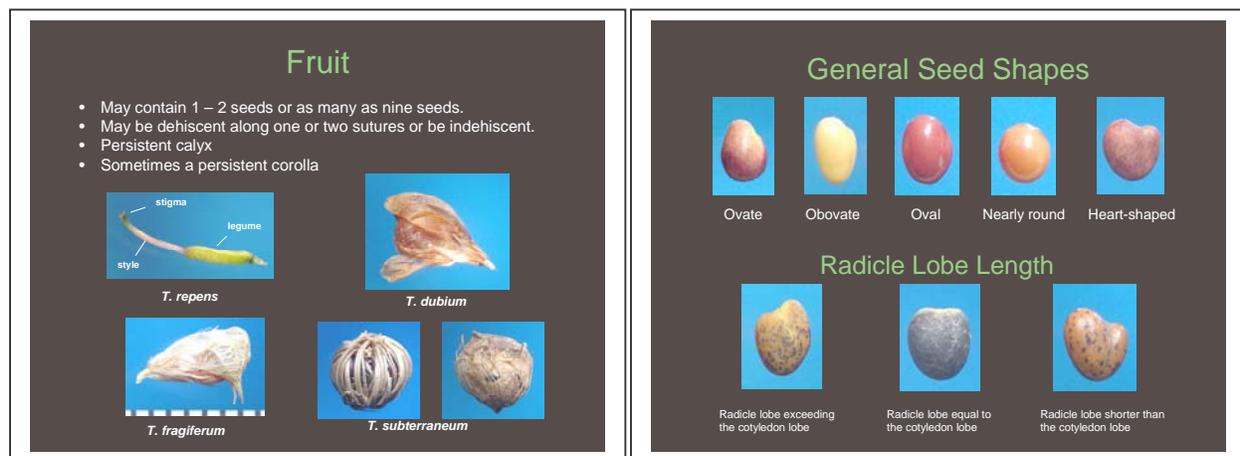


## TRAINING ACTIVITIES

Seeds are the propagules and reservoirs of plant germplasm that farmers rely upon. Scientists involved in seed lot quality assessment must possess an array of skills and knowledge in the areas of purity and germination testing, seed vigor and genetic purity testing. Laboratory analyses serve as the basis for seed trade and thus the exchange of billions of dollars in seed sales globally. Standardization of laboratory test procedures is key to the success of the seed industry. With the goal of promoting standardization among seed testing laboratories, providing training via workshops and supervision of individualized training programs in the field of seed technology is one of the missions of the CDFA Seed Laboratory. Many individuals that have received training from the CDFA Seed Laboratory staff have become Registered Seed Technologists (RSTs) following passage of a nationally administered examination.

The CDFA Annual Seed Workshop was held in conjunction with the 2006 California Seed Industry Conference, May 17 – 19. The workshop highlights included presentations on Asteraceae (Sunflower family) seed unit definitions; a proposed new method for General seed blower calibration; the seed laboratory and seed industry of Lebanon; discussion of AOSA Rules change proposals; and hands-on experiences with the germination of large seeded legumes (beans, peas, cowpeas, horsebean, etc.), identification of *Allium* (onions and garlics) seeds and small seeded legumes (alfalfa, clovers, crown vetch, lespedezas, medics, sourclover, sweetclover, and trefoils).

Workshop participants received various publications produced by the Seed Laboratory staff containing valuable information and personal observations on seed and fruit identification, seedling morphology, seedling abnormalities and quality evaluations. These publications contained diagnostic keys and more than 180 color photographs and illustrations highlighting key structures of seeds, fruits and seedlings critical for seed quality assessment.



Excerpts from the PowerPoint show on seed and fruit morphology in the Fabaceae.

In June, Seed Laboratory staff members participated in the Seed Issues Forum at the AOSA/SCST Annual Meeting, in Indianapolis, Indiana. Their poster presentation was on seed morphology of various noxious weed species of nightshades, groundcherries and dodders. Special emphasis was given to *Cuscuta japonica*, Japanese dodder and other dodder seed products being imported into the United States.



CDFA Seed Laboratory display during the Seed Issues Forum at the AOSA/SCST Annual Meeting, in Indianapolis, IN.

Compressed cakes of dodder seed are used in traditional Chinese medicine. Dodder seed imported into the U.S. must be devitalized before entry. In recent months the Seed Laboratory has received numerous samples of dodder cakes and raw dodder seed to confirm devitalization. Several of the samples have contained viable seed as determined by tetrazolium viability (a rapid biochemical test that indicates live tissue) and germination tests.



Compressed dodder cake package label (l.), compressed dodder cake imported from China (r.).



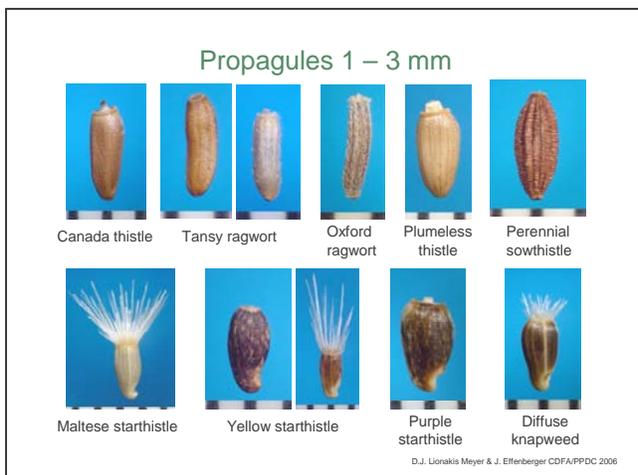
In the laboratory the dodder cakes are fragmented with a hammer and individual intact seeds are planted on blotter paper in a petri dish and placed in a germination chamber at 20°C. If the seed is viable a seedling should emerge after several days. Under laboratory conditions the seedling will live a short while, but will eventually die because as a parasitic plant it must rely on a host plant to obtain water and nutrients.



The red stained embryo tissue indicates a positive tetrazolium viability test of *Cuscuta* seed from imported dodder cake.

Scientists from the Plant Pest Diagnostics Center traveled to the sixteen CDFA Pest Exclusion Border Stations throughout California in August, September and October to provide agricultural pest (insect pests, weed seed pests, and plant diseases) identification training to border station personnel. Seed Laboratory staff provided training on weed seed and fruit identification. The Seed Laboratory prepared a draft version of a new noxious weed seed identification manual, containing hundreds of color photographs representing the 148 quarantine weed pests of interest in California. At each training session an explanation of how to use the new identification manual as a screening tool was made and each border station was presented a copy of the draft manual. The completed manual should be ready in early 2007.

In addition, specialized training was provided on digital photographic techniques of insect and seed specimens. Digital imaging is part of the new program in which high-quality digital images of suspect agricultural pests found during commodity inspections are taken by border station personnel and e-mailed to laboratory scientists for identification. Commodities can be held at the border stations until identifications are made. Preliminary identifications based on digital images can be made within minutes and shipments can either be cleared for entry or rejected. When fully implemented the digital imaging program will significantly improve the border station screening of commodities by eliminating costly delays in entry clearance associated with mailing specimens to the laboratory for initial identifications.



At left is an example from the size comparison portion of the California Noxious Weed Seed Identification Manual, where border station inspectors can make a rapid preliminary assessment of a suspected noxious weed pest based on size.

At right is an example from the detailed seed and fruit description portion of the California Noxious Weed Seed Identification Manual. Once a preliminary assessment has been made, inspectors can utilize this information as a guide of how best to capture digital images of a suspected noxious weed pest to be sent to the Seed Laboratory, via e-mail, for identification.

*Chorispora tenella* (Pall.) DC.  
Purple mustard

- Brassicaceae (mustard family).
- Fruit shatters into segments at maturity.
- Propagules include seed and one-seeded fruit segments.
- Seeds ca. 1 mm wide, 1.25 – 2 mm long, yellow-orange in color.
- Fruit segments straw-colored, dorsal side smooth, ventral side rough; caution: segments look like a stem fragments.
- **B-rated.**
- **Restricted Noxious Weed Seed.**

Mature fruit shattering into one-seeded segments.

Dorsal side

Ventral side

Seeds not typically found outside of fruit segments.

D.J. Lionakis Meyer & J. Effenberger CDFA/PPDC 2006

## SEED HERBARIUM

California has a diverse business and cultural environment and because of this new plant species from all points of the globe are either purposefully or accidentally brought into the state every year. Established in 1920, the CDFA Seed Herbarium serves as the repository for the second largest seed and fruit collection of this kind in the United States. Although originally intended to primarily house specimens of common agricultural crops and weeds, the collection has grown considerably since its establishment into a collection of worldwide coverage. The collection serves as the morphological reference base for all seed and fruit identification performed by our staff. The Seed Herbarium also serves as a valuable tool to visiting seed researchers and archeologists.

During 2006 two large collections were donated to the Seed Herbarium. International renowned botanist, and co-founder of the Cucurbit Network, Dr. Deena Decker-Walters donated her extensive worldwide collection (1000+ seed specimens) and field collection journals of the cucurbit family (Cucurbitaceae). Craig Dremann, owner of Redwood City Seed Company, donated approximately 1,000 seed specimens representing 130 taxa. These specimens are primarily of the grass family (Poaceae).

## SERVICE TO PROFESSIONAL SCIENTIFIC ORGANIZATIONS

Dr. Riad Baalbaki – Associate Seed Botanist

- Chairperson – Germination and Dormancy Subcommittee of the Research Committee, Association of Official Seed Analysts (AOSA), 2006
- Member-Statistics Subcommittee of the Research Committee, AOSA, 2006
- Member-Seed Pathology Subcommittee of the Research Committee, AOSA, 2006

Jim Effenberger – Senior Seed Botanist

- Member – Executive Board, AOSA, 2005 – present
- Chairperson – Bylaws Committee, AOSA, 1995 – present
- Chairperson – Ethics Committee, Society of Commercial Seed Technologists (SCST), 2003 – present
- Member – Purity Testing Subcommittee of the Research Committee, AOSA, 1994 – present

Deborah Meyer – Senior Seed Botanist, Supervisor

- Associate Editor – Seed Technology, jointly published by the AOSA and the SCST, 2001 - present
- Chairperson – Rules Committee, AOSA, 2001 – 2006
- Chairperson – Purity Subcommittee of the Research Committee, AOSA, 1994 – present
- Member – Seed Testing Standardization and Research Funding Committee, AOSA, 2001 – 2006
- Member – Purity Committee, International Seed Testing Association (ISTA), 1995 – present
- Member – Rules Committee, ISTA, 2005 – 2006
- Member – Registered Seed Technologist Board of Examiners, SCST, 2002 – present
- National Plant Board Representative – National Seed Health System – Seed Testing Working Group, 2000 – present
- Member, Community Advisory Council of the College of Natural Sciences and Mathematics, California State University, Sacramento, 2005 – present.

## **AEGILOPS SPECIES FROM SEMI-ARID AREAS OF LEBANON: VARIATION IN QUANTITATIVE ATTRIBUTES UNDER WATER STRESS**

R. Baalbaki, N. Hajj-Hassan and R. Zurayk  
*Crop Science* 46: 799-806 (2006)

The genus *Aegilops* (Poaceae) is an important genetic resource for bread (*Triticum aestivum* L.) and durum (*T. turgidum* L.) wheat improvement (Hegde et al., 2002; Zaharieva et al., 2003). *Aegilops* species adapted to growth under limited water availability in semi-arid areas are therefore a potential reservoir of genes for improving drought tolerance of cultivated wheats. Many *Aegilops* species are noxious weeds, especially outside their area of origin. *Ae. cylindrica* is a noxious annual weed in winter-wheat growing areas of the western United States, and *Ae. triuncialis* is a noxious weed in Northern and Central California rangelands (Donald and Ogg 1991). Therefore, in addition to their contribution to wheat improvement, studying the genetic structure, adaptation and patterns of growth of *Aegilops* species may lead to more efficient ways of their control as weeds.

*Aegilops* genetic resources have been successfully exploited to improve disease resistance in wheat (Thiele et al., 2002), but little use has been made of them for physiological improvement (Skovmand et al., 2001). Evaluating quantitative traits can provide the background against which genetic as well as qualitative phenotypic variation is compared. Valuable insight into the processes determining the phenotype, similar adaptation patterns, presence of useful genes, as well as evolutionary and taxonomic significance can be gained by studying the sources and extent of quantitative variation under drought stress (Pfenninger and Magnin, 2001).

The objectives of this investigation were to evaluate drought tolerance of several *Aegilops* species, to study the structure and extent of variation in quantitative attributes of those species when subjected to different degrees of water stress, and to identify quantitative attributes that can be used in evaluating *Aegilops* germplasm for breeding purposes.

### **MATERIALS AND METHODS**

Seeds from 21 populations of six *Aegilops* species (*Ae. biuncialis*, *Ae. cylindrica*, *Ae. geniculata*, *Ae. markgrafi*, *Ae. triuncialis* and *Ae. vavilovii*) were collected from 14 locations representing typical variation within semi-arid regions of Lebanon. A single patch of conspecific individuals separated from other individuals of the same species by more than 100 m was considered as one population. Seed samples from each population consisted of bulked seed from one spike collected from each of 20 plants at least 1-m apart. Quantitative attributes, namely plant dry weight, plant height, number of tillers per plant, days to maturity, productive tillering capacity, spike length, seed number per plant, number of kernels per spike, seed weight per spike and total yield per, were evaluated in the greenhouse at three soil moisture levels: no, moderate, or severe stress. The no stress treatment consisted of maintaining the soil at a field capacity of 100%, the moderate stress treatment consisted of maintaining field capacity at 75% and the severe stress treatment was achieved by maintaining field capacity at 50%

### **RESULTS AND DISCUSSION**

To facilitate the interpretation of results, quantitative attributes were divided into two groups, vegetative growth attributes (days to maturity, plant height, tiller number and above-ground dry weight) and reproductive attributes (productive tillers, kernels per spike, seed number, spike length, seed weight per spike and yield). Grouping

quantitative traits proved to be an effective way of identifying tolerant germplasm. Two drought tolerant species were identified, *Ae. geniculata* and *Ae. markgrafii*. Based on changes in vegetative attributes with increasing water stress, *Ae. geniculata* appeared to be the most drought tolerant species. Its vegetative attributes, especially above-ground dry weight, were the least affected by severe water stress (Table 1). Vegetative growth of all species was largely unaffected by moderate water stress, with no reduction in above-ground dry weight for any of the species except *Ae. triuncialis* (Table 1), reflecting the species' adaptation to semi-arid environments with limited water availability. However, above-ground dry weight of all species significantly declined under severe stress. Our results indicated that the decrease in biomass under drought was associated with plant height rather than tiller number, and height is therefore a better indicator than tiller number for drought tolerance of *Aegilops* species.

Based on changes in reproductive attributes under increasing water stress, *Ae. markgrafii* appeared to be drought tolerant and none of its reproductive attributes were affected by stress level (Table 1). In contrast, all reproductive attributes of *Ae. cylindrica* were significantly reduced with increased moisture stress, indicating its low tolerance to drought. In contrast to cultivated wheat, which shows a positive correlation between biomass and yield, we found no correlation between above-ground dry weight and yield of the six *Aegilops* species. This was probably because biomass was mainly dependent on height, an attribute unrelated to either yield or its components.

Plant height, seed weight, seed number and productive tillers were the most useful single traits for inclusion in a set of selection criteria for drought tolerance. However, a better approach to screening wild species would be to identify groups of traits (equivalent to new variables) with the highest contribution to overall variation under different water stress conditions. Based on our results, two new variables were identified and should be considered in selection programs aimed at yield stability under drought stress, a 'seed yield' variable and a 'tiller' variable. While the 'seed yield' variable, composed of seed number and weight, was a more important factor to consider under conditions of adequate moisture, the 'tiller variable', which included number of total and productive tillers, proved to be of higher relevance as a selection criterion under conditions of drought stress. Under severe water stress, the ability of plants to produce fertile tillers with few large seeds was identified as a distinguishing characteristic that should be considered in evaluating plants for drought tolerance.

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Table 1. Effect of water stress levels on plant attributes of six *Aegilops* species.

Attribute <sup>†</sup>	WSL <sup>‡</sup>	Species					
		<i>Ae. biuncialis</i>	<i>Ae. markgrafii</i>	<i>Ae. cylindrica</i>	<i>Ae. geniculata</i>	<i>Ae. triuncialis</i>	<i>Ae. vavilovii</i>
PDW (g)	1	15.79a <sup>§</sup>	13.13a	11.55a	10.61a	16.22a	13.80a
	2	13.27a	10.02ab	13.74a	8.78ab	12.45b	10.89ab
	3	8.20b	6.34b	6.75b	7.78b	9.66b	7.81b
PLH (cm)	1	46.75a	43.17a	47.83b	38.73a	47.97a	54.16a
	2	47.77a	40.33a	60.75a	35.97a	50.69a	46.31ab
	3	37.79b	44.58a	37.50c	37.08a	43.53b	40.00b
TNT	1	32.6a	30.2a	27.0a	29.6ab	25.1a	27.4a
	2	22.5a	27.8a	20.3a	35.4a	26.1a	18.1b
	3	21.2b	26.3a	23.0a	28.3b	21.1b	19.1b
DTM	1	175.5b	143.8b	137.7a	164.5a	167.1b	137.1a
	2	185.5ab	165.3a	137.0a	172.7a	165.6b	142.1a
	3	200.1a	162.5a	143.2a	178.8a	183.7a	136.7a
PTC	1	25.3a	24.0a	24.3a	21.9b	18.5a	24.2a
	2	15.3b	21.8a	18.7ab	30.8a	17.1a	13.9b
	3	17.7b	20.6a	14.8b	24.6ab	19.4a	12.8b
SLE (cm)	1	2.91b	8.13a	7.33a	2.11b	4.87a	7.48a
	2	2.98b	6.53a	6.82ab	2.24ab	5.29a	6.08a
	3	3.87a	7.39a	6.07b	2.37a	4.73a	6.58a
SNP	1	132.8a	189.2a	152.7ab	233.3a	107.0b	153.3a
	2	70.3b	146.6a	226.7a	157.1b	191.3a	85.1b
	3	81.1b	174.2a	61.5b	158.1b	132.5ab	91.9b
KPS	1	3.5a	6.7a	6.0ab	3.2a	4.4a	9.8a
	2	2.6b	5.7a	8.1a	3.2a	4.7ab	7.8ab
	3	3.9a	6.1a	4.8b	3.3a	5.5a	6.4b
SWS (g)	1	1.150a	1.243a	2.548a	2.265a	0.957a	2.116a
	2	0.742b	1.147a	1.940ab	1.550b	1.382a	1.023b
	3	0.702b	1.350a	0.823b	1.631b	1.060a	1.158b
YLD (g)	1	34.60a	34.69a	71.48a	60.56a	28.89a	63.31a
	2	17.64b	31.18a	36.88b	52.88ab	27.63a	15.33b
	3	14.24b	30.58a	14.07c	41.43b	30.12a	17.90b

<sup>†</sup> PDW: plant dry weight; PLH: plant height; TNT: number of tillers per plant; DTM: days to maturity; PTC: productive tillering capacity; SLE: spike length; SNP: seed number per plant; KPS: number of kernels per spike; SWS: seed weight per spike; YLD: total yield per plant.

<sup>‡</sup>Water stress levels. 1: no stress control; 2: moderate stress; 3: severe stress.

<sup>§</sup>Means in each column, for each attribute, followed by the same letter, are not significantly different at  $p \leq 0.05$ .

# ENTOMOLOGY

## ENTOMOLOGY LABORATORY STAFF

### **SYSTEMATISTS**

CHARLES BELLAMY, SUPERVISOR  
MATTHEW BUFFINGTON  
ANDREW CLINE  
MARC EPSTEIN  
ERIC FISHER  
STEPHEN GAIMARI, PROGRAM SUPERVISOR  
ROSSER GARRISON  
MARTIN HAUSER  
PETER KERR  
JOHN SORENSEN  
GILLIAN WATSON  
SHAUN WINTERTON

### **TECHNICAL STAFF**

SARAAH KANTNER  
SCOTT KINNEE  
RANDALL PLANT  
RAMONA RANDOLPH  
MARY-JEAN SAWYER

### **EMERITUS SCIENTISTS**

FRED ANDREWS  
RAYMOND GILL

### **AGRICULTURAL/SCIENTIFIC AIDES**

MIA BELLANTE  
HARMEET BOPARAI  
JENNY CHAU  
ROBERT COPSEY  
CLARISSA DEVEREL  
RACHEL GUZZETTA  
RAMON JACKSON  
WEI-MIN LI  
KARA NOYES  
DOMINIQUE OROZCO  
ERNIE RIBERAL  
OBIE SAGE  
JO VIRAY  
STEVE VU  
SCOTT WHITE  
DENNIS WHITLEY  
PATRICK WOODS

## ENTOMOLOGY LABORATORY OBJECTIVES

The primary objectives of the Insect Biosystematics Laboratory are to:

- Provide identification services to the Division's pest prevention programs, other government agencies, and the public in an accurate and timely fashion.
- Act as a reference repository for specimens and any associated data available for arthropods and mollusks of the State and region.
- Conduct research in biosystematics.
- Assist personnel in other agencies with problems related to insects and other arthropods and mollusks.

The laboratory evaluates and identifies insects and related arthropods and mollusks submitted by a variety of agency representatives. The most frequent clients are county agricultural commissioners, pest prevention branches, agricultural extension representatives, industry, universities, federal agencies and the public. Communication with scientists worldwide is essential to ensure a cooperative exchange of information and services. Identifications under routine conditions are usually made within two and one-half days of receipt and processing. Samples submitted as "RUSH" are normally processed in less than four hours. During periods when large numbers of samples are being processed, priority is given to samples that involve quarantine shipments likely to be held for inspection. This laboratory is the primary support unit for the state's eradication, control, survey, and biological programs involving injurious pests, including (but not limited to) exotic fruit flies, leaf-mining and other flies, Glassy-winged sharpshooter and other leafhoppers, Africanized honey bee, Red Imported fire ant, Asian longhorn beetle and other wood boring beetles, weevils and leaf beetles, Japanese beetle, European and Asian gypsy moths and various other moths, numerous scales, whiteflies and mealybugs, fleas, ticks, mites, spiders, snails, and many other domestic and exotic pests.

Identifications and services to agencies other than the county and state include: universities; other state departments of agriculture; USDA-ARS, USDA-APHIS, the US Forest Service, the US Fish and Wildlife Service and other federal agencies; museums; faunal inventories and surveys; private industry and the general public.

## NEW SPINY STRUCTURES FOUND ON THE NETTLE CATERPILLAR MOTH, DARNA PALLIVITTA

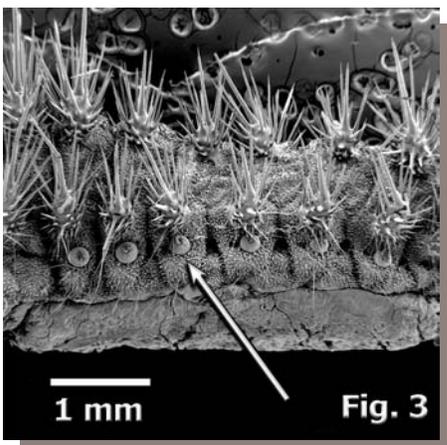
Marc E. Epstein



The nettle caterpillars of the moth family Limacodidae, as their name implies, are known for stinging spines that cause dermatitis. These spines are usually borne on two rows of fingerlike projections referred to as scoli or warts down the length of each side of the body (Fig. 1). Currently the big island of Hawaii is experiencing an outbreak of a nettle caterpillar, *Darna pallivitta*, on over 40 different plants including a number of palms (see plant damage in Fig. 2) and a number of complaints from people with burning rashes. It is believed that this invasive species was imported on potted palms from Taiwan (Nagamine & Epstein, in press). Over the past three years the Plant Pest Diagnostics Lab has received numerous caterpillars and cocoons of *D. pallivitta* after being intercepted in California on a variety of cut flowers, potted palms and *Dracaena*. It is now considered an A-rated pest.

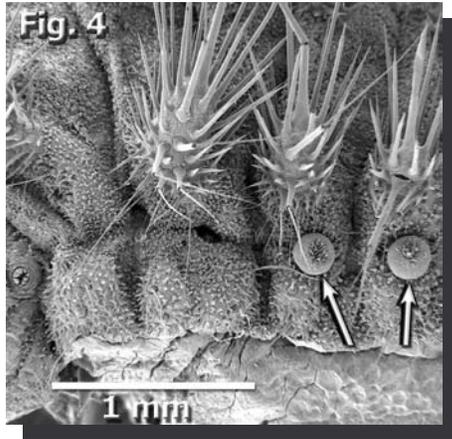


In 2006 I received several live caterpillars of *D. pallivitta* from a shipment of pygmy date palms as I was completing a scientific manuscript on this insect with my colleague Walter Nagamine from the Hawaii Department of Agriculture. The publication on the biology and description of the life stages of this species will appear in an upcoming issue of Pan-Pacific Entomologist. Upon viewing the caterpillars under low magnification of the microscope I observed small, spiny warts, referred to as SD2, located next to the spiracles, the tiny oval openings to an insect's tracheal breathing system (Figs. 3-4). These structures were not previously reported for nettle caterpillars in the literature, including those of *D. pallivitta*.



Caterpillars of moths and butterflies commonly have four or five stages, shedding their skin an equal number of times before they pupate, whereas in nettle caterpillars this typically occurs seven or eight times. In the quarantine facility at Hawaii Department of Agriculture in Honolulu, Nagamine found that *D. pallivitta* has up to 11 stages and

preserved each in alcohol. After discovering the new structures on full-grown caterpillars, I examined the larval stages 3 to 11 because earlier examination by electron microscope of the first two stages did not show them to be present. I found that the warts do not appear until the 6<sup>th</sup> stage and on only three segments. Additional warts are added on three more segments by the final stages. This is the first report of this type larval change in the Limacodidae, and perhaps in Lepidoptera in general. In earlier publications I have shown how structures can suddenly appear in later stages of caterpillars in Limacodidae and in their closest relatives the Dalceridae, but these have either involved the losses of warts following the first stage, the addition of hooks on the undersurface of the abdomen in late stages, or shape changes in the silk-spinning apparatus (= spinneret) (Epstein, 1996).



In the future it will be interesting to see whether a similar metamorphosis occurs in other *Darna* species or in other genera of Limacodidae. It is clear that to be able to see these structures, direct examination is needed rather than relying on normal caterpillar images in the literature or on the Internet. Perhaps the occurrence of these spiny structures and their late appearance in larval development will give useful clues on the historical relations between the *Darna* and other limacodid genera. A better understanding of these relationships can lead to better decision making on future biological-control agents for invasive species, such as *D. pallivitta*.

#### References cited:

Epstein, M.E. 1996. Revision and phylogeny of the limacodid-group families, with evolutionary studies on slug caterpillars (Lepidoptera: Zygaenoidea). *Smithsonian Contributions to Zoology*. No. 582. 102 pp. Washington D.C.: Smithsonian Institution Press.

Nagamine, W.T. and M.E. Epstein. (in press). Chronicles of *Darna pallivitta* (Moore 1877) (Lepidoptera: Limacodidae): biology and larval morphology of a new pest in Hawaii. *Pan-Pacific Entomologist*.

#### Caption:

Figures 1-2. Caterpillar and plant damage caused by *Darna pallivitta* (photographs by W. Nagamine).

Figures 3-4. SD2 spiny warts found on the 8<sup>th</sup> stage of *Darna pallivitta*, previously unknown in spiny caterpillars of the Limacodidae (electron micrographs by S. Kinnee).

## SYSTEMATICS OF THE BUPRESTOIDEA LEACH, 1815 (COLEOPTERA): PROGRESS REPORT FOR 2006

C. L. Bellamy  
Plant Pest Diagnostics Center

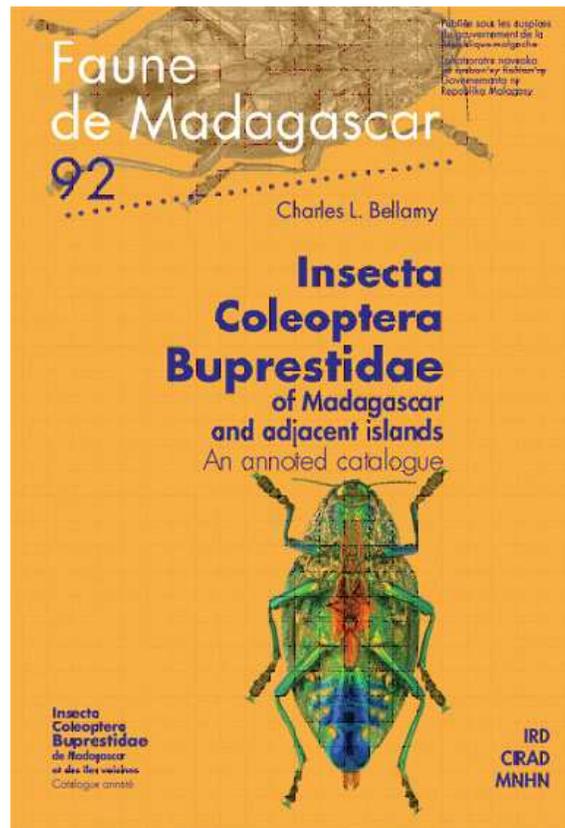
As detailed in the 2005 PPDC annual report, my research on jewel beetles (Coleoptera: Buprestidae) continues in several of the main themes:

### 1. The Madagascan Coraebini

([www.fond4beetles.com/Buprestidae/MadCor/intro.html](http://www.fond4beetles.com/Buprestidae/MadCor/intro.html))

The long-planned catalogue of Madagascan Buprestidae was published in September, 2006:

Bellamy, C. L. 2006. Insecta Coleoptera Buprestidae de Madagascar et des îles voisines, catalogue annoté. [Insecta Coleoptera Buprestidae of Madagascar and adjacent islands, an annotated catalogue]. *Faune de Madagascar* **92**:vi + 7-263 pp., 8 color plates.



### 2. The Buprestidae of Mexico

([www.fond4beetles.com/Buprestidae/Mexico/index.html](http://www.fond4beetles.com/Buprestidae/Mexico/index.html)) Two trips were taken to Mexico: Baja California 10-19 September and southern Mexico (Oaxaca, Puebla) from 13-22 October, 2006.

**New taxa proposed during 2006:**

- Acmaeodera obrienorum* Bellamy, 2006 – Jamaica  
*Austrochalcophora*, new genus, Bellamy, 2006 - Australia  
*Compsoglypha nigrocaerulea* Bellamy, 2006 – Madagascar (Figs. 6-8)  
*Dactylozodes* (*Nelsonozodes*), new subgenus, Bellamy & Moore, 2006  
*Gracilocala*, new genus, Bellamy, 2006 – Madagascar  
*Gracilocala bicolor* Bellamy, 2006 – Madagascar (Figs. 9-11)  
*Ivalouwayneia*, new genus, Bellamy, 2006 – Madagascar  
*Ivalouwayneia ruficapiticauda* Bellamy, 2006 – Madagascar  
*Madaphlocteis*, new genus, Bellamy, 2006 – Madagascar  
*Madassetia*, new genus, Bellamy, 2006 – Madagascar  
*Madassetia bicolor* Bellamy, 2006 – Madagascar (Figs. 1-3)  
*Madassetia unicolor* Bellamy, 2006 – Madagascar (Figs. 4-5)  
*Malagascoders*, new genus, Bellamy, 2006 – Madagascar  
*Paranastella viridis* Bellamy, 2006 – Madagascar  
Trichinorhipidina, new subtribe, Bellamy, 2006



### 3. The World Catalogue of Buprestoidea

([www.fond4beetles.com/Buprestidae/WorldCat/intro.html](http://www.fond4beetles.com/Buprestidae/WorldCat/intro.html))

The page-formatted catalogue files currently stand at near 3600 pages and is complete, with the index complete. Several significant monographs or regional catalogues were published in 2006 and have been added. The effort to complete this catalogue has resulted in the following publication:

Bellamy, C. L. 2006. Nomenclatural notes and corrections in Buprestidae (Coleoptera). *The Pan-Pacific Entomologist* **81**(3/4):145-158.

The International Commission of Zoological Nomenclature in 2006 published one new application and one comment on another case:

Bellamy, C. L. 2006. Case 3366. *Cisseis* Gory & Laporte de Castelnau, 1839 and *Curis* Gory & Laporte de Castelnau, 1838 (Insecta, Coleoptera): proposed conservation. *Bulletin of Zoological Nomenclature* **63**(4):247-250.

Bellamy, C. L. 2006. Comment on the proposed fixation of the feminine gender of the genus *Trachys* Fabricius, 1801 (Insecta, Coleoptera) and the form of derivation of family-group names based on *Trachys*. *Bulletin of Zoological Nomenclature* **63**(4):273-274.

### 4. Beetle Tree of Life Project

(<http://insects.oeb.harvard.edu/ATOL>)

This new project was funded by the National Science Foundation in 2005. I am serving as one of the nine Taxonomic Working Group (TWiG) leaders. The first meeting took place at Harvard University January 29 through February 4, 2006.

### 5. Woodboring Beetle LUCID Project

This project was funded by CPHST in 2006 and early progress occurred with the visit of Amanda Evans, Harvard University, during the fall months for her to learn general buprestid morphology and for us to begin our collaboration generating an interactive key to the 509 buprestid genera of the world.

### 6. Miscellaneous Publications

Curletti, G. & C. L. Bellamy. 2006. Nomenclatural notes on the genus *Agrilus* Curtis, 1825 (Coleoptera, Buprestidae). *Lambillionea* **106**(1):53-55.

Bellamy, C. L. 2006. Studies on the Australian Chalcophorini: a new genus for *Chalcophora subfasciata* Carter, 1916 and a review of the *Pseudotaenia* Kerremans, 1893 generic-group (Coleoptera: Buprestidae). *Zootaxa* **1206**:23-46.

Bellamy, C. L. 2006. New synonym in *Pseudhyperantha* Saunders, 1869 (Coleoptera: Buprestidae). *The Pan-Pacific Entomologist* **82**(1):82-85.

Bellamy, C. L. 2006. The systematic position of certain South American buprestid genera (Coleoptera: Buprestidae). *The Coleopterists Bulletin* **60**(2):192-196.

Bellamy, C. L. 2006. A new subtribe for *Trichinorhipis* Barr, 1948 (Coleoptera: Buprestidae). *The Pan-Pacific Entomologist* **82**(2): 140-143.

Bellamy, C. L. 2006. A new species of *Acmaeodera* Eschscholtz, 1829 from Jamaica (Coleoptera: Buprestidae). *The Pan-Pacific Entomologist* **82**(2):250-257.

Bellamy, C. L. & T. Moore. 2006. A replacement subgenus name in *Dactylozodes* Chevrolat, 1838 (Coleoptera: Buprestidae). *The Pan-Pacific Entomologist* **82**(2): 160-165.

## SCALES, MEALYBUGS, WHITEFLIES AND THRIPS, 2006

Gillian W. Watson

### Identifying unknown species

In January an undescribed thrips species was collected in Orange County, causing severe distortion of young leaves of *Myoporum* in landscape plantings. It was tentatively identified as *Teuchothrips* sp. This insect is new to California, and is spreading; subsequent samples have been collected in Santa Barbara, Los Angeles and Ventura Counties. It causes significant damage to young growth of amenity plantings of *Myoporum* along freeways. Dr Laurence A. Mound (Commonwealth Scientific and Industrial Research Organization, Canberra, Australia) has found that the species is native to Australia, and is currently describing it in a new genus.

In April, populations of a mealybug from San Luis Obispo County caused concern because they showed morphological variation bridging the range of variation of two similar species, *Planococcus citri* (present in California) and *P. minor* (which does not occur here). Samples were sent to Drs Dug Miller and Alessandra Rung at the USDA-ARS Systematic Research Laboratory in Beltsville, MD, for inclusion in their preliminary DNA study of this species complex. These populations were characterized as *P. citri*, but this incident highlighted the difficulties involved in identifying members of the *P. citri* / *minor* complex using morphology alone. A thorough molecular study of this complex is needed.

While on leave in the UK in November, Gillian visited The Natural History Museum, London (NHM), to exchange specimens of interest between the California State Arthropod Collection and that of the NHM; confer with colleagues; return a loan of *Bemisia* whiteflies; examine specimens of scales, mealybugs and aphids of research interest; and consult rare publications in their Entomology and General Libraries.

### Training activities

The Western Plant Pest and Disease Diagnostic Network (WPDN) held two training workshops, both lead by Gillian Watson and co-coordinated seamlessly by Dr Richard Hoenisch of WPDN. The workshops were well attended and the participants found them relevant and helpful.

The first workshop, "Slide making for identification purposes", was held at the University of Hawaii (Manoa Campus, Oahu), 23-24 January, delivered by Gillian Watson and Ray Gill; 18 participants from the continental US and US Pacific islands attended.

The second WPDN workshop, "Hemiptera: "Homoptera" ", was held at the University of California, Davis, 21-24 March, attended by 30 participants from the continental US and US Pacific islands. The workshop was delivered by experts from the University of Delaware, the Illinois Natural History Survey, USDA-APHIS-PPQ, USDA-ARS, University of California at Davis and CDFA-PPDB (Gillian Watson, Shaun Winterton and Ray Gill).

On 14 March 2006, a group of Agricultural Biologists and Inspectors from San Luis Obispo County Agricultural Commissioners Office visited CDFA-PPDB for training in pest recognition and collection methods. Gillian participated in the entomological training session in the afternoon.

PPDB's John Sorensen, Rosser Garrison, Dan Opgenorth, Timothy Tidwell and Gillian delivered three training sessions for Border Station staff. Mark Stirling of Pest Exclusion co-coordinated the necessary arrangements with great efficiency. The sessions were held at Truckee (15-16 August), Yreka (19-21 September), and lastly at Blythe (3-4 October) and Needles (5-6 October). These training presentations provided an excellent opportunity for exchange of information between biosystematists and inspection staff, fostering better communication and understanding between the two.

### **Research on *Bemisia whitefly* taxonomy**

This work involves an international multidisciplinary group including Ray Gill, Prof. Judy Brown (University of Arizona), Dr George Roderick (University of California at Berkeley) and Gillian, funded by USDA. In such a busy year it was difficult to find time for research, but some progress was made in comparative study of the adult morphology of several different biotypes of the *Bemisia tabaci* group.

### **Presentations**

Gillian presented a CDFA–PPDB seminar on 8 January, entitled “Integrated Pest Management of Cotton in Asia”. She also participated in the CDFA–PPDB Entomology presentations at State Scientists’ Day at the Capitol on 24 May, together with Rosser Garrison, Marc Epstein, Randy Plant and Thomas Manos.

## RESEARCH ON FLIES (DIPTERA)

Stephen D. Gaimari

Steve's research program has covered several groups of flies (Lauxanioidea, Asiloidea, Opomyzoidea), in addition to some work on fleas, and has forged many collaborations, including several foreign scientists. Included in his published (and in press) work in 2006 are papers with Brazilian, Georgian, Greek, Turkish, and American entomologists.

### A. The following papers were published in 2006, with a brief comment for each:

1. Clark, H.O., Jr., H.S. Shellhammer, & **S.D. Gaimari**. 2006. Ectoparasites found on salt marsh harvest mice in the northern salt marshes of Grizzly Bay, California. *California Fish and Game* 92: 52-54.

The salt marsh harvest mouse, *Reithrodontomys raviventris* Dixon (Rodentia: Muridae), is listed as an endangered species by both the federal government and the State of California. There are two subspecies, *R. r. halicoetes* Dixon in the northern marshes of San Pablo, Grizzly, and Suisun bays, and *R. r. raviventris* in the southern arm of San Francisco Bay. Both subspecies are considered to be keystone species in tidal and brackish marsh habitats. Little is known about ectoparasites on the salt marsh harvest mouse, and no flea records were previously known. Through a directed collecting effort, fleas were collected and identified as *Orchopeas leucopus* (Baker) (Ceratophyllidae: Ceratophyllinae), with voucher specimens (1 male, 1 female) placed in the California State Collection of Arthropods. The genus *Orchopeas* has been previously reported from species of *Reithrodontomys*, but not *R. raviventris*.

2. Kaydan, M.B., N. Kiliçer, N. Uygun, G. Japoshvili, & **S. Gaimari**. 2006. Parasitoids and predators of Pseudococcidae (Homoptera: Coccoidea) in Ankara, Turkey. *Phytoparasitica* 34(4): 331-337.

Natural enemies of mealybugs were surveyed at Ankara, Turkey, in 2001-2003. Twenty-three predatory species belonging to the insect orders Coleoptera (Coccinellidae, 17), Diptera (Chamaemyiidae, 3) and Neuroptera (Chrysopidae, 2; Hemerobiidae, 1), and twenty-three parasitoid species belonging to Hymenoptera, Chalcidoidea (Aphelenidae 2, Encyrtidae 15, Pteromalidae 4 and Signiphoridae 2), were determined. The following species are newly recorded for the Turkish fauna, with host information: *Sidis biguttatus* Matschulsky, *Nephus sinuatomaculatus* Sahlberg (Coccinellidae), *Leucopomyia alticeps* Czerny, *Parochthiphila (Euestelia) decipia* Tanasijtshuk (Chamaemyiidae), *Leptomastidea matritensis* Mercet, *Prochiloneurus bolivari* Mercet, *Rhopus* sp. nr. *acaetes* (Walker), *Stematosteres* sp., *Eunotus acutus* Kurdjumov, and *Chartocerus kurdjumovi* (Nikol'skaya) (Chalcidoidea).

### B. The following papers are *in press*, and will likely be published early in 2007:

1. **Gaimari, S.D.** Chamaemyiidae. In Brown, B.V., Borkent, A., Wood, D.M. and Zumbado, M. (ed.), *Manual of Central American Diptera*. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia.
2. **Gaimari, S.D.** Odiniidae. In Brown, B.V., Borkent, A., Wood, D.M. and Zumbado, M. (ed.), *Manual of Central American Diptera*. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia.

3. **Gaimari, S.D.** Three new Neotropical genera of Odiniidae (Diptera: Acalyptratae). *Zootaxa*.
4. **Gaimari, S.D.**, & D.W. Webb. Therevidae. In Brown, B.V., Borkent, A., Wood, D.M. and Zumbado, M. (ed.), *Manual of Central American Diptera*. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia.
5. **Gaimari, S.D.**, & V.C. Silva. Lauxaniidae. In Brown, B.V., Borkent, A., Wood, D.M. and Zumbado, M. (ed.), *Manual of Central American Diptera*. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia.
6. **Gaimari, S.D.**, & W.N. Mathis. World catalog and conspectus of the family Odiniidae (Diptera: Schizophora). *Myia*.
7. **Gaimari, S.D.**, P. Milonas, & C. Souliotis. . [in press]. Notes on the Biology, Taxonomy and Distribution of *Neoleucopis kartliana* (Tanasiytshuk) (Diptera: Chamaemyiidae). *Folia Heyrovskyana*.

### PPDB ENTOMOLOGISTS: GRADUATE STUDENT COMMITTEES

Three of the PPDB entomologists serve or served on graduate student committees (research, exam) or as external examiners in 2006, as follows:

Chuck Bellamy

Angelica Corona, Universidad Nacional Autonoma de Mexico, Mexico

Amanda Evans, Harvard University, Cambridge

Steve Gaimari

Nate Hardy, University of California, Davis

Cory Unruh, University of California, Davis

Shaun Winterton

Cory Unruh, University of California, Davis

Imelda Menchaca Armento, Universidad Autonoma Estado de Hidalgo, Mexico

## PPDB ENTOMOLOGISTS: EDITORIAL RESPONSIBILITIES AND SCIENTIFIC SERVICE

Seven PPDB entomologists served in an editorial capacity for several scientific journals, and provided other service to professional societies, as follows:

Chuck Bellamy

Editor-in-Chief\*: *The Pan-Pacific Entomologist* (2004 – 2007)  
English Language Editor: *Folia Heyrovskyana* (2002 – present)  
Past President: *The Coleopterists Society* (2005 – 2006)

Andrew Cline

Councilor: *The Coleopterists Society* (2006 – 2008)

Marc Epstein

Chairman, Archives and Records Committee, *The Lepidopterists' Society* (2004 – present)  
Lepidoptera Subject Editor: *Pan Pacific Entomologist* (2004 – present)

Steve Gaimari

Diptera Subject Editor: *Annals of the Entomological Society of America* (2001 – present); *The Pan-Pacific Entomologist* (2004 – 2006)  
Editor: *California Plant Pest and Disease Report* (2005 – present)  
Member, Section A subcommittee - Committee on Systematics Resources: *Entomological Society of America* (2005 – present)  
President Elect: *The Pacific Coast Entomological Society* (2006)

Rosser Garrison

Minor Orders Subject Editor: *The Pan Pacific Entomologist* (2004 – present)  
Odonata Subject Editor: *Zootaxa* (2006 – present)  
Editor: *Odonatologica* (1997 – present)

Peter Kerr

Molecular Systematics Subject Editor: *The Pan Pacific Entomologist* (2005 – present)

Shaun Winterton

Minor Orders Subject Editor: *The Pan Pacific Entomologist* (2004 – present)

\* Chuck's involvement continues a long history of CDFA scientists holding this position for the journal of the Pacific Coast Entomological Society, including most recently Ron Somerby, and previously Fred Andrews, Bob Dowell, Tom Eichlin, Alan Hardy, Dick Penrose and John Sorensen.

## CALIFORNIA STATE COLLECTION OF ARTHROPODS: 2006 REPORT

Charles L. Bellamy & Stephen D. Gaimari

The California State Collection of Arthropods (CSCA) is a scientific resource for the local, federal, and international community for research and identification of various groups of arthropods, especially insects. The collection is maintained by the Entomology Lab of the Plant Pest Diagnostics Branch of the California Department of Food and Agriculture, as an integral feature of the identification services provided to the citizens and business interests of the State, and to our peers and colleagues both nationally and internationally. Two curators (the authors) directly supervise the care, use, growth and development of CSCA, encouraging the use of this collection for research on the taxonomy and systematics of arthropod taxa. The web page for the collection is located at the following URL: <http://www.cdffa.ca.gov/phpps/ppd/CSCA.htm>.

The total number of prepared specimens exceeds 1.5 million, with more than 25,000 prepared specimens accessioned in 2006, including the start of an exchange program with the Museo de Ciencias Naturales in Salta, Argentina. With the CSCA's blanket permit to collect arthropods in California's State Park system, several seasonal survey efforts were undertaken, including Grover Hot Springs State Park headed by Peter Kerr, and Big Sur State Park headed by Andy Cline. CSCA's Frozen Tissue Collection has grown by over 500 determined samples from over 200 collecting events. Several holotypes and numerous paratypes were deposited in CSCA in 2006, and the collection has been recognized as an important repository for certain groups of arthropods. While personal examination of types may always be necessary, we plan to add multiple-view close-up digital images to the CSCA web pages for each type we hold. The inventory of the entire collection is nearly complete, so far with over 40,000 species.

As far as specimen usage, the CSCA issued 10 loans in 2006, representing nearly 5,000 specimens, and more than 25 visitors from the local, national, and international communities have come in to study our collections. These visitors included several longer-term visitors, including Amanda Evans (Harvard University). Additionally, numerous client groups have been given tours of the collection.

Collection management has been streamlined with the appointment of Ms Saraah Kantner as Collection Manager. Her duties include processing loan requests, reaccessioning loan returns, accessioning new materials, sorting incoming accessions, assuring that supplies are adequate for collection work, and keeping the inventory database up-to-date.

Through our Research Associates program, we encourage the use of the collection, the growth of the collection through their respective donations and allow them to cite their associate status, if necessary, to provide an institutional address for their publications or grants. Several additional scientists have applied to our program in 2006, and are being considered for this courtesy appointment. The Research Associates can be found on our website at: <http://www.cdffa.ca.gov/phpps/ppd/Entomology/CSCA/ResAssoc.htm>

# **PLANT PATHOLOGY**

2006 PLANT PATHOLOGY LABORATORY STAFF

## **PLANT PATHOLOGISTS**

CHERYL BLOMQUIST  
BARRY HILL  
SUZANNE ROONEY LATHAM  
DAN OPGENORTH  
SAMANTHA THOMAS  
TONGYAN TIAN  
TIMOTHY TIDWELL, SUPERVISOR  
YUNPING ZHANG

## **TECHNICAL STAFF**

JUN-JUN ESTOQUE  
TERRA IRVING  
ERIN LOVIG  
MONICA NEGRETE  
ALLEN NOGUCHI  
MARINELL SORIANO  
JEANENNE WHITE

## **AGRICULTURAL/SCIENTIFIC AIDES**

LYDIA CAM  
ANGEL CHAN  
CINDY CHEA  
MARAYAL CONCEPCION  
VINA DA  
CAROLINE DASALLA  
ROWENA DELEON  
DAGNE DEMISSE  
DEVIKA DUTT  
NOSA IHEGIE  
KARAH LEUNG  
MEGAN MARION  
MALAY MEY  
ISRAFIEL MOHAMMED  
ABEL UNZUETA  
STEVEN VU

## DIAGNOSTIC SERVICES PROVIDED BY THE PLANT PATHOLOGY LABORATORY INCLUDE:

- Diagnosis of samples submitted by pest prevention programs by state, county, and federal agencies, as well as academic and public sources.
- Diagnosis of samples submitted by the Fruit and Nut Tree and Grapevine Improvement Advisory Board to be tested for Prunus necrotic ringspot and prune dwarf viruses using enzyme-linked Immunosorbent assay (ELISA).
- Diagnosis of grapevine samples submitted by the Grapevine Registration and Certification Program for ELISA testing for the presence of grapevine fanleaf and leaf roll viruses.
- Diagnosis of plant samples specifically for Pierce's Disease, as part of the Statewide Glassy Wing Sharpshooter and Pierce's Disease Project.
- Diagnosis of samples as part of Homeland Security's National Plant Diagnostic Network (NPDN).
- Diagnosis of Seed samples examined and tested to determine phytosanitary seed health compliance prior to export.
- Diagnosis of miscellaneous plant samples submitted by individual farmers, Pest control advisors, U.C. cooperative extension agents, nurserymen, arborists, homeowners, government municipalities, educational institutions, and others.
- Diagnosis of samples collected for various plant disease surveys including Plum Pox, Sudden Oak Death, Citrus Canker, Rice Diseases, and others.

Of the samples handled by the plant pathology laboratory, some involve known fungal pathogens, some involve viral or phytoplasma pathogens, some involve bacterial pathogens, and some samples have plant disorders that have a physiological, chemical, or genetic cause. In addition, many samples have no detectable pathogen and require further sampling and or investigation. And lastly, some samples are the results of routine field inspections performed to confirm the pest-cleanliness of the commodity for various phytosanitary purposes, including export.

In addition, the Plant Pathology staff serves as a scientific resource to the Department of Food and Agriculture, County Departments of Agriculture, and others.

**"A" AND "Q" PESTS IDENTIFIED FOR CALENDAR YEAR 2006**

CALIFORNIA PLANT PEST DIAGNOSTICS CENTER  
PLANT PATHOLOGY LABORATORY

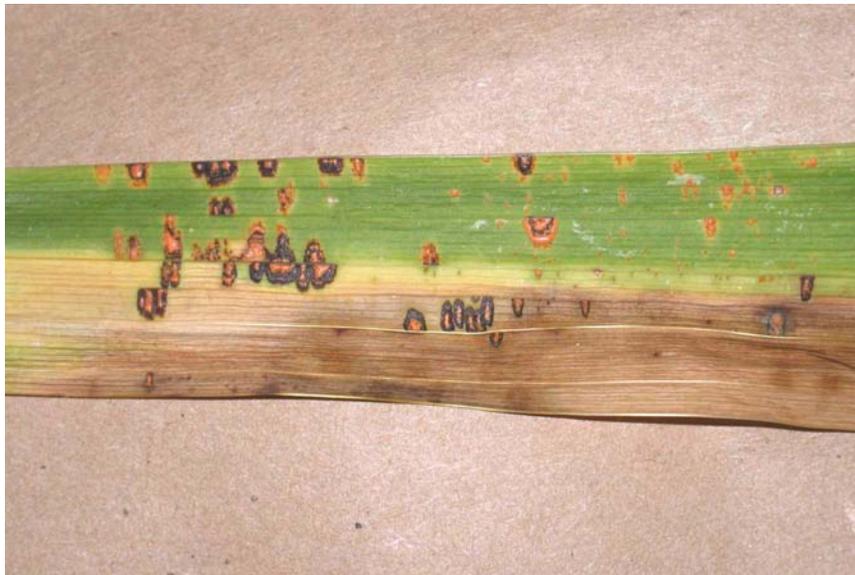
<b>Pathogen</b>		<b>Rating</b>	<b>Host</b>	<b>Common Name</b>	<b>County</b>	<b>City</b>
<i>Alternaria</i>	<i>yaliinficiens</i>	Q	<i>Pyrus communis</i>	Pear	San Francisco	San Francisco
<i>Ascochyta</i>	<i>clematidina</i>	Q	<i>Clematis</i> sp.	Clematis	Santa Cruz	Soquel
<i>Canna Yellow</i>	<i>Mottle virus</i>	Q	<i>Canna</i> sp.	Canna	Orange	Anaheim
<i>Canna Yellow</i>	<i>Mottle virus</i>	Q	<i>Canna</i> sp.	Canna	San Diego	San Diego
<i>Canna Yellow</i>	<i>Mottle virus</i>	Q	<i>Canna</i> sp.	Canna	Santa Barbara	Carpinteria
<i>Coleosporium</i>	<i>delicatulum</i>	Q	<i>Solidago canadensis</i>	Northern Goldenrod	Orange	Santa Ana
<i>Coleosporium</i>	<i>plumierae</i>	Q	<i>Plumeria rubra</i>	Plumeria	Orange	Huntington Beach
<i>Dasturella</i>	<i>divina</i>	Q	<i>Bambusa</i> sp.	Bamboo	Los Angeles	Arleta
	<i>juniperi-</i>				Redwood	R.H. Border
<i>Gymnosporangium</i>	<i>virginianae</i>	A	<i>Malus</i> sp.	Apple	Hwy.	Station
<i>Melampsora</i>	sp.	Q	<i>Salix lasiolepis</i>	Arroyo willow	Riverside	Meniffee
<i>Mycosphaerella</i>	<i>leucospermi</i>	Q	<i>Protea magnifica</i>	Queen Protea	Santa Barbara	Gaviota
<i>Peronospora</i>	<i>grisea</i>	Q	<i>Hebe</i> sp.	Hebe	Santa Barbara	Carpinteria
<i>Peronospora</i>	<i>radii</i>	Q	<i>Chrysanthemum frutescens</i>	Marguerite	Santa Cruz	Soquel
<i>Phoma</i>	<i>viburni</i>	Q	<i>Viburnum davidii</i>	Viburnum	Santa Cruz	Watsonville
<i>Phyllosticta</i>	<i>digitalis</i>	Q	<i>Digitalis</i> sp.	Foxglove	Santa Cruz	Soquel
<i>Phyllosticta</i>	<i>dracaenae</i>	Q	<i>Cordyline terminalis</i>	Green ti	Sonoma	Petaluma
<i>Phytophthora</i>	<i>foliorum</i>	Q	<i>Rhododendron</i> sp.	Azalea	Orange	Seal Beach
<i>Phytophthora</i>	<i>foliorum</i>	Q	<i>Rhododendron</i> sp.	Azalea	San Diego	Vista
<i>Phytophthora</i>	<i>foliorum</i>	Q	<i>Rhododendron</i> sp.	Azalea	Santa Barbara	Santa Barbara
<i>Phytophthora</i>	<i>foliorum</i>	Q	<i>Rhododendron</i> sp.	Azalea	Solano	Dixon
<i>Phytophthora</i>	<i>foliorum</i>	Q	<i>Camellia japonica</i>	Camellia	Ventura	A.W. Nursery
<i>Phytophthora</i>	<i>hibernalis</i>	Q	<i>Arbutus unedo</i>	Strawberry Tree	Sacramento	Galt
<i>Phytophthora</i>	<i>hibernalis</i>	Q	<i>Rhododendron</i> sp.	Rhododendron	Santa Cruz	Scotts Valley
<i>Phytophthora</i>	<i>hibernalis</i>	Q	<i>Rhododendron</i> sp.	Rhododendron	Sonoma	Sonoma

<i>Phytophthora nemorosa</i>	Q	<i>Umbellularia californica</i>	California Bay Laurel	Alameda	Oakland
<i>Phytophthora nemorosa</i>	Q	<i>Camellia sp.</i>	Camellia	Alameda	Oakland
<i>Phytophthora nemorosa</i>	Q	<i>Quercus agrifolia</i>	Coast Live Oak	Alameda	Castro Valley
<i>Phytophthora nemorosa</i>	Q	<i>Pieris japonica</i>	Pieris California Bay	Alameda	Oakland
<i>Phytophthora nemorosa</i>	Q	<i>Umbellularia californica</i>	Laurel	Contra Costa	Richmond
<i>Phytophthora nemorosa</i>	Q	<i>Osmanthus heterophyllus</i>	False Holly	Humboldt	Eureka
<i>Phytophthora nemorosa</i>	Q	<i>Osmanthus heterophyllus</i> 'goshiki'	Japanese False Holly	Humboldt	Eureka
<i>Phytophthora nemorosa</i>	Q	<i>Umbellularia californica</i>	California Bay Laurel	Humboldt	Mckinleyville
<i>Phytophthora nemorosa</i>	Q	<i>Umbellularia californica</i>	California Bay Laurel	Marin	Tomales
<i>Phytophthora nemorosa</i>	Q	<i>Umbellularia californica</i>	California Bay Laurel	Marin	Point Reyes
<i>Phytophthora nemorosa</i>	Q	<i>Umbellularia californica</i>	California Bay Laurel	Mendocino	Thorn Junction
<i>Phytophthora nemorosa</i>	Q	<i>Umbellularia californica</i>	California Bay Laurel	San Mateo	Woodside
<i>Phytophthora nemorosa</i>	Q	<i>Umbellularia californica</i>	California Bay Laurel	Santa Clara	Los Altos
<i>Phytophthora nemorosa</i>	Q	<i>Arbutus marina</i>	Arbutus sp.	Santa Cruz	Soquel
<i>Phytophthora nemorosa</i>	Q	<i>Rhododendron sp.</i>	Rhododendron	Santa Cruz	Scotts Valley
<i>Phytophthora nemorosa</i>	Q	<i>Camellia japonica</i>	Camellia	Solano	Dixon
<i>Phytophthora nemorosa</i>	Q	<i>Rhododendron sp.</i>	Rhododendron	Sonoma	Sebastopol
<i>Phytophthora nemorosa</i>	Q	<i>Umbellularia californica</i>	California Bay Laurel	Sonoma	Petaluma
<i>Phytophthora pseudosyringae</i>	Q	<i>Umbellularia californica</i>	California Bay	Alameda	Berkeley
<i>Phytophthora pseudosyringae</i>	Q	<i>Umbellularia californica</i>	California Bay	Contra Costa	Berkeley
<i>Phytophthora pseudosyringae</i>	Q	<i>Umbellularia californica</i>	California Bay Laurel	Humboldt	Whitehorn
<i>Phytophthora pseudosyringae</i>	Q	<i>Umbellularia californica</i>	California Bay	Mendocino	Leggett

<i>Phytophthora</i>	<i>pseudosyringae</i>	Q	<i>Prunus laurocerasus</i>	Laurel		
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia japonica</i>	English Laurel	Santa Cruz	Soquel
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia sasanqua</i>	Camellia	Alameda	Pleasanton
				Camellia	Alameda	Pleasanton
				California Bay		
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Umbellularia californica</i>	Laurel	Alameda	Berkeley
				California		
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Rhamnus californica</i>	Coffeeberry	Alameda	Oakland
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Quercus agrifolia</i>	Coast Live Oak	Alameda	Oakland
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Rhododendron sp.</i>	Rhododendron	Alameda	Fremont
				California Bay		
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Umbellularia californica</i>	Laurel	Contra Costa	Not listed
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia sp.</i>	Camellia	Contra Costa	Walnut Creek
				California Bay		
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Umbellularia californica</i>	Laurel	Humboldt	Mckinleyville
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Osmanthus fragrans</i>	False Holly	Humboldt	Mckinleyville
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Rhododendron sp.</i>	Rhododendron	Humboldt	Mckinleyville
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Osmanthus fragrans</i>	Sweet Olive	Humboldt	Mckinleyville
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Lithocarpus densiflorus</i>	Tan Oak	Humboldt	Not listed
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Viburnum tinus</i>	Viburnum	Humboldt	Mckinleyville
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia japonica</i>	Camellia	Los Angeles	La Verne
				California Bay		
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Umbellularia californica</i>	Laurel	Marin	Point Reyes
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia sasanqua</i>	Camellia	Marin	Fairfax
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Rhododendron sp.</i>	Rhododendron	Marin	Mill Valley
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Umbellularia californica</i>	California Bay	Mendocino	Philo
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia sp.</i>	Camellia	Mendocino	Fort Bragg
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Rhododendron sp.</i>	Rhododendron	Mendocino	Fort Bragg
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Lithocarpus densiflorus</i>	Tan Oak	Mendocino	Philo
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Ceanothus thyrsiflorus</i>	Blueblossom	Monterey	Moss Landing
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia sp.</i>	Camellia	Napa	Napa
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia sp.</i>	Camellia	Nevada	Grass Valley
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Rhododendron sp.</i>	Rhododendron	Nevada	Grass Valley

<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia japonica</i>	Camellia	Sacramento	Sacramento
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Rhododendron</i> sp.	Rhododendron California Bay	Sacramento	Sacramento
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Umbellularia californica</i>	Laurel	San Francisco	San Francisco
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Lithocarpus densiflorus</i>	Tan Oak California Bay	San Francisco	San Francisco
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Umbellularia californica</i>	Laurel	San Mateo	Woodside
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia</i> sp.	Camellia	San Mateo	Colma
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Quercus agrifolia</i>	Coast Live Oak	San Mateo	Portolla Valley
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Sequoia sempervirens</i>	Redwood	San Mateo	Pescadero
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Lithocarpus densiflorus</i>	Tan Oak California Bay	San Mateo	Pescadero
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Umbellularia californica</i>	Laurel	Santa Clara	Los Gatos
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Quercus agrifolia</i>	Coast Live Oak	Santa Clara	Saratoga
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Vancouveria planipetala</i>	Redwood Ivy California Bay	Santa Clara	Los Altos Hills
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Umbellularia californica</i>	Laurel	Santa Cruz	Soquel
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia</i> sp.	Camellia	Santa Cruz	Soquel
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Rhododendron</i> sp.	Rhododendron California Bay	Santa Cruz	Watsonville
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Umbellularia californica</i>	Laurel	Solano	Fairfield
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia</i> sp.	Camellia	Solano	Dixon
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Heteromeles arbutifolia</i>	Toyon California Bay	Solano	Fairfield
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Umbellularia californica</i>	Laurel	Sonoma	Occidental
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia</i> sp.	Camellia	Sonoma	Santa Rosa
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Lithocarpus densiflorus</i>	Tan Oak	Sonoma	Novato
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Camellia japonica</i>	Camellia	Tulare	Woodlake
<i>Phytophthora</i>	<i>ramorum</i>	Q	<i>Rhododendron</i> sp.	Rhododendron	Ventura	Simi Valley
<i>Phytophthora</i>	sp.	Q	<i>Rhododendron</i> spp.	Azalea	Santa Barbara	Santa Barbara
<i>Puccinia</i>	<i>horiana</i>	Q	<i>Chrysanthemum</i> sp.	Chrysanthemum	Santa Barbara	Carpinteria
<i>Puccinia</i>	<i>horiana</i>	Q	<i>Chrysanthemum</i> spp.	Chrysanthemum	Santa Cruz	Watsonville
<i>Puccinia</i>	<i>ludoviciana</i>	Q	<i>Artemisia</i> sp.	Artemisia	Santa Barbara	Lompoc

<i>Puccinia</i>	<i>rubigo-vera</i>	Q	<i>Leymus condosatus</i>	Wild Rye grass	Santa Barbara	Gaviota
<i>Ramularia</i>	<i>carthami</i>	Q	<i>Carthamus tinctorius</i>	Safflower	Sacramento	Galt
<i>Uromyces</i>	<i>junci-effusi</i>	Q	<i>Juncus xiphoides</i>	Juncus(herb)	Santa Barbara	Santa Barbara
<i>Uromyces</i>	<i>sisyrinchii</i>	Q	<i>Sisyrinchium montanum</i>	Blue-eyed grass	Santa Cruz	Santa Cruz
<i>Uromyces</i>	<i>transversalis</i>	Q	<i>Gladiolus sp.</i>	Gladiolus	San Diego	Oceanside



*Uromyces transversalis* (Gladiolus rust) a Q-rated autoecious rust pathogen detected in 2006 that produces transverse sori developing across the width of the leaf. Most other rusts on Monocots produce sori that develop longitudinally along leaf veins.



*Uromyces transversalis* (Gladiolus Rust). Urediniospore ultrastructure exhibiting characteristic recurved echinulation. (Scanning Electron Micrograph by Dr. Cheryl Bloomquist and Scott Kinnee).

## 2006 SUDDEN OAK DEATH PROJECT

CDFA's Plant Pest Diagnostics Laboratory continued its work plan activities of diagnostics and scientific support for CA counties. For California nurseries, the lab processed a total of 19,826 nursery samples, of which 117 tested positive for *Phytophthora ramorum* (*Pr*). (See table below)

Nursery Type	Total	Positive for <i>Pr</i>
Nursery Stock- Containerized	18418	117
Nursery Stock- In Ground	1162	0
Nursery Stock- Greenhouse Grown	205	0
Nursery Stock- Incoming Shipment	41	0
Total	19826	117

2006 Plant Pest Diagnostics Center activities for *P. ramorum* included:

- Completed pathogenicity tests of *P ramorum* infecting *Osmanthus heterophyllus* and *O. fragrans*.
- Plant Pest Diagnostics Center (PPDC) Laboratory hired 7 seasonal employees to process the SOD laboratory samples.
- Temporarily assigned 7 permanent employees to SOD project, including 3 exclusively for molecular testing, and 1 exclusively for ELISA testing
- Temporarily dedicated 8 laboratory rooms to accommodate SOD project for activities such as initial sample processing, DNA extraction, molecular sample testing, ELISA testing, culture plate reading, data entry, as well as general office and meeting space.
- PPDB Lab scientists gave numerous informational and training presentations to grower groups, nurseries, and county staff, *et al* on recognition of symptoms of *P. ramorum*.
- PPDB Lab scientists participated in various meetings, workshops, and training sessions with USDA to learn protocols and techniques.
- PPDB lab staff was called upon routinely to consult with County staff on specific samples and nurseries, instructions for re-sampling, soil sampling, etc.
- PPDB lab personnel successfully performed and passed provisional laboratory tests as part of the APHIS Provisional Laboratory Accreditation process for nested and quantitative PCR.

- PPDB collaborated with, and gave laboratory support to, several SOD projects with other scientists and agencies outside of CDFA, including the following:
  - Identification and characterization of a new *Phytophthora* species which causes a leaf spot in the nurseries on some SOD hosts. Publication of the description of *Phytophthora foliorum* with Kurt Lamour's lab at University of Tennessee in the journal, *Mycological Research*. *P. foliorum* is important because it can cross react in the nested PCR protocol for the detection of *P. ramorum*. Citation: Donahoo, R., Blomquist, C.L., Thomas, S.L., Moulton, J.K., Cooke, D.E.L., Lamour, K.H. (2006) *Phytophthora foliorum* sp. nov., a new species causing leaf blight of azalea. *Mycological Research* 110:1309-1322.
  - "SOD Busters" waste disposal research project in infested area (final year)
  - Processed samples for the Statewide Detection & Risk Modeling project with Ross Meetenmeyer's lab now at University of North Carolina.
  - Project with Steve Tjosvold with University of California Cooperative Extension (UCCE) involving seasonal timing of sampling activities for best chances of detection (second year).
  - Project with Frank Martin USDA, Mike Coffey UCR and others to test *P. ramorum* PCR-based diagnostics using field samples.
  - An article was published in *Plant Health Progress* with Steve Tjosvold, UCCE describing bud & branch infection of field-infected *Camellia* by *P. ramorum*. Tjosvold, S.A. Chambers, D.L., Thomas, S.L. and Blomquist, C.L. August 25, 2006. First report of *Phytophthora ramorum* infecting *Camellia* flower buds in North America. Online. *Plant Health Progress* doi: 10.1094/PHP-2006-0825-01-BR.
  - Project with Jim MacDonald and Lani Yakabe at UCD Plant Pathology involving management and disposition of *P. ramorum*-infested soil in nurseries.
  - Tested USFS samples obtained from ground checking of dying oaks spotted from airplane fly-overs.

**PLANT PATHOLOGY: BACTERIOLOGY LABORATORY**  
DAN OPGENORTH, SENIOR PHYTOBACTERIOLOGIST

In October of 2006 the USDA declared that Citrus Canker was established in Florida and that no further action would be taken to eradicate the pathogen. The disease is now strictly a management issue of citrus growers and the University Extension Service. If Florida citrus producers are able to successfully win approval to market their fruit in other states that grow citrus, it could result in increased pressure on our efforts to prevent the disease from entering California.

Our laboratory currently has the technology to diagnose Citrus Canker, however up to now our experience working with the pathogen has been somewhat limited since the pathogen has yet to be detected in California-grown citrus. However, CDFA field pathologists continue to send representative samples to our laboratory for evaluation from their spring and fall citrus canker surveys.

Citrus Greening Disease continues to be detected in Florida. To date, the greening pathogen has not been detected in any other states. Texas does, however, have the vector (citrus psyllid) that can transmit the greening pathogen. This past year Senior Plant Pathologist, D.O. Opgenorth, handled a number of citrus greening survey samples from California with the able assistance of Senior Agricultural Biological Technician, Terra Irving. Fortunately the pathogen was not detected in any of the survey samples collected last season.

The California Rice Disease Survey was expanded this year and several interesting samples were received following the inspection of research facilities at Albany and Davis. While the suspect plants were not inoculated, they did have symptoms reminiscent of a bacterial blight disease of rice. Because of this situation, our laboratory implemented the use of a classical PCR assay to determine if the suspected bacterial pathogen was present in the rice plants. The laboratory of Professor Pam Ronald at the University of California, Davis, generously provided positive control DNA for the pathogen of concern. It was determined that several DNA extraction methods could be used on infected plant tissue and that the classical PCR assay was capable of detecting all of the 49 strains of the pathogen that were used in research at the University. A special thanks goes to Dr. Sang Won Lee of the U.C. Davis Plant Pathology Department for his collaboration on this effort. .

Research on the disease, Angular Leaf Spot of Strawberry, has demonstrated that extremely sensitive nested and semi-nested PCR assays were not entirely specific. Although these tests are currently used in Europe on shipments of dormant transplants from California, it suggests that PCR detection from dormant crowns lacking foliage or disease symptoms is not a completely valid means of determining the presence of the bacterial pathogen. Thus, I propose that such results be confirmed using a grow-out test, to prove that the pathogen is present in suspect plant shipments. Steven Vu has been working on this research and it is anticipated that he will be able to finish and write up this work when he returns next year.

Black Rot of Crucifers is still a phytosanitary concern to seed producers and we continue to receive numerous samples each spring. While it is easy to culture the *Xanthomonas campestris* involved, the BIOLOG results are not conclusive for pathogenicity of those cultures. It seems that several bacterial sub-species found on the various Cruciferous

crops can actually incite the disease and that closely related sub-species may not be pathogenic. Thus, an investigation was done to determine if specific RAPD PCR patterns could be used to identify the truly pathogenic strains. At this time, the work seems promising, and hopefully Israfiel Mohammed will be able to finish his work on this project next year.

This is the fifth consecutive year that we have been working on Corn Stunt disease with the collaboration of Dr. Charles Summers of the U.C. Extension service, located in Parlier, California. Our diagnostic capabilities have evolved from symptomatology; to ELISA; to Classical PCR; and now Real Time PCR. With this technological evolution, the sensitivity of the assay has greatly increased. Research involving the genomic map of *Spiroplasma kunkelii* is being done at Oklahoma State University in the laboratory of Professor Jacqueline Fletcher. At her request we are providing materials that would allow the California strains of the pathogen to be characterized. Since the culture of this fastidious organism is difficult, the use of Real Time PCR prior to culturing helps to insure that attempts are made from plant materials with high bacterial titer. According to Dr. Pablo Carpane, we have had several positive cultures from the first group of tassels and the second group of leaf materials also appears to be promising. We trust this cooperative research effort will continue to be fruitful.

This year I participated in training presentations at the Truckee and Hornbrook Border Stations. It was interesting and rewarding to see how enthusiastic the inspectors were. Hopefully, our pathology group will be called upon in the future to do more of this type of training.

Finally, I would like to acknowledge all of my colleagues in Plant Pathology at the CDFA Laboratory who have helped me during the past year: Terra Irving, Steven Vu, Israfiel Mohammed, and Tracy Kwan. A special acknowledgement also goes to my collaborators at Parlier, California (Dr. Charles Summers), Oklahoma State University (Dr. Pablo Carpane & Dr. Jacqueline Fletcher), and U.C. Davis, (Dr. Sang Won Lee). It takes a consistent cooperative effort to make progress in Plant Pathology

## SEED HEALTH TESTING

YunPing Zhang and Allen Noguchi

The Seed Health Testing Laboratory at the Plant Pest Diagnostics Center performs seed health testing for the seed industry of California and other states. Most of these tests are carried out to fulfill the seed health requirements of importing countries, and so that the USDA can write the official Phytosanitary Certificates that are a necessary part of this process.

Table 1. Seed health tests were conducted for the following pathogens in 2006.

### Fungi

*Alternaria brassicicola*  
*Alternaria zinniae*  
*Ascochyta rabiei*  
*Botrytis allii*  
*Botrytis byssoidea*  
*Cercospora beticola*  
*Cladosporium cucumerinum*  
*Fusarium oxysporum* sp. *asparagi*  
*Fusarium oxysporum* f. sp. *radicis-lycopersici*  
*Fusarium oxysporum* f. sp. *Vasinfectum*  
*Glomerella gossypii*  
*Leptosphaeria mavculans*  
*Peronospora farinosa*  
*Plasmopara halstedii*  
*Puccinia allii*  
*Ralstonia solanacearum*  
*Sclerotinia* spp.  
*Spetoria helianthi*  
*Stemphylium radicinum*  
*Tilletia indica*  
*Urocystis cepulae*  
*Verticillium albo-atrum*  
*Verticillium dahliae*

### Bacterial

*Clavibacter michiganense* pv. *insidiosum*  
*Clavibacter michiganensis* pv. *sepedonicus*  
*Clavibacter michiganensis* subsp. *michiganensis*  
*Erwinia tracheiphila*  
*Pseudomonas aptata*  
*Pseudomonas cichoril*  
*Pseudomonas syringae* pv. *Maculicola*  
*Xanthomonas campestris* pv. *alfalfae*  
*Xanthomonas campestris* pv. *campestris*  
*Xanthomonas campestris* pv. *malvacearum*  
*Xanthomonas campestris* pv. *vesicatoria*

### Viruses

Arabis mosaic virus  
Asparagus Latent virus II  
Cucumber mosaic virus  
Lettuce mosaic virus  
Onion yellow dwarf virus  
Pepper mild mottle virus  
Squash mosaic virus  
Tomato ringspot virus

### Viroids

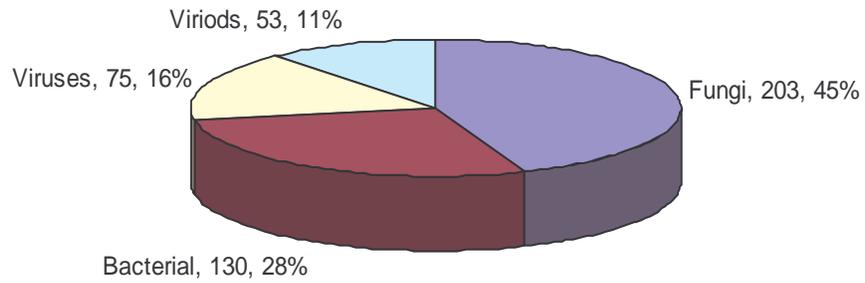
Potato spindle tuber viroid

During the calendar year 2006, the Seed Health Testing laboratory staff conducted 461 seed tests serving 26 different clients. These tests involved 19 different types of agricultural or horticultural seeds, either non-treated or treated with various chemicals. Tests were performed to detect 43 different seed pathogens, including 23 fungal, 11 bacterial, 8 viral, pathogens, as well as 1 viroid pathogen (see Table 1 and Figures 1,2). The cost recovery fees of \$40,285 were collected for this service.

As part of the national Karnal Bunt Survey Program, the Seed Health Testing Laboratory also tested wheat samples again this year for the presence of the Karnal Bunt pathogen, *Tilletia indica*. Thirty-seven wheat seed samples from seventeen counties were tested for *T. indica*. The pathogen was not detected from any of the National Survey Samples,

nor from any of the samples of wheat seed from the USDA-regulated area in the Southern California desert near Blythe, California.

**Figure 1. Percentage of seed samples tested for various pathogens**



**Figure 2. Chickpea seed plated on agar to detect the presence of the seed-borne fungal pathogen, *Ascochyta rabiei*.**

## DETECTION OF *CANNA YELLOW MOTTLE VIRUS*

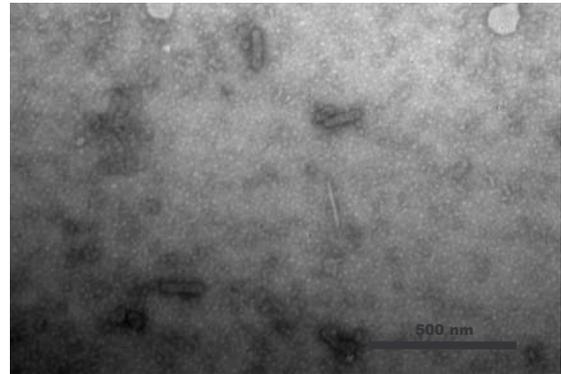
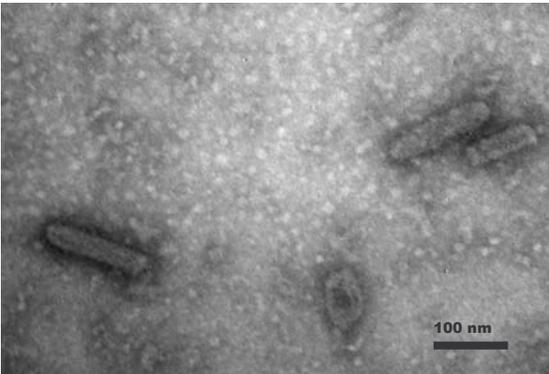
Tongyan Tian and Yunping Zhang  
Senior Plant Pathologists

In December 2004, we received several canna (*Cannas pp.*) plants from Santa Barbara County. Initial examinations indicated that the some of the plants exhibited veinal necrosis and mottling, symptoms described typical of *Canna yellow mottle virus* (CaYMV) disease. Those plants were tested positive using PCR for CaYMV (see report on 2004 annual report). After our initial detection of CaYMV, we have tested a large number of canna plants from several counties and here give an update on the diagnostics of this virus.



Canna leaves with symptoms of *Canna yellow mottle virus* infection.

CaYMV was first reported by Yamashita *et al.* in 1979 in Japan and later by Lockhart in 1988 in the United States. In 2004, a detection method was developed using PCR and CaYMV specific primers (Momol *et al.* 2004). We examined partially purified virions from symptomatic Canna plants under a transmission electron microscope (Hitachi-7500) and observed bacilliform virus particles which are consistent with the description of CaYMV.



Electron micrographs of partially purified virions of *Canna yellow mottle virus*.

CaYMV belongs to the genus *Badnavirus* in the family of *Caulimoviridae* and virions contain DNA. We extracted DNA using either Fast-prep DNA extraction kit (Q-Biogene)

or a method described by Rowhani *et al.* (2000). When Fast-prep extraction method was used, 1 µl of DNA diluted 1:100 with H<sub>2</sub>O was used as PCR template. We followed the detection method described by Momol *et al.* 2004 and the presence of CaYMV was determined by observation of a PCR product of 565 base pairs. Our initial PCR product was submitted for DNA sequencing and resulted DNA sequence was compared with those available in the GenBank using BLAST search. In 2004, there was no CaYMV DNA sequence available in the GenBank. However, our recent search found that our CaYMV sequence shares from 99% to 98% nucleotide sequence identity with those from Europe (e.g. Accession numbers EF189148, EF 156358). These results further confirmed our diagnostics of CaYMV.

Since December 2004, we have detected CaYMV in Santa Barbara, San Diego, Orange, Ventura and El Dorado counties. We believe that CaYMV is relatively common in California. In December 2006, a “C” rating was given to CaYMV.

#### **Reference Cited:**

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Momol, M. T., Lockhart, B. E. L., Dankers, H., Adkins, S. (2004). Canna yellow mottle virus detected in canna in Florida. *Plant Health Progress* doi:10.1094/PHP-2004-0809-01-HN. Plant Management Network.

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Yamashita, S., Natsuaki, T., Doi, Y. and Yora, K. (1979). *Ann. Phytopath. Soc. Japan* **45**: 85

**PATHOGENS OF TREES AND OTHER WOODY HOSTS IDENTIFIED  
FOR CALENDAR YEAR 2006**

**CALIFORNIA PLANT PEST DIAGNOSTICS CENTER**

<b>Host</b>	<b>Pathogen</b>		<b>County</b>	<b>City</b>
<i>Abelia sp.</i>	<i>Cuscuta</i>	<i>cf. japonica</i>	Sacramento	Sacramento
<i>Abies concolor</i>	<i>Phytophthora</i>	<i>ramorum</i>	Santa Clara	Los Gatos
<i>Abies grandis</i>	<i>Phytophthora</i>	<i>sp.</i>	Placer	Auburn
<i>Abies procera</i>	<i>Pucciniastrum</i>	<i>geoppertianum</i>	Orange	Corona Del Mar
<i>Acer circinatum</i>	<i>Tubercularia</i>	<i>vulgaris</i>	Santa Cruz	Soquel
<i>Acer platanoides</i>	<i>Uncinula</i>	<i>bicornis</i>	Santa Barbara	Santa Barbara
<i>Aesculus californica</i>	<i>Ascochyta</i>	<i>sp.</i>	Santa Cruz	Santa Cruz
	<i>Ascochyta</i>	<i>sp.</i>	Santa Cruz	Watsonville
	<i>Ascochyta</i>	<i>sp.</i>	Santa Cruz	La Selva Beach
<i>Albizia julibrissin</i>	<i>Fusarium</i>	<i>oxysporum f.sp. perniciosum</i>	Sacramento	Folsom
<i>Aloe striata</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Amelanchier grandiflora</i>	<i>Gymnosporangium</i>	<i>libocedri</i>	San Luis Obispo	Paso Robles

<i>Aralia sieboldii</i>	<i>Cladosporium</i>	<i>sp.</i>	San Luis	
	<i>Cladosporium</i>	<i>sp.</i>	Obispo	Nipomo
			Santa Barbara	Santa Barbara
<i>Aralia sp.</i>	<i>Penicillium</i>	<i>sp.</i>	San Luis	
			Obispo	Nipomo
<i>Araucaria bidwillii</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Arbutus menziesii</i>	<i>Mycosphaerella</i>	<i>arbuticola</i>	San Mateo	Millbrae
<i>Betula sp.</i>	<i>Melampsorium</i>	<i>betulinum</i>	Santa Cruz	Watsonville
<i>Brahea armata</i>	<i>Cladosporium</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Buddleja sp.</i>	<i>Cuscuta</i>	<i>cf. japonica</i>	Alameda	Oakland
	<i>Cuscuta</i>	<i>cf. japonica</i>	Fresno	Fresno
<i>Buxus japonica</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Isla Vista
<i>Calocedrus decurrens</i>	<i>Gymnosporangium</i>	<i>libocedri</i>	Monterey	Salinas
	<i>Schizophyllum</i>	<i>commune</i>	Colusa	Not listed
<i>Cercis occidentalis</i>	<i>Phytophthora</i>	<i>sp.</i>	Contra Costa	San Ramon
<i>Chamaecyparis elwoodii</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Cruz	Watsonville
<i>Chitalpa sp.</i>	<i>Phytophthora</i>	<i>sp.</i>	Ventura	Fillmore

<i>Cinnamomum camphora</i>	<i>Phytophthora</i> <i>Fusicoccum</i>	<i>sp.</i> <i>sp.</i>	Santa Barbara Sacramento	Santa Maria Sacramento
<i>Citrus aurantifolia</i>	<i>Colletotrichum</i> <i>Colletotrichum</i> <i>Colletotrichum</i> <i>Geotrichum</i> <i>Penicillium</i>	<i>acutatum</i> <i>acutatum</i> <i>acutatum</i> <i>sp.</i> <i>sp.</i>	San Bernardino Solano Sutter Riverside Riverside	Rialto Dixon Turlock Corona Corona
<i>Citrus sinensis</i>	<i>Phytophthora</i> <i>*Leptothyrium</i>	<i>sp.</i> <i>pomi</i>	Santa Barbara Needles	Santa Barbara Needles Insp. Sta.
<i>Citrus sp.</i>	<i>Cuscuta</i> <i>Geotrichum</i> <i>Phytophthora</i> <i>Tristeza virus</i>	<i>cf. japonica</i> <i>sp.</i> <i>citricola</i>	Shasta Riverside Solano Ventura	Redding Corona Vacaville Ventura
<i>Cordyline australis</i>	<i>Fusarium</i>	<i>solani</i>	Santa Barbara	Santa Barbara
<i>Cordyline terminalis</i>	<i>Phyllosticta</i>	<i>dracaenae</i>	Sonoma	Petaluma
<i>Cornus spp.</i>	<i>Cylindrosporium</i> <i>Ramularia</i> <i>Septoria</i>	<i>sp.</i> <i>sp.</i> <i>sp.</i>	Riverside Riverside Santa Cruz	San Jacinto San Jacinto Watsonville
<i>Cupressus sempervirens</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Guadalupe
<i>Dracaena sp.</i>	<i>Fusarium</i>	<i>moniliforme</i>	San Luis Obispo	Nipomo
<i>Euphorbia cotinifolia</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Cruz	Watsonville

<i>Euphorbia sp.</i>	<i>Melampsora</i>	<i>monticola</i>	San Diego	San Diego
<i>Ficus benamina</i>	<i>Pantoea</i>	<i>agglomerans</i>	San Mateo	San Mateo
	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
	<i>Rhizobium</i>	<i>rhizogenes</i>	Amador	Sunol
<i>Ficus macrophylla</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Ficus spp.</i>	<i>Erwinia</i>	<i>spp.</i>	Imperial	El Centro
	<i>Fig Mosaic virus</i>		Yolo	Winters
	<i>Fusarium</i>	<i>solani</i>	Los Angeles	Claremont
<i>Fraxinus angustifolia</i>	<i>Phomopsis</i>	<i>sp.</i>	Butte	Gridley
<i>Fraxinus sp.</i>	<i>Cylindrosporium</i>	<i>fraxini</i>	Humboldt	Eureka
<i>Heteromeles arbutifolia</i>	<i>Phytophthora</i>	<i>ramorum</i>	Solano	Fairfield
	<i>Entomosporium</i>	<i>mespili</i>	Los Angeles	Lower Lake
	<i>Phytophthora</i>	<i>sp.</i>	San Diego	San Marcos
	<i>Phytophthora</i>	<i>sp.</i>	Santa Cruz	Watsonville
	<i>Spilocea</i>	<i>photinicola</i>	Riverside	Murrieta
<i>Heteromeles arbutifolia</i>	<i>Spilocea</i>	<i>photinicola</i>	Santa Cruz	Soquel
<i>Howea forsteriana</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Juglans hindsii</i>	<i>Marssonina</i>	<i>juglandis</i>	Butte	Richvale
	<i>Xanthomonas</i>	<i>campestris pv. juglandis</i>	Lake	Not listed
<i>Juglans regia</i>	<i>Pantoea</i>	<i>spp.</i>	Yolo	Davis

<i>Juglans sp.</i>	<i>Marssonina</i>	<i>juglandis</i>	Sacramento	Wilton
	<i>Microstroma</i>	<i>juglandis</i>	Humboldt	Eureka
	<i>Microstroma</i>	<i>juglandis</i>	Stanislaus	Modesto
	<i>Microstroma</i>	<i>juglandis</i>	Tehama	Red Bluff
	<i>Pseudomonas</i>	<i>syringae</i>	Stanislaus	Oakdale
<i>Juniperus sp.</i>	<i>Pestalotiopsis</i>	<i>funerea</i>	San Luis	
	<i>Phytophthora</i>	<i>sp.</i>	Obispo	Arroyo Grande
			Santa Barbara	Santa Barbara
<i>Lauris nobilis</i>	<i>Phytophthora</i>	<i>nemorosa</i>	Yolo	Davis
<i>Leucodendron argenteum</i>	<i>Phytophthora</i>	<i>sp.</i>	San Francisco	San Francisco
<i>Liquidambar styraciflua</i>	<i>Xylella</i>	<i>fastidiosa</i>	Sacramento	Riverside
	<i>Xylella</i>	<i>fastidiosa</i>	San Diego	Redlands
	<i>Cuscuta</i>	<i>cf. japonica</i>	Sacramento	Sacramento
<i>Liquidambar sp.</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Lithocarpus densiflorus</i>	<i>Cystotheca</i>	<i>lanestris</i>	Mendocino	Fort Bragg
	<i>Phytophthora</i>	<i>ramorum</i>	San Mateo	Pescadero
<i>Lithocarpus densiflorus</i>	<i>Phytophthora</i>	<i>ramorum</i>	Humboldt	Not listed
	<i>Phytophthora</i>	<i>ramorum</i>	Mendocino	Boonville
	<i>Phytophthora</i>	<i>ramorum</i>	Mendocino	Calpella
	<i>Phytophthora</i>	<i>ramorum</i>	Mendocino	Fort Bragg
<i>Lithocarpus densiflorus</i>	<i>Phytophthora</i>	<i>ramorum</i>	Mendocino	Philo
	<i>Phytophthora</i>	<i>ramorum</i>	Mendocino	Point Arena

<i>Lithocarpus densiflorus</i>	<i>Phytophthora</i>	<i>ramorum</i>	Mendocino	Ukiah
	<i>Phytophthora</i>	<i>ramorum</i>	Sonoma	Novato
	<i>Phytophthora</i>	<i>ramorum</i>	San Francisco	San Francisco
	<i>Phytophthora</i>	<i>ramorum</i>	San Mateo	Woodside
	<i>Phytophthora</i>	<i>ramorum</i>	Santa Clara	Los Gatos
<i>Magnolia sp.</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Malus sp.</i>	<i>Botryosphaeria</i>	<i>ribis</i>	Humboldt	Eureka
	* <i>Gloeodes</i>	<i>pomigena</i>	Needles	Needles Insp. Sta.
	* <i>Gymnosporangium</i>	<i>juniperi-virginianae</i>	Redwood Hwy.	R.H. Border Station
	* <i>Mycrothyriella</i>	<i>rubi</i>	Needles	Needles Insp. Sta.
	<i>Nectria</i>	<i>galligena</i>	Humboldt	Eureka
	<i>Phytophthora</i>	<i>sp.</i>	Humboldt	Eureka
	<i>Spilocea</i>	<i>pomi</i>	Mendocino	Potter Valley
	<i>Schizothyrium</i>	<i>pomi</i>	Needles	Needles Insp. Sta.
<i>Musa sp.</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Myrica californica</i>	<i>Pestalotiopsis</i>	<i>sp.</i>	Santa Cruz	Soquel
<i>Myrtus communis</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Carpinteria
<i>Nandina domestica</i>	<i>Colletotrichum</i>	<i>gloeosporioides</i>	Riverside	Riverside
<i>Nerium oleander</i>	<i>Cuscuta</i>	<i>japonica</i>	Fresno	Fresno
	<i>Pseudomonas</i>	<i>savastanoi</i>	Butte	Chico
	<i>Pseudomonas</i>	<i>savastanoi</i>	San Luis	
	<i>Pseudomonas</i>	<i>savastanoi</i>	Obispo	Arroyo Grande
	<i>Pseudomonas</i>	<i>syringae</i>	San Luis	San Luis Obispo
<i>Xylella</i>	<i>fastidiosa</i>	Obispo	Hemet	
			Riverside	

<i>Nerium sp.</i>	<i>Phoma</i>	<i>exigua</i>	Marin	Novato
<i>Nerium sp.</i>	<i>Phoma</i> <i>Xylella</i>	<i>exigua</i> <i>fastidiosa</i>	San Luis Obispo San Diego	Not listed San Diego
<i>Olea europaea</i>	<i>Xylella</i> <i>Xylella</i> <i>Xylella</i>	<i>fastidiosa</i> <i>fastidiosa</i> <i>fastidiosa</i>	Orange Orange Orange	Santa Ana Tustin Yorba Linda
<i>Osmanthus fragrans</i>	<i>Phytophthora</i>	<i>ramorum</i>	Humboldt	McKinleyville
<i>Osmanthus heterophyllus</i>	<i>Phytophthora</i> <i>Phytophthora</i> <i>Phytophthora</i>	<i>nemorosa</i> <i>nemorosa</i> <i>ramorum</i>	Humboldt Humboldt Humboldt	Eureka McKinleyville McKinleyville
<i>Pachyra sp.</i>	<i>Phaeocystostroma</i>	<i>sp.</i>	San Luis Obispo	Nipomo
<i>Persea americana</i>	<i>Colletotrichum</i> <i>Phytophthora</i> <i>Phytophthora</i>	<i>gloeosporioides</i> <i>sp.</i> <i>sp.</i>	Santa Barbara Orange Santa Barbara	Santa Barbara Irvine Santa Barbara
<i>Palmaceae</i>	<i>Sphaerodothis</i>	<i>neowashingtoniae</i>	Sacramento	Sacramento
<i>Phoenix canariensis</i>	<i>Fusarium</i> <i>Gliocladium</i> <i>Phomopsis</i> <i>Sphaerodothis</i>	<i>oxysporum</i> <i>vermoeseni</i> <i>sp.</i> <i>neowashingtoniae</i>	State of Nevada Santa Barbara Santa Barbara Santa Clara	Las Vegas Santa Barbara Santa Barbara San Jose
<i>Pinus muricata</i>	<i>Fusarium</i>	<i>circinatum</i>	Marin	Point Reyes Station

<i>Pinus radiata</i>	<i>Fusarium</i>	<i>circinatum</i>	Marin	Point Reyes Station
<i>Pistacia chinensis</i>	<i>Botrytis</i> <i>Poria</i>	<i>cinerea</i> <i>sp.</i>	Mendocino Sacramento	Redwood Valley Sacramento
<i>Pittosporum crassifolium</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Carpinteria
<i>Pittosporum tenuifolium</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Carpinteria
<i>Pittosporum undulatum</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Platanus racemosa</i>	<i>Oidium</i>	<i>sp.</i>	Sacramento	Sacramento
<i>Platanus sp.</i>	<i>Microsphaera</i>	<i>penicillata</i>	San Luis Obispo	Arroyo Grande
<i>Plumeria rubra</i>	<i>Coleosporium</i>	<i>plumierae</i>	Orange	Huntington Beach
<i>Populus tremuloides</i>	<i>Marssonina</i>	<i>castagnei</i>	Riverside	Johnsville
<i>Prunus avium</i>	<i>Phloeosporella</i> <i>Oidium</i> <i>Tranzschelia</i>	<i>padi</i> <i>sp.</i> <i>sp.</i>	Stanislaus Stanislaus Imperial	Hickman La Grange Eureka
<i>Prunus cistena</i>	<i>Peronospora</i>	<i>sp.</i>	Riverside	San Jacinto
<i>Prunus domestica</i>	<i>Kabatiella</i> <i>Pseudmonas</i> <i>Rhizobium</i>	<i>prunicola</i> <i>syringae</i> <i>rhizogenes</i>	Santa Cruz Tulare Humboldt	Watsonville Yuba City Hydesville

<i>Prunus domestica</i>	<i>Tranzschelia</i>	<i>discolor</i>	Glenn	Fresno
<i>Prunus dulcis</i>	<i>Kabatiella</i> <i>Cuscuta</i>	<i>prunicola</i> <i>japonica</i>	Monterey Sacramento	El Nido Sacramento
<i>Prunus persica</i>	<i>Oidium</i> <i>Phytophthora</i> <i>Taphrina</i> <i>Wilsonomyces</i>	<i>sp.</i> <i>sp.</i> <i>deformans</i> <i>carpophilus</i>	Stanislaus Butte Colusa Colusa	Hughson Gridley Princeton Princeton
<i>Prunus sp.</i>	<i>Apiosporina</i> <i>Cuscuta</i>	<i>morbose</i> <i>cf. japonica</i>	Tulare Shasta	Camp Nelson Redding
<i>Pseudotsuga mensiesii</i>	<i>Phytophthora</i> <i>Phytophthora</i> <i>Phytophthora</i>	<i>sp.</i> <i>sp.</i> <i>sp.</i>	Butte Placer Placer	Chico Auburn Loomis
<i>Pseudotsuga mensiesii</i>	<i>Phytophthora</i>	<i>sp.</i>	San Mateo	Pescadero
<i>Punica granatum</i>	<i>Nematospora</i>	<i>coryli</i>	Riverside	Mecca
<i>Pyrus calleryana</i>	<i>Entomosporium</i>	<i>mespili</i>	Santa Cruz	Watsonville
<i>Pyrus sp.</i>	<i>Erwinia</i> <i>Erwinia</i>	<i>amylovora</i> <i>amylovora</i>	San Luis Obispo San Mateo	Paso Robles Menlo Park
<i>Quercus agrifolia</i>	<i>Cuscuta</i> <i>Discula</i> <i>Discula</i>	<i>cf. japonica</i> <i>umbrinella</i> <i>umbrinella</i>	Contra Costa Contra Costa Solano	San Pablo Concord Vacaville

<i>Quercus agrifolia</i>	<i>Phytophthora</i>	<i>nemorosa</i>	Alameda	Castro Valley
	<i>Phytophthora</i>	<i>ramorum</i>	Alameda	Oakland
	<i>Phytophthora</i>	<i>ramorum</i>	San Mateo	Portola Valley
	<i>Phytophthora</i>	<i>ramorum</i>	San Mateo	Hillsborough
	<i>Phytophthora</i>	<i>ramorum</i>	San Mateo	Woodside
	<i>Phytophthora</i>	<i>ramorum</i>	Santa Clara	Los Altos Hills
	<i>Phytophthora</i>	<i>ramorum</i>	Santa Clara	Saratoga
	<i>Phytophthora</i>	sp.	Alameda	Oakland
	<i>Phytophthora</i>	sp.	Sacramento	Sacramento
	<i>Sphaerotheca</i>	<i>lanestrus</i>	Del Norte	Walnut Creek
	<i>Sphaerotheca</i>	<i>lanestrus</i>	Riverside	Temecula
<i>Quercus douglasii</i>	<i>Microsphaera</i>	<i>penicilliata</i>	Santa Cruz	Watsonville
	<i>Phytophthora</i>	sp.	Sacramento	Sacramento
	<i>Phyllactinia</i>	<i>guttata</i>	Fresno	El Dorado Hills
<i>Quercus kelloggii</i>	<i>Cylindrosporium</i>	<i>kelloggii</i>	Yuba	Oregon House
<i>Quercus lobata</i>	<i>Discula</i>	<i>umbrinella</i>	Sacramento	R. Murieta
	<i>Sphaerotheca</i>	<i>lanestrus</i>	Santa Cruz	Watsonville
<i>Quercus rubra</i>	<i>Cystotheca</i>	<i>lanestrus</i>	Santa Clara	Palo Alto
	<i>Discula</i>	<i>umbrinella</i>	Santa Cruz	Soquel
<i>Quercus rubra</i>	<i>Sphaerotheca</i>	<i>lanestrus</i>	Sacramento	Rancho Murieta
	<i>Sphaerotheca</i>	sp.	Sacramento	Rancho Murieta
<i>Quercus sp.</i>	<i>Ascochyta</i>	sp.	San Francisco	Not listed
	<i>Cystotheca</i>	<i>lanestrus</i>	San Francisco	Not listed
			San Luis	
	<i>Cystotheca</i>	<i>lanestrus</i>	Obispo	Arroyo Grande
	<i>Cystotheca</i>	<i>lanestrus</i>	Yolo	Davis

<i>Quercus sp</i>	<i>Discula</i>	<i>quercina</i>	San Francisco	Not listed
	<i>Ganoderma</i>	<i>lucidum</i>	Placer	Granite Bay
	<i>Ganoderma</i>	<i>sp.</i>	Sacramento	Mather
			San Luis	
	<i>Microsphaeria</i>	<i>sp.</i>	Obispo	Arroyo Grande
	<i>Phloeospora</i>	<i>sp.</i>	Alameda	Castro Valley
	<i>Phyllactinia</i>	<i>guttata</i>	Sacramento	Orangevale
	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
	<i>Poria</i>	<i>sp.</i>	Sacramento	Sacramento
	<i>Sphaerotheca</i>	<i>lanestris</i>	Contra Costa	Port of Richmond
<i>Quercus suber</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Rhamnus alaternus</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Rhamnus californica</i>	<i>Phytophthora</i>	<i>cactorum</i>	Los Angeles	Azusa
	<i>Phytophthora</i>	<i>ramorum</i>	Alameda	Oakland
	<i>Phytophthora</i>	<i>sp.</i>	Santa Clara	San Martin
<i>Rhus laurina</i>	<i>Cuscuta</i>	<i>japonica</i>	Los Angeles	405 Freeway
<i>Rhus sp.</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Ribes sp. (Alternate Host)</i>	<i>Cronartium</i>	<i>ribicola</i>	San Francisco	San Francisco
	<i>Cronartium</i>	<i>ribicola</i>	Santa Cruz	Watsonville
<i>Rosa sp.</i>	<i>Coniothyrium</i>	<i>fuckelii</i>	Santa Clara	San Jose
	<i>Cuscuta</i>	<i>japonica</i>	Fresno	Fresno
	<i>Diplocarpon</i>	<i>rosae</i>	Santa Clara	San Jose
<i>Rosa sp.</i>	<i>Phragmidium</i>	<i>mucronatum</i>	Santa Clara	San Jose

<i>Rosa sp.</i>	<i>Phytophthora Sphaerotheca</i>	<i>sp. pannosa</i>	Santa Clara Contra Costa	San Jose Brentwood
<i>Rubus sp.</i>	<i>Cuscuta</i>	<i>cf. japonica</i>	Contra Costa	El Cerrito
<i>Salix laevigata</i>	<i>Melampsora Melampsora Melampsora</i>	<i>sp. sp. sp.</i>	Riverside Riverside Riverside	Menifee Nuevo Temecula
<i>Salix lasiolepis</i>	<i>Melampsora</i>	<i>sp.</i>	Riverside	Menifee
<i>Salix nigra</i>	<i>Melampsora</i>	<i>sp.</i>	Riverside	Menifee
<i>Salix sp.</i>	<i>Cuscuta Melampsora</i>	<i>cf. japonica epitea</i>	Contra Costa Sonoma	El Cerrito Sebastopol
<i>Sambucus sp.</i>	<i>Cuscuta</i>	<i>cf. japonica</i>	Contra Costa	El Cerrito
<i>Schefflera actinophylla</i>	<i>Colletotrichum</i>	<i>gloeosporioides</i>	San Diego	Valley Center
<i>Schefflera sp.</i>	<i>Alternaria</i>	<i>panax</i>	Santa Barbara	Santa Barbara
<i>Schinus molle</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Barbara
<i>Sequoiadendron giganteum</i>	<i>Fusicoccum</i>	<i>aesculi</i>	Merced	Le Grand
<i>Sequoia sempervirens</i>	<i>Phytophthora</i>	<i>ramorum</i>	San Mateo	Pescadero
<i>Syringa vulgaris</i>	<i>Ascochyta</i>	<i>syringae</i>	San Luis Obispo	Arroyo Grande

<i>Thuja plicata</i>	<i>Phytophthora</i>	<i>sp.</i>	Santa Barbara	Santa Maria
<i>Tupidanthus calyptratus</i>	<i>Alternaria</i>	<i>panax</i>	Santa Barbara	Carpinteria
<i>Ulmus americana</i>	<i>Ophiostoma</i>	<i>ulmi</i>	Sacramento	Sacramento
<i>Ulmus chinenses</i>	<i>Ophiostoma</i>	<i>ulmi</i>	Sacramento	Sacramento
<i>Ulmus parvifolia</i>	<i>Botryodiplodia</i>	<i>theobromae</i>	Sacramento	Sacramento
	<i>Gloeosporium</i>	<i>ulmicola</i>	Alameda	Livermore
	<i>Gloeosporium</i>	<i>ulmicola</i>	Humboldt	Eureka
	<i>Gloeosporium</i>	<i>ulmicola</i>	San Mateo	Redwood City
	<i>Ophiostoma</i>	<i>ulmi</i>	Sacramento	Sacramento
	<i>Ophiostoma</i>	<i>ulmi</i>	Sacramento	Marysville
<i>Ulmus procera</i>	<i>Ophiostoma</i>	<i>ulmi</i>	Napa	St. Helena
	<i>Ophiostoma</i>	<i>ulmi</i>	Sacramento	Sacramento
<i>Ulmus pumila</i>	<i>Ophiostoma</i>	<i>ulmi</i>	Riverside	Riverside
	<i>Ophiostoma</i>	<i>ulmi</i>	Santa Clara	Palo Alto
<i>Ulmus sp.</i>	<i>Ophiostoma</i>	<i>ulmi</i>	Alameda	Oakland
	<i>Ophiostoma</i>	<i>ulmi</i>	Sacramento	Galt
	<i>Ophiostoma</i>	<i>ulmi</i>	Sacramento	Sacramento
<i>Umbellularia californica</i>	<i>Phomopsis</i>	<i>sp.</i>	Sonoma	Santa Rosa
	<i>Phytophthora</i>	<i>nemorosa</i>	Alameda	Oakland
	<i>Phytophthora</i>	<i>nemorosa</i>	Alameda	Berkeley
	<i>Phytophthora</i>	<i>nemorosa</i>	Contra Costa	Oakland
	<i>Phytophthora</i>	<i>nemorosa</i>	Contra Costa	Richmond
	<i>Phytophthora</i>	<i>nemorosa</i>	Humboldt	Mckinleyville

<i>Umbellularia californica</i>	<i>Phytophthora nemorosa</i>	Humboldt	Orleans
	<i>Phytophthora nemorosa</i>	Humboldt	Redway
	<i>Phytophthora nemorosa</i>	Humboldt	Whitehorn
	<i>Phytophthora nemorosa</i>	Mendocino	Fort Bragg
	<i>Phytophthora nemorosa</i>	Mendocino	Mendocino
	<i>Phytophthora nemorosa</i>	Mendocino	Whitehorn
	<i>Phytophthora nemorosa</i>	San Mateo	Woodside
	<i>Phytophthora nemorosa</i>	San Mateo	Millbrae
	<i>Phytophthora nemorosa</i>	Sonoma	Petaluma
	<i>Phytophthora pseudosyringae</i>	Alameda	Oakland
	<i>Phytophthora pseudosyringae</i>	Alameda	Berkeley
	<i>Phytophthora pseudosyringae</i>	Contra Costa	Not listed
	<i>Phytophthora pseudosyringae</i>	Humboldt	Whitehorn
	<i>Phytophthora pseudosyringae</i>	Humboldt	Orleans
	<i>Phytophthora pseudosyringae</i>	Humboldt	Garberville
	<i>Phytophthora pseudosyringae</i>	Mendocino	Leggett
	<i>Phytophthora pseudosyringae</i>	Mendocino	Fort Bragg
	<i>Phytophthora pseudosyringae</i>	Mendocino	Middlebury
	<i>Phytophthora pseudosyringae</i>	Sonoma	Not listed
	<i>Phytophthora ramorum</i>	Contra Costa	El Sobrante
	<i>Phytophthora ramorum</i>	Contra Costa	Orinda
	<i>Phytophthora ramorum</i>	Contra Costa	Richmond
	<i>Phytophthora ramorum</i>	Humboldt	Eureka
	<i>Phytophthora ramorum</i>	Humboldt	Mckinleyville
	<i>Phytophthora ramorum</i>	Marin	Woodacre
	<i>Phytophthora ramorum</i>	Marin	Novato
	<i>Phytophthora ramorum</i>	Mendocino	Booneville
	<i>Phytophthora ramorum</i>	Mendocino	Fort Bragg
<i>Umbellularia californica</i>	<i>Phytophthora ramorum</i>	Mendocino	Mendocino
	<i>Phytophthora ramorum</i>	Mendocino	Point Arena
	<i>Phytophthora ramorum</i>	San Mateo	Burlingame
	<i>Phytophthora ramorum</i>	San Mateo	Hillsborough

<i>Umbellularia californica</i>	<i>Phytophthora ramorum</i>	San Mateo	Los Altos
	<i>Phytophthora ramorum</i>	San Mateo	Millbrae
<i>Umbellularia californica</i>	<i>Phytophthora ramorum</i>	San Mateo	San Mateo
	<i>Phytophthora ramorum</i>	San Mateo	Woodside
	<i>Phytophthora ramorum</i>	Santa Clara	Los Altos Hills
	<i>Phytophthora ramorum</i>	Santa Clara	Los Gatos
	<i>Phytophthora ramorum</i>	Santa Clara	Saratoga
	<i>Phytophthora ramorum</i>	Santa Cruz	Soquel
	<i>Phytophthora ramorum</i>	Solano	Fairfield
	<i>Phytophthora ramorum</i>	Solano	Vallejo
	<i>Phytophthora ramorum</i>	Sonoma	Glen Ellen
	<i>Phytophthora ramorum</i>	Sonoma	Guerneville
	<i>Phytophthora ramorum</i>	Sonoma	Petaluma
	<i>Phytophthora ramorum</i>	Sonoma	Occidental
	<i>Phytophthora ramorum</i>	Sonoma	Sebastopol
	<i>Phytophthora ramorum</i>	Sonoma	Sonoma
<i>Viburnum davidii</i>	<i>Colletotrichum sp.</i>	Santa Cruz	La Selva Beach
<i>Vitis vinifera</i>	<i>Cuscuta japonica</i>	Yuba	Not listed
	<i>Grapevine Leafroll 3 virus</i>	Lake	Clearlake Oaks
	<i>Grapevine Leafroll 3 virus</i>	San Diego	Escondido
	<i>Uncinula necator</i>	Santa Clara	Los Gatos
	<i>Xylella fastidiosa</i>	Madera	Madera
	<i>Xylella fastidiosa</i>	San Diego	Escondido
	<i>Xylella fastidiosa</i>	Santa Clara	Los Altos Hills

Vitis sp.

*Penicillium* sp.  
*Aspergillus* sp.

Orange  
Orange

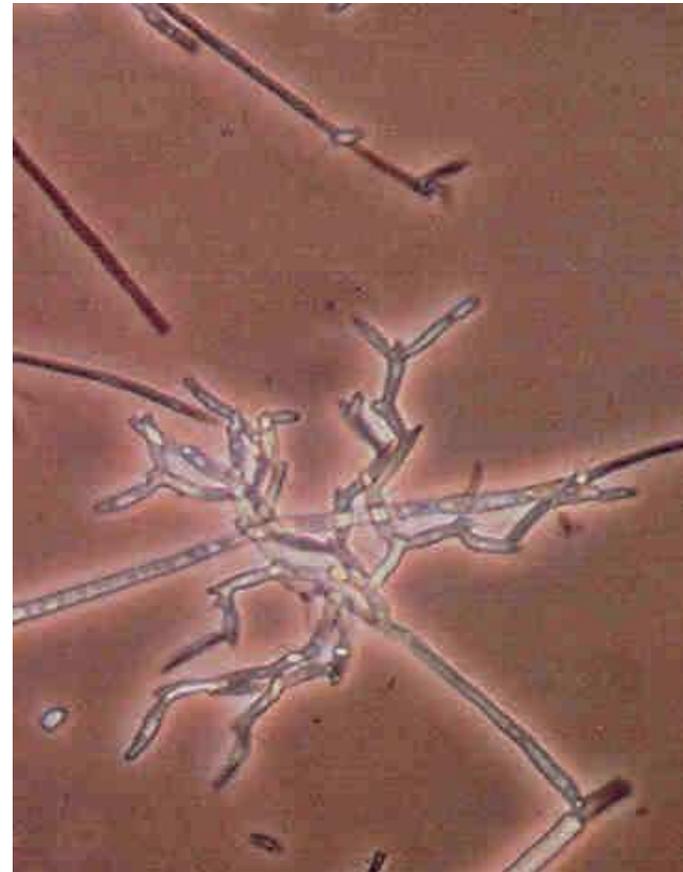
Garden Grove  
Garden Grove

**\* Intercepted Pests**

Compiled by Jeanenne White, CDFA, PPDC



Pitch Canker Disease of Monterey Pine, caused by *Fusarium circinatum*.



Polyphialides of *Fusarium circinatum*.

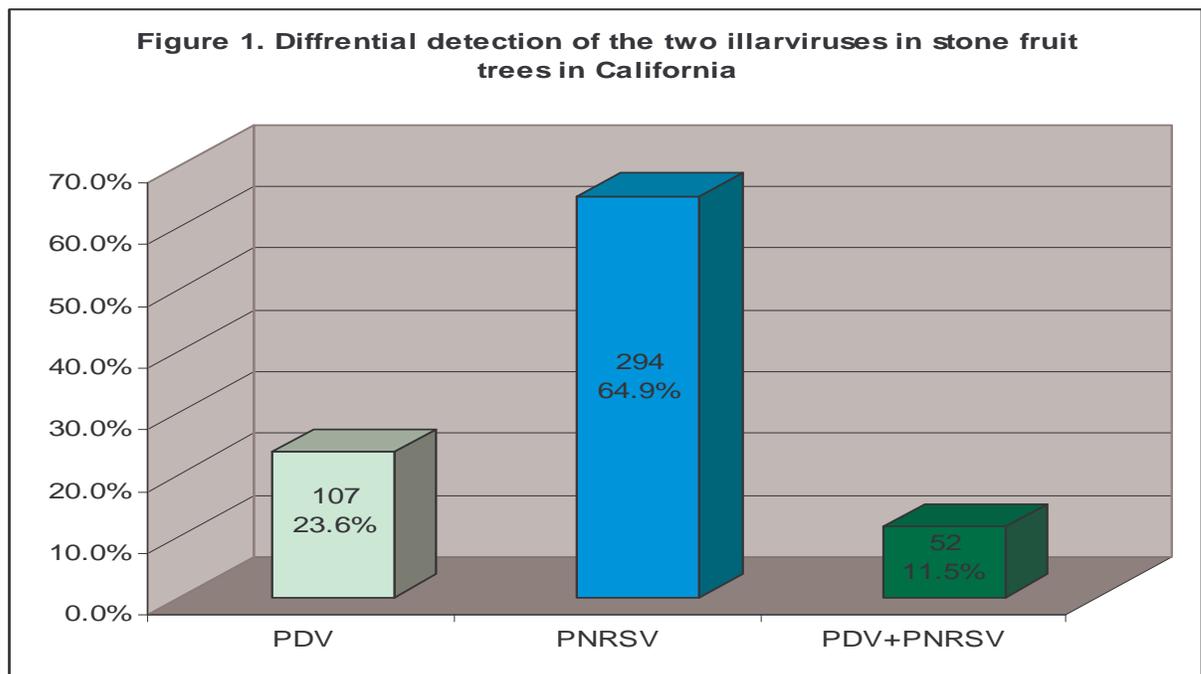
## NURSERY ANNUAL VIRUS SURVEY OF DECIDUOUS FRUIT TREE, NUT TREE, AND GRAPEVINE

YunPing Zhang, David Marion, Chris Banzhof, Jesus Estoque and Alex Ballesteros

Nursery, Seed and Cotton Program of Pest Exclusion branch administer the Nursery Registration and Certification program, which is supported by the California Fruit Tree, Nut Tree and Grapevine Improvement Advisory Board (IAB). IAB board allocates funds each year for annual survey of fruit tree and grapevine for specific viruses for the registered increase block which is then used to produce planting material for the industry.

The Nursery-IAB laboratory tested 47,218 stone fruit trees samples from 19 nurseries for Prune dwarf virus (PDV) and Prunus necrotic ringspot virus (PNRSV) in the year 2006. Most of the samples are from the nursery registration and certification program (47,218), 119 (0.31%) of which tested positive. There were also 8,193 service samples tested and 334 (4.08%) were positive.

Prune dwarf virus and Prunus necrotic ringspot virus are distinctive illarviruses. They each cause diseases with various types of symptoms among stone fruit trees. They can cause severe stunting on peach tree when mixed infected in same tree. We tested these two viruses in separate test to determine their distribution. Among all 453 positive samples by our combo test, 107 (23.6%) were infected by PDV, 294 (64.9%) were infected by PNRSV, and 52 (11.5%) were infected by both viruses (Figure 1). This result is consistent with previous year results in that PNRSV is the major virus infecting stone fruit trees in California.



Grapevine fanleaf virus was surveyed this year in the month of May. Each sample is composed of young shoot tips from five vines and tested with ELISA. Of the total of 1116 samples tested, none were positive.

Grapevine leaf roll associated viruses 2 and 3 were surveyed in the month of September to October. A total of 1532 grapevine samples were tested and 63 samples were tested positive for GLRaV 3 from three different nurseries. Remove of infected vines and adjacent vines in the certified blocks were advised.

Grapevine leafroll associated virus 7 is a newly discovered closterovirus infecting grapevines, which has not been fully characterized. With request from our biologist, the laboratory tested some grapevine clones for this virus by PCR. The virus was detected from some clones. Since the effect of this virus on grapevine has not been determined, no regulatory measures have been advised at this point regarding the infected vines in the field.

Acknowledgements: This project is supported by California Fruit Tree, Nut Tree, and Grapevine Improvement Advisory Board, Pest exclusion biologists, and participating nurseries.

THE EFFECT OF DORMANT SEASON SURVIVAL OF *XYLELLA FASTIDIOSA* IN  
GRAPEVINES ON PIERCE'S DISEASE EPIDEMICS IN CALIFORNIA

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Collaborators: J. Hashim, UCCE Viticulture advisor, Kern County, William Peacock,  
UCCE Viticulture Advisor, Tulare County

**Abstract:** The two California Pierce's Disease (PD) epidemics associated with population outbreaks of Glassy-winged Sharpshooter (GWSS), at Temecula in the mid-1990s and in Kern county, peaking in 2002, differed in the number of vineyards lost and the grapevine varieties affected. In Temecula, almost half of all vineyards of all varieties were lost to PD, whereas in Kern County only the vineyards of two varieties, Redglobe and Crimson Seedless, suffered losses; all the vineyards of the other four varieties were unaffected. A hypothetical explanation of this epidemiological pattern is that in those parts of California where the winters are more severe, dormant-season die-out of *Xylella fastidiosa* (*Xf*) is more likely, and only the earlier-season inoculations and infections survive the winter. The likelihood of *Xf* die-out is a function of both winter climate and varietal susceptibility. In Kern County, only the most susceptible varieties were affected by secondary (vine to vine) transmission, and early season primary transmission (where insect vectors acquire *Xf* from plant sources outside the vineyard) was of little consequence. Through field experiments, this project expands our knowledge of secondary transmission in the southern San Joaquin valley. The benefit to grape producers in this area will be twofold: 1) more accurate assessment of risk of economic loss from PD, and 2) suggestion of new integrated disease-management practices to control PD.

**Introduction:** The GWSS-associated PD epidemics in Temecula and in Kern County were the first instances of epidemic secondary transmission of PD in California since the Anaheim epidemic of 1885 – 1895. During the intervening 100+ years, losses from PD in California have resulted from primary transmission, and those losses have been economically manageable in most areas. In the General Beale epidemic in Kern county (which has a colder winter climate and longer dormant season than Temecula), only a small percentage of the vineyards were lost, and all of the lost vineyards were planted in only two of the six varieties in the area, Redglobe and Crimson Seedless.

The losses to vineyards of the other four varieties were very small—in most cases less than 1 in 10,000 vines. By contrast, all 12 of the Redglobe vineyards monitored in the General Beale area were significantly damaged, with a range of 2% to over 50% of the vines lost (Hashim, *et al*, 2003). Most of these vineyards were ultimately removed.

Grapevines acquire new *Xylella fastidiosa* (*Xf*) infections either by primary or secondary transmission. Primary transmission occurs when vector insects acquire the bacterium from source plants outside the vineyard, then fly into the vineyard to infect vines. Secondary transmission occurs when vector insects acquire *Xf* from an infected vine within the vineyard and then transmit the infection to other vines, known as vine-to-vine transmission.

The risks associated with these two kinds of transmission differ. The disease and vine loss pattern associated with primary transmission is linear; that is, a relatively constant number of vines per year become infected, so the yearly accumulation of PD vines increases additively and predictably. By contrast, the pattern of yearly accumulation of PD vines associated with secondary transmission is typically logarithmic, increasing as a log-function of the number of infected source vines that are present, so that entire vineyards can be lost within just a few years.

Secondary transmission cannot begin to occur until that time in the growing season when the bacterial cells in diseased vines have multiplied and moved within the vine; the cells travel from the refuge site, where they survived the dormant season, up into the new growth where vector insects can feed and acquire them. Secondary transmission of infection can then continue until the end of the growing season. However, infection does not equal disease. The phenomenon of over-winter curing of *Xf* infections is well-documented in most viticulture areas of California (Fiel *et al*, 2003). Early-season inoculations can result in infections which survive the dormant season and progress to chronic disease and vine death. Conversely, later-season infections do not become sufficiently established to survive the dormant season, and the vines are free of infection the following year (Fiel *et al*, 2003).

In most viticulture areas of California (Napa and Sonoma Valleys, for example), secondary transmission of infection regularly occurs, but it cannot begin early enough in the season for the infection to survive vine dormancy and progress to chronic PD. In these areas, secondary transmission occurs but does not result in disease.

We propose that in the General Beale area, secondary transmission of infection occurred in all varieties, possibly infecting large numbers of vines in every vineyard. The rate of *Xf* multiplication and movement varies within plant hosts (Hill and Purcell, 1995) and among grapevine varieties. In the most susceptible varieties, Redglobe and Crimson, the rate of bacterial multiplication and movement was faster, so the result was that the bacteria had a window of opportunity some time in mid-season when secondary transmission could progress to disease. Secondary transmission of infections could not occur before this time window, and secondary transmission of *Xf* after this time window did not survive vine dormancy. Thus, in the two susceptible varieties some, but not all, of the secondary infections progressed to chronic disease.

In the resistant varieties, however, by the time secondary transmission could begin, it was too late for the infections to become well enough established to survive vine dormancy, and virtually all of those infections died out, leaving the vines free of disease the following year. This is illustrated in the two hypothetical Figs 1 & 2 below. The position and shape of these two curves can be a function of the severity of winter climate, the length of the growing season, and the varietal susceptibility. Favorable factors (such as a short, mild dormant season) would move the curves toward each other, resulting in a greater probability of overlap —thus a bigger window of opportunity when secondary transmission would result in chronic disease. In the General Beale area, most of the varieties would be “resistant” to secondary transmission of PD (curves shifted apart); thus the vineyards were not lost to disease. Those same varieties, if grown in the Temecula area, would have the curves shifted toward greater overlap, and the varieties could then be lost.

Fig 1

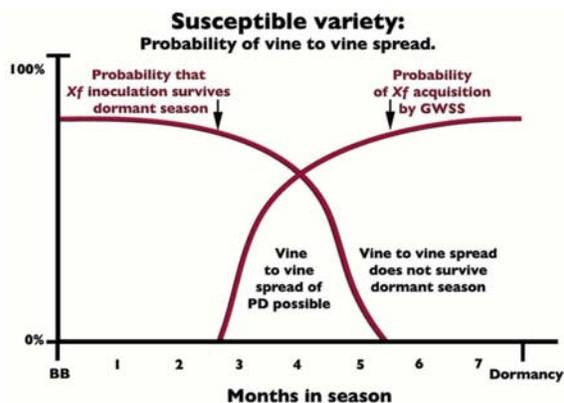
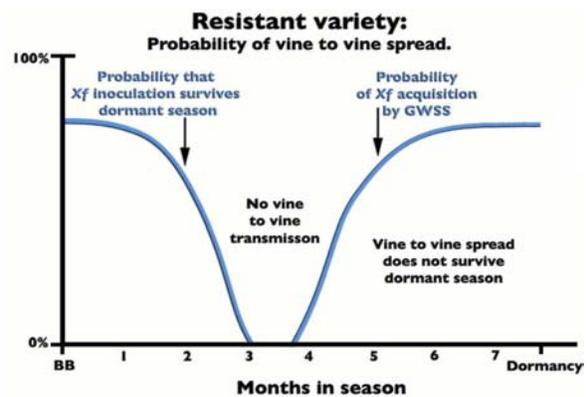


Fig 2



This project addresses the dynamics of secondary transmission in the southern San Joaquin valley. Previous work (Fiel *et al*, 2003) has examined the left-hand curve, dormant season survival by time of inoculation. However, little is known of the right-hand curve, probability of acquisition by GWSS with regards to time. Because of concerns about the possible transmission of PD to commercial vineyards, it was not possible to pursue the best experimental designs using insects to transmit *Xf*, nor to do the experiments in commercial vineyards in either Kern or Tulare Counties. Perhaps the only possible project site, a 3.2-acre vineyard on the University of California Kearney Research and Extension Center at Parlier, CA, was available, and using this site enabled us to begin experiments that might not otherwise have been done. This site had mature vines of two varieties, Thompson Seedless and Selma Pete (a table/raisin variety similar to Thompson). For the first time, we were able to examine the effect of varietal differences on our theoretical curves.

In addition, 850 mature Thompson vines were cut about 40 cm above the ground and were grafted with Red Globe, Thompson, and Princess in 2005. In three years when these vines are mature enough, other experiments can be done to further understand the influence of varietal differences on secondary transmission and over-winter survival of *Xf*. The projects discussed herein, with other projects that build on these concepts, will help extension advisors and growers devise new integrated disease management practices for PD.

#### Objectives:

Objective 1 is to follow over-winter survival of *Xf* associated with time of inoculation by needle-inoculating 20 to 35 vines at a time, of each variety, at twice-a-month intervals for 4 months beginning on May 1, 2005. Confirm all resulting infections by ELISA testing of each vine during the year that they are inoculated. Test all vines in late season 2006 to determine whether the infections persisted over the dormant season.

Objective 2 is to determine the time of detection of *Xf* in foliage in 2006. In May 2005, 60 vines of each variety would be needle-inoculated. At 2X per month intervals in 2006, all 120 vines to be sampled where *Xf* is most likely to appear in the new foliage to determine when *Xf* is detectible. Test all samples by ELISA, and store a part of each sample at minus 80<sup>0</sup>F for possible future PCR testing.

Objective 3 is to graft 850 mature Thompson vines with 3 varieties of differing PD susceptibility to enable future experiments in this vineyard about the influence of varietal differences on secondary transmission.

Results: Objective 1: The 180 Selma Pete vines used in these over-winter survival experiments were grafted in 2001 about 30 cm above the ground on to mature Thompson vines. These Selma Pete vines, now in their fourth growth year, and another 220 Mature Thompson Seedless vines were needle-inoculated in 2005 at twice-per-month intervals beginning at the May 1 through the middle of August, for a total of eight inoculation times. The inoculated vines were tested in late 2005, and the inoculations were 100% effective in producing infections in the vines. Each vine was inoculated in two places on opposite sides of the vine (different cordons) on first-year growth about 15 cm from old wood. At each inoculation site, both a petiole and the stem were inoculated with droplets containing ca. 10<sup>7</sup> *Xf* cells from a 9-day-old culture. The over-winter survival of the resulting infections is shown in Fig 3.

Objective 2: The samples for testing the time of *Xf* detection in the new foliage in 2006 were petioles taken from the site considered most likely to be where the bacterium would appear first, whenever possible from the base of the cane that was inoculated the previous year. Because each vine had two inoculation sites, two sites were sampled for each vine, and 60 vines produced 120 samples. In many vines, one side of the vine began testing

positive several weeks before the other side. Even on August 18, the samples from one side were still testing negative in 24 vines of Thompson and four vines of Selma Pete, respectively.

On June 14, petiole samples were collected from six vines that had tested positive on June 1 (three vines each of Thompson and Selma Pete). One basal petiole was tested from each new shoot, growing from old wood within 15 cm of the trunk. A positive petiole would mean that *Xf* was present in the basal portion of the cane. The Thompson and the Selma Pete had *Xf* in 5% (3 of 58) and 19% (12 of 62) of the canes respectively.

Fig 3

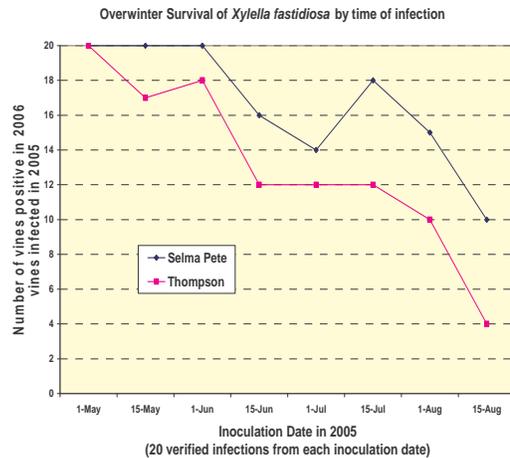
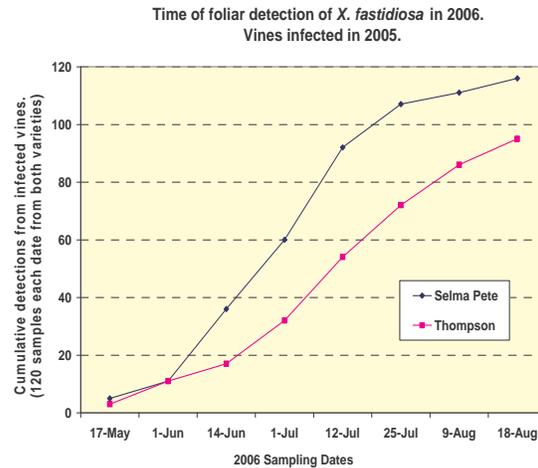


Fig. 4



Discussion: Discussion: The over-winter survival experiment (Fig. 3) was designed to represent the worst-case possibility, and therefore the results do not represent what might occur in an actual field situation, nor do the results agree with previous work at Kearney (Feil et.al., 2003). We chose to inoculate the base of the canes vs. more distal sites because the severity of the GWSS vectored PD epidemics has been in part attributed to the possibility that GWSS can feed (and therefore acquire and inoculate) at the base of the cane. Mid season basal inoculations are more likely to result in infections that survive the winter than more distal inoculation sites. We inoculated each site with a very large number of cells to insure that all inoculations would result in infections. We inoculated multiple millions of bacterial cells per inoculation into the xylem, compared to inoculations by GWSS or another vectors that might introduce a few (<100) cells. Our resultant curves (Fig. 3) were skewed far to the left in comparison to previous work at Parlier. Feil et.al. (2003) found that infections resulting from basal insect inoculations in July survived the winter, but none of their August inoculations, whether by insect or needle, or basal or distal, resulted in infections that survived. Our work is, however, the first case of comparing the differences in over-winter survival of *Xf* as a function of varietal susceptibility, supporting the idea that more susceptible varieties result in over-winter survival curves that are shifted to the right. It may be that irregularities in the shape and position of the curves in Fig 3 are the result of using an excessive number of bacterial cells per inoculation. We will address these aspects in future inoculation experiments.

The “time of foliar detection” curves in Fig.4 are probably not affected by the decision to inoculate with a worst-case design, and probably do represent actual field epidemic situations. These curves show a difference between varieties in when the bacteria become detectable in the new growth, and this is consistent with the hypothesis about secondary transmission that is represented in Figs. 1 & 2.

Putting together the information from Fiel et.al. (2003) and our Fig.4, we would predict that the window of possibility for secondary transmission that survives the following winter may begin in early June and end by early August. However possibility is not the same as probability, and epidemics are stochastic phenomena. When *Xf* is first detected it is present in only a small part of the total canopy; and it is highly patchy. Also in mid June only a small proportion of the canopy of chronically infected vines have detectible *Xf* in the foliage, where it would be available for vector acquisition. Therefore the target area, both in the vineyard and on the vine, where acquisition feeding might occur in mid June is a very small part of the total vineyard or canopy, especially compared with the target area in August and beyond. Also in mid June to August the target area where an infective vector must feed in order to inoculate a vine with an infection that survives the winter is a small and continuously shrinking portion of the canopy of a vine.

The fact that GWSS can feed at the base of canes in July and August does not speak to the probability that GWSS would prefer to feed at these target sites and search for them preferentially. Furthermore we know of no evidence that in mid summer GWSS prefers a basal feeding site (where either acquisition or inoculation might be successful) over the more available and vigorously growing outer parts of the canes. GWSS flying onto an infected vine in July would have a very small probability of randomly encountering a target feeding site that would result in acquisition. This raises the question why did secondary transmission play such a big role in the Temecula epidemic and in the susceptible varieties in the General Beale epidemic? We propose that the most important epidemiological factor, in addition to the ability of GWSS to feed at the base of the canes, is simply the extraordinarily high numbers of GWSS that occurred in these epidemics. One or a few GWSS landing on a vine may be very unlikely to acquire *Xf*, but when hundreds or even thousands of GWSS per vine are feeding and actively moving among the vines, the probability of *Xf* acquisition and transmission by a percentage of these GWSS becomes larger. This may be enough to explain the kind of secondary transmission that was observed. Also the effect of variety on shifting the shape and position of the curves as represented in Figs 1 & 2 may explain the varietal difference observed in the General Beale epidemic.

Fig. 4 represents new information. It does not however quantify the probability (vs. the possibility) that GWSS will acquire *Xf* by feeding on an infected vine. Our future efforts will be directed toward determining the geometric features of the target feeding area in an infected vine, and in exploring the behavioral feeding preferences of GWSS in the mid season. This will help to interpret the curves in Fig. 4 and to come closer to predicting a more realistic position and shape for the theoretical acquisition curve postulated in Fig. 2. The research vineyard at Kearney provides an opportunity to pursue these goals.

**Conclusions:** The results of these experiments support the hypothesis for secondary transmission that is represented in Figs 1 & 2 above, namely that the two curves which represent: (1) the probability that an *Xf* infection survives the dormant season, and (2) the probability of *Xf* acquisition by a vector must overlap for secondary transmission of *Xf* to survive dormancy and progress to PD. The experiment concerning time of foliar detection of *Xf* in previously infected vines provides some limits on when such overlap of these curves can begin, and previous work suggests the probable end of the window. We now better understand the severe losses of the two recent Kern and Temecula epidemics, and strategies are emerging for timely, effective, and affordable control practices to predict and avoid such losses in the future. The benefit to grape producers in this area will be twofold: 1) more accurate assessment of risk of economic loss from PD, and 2) suggestion of new PD management practices. For example protecting vines during the window of overlap might reduce or eliminate secondary transmission of PD. Practices that use this epidemiological knowledge may be thought of as Integrated Disease Management, a

concept analogous to Integrated Pest Management that has been so widely adopted and successful.

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## CDFA PLANT PEST DIAGNOSTICS SCIENTISTS EDUCATE STUDENTS AT ANNUAL STATE SCIENTISTS DAY EXHIBITION



Dr. John Chitambar of the PPDC Nematology Laboratory ponders a question posed by a student at State Scientists Day, while others examine laboratory displays and demonstrations.

Each year since State Scientists Day was founded in the late 1980s, the CDFA Plant Pest Diagnostics Center has participated in this annual educational outreach event every May by sending several of our scientific and technical staff to the grounds of the California State Capitol in Sacramento, California, to set up educational displays and demonstrations that include real specimens to stimulate and stoke the fires of scientific curiosity in the minds of literally thousands of young science students who travel from all over the state to attend this event. Hands-on displays of mounted insects, live exotic plants, and microscopes set up for viewing specimens of seeds, nematodes, and fungi always stimulate interesting discussions, questions, and great interest among both students as well as with their science teachers. The hope is that students, exposed to the exciting world of real, everyday applied science will have a greater appreciation of the sciences, and perhaps even develop the same love of and enthusiasm for science that they see modeled by all the science professionals at State Scientists Day.

## LABORATORY SCIENTISTS PROVIDE TRAINING FOR CDFA BORDER STATIONS

Several Diagnostic Scientists from the Plant Pest Diagnostics Center traveled to the various CDFA Pest Exclusion Border Stations this summer to provide training to their inspection partners working at the borders. Mark Stirling, a supervisor of Pest Exclusion's border station program, led the tour. The training consisted of PowerPoint presentations on the recognition of invertebrate and weed seed pests, and plant diseases. Specialized training was provided in photography of invertebrates and seeds for the digital identification program, in which high-quality digital images taken by border station staff are emailed to laboratory scientists, sometimes enabling them to make identifications in minutes as opposed to days.

During the border station tours, Entomologists Rosser Garrison, Gillian Watson and John Sorensen shared the entomology training. Dr. Watson covered recognition of sap-sucking insects (scale insects and mealybugs, aphids, psyllids, whiteflies and thrips), while Dr. Sorensen focused on differentiation between some native and exotic species of ants, with a special emphasis on fire ants including the infamous red imported fire ant (RIFA) in all its forms. Dr. Garrison covered a wide range of other insect groups, and other invertebrates like slugs and snails.



Gillian Watson, Insect Biosystematist, instructs inspectors from Blythe and Vidal Inspection Stations on the recognition of thrips injury to various plant parts.

Jim Effenberger, Seed Botanist, discussed the identification of seeds, particularly those of noxious weeds not known to occur in California. He explained how to use a new seed

identification guide prepared for border station use by the seed laboratory staff. A seed identification folder was provided for each border station.



Seed Botanist Jim Effenberger explains how to use a new seed identification guide book prepared by CDFA PPDC Seed Laboratory staff specifically for the border stations.

Plant Pathologists Dan Opgenorth and Tim Tidwell visited the northern and southern California stations respectively. They provided basic training in the recognition of Plant Diseases, including some high-profile diseases of citrus and stone fruits. They also covered proper sampling and appropriate packaging of disease specimens for sending to the diagnostic laboratory.

An important benefit of the training tours was that the training went both ways. The laboratory scientists also received an education in the often high-pressure job of the inspectors, by spending the afternoons after the morning training sessions “out on the line” with the inspectors at several border stations. They quickly developed a healthy respect for the inspectors, and an appreciation of the often-adverse conditions under which they perform their jobs with skill and professionalism. The lab scientists and Mark Stirling spent time with the inspectors at the station cutting and examining fruit, looking through nursery stock and inspecting trucks.



Plant Pathologist Tim Tidwell and Pest Exclusion Supervisor Mark Stirling assist Inspector Patricia Duarte at Vidal Station, examining limes from Mexico for pests.



John Sorensen, Insect Biosystematist, confirms a RIFA identification on-site at Vidal Inspection Station.

While the lab scientists were visiting Vidal station, a truck from Texas rolled up carrying a seemingly innocuous load of rolled plastic. The young inspector at the Vidal station had the driver open the truck for inspection and found exactly what she suspected she might find - fire ants. The ants stung the inspector— a routine hazard of the job. Since John Sorensen was among the visiting group, he quickly examined the ants microscopically and confirmed the identification on-site: *RIFA*. This set a new record for the fastest turn-around for a border station identification! The trucker elected to go to Blythe for fumigation of his load.

The 2006 border station training tour was a major success on all fronts. Station inspectors received valuable training, and lab scientists got an accurate picture of this vital part of the Plant Health and Pest Prevention Services. As a result, both groups have a much clearer vision of the “team” that together they comprise, and a better appreciation for the difficulties and nuances of one another’s jobs. It also opened wide the door of creativity and promoted an exchange of ideas so that both groups will be better able to better assist one another in the common goal of excluding unwanted pests from California.

All photographs were taken by Barbara Effenberger.

## STATE SCIENTISTS HELP MEADOWVIEW AREA SCHOOL WITH “GIVING TREE” CHRISTMAS PROJECT

The Meadowview region of South Sacramento is an inner-city area of Sacramento known for gangs, violence, and poverty. It is also the neighborhood where the California Department of Food and Agriculture’s Plant Pest Diagnostic Center (PPDC) Laboratory is located. Last Christmas, the Laboratory staff adopted a local Meadowview area school by creating the “Giving Christmas Tree.” Instead of decorating the Lab’s annual Christmas tree with traditional ornaments, school supplies and other needs specified by the school were used to decorate the tree and then were presented to the school. In 2006 the PPDC Laboratory adopted Mark Hopkins Elementary School, a local grammar school in which, according to Principal Laura Reed, 97% of the students are from families at or below poverty level. Building good character is a high priority at Mark Hopkins Elementary, and one particular program at the school that is especially intriguing is the “Caught you being good” program, in which good behavior is recognized and affirmed by awarding students “Husky Bucks” (the Husky is the school mascot) for situations in which they are covertly “caught” by teachers or staff in the act of demonstrating good behavior such as showing courtesy, being helpful, or voluntarily doing something positive for the school such as picking up trash. Periodically the students have opportunities to redeem their Husky Bucks in the school store for various toys and other items. Unfortunately, the store items used for these rewards are not funded by the school’s frugal budget. Consequently, the school relies on donations, or the teachers themselves purchase items to keep this and other such proven incentive programs afloat. The PPDC Lab staff responded by decorating this year’s Christmas tree with toys and games to stock the shelves of the school store so that programs like “Caught you being good” can continue to affirm students’ good behavior. Other items provided by the Lab staff included head phones for computers, and white shirts that are given away at the school to ensure that students always have the proper school uniform—a proactive measure to guard against the intentional or unintentional wearing of gang colors, which could precipitate problems in the neighborhood. The toys, shirts, and headphones donated by the lab will serve the 400-plus children throughout 2006. In addition to the Giving Tree, the school’s 6<sup>th</sup> grade science students were given a tour of the PPDC Laboratory and interacted with professional scientists and technical staff in a fascinating environment of Insect, Plant, and Seed collections, and even got a first-hand look through an electron microscope. Students learned that by staying in school, and getting a few science classes under their belt at the local Junior College, they could qualify to come and work in the PPDC laboratory themselves in a few short years.



(Left) Seed Botanist Riad Baalbaki demonstrates seed germination techniques to science students of Mark Hopkins Elementary School. (Right) Plant Pathologist Tongyan Tian explains the workings of the transmission electron microscope to the students.

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**Winterton, S.L.** (2006) New species of *Eupsilocephala* Kröber from Australia (Diptera: Therevidae). *Zootaxa*, 1372: 17-25.

Walter D.E. & **Winterton S.L.** (2007) Keys and the Crisis in Taxonomy: Extinction or Reinvention? *Annual Review of Entomology*, 52: 193-208.

**Winterton, S.L.** (2006) Aberrant wing venation in *Apochrysa lutea* (Walker) (Neuroptera: Chrysopidae: Apochrysinae) from Australia. *Australian Entomologist*, 33: 143-146.

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**Winterton, S.L.** & **Kerr, P.K.** (2006) A new species of *Alloxytropus* Bezzi (Diptera: Scenopinidae: Proratinae) from Israel. *Zootaxa*, 1155: 41-50.

**Winterton, S.L.** & **J. Scher** (2006) 'Aquarium and Pond Plants of the World. 2<sup>nd</sup> edition'. Lucid key. Animal and Plant Health Inspection Service (APHIS), United States Department of Agriculture (USDA), ver 1. (CD publication). [Revised and upgraded version of the previous interactive key to world genera of aquatic plants traded in the aquarium and pond plant industry for quarantine officials].

## 2006 PRESENTATIONS BY CDFA PPDC STAFF

**Baalbaki, R.** Setting up a seed lab in Lebanon. The CDFA Annual Seed Workshop and the California Seed Industry Conference, Woodland, CA, May 17 – 19, 2006.

**Bellamy, C. L.** "Is prettiness a valid character state?". CDFA PPDC Seminar series, Sacramento, CA, May 18, 2006.

**Cline, Andrew R.** Invited seminar: "Exploring Arthropod Diversity in a Lowland Tropical Forest: A Study from the San Lorenzo Protected Area in Panama." Montana State University, Bozeman, MT.

Elias, S. and **D. J. L. Meyer.** Tolerances in seed purity analysis. Research Session, Association of Official Seed Certifying Agencies/Association of Official Seed Analysts/Society of Commercial Seed Technologists Annual Meeting, Indianapolis, IN, June 2 – 8, 2006.

**Effenberger, J.** Identification of onions, leeks and chives. The CDFA Annual Seed Workshop and the California Seed Industry Conference, Sacramento, CA, May 17 – 19, 2006.

**Effenberger, J.** California noxious weed pest propagules. Border Station Training Sessions: Truckee, August 15 – 16; Hornbrook, September 19 – 21; Blythe, October 2 – 3; and Needles, October 5 – 6, 2006.

**Epstein, M.E.** Limacodidae along the Barva transect. Symposium: Tropical Arthropod Diversity from Sea-level to Cloud Forest: Project ALAS results from the Barva Transect. National Meeting of the Entomological Society of America, Indianapolis, Dec. 10, 2006.

**Gaimari, S.D.,** & M.S. Anderson. Raman-atomic force microscopy revealing nanometer-scale morphology and spectro-chemistry of the ommatidial surfaces of Dipteran compound eyes. VIth International Congress of Dipterology, Fukuoka, Japan.

**Gaimari, S.D.** Dipterology in an island paradise: Trekking through Fiji looking for lauxaniid flies. CDFA-PPD Seminar Series, Sacramento, CA.

**Gaimari, S.D.** One less acalyptrate family? The status of Eurychoromyiidae. VIth International Congress of Dipterology, Fukuoka, Japan

**Garrison, Rosser;** "*Insects from around the world-a photographic journey*" CDFA PPDC Seminar series, Sacramento, CA, September 22, 2006.

- Hauser, M.** "Scientific illustrations with Adobe Illustrator" Workshop, Department of Entomology, Iowa State University, Ames, IA. April 2006
- Hauser, M.** "*The basal radiation of Stiletto Flies - Evidence from time and space*" Oral presentation, Entomology seminar series, Iowa State University, Ames, IA. April 2006
- Hauser, M.** "Dipterological research in Madagascar" Oral presentation, Museum for Natural History Stuttgart, Germany. July 2006.
- Hauser, M.** "Mysterious Madagascar" Seminar series, CDFA, Sacramento, California. January 2006
- Hrusa, G.F.** Systematics and Evolution of *Rhododendron occidentale* (western azalea). 10-18-2006, McKinley Center, Sacramento. For the California Native Plant Society.
- Meyer, D. J. L.** General Blower calibration based on air velocity measurement. The CDFA Annual Seed Workshop and the California Seed Industry Conference, Woodland, CA, May 17 – 19, 2006.
- Meyer, D. J. L.** Seeds and fruits of small seeded legumes. The CDFA Annual Seed Workshop and the California Seed Industry Conference, Sacramento, CA, May 17 – 19, 2006.
- Meyer, D. J. L.** Identification of California noxious weed pest propagules. Oregon State University Seed Workshop, November 29, 2006.
- Meyer, D. J. L.** 2006. Cover illustration: 'Georgia Green' peanut, *Arachis hypogaea* L., seedlings showing normal development at day 6 of germination test. *Seed Technology*, Vol. 28(1).
- Meyer, D. J. L. and J. Effenberger.** Poster: Seed morphology of *Cuscuta* spp. (dodders), *Physalis* (ground cherry) and *Solanum* (nightshades). Seed Issues Forum, Association of Official Seed Certifying Agencies/Association of Official Seed Analysts/Society of Commercial Seed Technologists Annual Meeting, Indianapolis, IN, June 2 – 8, 2006.
- Peterson, P.** Normal and abnormal seedling structures in large seeded legumes: bean, chickpea, cowpea, horsebean, lima bean, pea, soybean and vetch. The CDFA Annual Seed Workshop and the California Seed Industry Conference, Sacramento, CA, May 17 – 19, 2006.
- Rooney-Latham, S.** Demystifying Esca: Recent findings on an ancient and elusive disease of grapevines CDFA PPDC Seminar series, Sacramento, CA, November 14, 2006.
- Shen-Horn, Yen and **M.E. Epstein.** Homology of copulatory structures of the Zygaenoidea, with special reference to genitalia reduction and functional morphology in Zygaenidae. Symposium: Genitalic Homology Challenges in the Lepidopteran Tree of Life. National Meeting of the Entomological Society of America, Indianapolis, Dec. 13, 2006.

**Scher, J.** "Introduction to Lucid Keys." WPDN, UC Davis Regional Center, Insect Identification Workshop: Homoptera, March 22, 2006, Davis, CA.

**Subbotin S.A.** *Molecular systematics of cyst-forming nematodes.* CDFA PPDC Seminar series, Sacramento, CA, July 12, 2006

**Tidwell, T.E.** The role that seed laboratories play in issuing a phytosanitary certificate. California Seed Industry Annual Conference, Woodland, CA, May 24, 2006.

**Tidwell, T.E.** 2006 California Tree Disease Summary. California Forest Pest Council Annual Meeting, Woodland, CA. November 14, 2006.

**Watson, G.** Integrated Pest Management of Cotton in Asia. CDFA PPDC Seminar series, Sacramento, CA, January 8, 2006.

**Winterton, S.L.** Integrated, multinational study on stiletto flies (Diptera: Therevidae): an example from the NSF (PEET) program. Pacific Coast Entomological Society. February, 2006.

**Winterton, S.L.** The ancestral lacewing had an aquatic larval stage: molecular Phylogeny and historical divergence time estimates for Neuropterida (Insecta: Neuroptera, Megaloptera, Raphidioptera). University of California, Davis, Department of Entomology seminar series. March, 2006.

**Winterton, S.L.** The position of Diptera in the Holometabola: Evidence from multiple nuclear genes. 6<sup>th</sup> International Congress of Dipterology, Fukuoka, Japan. September, 2006.

**Winterton, S.L.** Evolution of the therevoid clade (Diptera: Asiloidea) with special emphasis on window flies (Scenopinidae): a total evidence approach. 6<sup>th</sup> International Congress of Dipterology, Fukuoka, Japan. September, 2006.

**Winterton, S.L.** The future of multimedia: electronic and internet resources for Asiloidea research. 6<sup>th</sup> International Congress of Dipterology, Fukuoka, Japan. September, 2006.