Plant Pest Diagnostics Center Annual Report 2010

Tribulus terrestris *L.* or puncturevine (Zygophyllaceae) is a C-rated noxious weed pest and Restricted Noxious Weed Seed in California. The fruit consists of five seed-bearing segments that break apart at maturity. Each segment contains 3 to 5 seeds and has two stout spines that can inflict painful injury to humans and animals. The foliage contains saponin compounds that can be toxic to livestock when ingested in sufficient quantity. The plant is native to the Mediterranean region and is considered a noxious weed in most western states.

Contents

Credits

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Annual Report 2010
Plant Pest Diagnostics Center

OBJECTIVE

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.
- Social Responsibility expressed by a commitment to service of the local community's grade schools and colleges, as well as agricultural, gardening and civic organizations.

BACKGROUND

For more than eighty years, the Plant Pest Diagnostics Center (PPDC) has provided timely and accurate diagnostics of plant pests and diseases in support of the pest prevention programs of the California Department of Food and Agriculture. PPDC includes five laboratories: Botany, Entomology, Nematology, Plant Pathology and Seed Science which collectively employs about 50 permanent and 30 seasonal employees. The laboratories serve as a scientific resource and provide professional expertise to a number of clients including 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. The PPDC is the National Plant Diagnostic Network's (NPDN) recognized expert lab for the western region and provides diagnostic service and support to the NPDN and its partners. PPDC scientists, technicians and support staff strive to provide excellence in service and leadership in plant pest diagnostics and biosystematics. More information about PPDC is available at: http://www.cdfa.ca.gov/plant/PPD/

Diagnostics

Table 1 depicts the number of samples and specimens identified by the laboratory in 2010 that were submitted through the Pest and Damage Record (PDR) system, as compared with previous years. Most programs include special surveys or projects that generate additional samples that cannot be easily tracked by PDR numbers. Note that sample numbers are not comparable among the different disciplines (labs/programs) as an accurate comparison of workload since the time and work required to diagnose or identify different types of samples varies widely from lab to lab and even sample to sample.

Table 1. A comparison of numbers of samples received by the California Department of Food and Agriculture (CDFA) Plant Pest Diagnostics Center over the last six years.

Labs/Programs	2005	2006	2007	2008	2009	2010
Botany [1]	1,000	1,474	1,029	1,682	1,167	1,037
Entomology [2]	50,000+	50,000+	65,000+	70,000+	80,000+	85,000+
Nematology [3]	4,923	7,912	8,648	5,870	7,864	7,293
Plant Pathology [4]	103,451	87,434	78,872	90,531	92,218	120,262
Seed [5]	3,166	5,791	2,427	1,843	3835	4,245
Total	162,540	152,611	155,976	169,926	185,084	217,837
Yearly Change	– 2.2 %	– 6.1 %	+ 2.2%	+ 8.2%	+ 8.9%	+17.7%

[1] An additional 2,303 plant specimens were identified for curation and addition to the Plant Pest Diagnostics Botany Herbarium in 2010

[2] Estimate of actual specimens examined, but does not include the 100,000+ specimens of LBAM in 2010.

[3] 2010 figure includes Quarantine samples, Nursery Registration & Certification samples, USDA Survey Project samples, as well as Diagnostic samples.

[4] 2010 figure includes 64,487 samples tested for several target viruses as part of the California Deciduous Fruit Tree, Nut Tree, and Grapevine Improvement Advisory Board (IAB) program; 22,039 Sudden Oak Death (SOD) samples; 9,111 plant samples and 3,800 Asian Citrus Psyllid samples tested for the Huanglongbing (HLB) pathogen; 6,461 samples tested for Citrus Trizteza Virus; 23,475 samples tested for the Plum Pox Virus Survey; 178 samples tested for the Sweet Orange Scab Pathogen, Elsinoe australis; and 29,670 for general diagnostic plant pathology.

[5] Quarantine, phytosanitary and noxious weed seed examinations require identification of 25,000 seeds per sample. Purity analyses require identification of 2,500 seeds per sample. Thus in 2010 the total number of seeds or other propagules actually examined for identification exceeded 16,700,000. Germination tests require the evaluation of 400 seedlings per sample; thus the total number of individual seedlings evaluated for germination tests was approximately 365,600.

Research

The scientists at PPDC continue to conduct research and publish scientific papers as part of the branch mission. PPDC staff published 48 scientific papers, books, manuals or other publications in the past year. In addition, 42 oral presentations and/or posters were given at various professional meetings, seminars, and training workshops. A list of scientific publications and presentations for 2010 are included at the end of this report.

Seminar Series

The Plant Pest Diagnostics Center seminar series began in 2004 with the goal of sharing information on any aspect of basic or applied research and diagnostics. Invited speakers come from within CDFA and various other institutions.

The seminar series continued through 2010, with fourteen presentations, representing the regular monthly seminars and two special seminars, given during the year. Speakers included scientists from the PPDC and other CDFA branches as well as the USDA-APHIS, the University of California at Davis and Riverside, the University of California Cooperative Extension, Stoller USA and Corpoica (Corporación Colombiana de Investigación Agropecuaria).

- **Dr Lynn Kimsey** (UC Davis Entomology Department)
  "Anthropogenic impacts on insect biodiversity: heat and insanity in Imperial County" - 21 January
- **Steven Koike** (Plant Pathology Farm Advisor, U.C. Cooperative Extension)
  "Novel and Interesting Plant Disease Developments in Coastal California" - 18 February
- **Prof. Richard Stouthamer** (UC Riverside Entomology Department)
  "Use and misuse of molecular markers for insect identification and biological control" - 1 March
- **Lance Beem** (Stoller USA)
  "Impact of Plant Hormone and Flavonoid Regulation on Insect Pests" - 18 March
- **Dr Charles Bellamy** (CDFA/PPDB Entomology)
  "Insect diversity in Southern Africa: beetles and plants of the succulent Karoo" - 22 April
- **Dr Jinya Qiu** (USDA-APHIS)
  "Technology of real-time PCR detection of soil nematodes & its potential use in the CAPS survey program" - 27 May
- **Dr Natalia von Ellenrieder** (CDFA/PPDB Entomology)
  "Argentina's biogeography: examples from the insect realm" - 23 June
- **Dr Dean Kelch** (CDFA/PPDB Botany)
  "Evolution in the tropical conifer family Podocarpaceae" - 15 July
- **Dr Takumasa Kondo** (CORPOICA, Colombia)
  "Scale insects on avocados in Colombia" - 5 August
- **Dr David Morgan** (CDFA Pierces' Disease Program)
  "Glassy Winged Sharpshooter Biological Control" - 19 August
- **Dr Louie H. Yang** (UC Davis) "Resource pulses in time and space: periodical cicadas, hurricanes and some thoughts for the future" - 16 September
- **Dr Robert Price** (CDFA-PPDB Seed)
  "Diversity and Relationships of the Temperate Zone Conifers" - 21 October
- **Dr Barry Hill** (CDFA/PPDB Plant Pathology)
  "Pierce's Disease Epidemiology II: what Barry did next..." - 18 November
- **Baldo Villegas** (CDFA/Integrated Pest Control)
  "The status of new weed biological control projects" - 15 December

California State Collection Of Arthropods

2010 Report

The California State Collection of Arthropods (CSCA) is a scientific resource for the local, state, 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 Center, and serves as the primary resource for our mission of insect identification and diagnostics. Two curators, a collection manager, and the entire scientific staff directly supervise the care, use, growth and development of CSCA by 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 website: http://cdfa.ca.gov/plant/ppd/csca.html.

The CSCA issued 18 loans in 2010 representing 3,085 specimens, and hosted 57 visitors from the local, national and international communities to study the collection on site. Visitors came from several North American institutions, including the USDA, Cornell University, Purdue University, the Natural History Museum of Los Angeles, and the State Departments of Agriculture of Idaho, Nevada, and Oregon. International visitors came from around the world including, the Natural History Museum of Denmark, Zoological Institute (St. Petersburg, Russia), National Museum of South Africa, National Taiwan University, and Australian Quarantine Services.

The total number of prepared specimens now exceeds 2 million, with approximately 100,000 prepared specimens accessioned in 2010. With the CSCA's blanket permit to collect arthropods in California's State Park system, several seasonal survey efforts were undertaken in 2010, including Grover Hot Springs State Park, Indian Grinding Rock State Historical Park, Bothe Napa Valley SP, and Annadel SP. At least 18 holotypes and numerous paratypes were deposited in CSCA in 2010, and the collection has been recognized as an important repository for certain groups of arthropods. While personal examination of types may always be necessary, there are plans to add multiple-view, high magnification and high resolution digital images to the CSCA Web page for each species held. CSCA's frozen tissue collection also continues to grow.

An inventory of the entire collection is nearly complete with more than 41,000 species recorded so far. In 2010, the curators were awarded a National Science Foundation grant in the Biological Research Collections program, for specimen-level databasing of certain California arthropod groups. This award is a collaborative project titled "CalBug," an interactive database using arthropods to examine impacts of climate change and habitat modification", with UC Berkeley (lead institution), UC Davis, California Academy of Science, and the San Diego Natural History Museum.

To accommodate interested vocational and avocational entomologists locally, regionally, and worldwide the CSCA has a Research Associate program. Through the associate program, PPDC encourages the use of the collection, the growth of the collection through respective donations, and allows associates to cite their status, if necessary, to provide an institutional address for publications or grants. Several additional scientists have applied to our program in 2010 and have been awarded this courtesy appointment. A list of Research Associates can be found on the branch website at: http://cdfa.ca.gov/plant/ppd/entomology/resassoc.html

The CSCA houses specimens used for reference and scientific study as well as educational purposes. LEFT: a drawer of pest specimens intercepted as they entered California. RIGHT: a display drawer full of exotic and local beetle specimens illustrates the variety of shapes, sizes, and colors found in this diverse group.

Plant Pest Diagnostics Center 2010 Highlights & Accomplishments

The following is a sampling of some of the accomplishments of the Plant Pest Diagnostics Laboratory from 2010. It is intended to reflect a few of the highlights of the year but is not an exhaustive list.

- The CDFA PPDC diagnostic laboratory provided timely and accurate identifications and diagnoses for over 200,000 pest specimens from numerous sources—municipal, private, and academic.
- Numerous new and novel molecular DNA tests were developed by CDFA PPDC scientists for accurate and early detection and identification of agricultural pests such as the Palm Wilt pathogen, several species of root knot nematodes, the Corn Stunt Phytoplasma and Western X Disease Phytoplasma in insect vectors, as well as various Stramenopile pathogens such as Downy Mildews and *Phytophthora* spp. This has reduced the diagnostic process from weeks to hours for many serious pathogens.
- In January, the PPDC lab hosted entomologist Dr. Soad Abdel-Razak from the Plant Protection Research Institute, Egypt Department of Agriculture who worked with Senior Insect Biosystematist Dr. Gillian Watson, identifying species of scale insects found in Egypt. This collaboration benefited CDFA by updating our awareness of pest species known from the Mediterranean Region, an area climatically similar area to California.
- PPDC staff continued to average greater than 40 peer-reviewed scientific publications and oral presentations per year.
- In January, Senior Plant Pathologists Dr. Suzanne Rooney-Latham and Dr. Cheryl Blomquist confirmed the presence of *Stigmina palmivora* on fronds of a diseased palm sample that originating from Florida. The sample had been intercepted in Kings County by a dog team. *Stigmina palmivora* is an important foliage disease of many palm species, causing severe leaf spotting and frond necrosis. The disease has been found in Florida, Kenya, South Africa, Myanmar and Japan. There have been no previous reports of the disease in California.
- In February, Senior Insect Biosystematist Dr. Marc Epstein presented a workshop on identification of the European Grapevine Moth, *Lobesia botrana*, at the Los Angeles County Agricultural Commissioner's Office for entomologists from the Southern California counties, USDA, and CDFA employees including field trapping supervisors.
- Many PPDC State scientists continued to be active participants on professional committees and activities at state, university, federal, and international levels.
- In February, the Burrowing Nematode, *Radopholus similis* was detected in plant shipments of *Calathea* species imported from Florida and destined for San Mateo County, California. *Radopholus similis*, which is not present in California, is a high-risk and quarantine pest that lives within plant roots and is readily spread with infested plants. If infected plants had been allowed entry, the resulting establishment and spread of the nematode might have resulted in serious economic loss to California's citrus, strawberry, carrot and ornamental industries.
- Numerous "First Reports" were published for various invasive species new to California or the United States. These included peer-reviewed journal publications of pathogens, nematodes and insects new to California.

Sulfur cinquefoil, *Potentilla recta*, an A-rated weed specices intercepted in 2010. (Photo: Montana Statewide Noxious Weed Awareness and Education Program Archive, Montana State University, Bugwood.org)

- In March, the Annual California Nematology Workshop was held in collaboration with the University of California. This workshop is designed for pest control advisors and applicators, growers, farmers, retail and nursery employees, municipal, county and state employees, park and recreation personnel, educators, university educators and students, and consultants. State Nematologists were active in all aspects including strategic planning, development, presentations and discussions. In addition the Nematology staff presented seminars and classes throughout the year at the University of California, Davis and Riverside, State and County offices, International Universities, and local high schools.
- PPDC scientists continued to identify recurrent invasive species that are intercepted or detected in time for eradication within the state. 2010 identifications included the A-rated Cedar Apple Rust pathogen on an apple specimen from a vehicle originating from Shawnee, Oklahoma, and an A-rated peren-

nial weed, *Potentilla recta* (sulfur cinquefoil) which is listed as a noxious weed in several states, from Mad River, California in Trinity County. In addition, PPDC Botanists identified three different "A" rated species of *Centaurea* sp. (star thistles and knapweeds) in one week that had been intercepted at border stations.

- In March, A turnip sample with severe galling, grown by Master gardeners at the Fair Oaks Horticulture center in Sacramento, was submitted to the PPDC. The causal agent of clubroot, *Plasmodiophora brassicae*, was identified by CDFA Plant Pathologists Dr. Rooney-Latham and Dr. Blomquist from the resting spores present in root tissue. Clubroot, caused by a B-rated pathogen persistent in the soil, was inadvertently brought in on seedlings of a brassicaceous crop from a coastal county. Most Brassicas such as broccoli, mustard, radish, Brussels sprouts and cabbage are susceptible. Although occasionally detected in coastal regions, this was the first record of clubroot in Sacramento and the Central Valley.
- In April, the fungal pathogens *Pseudocercospora pseudoeucalyptorum* and *Teratosphaeria molleriana* (synonym: *Mycosphaerella molleriana*) were detected from eucalyptus samples causing leaf spots and defoliation of *Eucalyptus globulus* in Marin county. There are few reports of these pathogens in California but they are common foliar pathogens on Eucalyptus species worldwide. *Pseudocercospora pseudoeucalyptorum* and *Mycosphaerella marksii* were also detected from eucalyptus samples causing defoliation in San Francisco County. The detection of *M. marksii* was a new report for California. *Mycosphaerella marksii* has been primarily reported from Australia, but also from South Africa, Ethiopia and Indonesia. Senior Plant Pathologist Dr. Rooney-Latham made the determinations.
- In May, Scientists from the PPDC participated in the 22nd Annual State Scientists' Day at the grounds of the State Capitol. Exhibits of live plants and animals, hands-on microscopic examination of specimens, from Botany, Seed Botany, Entomology, and Nematology were viewed by approximately 3,000 elementary children (fourth to sixth graders) who attended. Each year several PPDC scientists and technicians staff the booths.

PPDC Botantist Den Kelch showing off pressed plant specimens and live cacti to elementary school students at the 2010 State Scientists' Day.

- A number of highly effective seed science training workshops were conducted by CDFA PPDB scientific staff for seed scientists from private, government, and academic sectors of California and the Western United States.
- In May, Dr. Ed Biffin, Botanist from the Australian National Herbarium visited the PPDC to work with Senior Plant Taxonomist Dr. Dean Kelch to establish network connections with the Australian Botanical Institution and to collaborate on plant identifications. Australia shares many weeds with California and this collaboration should benefit both institutions.
- The Seed Science Laboratory provided numerous seed and fruit specimens from the CDFA Seed Herbarium of potential weeds found in table grape growing regions of California for the Identification Technology Program, USDA/APHIS/PPQ, Fort Collins, Colorado. The Seed Laboratory staff scientists are working in collaboration with USDA to construct a new diagnostic LUCID computer-based seed key for weedy plant species that may contaminate California grown table grapes to be exported to Australia and New Zealand. The new key will be a valuable diagnostic tool for agricultural inspectors in California, Australia, and New Zealand which can be used to quickly identify weedy contaminants and determine if they are of quarantine significance.
- In May, scientists Dr. Ben Normark and two graduate students from the University of Massachusetts and Mr. John Dooley of the USDA port plant quarantine inspection facility, San Francisco visited the PPDC Laboratory to collaborate with Senior Insect Biosystematist Dr. Gillian Watson on a USDA-funded project on DNA sequencing of armored scale insects. This information will facilitate the development of DNA bar-coding for identification of quarantine interceptions, and better understanding of generic boundaries and relationships among the armored scale insects.
- The PPDC lab participated in an educational project in partnership with the Cooperative Work Experience and Internship Program of a local community college in Sacramento. In this program a student was hired as a scientific aide to work on various disease projects in the Plant Pathology Lab. As part of the program the student initially sets goals for himself in conjunction with his instructor and supervisor to learn new skills by working under the supervision of scientists and technicians who are experts in those skills. Late in the semester, the course instructor visited the work site to observe the student in action using his new skills. The student's performance is ultimately evaluated by the lab scientist, the instructor, as well as the student himself. All parties were very satisfied with the results of this collaboration, so we anticipate additional participants in this educational program in the future.
- In May, a graduate level diagnostic class from U.C. Davis, including Professor and Extension Specialist, Dr. Mike Davis, visited the PPDC laboratory to see first-hand the workings of a plant pathology laboratory dedicated primarily to diagnostics. The students also learned about the importance and the role of diagnostics in pest prevention programs like those of CDFA's.
- An ongoing survey for Potato Cyst Nematode (PCN) continued through 2010. The survey is funded by the United States Department of Agriculture (USDA) and is conducted nationwide.

The survey was initiated in 2006 in response to the discovery of the potato cyst nematode, *Globodera pallida*, in Idaho. To date, a total of 2031 samples have been collected and processed. All samples have been negative for PCN.

- The Seed Science Laboratory made numerous identifications of Brassicaceae plant specimens for CDFA Biocontrol for a collaborative seed collection project for Biocontrol of Brassicaceae Weeds. These samples were accessioned into the CDFA Herbarium and the CDFA Seed Herbarium.
- In May, Dr. Nathan Havill, USDA Forest Service, visited fly specialist Dr. Steve Gaimari to work on a collaborative project on DNA sequencing of predatory flies attacking hemlock woolly adelgid and other pine-feeding adelgids and aphids. This project facilitates the development of DNA barcoding for identification of biological control agents, helps monitor establishment of released biological control agents, and to better understand generic boundaries and relationships among these flies.
- In June, Senior Seed Botanist, Dr. Riad Baalbaki, successfully completed the requirements of the Association of Official Seed Analysts (AOSA) to become a Certified Seed Analyst–Germination.
- Throughout 2010, more than 100,000 European grapevine moth (EGVM) individuals were identified by PPDC Senior Insect Biosystematist Dr. Marc Epstein with assistance from Agricultural Bio-Technician, Obie Sage.
- In June, The PPDC Seed Laboratory was selected by the Association of Official Seed Analysts/Society of Commercial Seed Technologists (AOSA/SCST) as the lead facility for updating the Seedling Evaluation Handbook. The Seedling Evaluation Handbook is part of the official rules of seed testing and is the authoritative reference for all North American seed analysts and regulatory officials in evaluating seedlings. The main objective of this project, lead by Senior Seed Botanist Dr. Riad Baalbaki with assistance from Dr. Sabry Elias (Oregon State University) and Dr. Miller McDonald (Ohio State University) is to revise and expand the contents of the Seedling Evaluation Handbook. This will be done by digitally documenting and publishing normal and abnormal seedling development patterns of hundreds of important commercial plant species. AOSA/SCST have agreed to provide all the needed documentation equipment, to be housed at the Seed Laboratory at CDFA.
- In collaboration with WPDN, a specimen of pest thrips was submitted in July for identification by cooperative extension personnel from Alaska. The specimen was identified as *Taeniothriops orionis* by Senior Insect Biosystematist Dr. Gillian Watson. This species is native to western North America and has been recorded from several western US states and Canada; however, it had never been reported as causing damage. This thrips species is new to Alaska but has become very common in some US cities this year, and has become a backyard and nursery nuisance.
- The Seed Science Laboratory provided numerous identifications of seeds, fruits, or associated material from wetland and pasture core samples for the US Geological Survey/ WERC Dixon Field Station in support of an ongoing assessment of wildlife habitat quality in northern California and southeastern Oregon.
- In July, Senior Seed Botanist Dr. Riad Baalbaki was selected by the Association of Official Seed Analysts and the Society of Commercial Seed Technologists to serve as an Editor for the international scientific journal Seed Technology. This journal contains scientific papers emphasizing applied and basic research in emphasizing applied and basic research in seed physiology, pathology, and biology related to seed development, maturation, germination, dormancy and deterioration, as well as notes on new laboratory techniques and laboratory test standardization.
- CDFA PPDB continued to serve as the diagnostic "hub" laboratory for the Western Region of the USDA/Homeland Security's National Plant Diagnostic Network in partnership with the University of California, Davis. This includes the eleven western states and pacific territories of American Samoa and Guam. Our division's Plant Pest Diagnostic Lab serves the 11 Western States and Pacific Territories by providing expertise and assistance to the Western Region for pest confirmations and particularly difficult diagnoses.

***Duponchelia foveali*, a highly destructive pest of a diverse list of plants was found in California this year**

- In July, Senior Insect Biosystematist Dr. Marc Epstein identified a new moth pest to California, *Duponchelia fovealis*. The moth is a highly destructive pest of many vegetables and fruits, ornamentals, and even aquatic plants.
- Plant Pathology scientists continued teaching graduate level courses in plant disease diagnostics at the University of California, Davis.
- The PPDC tested citrus samples from nursery propagative sources for compliance with the citrus Trizteza virus (CTV) state quarantine. All samples were tested by Enzyme Linked Immunosorbent assay (ELISA) and positive detections were confirmed by reverse transcriptase polymerase chain reaction (RT-PCR).
- In September, 24 students from a Modesto Junior College Plant Diagnostics Class accompanied by their professor, visited the

Jeremy Holloway (left), Scientific Associate at The Natural History Museum in London, UK with PPDC Systematic Entomologist Marc Epstein (right).

Adult, larva and pupal case of the Red Palm Weevil, *Rhynchophorus ferrugineus,* found in Laguna Beach, California in the Fall of 2010. (Photos: M. O'Donnell, CDFA PPDC)

PPDC to see how CDFA, and specifically the diagnostics lab, is a valuable resource to the agricultural industry. The students in the class have diverse backgrounds and interests -- some are Pest Control Advisors, some are aspiring to become tree, vine, or vegetable farmers, some want to become agriculture teachers, and some are planning to transfer to Cal Poly or UC Davis to complete their undergraduate degrees.

- In August, Insect Biosystematist Dr. Marc Epstein traveled to Europe to visit the United Kingdom's Natural History Museum (London) to study, photograph and borrow specimens of invasive leaf rollers and other agriculturally destructive moth species. This was followed by a trip to collect life stages of the new-to-California European Grapevine Moth (EGVM) at the USDA-ARS Lab in Montpellier, France and Italy in collaboration with the international EGVM working group members.
- The National Karnal Bunt survey was completed in December by PPDC staff. Fifty wheat seed samples representing 24 counties were tested in 2010 but as in previous years of the National Survey, *Tilletia indica* was not detected. In addition, Karnal Bunt was not detected in the Federal quarantine area in Riverside County in 2010, and the ten year old federal quarantine was lifted from California.
- In September, the PPDC hosted several visiting scholars from the National Taiwan University's Research Center for Plant Medicine, Taipei, Taiwan, giving them a tour of the facility and interacting with them on diagnostic techniques and issues.
- The Seed Science Laboratory participated in several cooperative research studies among public and private seed laboratories throughout the United States and Canada for validation of proposed laboratory testing procedures to be used for regulatory purposes.
- In October, 2010 field surveys and laboratory diagnosis for Potato Cyst Nematode (PCN) produced nearly 2,600 samples. Although a common grass cyst nematode, *Heterodera mani*, was detected in potato field soils in 2010, the survey data demonstrated that California appears to remain free of the federally quarantined golden cyst nematode, *Globodera rostochiensis*, and the potato pale cyst nematode, *G. pallida*.
- In September, Master Gardeners from Amador County visited the PPDB for training in the diagnosis of plant pests and proper sample collection for pest diagnosis.
- In September, Senior Insect Biosystematist Dr. Andrew Cline identified specimens of the Red Palm Weevil (*Rhynchophorus ferrugineus*) that were detected in a Canary Island date palm tree in Laguna Beach in Orange County, CA. This was a new state and country record for this weevil. The Red Palm Weevil occurs in Asia, Africa, Australia, the South Pacific, the Middle East, and parts of Europe as well as on the island of Aruba and the Lesser Antilles in the Caribbean. The weevil is a destructive pest of numerous agriculturally important palms, and its hosts include date palm, oil palm, coconut palm, and many genera of palms including Phoenix, Washingtonia, Areca, Sabal, and several others. The weevil also threatens native palm species found in California.
- The PPDC tested more than 20,000 Stone Fruit trees as part of a state-wide Plum Pox Virus survey. This virus has the potential of curtailing exports of several of California's most valuable crops. Test results demonstrated that California trees continue to be free of this disease.
- In October, the PPDC Laboratory received a new diagnostic tool, the Tescan Vega III variable pressure scanning electron microscope (VP-SEM). This instrument will make a significant contribution to the diagnostic programs of all five laboratories at the PPDC Laboratory.
- Under a universal USDA permit to receive samples for diagnosis, the Plant Pathology Lab received samples of diseased coco pods from agricultural officials in Ecuador who asked for assistance with diagnosis of a Cacao disease. After successfully culturing and identifying the pathogen from the diseased pods, the disease was diagnosed by PPDC Plant Pathologists as "Frosty Pod" Disease, caused by the fungal pathogen, *Moniliophthora roreri* [=*Crinipellis roreri*].
- In October, a rust pathogen, *Melampsoridium hiratsukanum*, was identified on a specimen of White Alder from a nursery in Santa Cruz by Dr. Cheryl Blomquist of the Plant Pathology Lab. This was a new North American Record, previous finds of the pathogen having only been reported in Japan. Interestingly,

the pathogen actually had been detected previously in California in the 1930s and the specimen was submitted to the Federal herbarium in Beltsville, MD, but had been misidentified at that time and the identification was never published. After this recent detection and a correct identification, it was subsequently found in two additional locations in the Central Valley.

- Seed Science Laboratory scientists worked in collaboration with ethnoecologist Dr. Kat Anderson, USDA, Natural Resource Conservation Service (NRCS), National Plant Data Center, and the Phoebe A. Hearst Museum of Anthropology, UC Berkeley to identify seed, fruit, and plant fragment samples collected from tribal members of California's indigenous people. The samples were collected in the early part of the twentieth century and have been stored, untouched, at the Phoebe Hearst Museum. The study is to determine what plant species were collected and used for food, fiber, and medicine by the various tribes. Project scientists in the Seed Science Laboratory examined 137 samples and identified nearly 169,000 seeds, fruits, and vegetative materials representing 174 plant species.
- In October, and again in December, the PPDC hosted the 6th grade classes of the Mark Hopkins Elementary School, a local grammar school located in the Meadowview neighborhood of Sacramento. For several years running the PPDC staff has given these local inner-city school students a hands-on science learning experience. The staff enjoys hosting the students each year in part because it is viewed as part of our social responsibility as a high-profile resident of the community and as state employees to reach out and serve the human, social, and educational needs of the economically challenged Meadowview Community.
- Throughout the year, the PPDC laboratory provided diagnostic and pest identification assistance on several samples received from our Western Plant Diagnostic Network (WPDN) diagnostic laboratory partners in the Pacific—including specimens from Hawaii, Guam, and American Samoa. One example yielded the diagnosis of Iris Yellow Spot Virus on a Maui onion from the Hawaiian Islands by PPDC Plant Virologist Dr. Tongyan Tian in collaboration with the WPDN Laboratory at the Hawaii Department of Agriculture.
- In October, PPDC Nematologists identified the citrus nematode, *Tylenchulus semipenetrans* which was found in samples of California grown mature olive tree shipments destined to Mexico and Florida. The citrus nematode is an economically important pest to the citrus industry. The species has three biotypes based on the preference of plant hosts parasitized. California has at least two of the three biotypes and therefore, citrus nematode-infested shipments are of concern to several trading partners
- In November, Sweet orange scab (SOS) caused by *Elsinoë australis* was intercepted and diagnosed from grapefruit rinds from Texas intercepted at a Southern California Border Station. The fungal pathogen was first confirmed in the United States in July 2010 on citrus in Texas, but is thought to have been in the gulf coast area of Texas much longer. Symptoms include scab-like lesions primarily on the fruit, but occasionally on twigs and leaves. This was the first confirmed interception of SOS into California.
- In late December, the Botany laboratory received a sample of Japanese dodder, a noxious parasitic weed, from Sacramento County with immature fruits. This was the first detection of a population with potentially reproductive branches. Samples received in winter after hard frosts typically show signs of severe cold damage that kill the late-maturing fruits. Despite unseasonably cold weather in 2010, this sample was unique in that it showed no damage, thus being capable of producing seed in the Central Valley. Production of fertile seed in CA would significantly reduce chances of eradication.
- PPDC Botanists expanded the CDFA PPDB Botany Herbarium which is networked with the "Consortium of California Herbaria", and includes several other California Herbaria from Academia. This resource aids in the identification of many new invasive plant species, including those in the nursery trade, before they become major agricultural pests in California.
- Seed Science Laboratory Scientists authored or co-authored numerous standardized seed testing procedures that were adopted by the Association of Official Seed Analysts for use in North America.

Staffing Changes
Departures

Umesh Kodira (left) with the California Secretary of Agriculture, A.G. Kuwamura (right), at State Scientists' Day, 2010.

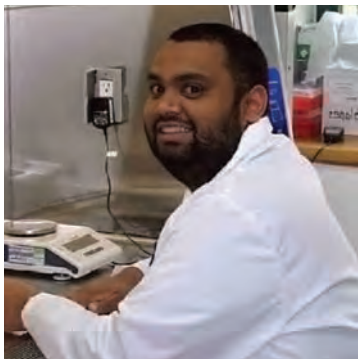
After seven years as Plant Pest Diagnostics Branch Chief, **Dr. Umesh Kodira** left CDFA to take a position with USDA-APHIS in Riverdale, Maryland as Chief of the Government Relations Branch, Biotechnology Regulatory Services. Umesh did much to improve the PPDC lab during his tenure, including a significant expansion of the lab's molecular testing facilities and capabilities, as well as the hiring of several new key employees.

Senior Seed Botanist Jim Effenberger.

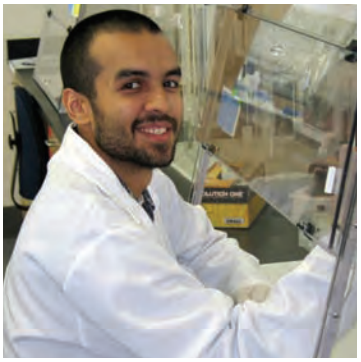
With a career in seed testing spanning nearly 40 years, Senior Seed Botanist **Jim Effenberger** retired from government service at the end of October 2010. Jim began his seed testing career in a graduate assistantship program at Iowa State University. Later he joined the staff at the USDA ARS Seed Laboratory in Sacramento where he worked for ten years until the lab closed in 1982. Since that time he has been with the California Department of Food and Agriculture Seed Laboratory, also located in Sacramento. For the past 28 years in our lab he displayed true enthusiasm for his work, ever curious about every nuance of seed testing and botany. There were days in the laboratory when he spent endless hours on the phone answering innumerable questions posed by folks in the seed industry regarding purity testing, seed labeling issues, seed and plant identifications, import/export problems, and on, and on, and on…

Most days you could find Jim peering through the microscope working on an "unknown" identification or a seed lot purity analysis. Jim contributed greatly to both Association of Official Seed Analysts (AOSA) and Society of Commercial Seed Technologists (SCST) by serving as a member of the AOSA Executive Committee, as chairman of the AOSA Uniformity and Standardization Committee, AOSA Rules Committee, AOSA By-laws Committee, and SCST Ethics Committee, and as a member of many other committees. Over the years he has served as a mentor to many seed analysts, some of whom have gone on to obtain accreditation as Registered Seed Technologists. In 2002 the Front Range Seed Analysts presented Jim with the Anna Lute Award for his devotion to seed analysts, seed testing, and the seed industry. Our laboratory is a tour stop for many dignitaries from all over the world, university classes, agriculture officials, and gardening groups. Jim served as our "official" tour guide because of his exuberant style. Whether the tour was merely 5 minutes or 2 hours in duration he would always fill the participants with a sense of the importance of seeds to our daily lives. He will be greatly missed, but we wish him a long, happy, and adventure-filled retirement.

Staffing Changes
New Employees


Israfiel Mohammed

Israfiel Mohammed joined the plant pathology diagnostic team as an Agricultural Biological Technician after serving as a Scientific Aide in the Plant Pathology Laboratory for several seasons. "Iz" graduated from the California State University at Sacramento with a Bachelor's degree in Biological Science with an emphasis in molecular and microbiology. His current work focuses on molecular diagnostics of various pathogens, particularly the Huanglongbing (HLB) pathogen, as well as diagnostics of bacterial pathogens in general.


Abel Unzueta

Abel Unzueta joined the plant pathology diagnostic team as an Agricultural Biological Technician after serving as a Scientific Aide in the Plant Pathology and Entomology Laboratories for several seasons. Abel graduated from the University of California at Davis with a Bachelor's degree in Biochemistry and Molecular Biology. His work focuses on the molecular diagnostics of various pathogens and arthropods, but particularly the Huanglongbing (HLB) bacterium and Sudden Oak Death pathogen.


Dominique Orozco

Dominique Orozco joined the Entomology Laboratory as an Agricultural Biological Technician after serving as a Scientific Aide in the Entomology Laboratory for several years. Dominique attended UCD, focusing primarily on Entomology and Animal Biology. Her current responsibilities include technical preparation of insect specimens and training new employees in insect preservation methods. She spends a significant amount of time working with fruit flies in particular, screening sterile release flies and verifying QC fruit fly specimens.


Natalia von Ellenrieder

Dr. Natalia von Ellenrieder joined the Entomology Laboratory as an Associate Insect Biosystematist, responsible for identifying Auchenorrhyncha, Sternorrhyncha (scales, mealybugs, whiteflies, aphids, psyllids), Thysanoptera (thrips), and Mollusca. Her responsibilities include making critical identifications based on morphology and DNA analysis. Dr. von Ellenrieder received her PhD in Natural Sciences with an emphasis in Entomology from the Universidad Nacional de La Plata, Argentina, and has extensive experience in both research and teaching in entomology.

Larry Bezark was appointed in December as the Interim Branch Chief of the PPDC. Larry has many years of experience as both a scientist, specializing in entomology and biological control, as well as an administrator, having served as a supervisor of scientists and branch chief in CDFA for many years.

2010 Annual Report of the Botany Laboratory

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 missions. The Botany Laboratory herbarium (known internationally as The Herbarium of the California Department of Agriculture, or simply "CDA") currently contains more than 55,000 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/ CDA Herbarium 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. In 2010, the Plant Pest Diagnostics Botany Lab received 1037 samples for identification along with Pest and Damage Report (PDR). Of those, 138 were identified as 'A'-rated weeds, 131 were 'B'-rated (11.2%), and 31 (2.6%) were 'Q'-rated. In 2010, approximately 2,556 new specimens were identified, cataloged, and added to the CDA Herbarium, expanding the collection to more than 55,000 mounted specimens. The Botany Laboratory's participation in an exchange program with other herbaria from around the country and the world continues to increase taxonomic diversity within the collection. Through this program approximately 874 new specimens were obtained, identified, and mounted in 2010.

Diagnostic Services for California Border Stations

Thousands of vehicles pass through California's borders every day. Border station agents are on the alert to stop pests from entering the state. When unknown or suspicious plant material is found, the Botany Lab provides the necessary identifications to undertake appropriate action. Although material from all states in the union are found on cars, trucks, and boats entering the state, most of the material found in 2010 hailed from neighboring states such as Oregon and Nevada. In 2010, many plant pests belonging to the thistle tribe were found clinging to vehicles or within trailers or hay bales. Canada thistle (*Cirsium arvense*), arguably the worst weed in North America, is a common find (Figure 1); often the intercepted material contains mature fruits bearing fertile seeds. Scotch thistle (*Onopordum acanthium*) is a robust, spiny plant locally naturalized in California. It can form nearly impenetrable barriers of spines where it is established. Seed heads often were intercepted at the border stations and sent to the botany lab for identification.

Figure 1. Canada thistle (*Cirsium arvense*) is perhaps the worst weed in North America. Its seed heads are often intercepted by California border stations on vehicles and sent to the CDFA Botany Laboratory for confirmation.

Figure 2. Capeweed (*Arctotheca calendula*) in a horse pasture in Marin County.

Figure 3. South American spongeplant (*Limnobium laevigatum*) invading a California river.

Diagnostic Services for California County Agriculture Commissioners

Most weed control efforts in California are initiated at the county level and by local Weed Management Areas. In 2010 botany lab staff identified well over 1000 specimens for county agricultural staff members. The most important examples were identifications confirming the identity of pest species, thus allowing the initiation of pest control. For example, new populations of slender false brome (*Brachypodium sylvaticum*) and capeweed (*Arctotheca calendula*), both CDFA A-rated pests, were identified in 2010 (Figure 2). Also important are the identification of new species that have the ability to invade California. Such species identified in 2010 include purple ragwort (Senecio elegans) and endive daisy (*Rhagadiolus stellatus*).

Diagnostics & Locations of Aquatic Weeds

Of all plant pests, aquatic weeds are most likely to affect the mission of multiple state agencies. They choke canals and irrigation channels, thus negatively impacting agriculture. They can infest rice fields and reduce productivity in this important crop in California. Infestations of rivers, lakes, and the Delta can result in problems for recreational and commercial water navigation. Fishing can be rendered difficult. Aquatic weeds are more likely than most weeds to significantly modify habitat, thus reducing populations of native and endangered species. California, with its relatively mild climate and its highly connected waterways, is particularly susceptible to infestations of aquatic weeds. Along with well-established pests such as water hyacinth (*Eichhornia crassipes*) and Brazilian waterweed (*Egeria densa*), an explosion of the A-rated pest South American spongeplant (*Limnobium laevigatum*) in the Delta was identified in 2010 (Figure 3). This plant has the potential to be as bad an aquatic pest as water hyacinth (or possibly worse). The finding of millions of seedlings in the Delta necessitated the botany lab to confirm these new localities from immature or atypical plant material. Control and monitoring of this pest in partnership with the California Department of Boating and waterways and the California Department of Water resources was begun in 2010 and will continue through 2011.

A wetland pest, the B-rated pest scarlet wisteria (Sesbania punicea) is a plant that often spreads along waterways. In recent years its range has been expanding. In 2010 a field response team was assembled to find, map, and control all populations of this weed. The task force sent specimens from all known and new populations of scarlet wisteria to the botany lab for confirmation and documentation. These specimens have now been confirmed and integrated into the permanent collection.

Field Work to Identify Spreading Weeds

In decades past, botany lab scientists spent a significant time in the field identifying and collecting weeds. As faster means of communication have reduced turnaround times for identifications, efficiency and rapidity have taken precedence as primary goals of the botany lab. This has resulted in faster service for and greater availability to our clients. In addition, fieldwork is necessary to add new specimens to the herbarium. Trained botanists with decades of experience in California botany and a focus on invasive species often notice new taxa and range extensions that others tend to miss. Therefore, fieldwork remains a crucial aspect of carrying out our mission here at CDFA. In many cases introduced plants may be present in small populations for decades and pose little problem to agricultural fields, rangelands, and wildlands. Then they enter a phase in which they expand to new habitats and new geographic regions. At this point they may pose a significant threat to California's economy and ecology. Few people today realize that for more than 60 years in California yellow star-thistle (*Centaurea solstitialis*) was viewed as an uncommon introduced plant that wasn't highly invasive. Today it is viewed as one of the worst plant pests in the state. A new example of this phenomenon is the endive daisy (*Rhagadiolus stellatus*), a plant native to the Mediterranean (Figure 4). In 2010 botany lab staff identified new populations of endive daisy while performing fieldwork in Napa County. This species had been known from three sites in Napa County and

one from Sonoma County for many years. These new populations were notable because the plants dominated the understory layer in lightly shaded oak forests and in the adjacent grassland habitat. As such, this species was already causing negative impacts in rangelands in its (currently) limited range. As its populations spread from their current range, they will likely prove invasive in agricultural settings as well. Endive daisy is a significant crop pest in the Eastern Mediterranean.

New weed species are entering California relatively regularly. In 2010, botany lab staff identified a weed species new to North America. This is the Spanish mercury (*Mercurialis ambigua*), a member of the spurge family. Spanish mercury is a close relative of common mercury (*Mercurialis annua*), and has previously been mistaken for that species. While common mercury is an uncommon weed of the San Francisco Bay Area, Spanish mercury currently is known only from Davis and from northwestern Contra Costa County in California. This provides us the opportunity to control weed pests before they spread beyond control and illustrates the importance of early detection.

Figure 4. Endive daisy (*Rhagadiolus stellatus*). Note the star-like fruit. This weed is actively spreading in North Bay counties

Identification of Insect Hosts

In 2010 the botany lab has continued to identify plants that are serving as hosts for possibly noxious insects. For example, botany lab staff found a seriously defoliated island oak (*Quercus tomentella*) grown as a street tree in Southern California (Figure 5). This species, native to the California Channel Islands, is rarely cultivated. In this particular situation it had been attacked by a lepidopteran pest while nearby coast live oaks were not noticeably affected. The culprit turned to be the California oak moth (*Phryganidia californica*), and the Island oak was a previously unreported host plant for this pest.

In 2010 an opportunity came to identify a new host for an armored scale species that is unknown from California and that is possibly new to science. The sample came from Arizona and was on a leaf fragment that was too small to identify. Using techniques developed in the botany laboratory to use DNA sequences for diagnosis, the host plant was identified as *Jasminum sambac*, the jasmine used to flavor jasmine tea and an important ornamental plant in California. This diagnosis will prove useful in elucidating the identity, biology, and risk assessment of this new plant pest.

Figure 5. A grove of island oaks (*Quercus tomentella*) on Santa Rosa Island. This island endemic is a newly reported host for California oak moth (*Phryganidia californica*).

Figure 6. **Black mondo grass (*Ophiopogon planiscapus* 'Nigrescens') is a popular edging plant in California. Attack by *Pithiun splendens* will cause death of the plant.**

Figure 7. **Capeweed (*Arctotheca calendula*) has been subject to considerable taxonomic confusion.**

IDs for Plant Disease Hosts

The CDFA botany lab continues to identify plant hosts of plant diseases. For example, in 2010 botany staff noticed an unusual disease attacking black mondo grass (*Ophiopogon planiscapus* 'Nigrescens') in a big box store nursery (Figure 6). Mondo grasses and the related lily-turfs (*Liriope* spp.) are important nursery plants in California, with some variety or other being sold at almost every nursery in the state. After being brought to the CDFA plant pathology lab, the culprit was identified as *Pithiun splendens*, an unusual oomycete not yet reported from California. It attacks the roots of various cultivated plants and is generally fatal to its host.

Other examples include finding new host plants for sudden oak death. Sudden oak death (*Phytophthora ramorum*) is a pathogen that is heavily regulated by states, the U.S.A. and many other countries. It now is known to attack a long list of woody plants. Nevertheless, it is crucial to identify all potential hosts in order to prevent exported California nursery stock from triggering quarantine actions on the part of other polities. It is also important to prevent infected nursery stock being imported to spread the disease to new areas. In one instance in 2010 the botany lab identified Chinese loropetalum (*Loropetalum chinense*) as a new sudden oak death (SOD) host on a plant sample that tested positive for SOD. This member of the witch hazel family (Hamamelidaceae) is an extremely common nursery plant in the Western U.S., as well as in milder temperate areas of the country.

Technical Taxonomic Advice for Federal Partners

Working with state and federal partner agencies to ensure the correct identification of plants promotes interagency cooperation and ensures that regulatory action is consistent and seamless. An example in which the CDFA botany contributed to better understanding of invasive plants concerns the United States Department of Agriculture's (USDA) recent finalized listing of capeweed (*Arctotheca calendula*) as a noxious weed (Figure 7). The taxonomy of this species and its relatives is confused. Plants labeled *A. calendula* are commonly sold in nurseries as a vegetatively propagated groundcover. The California Department of Food and Agriculture has treated this horticultural plant as the "sterile form" of *A. calendula*; CDFA lists the "fertile form" as a state noxious weed. In fact, the sterile plant of horticulture is a different species, creeping capeweed (*A. prostrata*). This plant is a vigorous groundcover (read garden thug) that spreads aggressively via rooting stems and rhizomes, but has, so far, been found only where it was planted. It isn't fertile in California. Some other sterile plants are noxious weeds, such as giant reed (*Arundo donax*) and Bermuda buttercup (*Oxalis pes-caprae*), but current collections do not demonstrate that creeping capeweed is easily dispersed via plant parts. In 2010 CDFA botany lab staff worked with USDA staff to ensure that correctly labeled creeping capeweed will not be regulated in interstate commerce due to the federal listing of *A. calendula* as a noxious weed. Therefore, nursery grown plants of *A. prostrata* will not be banned from interstate commerce. At the CDFA herbarium we have collections of true *A. calendula* from Humboldt, Marin, San Mateo, Merced and Stanislaus Counties. These populations are undergoing control, but eradication has proven difficult. Agricultural Biologists for CDFA recently have seen promising control results from use of the herbicide Milestone.

The USDA maintains a website for the identification of plants and seeds via the GRIN website. In 2010, a query was received as to the identity of a grass fruit illustrated on the website, as there was doubt as to whether it represented a native or non-native species. This plant was identified by the CDFA botany lab as an intermediate between two native species: purple needlegrass (*Nassella pulchra*) and nodding needlegrass (*Nassella cernua*). This is a condition that arises through hybridization according to the Flora of North America.

Figure 8. Carolina cherry (*Prunus caroliniana*) a horticultural shrub whose fruits are not poisonus.

Figure 9. Khat (*Catha edulis*) wrapped for sale. This interdited drug is commonly shipped into California from Somalia via other countries.

Figure 10. Fig 13. Brownie thistle (*Cirsium quercetorum*) is one of the native California thistles. CDA has the best collection of specimens of these hard-to-collect plants in Western North America

Diagnostic Services for Toxic Plants

Poison control centers use various sources to identify potentially toxic plants. Every year the CDFA botany lab is called upon to identify plants in cases of potential human or livestock poisoning. For example, in 2010 the botany lab was able to rule out the danger of Pyracantha and Carolina cherry (*Prunus caroliniana*) fruits in the potential poisoning of an adult male found dead in his home and in the case of a child who had ingested several fruits from a horticultural shrub (Figure 8). Also, in 2010 occasional plants were submitted and identified in cases of livestock loss. In some cases the plants submitted pose no threat to livestock (e.g., dwarf owls-clover [*Triphysaria pusilla*] and French cottonrose [*Filago gallica*]). In other cases, the submitted sample is a potential source of the problem (e.g., lupines [*Lupinus* spp.]).

Diagnostic Services for Mail Interceptions

The Department of Food and Agriculture operates facilities to inspect packages coming into the state. On occasions they intercept narcotic plants from outside the country. Although the USDA intercepts many of these plants, sometimes shipments are intercepted by CDFA. In 2010, shipments of khat (*Catha edulis*) were intercepted and sent to the CDFA botany lab for identification (Figure 9). Khat in any form is illegal in the United States and Canada. Under the terms of the U.S. Controlled Substances Act, cathinone is considered a Schedule I drug and cathine is considered a Schedule IV drug. Cathinone and cathine are also controlled under the United Nations' Convention on Psychotropic Substances. Almost all khat shipped to the United States originates in Somalia, although it is transshipped through many countries.

Khat leaves have been illegally bundled and shipped into the United States in increasing amounts since the 1990s. According to the statistics available from the NDIC at the beginning of 2005, "the amount of khat seized by U.S. federal law enforcement officers increased dramatically from 14 metric tons (about 31,000 pounds) in 1995 to 37 metric tons (about 82,000 pounds) in 2001." Although the shipments of khat intercepted by the CDFA are small in comparison, they represent interdictions of dangerous narcotics whose sale is providing funding for the ongoing conflict in Somalia.

Curation of the CDFA Herbarium (CDA)

CDFA botany lab staff collected, identified, confirmed, labeled, mounted and/or filed over 2500 plant specimens in 2010, increasing our holdings by 5%. Specimens predominantly were acquired through staff-collected specimens or pest damage report (PDR) samples that were retained as voucher specimens. The staff collections and PDR specimens are particularly important as few are duplicated at other herbaria (that is, the actual collected material is only represented at CDA), and thus they represent data unique to the CDFA herbarium. These unique collections, or unicates, confer upon CDA, which is unusually rich in unicate specimens, an importance beyond its size. The CDA has an unsurpassed collection of thistles and aquatic weeds (Figure 10). Most of these accessions represent plants growing in California and thus contribute also to the online dataset of the Consortium of California herbaria. In 2010, botany lab staff redoubled their efforts to enlist partner NGO staff and volunteers to contribute specimens documenting

new weed localities to the CDFA herbarium. In addition, as PDRs often include horticultural plants, efforts were made in 2010 to augment the herbarium's already substantial collection of California horticultural plants.

ID New Pathways for Invasive Weed Entry

A grower in Davis, California submitted several four inch plant pots containing unusual weeds to the CDFA botany lab. These pots were obtained from a Nursery of Ripon, CA and one other nursery. The plants had been planted in a potting mix from the mix distributor and they wanted to know the identity and likely source of the weeds.

A complete list of the components of this potting mix was not available, but peat moss and coco fiber are at least two of these. The coco fiber or "coir" is imported from Sri Lanka. Coco fiber is used as a root support in hydroponic growing operations, and also apparently as a component in some soil-less mixes. Given the identity of the weeds (see below), it would appear that the coco fiber component was the source of the weed seed. All these plants are pantropical weeds, known in Sri Lanka. Several, noted on the list below, are also found in the southeastern North America and *Chenopodium glaucum* ssp. *glaucum* is also in other parts of the continent. In addition, all are common in India/Sri Lanka, including the *Spermacoce* and *Catharanthus* that are not known in the continental US.

Weeds identified in the horticulture potting mix included *Spermacoce latifolia* (oval-leaf false buttonweed), a pantropical weed that currently is known in the U.S. only from Hawaii. It also included *Mitracarpus hirtus* (tropical girdlepod), a pantropical weed introduced in the southeastern U.S. *Catharanthus pusillus* (dwarf periwinkle) was present; this is a tropical weed, widespread in southeastern Asia, but it is not currently known in North America. *Cleome viscosa* (tickweed) is a plant of possible New World origin, but it is now a pantropical weed. Tickweed also is found in the southeastern U.S. The CDFA herbarium has a specimen of this species that derived from Sri Lankan coco fiber in the late 1990s. *Chenopodium glaucum* ssp. *glaucum* (oakleaf goosefoot) is world-wide in distribution, and it is apparently native in much of the range. However, two geographic subspecies (*C. g.* ssp. *glaucum* and *C. g.* ssp. *salinum*) are known. These taxa were originally allopatric (with separate ranges), with the latter native in North America. The typical subspecies (ssp. *glaucum*) is now naturalized in North America as well, but is not currently in California. *Solanum viarum* (tropical soda apple) is native to South America and it is a serious pest in subtropical areas of the southeastern U.S. It is also known in the old world, including India and Africa and is likely to occur in Sri Lanka. Tropical soda apple is listed as a U.S. Federal Noxious Weed. It is also listed as a noxious weed in several states other than California. The worst potential California weed found in the potting mix was *Parthenium hysterophorus* (Santa Maria feverfew, Figure 11). Native to the New World tropics, this plant is now a serious pest in much of the Old World tropics. It is also present as a weed in the Southeastern states of the U.S. It has become a common weed in India, Australia and parts of Africa. In some areas, outbreaks have been of almost epidemic proportions, impacting crop production, livestock and human health. Many of these problems are due to its toxic properties.

Figure 11. Santa Maria feverfew (*Parthenium hysterophorus*) infestation in India. This is a noxious pest that could cause significant harm to California agriculture were it introduced.

These toxicities are of various types, ranging from common allelopathic affects on crop germination and growth to suppression of fruiting and flowering via contact with the pollen. *Parthenium hysterophorus* can act as an alternate host for a number of plant pests, functioning as an inter-season reservoir or inoculum source in, for example, the scarab beetle pest of sunflower (*Pseudoheteronyx* sp.) in central Queensland, Australia and plant parasitic nematodes in the USA. Parthenium hysterophorus may also act as a secondary host of plant diseases. As an allergen, it is a serious problem to human populations. It is estimated that within 10 years of exposure to Parthenium pollen or dust from other plant parts, 10-20% of the population will develop allergic reactions, ranging from hayfever to severe contact dermatitis. Ecologically, this highly invasive species has the potential to disrupt natural ecosystems. It has been reported as causing a total habitat change in native Australian grasslands, woodlands, riverbanks and floodplains. As to its affect on California ecosystems the potential is limited to certain areas. *Parthenium hysterophorus* is adapted to warm, moist environments. These conditions are not widespread in California, even in the summer months; however, local habitats, irrigated regions around crop fields, and other permanently moist, open, warm locations may be invaded and occupied. The southern and central coastal zones, and the Imperial Valley may be especially vulnerable.

Soil mix components should be steam fumigated before importation to the U.S. Evidently, some are not. This is an issue for both USDA, as well as for CDFA. The sample examined by the CDFA botany lab harbored a Federal Noxious weed (FNW), tropical soda apple. This highlights the necessity to consider potting mix components as a potential pathway of new weeds. As soils mixes are sold throughout the nation and then individual consumers buy the plant containers and add them to their gardens, they can serve as an unsurpassed dispersal mechanism for any weed contaminants. After the reporting of this find by CDFA botany lab staff to the USDA pest risk analysis division, a pest risk assessment was begun of coir as a pathway for plant pests.

As mentioned above, aquatic weeds are potentially some of the worst pests in terms of potential economic damage. The botany lab receives samples mailed from out-of-state aquarium and pond supply companies. These sometimes include rated plant pest species. In order to stay abreast of current plant species being sold, botany lab staff often visit nurseries in their free time, as plant fashions are constantly changing and new species regularly are being introduced into the California nursery trade. In visits to several aquarium stores in 2010, botany lab staff identified two different plants rated as noxious weeds by CDFA. Argentine waterweed (*Egeria naias*) and/or South America spongeplant (*Limnobium laevigatum*) were being sold in at least four different locations. Argentine waterweed is not currently known as naturalized in California, but it is a water column filling plant that is a serious pest in New Zealand and Argentina. It is a close relative of Brazilian waterweed (*Egeria densa*) a noxious weed that chokes thousands of acres of water in California. South American spongeplant is a pest that has a dedicated eradication project sponsored by CDFA and the California Department of boating and waterways.

Expert Consultation with Invasive Species Policy Committees

In 2010 botany lab staff participated in strategic planning by offering expert advice and document review regarding large initiatives including invasive species. Increasing awareness of the negative and significant effects of invasive species on the economy and the environment has led to several major initiatives to deal with this issue using strategic approaches. Examples include CISAC (California Invasive Species Advisory Council), NISC (National Invasive Species Council), Cal-HIP (California Horticultural Invasive Prevention) and the CDFA Programmatic Environmental Impact Report committees. All of these initiatives seek input from Specialists and stakeholders to develop new and innovative strategic approaches to controlling and raising public awareness about invasive species.

Outreach to NGO Partners

The botany lab continues to provide assistance and advice where needed to partner organizations whose mission includes the control and prevention of weeds in California. In 2010 botany lab staff spoke on new and spreading weeds at the California Weed Control Council annual conference. Interactions with Cal- IPC (California Invasive Plant Council) included providing advice on the ongoing weed spread modeling project and giving a seminar on plant voucher techniques. Service to BAEDN (the Bay Area Early Detection Network) included providing advice on their draft weed vouchering protocol and recommending rapid response candidates by identifying newly spreading weeds in the San Francisco Bay Area. In 2010, a population of *Hypericum grandifolium* (Malfurada), a potentally invasive plant, was found by BAEDN staff and identified as a new report for North America by the CDFA botany lab (Figure 12). As more land managers and amateur volunteers become involved with invasive plant location and control, the taking of voucher specimens to confirm and document occurrences become even more important. In this regard, the botany lab has been working with partner organizations and NGOs to ensure that proper voucher specimens are taken and sent to the CDA Herbarium. These efforts are beginning to bear fruit, as more attention is paid to this often neglected aspect of invasive plant management.

Figure 12. Malfurada (*Hypericum grandifolium*) is a newly introduced plant in California that was found by BAEDN staff and identified by the CDFA Botany Laboratory.

Molecular Diagnostics

The use of comparative DNA data to diagnose plant pathogens and larval insects has become commonplace at the Plant Pest Diagnostics Laboratory. Mostly these techniques are used to confirm the presence or absence of a specific, targeted pest. In 2010 the botany lab expanded its general diagnostic work to include molecular diagnostics of fragmentary or sterile material that cannot be identified using morphological characters. This has been especially useful in identifying fragmentary specimens from border stations or host pieces included in insect samples. In addition, these techniques have been used in 2010 to identify seeds by extracting the DNA from single seeds. This can be quite useful when specimens are received that are not represented by specimens in the seed herbarium. Generally the nuclear internal transcribed spacer (nITS) region is used for diagnostic purposes. ITS sequences usually vary between species, universal PCR primers for flowering plants are available, it is easy to amplify using PCR, and there are ITS sequences of many plant species available online to compare with the unknown sample DNA sequences. Therefore, it is a good candidate to use for general diagnostic purposes. An example of the utility of this approach was the identification of *Vitex lucens*, a rare horticultural shrub submitted for identification by San Diego county staff (Figure 13).

Figure 13. ***Vitex lucens*** **is a rare tree from New Zealand. A sterile specimen was identified by botany laboratory staff utilizing the DNA marker ITS after being found in San Diego County .**

Figure 14. Himalayan blackberry (Rubus bifrons) is spiny weed whose preferred name has changes four times in 20 years. The taxonomic crosswalk helps online visitors navigate the taxonomic labyrinths of this and similar species.

Participation in Consortium of California Herbaria

The Consortium of California Herbaria was developed to serve as a gateway to information from California vascular plant specimens that are housed in herbaria throughout the state. The database includes information from about 1.2 million specimens, all searchable through a single interface. Currently, collections from sixteen herbaria are accessible through this interface. The participating institutions cooperate under the guidelines of a Memorandum of Understanding. The data included in this database are a snapshot of the California vascular plant collections at participating institutions.

In 2010 the CDFA herbarium (CDA) submitted 18,536 specimen records to the Consortium, of which over 6000 were newly submitted records. All specimens were reviewed for determination accuracy, and indeed, all specimens of the group held at CDA were reviewed and reclassified if necessary. Approximately 75% of the CDA records are geo-referenced and can be mapped.

In addition, CDA has an exemplary representation of the weeds of California, representing specimens from every county in California. As a pilot study of the use of the Consortium for research, CDA partnered with University of California and Rancho Santa Ana Botanic Garden to database and geo-reference all specimens of weedy taxa at the three herbaria. This project was funded by a grant awarded by the Global Biodiversity Information Facility (GBIF), an international organization that is working to make the world's biodiversity data accessible anywhere in the world (www.gbif.org).

Update of Online Taxonomic Resources

CDFA botany lab member Dr. Fred Hrusa began an update of the California botanical crosswalk, his currently online nomenclatural synonymy for plants growing spontaneously in California. The Jepson Manual, California's primary botanical and floristic reference, most recently published in 1993, will publish an updated second edition in late 2011. The update of the online reference to botanical synonymy will allow all users of California plant information to quickly cross-reference (thus the name XWalk, see http://ucjeps.berkeley.edu/db/crosswalk/index.html) any name they have to those names used in The Jepson Manual edition 2 (see Figure 14). The crosswalk was used extensively after the publication of the first edition of The Jepson Manual. The second edition of the Jepson Manual promises to have even more name changes, so the crosswalk will be equally or more important to those researching the best names for plants of California, including weeds and other economically important plants.

Flora North America Treatment Review

In 2010, botany lab staff continued reviewing and editing of floristic treatments for the Flora of North America project. Flora of North America North of Mexico is a synoptic floristic account of the plants of North America north of Mexico. The flora is intended to serve both as a means of identifying plants within the region and as a systematic conspectus of the North American flora. Taxa and geographical areas in need of further study also are identified in the flora. Flora of North America North of Mexico will be published in 30 volumes. In 2010 treatments of 12 families and 39 genera were reviewed and edited. Included among the latter are the following genera composed either wholly or partially of noxious or invasive weeds in California. The ability to access the most recent and technically current treatments of weedy groups provides department scientists with up to date information regarding the occurrence, behavior, and most importantly, identity and relationships for actual or potential weedy plants in California. Weedy

groups whose treatments were reviewed by botany lab staff in 2010 include gorse (*Ulex*), Austrian peaweed (*Sphaerophysa*), acacias (*Senegalia* and *Mariosousa*), kudzu (*Pueraria*), rust-harrow (*Ononis*), myoporum (*Myoporum*), mullein (*Verbascum*), shepherd's needle (*Scandix*), bur-chervil (*Anthriscus*), hedge-parsley (*Torilis*), spotted rockrose (*Tuberaria*), rockrose (*Cistus*), leaf-flower (*Phyllanthus*), malva rosa (*Lavatera*), St. John's wort (*Hypericum*), silverberry (*Elaeagnus*), and butterfly bush (*Buddleja*, Figure 15).

Figure 15. **Butterfly bush (*Buddleja davidii*) is both a popular garden plant and a weedy shrub in Northern California.**

In addition, groups containing important edible or ornamental crop plants were also reviewed and edited. These include garbanzo bean (*Cicer*), fenugreek (*Trigonella*), sugar pea (*Pisum*), Parsnip (*Pastinaca*), wild lilac (*Ceanothus*), sumac (*Rhus*), St. Johns wort (*Hypericum*), tree mallows (*Lavatera*), rockrose (*Cistus*), butterfly bush (*Buddleja*), monkeyflowers (*Mimulus*), and cow-itch tree (*Lagunaria*).

2010 Annual Report of the Entomology Laboratory

Entomology Laboratory Objectives

The primary objectives of the Entomology Laboratory are to:

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

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 commissioner offices, other Branches of CDFA, 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, or critical extensions in the delimitation of pests under eradication. 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; leafmining and other flies; glassy-winged sharpshooter and other leafhoppers; Asian citrus psyllid; Africanized honey bee; red imported fire ant; Asian longhorn beetle and other wood boring beetles; Japanese beetle; red palm weevil and other weevils and leaf beetles; European and Asian gypsy moths; light brown apple moth, European grapevine moth and various other moths; numerous scales, whiteflies and mealybugs; ticks, mites, spiders and other arachnids; Zebra and Quagga mussels and other mollusks; as well as 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 USDA Forest Service, the US Fish and Wildlife Service and other federal agencies; museums; faunal inventories and surveys; private industry and the general public.

The Diagnosticians & Their Specialties

- Dr. Charles Bellamy
  - Coleoptera (beetles)
- Dr. Andrew Cline
  - Coleoptera (beetles)
- Dr. Marc Epstein
  - Lepidoptera (moths, butterflies)
- Dr. Stephen Gaimari
  - Diptera (flies), Phthiraptera (lice), Siphonaptera (fleas)
- Dr. Rosser Garrison
  - Hemiptera: Heteroptera (true bugs), all lower insect orders, Mollusca (snails, slugs, mussels),
- Dr. Martin Hauser
  - Diptera (flies), molecular systematics.
- Dr. Peter Kerr
  - Arachida (mites, spiders, etc), molecular diagnostics
- Dr. Alessandra Rung
  - Hemiptera: Auchenorrhyncha (leafhoppers), Sterorryhcha (psyllids)
- Dr. John Sorensen
  - Sternorrhyncha: Aphidoidea (aphids), Hymenoptera (ants, bees, wasps)
- Dr. Natalia von Ellenrieder
  - Sternorrhyncha (scales, mealybugs, whiteflies, aphids, psyllids), Thysanoptera (thrips), Mollusca (snails, slugs, mussels)
- Dr. Gillian Watson
  - Sternorrhyncha (scales, mealybugs, whiteflies), Thysanoptera (thrips)
- Dr. Shaun Winterton
  - Lepidoptera (moths)

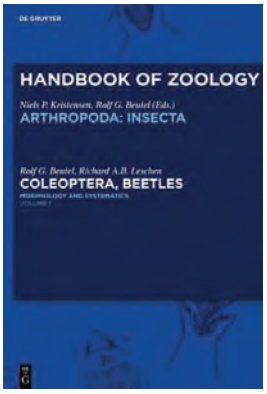
Taxonomy & Systematics of Coleoptera

Progress Report 2010

A.R. Cline

Several research projects were undertaken and/or completed in 2010. Research projects in 2010 spanned different biological disciplines; however, most were focused on the taxonomy and systematics of Cucujoidea families. Below is an outline of the major projects completed.

I. The much anticipated second volume on Coleoptera for the Handbook of Zoology was published in early 2010. This large tome will provide detailed information on the taxonomy, biology, and systematics of Coleoptera families in the Elateroidea, Bostrichiformia and a large portion of the series Cucujiformia. Dr. Cline authored or coauthored seven chapters on the following beetle families within Cucujoidea: Kateretidae, Nitidulidae, Smicripidae, Biphyllidae, Byturidae, Discolomatidae, and Corylophidae. These chapters will provide future workers with a foundational knowledge of these beetle taxa.[1]



II. In an effort to help stabilize the internal taxonomy of the family Biphyllidae, Dr. CLine coauthored a short scientific note synonomyzing the genera *Anchorius* and *Anobocoelus* (Figure 1).[2]

III. As part of a long term multi-phase project to completely revise the New World members of the family Kateretidae at the species level, Dr. Paolo Audisio and Dr. Cline published the initial paper outlining the genera to be treated as well as a full revision of the genus *Anthonaeus* (Figure 2). This series of projects will culminate in a complete global phylogeny of the family at the genus level based on adult and larval datasets as well as molecular data from 6 gene sequences.[3]

IV. The description of beetle diversity is an ongoing research pursuit, and typically includes revisionary and/or monographic works. The Kateretid *Anthonaeus bajaensis* was described this year (Figure 3).

V. Other activities in 2010 included the following:

Professional Service

- Treasurer and Membership Secretary – The Coleopterists Society
- Zootaxa Subject Editor (Coleoptera: Bostrichiformia, Cucujiformia - Lymexyloidea)
- Manuscript Referee – Insecta Mundi, Zootaxa, The Coleopterists Bulletin
- Grant Reviewer – National Science Foundation, USDA Farm Bill Appropriations

Professional Presentations

- Entomological Society of America, San Diego, CA – poster presentation on small hive beetle adaptive leg morphology.
- Pacific Coast Entomological Society, Sacramento, CA – invited seminar on sap beetles

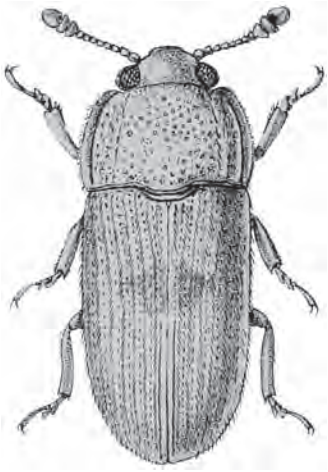


Figure 1. ***Anchorius championi*** **(Sharp)**

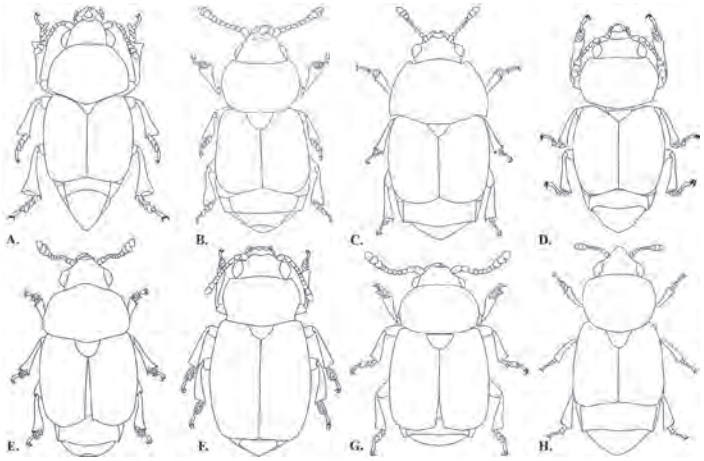


Figure 2. A figure from the first in a series of publications that will focus on the revision of New World Kateretidae. Dorsal habitus drawings. A) ***Amartus tinctus*****, B)** ***Anthonaeus agavensis*****, C)** ***Brachypterolus pulicarius*****, D)** ***Brachypterus urticae*****, E)** ***Cercometes deyrollei*****, F)** ***Heterhelus sericans*****, G)** ***Kateretes scissus*****, and H)** ***Neobrachypterus nigropiceus.***

Figure 3. ***Anthonaeus bajaensis*** **Cline & Audisio**

[1] Cline, A.R. 2010. Smicripidae Horn 1879. Pp. 407-411. *In* Leschen, R.A.B., R.G. Beutel, & J.F. Lawrence (eds.) Handbook of Zoology. Volume IV. Arthropoda: Insecta. Part 38. Coleoptera, Beetles. 786pp.

Cline, A.R., M.A. Goodrich & R.A.B. Leschen. 2010. Byturidae Jacquelin duVal, 1858. Pp. 286-292. *In* Leschen, R.A.B., R.G. Beutel, & J.F. Lawrence (eds.) Handbook of Zoology. Volume IV. Arthropoda: Insecta. Part 38. Coleoptera, Beetles. 786pp.

Cline, A.R. & F.W. Shockley. 2010. Biphyllidae LeConte, 1861. Pp. 306-311. *In* Leschen, R.A.B., R.G. Beutel, & J.F. Lawrence (eds.) Handbook of Zoology. Volume IV. Arthropoda: Insecta. Part 38. Coleoptera, Beetles. 786pp.

Cline, A.R. & S.A. Ślipiński. 2010. Discolomatidae Horn, 1878. Pp. 435-442. *In* Leschen, R.A.B., R.G. Beutel, & J.F. Lawrence (eds.) Handbook of Zoology. Volume IV. Arthropoda: Insecta. Part 38. Coleoptera, Beetles. 786pp.

Jelínek, J. & A.R. Cline. 2010. Kateretidae Erichson in Agassiz, 1846. Pp. 386-390. *In* Leschen, R.A.B., R.G. Beutel, & J.F. Lawrence (eds.) Handbook of Zoology. Volume IV. Arthropoda: Insecta. Part 38. Coleoptera, Beetles. 786pp.

Jelínek, J., C.E. Carlton, A.R. Cline, & R.A.B. Leschen. 2010. Nitidulidae Latrielle, 1802. Pp. 390-407. *In* Leschen, R.A.B., R.G. Beutel, & J.F. Lawrence (eds.) Handbook of Zoology. Volume IV. Arthropoda: Insecta. Part 38. Coleoptera, Beetles. 786pp.

Lawrence, J.F., S.A. Slipinski, & A.R. Cline. 2010. Corylophidae LeConte, 1852. Pp. 472-481. *In* Leschen, R.A.B., R.G. Beutel, & J.F. Lawrence (eds.) Handbook of Zoology. Volume IV. Arthropoda: Insecta. Part 38. Coleoptera, Beetles. 786pp.

[2] Cline, A.R. & J.V. McHugh. 2010. New Generic Synonymy in Biphyllidae (Coleoptera: Cucujoidea), with a Checklist of *Anchorius* Casey 1900. The Coleopterists Bulletin 64:98-99.

[3] Cline, A.R. & P. Audisio. 2010. Revision of the New World Short-Winged Flower Beetles (Coleoptera: Cucujoidea: Kateretidae). Part I. Generic Review and Revision of *Anthonaeus* Horn, 1879. The Coleopterists Bulletin 64: 173-186.

Mealybug, Scale & Whitefly Research

G. W. Watson

Identifications

A cactus-feeding mealybug native to South America, *Hypogeococcus pungens* Granara de Willink, was identified from outdoors in California for the first time in August 2010, on cacti in Los Angeles County. The infestation has since been eradicated. The mealybug forms dense colonies on the growing points of cacti in the sub-family Cereanae of the Cactaceae, causing distorted and stunted growth. Serious damage can be caused, so this species was deliberately introduced to Australia (Queensland) in 1974 as a biological control agent against invasive introduced *Eriocereus* spp. The mealybug is extending its range and now occurs in southern Europe, the Caribbean Islands and Florida. This insect remains a potential threat to both the horticulture industry and some native Californian cacti.

International Collaboration & Research

Solenopsis Mealybug

Late in January 2010, Australian Biosecurity officials contacted Dr. Watson with a request to identify a new mealybug pest, *Phenococcus solenopsis* Tinsley, found damaging cotton in Queensland (Figure 1). Identification by a recognized world expert was required before Australian officials could act against the infestations. This invasive pest has devastated cotton in Pakistan and India in recent years and is now impacting cotton yields in China and Australia (all major cotton-producing countries). The price of cotton is rising as a result. Vegetable crops are also being attacked.

Solenopsis mealybug occurs in southern California and may be native here. The CLIMEX analysis of the potential distribution of this mealybug that Dr. Watson collaborated on in 2009 has been published (Wang *et al.*, 2010). There is uncertainty as to whether the pest is a single, morphologically variable species or a cryptic species complex. Dr. Watson began collaboration with a Ph.D. student at Beijing Academy of Sciences, Ms. Li Ya-Lan, in a molecular study of *P. solenopsis* samples from around the world, to help clarify the taxonomic status of this invasive insect.

Figure 1. Solenopsis mealybug, *Phenacoccus solenopsis*, the invasive pest damaging cotton and vegetable crops in the Oriental Region and Australia. Photo by M. Gorton AQIS Cairns.

New Country Records of Invasive Species

Collaboration with Dr. R. Muniappan of USDA-CPHST (Virginia Tech), scientists at Clemson University, and contacts in southern Asia and West Africa has continued, with Dr. Watson identifying new country records of invasive species (particularly *Ph. solenopsis, Ph. manihoti* Matile-Ferrero and *Paracoccus*

marginatus Williams & Granara de Willink) from these regions. This work resulted in publication of a scientific note in 2009; another was submitted to *Journal of Agricultural and Urban Entomology* in 2010. Publication of the new country records facilitates release of USAID funds to assist with the development of biological control programs in the affected countries.

Papaya Mealybug

Authoritative identification by Dr. Watson of papaya mealybug *(P. marginatus)* from a major mealybug outbreak in Sri Lanka in 2008 resulted in provision of the relevant parasitoid wasps (*Acerophagus papayae*) by USAID; they were released in Sri Lanka in May 2009 and by August 2009 the mealybug outbreak was declining due to heavy parasitism. Similarly, Dr. Watson's authoritative identification of papaya mealybug in India (Tamil Nadu) set in motion a biological control program that is proving effective. Papaya mealybug (Figure 2) is continuing to spread in the Oriental Region, attacking cotton and vegetables as well as papaya.

Collaborative Research on Armored Scales

On 19 May 2010, Dr. Watson was visited by Prof. Benjamin Normark and two graduate students from the University of Massachusetts, and Mr John Dooley (USDA port plant quarantine inspection facility, San Francisco) to plan project work on the DNA sequencing of armored scale insects. The work, funded by the USDA-CREES Agriculture and Food Research Initiative, will develop DNA bar-coding for the identification of quarantine interceptions, and better understanding of generic boundaries and relationships among the armored scale insects. The objectives are: (1) improved accuracy of species-level identification at plant quarantine inspection; (2) discovery of cryptic species complexes that are invasive; and (3) discovery of geographic sources of genetic diversity within invasive species.

Figure 2. ***Paracoccus marginatus,*** **the papaya mealybug, killing papaya trees in Indonesia. Insert: live mealybugs are yellow; the black ones are dead. Photographs by Prof. Aunu Rauf, Institut Pertanian Bogor (Java).**

Training Provided

Dr. Soad Abdel-Razak, Research Entomologist at the Egyptian Department of Agriculture, visited Dr. Watson from 28 Dec. 2009 to 29 January 2010 for training and collaborative work on the scale insects and mealybugs of Egypt.

Publications

Wang, Y., **Watson, G.W.** & Zhang, R. 2010. The potential distribution of an invasive mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae), and its threat to cotton in Asia. *Agricultural and Forest Entomology*, **12**(4): 403-416.

Muniappan, R. Shepard, B.M., **Watson, G.W**., Carner, G.R., Rauf, A., Sartiami, D., Hidayat, P., Afun, J.V.K., Goergen, G. and Ziaur Rahman, A.K.M. (submitted 2010) New records of invasive insects (Hemiptera: Sternorrhyncha) in southern Asia and West Africa. *Journal of Urban and Agricultural Entomology* 26.

Dipterological Research Activities in 2010

S. Gaimari, M. Hauser, P. Kerr, O. Lonsdale, A. Rung, & S. Winterton

Refereed Publications

Books

The second and final volume of the Manual of Central American Diptera was published in 2010, with chapters by several CDFA staff. The full title of the work is as follows, with the CDFA authored chapters after:

Brown, B.V., A. Borkent, J.M. Cumming, D.M. Wood, N.E. Woodley & M. Zumbado (eds.). (2010) *Manual of Central American Diptera, Volume 2*. National Research Council Press, Ottawa, pp. xvi + 715-1442.

- **Gaimari, S.D.** & V.C. Silva. Lauxaniidae. Pages 971-995.
- **Gaimari, S.D.** Chamaemyiidae. Pages 997-1007.
- **Gaimari, S.D.** Odiniidae. Pages 1049-1055.
- **Lonsdale, O.** & D.K. McAlpine. Somatiidae. Pages 833-835.
- **Lonsdale, O.** & S.A. Marshall. Clusiidae. Pages 1041-1048.
- Mathis, W.N. & **A. Rung**. Periscelididae. Pages 1987-1092.
- **Rung, A.** & W.N. Mathis. Aulacigastridae. Pages 1083-1085.

Journal Publications

Gaimari, S.D., & V.C. Silva. 2010. Revision of the Neotropical subfamily Eurychoromyiinae (Diptera: Lauxaniidae). *Zootaxa* 2342: 1-64. [open access at http://www.mapress.com/zootaxa/2010/f/zt02342p064.pdf]

Abstract. The status of the enigmatic family Eurychoromyiidae is revised to a subfamily of Lauxaniidae, and the entire subfamily is revised with a key to genera and species, and maps for all species. Previously monotypic with only the species *Eurychoromyia mallea* Hendel, one closely related genus, *Tauridion* Papp & Silva, is moved into this subfamily, and five new genera are described: *Choryeuromyia*, *Euryhendelimyia*, *Eurystratiomyia*, *Physegeniopsis*, and *Roryeuchomyia*. Besides the type species for *Eurychoromyia* and *Tauridion*, all species herein are new,

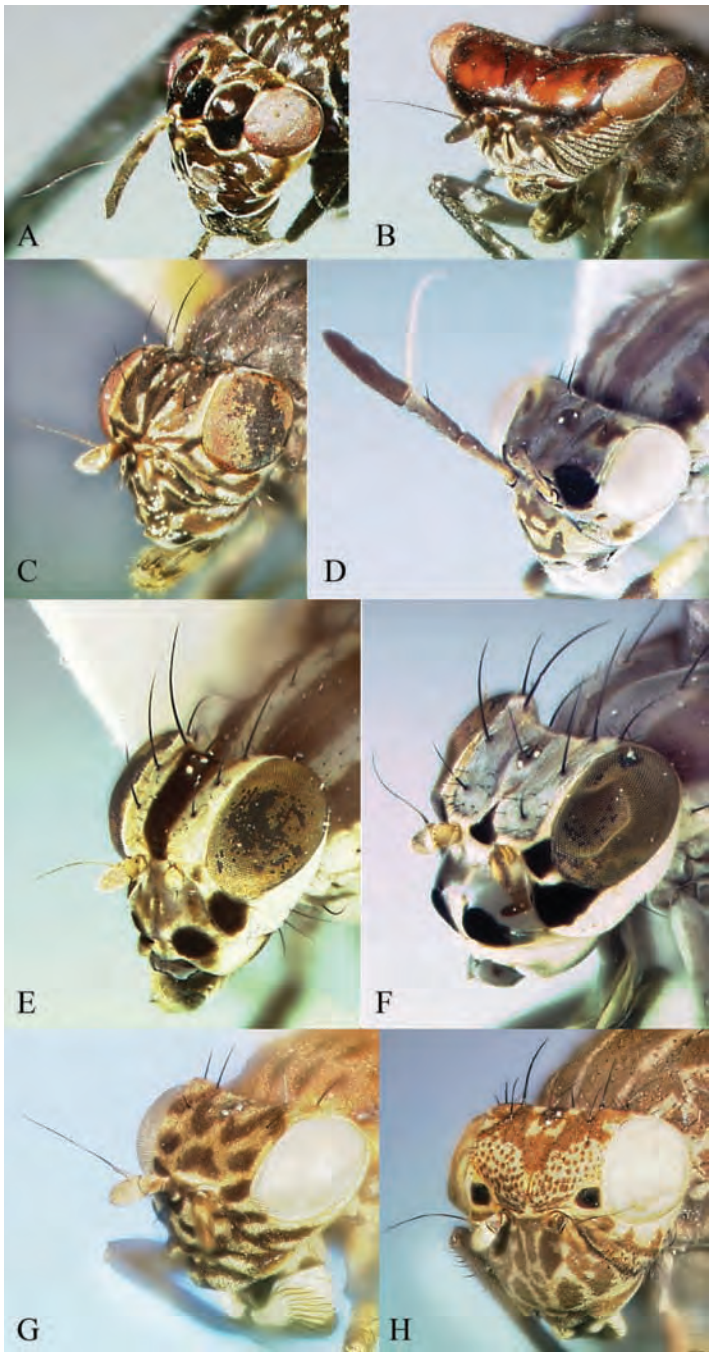


Figure 1. Heads of several eurychoromyiine species. A) *Choryeuromyia xenisma* Gaimari & Silva, B) *Eurychoromyia mallea* Hendel, C) *Euryhendelimyia schlingeri* Gaimari & Silva, D) *Eurystratiomyia epacrovitta* Gaimari & Silva, E) *Physegeniopsis albeto* Gaimari & Silva, F) *Physegeniopsis hadrocara* Gaimari & Silva, G) *Roryeuchomyia tigrina* Gaimari & Silva, H) *Tauridion shewelli* Papp & Silva.

Figure 2. Habituses of Mycetophilidae, *Azana frizelli* Kerr (left) and *Azana malinamoena* Kerr (right).

including *Choryeuromyia xenisma* (type species of genus), *Euryhendelimyia schlingeri* (type species of genus), *Eurystratiomyia epacrovitta*, *Eurystratiomyia erwini* (type species of genus), *Physegeniopsis albeto, Physegeniopsis ankhoidea* (type species of genus), *Physegeniopsis hadrocara*, and *Roryeuchomyia tigrina* (type species of genus). Eggs are described for *Tauridion shewelli* and *Physegeniopsis albeto*.

Kerr, P.H. 2010. New *Azana* species from Western North America (Diptera: Mycetophilidae). *Zootaxa* 2397: 1-14.

Abstract. Two new species of fungus gnats (Diptera: Mycetophilidae), *Azana malinamoena* and *Azana frizzelli*, spp. nov., are described and figured from California. These species represent the first records of *Azana* for western North America. A diagnosis of the genus *Azana* Walker is presented and a provisional key for the New World species of the genus is given. The discovery of *A. malinamoena* and *A. frizzelli* in California and their apparently close relationship to *A. nigricoxa* Strobl from south-western Europe (rather than to the only other *Azana* species known from North America, *A. sinusa* Coher) implies a more complicated biogeographic history of this genus in North America, one that probably includes multiple, independent dispersal events.

Kerr, P.H. 2010. Phylogeny and classification of Rhagionidae, with implications for Tabanomorpha (Diptera: Brachycera). *Zootaxa* 2592: 1–133.

Abstract. This paper updates current knowledge of Rhagionidae and related taxa within the infraorder Tabanomorpha. An estimate of phylogeny for the group is presented, based on 127 morphological characters for 60 ingroup species and molecular characters consisting of 3200+ bp sequences of 28S rDNA for 38 ingroup species. The morphology and molecular datasets are analyzed separately and in a combined analysis, using parsimony, maximum likelihood, and Bayesian methods. Morphological and molecular data, when analyzed separately and in combination, yield similar hypotheses of the evolution within Tabanomorpha. Arthrocerinae (Rhagionidae), Chrysopilinae (Rhagionidae), Rhagioninae (Rhagionidae), Spaniinae (Rhagionidae), Tabanoidea (Pelecorhynchidae, Oreoleptidae, Athericidae, and Tabanidae), and Vermileonidae are recovered consistently. The relationships among the major tabanomorph clades, including Austroleptis Hardy and Bolbomyia Loew, remain weakly supported, however. Rhagionidae are recognized as a monophyletic group of four subfamilies and at least 15 extant genera. The subfamily Spaniinae is defined by a special modification of tergite 9 of the female genitalia, which is shared by members of Omphalophora Becker, Ptiolina Zetterstedt, Spania Meigen, Spaniopsis White, and Symphoromyia Frauenfeld. Litoleptis Chillcott is also placed in this group, however this could not be confirmed because females of this genus were not available. The concept of Omphalophora is clarified and the genus is resurrected from synonymy with Ptiolina. On this basis, several species are newly transferred to Omphalophora; they include O. cinereofasciata (Schummel 1837) n. comb., O. fasciata (Loew 1869b) n. comb., O. majuscula (Loew 1869b) n. comb., and O. nigripilosa (Hardy & McGuire 1947) n. comb. Chrysopilinae is defined by having scale-like setae on the thorax and femur, as in Chrysopilus Macquart, Schizella Bezzi, and Stylospania Frey. Solomomyia Nagatomi is recognized as a new junior synonym of Chrysopilus. Seven new names within the genus Chrysopilus are created for binomials that are preoccupied. These include C. amulus Kerr nom. nov. for C. latifrons Williston 1901 (preoccupied by C. latifrons Bezzi 1898), C. batak Kerr nom. nov. for C. tomentosus Meijere 1924 (preoccupied by C. tomentosus Bigot 1887), C. mawambus Kerr nom. nov. for C. obscuripes Brunetti 1927 (preoccupied by C. obscuripes Speiser 1923), C. meunieri Kerr nom. nov. for C. nagatomii Evenhuis 1994 (preoccupied by C. nagatomii Yang & Yang 1991), C. occidentalis Kerr nom. nov. for C. lucifer Adams 1904 (preoccupied by C. lucifer Walker 1852), and C. amorimi Kerr nom. nov. for C. fascipennis Bromley in Curran 1931 (preoccupied by C. fascipennis (Brunetti 1920)). Chrysopilus sinensis (Yang et al. 1997) n. comb. is transferred from Spatulina Szilády, where this species was originally placed. Arthrocerinae contains a single genus, Arthroceras Williston. Phylogenetic analyses consistently show strong support for a clade consisting of Arthrocerinae, Chrysopilinae, and Spaniinae; most females of these subfamilies have spermathecal duct accessory glands. Spermathecal duct accessory glands are reported here for the first time and are unique in Tabanomorpha. Rhagioninae is the earliest branching subfamily

Figure 3. Habitus of *Arthroteles cinerea* Stuckenberg (Rhagionidae)

of Rhagionidae. The saw sclerite in the larval mandible may be synapomorphic for this subfamily. Members of Rhagioninae include Atherimorpha White, Desmomyia Brunetti, Rhagio Fabricius, and Sierramyia Kerr gen. nov. Atherimorpha setosus (Philippi 1865) is recognized as a new synonym of Atherimorpha praefica (Philippi 1865) and Neorhagio Lindner 1924 is recognized as a new synonym of Atherimorpha. Sierramyia gen. nov. is erected for two species from Mexico that were originally placed in Neorhagio (type species: Neorhagio caligatus Santos 2006). Rhagina Malloch is recognized as a new synonym of Rhagio. As a result, Rhagio yangi Kerr nom. nov. is created for R. sinensis Yang & Yang 1993a (preoccupied by R. sinensis Yang & Nagatomi 1992, n. comb.). Two enigmatic genera, Bolbomyia Loew and Austroleptis Hardy are retained within their own families, Bolbomyiidae status revised and Austroleptidae, respectively. Alloleptis tersus Nagatomi & Saigusa is incertae sedis within Rhagionoidea. Comments on larval morphology of Tabanomorpha are given in light of this work. A key is given to all families of Tabanomorpha and genera of Rhagionidae. The genera of Austroleptidae, Bolbomyiidae, and Rhagionidae are diagnosed, re-described, and re-classified based on characters and relationships established by the phylogenetic analyses, with a list of included species for each genus. A history of the recent classification of Rhagionidae and related taxa is also provided.

Winkler I. S., **A. Rung**, and S. J. Scheffer. 2010. Hennig's orphans revisited: Testing morphological hypotheses in the "Opomyzoidea." *Molecular Phylogenetics and Evolution* 54 746–762.

Abstract. The acalyptrate fly superfamily Opomyzoidea, as currently recognized, is a poorly-known group of 14 families. The composition of this group and relationships among included

Figure 4. Aulacigaster neoleucopeza Mathis & Freidberg (Aulacigastridae) on slime flux. Photo by Martin Hauser, CDFA, PPDC.

families have been controversial. Furthermore, the delimitation of two opomyzoid families, Aulacigastridae and Periscelididae, has been unstable with respect to placement of the genera *Stenomicra*, *Cyamops*, and *Planinasus*. To test the monophyly of Opomyzoidea, previously proposed relationships between families, and the position of the three problematic genera, we sequenced over 3300 bp of nucleotide sequence data from the 28S ribosomal DNA and CAD (rudimentary) genes from 29 taxa representing all opomyzoid families, as well as 13 outgroup taxa. Relationships recovered differed between analyses, and only branches supporting well established monophyletic families were recovered with high support, with a few exceptions. Opomyzoidea and its included subgroup, Asteioinea, were found to be non-monophyletic. *Stenomicra*, *Cyamops*, and *Planinasus* group consistently with Aulacigastridae, contrary to recent classifications. Xenasteiidae and Australimyzidae, two small, monogeneric families placed in separate superfamilies, were strongly supported as sister groups.

Non-Refereed Publications & Abstracts

Gaimari, S.D. 2010. Announcing the retirement of Laszlo Papp. *Fly Times* 45: 10.

Gaimari, S.D. 2010. Second request for material of adelgid-feeding Chamaemyiidae. *Fly Times* 44: 8.

Gaimari, S.D. (ed.) (2010) *Fly Times* 44: 1-28. http://www.nadsdiptera.org/News/FlyTimes/issue44.pdf

Gaimari, S.D. (ed.) (2010) *Fly Times* 45: 1-44. http://www.nadsdiptera.org/News/FlyTimes/issue45.pdf

Gaimari, S.D., & N. Havill. 2010. Phylogeny of the adelgid-feeding Leucopini (Diptera: Chamaemyiidae). *Abstracts, 7th International Congress of Dipterology*, San Jose, Costa Rica, p 85.

Gaimari, S.D., & R.M. Miller. 2010. Overview of Afrotropical Lauxanioidea. *Abstracts, 7th International Congress of Dipterology*, San Jose, Costa Rica, p 86.

Hauser, M. 2010. Aiming towards more resolution - challenges for a phylogeny of Stratiomyidae. *Abstracts, 7th International Congress of Dipterology*, San Jose, Costa Rica, p 108.

Hauser, M., & N.E. Woodley. 2010. Stratiomyidae biodiversity of Madagascar – Is the island richer than the continent? Abstracts, 7th International Congress of Dipterology, San Jose, Costa Rica, p 109.

Holston, K.C., **M. Hauser** & M.E. Irwin. 2010. An overview of Afrotropical endemism in Therevidae. *Abstracts, 7th International Congress of Dipterology*, San Jose, Costa Rica, p 114.

Pape, T., M. Kotrba & **S.D. Gaimari**. 2010. A Society for all Dipterists!? *Fly Times* 45: 2-3.

Ülgentürk, S., F. Szentkıralyı, **S. Gaimari**, N. Uygun, A. Saboori, S. Seven, O. Dursun & S.H. Civelek. 2010. Predators of *Marchalina hellenica* Genn. (Hemiptera: Marchalinidae) on Turkish pine in Turkey. *Book of Abstracts, XII International Symposium on Scale Insect Studies*, Chania, Crete, Greece, pp 58-59.

Winterton, S.L. 2010. Cybertaxonomy as a new paradigm for documenting biodiversity: technological advances, opportunities and the culture of taxonomy. *Abstracts, 7th International Congress of Dipterology*, San Jose, Costa Rica, p 274.

Winterton, S.L. 2010. Overview of Afrotropical window flies (Scenopinidae). *Abstracts, 7th International Congress of Dipterology*, San Jose, Costa Rica, p 273.

Winterton, S.L., & S.I. Morita. 2010. Phylogenetic relationships of Acroceridae and Nemestrinidae (Nemestrinoidea). *Abstracts, 7th International Congress of Dipterology*, San Jose, Costa Rica, p 275.

Winterton, S.L., B.M. Wiegmann, **S.D. Gaimari**, **M. Hauser**, H.N. Hill, K.C. Holston, M.E. Irwin, C.L. Lambkin, M.A. Metz, D.W. Webb, L. Yang & D.K. Yeates. 2010. Phylogeny of the therevoid clade (Asiloidea: Therevidae, Scenopinidae, Apsilocephalidae, Evocoidae): a really, really big molecular matrix approach. *Abstracts, 7th International Congress of Dipterology*, San Jose, Costa Rica, p 276.

7th International Congress of Dipterology

Some events in the life of a Dipterist are more important than others – so an International Congress of Dipterology is without a doubt the most important meeting a Dipterist would want to go. Every four years fly specialists, forensic entomologists, students, faculty and amateurs with a focus on flies meet to present and discuss the latest research. This outstanding series of meetings began in 1986 in Budapest, Hungary. A new country is chosen each time to host the event, so the congress has visited Bratislava, Czechoslovakia in 1990, Guelph, Canada in 1994, Oxford, United Kingdom in 1998, Brisbane, Australia in 2002, Fukuoka, Japan in 2006 and finally San Jose, Costa Rica in 2010.

To this event, three CDFA entomologists, Drs. Steve Gaimari, Shaun Winterton and Martin Hauser, traveled in August 2010 to Costa Rica to meet old friends and colleagues, and to make new ones, and to be immersed in all the latest advances in fly research. The congress was attended by more than 200 Dipterists from 35 countries and 5 continents. In total over 280 oral and poster presentations were given which spanned every aspect of Dipterology from taxonomy, phylogenetics and cybertaxonomy to pest control and forensic entomology. The three CDFA entomologists contributed 9 presentations, Shaun and Martin organized one symposium, and Steve was on the Organizing Committee for the meeting. To see the list of presentations, see below. Dr. Gaimari was also elected as a member on the Council of International Congress of Dipterology.

The congress spanned from the 8th through the 13th August 2010. After the meeting Drs. Winterton and Gaimari flew back to California, while Dr. Hauser attended one of the organized field trips to the Monte Verde field station to explore the local fly fauna together with several friends from around the world. The 2010 was such a great success that expectations are high for the 2014 congress to be held in Potsdam, Germany.

Presentations

"Aiming towards more resolution - challenges for a phylogeny of Stratiomyidae." (author: **M. Hauser**) [7th International Congress of Dipterology (Symposium: Phylogeny and Taxonomy within the "orthorrhaphous" Diptera), San Jose, Costa Rica]

" An overview of Afrotropical endemism in Therevidae." (authors: K.C. Holston, **M. Hauser** & M.E. Irwin) [7th International Congress of Dipterology (Symposium: Advances in Afrotropical Dipterology), San Jose, Costa Rica]

"An overview of Afrotropical Lauxanioidea." (authors: **S.D. Gaimari** & R.M. Miller) [7th International Congress of Dipterology (Symposium: Advances in Afrotropical Dipterology), San Jose, Costa Rica]

"Cybertaxonomy as a new paradigm for documenting biodiversity: technological advances, opportunities and the culture of taxonomy." (author: **S.L. Winterton**) [7th International Congress of Dipterology (Symposium: Getting Diptera taxonomy up-to-date: New frontiers and the web), San Jose, Costa Rica]

"Overview of Afrotropical window flies (Scenopinidae)." (author: **S.L. Winterton**) [7th International Congress of Dipterology (Symposium: Advances in Afrotropical Dipterology), San Jose, Costa Rica]

"Phylogenetic relationships of Acroceridae and Nemestrinidae (Nemestrinoidea). (author: **S.L. Winterton** & S.I. Morita) [7th International Congress of Dipterology (Symposium: Phylogeny and Taxonomy within the "orthorrhaphous" Diptera), San Jose, Costa Rica]

"Phylogeny of the adelgid-feeding Leucopini (Diptera: Chamaemyiidae)." (authors: **S.D. Gaimari** & N.P. Havill; poster) [7th International Congress of Dipterology, San Jose, Costa Rica]

"Phylogeny of the adelgid-feeding Leucopini (Diptera: Chamaemyiidae)." (authors: **S.D. Gaimari**, N.P. Havill, Joanne Klein & Adalgisa Caccone; poster) [5th Hemlock Woolly Adelgid Symposium, Asheville, NC]

"Phylogeny of the therevoid clade (Asiloidea: Therevidae, Scenopinidae, Apsilocephalidae, Evocoidae): a really, really big molecular matrix approach." (authors: **S.L. Winterton**, B.M. Wiegmann, **S.D. Gaimari**, **M. Hauser**, H.N. Hill, K.C. Holston, M.E. Irwin, C.L. Lambkin, M.A. Metz, D.W. Webb, L. Yang & D.K. Yeates) [7th International Congress of Dipterology (Symposium: Phylogeny and Taxonomy within the "orthorrhaphous" Diptera), San Jose, Costa Rica]

"Predators of *Marchalina hellenica* Genn. (Hemiptera: Marchalinidae) on Turkish pine in Turkey." (authors: S. Ülgentürk, F. Szentkıralyı, **S. Gaimari**, N. Uygun, A. Saboori, S. Seven, O. Dursun & S.H. Civelek) [poster, 12th International Symposium on Scale Insect Studies, Chania, Crete, Greece]

"Stratiomyidae biodiversity of the Ethiopian region – Is the island richer than the continent?" (authors: **M. Hauser** & N.E. Woodley) [7th International Congress of Dipterology (Symposium: Advances in Afrotropical Dipterology), San Jose, Costa Rica]

The European Grape Vine Moth NOT Found In California: *Eupoecilia ambiguella* (Hübner)

T.M. Gilligan & M. E. Epstein

Figure 1. The Instituto Agrario di San Michele all'Adige (IASMA) Research Centre in Trento Province, Italy

The European grape vine moth (EGVM), *Lobesia botrana* ([Denis & Schiffermüller]), an invasive Palearctic grape pest, was discovered in Napa Valley in September 2009. The species is in the Lepidoptera family Tortricidae, a group commonly known as leaf-roller moths. Another European tortricid grape pest, *Eupoecilia ambiguella* (Hübner), is sometimes confused with EGVM because the two species are often referenced by the same common names: European grape vine moth, European grape berry moth, grape berry moth, vine moth, grape leaf roller, or grape fruit moth. The two species also share nearly identical larval biology, their native distributions overlap, and the larvae cause similar damage to grape. *Eupoecilia ambiguella* is widely distributed across the Europe and parts of Asia, where it is more common in cooler and humid climates than *L. botrana*, and it is not considered established outside of the Palearctic.

In late August 2010 we visited the IASMA (Instituto Agrario di San Michele all'Adige) Research Centre in the Trento Province of northern Italy (Figure 1). Both *E. ambiguella* and *L. botrana* are found in Trentino-Alto Adige vineyards, although *E. ambiguella* occurs at higher elevations and *L. botrana* is more common in the lower valleys. Here we compare and contrast these two grape moths and provide some basic diagnostics to identify *E. ambiguella* adults and larvae.

Recognition

Adult

The forewing is yellow or yellowish orange with a well defined dark brown to black median fascia (Figure 2A, Figure 4). Males and females exhibit no sexual dimorphism in wing pattern although females may be slightly larger than males. Males lack a forewing costal fold. Male genitalia are distinguished by a reduced uncus, short socii, prominent transtilla, distally triangular valva, and large aedeagus (Figure 3A). Female genitalia are distinguished by a broad, short ductus burase and a corpus bursae with numerous sclerotizations and spines (Figure 3B).

The adult forewing length is 6.0-7.5 mm. Although this overlaps in size with *Lobesia botrana*, the two are easily separated: *L. botrana* has leaden gray, brown and cream-colored forewings (Figure 2B) in contrast with the yellow *E. ambiguella*. *Eupoecilia ambiguella* may be confused with other species of *Eupoecilia* or European members of the tortricid tribe Cochylini, although *E. ambiguella* is the only species in this group commonly associated with grape. A genitalic dissection can be used to confirm *E. ambiguella* adults if necessary.

Larva

Late instar larvae are approximately 10-12 mm in length (Figure 5). The head, prothoracic shield, and legs are dark brown to black. Body color varies from brown to yellow and green. Pinacula are large, conspicuous, and brown. The anal shield is pale brown.

Larvae cause damage similar to *Lobesia botrana* and the two species can be found sympatrically. Other tortricid grape pests include: *Argyrotaenia franciscana*, *Argyrotaenia ljungiana*, *Epiphyas postvittana*, *Paralobesia viteana*, *Platynota stultana*, and *Proeulia* species. Larvae of *E. ambiguella* can be separated from

Figure 2. A: *Eupoecilia ambiguella* adult; B: *Lobesia botrana* adult .

Figure 3. A: *Eupoecilia ambiguella* male genitalia; B: *E.ambiguella* female genitalia

the larvae of the other tortricid grape-feeding pests listed here by the L-group (or prespiracular) pinaculum on T1, which extends horizonally beneath the spiracle in *E. ambiguella*. *Lobesia botrana* larvae are easily separated by having no extension of this pinaculum below the spiracle and having light-colored, less conspicuous pinacula.

Biology

The life cycle of *E. ambiguella* is similar to that of *Lobesia botrana*, with the exception of two generations for *E. ambiguella* versus three or more generations for *L. botrana*. Over most of its range, adults are present in May and June for the first generation and again in August and September for the second generation.

Females deposit eggs singly on buds, pedicels, and flowers during the first generation and on grape berries during the second generation. Early instar larvae burrow into the buds or berries and feed internally; later instars web together buds or berries, and a single larva can feed on up to a dozen berries. Pupation occurs in leaves for the first generation and under bark for the second generation. Overwintering occurs as a second generation pupa. Development time is highly dependent on temperature and humidity. The optimum relative humidity level for development is 70% or higher; eggs will fail to hatch at low relative humidity levels.

Economic losses on grape are caused by direct feeding damage and secondary infections. Feeding damage is similar to that of Lobesia botrana, with larvae of the first generation causing minor damage by feeding on flower buds, and those of the second generation causing the most damage by feeding on grape berries. The most significant losses are due to secondary infection of feeding sites on berries and clusters by *Botrytis cinerea*. Economic thresholds vary with the type of grape and cultivar.

Host plants

Although grape (*Vitis vinifera*) is the most economically important host, *E. ambiguella* has been recorded from plants in several families (Table 1).

Summary

The recent discovery of *L. botrana* in Napa Valley demonstrates that California vineyards are vulnerable to invasive tortricid grape pests. Although not yet recorded from North America, *E. ambiguella* is an important pest of grape in the Palearctic and could become a significant threat if introduced into California. This contribution provides information that can be used to identify *E. ambiguella* adults and larvae and characters to separate them from *L. botrana*.

Table 1: Partial host list for *E. ambiguella*.

Family	Scientific Name	Common Name
Aceraceae	*Acer campestre* L.	hedge maple
Araliaceae	*Eleutherococcus* Maxim.	Siberian ginseng
Araliaceae	*Hedera helix* L.	English ivy
Araliaceae	*Hedera* L.	ivy
Caprifoliaceae	*Lonicera* L.	honeysuckle
Caprifoliaceae	*Lonicera periclymenum* L.	European honeysuckle
Caprifoliaceae	*Lonicera ramosissima* Franch. & Sav. ex Maxim.	
Caprifoliaceae	*Symphoricarpos* Dunham.	snowberry
Caprifoliaceae	*Viburnum* L.	viburnum
Cornaceae	*Cornus* L.	dogwood
Cornaceae	*Cornus mas* L.	Cornelian cherry
Cuscutaceae	*Cuscuta* L.	dodder
Cuscutaceae	*Cuscuta reflexa* Roxb.	giant dodder
Grossulariaceae	*Ribes* L.	currant
Oleaceae	*Ligustrum* L.	privet
Oleaceae	*Syringa* X *persica* L.	Persian lilac
Rhamnaceae	*Frangula alnus* Mill.	glossy buckthorn
Rhamnaceae	*Rhamnus* L.	buckthorn
Rosaceae	*Prunus* L.	
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	Virginia creeper
Vitaceae	*Vitis vinifera* L.	wine grape

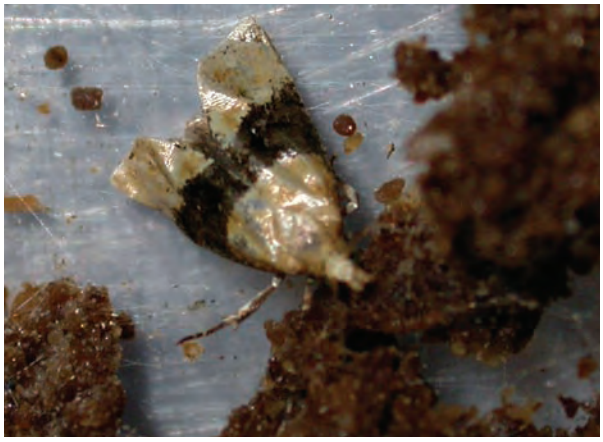


Figure 4. *Eupoecilia ambiguella* adult in IASMA lab colony in Italy

Figure 5. *Eupoecilia ambiguella* larva in lab colony in Italy

Acknowledgments

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2010 Annual Report of the Nematology Laboratory

Detection of Plant Parasitic Nematodes in California, 2010

John Chitambar, Ke Dong, Sergei Subbotin & René Luna

The Nematology Laboratory of the Plant Pest Diagnostics Branch (PPDB) 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 1: provide nursery certification and standards of pest cleanliness, 2: prevent the introduction and spread of regulatory significant pests, and 3: provide phytosanitary certification of foreign export commodities.

The Nematology Laboratory comprises three Senior Nematologists, one Senior Agricultural Biological Technician and a support staff of three Scientific Aides. The role and responsibilities of the State Nematologists are:

- 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.
- Education of students and other groups in nematology topic.
- Research in nematode taxonomy, methodologies, and other areas of regulatory nematology.

The Senior 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.

Nematode Sample Load

During 2010 at total of 7,293 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. Most nursery samples of plants for sale by the grower comprised garlic (69 seed bulb samples), strawberries (1,310 foliage and root samples), grape and stone fruits (258 root and soil samples) collected through the State's Registration and Certification, and Nematode Control programs. The potato cyst nematode survey generated 2,839 soil samples in 2010.

Table 1. Total number of samples per program received by the CDFA Nematology Laboratory in 2010

Nematode Detection Program	No. of samples
Quarantine (total)	**2,788**
Incoming External Quarantine	1,743
Border Station Interceptions	106
Export Phytosanitary Certification	934
Others	5
Nursery (total)	**1,635**
Registration and Certification[1]	1,399
Nematode Control[2]	228
Others	8
Commercial (total)	**2,870**
Potato Cyst Nematode Survey	2,839
Assistance to other agencies	31
Total	***7,293***

[1] includes garlic & strawberry [2] includes stone-fruit & nut trees

Detections of Interest and Significance

Three species of particular interest and significance were detected in 2010, namely, burrowing nematode (*Radopholus similis*), rye grass cyst nematode (*Heterodera mani*) and banana spiral nematode (*Helicotylenchus multicinctus*).

Burrowing Nematode

Radopholus similis was detected in imported quarantine nursery shipments of *Calathea* sp. from Florida to San Mateo County, and in nursery shipments of *Pothos* sp. cv. Marble Queen from Guatemala to San Joaquin County. The burrowing nematode is not present in California and is a High-risk, invasive pest. CDFA's external quarantine program has successfully prevented the long-term establishment of this devastating nematode pest within California agriculture.

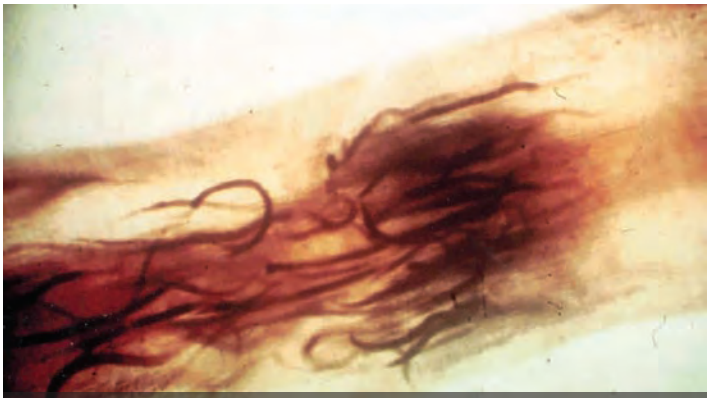


Figure 1. Burrowing nematode, *Radopholus similis*, within citrus root.

Figure 2. Necrotic root lesions caused by burrowing nematode.

Figure 3. Anterior head end of the burrowing nematode, *Radopholus similis*

Figure 4. An ornamental *Marantha* sp. plant destroyed by burrowing nematode (left) compared to a non-infested plant (right).

The burrowing nematode is a migratory endoparasite of plant roots. All life stages of the nematode are found within roots and rhizosphere soil. All stages feed after egg hatch, and the life cycle is completed within the root cortex (Figure 1). Reproduction is sexual although parthenogenesis (egg production without fertilization) is possible. Because of its particular feeding behavior and development, pathways for introduction of the burrowing nematode to California include infested plant roots, corms, cutting, rootings, and rhizosphere soils (Figure 2 & Figure 3).

In the United States *Radopholus similis* is present in Alabama, Arkansas, Florida, Georgia, Louisiana, North Carolina, South Carolina, Mississippi, Texas, Hawaii, and Puerto Rico. The nematode species is found worldwide in tropical and subtropical regions. It occurs wherever bananas are grown, including, Africa, Asia, South America, southern Europe, and the United States.

There are over 350 host plants of which citrus, strawberry, carrots and ornamentals are examples of major hosts cultivated in California (Figure 4). Losses of 50-80% in grapefruit yield and 40-70% in orange yield have been experienced in Florida. In California, the nematode prefers coarse, sandy soils which are present in the Coachella Valley, the Bard Valley near Blythe, the Edison-Arvin citrus district of Kern County, and in streaks throughout the state. Citrus and date palm, good hosts of the nematode, in the Coachella Valley are planted in soils subject to temperatures favorable to the development of the nematode. Host crops cultivated along the coastal areas, when planted in sandy soil, experience soil temperatures that can favor the development of the nematode if even for a few months.

Ryegrass Cyst Nematode

Heterodera mani was detected in a potato field soil in Sonoma County (Figure 5). *H. mani* was formerly given a "Q" pest rating, however, subsequent to this reported detection, the rating was changed to a "B." In the past, The grass cyst nematode was assigned a Q-rating assignment due to the confusion that then existed over its definite identification due to its morphological variability and similarity to the closely related species *H. avenae*, the cereal or oat cyst nematode – which is not present in California. Recent development of molecular diagnostic tools clearly distinguishes *H. mani* from *H. avenae* (Figure 6). To date, within California *H. mani* has been detected in 5 coastal counties namely, Santa Cruz, San Mateo, Sonoma, Marin and Mendocino.

The ryegrass cyst nematode is a sedentary endoparasite of plant roots. Infective second-stage juveniles penetrate host plant root epidermal cells, completely invade cortical cells and move toward the vascular cylinder where a sedentary feeding site is established. Once the feeding site is penetrated by the nematode's stylet and feeding is initiated, the juvenile enlarges as it develops through three molts of its cuticle, to a swollen, sedentary adult female, or migratory, worm-shaped adult male. Following fertilization, eggs may be laid outside the nematode body, although most are retained within the female body. Upon death, the body of the female is transformed to a tanned, thick-walled cyst. The cyst body protects the internal eggs against non-favorable influences of adverse environment and pesticides. Plant host root exudates serve as stimulants for nematode egg hatch as well as attractants to hatched

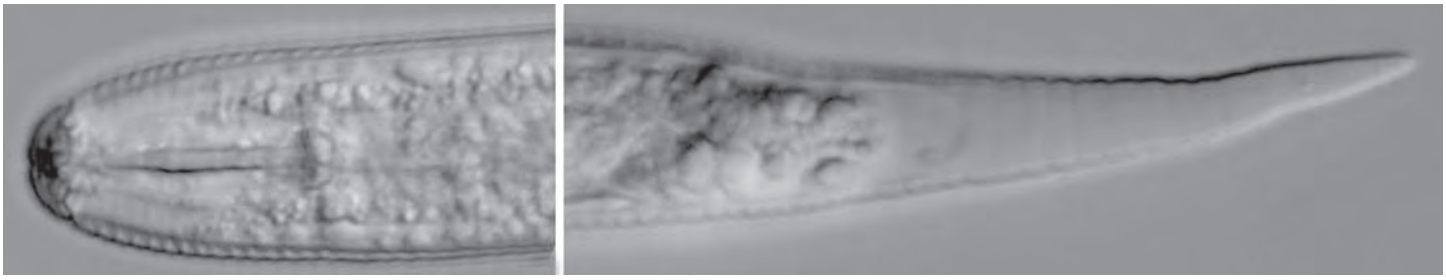


Figure 5. **Anterior head end and posterior tail end of the ryegrass cyst nematode, *Heterodera mani.***

juveniles. Due to its particular feeding and developmental biology, the nematode is readily spread to non-infested regions through the movement of soils and host plant roots that are infested with juveniles, adults and/or cysts.

The grass cyst nematode has been detected in limited regions within California. Internationally, it is distributed in Europe and South Africa.Fields cultivated with perennial ryegrass can suffer considerable damage due to *Heterodera mani*. Other grasses that are hosts to the nematode include several species of orchard grass (*Dactylis* spp.), meadowgrass (*Festuca* spp.), ryegrass (*Lolium* spp.), foxtail (*Alopecurus geniculatus*), fescue grass (*Vulpia* sp.) and *Glyceria fluitans*. The greatest impact for economic loss is the turf industry. Earlier reports by several authors (not listed here) of *H. mani*-like cyst nematodes detected in cereals and grasslands were later identified as different species.

Banana Spiral Nematode

Helicotylenchus multicinctus was detected in root and soil samples belonging to a quarantine shipment of ornamental *Ficus binnendijkii* plants from Florida destined to San Mateo County, California (Figure 7). The nematode species has been detected before in similar shipments of ornamental banana plants sent to San Diego County. The status of the distribution and economic impact on California agriculture and environment is uncertain, however, the biology of this particular species significantly separates it from other species of *Helicotylenchus*.

H. multicinctus is an ecto-endoparasite of host plant roots. Unlike other species of the genus, the banana spiral nematode invades outer layers of host cortical tissue producing small necrotic lesions. Apparently, the nematode does not invade deeper cortical tissue. In fact, all stages of the nematode are found within the roots and the nematode completes its life cycle as an endoparasite. Additionally, it is found in soil around plant roots. Because of its feeding and developmental biology the nematodes are easily introduced and spread to non-infested regions through infested soil, plant root and other root "seed stock."

The nematode is an important pest of banana and has also been recorded globally on several plant hosts including, mango, citrus, maize, rice, grass, grapevine, grasses, and ornamentals of primary interest to California agriculture and environment. Ornamental banana plants are commonly propagated in regions of California. Knowledge of the extent of plant damage and loss has been gained through reports of laboratory and natural field studies conducted mainly on banana. Considerable economic damage in banana has been reported from Israel, Australia, and in the Windward Islands, all which have similar climates and environments to California.

Banana spiral nematode is distributed wherever banana is cultivated globally. It has been recorded in several countries Europe, Asia, Pacific Islands, Africa, South America and North America (USA). In the USA, it has been reported in Florida and New Jersey.

Knowledge of the distribution of banana spiral nematode in California is doubtful mainly due to the fact that for several years a general rating requiring no regulatory action against the pest was used, thereby resulting in those nematodes only being identified up to their genus status. It is possible that the species is already present in California, however, it has not been detected in surveys and internal regulatory Nematology programs for the past five to six years.

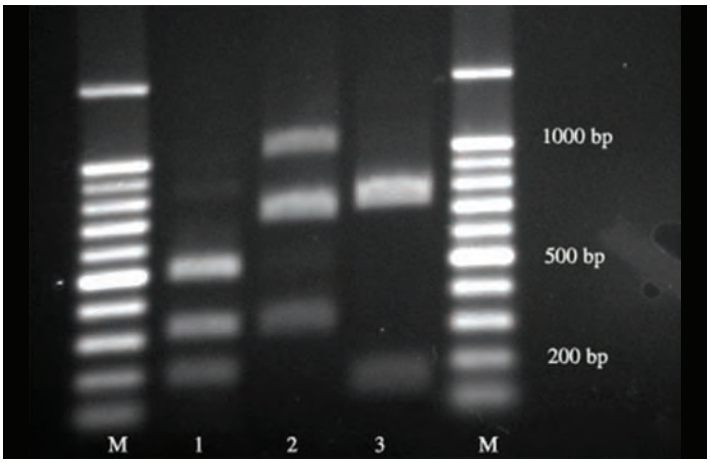


Figure 6. **RFLP with three restriction enzymes. M = DNA, 100 bp marker; 1 = HinfI, 2 = RsaI, 3 = CfoI. (CfoI – a diagnostic enzyme for *H. mani*: it generates restriction fragments 743, 151, 151 (Subbotin et al., 2003).**

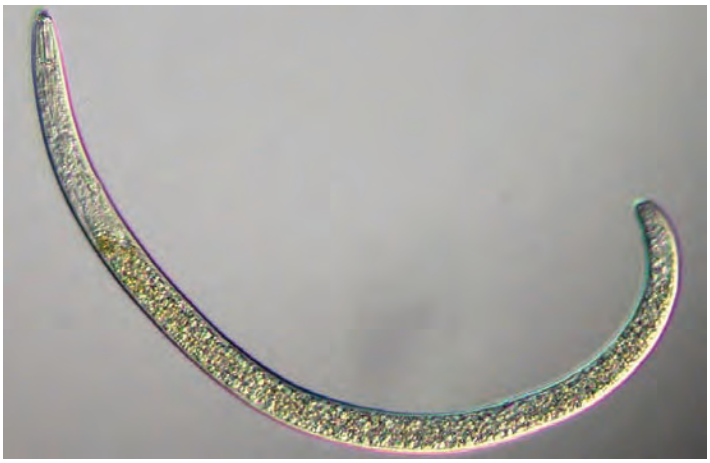


Figure 7. **The banana spiral nematode, *Helicotylenchus multicinctus.***

Status of Survey Projects

Potato Cyst Nematode 2009 Survey

In 2010, CDFA's Nematology Laboratory was involved in the potato cyst nematode survey project which was sponsored by the United States Department of Agriculture (USDA) as part of the latter's national survey project (Figure 8 & Figure 9). The operational responsibilities for the two projects (sample collection) were undertaken by the Pest Detection and Eradication Program Branch (PDEP), while survey planning, sample processing and nematode diagnostics were conducted by the Nematology Laboratory, CDFA-PPDB. In addition, CDFA nematologists were involved both individually and collectively in research, training, consultations, professional seminars and committee participatory responsibilities.

The Survey was in accordance with USDA's plan to re-convene surveys for the potato cyst nematode every two years. The plan was initiated in 2006 after the first detection of the pale cyst potato nematode, *Globodera pallida*, in Idaho. The 2010 survey was based on California's 2009 and 2010 potato acreage cultivated to seed and production potatoes. In addition to the 2009 acreage, 37 seed potato fields representing 2010 potato acreage, were included. Seed potato was cultivated in four counties in 2009 (Kern, San Joaquin, San Luis Obispo and Santa Barbara), and in three counties in 2010 (Kern, Santa Barbara and San Joaquin). In 2009, production potato was cultivated in seven counties (Kern, Marin, Modoc, San Benito, Siskiyou, Sonoma and Yolo) and six counties in 2010 (Kern, Modoc, Monterey, Siskiyou, Sonoma and Yolo). Unlike the 2006 sampling protocol whereby only perimeter regions of fields were sampled, in 2009 and 2010, entire fields were sampled in accordance to USDA-APHIS protocol (2008 PCN National Survey Protocol: Full-Field Hand Sampling Survey, Method B1). All fields per county cultivated to seed potato were sampled, while only ten percent of production potato fields per county were randomly selected for the survey. This limited bias in the distribution of fields across counties to be sampled. Though the selection was mainly random, special attention was paid to fields with a higher likelihood of infestation and detection. This included fields that had been planted to potatoes consecutively and had been in potato production for the longest period of time (including rotation). In both types of fields, soil sampling was done at a rate of a one-pound composite soil sample (comprised of 100 x 5 g sub samples) per acre. Samples were sent in their entirety to the Nematology Laboratory for processing and cyst nematode diagnosis. Soil samples were processed specifically for the extraction of nematode cysts using a combination of the gravity sieving and sugar centrifugation techniques.

A total of 2,839 soil samples were processed and examined in 2010, while 3,702 samples were generated in 2009. Potato cyst nematodes were not found in the combined 6,541 soil samples, however, ryegrass cyst nematode, *Heterodera mani* was found in samples collected in 2010 from a single field in Sonoma County.

Workshops, Conferences & Annual Meetings

State nematologists participated in several professional meetings in 2010. These included mainly: 42nd Annual California Nematology Workshop held at the Kearney Agricultural Research Station in Kearney, California, and in partnership with the University of California (UC) Nematology Departments at Davis and Riverside. The workshop was designed for an audience of pest control advisors and applicators, growers, farmers, retail and nursery employees, municipal, county and state employees, park and recreation personnel, educators, university educators and students, and consultants. Dr. John Chitambar gave a talk on "Detection of Quarantined Nematode Pests: Actions, Results and Current Status."

Annual meeting of the University of California Division of Agriculture and Natural Resources (DANR) Nematology Workgroup in Salinas, California. State nematologists serve as members of the workgroup along with UCD and UCR Nematology Department faculty. The main purpose of the workgroup is to collaboratively plan and coordinate research and extension program activities that directly concern California agriculture; presentations were made by State nematologists at each event.

Throughout the year, Nematologists, with the aid of the laboratory staff, conducted several educational presentations to students and other visitors from schools, colleges, University of California, plant industries, private, county, state and federal agencies.

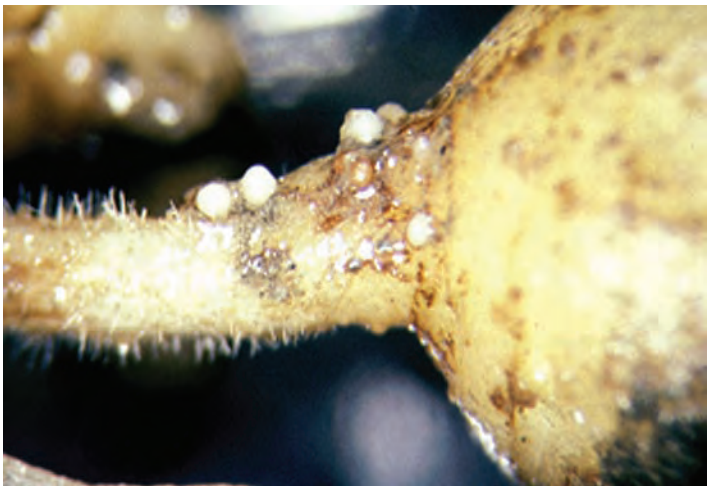


Figure 8. White female potato cyst nematodes, *Globodera rostochiensis*, on the stolon of a potato.

Figure 9. Damage to potato plants caused by potato cyst nematode (left: healthy; right: diseased).

2010 Annual Report of the Plant Pathology Laboratory

The mission of the Plant Pathology Lab is to provide timely and accurate diagnoses of plant diseases caused by fungi, oomycetes, viruses and virus-like pathogens, and bacteria including phytoplasmas. In addition to our primary mission, we troubleshoot disorders with physiological, chemical or genetic causes and we test seed-producing plants and seed itself for specific seed-born diseases for seed health compliance prior to export. Our clientele includes the pest prevention programs of CDFA, County Agricultural Commissioners, USDA, other state and federal agencies, UC Cooperative Extension service, the agricultural industry (including individual farmers, pest control advisors, commodity groups, nurserymen, and arborists), homeowners, government municipalities, and educational institutions. In addition to general plant pathology samples, each diagnostician runs at least one major testing project focused on one or more diseases of extreme economic importance to the state of California. The projects include:

- HLB Huanglongbing (HLB)/Citrus Greening Disease testing of trees and the insect vector, the Asian Citrus Pysillid (ACP).
  - ACP has been found in seven southern California counties. In response to presence of the vector in California both psyllid and symptomatic trees are tested for this devastating disease. HLB is present in Florida, Georgia, South Carolina, and Louisiana but not in California. Dr. Dan Opgenorth was responsible for this project in 2010. Lucita Kumagai and Dr. Dan Opgenorth will share responsibilities for this project in 2011.
- Citrus Tristeza Virus (CTV) testing
  - In service to the CA citrus industry, with goal of early detection of CTV in propagation stock to prevent infection of new and replacement citrus trees. Dr. Tongyan Tian directs this project.
- Plum Pox (PPV) Survey
  - In service to the stone fruit industry, with goal of early detection and eradication if PPV is ever introduced into the state. Dr Tongyan Tian directs this project.
- Sudden Oak Death / Phytophthora ramorum testing
  - In service of the CA Nursery industry and CA forestry stakeholders. Nurseries that ship plant species that have been shown to be hosts of *P. ramorum* out of state are required to be tested yearly for this disease. Dr. Suzanne Rooney-Latham directs this project.
- Sweet Orange Scab (SOS) testing
  - In response to the USDA and competing citrus producing states, a survey of Citrus in California was begun in November, 2010. This disease caused by *Elsinoe austalis* is known to exist in Florida, Arizona, and Texas, but has not been confirmed in California. Dr. Cheryl Blomquist directs the testing.
- California Deciduous Fruit Tree, Nut Tree and Grapevine Nursery Registration and Certification Program.
  - Fruit trees are tested for Prunus Necrotic Ringspot Virus and Prune Dwarf virus and grapevine nursery stock is tested for grapevine fanleaf virus and grapevine leafroll associated viruses to ensure California nursery stock has no detectable viruses. Dr. YunPing Zhang is responsible for this testing program.

The Diagnosticians & Their Specialties

- Dr. Dan Opgenorth: plant pathogenic bacteria, including phytoplasmas
- Ms. Lucita Kumagai: plant pathogenic bacteria
- Dr. Suzanne Rooney-Latham: Fungi and oomycetes
- Dr. Cheryl Blomquist: Fungi and oomycetes
- Dr.Tongyan Tian: plant viruses excluding woody plants
- Dr.Yungping Zhang: woody plant viruses including fruit trees and grapevines, and seed health testing

In addition, the PPDC also houses a plant pathologist with the Pierce's Disease Branch who is responsible for research and diagnosis of *Xylella fastidiosa*, the pathogen of Pierce's Disease of Grapevines, as well as other diseases in other hosts. Dr. Barry Hill is responsible for this program.

Fungal Rust Disease & Selected Profiles of Unique Detections

Cheryl Blomquist, Suzanne Latham & Jeanenne White

Rust fungi, classified in the Order Uredinales, Class Basidiomyetes, comprise the largest groups of phytopathogenic fungi encompassing approximately 7,000 described species of obligate parasites growing and producing only in living plants. As a group, the rusts are among the most economically important pathogens parasitizing a wide range of host plants including ferns, conifers, and angiosperms (both mono-and dicotyledonous). Current classification of the rusts into 13 families is based upon life cycle variations, fruiting structure morphology and host associations. These organisms are called "rusts" because of the spore-producing structures, referred to as sori, that develop on green plants are often orange to reddish-orange in color.

Rusts exhibit some of the most complex life cycles in the Eumycota kingdom producing up to five morphologically and functionally different spore states in a life cycle including: basidiospores, spermatia, aeciospores, urediniospores and teliospores. Different spore states may develop on a plant at different times of year or may appear together simultaneously. They may also appear at different times on different hosts in differing geographical areas. Aeciospores are often produced in the spring, urediniospores in the summer, and teliospores in late fall or until low temperatures kill the plant host tissue. Basidiospores may be produced in the spring from germinating teliospores and initiate new infections of a plant. All five spore states are not found in all rust species. Rust life cycle variations can include all spore states (macrocyclic), lack the uredinial state (demicylic), or lack both the aecial and uredinial state (microcyclic).

To add to this complexity, rust species may not only have different spore states but might also require two phylogenetically distinct host plants to complete a life cycle. Heteroecious rusts need two plant species for life cycle completion (i.e. aecia develop on one host plant and telia develop on a completely different plant species in a different plant family). In contrast, autoecious rusts complete an entire life cycle on one host plant (i.e. the aecia and telia develop on the same plant).

In 2010, the CPPDC Plant Pathology laboratory confirmed several rust species on native host plants and grasses. Detections of rusts on nursery-grown alder trees and sedum (stonecrop) plants added to the already interesting variety of rust specimens submitted to the lab.

Rust on Native Hosts

California native plants are a highly diversified group of host plants that are often infected by the various fungal rust groups. California's Mediterranean type climate with mild wet winters and warm dry summers produce a wide speciation of native plants and grasses. Currently there are 7,221 native plant taxa known in California (Jepson Manual of CA vegetation-in press) including 300 species of native grasses. Native plants have co-evolved with animals, fungi and other microorganisms, to form a complex network of relationships that make up our native ecosystems (natural communities).

Many of the rust fungi are host specific, developing compatible associations with the plants they parasitize. Infected plants nearly always go on to complete their life cycles, usually producing fewer flowers and less seed. Because rusts are usually host-specific they have been tried as bio-control agents of noxious weeds such as star thistle. *Puccinia* and *Uromyces* species, parasitize the largest range of native hosts, infecting plants in numerous plant families.

In 2010, *Puccinia* species were identified on native host plants including *Puccinia convolvuli* on *Calystegia occidentalis spp. occidentalis* (morning glory), *Puccinia pulverulenta* on *Epilobium spp*. (Epilobium), *Puccinia oenotherae* on *Clarkia unguiculata* (farewell-to-spring, Godetia), and *Puccinia coronata* on *Deschampsia cepitosa* (tufted hair grass). *Uromyces unitus* was detected on *Lewisia cantelovii* (Cantelow's lewisia) a native

Figure 1. ***Deschampsia cespitosa*** **(Tufted hair grass), densely tufted, clump forming, native perennial cool season grass in the Poaceae family (A). Leaves form basal tufts that produce the inflorescence and spikelets which are usually two and occasionally three-flowered (B). Heteroecious rust fungi such as** ***Puccinia coronata*** **commonly infect the leaves and stems of grasses and grain crops developing both uredial and telial spore stages. Pycnial and aecial stages are produced on the alternate hosts,** ***Rhamnus*** **spp. (coffeeberry).**

Figure 2. Teliospores exhibiting unique morphological characteristics of the fungus, *Puccinia coronata*, crown rust, develop from telium sori produced on the grass leaves and stems during the spring. The light brown spores exhibit a flattened apical cell crowned with 5-8 digitate, sometimes with dichotomous branching, medium brown appendages. Teliospores are septate, 2 celled and emerge on short, thick pedicels.

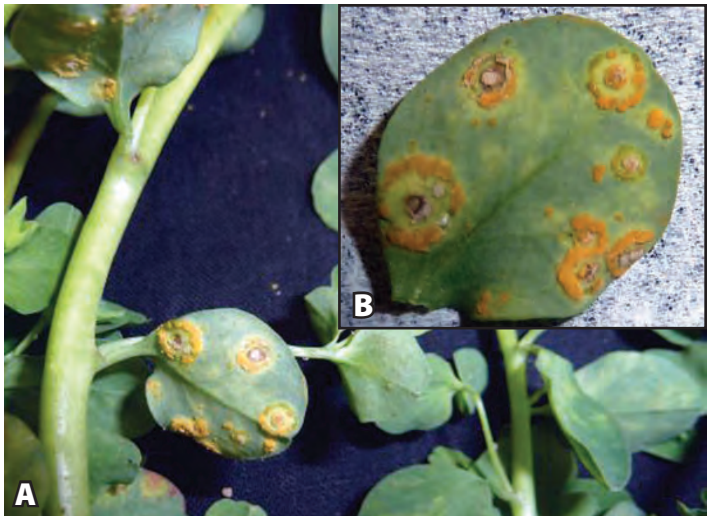


Figure 3. *Melampsora euphorbiae* rust on *Euphorbia peplus* (Petty spurge). Typical symptoms of coalescing chorotic lesions on upper leaf surfaces. Lower (abaxial) leaf surface with uredia developing in the early to late spring (A). As infection progresses uredia may also form on the upper leaf surfaces (B). Scattered orange uredia fruiting structures commonly arranged in a circular pattern causing leaf chlorosis.

perennial herb endemic to California included in the California Native Plant Society (CNPS) Inventory of Rare and Endangered Plants. *Melampsora euphorbiae*, in the Melampsoraceae family of rusts, was detected on *Euphorbia peplus* (Petty Spurge), an annual herb host which is not native but has been introduced into California and become naturalized in the wild growing as a weed in many locations.

Puccinia coronata, a heteroecious rust (*Rhamnus spp*.-coffeeberry have been identified as alternate hosts), the causal agent of crown rust infections on barley and oats was identified from a nursery on the perennial herb grass, *Deschampsia cespitosa* (Figure 1). Laboratory identification was made on the basis of host and morphology of uredinial and telial structures, on symptomatic plant tissue, as well as the spore characteristics. Telia of *P. coronata* produce teliospores that develop in early spring, on grass leaflets, spiklets and florets. These spores have prominent digitate (finger-like) appendages at the apex giving the spores a crowned appearance, hence the name *coronata*. (Figure 2). It is not clear whether the *P. coronata* found on *D. cespitosa* is the same *forma specialis* that infects either oats or barley. This could be assessed by inoculating oats and barley with this rust isolate to see if it causes disease on these economically important grains.

Melampsora euphorbiae, an autoecious rust (completing its life cycle on one host species), was detected on the weed *Euphorbia peplus* (petty spurge), growing in Sacramento County. This phytopathogen can cause severe damage to host leaves interfering with flower production. It infects many of the spurge plant species and has been studied as a potential biocontrol agent of North American weeds such as *Euphorbia escula* (Leafy Spurge) and *Euphorbia cyparissias* (cypress spurge). The rust produces conspicuous light to medium orange pustules (uredia), typically scattered in a circular pattern on the lower leaf surfaces of *Euphorbia peplus* (Figure 3). Initially the upper leaf surfaces exhibit chlorotic spots which eventually coalesce. Uredia produce yellow/orange urediniospores exhibiting thick finely echinulate

Figure 4. *Melampsora euphobiae* urediniospores develop within the uredia fruiting structures forming intermixed with characteristic truncate uredinial paraphyses, sterile hyphal elements (A). Spores are golden-yellow, exhibit a colorless cell wall 2-3um thick, and are finely echinulate. B: *M. euphorbiae* rust telia sori on stems of *Euphorbia peplus,* petty spurge (B). Telia are amphigenous, formed under the epidermis of the plant, dark chocolate brown and produce the teliospores during mid to late spring. The spores are prismatic, approx. 7-13 by 32-45µm, and have light chestnut brown cell walls which are uniformly 1-1.5um thick and smooth surfaced.

(spiny) surface walls, 15-22 x 12-20um in size, and are intermixed with numerous characterisitic capitate hyaline paraphyses (sterile hyphal elements) (Figure 4 A). The telial state of this rust commonly occurs on the host stems late in the season, rather than on leaves, growing under the epidermis of the plant in elongate flat reddish-brown to black lesions (Figure 4 B).

Puccinia pulverulenta infects various *Epilobium spp*. within the Onagraceae family including *Epilobium minutum* (desert willow-herb), *E. hirsutum* (hairy willow-herb), *E. parviflorum* (small flowered willow-herb), and *E. montanum* (broad-leaved willow-herb). Both the aecial and uredinial states of this pathogen were detected on *E. minutum* in 2010 (see Figure 5). Aecia appear in late spring (approx. May – June) developing on the abaxial leaf surfaces as closely scattered orange-colored, spectacular cup-shaped fruiting structures with revolute edges on particular species of *Epilobium* (Figure 6 A). Aeciospores are globoid,

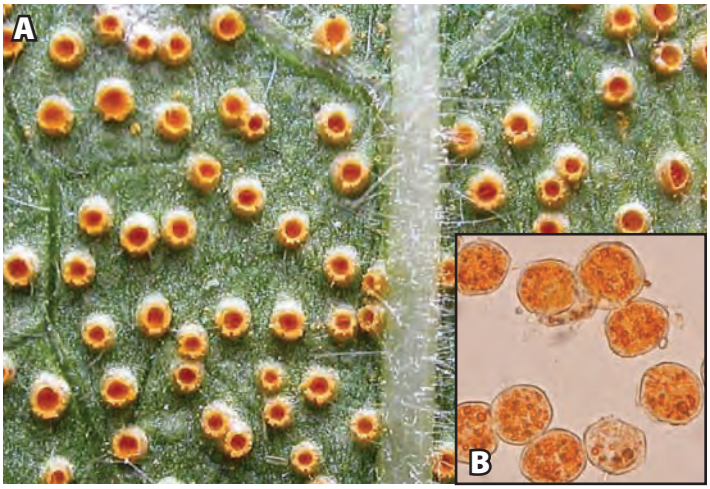
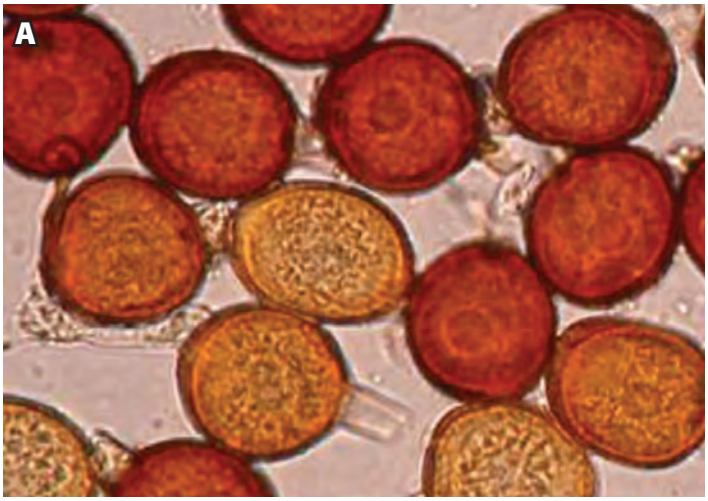


Figure 5. ***Puccinia pulverulenta*** **aecia sori cupulate (cup-shaped) profusely covering an abaxial leaf surface of** ***Epilobium hirsutum*****, hairy willow-herb (A). Orange-red spores, which develop in the aecial fruiting structures, are globoid to ellipsoid in shape and have a densely verrucose cell wall (more warty rather than spiny) as shown in the insert of** ***P. pulverulenta*** **aeciospores from** ***E. minutum*****, desert willow-herb (B)**

Figure 6. ***Puccinia pulverulenta*** **teliospores produced by the telia that develop late in the spring to fall (September/October). The two-celled ellipsoid shaped teliospores exhibit distinct morphological characteristics including a broad hyaline papilla or umbo over the upper cell apical pore, the lower cell is constricted at the septum, formed on a delicate hyaline pedicel. The cell wall is smooth or slightly rugose.**



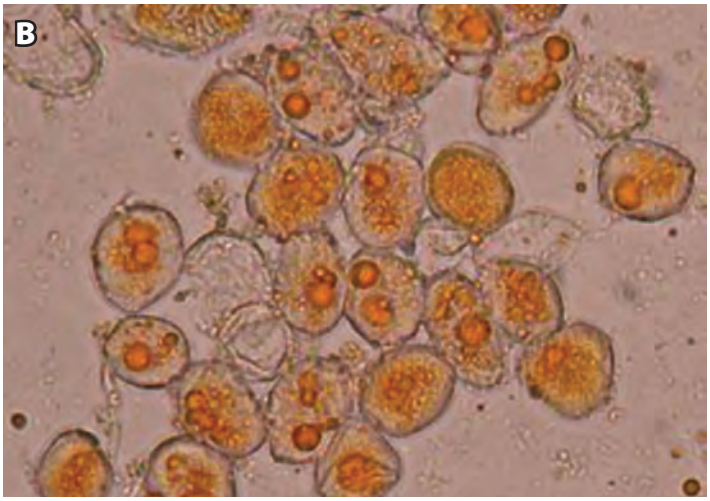


Figure 7. ***Uromyces unitus*** **rust on the perennial herb** ***Lewisia cantelovii*** **(A). This rust has single celled teliospores characteristic of the genus Uromyces. Spores are produced by the telia sori (B).** ***U. unitus*** **aeciospores develop on the same host plant from different fruiting structures, the cupulate (cup-shaped) aecia. Aeciospores are globoid, often angular, and minutely verrucose.**

finely verrucose, orange to red-orange and approximately 13x20 by 13x23um (Figure 6 B). Uredia are produced later in the same infected leaf areas, spreading further to the newly formed leaves by urediniospore infection. In September and October the leaves may be thickly covered with the telia sori. Microscopic analysis of the teliospores confirmed unique morphological features used to identify this rust fungus (see Figure 7). Symptoms on leaves may include chlorosis, malformation, and eventual tissue necrosis.

Laboratory identification confirmed both the aecial and telial states of the autoecious rust fungus *Uromyces unitus* on *Lewisia cantelovii* (Portulacaceae family) from Plumas County (Fig. 8 A, B). This rust infects several members of the Portulacaceae family in four distinct areas of the western United States. The range in which this rust was found extends from Central Idaho through Eastern Oregon into the Sierra Nevada and Central California. *L. cantelovii* is a perennial herb that grows in rocky, moist mountain habitats located from the Klamath Mountains to the northern Sierra Nevada.

Other unusual detections on native hosts included *Puccina convolvuli* on *Calystegia occidentalis spp. occidentalis* and *Puccina oenotherae* on *Clarkia unguiculata* which were collected by Dr. Dale Woods in IPC. *P. convolvuli* was identified from powdery dark cinnamon brown uredia and characteristic ellipsoid and obovate, spiny urediniospores. *P. oenotherae* was detected on leaves of Clarkia. Both uredia and telia were present on the plant when it was collected in June. Clarkia is in the Onagraceae family and grows wild in many natural habitats including chaparral, foothill woodland, valley grassland and coastal strand environments.

Identifying micro-organisms that naturally parasitize our native plants is a great pleasure and challenge because they are so diverse and beautiful. They are also a part of California's unique ecosystems affecting the fragile botanical resources which are invaluable to preserve for future generations.

Rust on Alder

Melampsoridium hiratsukanum was identified on a specimen of white alder from a nursery in Santa Cruz County. This is a new United States record with this rust having been reported only in Japan and Europe. The pathogen had actually been found in California in the 1930's when a sample was submitted to the Federal herbarium in Beltsville, MD. The sample had been misidentified and when the identification was later revised to *M. hiratsukanum*, the revision was never published. After this recent detection in California and discovery of the herbarium specimen by Dr. Joe Bischoff at the U.S.D.A., and its identification, *M. hiratsukanum* has been found in additional locations in the Central Valley. Speculation is that the pathogen is probably widespread in California.

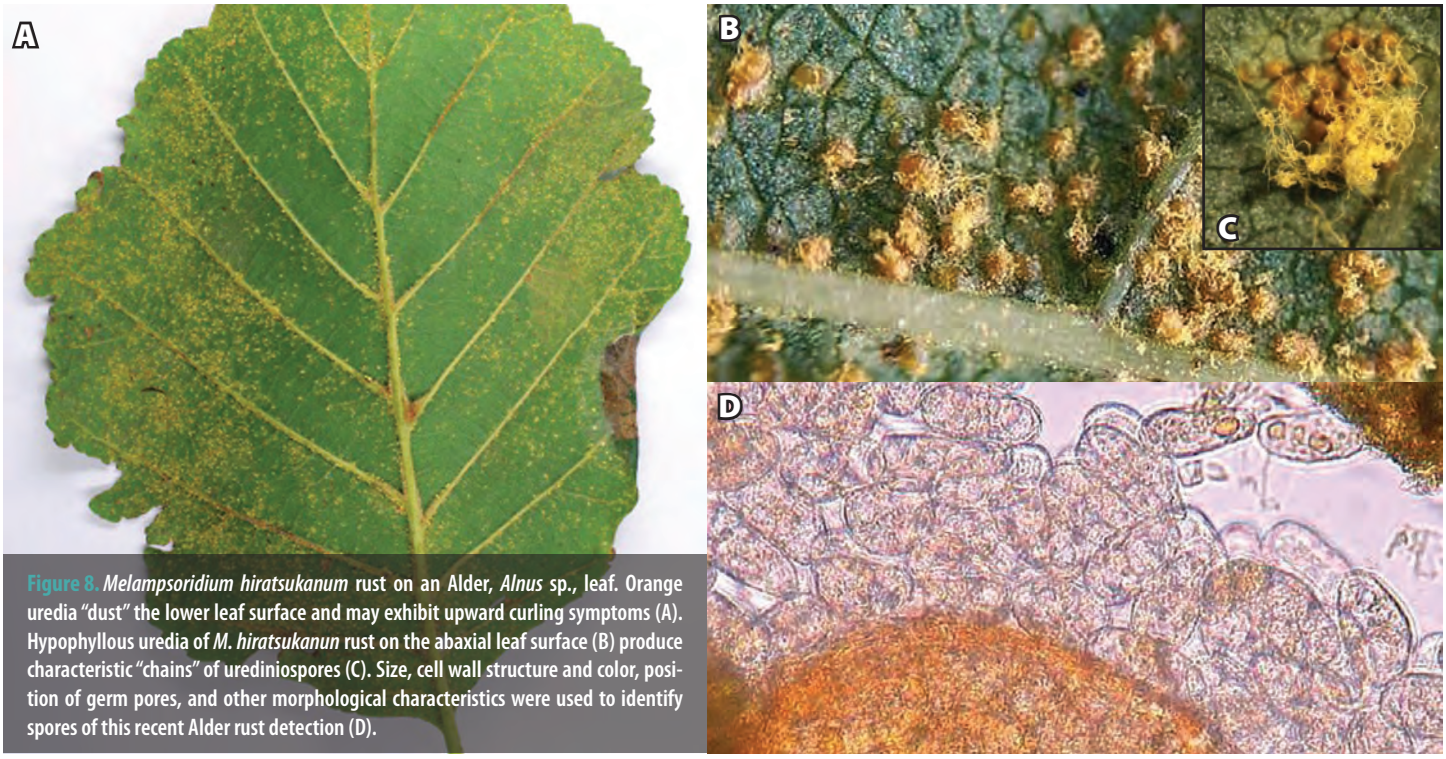


Figure 8. ***Melampsoridium hiratsukanum*** **rust on an Alder,** ***Alnus*** **sp., leaf. Orange uredia "dust" the lower leaf surface and may exhibit upward curling symptoms (A). Hypophyllous uredia of** ***M. hiratsukanum*** **rust on the abaxial leaf surface (B) produce characteristic "chains" of urediniospores (C). Size, cell wall structure and color, position of germ pores, and other morphological characteristics were used to identify spores of this recent Alder rust detection (D).**

Rust on Sedum

An unknown rust was detected on *Sedum spurium* 'John Creech' plants in San Mateo County. The succulent plants originated from a nursery in Colorado. A few minute rust pustules were present on the stems and leaves. Microscopic analysis revealed urediniospores that were round to oblong, thick-walled and measured 16-24 x 15-18um. Spores sizes did not match the descriptions of any of the *Puccinia* spp. known to occur on *Sedum*. Due to the small amount of diseased material available, we were unable to perform molecular analysis on the rust and its identity remains unknown.

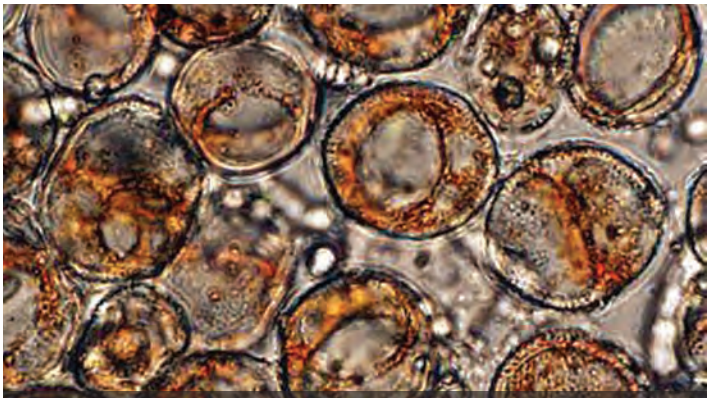


Figure 9. An Unknown rust fungus on ***Sedum spurium,*** **"John Creech" plants. Urediniospores (above) were globoid to oblong, thick-walled and 16-24 x 15 -18um. Spore sizes did not match descriptions of any** ***Puccinia*** **spp. known to occur on** ***Sedum*****.**

Rust Pathogen	Common Name	Host	County	City	Rating
Cerotelium fici	Fig rust	*Ficus elastica*	San Diego	Valley Center (owner)	C
*Gymnosporangium libocedri**	Incense Cedar Rust/Pear Rust	*Cedrus* sp.	Tulelake Border Sta.		C
Kuehneola uredinis	Blackberry Stem Rust	*Rubus* sp. (var. Olallie)	Santa Cruz	Watsonville	C
Melampsora euphorbiae	Rust on Petty Spurge	*Euphorbia peplus*	Sacramento		C
Melampsora epitea	Willow Rust	*Salix* sp.	San Luis Obispo	Arroyo Grande	C
Melampsora hypericorum	Hypericum Rust	*Hypericum* sp.	Santa Barbara	Carpinteria	C
*Melampsora medusae**	Rust on Poplar	*Populus tremuloides*	Benton Border Sta.		C
*Melampsora medusae**	Rust on Poplar	*Populus* sp.	Truckee Border Sta.		C
Melampsoridium betulinum	Rust on Birch	*Betula pendula*	Santa Cruz	La Selva Beach	C
Melampsoridium hiratsukanum	Rust on Alder	*Alnus* sp.	Santa Cruz	Santa Cruz	Z
Phragmidium tuberculatum	Rose Rust	*Rosa* sp.	State of New York**		C
Puccinia allii	Allium Rust	*Allium sativum*	Fresno	Cantua Creek	C
Puccinia allii	Allium Rust	*Allium sativum*	Fresno	Huron	C
Puccinia allii	Allium Rust	*Allium sativum*	El Dorado	Placerville	C
Puccinia carthami	Safflower Rust	*Carthamus tinctorious*	Sutter	Woodland	C
Puccinia carthami	Safflower Rust	*Carthamus tinctorious*	Yolo	Woodland	C
Puccinia convolvuli	Rust on Morning Glory	*Calystegia occidentalis* spp. *occidentalis*	Butte		C
Puccina coronata	Rust on Tufted hair grass	*Deschampsia cespitosa*	Riverside	San Jacinto	C
Puccinia dioicae var. *extensicola*	Rust on Aster	*Aster* sp.	Sonoma	Glen Ellen	C
Puccinia graminis	Stem Rust of Cereals & Barberry		Sonoma		C
Puccinia helianthi	Sunflower Rust	*Helianthus annuus*	Glenn	Glenn	C
Puccinia helianthi	Sunflower Rust	*Helianthus annuus*	Sutter	Woodland	C
Puccinia hemerocallidis	Daylily Rust	*Hemerocallis* sp.	Santa Cruz	Corralitos	C
Puccinia heucherae	Rust on Coral Bells	*Heuchera* sp.	Santa Cruz	Soquel	C
Puccinia horiana	Chrysanthemum White Rust	*Chrysanthemum* sp.	Santa Barbara	Carpinteria	Q
Puccinia iridis	Iris Rust	*Iris* sp.	Santa Clara	San Jose	C
Puccinia lagenophorae	Rust on Aster	*Aster* sp.	Contra Costa	Concord	C
Puccinia malvacearum	Rust on Lavatera	*Lavatera* sp.	San Benito	Hollister	C
Puccinia menthae	Mint Rust	*Mentha* sp.	San Luis Obispo	Arroyo Grande	C
Puccinia menthae	Mint Rust	*Mentha* sp.	Santa Cruz	Aptos	C
Puccinia menthae	Mint Rust	*Mentha* sp.	Tehama	Red Bluff	C
Puccinia oenotherae	Rust on Clarkia	*Clarkia unguiculata*	Butte	Butte	C
Puccinia psidii	Guava Rust, Eucalyptus Rust	*Melaleuca* sp.	San Diego	San Diego	B
Puccinia pulverulenta	Rust of Epilobium and Fuchsia	*Epilobium minutum*	Plumas		C
Puccinia striiformis	Stripe Rust of Barley	*Hordeum vulgare*	Fresno	Laton	C
Puccinia striiformis	Stripe Rust of Wheat	*Triticum* spp.	Stanislaus	Modesto	C
*Puccinia tanaceti**	Tanaceti Rust on Artemisia	*Artemisia* sp.	Benton Border Sta.		C
Puccinia sp. *nov.*	Rust on Sedum	*Sedum* spp.	San Mateo	Pacifica	Q
Uromyces transversalis	Gladiolus Rust	*Gladiolus* sp.	Los Angeles	Los Angeles	Q
Uromyces transversalis	Gladiolus Rust	*Gladiolus* sp.	Orange	Garden Grove	Q
Uromyces transversalis	Gladiolus Rust	*Gladiolus* sp.	San Diego	San Diego	Q
Uromyces transversalis	Gladiolus Rust	*Gladiolus* sp.	Santa Cruz	Santa Cruz	Q
Uromyces transversalis	Gladiolus Rust	*Gladiolus* sp.	Santa Cruz	Watsonville	Q
Uromyces unitus	Lewisia Rust	*Lewisia cantelovii*	Plumas		Z

Table 1. Rust Fungi Identified in 2010. * Intercepted Pests **Specimen from Margery Doughtrey, Cornell University, N.Y.

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Kelch, Dean G., CPPDC, CDFA, Senior Plant Taxonomist – personal communication.

Photo Credits

Figure 1 A. http://facultystaff.richmond.edu

Figure 1 B. James Lindsey's Ecology of Commanster Site (http://popgen.unimaas.nl-jlindsey/commanster.html).

Figure 2. http://www.bioimages.org.uk/html. Photomicrograph image P69379 by Malcolm Storey, 2007.

Figure 3 A & B. Photographs by Cheryl Blomquist, Senior Plant Pathologist, CPPDC, CDFA.

Figure 4 A & B. http://www.bioimages.org.uk/html. Photomicrograph image P87270 by Malcolm Storey.

Figure 5 A. http://www.fungalpunknature.co.uk/Fungi/Fungal gallary.html.

Figure B. Photomicrograph by Cheryl Blomquist, Senior Plant Pathologist, CPPDC, CDFA.

Figure 6. Photomicrograph by Cheryl Blomquist, Senior Plant Pathologist, CPPDC, CDFA.

Figure 7 A & B. Photomicrographs by Cheryl Blomquist, Senior Plant Pathologist, CPPDC, CDFA.

Figure 8 A. http//www.bioimages.org.uk/html. Image P71628 photograph by Malcolm Storey, 2007.

Figure 8 B & C. Photographs by Cheryl Blomquist, Senior Plant Pathologist, CPPDC, CDFA.

Figure 8 D. Photomicrograph by Cheryl Blomquist, Senior Plant Pathologist, CPPDC, CDFA.

Figure 9. Photomicrograph by Suzanne Latham, Senior Plant Pathologist, CPPDC, CDFA

Plum Pox Virus Survey & Citrus Tristeza Virus Detection at the Plant Pest Diagnostics Center

Tongyan Tian, Amanda Eberle, Ran Wei, Lindsay Rains, Nicole Buchanan, Andrew Hyun, & Kristina Lewis

Plum Pox Virus Survey

Plum pox is a very severe disease of stone fruits in many parts of the world, including Europe, the Mediterranean and the Middle East (EPPO Data Sheets on Quarantine Pests). Plum pox disease, also known as "Sharka," is caused by Plum pox virus (PPV). Plum pox disease exhibits a wide range of symptoms, such as color break in flowers, rings on leaves and fruits and deformation of fruit and leafs. Symptoms vary depending on the strain of PPV, host species and variety, as well as environmental conditions. The first North American detection occurred in 1999 in the state of Pennsylvania. A second detection occurred the following year in Ontario, Canada.

PPV is not known to be present in California. The CDFA participated in the U.S. Department of Agriculture sponsored PPV survey from 2000 to 2005. All the samples tested at Plant Pest Diagnostics Center were negative for the virus. The USDA survey for PPV stopped in 2005 because of lack of funding but was resumed in 2010.

Between April and June of this year, stone fruit trees were sampled from southern, central and northern California districts. Each sample contained 8 leaves from 2 trees. The PPDC processed a total of 23,745 samples from 47,490 stone fruit trees. All the samples tested were negative using Enzyme-linked immunosorbent assay (ELISA) testing.

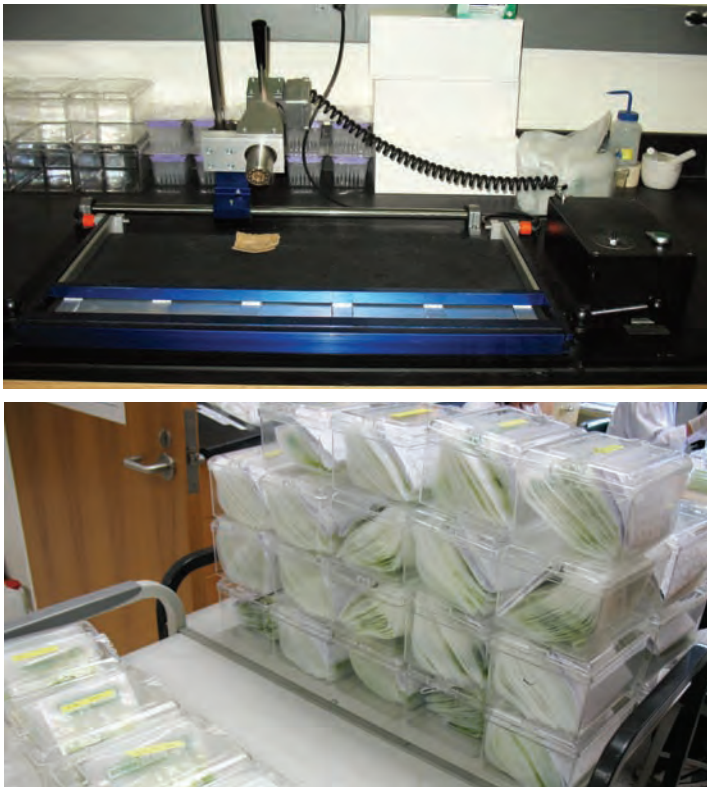


Figure 1. In 2010, we purchased a tissue homogenizer, Homex 6 (top), from Bioreba to process leaf samples for ELISA. Processed leaf samples (bottom) ready for ELISA testing.

Citrus Tristeza Virus Detection

Citrus tristeza virus (CTV) is distributed worldwide in all the citrus producing regions. Numerous strains of CTV have been identified and characterized but only mild strains of CTV are known to be present in California. In 2009 the Plant Pest Diagnostics Center started testing mother trees from California citrus nurseries as part of CDFA's Nursery Certification Program. We established our testing procedures by first screening samples using an ELISA test. Samples that tested positive or inconclusive by ELISA testing were further tested by Real Time-PCR (qPCR).

A total of 4,028 trees were tested in 2009. Five of the sampled trees were positive for CTV by ELISA test and confirmed by qPCR. In 2010 a total of 6,461 trees were tested, a sixty percent increase from the previous year. Twelve trees tested positive for CTV in 2010 by both ELISA and qPCR however, four trees tested positive by ELISA but negative by RT-PCR testing. Subsequent recollections from the four trees were negative using both ELISA and RT-PCR tests, suggesting possible false positives were given by the ELISA test.

In the beginning of 2010 season, 6 scientific aides participated in both projects. Lindsay Rains, a CTV testing veteran, passed on her experience to new seasonals and helped coordinate both project until her transfer to a new career at the Pest Exclusion Branch. Following Lindsay's departure, Amanda Eberle took the lead for CTV detection testing and Ran Wei lead the PPV survey testing. Nicole Buchanan, Andrew Hyun and Kristina Lewis worked on both projects with occasional help from other employees at the Plant Pest Diagnostics Center.

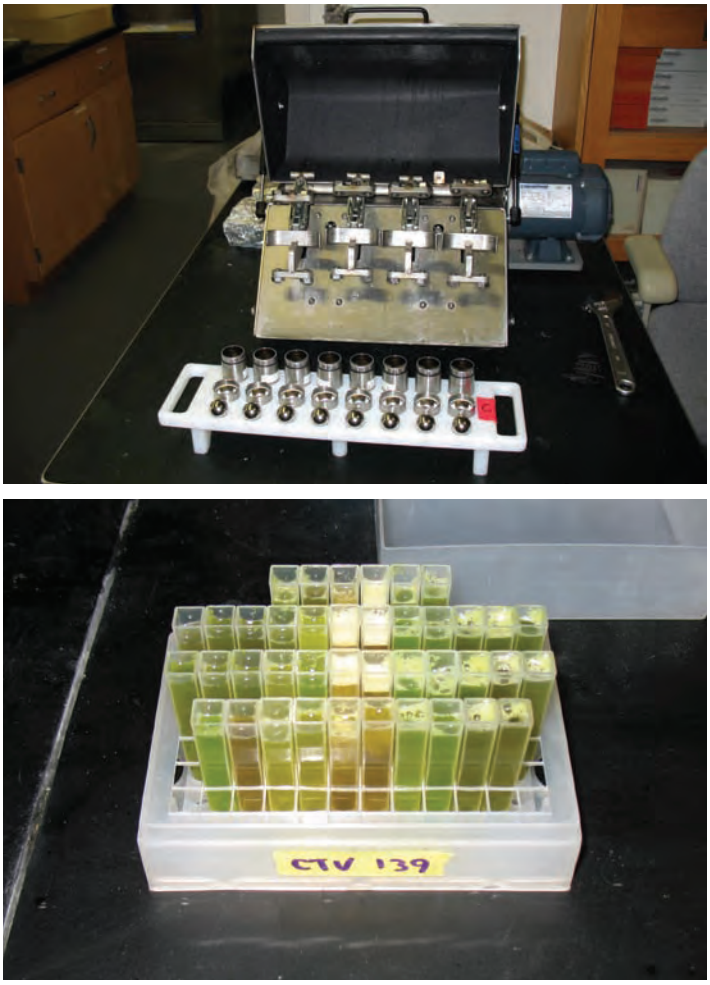


Figure 2. Citrus leaf petioles were homogenized using KLECO Pulverizer (top) and sap transferred to cubetubes before ELISA testing (bottom)..

2010 Asian Citrus Psyllid & Huanglongbing Recap

D. Opgenorth, I. Mohammed, P. Woods, J. Haynes, M. Negrete, A. Unzuela, & L. Kumagai

Huanglongbing (HLB), also known as Citrus Greening, is considered to be the most devastating disease of citrus worldwide. The disease is associated with three species of fastidious, phloem-limited bacteria: *Candidatus* L. africanus (Laf) first reported in Africa; *Ca.* L. americanus (Lam) first discovered in Brazil; and *Ca.* Liberibacter asiaticus (Las) first reported in Asia. Las, which is associated with Asian HLB (Citrus Greening), is now reported to be the most prevalent species. Only the Las and Lam bacteria are vectored by the Asian Citrus Psyllid (ACP) (*Diaphorina citri* Kuwayama). While the heat-sensitive Laf bacteria is vectored by the African Citrus Psyllid (*Trioza erytreae* del Guercio). Currently, there is a national quarantine for ACP in Alabama, Mississippi, Texas, Arizona, California, Hawaii, Guam, Marianas Islands, and American Samoa. A national quarantine exists for ACP and HLB in Florida, South Carolina, Georgia, Louisiana, Puerto Rico, and the US Virgin Islands.

Since the first California detection of Asian citrus psyllid in August of 2008, seven southern counties have been placed under quarantine for ACP: Ventura, San Diego, Imperial, Orange, Los Angeles, San Bernadino and Riverside. ACP and HLB detection surveys is federally funded and conducted all year round. The Plant Pest Diagnostics Branch (PPDB) is currently in its third year of testing ACP and plant samples for the HLB pathogen, specifically Las and Lam, using real-time PCR (qPCR). Although the qPCR protocol is the current USDA-APHIS approved standard diagnostic method for testing HLB, other methods for more rapid large-scale screening and differentiation of the three *Candidatus* Liberibacter are currenltly being pursued.

In 2010, the PPDC tested 3,527 ACP samples, an increase of more than a 1,500 samples from 2009. Las and Lam were not detected in any of the ACP samples using qPCR. The majority of ACP samples came from Los Angeles County (2,933). Other samples came from

Imperial County (503), San Diego County (62), Orange County (28), with one from San Bernardino County. New 2010 ACP findings were reported in San Bernardino County, Riverside County, and Ventura County. Two major changes were made regarding the testing of ACP in 2010. First, the lab discontinued testing ACP samples taken from sticky traps to avoid inconclusive results due to poor quality DNA. The current sampling protocol involves collecting ACP adults and nymphs from trap locations using sweep nets or Dvac. The psyllids are counted and transferred into vials containing alcohol prior to sending them to the lab for HLB testing. Another important change made was in composite sampling. USDA produced data showing that pooling 25 psyllids per sample show no reduction in the sensitivity of the multiplex qPCR test. This change in sampling has significantly reduced the ACP sample load for the lab.

In addition to ACP samples, PPDB tested 9,111 citrus plant samples in 2010, an increase of almost 7,000 more samples than the previous year. Las and Lam were not detected in any of the plant samples using qPCR. These samples were collected in a 100-m radius of ACP detections or taken from nurseries, commercial orchards and residential gardens as part of the HLB detection survey. Most of the samples came from the following counties: Los Angeles (41%), Imperial (33%), and Riverside (13%). The remaining 13% came from border stations and 27 other counties throughout the state. The monthly sample load varied from around 300 to over 1,400 samples. July thru October was the busiest with an average monthly sample load of around 1,300 samples.

Several factors contributed to the increase in the number of plant samples received last year. The discovery of ACP in new counties contributed to most of the increase but there were two incidents worth mentioning that also triggered a spike in the plant sample load. The first incident occurred in late March when curry leaves (*Murraya* sp.) sent from Orange County tested positive for HLB. The sample was sent to USDA for confirmation and found to be negative for *Ca.* Liberibacter. The second incident occurred in July when a citrus tree in Los Angeles County was thought to have been positive for HLB. The presumptive diagnosis was made by another laboratory. This lead to an increase in the number of samples sent to PPDB from 535 in June to 1,164 in July to 1,410 sent in August. However, after extensive testing by qPCR, the tree was confirmed to be negative for HLB.

Overall, the Plant Pathology Lab tested 12,638 HLB samples and conducted >22,000 HLB qPCR tests for the year.

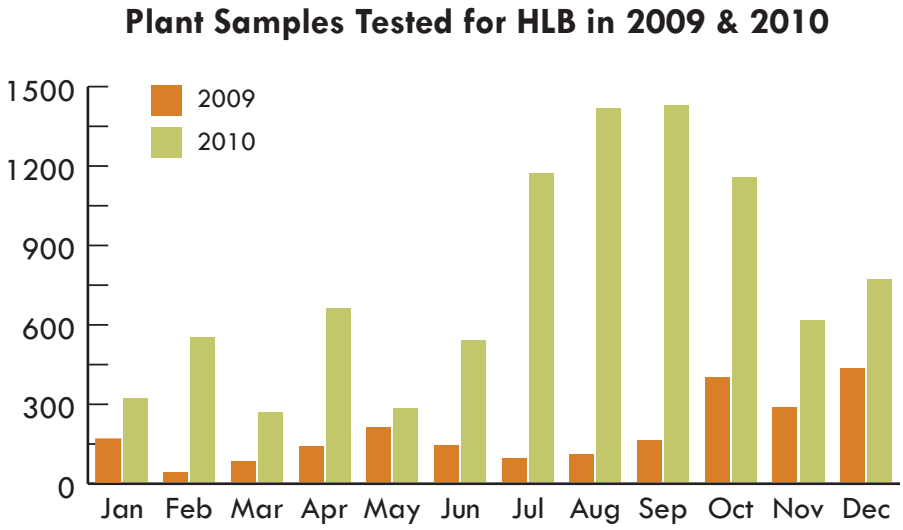


Figure 1. Plant samples that were sent to the PPDC for HLB testing during 2009 and 2010. 2010 saw a significant increase in the number of samples tested as nearly seven thousand additional samples were tested compared with the previous year.

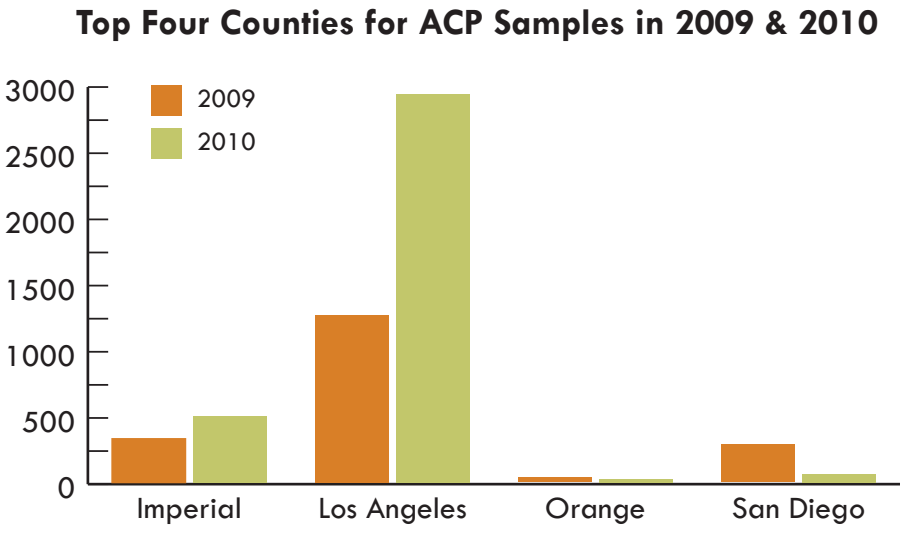


Figure 2. The top four counties contributing to the total ACP testing during 2009 and 2010. The majority of samples came from Los Angeles county during both years (about 66% in and 83% of the total in 2009 and 2010 respectively).

Seed Health Testing 2010

YunPing Zhang & Timothy Tidwell

The Seed Health Testing preformed by the California Department of Food and Agriculture performs tests on seed samples officially drawn and sealed by the Agricultural Commissioners' offices which act on behalf of USDA-APHIS. The testing service supports foreign and domestic trading of various agricultural, ornamental, and forest seeds as part of the phytosanitary requirements of different trading partners.

During the calendar year 2010, The Plant Pest Diagnostics Center (PPDC) Plant Pathology laboratory staff conducted 182 seed tests. The seed samples originated from 14 different clients in California and other states. A total of 23 different seed-borne pathogens were detected, including 16 fungi, 1 bacterium, 4 viruses and 1 viroid (Table 2). Total revenue generated from fees charged to clients for this service was $6,968.82.

The tests performed by the Seed Health Testing Laboratory involved 15 different types of agricultural or horticultural seeds, treated or untreated with various chemicals (Table 1). The majority of the tests were performed on Wheat and Onion. These two crops accounted for 67% of the seed tests, while 13 other plant species accounted for 33% of the seed tests. The fifty wheat samples collected from twenty three California Counties were tested for *Tilletia indica* as part of the National Karnal Bunt Survey Program. No positive samples were detected.

Seed	No.	Seed	No.	Seed	No.
Alfalfa	10	Coriander	1	Squash	1
Asparagus	6	Cucumber	2	Sweet pepper	1
Barley	3	Eggplant	1	Tomato	2
Beet	1	Onion	68	Watermelon	6
Chinese cabbage	1	Soybean	4	Wheat	54

Table 1. Types of seed tested for seed borne plant pathogens in the year 2010.

Pathogen	No.
Fungi	
Alternaria brassicae	1
Alternaria brassicicola	1
Botrytis allii	66
Botrytis byssoidea	1
Choanephora curcurbitarum	6
Didymella bryoniae	6
Fusarium oxysporum	1
Phoma lingam	1
Phoma medicagines	1
Puccinia allii	1
Peronospora hyoscyami sp. tabacina	1
Tilletia indica	7
Tillitia controversa	6
Urocestis cepulae	1
Uromyces betae	1
Verticillium albo-atrum	9

Pathogen	No.
Bacteria	
Xanthomonas campestris pv. campestris	1
Viruses	
Asparagus virus II	6
Bean pod mottle virus	1
Southern bean mosaic virus	1
Tobacco ringspot virus	10
Tomato ringspot virus	13
Viroids	
Tomato bunchy top viroid	2

Table 2. Seed pathogens tested at the PPDB in 2010.

The Nursery Annual Survey of Deciduous Fruit Tree, Nut Tree and Grapevine for 2010

YunPing Zhang

The California Fruit Tree, Nut Tree and Grapevine Improvement Advisory Board (IAB) allocates funds each year to survey deciduous fruit trees, nut trees and grapevines for a range of viruses of most concern by the industry. These trees are part of the registered increase block that is used to produce industry planting material. This survey is carried out by the staff of the Nursery, Seed and Cotton Program of the Pest Exclusion branch, including plant pathologists, field agricultural biologists, and seasonal agricultural aides.

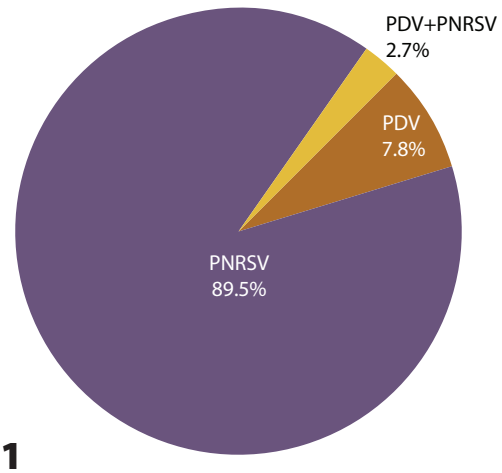
A record number of 56,315 stone fruit tree samples were tested in 2010 for two ilarviruses, Prune dwarf virus (PDV) and Prunus necrotic ringspot virus (PNRSV) during calendar year 2010. These samples were collected from three nurseries in Sacramento county and thirteen nurseries in Fresno county. A combo Enzyme-Linked Immunosorbent Assay (ELISA) test was used for both viruses. Most of the samples were from the nursery registration and certification program (47,125), of which 319 (0.68%) tested positive for PDV and/or PNRSV. There were also 9,190 service samples tested, of which 169 (1.84%) were positive for PDV and/or PNRSV. Each positive sample was further tested by ELISA to determine which specific virus is responsible for the infection. The result revealed that 58 (7.8%) were infected with PDV, 436 (89.5%) with PNRSV, and 13 (2.7%) with mixed infection of both viruses (Figure 1).

During the month of May 2010, grapevines in the nursery program were surveyed for Grapevine fanleaf virus (GFLV). There were seventeen participating nurseries: one from Redding, seven from Sacramento, eight from Fresno, and one from Riverside. Each sample was composed of young shoot tips from 3 vines and tested by ELISA. Of 2,661 samples tested, only 1 sample was found to be positive for GFLV.

From September to November, grapevines were also surveyed for Grapevine leafroll associated viruses 2 (GLRaV2) and 3 (GLRaV3). A total of 5,511 samples from fifteen participating nurseries (two from Redding, three from Sacramento, three from Fresno, and one from Riverside) were tested by ELISA. None of the samples tested positive for GLRaV 2 but 64 samples from Fresno tested positive for GLRaV 3. Removal of the infected vines and a delimitation survey of adjacent areas was advised.

The number of trees surveyed by the Nursery Registration and Certification (R&C) program has increased significantly over the years, from less than 10,000 trees in 1991 to over 56,000 trees in 2010 (Figure 2). The number of infected trees in the R&C program has been kept at a very low level of about 0.5% while the number of infected trees not in the R&C program (service samples) was much higher (Figure 3). This program has played a very important role in supporting the California nursery and agriculture industry.

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



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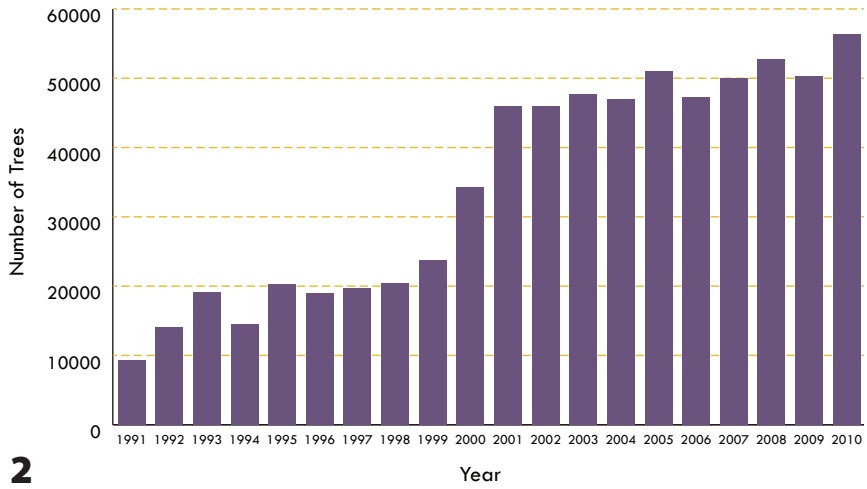

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Figure 1. Percentages of infection of positive samples, with either Prune Dwarf Virus (PDV) and/or Prunus necrotic ringspot virus (PNRSV) from the 2010 survey.
Figure 2. Number of trees tested by ELISA each year, starting with 1991 and proceeding through 2010.

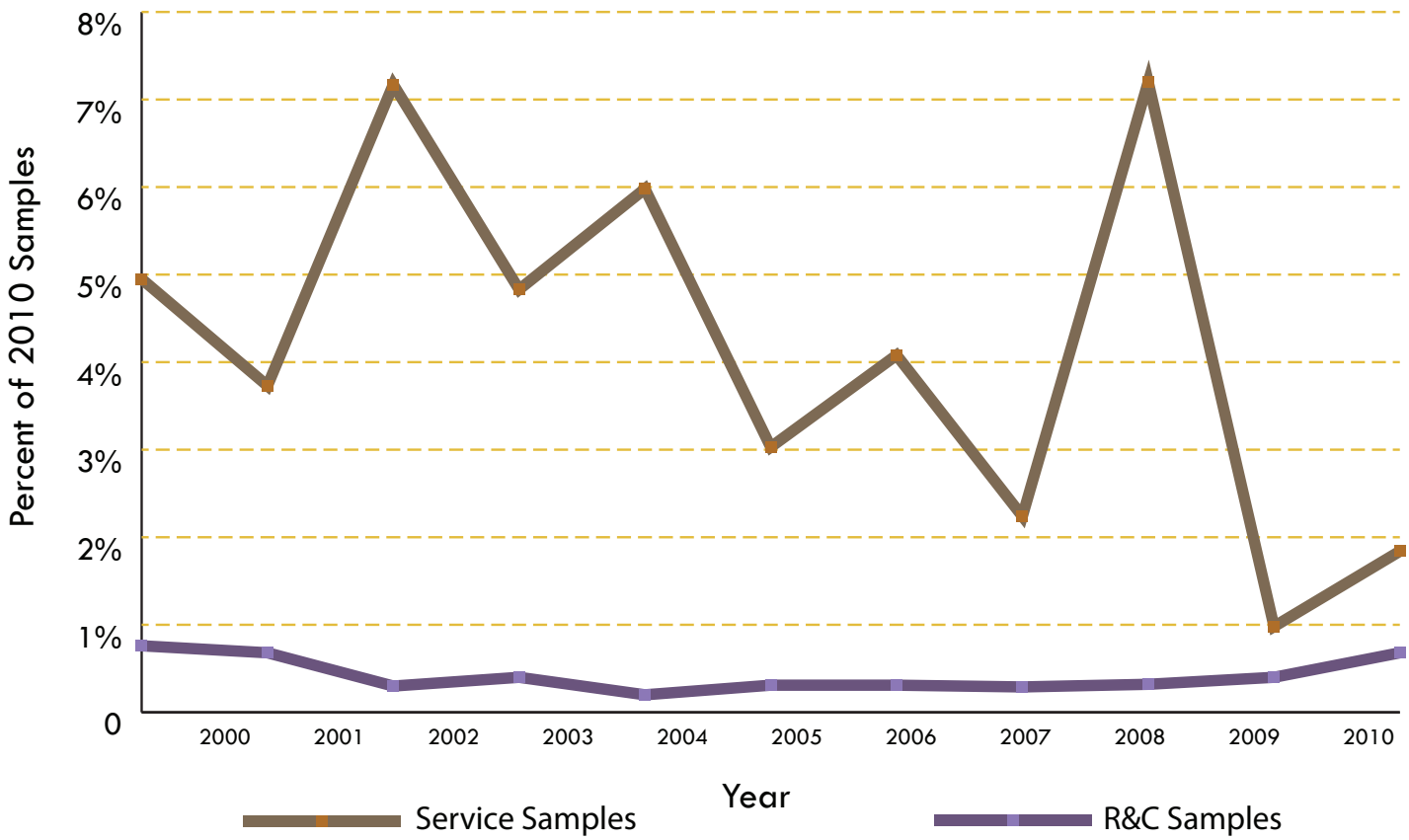

Figure 3. Detection of PDV/PNRSV from Registry and Certification (R&C) samples versus service samples taken in 2010.

HLB & Other Testing Activities 2010

Dan Opgenorth

Citrus Greening (huanglongbing or commonly, HLB) has taken the majority of my time this year because of an increase of the number of plant samples. At one time we received over 1,400 samples in a single month and close to 10,000 samples total for the calendar year. A summary of the significant testing that occurred this year is outlined in below. A separate report with more details on the lab's HLB activities can be found on page XX.

HLB Significant Developments

One important issue concerning HLB was the discovery of curry and citrus trees in Los Angeles County that consistently produced high Ct values. These samples were sent to USDA for evaluation and found to be 96% identical with the HLB bacteria. However, this was not considered a positive for HLB, but would indicate that other bacteria are present in the environment which can produce a diagnostic result consistent with a positive PCR test. Given the small portion of DNA used in the Real Time assay, this should not be surprising.

Psyllid testing has become more efficient with USDA approval of multiplex PCR for *Candidatus Liberobacter asiaticus* (Las) and americanus (Lam) strains of the bacteria. This process takes half the time and reagents and both tests can be performed at the same time. We have also expanded the number of staff trained in this technique from three to five, letting us distribute the workload for this large project among the staff. In addition, more seasonals have been trained to process samples, and more of our permanent technicians have been trained in performing DNA extractions. Since we are no longer testing psyllids from traps, this should help to reduce our work load and improve efficiency.

A new pathologist, Lucita Kumagai, has taken the responsibility for the project, but I will remain in a consulting capacity during the 2011 calendar year.

Phytoplasma Based Diseases

Diseases incited by phytoplasma are becoming more of a concern to countries importing stone fruit and grape materials for propagation. Because of this I have tried to implement techniques that would help to rapidly identify the presence of the pathogens from symptomatic materials. A promising method that combines a rapid extraction method and Real Time PCR (qPCR) has been identified. However, additional diagnostic work would be necessary to confirm the presence of the specific phytoplasma because of the generic nature of the assay and possible inclusion of other, non-target bacteria. My work with Corn Stunt Spiroplasma and Cherry Buckskin should help to provide useful background for more critical diagnostic work in the future.

Last year I provided training for UC Farm Advisor Carol Frate in using PCR for the detection of Corn Stunt in the Central Valley. Since her sabbatical leave is now over, I plan to once again help her with Corn Stunt diagnostic work in the upcoming year. During her 2010 sabbatical year, it was noticed that Corn Stunt caused by a spiroplasma was not as frequently detected as in previous years. However, similar symptoms were still evident on field corn. Out of curiosity, I tested some of this material with our generic assay for phytoplasma and found several positives. Seed embryos and seedling plants also tested positive. It seems that the Corn Bushy Stunt (CBS) Phytoplasma, which is part of the Corn Stunt Disease Complex, is now becoming increasingly more prevalent. My intent is to prove that CBS is now the major issue on corn in the Central Valley and that the phytoplasma is seed born. This would explain why CBS remains a persistent problem for California. My biotechnology skills in areas of extraction and sequencing will need to be enhanced to be able to confirm my suspicions.

Diagnostic evidence provided by my laboratory concerning Cherry Buckskin disease provided the documentation necessary to remove an orchard that was providing a reservoir of disease. While the generic assays are not totally conclusive, it provides a valuable initial diagnostic tool to determine which samples warrant additional work. As with the corn project, I intend to follow up on this work and with the sequencing necessary to show the involvement of specific phytoplasma in the hosts and the vectors. This should be beneficial in dealing with future phytosanitary and quarantine issues that are becoming increasingly more evident.

Last year I also worked with implementation of Laminar flow devices for the detection of Angular Leaf Spot on Strawberries and Fire Blight of Pome fruits. This work has demonstrated that strawberry crowns harboring the bacteria can be identified and blight cankers that appear to be dormant can test positive . In each case the positives were confirmed with an actual culture of the bacteria. Because these assays can be easily used in the field, they are adaptable to a wide variety of potential detection issues involving phytosanitary issues. This is an important diagnostic procedure that I will continue to develop to better suit the needs of our laboratory.

Grape nursery stock presents a major concern for the presence of Crown Gall. It seems that the industry has neglected this problem because the growing conditions in most of California are not conducive to the development of the disease. However, when this stock is planted in areas where cold injury is possible a severe situation could develop. In a personal communication with the Foundation Plant Materials Service (FPMS), this disease was deemed to be a major concern to the industry. In this regard, I plan to gain experience with any new diagnostic improvements relating to the disease.

Field Investigations

- Solano County was concerned with herbicide overspray on grapes which involved a considerable area including parts of Sacramento County.
- A sunflower seed producer had an interesting condition on one variety that we thought was bacterial in nature. Several potential bacteria were isolated, but none were a typical candidate for the disease symptoms. USDA workers in Iowa will be following this variety in the Mid-West plantings this coming year.
- In Petaluma, an interesting situation concerning Fire Blight on Cotoneaster had developed. It seems that an insect infestation on the plants had caused injury that predisposed the plants to extensive disease.

Acknowledgments

I would like to acknowledge the work of Israfiel Mohammed for his work on the HLB project. He is now responsible for initiation, record keeping and training of staff. The senior technicians (Monica Negrete, Jennifer Haynes and Patrick Woods) are also making a major contribution to our biotechnology diagnostic effort. A special thanks to my immediate supervisor Tim Tidwell and to former Branch Chief Umesh Kodira who continued to provide their support and the resources necessary to do our work and expand our diagnostic abilities.

2010 Annual Report of the Seed Science Laboratory

Seed Laboratory Responsibilities

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

Background

The Seed Science Laboratory (SSL) serves the Department and other clients by identifying seed and other plant disseminules, evaluating seed lot purity, viability and seedling growth potential, researching and developing new and better ways to assess the value of seed for planting, and training others in the field of seed science and technology. Samples are submitted to the laboratory by regulatory enforcement programs within the Department (primarily through the Pest Exclusion Branch), other state, county, and federal agencies, and by non-regulatory clients such as seed producers and distributors, commercial and private seed laboratories, academic institutions, museums, and private citizens.

While only 3% of all crop acreage in the state is dedicated to seed production, a recently published study shows that the seed produced represents about 13% of the U.S. seed market and nearly 8% of the global seed market (see The California Seed Industry: A Measure of Economic Activity and Contribution available at http://aic.ucdavis.edu). California's seed industry generates more than $1 billion in domestic seed sales and nearly $3 billion in gross revenue worldwide annually. Good seed quality contributes significantly to the value of seed in the marketplace. The ultimate purpose of the seed testing conducted by the SSL is to determine the value of seed for planting, thereby protecting against potential crop failure and the invasion of weed pests. The primary role of the SSL is to serve as the official regulatory seed testing laboratory for California. Testing in this capacity is conducted in accordance with the Federal Seed Act (FSA) Regulations. The FSA regulates interstate shipment of agricultural and vegetable seeds and requires that seeds in interstate commerce be labeled with certain information required for the consumer to make informed decisions based on truthful labeling and advertising.

In addition to the role of a regulatory testing laboratory, the SSL is regarded by the seed industry as an impartial authority and serves as a primary resource for seed quality assessment. The laboratory provides critical analyses necessary for seed lot labeling, trade documentation, and phytosanitary export clearance. Seed quality assessments provided by the laboratory are frequently utilized in resolving contract disputes among seed trade parties. Laboratory testing for these purposes is specifically conducted in accordance with internationally recognized methods and procedures published by the Association of Official Seed Analysts (AOSA) and the International Seed Testing Association (ISTA).

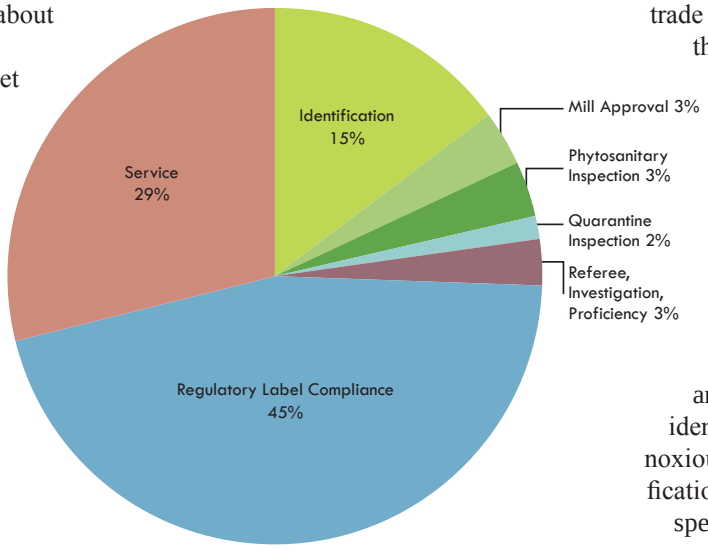

Figure 1. Seed Science Laboratory sample workload for 2010. Note: Quarantine, phytosanitary and noxious weed seed examinations require identification of 25,000 seeds per sample. Purity analyses require identification of 2,500 seeds per sample. Total numbers of seed identifications are in excess of 16,700,000. Germination tests require the evaluation of 400 seedlings per sample; the total number of seedlings evaluated is in excess of 365,600.

Seed quality testing is only one function of the SSL. Samples are also received for seed and fruit identification, quarantine check for noxious weed seeds, feed mill certification check for viable weed seeds, special investigation in crop failure cases, inter-laboratory ring testing for method validation and training purposes, and proficiency testing to maintain accreditation.

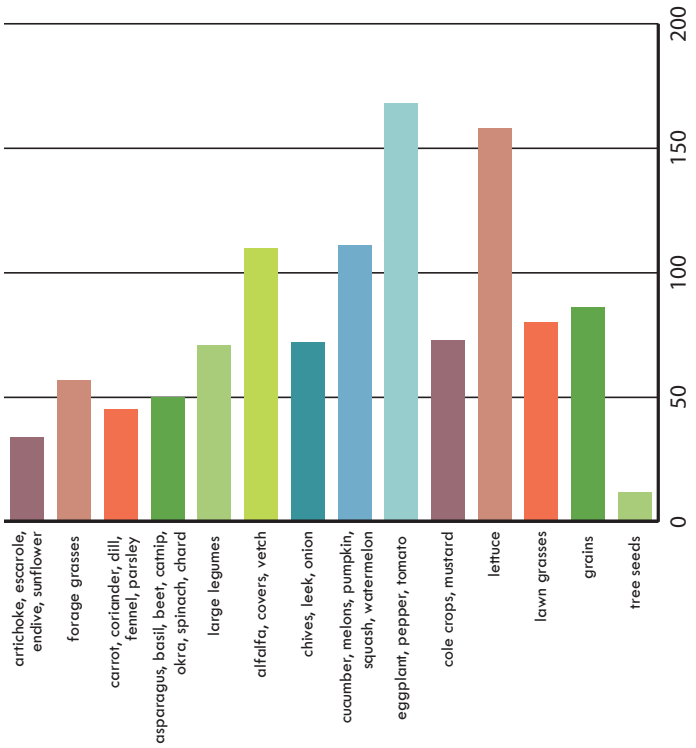

Figure 2. Kinds of seed submitted to the Seed Science Laboratory for seed quality assessment in 2010.

Figure 3. Lawn grass mixture sample contaminated with Canada thistle, *Cirsium arvense*, (red circle) and purple mustard, *Chorispora tenella*, (white circles), both noxious weeds. Photograph by Deborah Meyer, PPDC, CDFA.

Figure 4. Onion seedlings in a germination test demonstrating some common types of root abnormalities encountered in the laboratory. Seedlings with such abnormalities indicate the seed lot is of poor quality and the crop would most likely fail in the field. Photograph by Riad Baalbaki, PPDC, CDFA.

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

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

Sample Workload

The 2010 SSL sample workload was segregated into seven general categories: (1) identification of unknown seeds and fruits submitted from a variety of sources, including federal, state, county, university, and private entities; (2) mill approval inspection for viable weed seeds in livestock feed; (3) phytosanitary inspection in support of federal certification to meet export requirements; (4) quarantine noxious weed seed examination in support of both interior and exterior quarantine inspection programs; (5) referee, investigation, and proficiency testing; (6) regulatory label compliance and seed quality assessment testing in support of the seed regulatory enforcement program; and (7) fee-based seed quality assessment testing as a service to the seed industry. Roughly three-quarters of the laboratory testing workload in 2010 was dedicated to seed quality testing. A summary of the 2010 Seed Laboratory sample workload based on time per sample type is given in Figure 1.

Seed Quality Assessment Testing

California is ecologically diverse; therefore, the variety of crops grown is diverse. California is both a consumer of seed for crop production, and a seed producer. In 2010, the SSL tested a wide variety of crop seeds as a service to the seed industry and for seed law enforcement, including agricultural crops, herbs and spices, vegetables, forage grasses and legumes, lawn grasses, native species, and tree seeds (Figure 2).

The purpose of seed quality assessment is to determine the value of the seed for planting. The tests used to assess seed quality are based on standardized protocols used by all seed laboratories worldwide. Seed quality assessment results form the basis upon which the market value of seed is determined. Accurate and timely testing of seed is critical to the movement of seed in the marketplace and to provide information necessary for the consumer to make a well informed purchase decision.

Assessment is performed on representative samples drawn from seed lots in the marketplace or from seed lots being prepared for the marketplace. In general, the assessment involves visual inspection of the seed sample to verify the identification of the kind of seed and to retrieve and identify all contaminants, such as inert

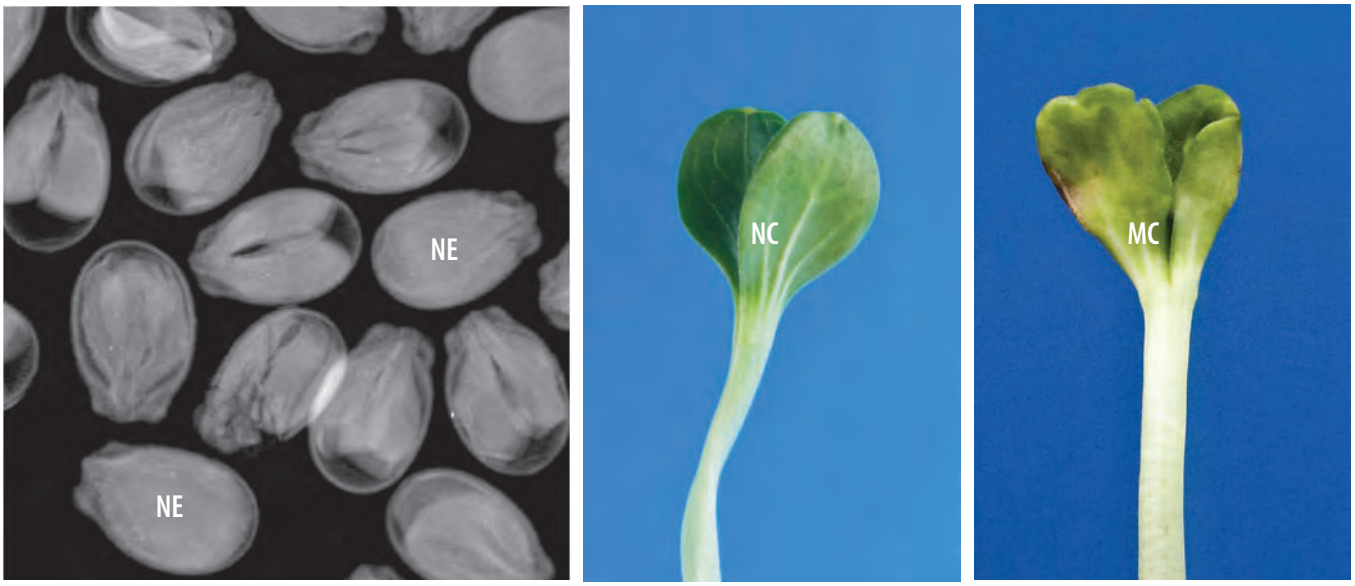

Figure 5. LEFT: X-ray image of watermelon [*Citrullus lanatus* (Thumb.) Matsum. & Nakai var. *lanatus*] seed sample containing two seeds with normally formed embryos (NE) among numerous seeds with malformed embryos. MIDDLE: Seedling developed from normally formed embryo; note the well formed (normal) flat cotyledons (NC). RIGHT: Seedling developed from malformed embryo; note the folded and misshapen cotyledons (MC). Photographs by Riad Baalbaki, CDFA, PPDC.

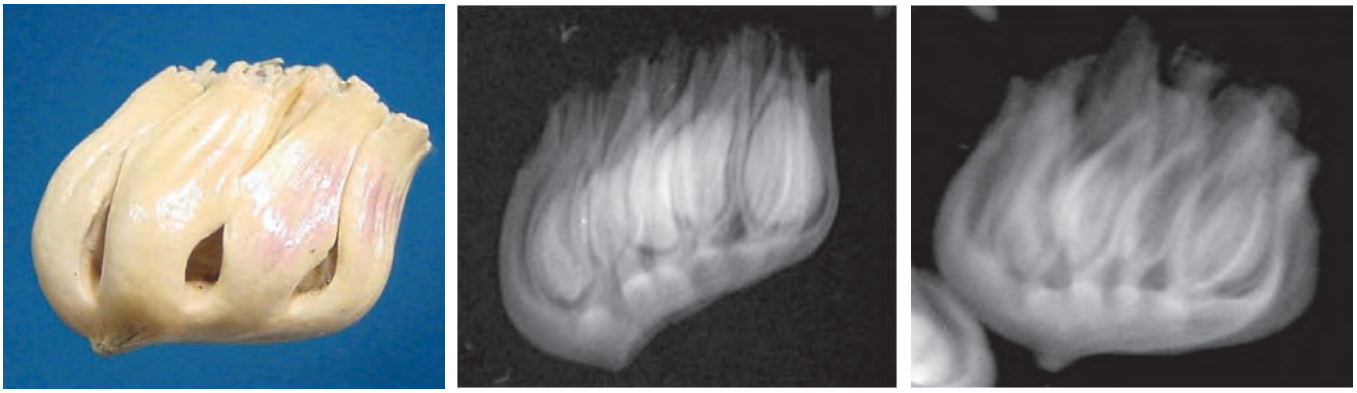

Figure 6. Buffalograss [*Bouteloua dactyloides* (Nutt.) Columbus] seed unit consisting of several fused spikelets forming a tough exterior surrounding several seed grains (caryopses) (left). X-ray imaging can be used to determine whether or not the seed unit contains grains. In the middle image the unit contains several grains, while the image at right does not contain grains and is of no planting value. Photograph by Deborah Meyer, CDFA, PPDC

matter and disseminules of other plant species, including species designated as noxious weeds (Figure 3). Such tests require microscopic examination of thousands of seeds per sample. High quality seed lots contain few contaminants, while low quality seed lots contain a higher percentage of contaminants. The percentage by weight of pure seed, other crop seeds, inert matter, and weed seeds is determined and this information is found on the seed lot label and other documentation used in seed trade.

Once the pure seed is separated from the contaminants the samples are evaluated for the ability of the pure seed to produce well-developed seedlings. Hundreds of seedlings from each sample are individually evaluated to determine if the structures essential to produce normal plants under favorable conditions are present (Figure 4). High quality seed lots produce high germination percentages under optimum laboratory conditions. This can, but does not always, indicate the potential for good field stand. Further testing may be required to separate seed lots with high germination potential and good vigor from those with high germination potential but low vigor. High vigor seed will usually perform well under a wide variety of field conditions, while low vigor seed will not.

This year the SSL was awarded a USDA-APHIS-PPQ grant in support of "Enhancing Laboratory Diagnostics Technology to Support California Agriculture." The grant funds were used to purchase a digital X-ray unit enabling scientists to examine the internal structures of plant propagules and seedlings in non-destructive ways. Examples of applications in which X-ray technology enhances the lab's ability to assess seed quality include examining embryo structures of seeds prior to germination in order to determine how various malformations of the embryo can lead to development of particular seedling abnormalities (Figure 5) and ascertaining seed unit fill as a means to determine potential planting value without employing destructive dissection techniques (Figure 6).

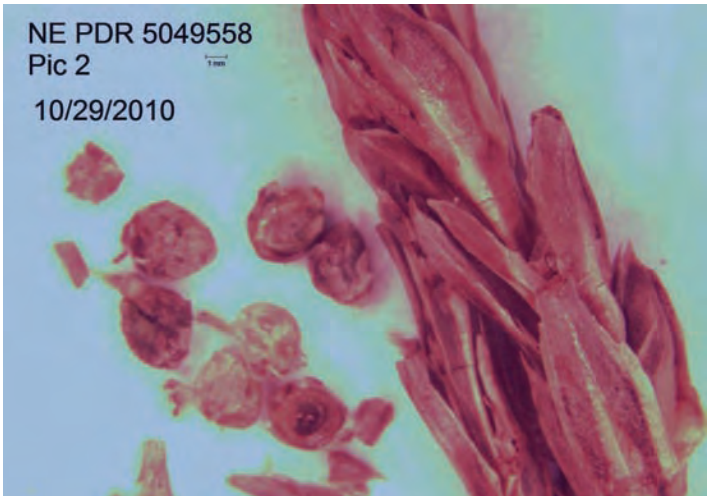

Figure 7. **Example of digital image submitted by the Needles Border Inspection Station via email to the Seed Science Laboratory for rush identification of a contaminant found in a 40,000 lb load of alfalfa hay from Colorado entering California. The specimen was identified as *Salsola collina* Pall., spineless Russian-thistle, an A-rated noxious weed pest.**

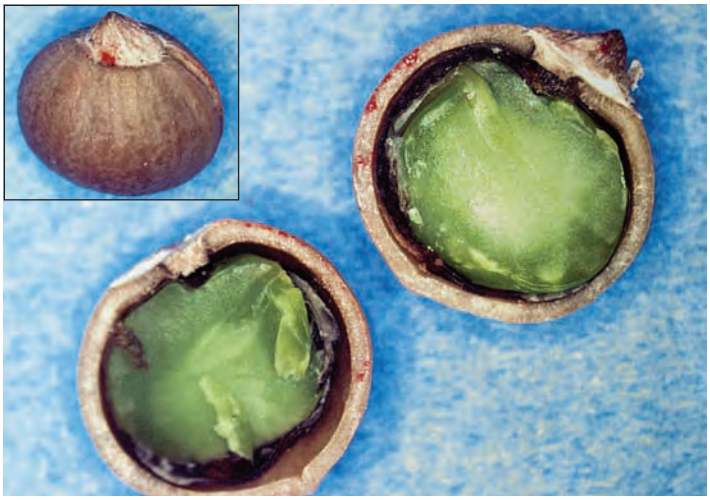

Figure 8. **Digital images submitted by the Canadian Food Inspection Agency – National Seed Herbarium for identification of seeds that were found in a sunflower seed lot imported from California. The specimen was identified as *Pistacia chinensis* Bunge, Chinese pistache.**

Seed Identification

The SSL houses the second largest seed herbarium in North America and because of this the lab is considered an important resource for anyone in need of assistance with identifications of seeds, fruits, and other plant disseminules. Specimens for identification are received from a variety of sources including county agricultural inspectors, border inspection stations, private seed testing laboratories, seed companies, government seed laboratories from other states, archaeologists, environmental consultants, veterinarians, university researchers and private citizens. The need to know the identity of a seed specimen varies considerably from one source to another and is not always related to agriculture. Whether the specimen is taken from a seed lot, found in or on agricultural commodities, farm equipment, heavy equipment, recreational vehicles, or self movers, found stuck to the side of a house or a landscape plant, found in the stomach of a dead animal, retrieved from the site of an ancient civilization, or found at the scene of a crime, we will attempt to identify it because the information is important to the person that submitted the specimen.

Most commonly, seed and fruit specimens are received via the mail or other delivery service. Specimens are usually identified within a day or two of arrival and the information sent to the requesting party. In an effort to service our clients more efficiently we also accept specimens via emailed photographs. Depending on the quality of the image, tentative identifications can be made while the actual specimen is en route to the laboratory. This has proven quite useful for CA border inspection stations needing to clear shipments for entry into the state (Figure 7) and for seed testing laboratories needing rush identifications (Figure 8).

In 2010, the Seed Science Laboratory received specimens from other seed laboratories, including private and industry laboratories, and government seed laboratories from other states and countries, needing assistance with seed and fruit identification of contaminants found during seed lot quality assurance testing. The specimens represented a wide variety of plant families, but more than one-third of the specimens were from the Poaceae or grass family (Figure 9).

Aside from specimens obtained during routine seed quality testing, the SSL provided assistance to the CDFA Bio-control Program identifying numerous specimens of weeds from the Brassicaceae or mustard family. Also identified were approximately 300 seed and fruit samples for the US Geological Survey – Western Ecological Research Center Field Station, Dixon, California. These specimens, often quite weathered and sometimes partially germinated, were obtained from pasture cores and wetland water samples in northeastern California and southeastern Oregon for an investigation of waterfowl habitat quality in relation to land use practices. A variety of carbonized seed and fruit specimens were received for identification from archaeologists studying a pre-historic site in the San Emigdio Hills of Kern County, southwest of Bakersfield, CA.

Nearly half of all identification samples received from CDFA Border Inspection Stations in 2010 were A- and B-rated target noxious weed pests, primarily thistles (*Carduus nutans*, *Onopordum acanthium*), knapweeds (*Acroptilon repens*, *Centaurea diffusa*, and *C. maculosa*), spineless Russian-thistle (*Salsola collina*), hoarycresses (*Cardaria draba* and *C. pubescens*), and halogeton (*Halogeton glomeratus*) (Figure 10). The remaining samples received from the Border Stations consisted of an assortment of plant disseminules that look similar to and in some cases are closely related to many of the target species of concern to California agriculture.

Designed primarily to assist CDFA Plant Quarantine Inspectors with identification of suspect plant material encountered at border stations, SSL scientists published the California Noxious Weed

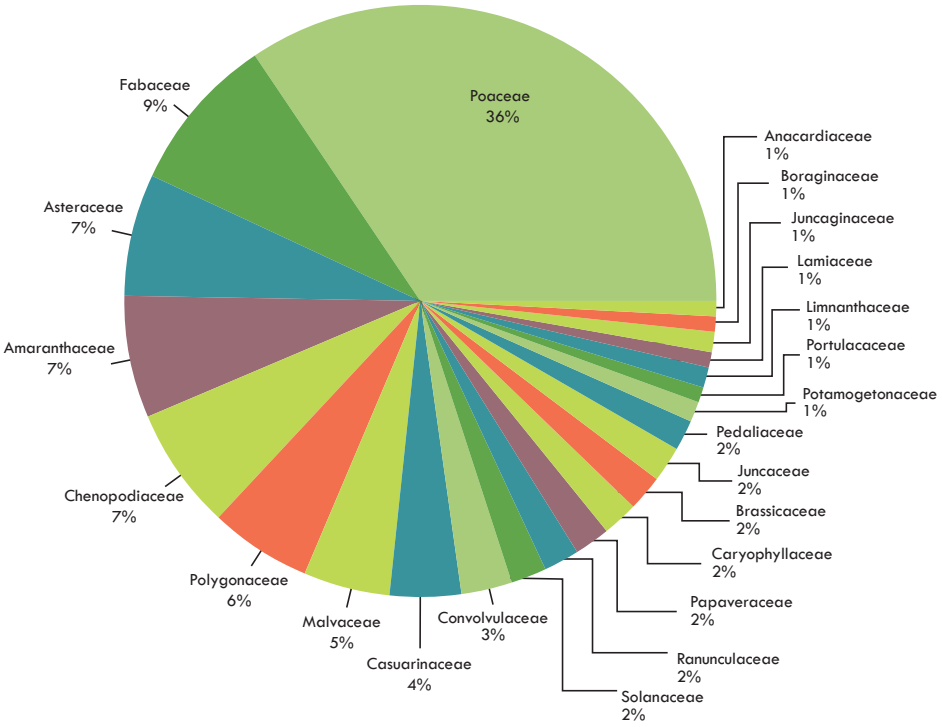

Figure 9. Plant families represented in identification samples received from private and industry seed laboratories, and government laboratories from other states and countries.

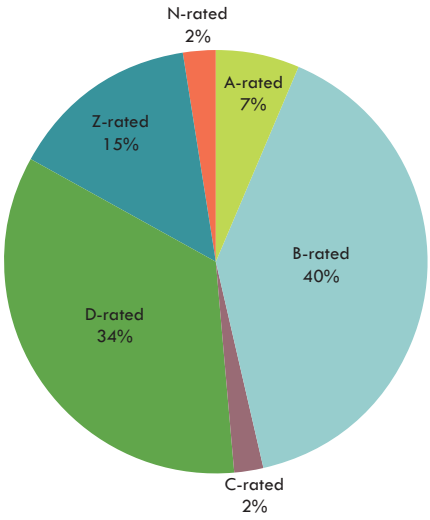

Figure 10. Percentages of samples in each pest rating category received from CDFA Border Inspection Station in 2010. A, B, and C-rated pests are of greatest concern requiring quarantine action by the state or county. D-rated specimens are non-target species. N-rated specimens are fragmentary and considered non-threatening. Z-rated specimens are from non-native species that are already widely established in California.

Disseminules Identification Manual. The manual is a photographic key to 164 species recognized as noxious weeds or potentially invasive species in California (Figure 11). The publication is available for free download at http://www.cdfa.ca.gov/plant/ppd/PDF/2010_CA_Noxious_Weed_Disseminules_Identification_Manual.pdf

Cooperative Projects

Seed quality testing based on the AOSA Rules for Testing Seeds forms the framework upon which standardization among seed testing laboratories in North American is built. The AOSA Rules are continuously updated via adoption of new or improved methods resulting from cooperative research. The AOSA Seedling Evaluation Handbook is part of the official rules of seed testing and is the authoritative reference used in evaluating seedlings for germination testing. Though the Handbook underwent some changes since its original publication in 1992, it has not undergone a significant revision. A major revision is currently underway to update the content, and expand the scope to include previously undescribed normal and abnormal seedling morphologies for many commercially grown crops. The revision will included hundreds of detailed color photographs of normal and abnormal

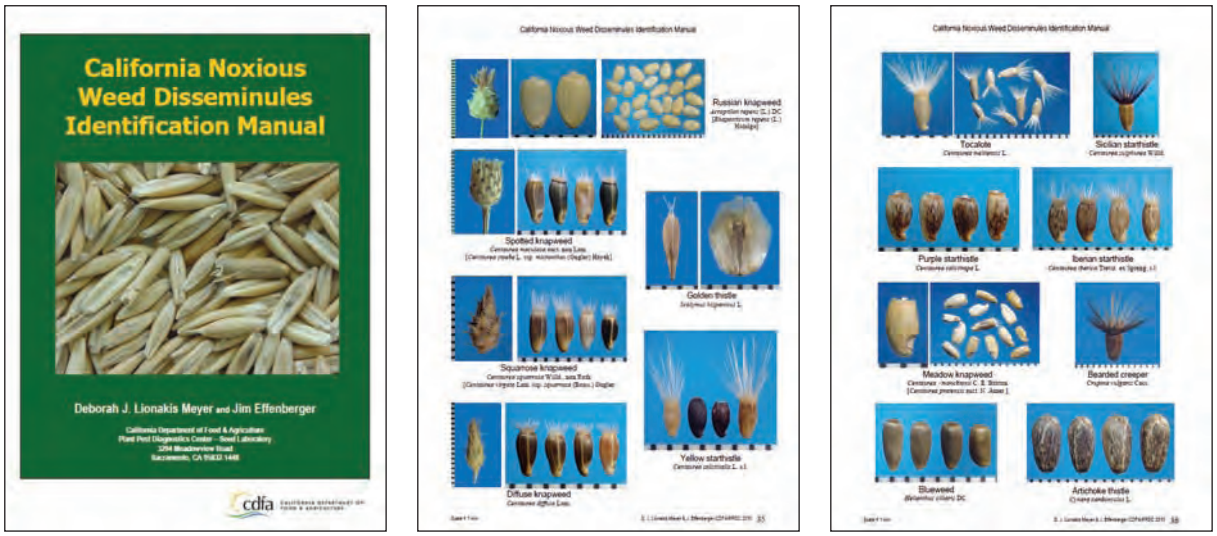

Figure 11. Excerpts from California Noxious Weed Disseminules Identification Manual.

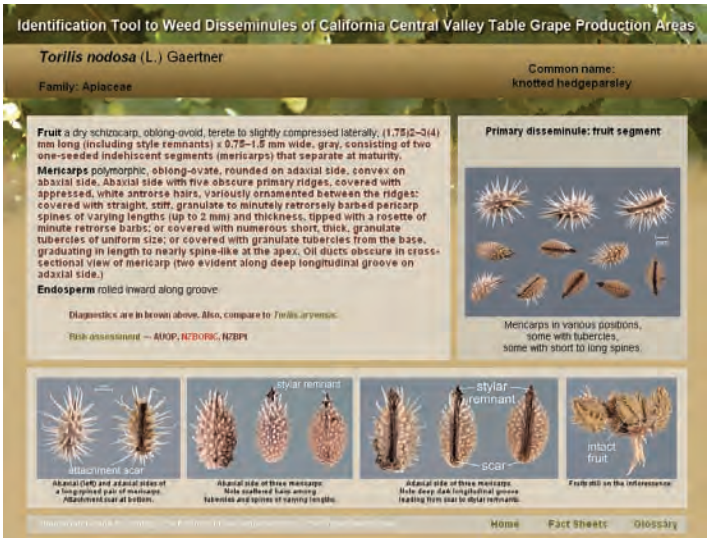

Figure 12. Example of the taxonomic fact sheet for *Torilis nodosa*, knotted hedgeparsley, to be included in the interactive matrix style identification key being developed cooperatively by CDFA SSL and USDA-APHIS-PPQ-CPHST using Lucid® software.

seedling structures aimed to improve seedling evaluation and further standardize germination test results among laboratories conducting testing for labeling and enforcement purposes. This multi-year project will be a collaborative effort led by three editors, Drs. Miller McDonald (Ohio State University), Sabry Elias (Oregon State University), and Riad Baalbaki (CDFA-SSL). The editors will develop new content as necessary, revise and update current contents, and edit the final version of the new Handbook. Seedling photography will take place at the SSL (see example of onion seedling abnormalities in Figure 4). As needed, AOSA/SCST members will be asked to review descriptions of each plant family.

The pre-clearance program negotiated by USDA for the export of California Table Grapes to Australia and New Zealand requires that specific weed disseminules of concern are properly identified in order for the lot to be certified for export. This program involves the movement of millions of boxes of table grapes annually. The limited or nonexistent resources to rapidly identify specific target species in these shipments results in cancellation orders or removal of perishable grape lots pending the identification of contaminants prior to phytosanitary certification. This unnecessarily stops the movement of grape lots when government inspectors are unable to identify contaminants due to the lack of adequate resources in the field, packing houses, shipping terminals, and ports. In order to limit losses and delays due to inadequate weed seed identification capabilities the USDA-APHIS-PPQ-CPHST and CDFA SSL are working cooperatively on development of a digital diagnostic tool for weed disseminules that can be found in table grapes grown in the Central Valley of California. The tool will significantly upgrade identification capabilities for county, state, federal, and international quarantine regulators, growers, and the industry representatives involved with international shipments of California table grapes. The SSL has sent nearly 300 specimens of target weed species to USDA-APHIS-PPQ-CPHST to be digitally photographed and incorporated into the interactive matrix style identification key developed using Lucid® software. The SSL scientists will also provide taxonomic and identification guidance to the USDA tool developer and will provide critical review of the taxon fact sheets. This is a multi-year project with target completion in early 2012. An example of the fact sheet for *Cenchrus spinifex* Cav. (coast sandbur) is shown in Figure 12.

One of the more interesting projects the scientists are involved in is cooperative work with ethnoecologist Dr. Kat Anderson, USDA, Natural Resource Conservation Service (NRCS), National Plant Data Center, and the Phoebe A. Hearst Museum of Anthropology (PAHMA), UC Berkeley. The project involves identification of seed, fruit, and plant fragment samples collected from tribal members of California's indigenous people. The samples were collected in the early part of the twentieth century and have been stored, untouched, at the PAHMA until this study was undertaken. The purpose of the study was to determine what plant species were collected and used for food, fiber, and medicine by the various tribes. During this two-year project (2009 and 2010) scientists in the SSL identified nearly 169,000 seeds, fruits, and vegetative materials from 187 taxa representing 112 genera. An example of one sample featured in the soon to be published project report is shown in Figure 13.

Figure 13. Cat. No. 1-11969. In July 1907, Samuel A. Barrett collected "uncleaned and unseparated seeds of 6 different kinds" from the Yuki in Round Valley. There were four main components of this seed sample identified (see CDFA Report No. 3479). A: shortbush seablush [*Plectritis congesta* (Lindl.) DC.]; B: smooth tidytips (*Layia chrysanthemoides*) disk cypselae; C: smooth tidytips (*Layia chrysanthemoides*) ray cypselae enclosed in bracts; D: California buttercup (*Ranunculus californicus* Benth.); E: fiddleneck, possibly Menzies' fiddleneck [*Amsinckia menziessii* (Lehm.) A. Nelson & J. F. Macbr.].

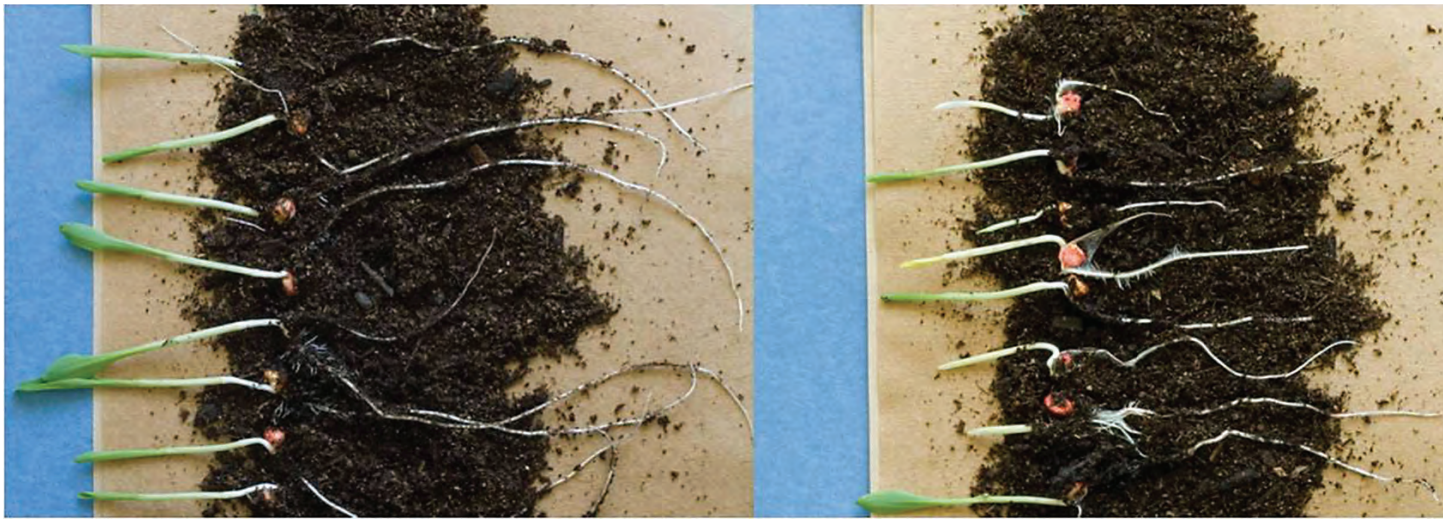

Figure 14. Corn Cold Test – example of an AOSA seed vigor test in which seeds and seedlings are subjected to two stress factors; sub-optimal temperatures and soil-borne pathogens. Vigorous seedlings with good root and shoot development, indicative of the potential for seedling establishment under a wide variety of field conditions (left) versus less vigorous seedlings displaying non-uniform development that are likely to have poor field stand under stressful conditions (right). Photograph by Riad Baalbaki, PPDC, CDFA.

Figure 15. *Bunias orientalis*, hill mustard, a Eurasian weed species introduced to North America. Seed (left) and fruits (right). Photographs by Robert Price, PPDC, CDFA.

Training Workshop

Laboratory seed 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 crucial 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 SSL. Over the years, many individuals that have received training from the CDFA Seed Laboratory staff have received Registered Seed Technologist (RST) or Certified Seed Analyst (CSA) accreditation following passage of nationally administered examinations.

In 2010 the SSL hosted a Seed Workshop, September 22 – 24, at the Plant Pest Diagnostics Center. Workshop participants received various publications and a CD-ROM produced by the SSL staff containing valuable information and personal observations on seed and fruit identification, seedling morphology, seedling abnormalities and quality evaluations. These publications and CD-ROM contained diagnostic keys, color photographs and illustrations highlighting key structures of seeds, fruits and seedlings critical for seed quality assessment. Workshop participants enjoyed a mixture of lectures and hands-on practical training exercises. Seed and fruit specimens were provided for

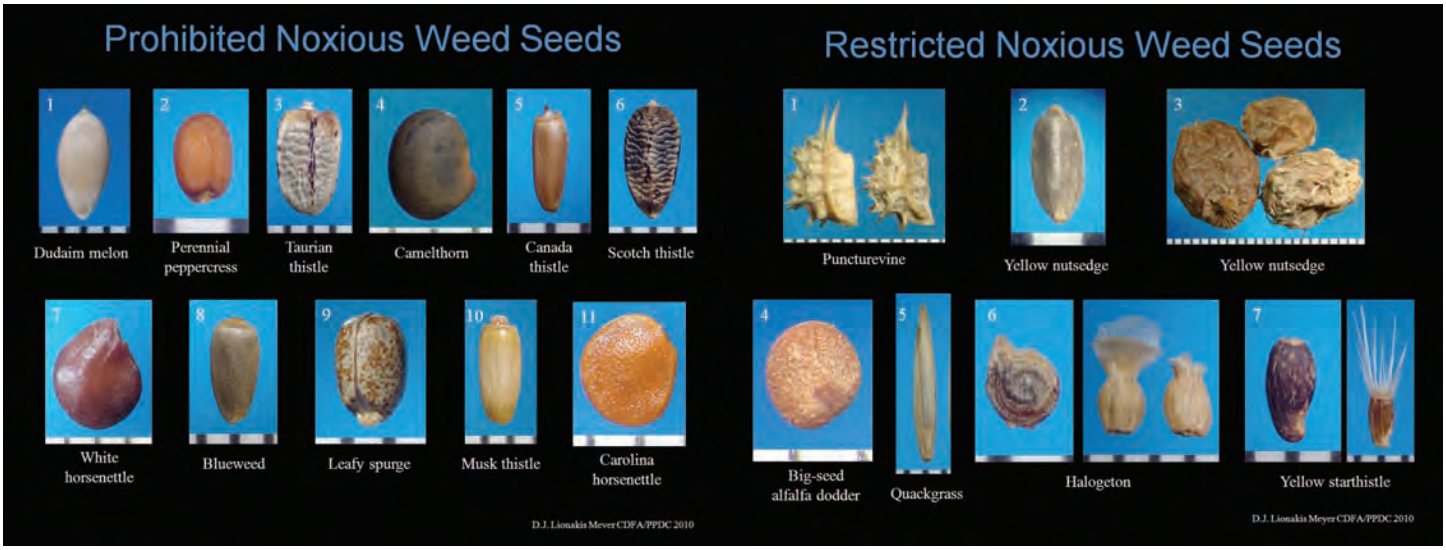

Figure 16. Examples of some prohibited and restricted noxious weed seeds examined at the SSL Seed Workshop. Photographs by Deborah Meyer, PPDC, CDFA.

participants to enhance seed reference collections in their own laboratories. The SSL scientific staff made presentations on the following topics:

- The germination test: methods and procedures in the AOSA and ISTA Rules.
- Germination test setup: proper conditions and common pitfalls.
- Seedling evaluation: using virtual examples covering major families.
- The need for seed vigor testing (Figure 14).
- Brassicaceae: the taxonomy and identification of seeds and fruits of crop and weed species in the mustard family (Figure 15).
- Changes to the California noxious weed list.
- Prohibited and restricted noxious weed seeds in the California Seed Law (Figure 16).
- Problems with the current AOSA pure seed unit definitions.
- The identification of crop and noxious Sorghum species (Figure 17).

Figure 17. LEFT: Diagnostic features of Sorghum spikelets and RIGHT: five types of sorghum examined at the SSL Workshop. Photographs by Jim Effenberger, PPDC CDFA

PPDC Scientist Editorial Responsibilities & Scientific Service

Many PPDB scientists serve in an editorial capacity for several scientific journals, and provided other service to professional societies, as follows:

Riad Baalbaki

- Chairperson: AOSA Germination and Dormancy Research Subcommittee
- Co-chairperson: AOSA Vigor Evaluation Research Subcommittee
- Editor: Seed Technology

Chuck Bellamy

- Editor: The Coleopterists Society, *Patricia Vaurie Monograph Series*
- English Language Editor: *Folia Heyrovskyana*
- Subject Editor (Coleoptera: Buprestoidea): *Zootaxa*, *ZooKeys*
- Manuscript Referee: *The Coleopterists Bulletin*, *The Pan-Pacific Entomologist*, *Zootaxa*
- Investments Counselor: The Coleopterists Society
- Webmaster: Pacific Coast Entomological Society (http://www.pcentsoc.org)

Andrew Cline

- Treasurer & Membership Secretary: *The Coleopterists Society*
- Subject Editor*: Zootaxa* (Bostrichiformia, Lymexyloidea)
- Manuscript Referee: *Zootaxa, Insecta Mundi, The Coleopterists Bulletin*
- Grant Reviewer: National Science Foundation, USDA Farm Bill Appropriations

Jim Effenberger

- Member: AOSA Purity Testing Research Subcommittee

Marc Epstein

- Chairman: Archives & Records Committee: *The Lepidopterists' Society*
- Lepidoptera Subject Editor: *Pan Pacific Entomologist*

Dean Kelch

- Board Member: California Botanical Society
- Workshop Leader: Jepson Herbarium, April, 2010
- Undergraduate Laboratory Training for NSF funded grant
- Manuscript Reviewer: *Nature, Plant Systematics & Evolution, International Journal of Plant Science, Systematic Botany*

Steve Gaimari

- Advisory Board: *International Cooperative Biodiversity Group, Indonesia*; Editorial, *African Invertebrates*
- Council Member: *International Congresses of Dipterology*
- Diptera Subject Editor: *Annals of the Entomological Society of America*
- Editor: *California Plant Pest and Disease Report, Fly Times*, Newsletter of the North American Dipterists Society
- Manuscript Referee: *Acta Amazonica*, *African Entomology*, *African Journal of Agricultural Research*, *Systematic Entomology*, *Zootaxa*
- Member: Organizing Committee, *7th International Congress of Dipterology*, San Jose, Costa Rica (2009–2010); Diagnostics Committee, Lab Accreditation Subcommittee, Ad Hoc Entomology Committee, Associated Programs Committee National Plant Diagnostics Network

Rosser Garrison

- Odonata Subject Editor: *The Pan Pacific Entomologist*, *Zootaxa*
- Editor: *Odonatologica*

Martin Hauser

- Diptera Subject Editor: *Pan Pacific Entomologist*, *Proceedings of the Entomological Society of Washington, Studia Dipterologica*, *ZooKeys,*
- Manuscript Referee: *Annals of the Entomological Society of America, Cladistics, Insect Systematics & Evolution, Israel Journal of Entomology, The Canadian Entomologist, Studia Dipterologica, Systematic Entomology, Zoology in the Middle East, Zootaxa, ZooKeys*

Fred Hrusa

- Reviewer*: Flora North America*, *Jepson Manual*
- Editorial Board Member: *Madroño*

Peter Kerr

- Subject Editor (Sciaroidea): *Zootaxa*
- Molecular Systematics Subject Editor: *The Pan Pacific Entomologist*
- Insect Systematics Subject Editor: *Journal of Insect Science*
- Manuscript Referee: *Zookeys, The Canadian Entomologist*, *Annals of the Entomological Society of America*

Deborah Meyer

- Associate Editor: *Seed Technology*
- Chairperson: AOSA Rules Issues and Review Committee, AOSA Purity Testing Research Subcommittee
- Member: Purity Committee, International Seed Testing Association (ISTA), SCST Registered Seed Technologist Board of Examiners, Community Advisory Council of the College of Natural Sciences and Mathematics, California State University, Sacramento
- National Plant Board Representative: National Seed Health System – Policy and Procedures Advisory Board

Sergei Subbotin

- Chief Editor: *Russian Journal of Nematology*
- Editorial Board: *Nematology*
- Taxa and Subject Editor: *ZooKeys*

Natalia von Ellenrieder

- Membership Secretary: *Worldwide Dragonfly Association*
- Neotropical Odonata Subject Editor: *Zookeys*
- Manuscript Referee: *Bulletin of American Odonatology, International Journal of Odonatology, Journal of the Kansas Entomological Society, Lundiana, Revista Colombiana de Entomología, Revista Mexicana de Biodiversidad, Revista de la Sociedad Entomológica Argentina, Zootaxa*

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Yakabe L.E., S.R. Parker & D.A. Kluepfel. 2010. Effect of pre-plant soil fumigants on *Agrobacterium tumefaciens*, pythiaceous species, and subsequent soil recolonization by *A. tumefaciens***.** *Crop Protection* 29: 583–590. doi.org/10.1016/j.cropro.2010.01.001.

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2010 Presentations

PPDC Scientists are listed in bold.

Atkinson, E.B., J.D. Ellis, & **A.R. Cline.** 2010. "Adaptive leg morphology of the small hive beetle, *Aethina tumida* Murray (Coleoptera: Nitidulidae)." Entomological Society of America, San Diego, CA.

Baalbaki, R. September 22, 2010. "Seed germination and seedling evaluation: principles, procedures and examples." Workshop presentation-Seed Laboratory, Plant Pest Diagnostics Center; California Department of Food and Agriculture.

Baalbaki, R., & S. Elias. June 6, 2010. "Statistics for seed testing: applications, data analysis and tolerances." Workshop presentation-Association of Official Seed Analysts and the Society of Commercial Seed Technologists, Annual Meeting, St. Louis, MO.

Baalbaki, R. June 8, 2010. "Seedling evaluation: updated handbook content, development of seedling evaluation CDs, and work plan." Presentation-Association of Official Seed Analysts and the Society of Commercial Seed Technologists, Annual Meeting, St. Louis, MO.

Chitambar, J. "Detection of Quarantined Nematode Pests: Actions, Results and Current Status." Presented at the 42nd California Nematology Workshop. March 23, 2010. Kearney Agricultural Research Station, Kearney, California.

Chitambar, J. "Protecting California against Invasive Nematode Pests." Seminar Speaker. Department of Nematology, University of California, Davis, Spring 2010 Seminar Series NEM 290.

Cline, A.R. 2010. "The Wonderful world of sap beetles." Pacific Coast Entomological Society, Sacramento, CA.

Effenberger, J. May 11, 2010."Testing for Compliance & Labeling. California Seed Industry" Conference. Stanislaus County Agricultures Center, Modesto, CA.

Effenberger, J. September 24, 2010. **"**Identifying *Sorghum*. The identification of Johnsongrass, almum, sudangrass and sorghum spikelets." California Seed Analysts and Seed Researchers Workshop. Plant Pest Diagnostics Center, Sacramento, CA.

Epstein, M.E. & T.M. Gilligan. Dec. 22, 2010. "How to collect and prepare specimens of moths." National Museum of Kenya. Nairobi, Kenya.

Epstein, M.E. February 2010. "Limacodidae and Invasive Moth Species." Lorquin Entomology Club, Los Angeles.

Epstein, M.E. February 2010. "Identification of the European Grapevine Moth, *Lobesia botrana."* Workshop for entomologists and trapping supervisors from the Southern California counties. . Los Angeles.

Gaimari, S.D. & R.M. Miller. August, 2010."An overview of Afrotropical Lauxanioidea." [7th International Congress of Dipterology (Symposium: Advances in Afrotropical Dipterology), San Jose, Costa Rica]

Gaimari, S.D. & N.P. Havill. August, 2010."Phylogeny of the adelgid-feeding Leucopini (Diptera: Chamaemyiidae)." [poster, 7th International Congress of Dipterology, San Jose, Costa Rica]

Gaimari, S.D. N.P. Havill, J. Klein & A. Caccone. 2010. "Phylogeny of the adelgid-feeding Leucopini (Diptera: Chamaemyiidae)." [poster, 5th Hemlock Woolly Adelgid Symposium, Asheville, NC]

Hauser, M. December 15, 2010. **"**When vinegar flies go bad – the story of *Drosophila suzukii*." Invited talk, ESA meeting, Spotted Wing Drosophila across Boundaries and Perspectives, San Diego, CA.

Hauser, M. August 8, 2010. **"**An overview of Afrotropical endemism in Therevidae." Invited talk, 7th International Congress of Dipterology, Coauthored with Kevin Holston and Mike Irwin. San Jose, Costa Rica,

Hauser, M. August 8, 2010. **"**Stratiomyidae biodiversity of the Ethiopian region – Is the island richer than the continent?" Invited talk, 7th International Congress of Dipterology, Coauthored with Norm Woodley. San Jose, Costa Rica.

Hauser, M. August 10, 2010. **"**Aiming towards more resolution - Challenges of a Stratiomyidae Phylogeny." Invited talk, 7th International Congress of Dipterology. San Jose, Costa Rica.

Holman, Garth, RC Cronn, David S. Gernandt, Sean W. Graham, **Dean Kelch,** Aaron Liston, Sarah Mathews, Matthew Parks, Hardeep Rai, Linda A. Raubeson, Gar W. Rothwell, Dennis Stevenson Wm., Ruth A. Stockey & Christopher S. Campbell. July, 2010. "Rooting Pinaceae." 2010 Annual National Botany Conference. Providence, RI.

Kelch, Dean. March, 2010. "Flora of the Carquinez Strait." Wayne Roderick Memorial Lecture Series. East Bay Parks Botanic Garden. Berkeley, CA.

Kelch, Dean. April, 2010. "Fifty-one plant families in the field." Jepson Herbarium workshop series. . San Francisco Bay Area.

Kelch, Dean. May, 2010. "Evolution in the Podocarpaceae." CDFA Plant Pest Diagnostics Center seminar series. Sacramento, CA.

Kelch, Dean. May, 2010. "Mimicking Science Interpretation." Dept of Entomology seminar. University of CA, Davis.

Kelch, Dean. June, 2010. "Using gymnosperms as a teaching model in the classroom." San Francisco Botanic Garden. San Francisco, CA.

Kelch, Dean. July, 2010. "Multigene approaches to resolving deep branches in Podocarpaceae Phylogeny." 2010 Annual National Botany Conference. Providence, RI.

Kelch, Dean, Linda A Raubeson, Sarah Mathews, Hardeep Rai & Abigail Moore. July, 2010. "Multigene approaches to resolving deep branches in Podocarpaceae Phylogeny." 2010 Annual National Botany Conference. Providence, RI.

Mathews, Sarah, Christopher S. Campbell, RC Cronn, David A. Gernandt, Garth Holman, Steffi Ickert-Bond, **Dean Kelch**, Jianhua Li, Aaron Liston, Damon Little, Gene Mapes, Wenbin Mei, Julie A. Morris, Nathalie Nagalingum, Matthew Parks, Hardeep Rai, Linda A. Raubeson, Gar W. Rothwell, Patricia E. Ryberg, Andrea E. Schwarzbach & Ruth A. Stockey. July, 2010. "A focus on gymnosperm clades: Establishing the context to understand seed plant phylogeny." 2010 Annual National Botany Conference. Providence, RI.

Meyer, D. J. L. May 11, 2010. **"**The evolution of seed testing." California Seed Industry Conference, Modesto, CA.

Meyer, D. J. L. Sept. 2010. "Noxious weed seed identification." CDFA Seed Industry Workshop, Sacramento, CA.

Meyer, D. J. L. Sept. 2010. "Changes to the California noxious weed list" CDFA Seed Industry Workshop, Sacramento, CA.

Meyer, D. J. L. Sept. 2010. "Problems with the current Association of Official Seed Analysts pure seed unit definitions." CDFA Seed Industry Workshop, Sacramento, CA.

Price, R.A. Sept. 2010. "Seeds and Fruits of Weedy Brassicaceae", CDFA Seed Industry Workshop, Sacramento, CA

Price, R.A. & D. J. Lionakis Meyer. Sept. 2010. "Internet Resources for Seed Identification." CDFA Seed Industry Workshop, Sacramento, CA.

Price, R.A. 2010. "Diversity and Relationships of Temperate Zone Conifers." CDFA-PPD Seminar Series.

Raubeson, Linda A., Justina Aguilera, Cristy Bunnell, Christopher S. Campbell, Timothy W. Chumley, RC Cronn, Ashley Dutton, David S. Gernandt, Garth Holman, **Dean Kelch**, Jianhua Li, Aaron Liston, Damon Little, Wenbin Mei, Julie A. Morris, Matthew Parks, Hardeep Rai, Andrea E. Schwarzbach, Daniel Smith, Dennis Wm. Stevenson, Josh Talen & Sarah Mathews. July, 2010. "Seed plant phylogeny – 78 plastid genes and 50 taxa – will more data make a difference?" 2010 Annual National Botany Conference. Providence, RI.

Rothwell, Gar W., Christopher S. Campbell, David A. Gernandt, Elizabeth J. Hermsen, Garth Holman, **Dean Kelch**, Steffi Ickert-Bond, Damon Little, Gene Mapes, Sarah Mathews, Patricia E. Ryberg, Dennis Wm. Stevenson, Ruth A. Stockey & Yong Yang. July, 2010. "The role of morphology in contemporary analyses of seed plant phylogeny." 2010 Annual National Botany Conference. Providence, RI.

Tidwell, T.E. January 21, 2010. "Diagnosing diseases, animal injury and abiotic disorders of Trees." Sacramento Tree Foundation, Sacramento, CA.

Tidwell, T.E. May 11, 2010. "Seed Health Testing and the Impact on California Seed Exports" California Seed Industry Conference, Stanislaus Agriculture Center, Modesto, CA.

Ülgentürk, S., F. Szentkıralyı, **S. Gaimari**, N. Uygun, A. Saboori, S. Seven, O. Dursun & S.H. Civelek. 2010. Predators of *Marchalina hellenica* Genn. (Hemiptera: Marchalinidae) on Turkish pine in Turkey [poster, 12th International Symposium on Scale Insect Studies, Chania, Crete, Greece]

von Ellenrieder, N. June 2010. "Argentina's Biogeography: Examples from the Insect Realm." CDFA seminar series. Sacramento, CA.

Yakabe L.E., S.R. Parker & D.A. Kluepfel**. 2010**. "Incidence and control of seed-borne sources of *Agrobacterium tumefaciens* in walnut production." Walnut Research Conference, 20-22 January, Bodega Bay, CA.