

Plant Pest Diagnostics Center 2008 Annual Report



PLANT PEST DIAGNOSTICS CENTER 2008 ANNUAL REPORT

MISSION	1
VISION	1
VALUES	1
SAMPLES PROCESSED	1
2008 ACHIEVEMENTS	2
SEMINAR SERIES	3
RESEARCH	3
CALIFORNIA STATE COLLECTION OF ARTHROPODS	3
STAFFING CHANGES	4
DEPARTURES	6
NECROLOGY: SADEK AYOUB	7
2008 SEMINAR SERIES SCHEDULE	8
BOTANY LABORATORY 2008 ANNUAL REPORT	9
ENTOMOLOGY LABORATORY 2008 ANNUAL REPORT	22
NEMATOLOGY LABORATORY 2008 ANNUAL REPORT	45
SEED SCIENCE LABORATORY 2008 ANNUAL REPORT	66
PLANT PATHOLOGY LABORATORY 2008 ANNUAL REPORT	75
NATIONAL PLANT DIAGNOSTIC NETWORK ACTIVITIES	128
2008 CHARITABLE PROJECT	130
2008 PUBLICATIONS AND PRESENTATIONS	131

Cover Image: *Neefia humeralis* Bellamy 2003, one of seven new species of a new genus of metallic wood boring beetles (Buprestidae) from Madagascar. Reference: Bellamy, C. L. 2003. The Madagascan Coraebini (Coleoptera: Buprestidae: Agrilinae): Part 4, New genera and species. Zootaxa 174:1-19, 3 color plates. Scanned image from an original watercolor drawing by Andre Owlage.

PLANT PEST DIAGNOSTICS CENTER

Umesh C. Kodira, Branch Chief

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

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

VALUES:

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

The Plant Pest Diagnostics Center (PPDC) provides timely and accurate diagnostics of plant pests and diseases in support of the pest prevention programs of the Department. PPDC has five laboratories Botany, Entomology, Nematology, Plant Pathology and Seed with about 50 permanent and 30 seasonal employees. The Branch also serves as a scientific resource and provides 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 also a collaborator with the National Plant Diagnostic Network (NPDN), is recognized as the expert lab for the western region, and provides diagnostic service and support to the NPDN. The 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/phpps/PPD/>.

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

SAMPLES PROCESSED

Following is a table representing the number of samples and specimens submitted to the laboratory in 2008, compared with previous years. Most programs include special surveys or projects that generate additional samples than cannot be easily tracked by Pest and Damage Report 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.

Labs/Programs	2003	2004	2005	2006	2007	2008
Botany ¹	3,284	1,008	1,000	1,474	1,029	1,682
Entomology ²	36,146	45,000+	50,000+	50,000+	65,000+	70,000+
Nematology ³	4,782	3,874	4,923	7,912	8,648	5,870
Plant Pathology ⁴	88,233	109,398	103,451	87,434	78,872	90,531
Seed ⁵	3,067	6,923	3,166	5,791	2,427	1,843
Total	135,512	166,203	162,540	152,611	155,976	169,926

¹ An additional 3000 botany specimens were examined & identified for herbarium curation.

² Estimate of specimens examined.

³ Includes Quarantine samples, Nursery Registration & Certification samples, USDA Survey Project samples, as well as Diagnostic samples.

⁴ Includes 59,794 samples tested for several target viruses as part of the California deciduous fruit tree, nut tree, and grapevine Improvement Advisory Board (IAB) Program.

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. In 2008 the total number of seeds or propagules actually examined for identification was in excess of 18,600,000. Germination tests require the evaluation of 400 seedlings per sample; thus the total number of individual seedlings evaluated for germination tests was in excess of 440,000.

PLANT PEST DIAGNOSTICS CENTER (PPDC) 2008 ACHIEVEMENTS

- The Plant Pest Diagnostics Center (PPDC) continued to successfully provide timely and accurate diagnostics of plant pests and diseases in support of the pest prevention programs of the Department. The PPDC diagnosed/identified a number of new pests and diseases, thereby helping prevent the spread/establishment of these pests. Examples include, identification of Mediterranean fruit fly, Oriental fruit fly, Guava fruit fly, Light Brown Apple moth (LBAM) Asian Citrus Psyllid (ACP), Gypsy moth, Quagga Mussel, Zebra Mussel, Chrysanthemum White Rust, a new Downey Mildew pathogen of basil, a new species of Rust on rose, a new species of *Salsola* (tumble weed), etc.
- The PPDC processed nearly 170,000 samples and made determinations to assist the Department and the public. About 1,500 samples were processed for phytosanitary certification, thereby assisting in the export of agricultural products worth millions of dollars. About 30,000 samples of nursery stock were tested for Sudden Oak Death pathogen, which enabled California nursery stock to be shipped outside the state. Similarly, thousands of specimens of LBAM and ACP were identified, which enabled the growers to meet the quarantine requirements.
- The PPDC houses the California State Collection of Arthropods with about 2.0 million specimens, a 50,000 specimen seed herbarium, and a 50,000 specimen plant herbarium. During this year, tens of thousands of new specimens were added to these important reference collections of the state.

- This Branch has continued to serve as a scientific resource and has provided professional expertise to a number of clients including the United States Department of Agriculture (USDA), County Agricultural Commissioners, the University of California Cooperative Extension, the agriculture industry and the public.
- The PPDC is a partner with the National Plant Diagnostic Network (NPDN), and is recognized as the expert lab for the Western Plant Diagnostic Network (WPDN) consisting of the 9 western states and the Pacific territories.
- The scientists at the PPDC continue to do research and publish scientific papers as part of the mission of this branch. The scientists at PPDC published numerous (more than 60) scientific papers, books, manuals, and other publications. In addition, many oral presentations and/or posters were given at various professional meetings, seminars, and training workshops. The scientists have conducted several training sessions/workshops in pest collection and identification for the Border Inspection personnel, county biologists, UC Master Gardeners, various college and university classes, Biologists of other State Departments such as Cal Trans, and scientists from numerous private California seed companies.

SEMINAR SERIES

The Plant Pest Diagnostics Center seminar series began in 2004 to enable scientists to present research data and discuss ongoing research and pest issues of general importance and has continued throughout 2008 with enthusiasm and participation by many from within and outside of our branch. Speakers have included scientists from the PPDC, USDA, University of California, Davis and visiting scientists from other universities and agencies. The focus of the seminar series has been to share information on any aspect of basic or applied research or diagnostics. See page eight for a list of seminars in the 2008 PPDC seminar series.

RESEARCH

The scientists at the PPDC continue to do research and publish scientific papers as part of the mission of the branch. In the past year, members of the PPDC published 67 scientific papers, books, manuals or other publications. In addition, 38 oral presentations and/or posters were given at various professional meetings, seminars and training workshops. A list of scientific publications and presentations for 2008 are included at the end of this report.

CALIFORNIA STATE COLLECTION OF ARTHROPODS: 2008 REPORT

The California State Collection of Arthropods (CSCA) is a scientific resource for the local, federal and international community for research and identification of various groups of arthropods, especially insects. The collection is maintained by the Entomology Lab of the Plant Pest Diagnostics Branch of the California Department of Food and Agriculture. Three curators and a collection manager, and the entire scientific staff, directly supervise the care, use, growth and development of CSCA, encouraging the use of this collection for research on the taxonomy and systematics of arthropod taxa. The web page for the collection is located at the following website: <http://www.cdafa.ca.gov/phpps/ppd/csca.html>. As far as specimen usage, the California State Collection of Arthropods issued 28 loans in 2008 representing nearly 13,000 specimens, and hosted more than 20 visitors from the local, national and international communities to study the collections on site. Visitors came from places as far away as Australia (Australian National Insect Collection), the Republic of South Africa (Albany Museum), and Germany (Naturkunde-museum Wiesbaden).

The total number of prepared specimens is about 2 million, with more than 75,000 prepared specimens accessioned in 2008. With the CSCA's blanket permit to collect arthropods in California's State Park system, several seasonal survey efforts were undertaken in 2008,

including Annadel, Indian Grinding Rock Historical, and Patrick's Point State Parks, as well as Humboldt Bay National Wildlife Refuge. CSCA's frozen tissue collection continues to grow. At least 6 holotypes and numerous paratypes were deposited in CSCA in 2008, 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 close-up digital images to the CSCA Web page for each species held. The inventory of the entire collection is nearly complete with nearly 40,000 species so far.

Through the Research Associates program, PPDC encourages the use of the collection, the growth of the collection through their respective donations and allow them to cite their associate status, if necessary, to provide an institutional address for their publications or grants. Several additional scientists have applied to our program in 2008, and have been awarded this courtesy appointment. The Research Associates can be found on the Internet at: <http://www.cdfa.ca.gov/phpps/ppd/csca.html#associates>

STAFFING CHANGES



Donna Imes



Martin Hauser

Donna Imes joined the Entomology laboratory as an Agricultural Biological Technician, after serving as a Scientific Aide in both the Nematology Laboratory and the Plant Pathology Laboratory. Donna graduated from University of California at Davis with a B.S. in Animal Biology in 2004 and is currently pursuing a Master's Degree in Forensic Science.

Dr. Martin Hauser is our newest Associate Insect Biosystematist, with the primary responsibility in the Entomology Laboratory of identifying Diptera specimens (flies). Dr. Hauser received his Ph.D. in Entomology from the University of Illinois at Urbana-Champaign in 2005 and worked as a postdoctoral researcher at the CDFA between 2005 and 2007. Most recently he was a Research Associate Professor at the University of South Carolina in Columbia, SC.

Patrick Woods joined the Botany Laboratory as an Agricultural Biological Technician, after serving as a Scientific Aide on the Light Brown Apple Moth Project in the Entomology Laboratory. Patrick brings a high level of skill in the area of molecular biology to the Botany Laboratory. In his first few months on the job Patrick worked closely with Senior Plant Taxonomist Dean Kelch to develop a very reliable diagnostic PCR test to identify the highly invasive weed, Japanese Dodder (*Cuscuta japonica*). Confirmation of this serious exotic pest had been problematic since in California's relatively mild climate the plant would not produce flowers, which are necessary for a morphological identification.

Obediah Sage joined the Entomology laboratory as an Agricultural Biological Technician. Obie has worked in the PPDC Entomology Lab as a Scientific Aide since early 2005, and has been assisting with LBAM diagnostics full time since early 2007. Prior to his work at the PPDC, he worked at UC Davis's Bohart Museum while attending UCD. Obie has had a lifelong interest in insect biology, including over 20 years of experience rearing and collecting Lepidoptera.



Patrick Woods



Obediah Sage

Jacqueline Kishmirian joined the Entomology laboratory as an Agricultural Biological Technician, after serving as a Scientific Aide on the Light Brown Apple Moth Project. Her primary duties include managing the California State Collection of Arthropods and providing technical support to the scientific staff. Jacqueline graduated from University of California at Davis with a B.S. in Entomology in 2007.

Megan O'Donnell joined the Entomology laboratory as an Agricultural Biological Technician, after serving as a Scientific Aide on the Light Brown Apple Moth Project in the Entomology Laboratory. Megan graduated Summa Cum Laude from Southern Oregon University in 2005 with a B.F.A in Fine Arts and a minor in Biology.



Jacqueline Kishmirian



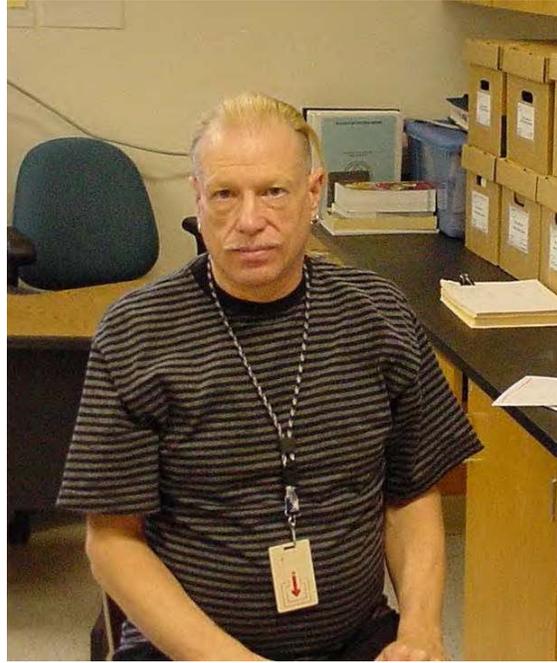
Megan O'Donnell

DEPARTURES

Senior Seed Botanist, **Paul Peterson**, retired after 33 years of state service in the Seed Laboratory. Mr. Peterson is widely recognized in the seed industry as an expert in seed and seedling physiology and is best known for his work with vegetable crops. He received accreditation as a Certified Seed Analyst through the Association of Official Seed Analysts. During his long career, Mr. Peterson provided training to many industry and government seed technologists.

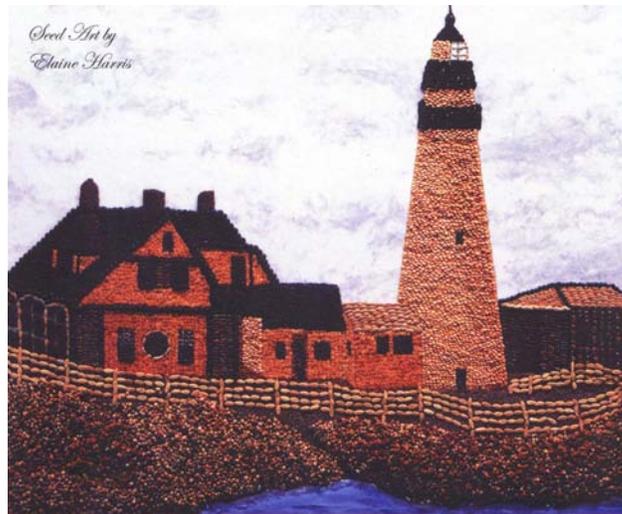


Elaine Harris



Paul Peterson

Elaine Harris, Senior Lab Assistant, retired from state service after nearly 18 years with the Seed Laboratory. In addition to being a valuable member of the Seed Laboratory's technical staff, Ms. Harris is also a talented artist. One of her specialties is creating art using seeds.



Seed art by Elaine Harris

NECROLOGY: SADEK AYOUB

In October of 2008, Retired Nematologist Sadek Ayoub passed away in Sacramento, CA at the age of eighty-six. Sadek joined the Nematology Laboratory (CDFA) in 1958 as a Nematologist and retired as a Senior Nematologist in the early 1990s after working for the CDFA Plant Pest Diagnostics Laboratory for more than thirty years. Among other duties, he had the responsibility of providing training in nematology to county agricultural officials. He thoroughly enjoyed doing this as he used to tell his colleagues, with a twinkle in his eye, that his job was "to sell the merchandise." The classes were well attended by a number of county personnel—some of whom had nothing to do with nematology. Everyone just loved his laid-back style and were always greatly amused by him. Sadek was part in a very active program. Nematology in California was still in its infant stage at that time with new detections being made frequently.



Plant-parasitic nematode identification was Sadek's expertise. His accomplishments included reporting the first occurrence of *Ditylenchus destructor*, the potato rot nematode, a B-rated pest, in California. Sadek published reports of new host findings for the root lesion nematodes, *Pratylenchus coffeae* and *P. zae* in California, as well as a list of tropical host plants of the burrowing nematode, *Radopholus similis*. Along with UC Davis nematologists, Dr. Armand Maggenti, Dr. W. Hart and others, he was involved in establishing the pre-plant hot water control measures for grape rootstock and thereafter, monitoring those measures as and when required by CDFA Nursery Program for certified growers. Perhaps one of Sadek's greatest contributions was his training manual, "*Plant Nematology: An agricultural Training Aid*" illustrated by Charles S. Papp and published in 1977. It continues to be used internationally as an important reference for instructors and researchers in plant nematology.

In addition to doing nematode identification, Sadek was also an Instructor for a State-mandated "Defensive Driving Training" course as well as the Branch Safety Officer—which occasionally made for some amusing situations. One time a scientist made a request for an escape door out of a small laboratory room since there was only one way out and it was through a narrow passage that could be cut off in case of a fire. Although there were no funds for such construction and remodeling, a few days later Sadek, the innovative Safety Officer that he was, dutifully delivered an authentic firefighter's ax to the scientist, instructing him to "make his own door" through the wall in case of a fire. Even in his retirement, Sadek visited the laboratory to socialize and encourage the staff, and occasionally to help PPDB scientists with their research and diagnostics projects. For example, since Sadek was fluent in several languages he would occasionally assist PPDB Scientists by translating journal articles from other languages, particularly French or Arabic, into English.

Sadek was a kind-hearted person who enjoyed life and people. He knew the best restaurants to visit and enjoyed telling others about the "good-old days" when scientists were respected and greatly supported by their administrators. After retirement, Sadek worked as a consultant for a private agricultural consulting agency. He worked as a consultant in his home country of Egypt and encouraged many students there to pursue their education, as he did, in the USA.

California Department of Food & Agriculture, Plant Pest Diagnostics Branch 2008 Seminar Series

- Mark Stirling** (CDFA Pest Exclusion) 24 January 2008
Title: "The first line of defense - pest exclusion at the border stations"
- Dr Peter Kerr** (CDFA / PPDB Entomology) 21 February 2008
Title: "Collections management: vouchering for the future"
- Dr William Roltsch** (CDFA Biological Control) 20 March 2008
Title: "Biological control of Pink Hibiscus Mealybug"
- Baldo Villegas** (CDFA Biological Control) 17 April 2008
Title "The good, the bad and the buggly – life on roses"
- Dr Sergei Subbotin** (CDFA/PPDB Nematology) 15 May 2008
Title: "On phylogenetics and phylogenomics, illustrated by nematode examples"
- Dr Cheryle O'Donnell** (UC Davis) 12 June 2008
Title: "Phylogenetic analysis of western flower thrips, *Frankliniella occidentalis*, in California"
- Dr Richard Penrose** (CDFA Pest Detection) 24 July 2008
Title: "CDFA's Exotic Woodborer Detection Program"
- Dr Suzanne Rooney Latham** (PPDB Plant Pathology) 18 September 2008
Title: "Fungi: the good, the bad and the ugly"
- Dr Riad Baalbaki** (PPDB Seed Laboratory) 23 October 2008
Title: "Plants, pests, energy budgets and global warming"
- Dr Martin Hauser** (PPDB Entomology) 20 November 2008
Title: "Desert diversity - arthropod inventory in the United Arab Emirates"
- Mark Stirling** (CDFA Pest Exclusion) 18 December 2008
Title: "Antiquarian books on natural history"

Scheduled presentations are at 3:00pm on Thursdays.

For more information contact Gillian Watson, phone: (916) 262 1155, email: gwatson@cdfa.ca.gov
Seminar series website: <http://www.cdfa.ca.gov/phpps/ppd/Entomology/CSCA/seminar.htm>

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2008 ANNUAL REPORT OF THE BOTANY LABORATORY

2008 BOTANY LABORATORY STAFF

Fred Hrusa
Dean Kelch
Patrick Woods
Yoshiko Kinmonth
Matthew Beyer
Mary Jo Colletti

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 the "CDA,") currently contains more than 50,000 specimens and has an active specimen exchange program with state, national and international herbaria. These specimens form the basis for ensuring accurate identification of plants new to or currently growing in California. Field investigations are also an essential part of the program; not only to collect specimens, duplicates of which form the nucleus of the exchange program and populate the collection itself, but also to evaluate such things as the environmental conditions influencing the presence of new or existing plant populations. Seventy-five percent of the counties submit 90% or more of their plant specimens to the Botany Laboratory/Herbarium CDA for identification or confirmation. The ability of the laboratory to assist field programs promptly and accurately has aided in pinpointing the distribution of the major weed pests in the state. The Botany Lab has begun a long-term project to database the entire herbarium collection and make the data available on the web as part of the Consortium of California Herbaria, which provides plant specimen data from 18 different California herbaria. One-stop shopping for botanical information will revolutionize the ability of scientists to understand plant distribution and systematics in California. This outreach to other botanical institutions is an example of forming alliances with other organizations and increasing the use and relevance of the CDA Herbarium to the California community.

In 2008, the Botany Lab received 1682 samples with Pest and Damage Reports (PDRs) for identification. Of those 1682 PDR samples, 117 were identified as 'A'-rated pests, 133 were 'B'-rated, and 67 were 'Q'-rated. In 2008, approximately 3,000 new specimens were added to the CDA Herbarium, expanding the collection to nearly 55,000 mounted specimens. The Botany Laboratory's participation in an exchange program with other herbaria, both local and international, continues to increase taxonomic diversity within the collection. Through this program approximately 1500 new specimens were obtained and mounted in 2008.

Of special interest in the Botany Lab in 2008 was the development of a rapid molecular test for identifying Japanese Dodder, *Cuscuta japonica*, in the absence of floral parts, which are necessary to make a morphological identification. This research, conducted by Botanist Dr. Dean Kelch and technician Patrick Woods of the Botany Laboratory, was supported by funds from the Integrated Pest Control Branch of CDFA, which conducted surveys and the control effort for Japanese Dodder in California. An article detailing the study and the protocol that was developed follows on pages 13 through 19.

A significant area of research for PPDB Botanist, Dr. Fred Hrusa, has been resolving the taxonomic questions concerning the genus *Salsola* in California. Dr. Hrusa, who is a recognized taxonomic authority on North American *Salsola* species, notes that although *Salsola australis*, "Russianthistle," has been recognized in California for some time, it has frequently been confused with *Salsola tragus*, the common tumbleweed, since at least the late 1950s and that many specimens identified as *S. tragus* in the past (or as *S. kali*, *S. pestifer*, or as *S. kali* ssp. *tenuifolia*) were likely *S. australis*. In addition, Dr. Hrusa notes that *Salsola australis* also differs in its habit and behavior from *Salsola tragus*, as he explains in the following short synopsis:

Salsola tragus:

Tumbles. A serious road and fire hazard in areas where it blows across highways and accumulates against fences etc. Tumbling is a seed dispersal mechanism. The seeds are persistent on the plant and do not fall naturally, but rather require the shaking that a long bouncing across the ground provides. The result is that the plant tends to occupy roadsides and other flat areas, not steep hillsides. *S. tragus* is widespread, found almost throughout North America, predominantly away from the coast and as high as 9000 ft. elevation. Early in the growing season, *S. tragus* is soft and succulent, and is often grazed. Later it becomes hard and wiry, very spiny, and is not grazed to any extent.

Salsola australis:

Does not tumble to any great extent, although it will eventually fall over and roll a little ways, its shape is not round and dense like *S. tragus*. *Salsola australis* drops its seeds in place. It thus occupies both steep hillsides and flat areas. It occurs at lower elevations than does *S. tragus*, and is seldom found above about 1000 ft. elevation. It is the predominant "Russianthistle" (it may be native to Australia although we are not certain of its original distribution) along the south coast. It is frequent in Arizona and northern Mexico and is found as far east as Texas. It is a weed of disturbed areas, coastal beaches, agricultural areas (it is esp. frequent in rocky soils on which grapes are sometimes grown and is common around vineyards in the San Joaquin Valley), roadsides, railroad tracks and sidings, and open grasslands. Compared to *S. tragus*, *Salsola australis* is a soft and succulent, although somewhat spiny, plant late into the growing season, and in contrast to *Salsola tragus*, is often grazed by cattle well into the later summer.

The USDA and CDFA continue to seek biological control agents for both *Salsola australis* and *Salsola tragus*.

An abstract of a paper published by Hrusa & Gaskin in 2008 which details the *Salsola* situation in California follows on page eleven.

THE *SALSOLA TRAGUS* COMPLEX IN CALIFORNIA (CHENOPODIACEAE):
CHARACTERIZATION AND STATUS OF *SALSOLA AUSTRALIS* AND THE
AUTOCHTHONOUS ALLOPOLYPLOID *SALSOLA RYANII* SP. NOV.

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ABSTRACT

Over the past century in California, the invasive weed *Salsola tragus* (russianthistle) has become a widespread and troublesome pest plant. Early attempts at biological control of russianthistle achieved only partial success. Efforts to improve effectiveness of renewed biocontrol efforts revealed that two distinct, often sympatric, genetic entities comprise what has been called *Salsola tragus*: *Salsola tragus* and *Salsola* 'type B'. Efforts to identify and characterize 'type B' resulted in recognition of a third form, 'type C'. We present a taxonomic and morphological examination of *Salsola tragus*, *Salsola* 'type B', *Salsola* 'type C' and *Salsola paulsenii* using discriminant analysis with DNA sequence genotypes as the taxonomic framework. *Salsola tragus* and 'type B' were morphologically distinct; 'type C' was morphologically intermediate between them and contained DNA sequence genotypes that were an additive mixture of haplotypes mostly exclusive to tetraploid *S. tragus* and others exclusive to diploid 'type B'. 'Type C' is a fertile allohexaploid that originated via hybridization between *S. tragus* and 'type B'. We provide a pre-existing name, *Salsola australis*, for 'type B', and propose *Salsola ryanii* sp. nov. for 'type C'. Morphological variation, habitats, and dispersal behaviors among these *Salsola* taxa were examined in the herbarium and in the field. These are compared and discussed.

HRUSA, G.F. AND J. F. GASKIN 2008. Madrono 55(1): 113-131.

Dedicated to Dr. Sergei L. Mosyakin, whose encouragement, photographs, specimens, and herbarium data from Russia and the Ukraine, both began and finished this study.

A number of Cdfa personnel were involved in this project, especially Dr. Mike Pitcairn and Dr. Pat Akers of the Integrated Pest Control Branch Biocontrol Program of the California Dept. of Food and Agriculture were instrumental in the first author's access to *Salsola* materials. Scott Kinnee of Cdfa Plant Pest Diagnostics assisted with technical presentation issues and walked the first author through the SEM photography. We give a special thanks to Genevieve Walden for her fine line drawings, all created while working as a scientific aide in the Botany Laboratory at Plant Pest Diagnostics.

Molecular analyses were supported in part by funding from the U.S. Department of the Interior, Bureau of Land Management and Bureau of Indian Affairs, and was performed by K. Mann, J. Lassey, and J. Londo of USDA. Additional USDA collaborators included Dr. Lincoln Smith, Dr. Fred Ryan and M. Irene Wibawa.

CATALOGUE OF NONNATIVE VASCULAR PLANTS OCCURRING
SPONTANEOUSLY IN CALIFORNIA BEYOND THOSE ADDRESSED IN THE JEPSON
MANUAL – PART II

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ABSTRACT

We present Part II of a catalogue documenting nonnative vascular plant taxa occurring spontaneously in California beyond those addressed in The Jepson Manual: Higher Plants of California (Hickman 1993). Here we document an additional 117 taxa occurring spontaneously in California that were not accounted for in Part I (Hrusa et al. 2002) or in The Jepson Manual. The catalogue was compiled from new collections by the authors and others, previously existing herbarium specimens, peer-reviewed publications, other printed reports, and direct communications with field botanists. Only reports backed by herbarium vouchers are accepted as adequately documented. Of the 117 taxa, 42 are fully or sparingly naturalized in relatively undisturbed wildland habitats, 14 are naturalized in non-wildlands (roadsides, fallow fields, croplands, other disturbed areas), 13 are tenuously established or locally persisting, 22 are weeds of greenhouse or other horticultural environments, 7 are presumed to be non-persisting casuals (waifs), and for 19 there is no current information. Taxa recorded as already being widely naturalized and/or potentially significant pests include *Brachypodium sylvaticum*, *Cuscuta japonica*, *Danthonia decumbens*, *Glyceria declinata*, *Juncus usitatus*, *Melaleuca viminalis*, *Rytidosperma penicillatum*, *Verbena incompta* and *Zostera japonica*.

DEAN, ELLEN, FRED HRUSA, GORDON LEPPIG, ANDREW SANDERS, AND
BARBARA ERTTER, 2008. Madrono 55(1): 93-112.

MOLECULAR DETERMINATION OF IMMATURE AND STERILE SPECIMENS OF *CUSCUTA JAPONICA* (CONVOLVULACEAE) USING RESTRICTION FRAGMENT LENGTH POLYMORPHISMS

Patrick Woods, Dean Kelch and Fred Hrusa

In 2008, the CDFA Botany Laboratory developed a methodology to diagnose incomplete samples of the noxious weed Japanese dodder from native species of dodder.

INTRODUCTION

The dodders (*Cuscuta* spp.) are a genus of parasitic vines in the bindweed family (Convolvulaceae). In California, there are seventeen recognized taxa in eight native and one introduced species (Hickman, 1993). Two additional introduced dodders, Japanese dodder (*C. japonica*) and giant dodder (*C. reflexa*) have also been detected, with the former common and the latter perhaps extirpated. Some, such as canyon dodder (*C. subinclusa*) attack woody plants and rarely appear on agricultural species (although they may occur on cultivated shrubs). Others, such as five-angled dodder (*C. pentagona*) attack herbaceous plants and can be a problem in agricultural settings. Dodder infestation can lead to a significant decrease of crop productivity (Farah and Al-Abdulsalam, 2004; Pennisi, 2006). For this reason, California native dodders are some of the few native species that are rated as weeds by the California Department of Food and Agriculture. (California Code of Regulations, Section 4500).

Japanese dodder (*C. japonica*), an introduced species, was first detected in California in 2004. Japanese dodder is different from native species in its robust growth (Figure B1) that allows it to overwhelm and eventually kill larger woody plants. In addition, Japanese dodder flowers (Figure B2) only after a long growing season. In California, growth is often checked by cold weather before flowering can occur. Therefore, most of the spread of Japanese dodder has occurred by translocation of vegetation material, either serendipitously or, more often, by human agency. Because Japanese dodder is used by some ethnic groups in their pharmacopoeia, new infestations are actively established despite the deleterious effects on the host plants. The host range of Japanese dodder comprises a wide range of woody horticultural species, as well as some species, such as citrus, that are important to California agriculture.

Because of their current limited distributions in California and their potential to have large negative impacts on ornamental plantings and orchards, non-native dodders (including Japanese dodder) were given a pest rating of "A" by the California Department of Food and Agriculture. This is in contrast to native species of dodder that have a pest rating of "C", generally viewed as a lower (at least less time critical) pest rating. As Japanese dodder stems are usually thicker than in the native species, size is an obvious but not consistently reliable method to distinguish Japanese from native dodder species. The CDFA Botany Laboratory has identified morphological vegetative characters to distinguish Japanese dodder from native species, but this is not necessarily a reliable way to distinguish sterile specimens from other closely related, non-native dodder species, such as giant dodder. Most specimens received by the botany laboratory are sterile specimens. This means that the vast majority of specimens received are identified as *C. cf. japonica* ("cf." stands for *confer*, a botanical notation indicating that the specimen under consideration may be the species in question, but the specimen is insufficient for a definitive identification).



Figure 1: Japanese Dodder growing in the wild. Photo by Fred Rinder. Fresno Co. Department of Agriculture.



Figure 2: *Cuscuta japonica* flowers in situ. Photo by Fred Rinder, Fresno Co. Department of Agriculture.

The listing of all non-native dodder species as A-rated pests (in 2007) allowed the rating and control of non-native dodder specimens not definitively identified as *C. japonica*. Nevertheless, it also created some problems. The CDFA seed laboratory is not able to distinguish the seed of some non-native dodder species from native dodder species. This complicates the assigning of pest ratings to samples and seed contaminants with some dodder seed in them. In addition, if a dodder closely related to Japanese dodder were to be introduced, its detection and control might be delayed if it were identified merely as *C. cf. japonica*. For these reasons, the CDFA Botany Laboratory, in collaboration with the CDFA Japanese dodder control project, embarked on a project to develop easy and repeatable laboratory diagnostic techniques to diagnose native dodder species, Japanese dodder, and other species closely related to Japanese dodder (Table 1).

In order to develop these diagnostic tests, 92 GenBank sequences of the ITS gene for accessioned *Cuscuta* species found in California and for species related to Japanese dodder were analyzed for Restriction Fragment Length Polymorphism (RFLP) recognition sites. Fifty-nine sequences were generated in-house from freshly collected specimens and mounted, dry specimens in the CDA Herbarium.

List of relevant species grouped as assigned by Yuncker 1932, except as noted.	GenBank Sequences	In-House Sequences
Subgenus Monogyna (the giant dodders)		
<i>C. exaltata</i>	1	-
<i>C. japonica</i> *	4	15
<i>C. reflexa</i> *	2	3
<i>C. lupuliformis</i>	3	-
<i>C. monogyna</i>	2	-
Subgenus Grammica (includes the native dodders)		
<i>C. denticulata</i>	4	2
<i>C. howelliana</i> **	3	-
<i>C. pentagona</i>	5	2
<i>C. salina</i>	10	-
<i>C. subinclusa</i>	4	1
<i>C. californica</i>	7	1
<i>C. cephalanthi</i>	5	1
<i>C. indecora</i>	7	-
Subgenus Cuscuta section Eucuscuta (old world, non-giant dodders)		
<i>C. epilinum</i>	3	-
<i>C. europaea</i>	6	-
<i>C. approximata</i> *	8	2
<i>C. epithymum</i>	5	-
<i>C. palaestina</i>	3	-
<i>C. planiflora</i>	8	-
<i>C. triumvirati</i>	2	-
<i>C. sp</i> misidentified and unidentified	-	13
<i>C. cf. japonica</i>	-	19
Total	92	59

Table 1: List of species of dodder included in the present study, with number and source of DNA sequence samples included for each taxon. * = Introduced species observed in California. ** *C. howelliana* described subsequent to Yuncker, 1932.

Fresh and dried tissues were used for total genomic DNA extraction. These samples were then used for polymerase chain reaction (PCR) to amplify the target ITS DNA sequence fragments of the nuclear DNA using the protocol of White et. al. (1990). PCR reagents differed slightly to accommodate DNA extractions from either fresh or dried tissue specimens

Resulting PCR products were electrophoresed on an agarose gel and ran against a ladder) for size comparison. PCR products were purified using QIAquick PCR Purification Kit Protocol (QIAgen) and quantified, then sequenced.

Sequences were edited in Sequencher 4.7 (Gene Codes) and analyzed against related species sequences in BioEdit Sequence Alignment Editor v7.0.5.3 (Hall, 1999). Analysis consisted of confirming in-house amplifications against published sequences and confirming RFLP cut sites for diagnostic significance.

Restriction enzymes are enzymes that cut DNA at particular points, producing DNA fragments of specific size. As the size of DNA fragments is directly related to the underlying DNA sequence, one can use such samples to assign an unknown sample to a known taxon by running the samples on an electrophoretic gel (Figure B3). AatII, NlaIII, and PmlI were the enzymes used to differentiate *C. japonica* from the other *Cuscuta* spp. occurring in California (Hickman, 1993), as well as related species within the subgenus *Monogyna* (Yuncker, 1932) and species related to *C. approximata*, another non-native *Cuscuta* occurring in California.

Sequence analysis indicates that the AatII cut site is present only in three species of the subgenus *Monogyna* (*C. exaltata*, *C. japonica*, and *C. reflexa*), which occurs at approximately 475 base pairs (bp). This cut site is not present in any of the other species studied. All three species noted above will cut when digested with NlaIII, but the cut sites vary between these taxa. *C. exaltata* cuts twice at approx. 65bp and 490bp, which results in three bands at approx. 65bp, 90bp, and 425bp. *C. japonica* cuts once, resulting in two bands at approx. 175bp and 475bp. *C. reflexa* cuts once at approx. 20bp, the gel image of which is nearly indiscernible from the undigested PCR product. *C. exaltata* is differentiated at the PmlI cut site, as neither *C. japonica* nor *C. reflexa* retained the PmlI target sequence. *C. exaltata* cuts once at approx. 145bp.

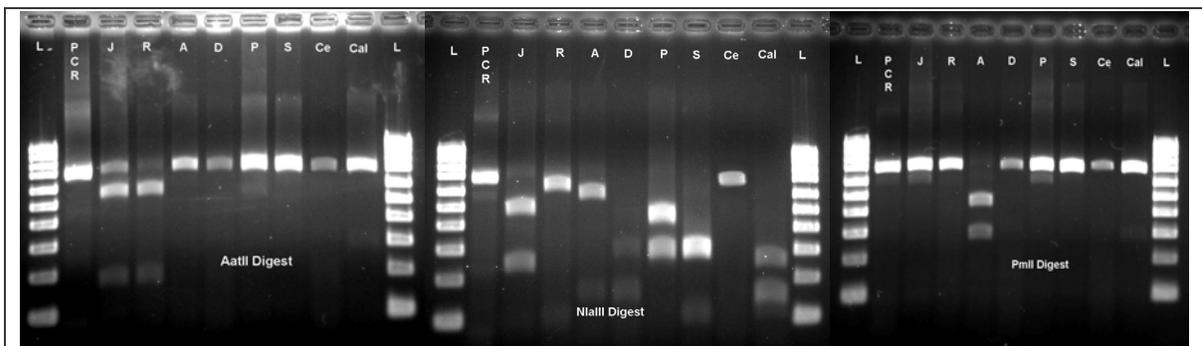


Figure 3: Restriction fragment profiles from three digestions, restriction endonucleases noted on gel image. L = Ladder, PCR = undigested ITS5/ITS4 amplification, J = *C. japonica*, R = *C. reflexa*, A = *C. approximata*, D = *C. denticulata*, P = *C. pentagona*, S = *C. subinclusa*, Ce = *C. cephalanthi*, Cal = *C. californica*.

Sequences from GenBank were compared to sequences generated in-house to ensure proper grouping, thereby decreasing the chances of specimen misidentification. This comparison also included sequences derived from unknown *Cuscuta* specimens. While the phylogenies produced from these sequences correctly placed each specimen into their respective subgenus, some species, where multiple sequences were included in the analysis, incorrectly resolved species-level relationships. Incidence of improper species-level structuring was observed in sequences attributed to *C. planiflora* and *C. epithymum*. Sequence analysis results correctly supported findings from previous studies into *Cuscuta* phylogenetics (Stefanovic, et. al., 2003; McNeal, et. al., 2007; Garcia and Martin, 2007; Stephanovic, et. al., 2007).

DISCUSSION

The use of the restriction endonucleases as implemented in this project are sufficient to distinguish *C. japonica* and sister taxa, *C. reflexa* and *C. exaltata*, from the native *Cuscuta* spp. found in California. As well, all 19 *C. cf. japonica* specimens' sequences matched known *C. japonica* sequences and cut as expected when digested with the three endonucleases used. *C. approximata*, another introduced species not closely related to *C. japonica*, is distinguishable. Using one specific enzyme alone resolves the three introduced species from the native species. However, because of the possibility of new introductions by closely allied giant dodder taxa, such as *C. exaltata*, two other enzymes are included in the diagnostic. These two endonucleases ensure these other giant dodder identities. This RFLP diagnostic is useful and efficient primarily because the cut sites necessary to differentiate the target species are present on one easily obtained piece of DNA. This reduces the time and money needed to get a diagnosis.

This early work opens the possibility of developing a molecular diagnostic to identify fragmented or immature plants or *Cuscuta* seeds from unidentified species. This could be accomplished by using conditional-RFLP, whereby depending on the outcome of one restriction digest, contingent digests will be employed or not employed until the identity of the unknown is satisfied, much in the same manner as couplet keys are used in morphological identifications. Further study into the molecular make-up of native species will be required.

While this diagnostic works well for confirming the identification of immature *Cuscuta japonica* detections, it is limited in its usefulness in identifying other related taxa within subgenus *Monogyne* that were not included in our dataset. Some related taxa were not sequenced due to the unavailability of representative material, either fresh or preserved, nor were verified sequences available in GenBank. *Cuscuta cassyoides*, *C. timorensis*, and *C. gigantea*, for example, have not been part of any study cited here. Future phylogenetic studies of this subgenus will elucidate the molecular variations necessary to further refine this diagnostic.

REFERENCES

- Farah A. F. and M.A. Al-Abdulsalam. 2004. Effect of Field Dodder (*Cuscuta campestris* Yuncker) on Some Legume Crops. Scientific Journal of King Faisal University (Basic and Applied Sciences) .5: 103–113.
- Garcia, M. A., and M. P. Martin. 2007. Phylogeny of *Cuscuta* Subgenus *Cuscuta* (Convolvulaceae) Based on nrDNA ITS and Chloroplast *trnL* Intron Sequences. *Systematic Botany*. 32(4): 899–916.
- Hall, T.A. 1999. BioEdit: A User-friendly Biological Sequence Alignment Editor and Analysis Program for Windows 95/98/NT. Nucl. Acids. Symp. Ser. 41:95–98.
- Hickman J. C. 1993. The Jepson Manual: Higher Plants of California. University of California Press. Berkeley, California.
- McNeal, J. R., K. Arumugunathan, J. V. Kuehl, J. L. Boore, and C. W. dePamphilis. 2007. Systematics and Plastid Genome Evolution of the Cryptically Photosynthetic Parasitic Plant Genus *Cuscuta* (Convolvulaceae). *BMC Biology*. 5:55.

- Pennisi, E.. 2006. Parasitic Weed Uses Chemical Cues to Find Host Plant. *Science Magazine* 313:1867.
- Stefanovic, S., D. F. Austin, and R. G. Olmstead. 2003. Classification of Convolvulaceae: A Phylogenetic Approach. *Systematic Botany*. 28(4): 791–806.
- Stephanovic, S., M. Kuzmina, M. Costea. 2007. Delimitation of Major Lineages Within *Cuscuta* Subgenus *Grammica* (Convolvulaceae) Using Plastid and Nuclear DNA Sequences. *American Journal of Botany*. 94(4): 568–589.
- White, T. J., T. Bruns, S. Lee, and J. Taylor. 1990. Amplification and Direct Sequencing of Fungal Ribosomal RNA Genes for Phylogenetics. IN PCR Protocols: A Guide to Methods and Applications. Academic Press, Inc. 315–322.
- Yuncker, T. G. 1932. The Genus *Cuscuta*. IN Memoirs of the Torrey Botanical Club. George Banta Publishing Company. Menasha, Wisconsin. 18(2): 113–331.

AGENCY OUTREACH: CAPITOL PARK TREE INVENTORY

In 2008, the CDFA Botany Laboratory worked with the California State Park Service to develop a complete tree inventory of Capitol Park.

Capitol Park is the historically significant arboretum surrounding the California Capitol in downtown Sacramento. It includes a huge variety of tree species, as well as an extensive collection of camellias. Some of the trees date back to the building of the capitol in the 1870s. Other trees represent unusual specimens that are rare in California (Figure 4) or unusual for their large size. Free public tours of the park are given daily by the State Park Service.

Unfortunately, like many such historic gardens, the records for Capitol Park are incomplete. Some of the plantings are well documented, but most others are not. In order to remedy this situation, a project to map and identify all the trees in the park was implemented. This would result in new interpretive materials for the public, as well as serving as an important historic record of Capitol Park. CDFA Senior Plant Taxonomist Dr. Dean Kelch has been helping the Capitol Park staff involved with the inventory to identify tree specimens and has served as an editor for resulting documents. A new brochure for the public is being produced.



Figure 4. Sweet michelia (*Michelia doltsopa*), one of the rare trees growing in Capitol Park and appearing in the Capitol Park Tree Inventory. Photo by Dean Kelch.

AGENCY OUTREACH: FIELD BOTANY WORKSHOP FOR CALTRANS BIOLOGISTS

In 2008, the CDFA Botany Laboratory worked with the California Department of Transportation (Caltrans) by teaching biologists to better identify weeds and rare plant species. Although the spring of 2008 was not noted by an abundant spring bloom, there were more than enough flowers for CDFA Senior Plant Taxonomist Dr. Dean Kelch to teach a four day field class in plant identification for 17 Caltrans biologists (Figure 5). The Caltrans biology team deals with many issues relating to rare and weedy plant species. Nevertheless, most Caltrans biologists are from a background with little or no training in plant identification. This workshop serves as an in-depth introduction to recognizing common plant families and genera in Northern California. It also includes intensive training in diagnosis of unknown plant samples using the Jepson Manual, the main technical plant identification guide for California. By basing all but the introductory session at field sites, retention of learned information is increased and conditions better match those experienced by the Caltrans crew.



Figure 5: "51 Plant Families in the Field" workshop participants examine a large blue-blossom (*Ceanothus thyrsiflorus*) on Mt. Tamalpais. Photo by Dean Kelch.

2008 ANNUAL REPORT OF THE ENTOMOLOGY LABORATORY

ENTOMOLOGY LABORATORY STAFF SYSTEMATISTS

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SARA WEST
DENNIS WHITLEY

EMERITUS SCIENTISTS

FRED ANDREWS
ERIC FISHER
RAYMOND GILL

ENTOMOLOGY LABORATORY OBJECTIVES

The primary objectives of the Insect Biosystematics Laboratory are to:

- Provide identification services to the Division's pest prevention programs, other government agencies, and the public in an accurate and timely fashion.

- Act as a reference repository (California State Collection of Arthropods) for specimens and any associated data available for arthropods and mollusks of the State and region.

- Conduct research in biosystematics.

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

Systematics of the Buprestoidea Leach, 1815 (Coleoptera): Progress during 2008

C. L. Bellamy, Plant Pest Diagnostics Center

As detailed in the 2007 PPDC annual report, my research on jewel beetles (Coleoptera: Buprestidae) continues in several of the main themes:

1. **The Madagascan Coraebini** (www.fond4beetles.com/Buprestidae/MadCor/intro.html)
Bellamy, C. L. 2008. A new monotypic genus of ant-mimicking Coraebini (Coleoptera: Buprestidae: Agrilinae) from Madagascar. *Zootaxa* 1817:65-68.
2. **The Buprestidae of Mexico** (www.fond4beetles.com/Buprestidae/Mexico/index.html)
Westcott, R. L., H. A. Hespeneheide, J. Romero N., A. Burgos Solorio, C. L. Bellamy & A. Equihua M. 2008. The Buprestidae (Coleoptera) of Morelos, Mexico, with description of six new species, and a partially annotated checklist. *Zootaxa* 1830:1-20.
3. **The World Catalogue of Buprestoidea**
(www.fond4beetles.com/Buprestidae/worldcatalogue.html)

The first four volumes were published by Pensoft Publishers starting in April, 2008:

Bellamy, C. L. 2008. *A World Catalogue and Bibliography of the Jewel Beetles* (Coleoptera: Buprestoidea). Volume 1: Introduction; Fossil Taxa; Schizopodidae; Buprestidae: Julodinae - Chrysochroinae: Poecilonotini. Pensoft Series Faunistica No. 76, 625 pp. Pensoft Publishers, Sofia–Moscow.

The first complete world catalogue of the jewel beetles, the eighth largest beetle family Buprestidae and its small North American sister-group Schizopodidae, since Jan Obenberger's six fascicle (1926-1937) contribution to the Horn & Schenkling *Coleopterorum Catalogus*. Published in five volumes (more than 3200 pages in total), this catalogue presents a full taxonomic history for all taxa, including fossils, along with distribution and type repository data. The catalogue follows the evolving modern classification which, for Buprestidae, employs 6 subfamilies, 47 tribes, 39 non-nominate subtribes, 513 genera and more than 14,700 valid species. In addition, the first large bibliography on the subject concludes the catalogue with more than 8000 citations.

In the present volume 1, a 29 page Introduction provides definition, structure and acknowledgment. The catalogue begins with a listing of fossil jewel beetles before commencing with the extant taxa. The small Schizopodidae come before the Buprestidae, which includes the subfamilies Julodinae, Polycestinae (including the first of the six large genera: *Acanoderes*), Galbellinae and the first part of Chrysochroinae.

Pensoft Series Faunistica No 76

9 783448 423164

Photographs by © Charles L. Bellamy

CHARLES L. BELLAMY

WORLD CATALOGUE AND BIBLIOGRAPHY OF THE JEWEL BEETLES (COLEOPTERA: BUPRESTOIDEA) CHARLES L. BELLAMY VOLUME 1

WORLD CATALOGUE AND BIBLIOGRAPHY OF THE JEWEL BEETLES (COLEOPTERA: BUPRESTOIDEA)

VOLUME 1

INTRODUCTION; FOSSIL TAXA;
SCHIZOPODIDAE;
BUPRESTIDAE;
JULODINAE – CHRYSOCHROINAE;
POECILONOTINI

PENSOFT

Bellamy, C.L. 2008. *A World Catalogue and Bibliography of the Jewel Beetles* (Coleoptera: Buprestoidea), Volume 2: Chrysochroinae: Sphenopterini through Buprestinae: Stigmoderini, Pensoft Series Faunistica No. 77, pp. 626-1260, Pensoft Publishers, Sofia–Moscow.

Bellamy, C.L. 2008. *A World Catalogue and Bibliography of the Jewel Beetles* (Coleoptera: Buprestoidea), Volume 3: Buprestinae: Pterobothrini through Agrilinae: Rhaeboscelina, Pensoft Series Faunistica No. 78, pp. 1261-1931, Pensoft Publishers, Sofia–Moscow.

Bellamy, C.L. 2008. *A World Catalogue and Bibliography of the Jewel Beetles* (Coleoptera: Buprestoidea), Volume 4: Agrilinae: Agrilina through Trachyini, Pensoft Series Faunistica No. 79, pp. 1932-2684, Pensoft Publishers, Sofia–Moscow.

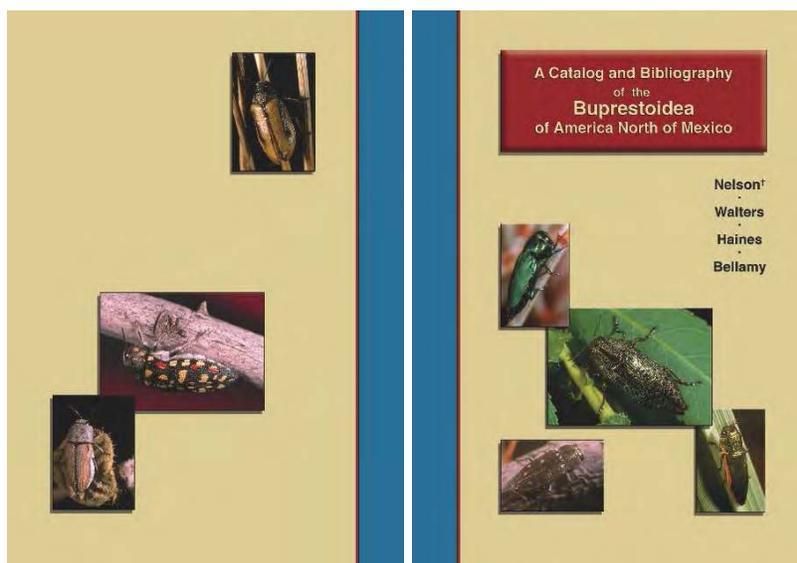
The International Commission of Zoological Nomenclature in 2008 published Opinion 2214 ruling on Case 3366 (Bellamy 2006):

ICZN. 2008. Opinion 2214 (Case 3366). 2008. *Cisseis* Gory & Laporte de Castelnau, 1839 and *Curis* Gory & Laporte de Castelnau, 1838 (Insecta, Coleoptera, Buprestidae) generic names not conserved. *Bulletin of Zoological Nomenclature* 65(4):325-326.

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

4. Catalog and Bibliography of Buprestoidea of America North of Mexico

Nelson, G. H., G. C. Walters, Jr., R. D. Haines & C. L. Bellamy. 2008. A catalog and bibliography of the Buprestoidea of America North of Mexico. *The Coleopterists Society, Special Publication No. 4*, pp. iv + 1-274.



5. Miscellaneous Publications

- Bellamy, C. L. 2008. The genus *Maoraxia* Obenberger in Fiji (Coleoptera: Buprestidae: Maoraxiini). In: N. L. Evenhuis & D. J. Bickle (Eds.): *Fiji Arthropods X, Bishop Museum Occasional Papers* 97:3-12.
- Bellamy, C. L. 2008. New Coraebini Bedel, 1921 from West Africa (Coleoptera: Buprestidae: Agrilinae). *The Coleopterists Bulletin* 61(4)(2007):560-566.
- Bellamy, C. L. 2008. Delayed, or prolonged, emergence of three uncommon California Buprestidae (Coleoptera). *The Pan-Pacific Entomologist* 83(4)(2007):366-368.
- Bellamy, C. L. 2008. A new replacement name in *Lampetis* Dejean, 1833 (Coleoptera: Buprestidae). *Zootaxa* 1733:68.
- Bellamy, C. L. 2008. A replacement genus-group name in Buprestidae (Coleoptera). *Zootaxa* 1791:68.
- Bellamy, C. L. 2008. New taxa, distribution and biological records of Afrotropical Coraebini Bedel, 1921 (Coleoptera: Buprestidae: Agrilinae). *Zootaxa* 1848:1-15.
- Bellamy, C. L. & T. Lander. 2008. The synonymy of *Cyalithoides fulgida* Fisher, 1922 with *Chrysodema robusta* Deyrolle, 1864 (Coleoptera: Buprestidae: Chrysochroinae). *Zootaxa* 1811:34-36.
- Bellamy, C. L. & T. Weir. 2008. The reinstatement of *Julodimorpha saundersii* Thomson 1879 (Coleoptera: Buprestidae) as a valid species. *Zootaxa* 1751:46-54.
- Ghahari, H., C. L. Bellamy, H. Sakenin & R. Patterson. 2008. A contribution to new records of Iranian Buprestidae (Coleoptera). *Munis Entomology & Zoology* 3(2):636-642.
- MacFadyen, D. N., B. K. Reilly, C. L. Bellamy & R. J. Eiselen. 2008. Morphological differences between three South Africa species of *Evides* Dejean, 1833 (Coleoptera: Buprestidae). *The Coleopterists Bulletin* 61(4)(2007):509-517.

6. New taxa (GENERA & species) proposed during 2008:

CAMERUNADORA Bellamy, 2008

Camerunadora bifasciata Bellamy, 2008 – Cameroun

DUNCANIUS Bellamy, 2008 (replacement name for *Neomorphus* Bellamy, 1992)

ETHIOPOEUS Bellamy, 2008

Holubia gabonica Bellamy, 2008 – Gabon

Lampetis dejongi Bellamy, 2008 (replacement name for *L. suspecta* (Thomson, 1879))

MADECORFORMICA Bellamy, 2008

Madecorformica silhouetta Bellamy, 2008 - Madagascar

Maoraxia kadavuensis Bellamy, 2008 – Fiji

Maoraxia tokotai Bellamy, 2008 – Fiji

Maoraxia viti Bellamy, 2008 – Fiji

Paranastella natalensis Bellamy, 2008 – South Africa

Pseudokerremansia zuluensis Bellamy, 2008 – South Africa

Strandietta austroafricana Bellamy, 2008 – South Africa

Taxonomy and Systematics of Coleoptera. Progress Report 2008

A.R. Cline, Plant Pest Diagnostics Center

Numerous research projects were undertaken throughout 2008. These projects spanned numerous taxonomic and biological disciplines; however, most were focused on the Cucujoidea families Nitidulidae and Kateretidae. Dissemination of results from these projects was equally diverse. Below is an outline of the major projects completed in 2008.

I. A trip to Europe (Paris, Prague, and Rome) led to two very important collaborations with Nitidulidae specialists Drs. Josef Jelínek (Czech Republic) and Paolo Audisio (Italy). Dr. Jelínek and I began 4 collaborative manuscripts describing numerous new nitidulid taxa that will better enable a more robust phylogenetic analysis of New World Cryptarchinae and global Nitidulinae. Publication of these works will likely occur in 2009 and 2010.

Dr. Audisio and I, along with several other scientists collaborated and published the following paper that describes a new genus from southern Africa and helps ameliorate some taxonomic confusion that has surrounded taxa within Meligethinae. Three more manuscripts derived from this collaboration are currently “in press” or “in prep.”

Audisio P., Kirk-Spriggs A.H., Cline A.R., Trizzino M., Antonini G., Mancini E. and DeBiase A. 2008. A new genus of pollen-beetle from South Africa (Coleoptera: Nitidulidae), with discussion of the generic classification of the subfamily Meligethinae. Insect Systematics and Evolution 39: 419-430.

II. Monographic revisions of select genera within the nitidulid subfamily Nitidulinae continue to be a major component of my research. The following manuscript was published in 2008 that completely revised the genus *Pocadius*, including both adult and larval forms, an identification key to all 46 species, and more than 300 figures illustrating various anatomical aspects of the inclusive species.

Cline, A.R. 2008. Revision of the Sap Beetle Genus Pocadius Erichson, 1843 (Coleoptera: Nitidulidae: Nitidulinae). Zootaxa 1799: 1-120.

III. Bizarre ecological aspects and peculiar life history strategies of beetles are always an interesting component of my research program. A multi-year project to understand the beetle fauna associated with pocket gopher burrows in Louisiana culminated in the following publication in 2008. Beetles in this rather restrictive and closed ecosystem possess not only interesting morphological adaptations, but also have unique and often disjunct distribution patterns.

Tishechkin, A.K. & A.R. Cline. 2008. The beetle (Coleoptera) fauna of pocket gopher burrows in Louisiana. Proceedings of the Entomological Society of Washington 110: 331-339.

IV. Faunistic surveys and biodiversity inventories will likely remain an important aspect of any taxonomist's professional life. The final manuscript of a multi-year project to understand and document the beetle fauna of the Maritime Provinces of Canada was published in 2008.

Majka, C.G., R. Webster & A.R. Cline. 2008. New Records of Nitidulidae and Kateretidae (Coleoptera) from New Brunswick, Canada. Zookeys 2:337-356.

V. Nitidulidae, and many other Cucujoidea, are important in agricultural ecosystems and may have profound effects on various commodities. A recent collaborative effort with Dr. James Ellis at the University of Florida has been initiated to better understand various biological aspects of the small hive beetle, *Aethina tumida* Murray. This beetle can be exceedingly deleterious to the normal functioning and health of honeybee hives, and can have a dramatic negative affect on hive numbers. As part of a multi-project effort to better understand these beetles and other nitidulids associated with the hive environment, I became a committee member on one of Dr. Ellis' Ph.D. students, Edward Atkinson, and also published the following paper in 2008.

Ellis, J.D., K.S. Delaplane, A.R. Cline, & J.V. McHugh. 2008. The association of multiple sap beetle species (Coleoptera: Nitidulidae) with western honeybee (Apis mellifera) colonies in North America. Journal of Apicultural Research 47(3)188-189.

VI. The need for improved diagnostic capabilities for various groups of beetles is in high demand. To help alleviate some of the identification problems that various local, state, and federal entities were having with wood-boring beetles, Dr. Charles Bellamy (CDFA-PPDB), Dr. Michael Ivie (Montana State University), Julia Scher (USDA-CPHST), and I began a multi-year project to produce online interactive LUCID tools for wood-boring beetles families, world genera of Bostrichidae, and world genera of Buprestidae. The first of these, e.g. the wood-boring beetle family tool, was completed in 2008 and is now available online.

Cline, A.R., M. A. Ivie, C. L. Bellamy, & J. Scher. 2008. Wood Boring Beetles of the World: Wood Boring Beetle Families, Lucid v. 3.4. USDA/APHIS/PPQ Center for Plant Health Science and Technology, California Department of Food and Agriculture, and Montana State University.
[<http://keys.lucidcentral.org/keys/v3/WBB/Home.htm>]

VII. New Taxa Described in 2008.

New Genera:

Sebastiangethes Audisio, Kirk-Spriggs & Cline

New Species:

Pocadius antennuliferus

Pocadius ashei

Pocadius barclayi

Pocadius bicolor

Pocadius carltoni

Pocadius centralis

Pocadius cochabambus

Pocadius coxus

Pocadius crypsis

Pocadius dominicus

Pocadius endroedyi

Pocadius falini

Pocadius fasciatus

Pocadius femoralis

Pocadius fusiformis

Pocadius globularis

Pocadius insularis

Pocadius kirejtshuki

Pocadius luisalfredo

Pocadius nigerrimus

Pocadius okinawaensis

Pocadius pecki

Pocadius peruensis

Pocadius tepicensis

Pocadius wappesi

Sebastiangethes anthystrixoides Audisio, Kirk-Spriggs & Cline

WOOD BORING BEETLES OF THE WORLD PART 1: WOOD BORING BEETLE FAMILIES A NEW LUCID INTERACTIVE IDENTIFICATION TOOL

BY ANDREW CLINE, MICHAEL IVIE,
CHARLES BELLAMY, AND JULIA SCHER

The Center for Plant Health Science and Technology (USDA/APHIS/PPQ/CPHST) announced the release of its newest identification tool: Wood Boring Beetles of the World Part 1: Wood Boring Beetle Families A new Lucid« interactive identification tool by Andrew Cline, Michael Ivie, Charles Bellamy, and Julia Scher.

Wood Boring Beetle Families was created through a federal-state collaboration among USDA/APHIS/PPQ CPHST, California Department of Food and Agriculture, and Montana State University. The interactive tool contains the resourceÆs top level key, which helps users identify to which family a wood boring beetle adult or larva belongs. Users will then be directed to tools to genera of the individual families. Family level tools for two of those families, the Buprestidae and Bostrichidae, are currently under development and are planned for release in 2009.

Drs. Bellamy and Cline are beetle experts in the PPDB Entomology Laboratory, and Julia Scher is a USDA scientist who has composed and collaborated with CDFA PPDB Laboratory scientists on several other Lucid Keys.

Wood Boring Beetles of the World Part I: Wood Boring Beetle Families

A new Lucid® interactive identification resource to the world's genera of wood boring beetles

Authors: Andrew R. Cline, Michael A. Ivie, Charles L. Bellamy, Julia Scher

CPHST is pleased to announce the release of its newest identification resource, *Wood Boring Beetles of the World Part I: Wood Boring Beetle Families*. This resource is being developed in response to the growing threat to our forests and timber and wood products industries from beetles that attack by burrowing in wood and are often transported in wooden pallets and shipping crates. *Wood Boring Beetle Families* was created through a federal-state collaboration among USDA/APHIS/PPQ – CPHST, California Department of Food and Agriculture (CDFA), and Montana State University (MSU). This tool contains the resource's top level key, which helps users identify to which family a wood boring beetle adult or larva belongs. Users will then be directed to tools to genera of the individual families. Family level tools for two of those families, the Buprestidae (jewel beetles) and Bostrichidae (powder-post beetles), are currently under development.

Wood Boring Beetles of the World Part I: Wood Boring Beetle Families was developed and released in Lucid version 3.4 software and uploaded to the Internet to support easy access by PPQ and its cooperators. *Wood Boring Beetle Families* can be accessed at:

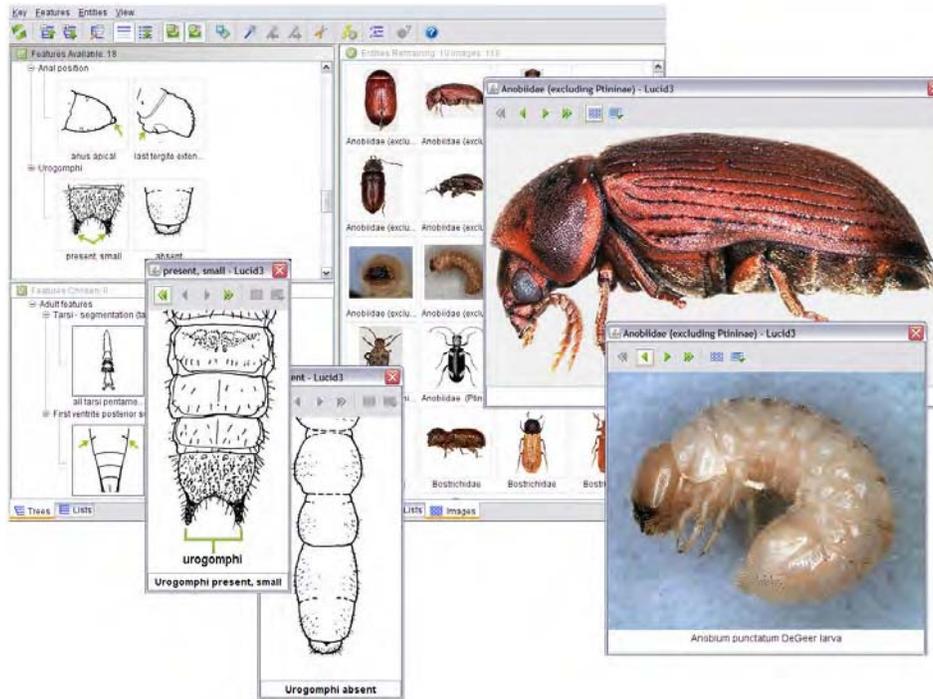
<http://www.lucidcentral.org/keys/v3/WBB>

Wood Boring Beetles of the World Part I: Wood Boring Beetle Families is cross-platform; it can be viewed and used on PCs or Macs. The interactive key component of this identification resource requires that your computer has Java Runtime Environment version 1.4.2 or greater installed; Lucid software is not necessary.

The screenshot shows the home page of the Lucid3 resource. On the left is a large image of a green jewel beetle. The title 'Wood Boring Beetles of the World' is prominently displayed at the top. Below the title, it states 'a Lucid identification resource to the world's genera of wood boring beetles' and lists the authors: Andrew R. Cline, Michael A. Ivie, Charles L. Bellamy, and Julia Scher. A navigation menu includes links for 'About this Resource', 'About Wood Boring Beetles', 'Identification Keys' (with sub-links for 'WOOD BORING BEETLE FAMILIES', 'BOSTRICHIDAE GENERA (in development)', and 'BUPRESTIDAE GENERA (in development)'), 'How to Use Keys', 'Key System Requirements', 'Browse Fact Sheets', 'Glossary', and 'References'. There are also links for 'Publication', 'Authors', 'Contact', 'Acknowledgements', 'Copyright', and 'Disclaimers'. At the bottom, logos for USDA, APHIS, CDFA, and MONTANA STATE UNIVERSITY are visible. A footer note states 'Identification keys are Lucid version 3.4 Java applets' and 'Site last modified: November 7, 2008'.

Home page of the Lucid3 resource *Wood Boring Beetles of the World*.

As globalization continues, the need to accurately and efficiently identify beetles derived from wood and wood products will rise. Wood used to support, brace, or package commodities during shipment provides a pathway for global transport of wood boring beetles. Storage of commodities packaged or shipped with low grade wood products near forested lands, the disposal of wood packaging in or near natural forest, and the transport of firewood further provide an avenue for introduction and establishment of non-indigenous beetle taxa.



Wood Boring Beetle Families key matrix and associated media: interactive matrix (background); illustrations for the two states of the larval feature “Urogomphi,” a photograph of an *Anobium punctatum* DeGeer larva and of a *Xyletinus* sp. adult (foreground).

Lucid keys are easy-to-use, electronic, and matrix-based. In a matrix-type key, users can select characters to examine, and are thus not hampered by the pathway structure of traditional paper-based dichotomous keys. Identification is facilitated by multimedia (images, Html pages) attached to taxa and characters. This tool is illustrated with easy to understand character drawings and finely detailed photographs and drawings of representative species. Taxon fact sheets include descriptions of both larvae and adults along with pest information.

The authors of *Wood Boring Beetles of the World Part 1: Wood Boring Beetle Families*, Drs. Andrew Cline and Charles Bellamy (CDFA), Dr. Michael Ivie (MSU) and Julia Scher (USDA/APHIS/PPQ - CPHST), would appreciate receiving any comments about the value and usefulness of this tool and learning of any problems you encounter when accessing or using the tool. Please contact Julia via email (julia.l.scher@aphis.usda.gov) or by phone (970-490-4465).

To learn more about Lucid software and other Lucid tools, visit www.lucidcentral.org. For information concerning identification tools and resources for plant protection and quarantine activities, contact Terrence Walters (terrence.w.walters@aphis.usda.gov).

SCALES, MEALYBUGS, WHITEFLIES AND THRIPS, 2008

Gillian W. Watson

PRESENTATIONS

Study of a whitefly sample sent from Indonesia (Java) was confirmed by Gillian as the first record of giant whitefly (*Aleurodicus dugesii*) in the Austro-Oriental Region. This finding was announced at a local meeting of the Entomological Society of Indonesia at Bogor, Western Java, Indonesia, on 20 March 2008, in a presentation: Hidayat, P. & WATSON, G.W. (2008) Recognition of giant whitefly, *Aleurodicus dugesii* Cockerell (Hemiptera: Aleyrodidae), a potential pest newly introduced to Indonesia. The presentation was made by Prof. P. Hidayat.



Giant whitefly, *Aleurodicus dugesii*: colony on a leaf underside. Photograph by P. Hidayat.

BIOSYSTEMATIC ACTIVITIES

During 2008, Gillian collaborated with Prof. Joseph Morse of University of California, Riverside, and his molecular research team in a survey and molecular characterization of armored scale insect species intercepted on avocado fruit from Mexico at Blythe Border Inspection Station between April and September 2007. The data collected enabled estimation of the approximate number of live scale species, adult females and live eggs and crawlers of each of eight species of armored scale identified during this survey. Only one of these species is known to be established in California. This information was submitted to the Journal of Economic Entomology as a Forum article early in 2009.

Gillian also collaborated with Dr Gregory Evans (USDA, Systematic Entomology Laboratory at Beltsville, MD) and Dr Douglass Miller (ex-USDA-ARS, retired) to describe and name a

species of armored scale insect intercepted on avocado fruit from Mexico as new to science. The description was in press at the end of 2008.



Abgralaspis aguacatae Evans, Watson & Miller, a new species of armored scale on the skin of imported avocado fruit from Mexico. Photograph by G. Arakelian.

On 5–6 February 2008, Kevin Hoffman and Gillian Watson met up with two representatives from each of California Avocado Commission and USDA-APHIS for an informal tour of avocado pack-houses (two in San Diego County and two in Ventura County) to review pack-house practices in handling Mexican avocado fruit, and the likely risk this might present for establishment of alien armored scale insect species in the nearby Californian avocado groves. Gillian made recommendations for minimizing the risk. A visit was also made to Prof. Joseph Morse's research team at UC Riverside to discuss their molecular analysis of armored scale insects collected from Mexican avocados at Blythe Inspection Station.



Re-packaging avocados at a Californian pack-house.

Numerous southern Asian countries are currently suffering significant crop damage caused by an accidentally introduced species of *Phenacoccus* from the New World. The species, which belongs to the *P. solenopsis* complex, apparently is present in California. Gillian and Dr Kris Godfrey (Integrated Pest Control) have been collaborating with Dr Zvi Mendel of the Volcani Institute in Israel to find a suitable parasitoid for use in biological control. A parasitoid collected in California has established a breeding population in culture in Israel but field trials have not yet commenced. Meanwhile Gillian and Dr Alessandra Rung have been collecting *Phenacoccus* samples from California and other countries for DNA analysis, to try and determine the number of *Phenacoccus* species involved.



Phenacoccus solenopsis on the root of a weed in California



Sweet peppers damaged by *P. solenopsis* in Israel. Photographs by Dr Z. Mendel.

Late in 2008, Gillian was sent mealybug samples from Indonesia and India for identification; both were papaya mealybug (*Paracoccus marginatus*), a serious pest of papaya and numerous other crops. Authoritative identification was necessary to enable U.S.A.I.D. to

provide these countries with biological control agents. These were the first Oriental region records of this neotropical species; publication of these records in the Journal of Agricultural and Urban Entomology is in press.



Paracoccus marginatus dasmaging papaya trees in Indonesia. Photographs by A. Rauf.

California Academy of Sciences opened a new building in September 2008 that contains an indoor rainforest exhibit. Prior to the opening, some of the rainforest plants had scale and mealybug problems. In an attempt to find appropriate biological controls, the museum sent some samples to PPDB for identification. Several Q-rated pests were identified: mites, psyllids, scales and mealybugs, and an A-rated red wax scale (*Ceroplastes rubens*). Interior pest exclusion was notified and CDFA biologists Vince Arellano, Katie Filippini, Stephanie Theodore and Wendi Wilkinson were sent to collect official samples. They found multiple pests including an A-rated mealybug (*Dysmicoccus grassii*), a Q-rated psyllid that was probably from South America, and Q-rated armored scale (*Hemiberlesia* sp.). The plants on hold and re-inspected after treatment. No signs of the infestation were found and the plants were released from quarantine.

TRAINING RECEIVED

The Western Plant Pest Diagnostic Network kindly funded Gillian's travel and subsistence so she could attend the "Pest and Native Thysanoptera of California and the Western USA: an Identification Workshop" at the University of California at Riverside, 8–11 September 2008. This excellent workshop was taught by Dr Laurence Mound from CSRO, Canberra, Australia and Dr Mark Hoddle of UC Riverside. It was attended by federal, state and university entomologists from Canada, Australia, California, Oregon, Utah, New Mexico, Florida, Hawaii and Mexico. In addition to hands-on training on the preparation and identification of thrips, it provided insights into their biology, behaviour and roles in the ecosystem. The workshop also provided an excellent opportunity to network with colleagues from other states and countries. We tested a new Lucid identification aid to the thrips of California, which has proved to be extremely useful since.

PUBLICATIONS

Nunes, E.S., Brown J.K., Moreira, A.G., WATSON, G., Lourenção, A.L., Piedade, S.M.S., Rezende, J.A.M., and M.L.C. Vieira (2008) First report and differential colonization of *Passiflora* species by the B Biotype of *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) in Brazil. *Neotropical Entomology* **37**(6): 744–746.

Dipterological research in 2008

M. Hauser, Plant Pest Diagnostics Center

In 2008 several projects in Diptera systematics and taxonomy were started, continued or finished. Here is a brief overview of the progress made in 2008.

I. Arthropod Fauna of the United Arab Emirates

A collecting trip in the spring of 2008 to the UAE was funded by Anthonius van Harten's Arthropod project. During the 2-week collecting trip, many new taxa were collected and photographed. The results of this collecting trip will be included in a second chapter on Stratiomyidae, a chapter on Therevidae, and a joint chapter with JH Stuke on Diopsidae. All chapters will be published in the third volume of the Arthropod Fauna of the United Arab Emirates. The Stratiomyidae chapter (cited below) in the first volume included the description of a new species, *Microchrysa arabica*.

Hauser, M. (2008): Order Diptera, family Stratiomyidae 1:591-601In: van Harten, A. (2008): Arthropod Fauna of the United Arab Emirates. Volume 1, 754pp.



II. Asian Stratiomyidae

For several years one of the focal regions for Stratiomyidae systematic research has been Asia. Material from various sources and projects has contributed to a much better understanding of the fauna, taxonomy, and biogeography of this understudied region. Material collected from different regions in Taiwan, South Korea and Japan lead to the discovery of several new species that will be published in 2009.



III. Australian *Eumerus* (Diptera: Syrphidae)

The genus *Eumerus* is one of the most species rich Syrphid genera in the Old World. The center of diversity is Africa, especially South Africa, as well as Central Asia and the Mediterranean. The Australian fauna is not particularly diverse, with only 14 described species, of which at least 4 are introduced. However, material on loan from several Australian and US collections yielded at least six undescribed species. The larvae of these flies live in rotten plant material and some species are considered pests in cut flower bulbs.



Eumerus peltatus

IV. *Stenogephyra* (Diptera: Therevidae)

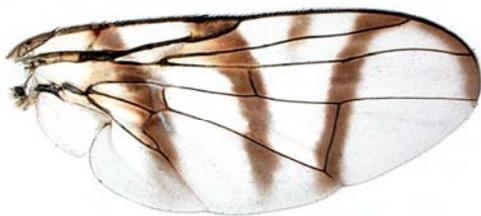
In cooperation with D. Webb (Urbana, IL), a revision of the South African genus *Stenogephyra* was initiated. These very small and enigmatic Therevidae were only recently described in the late 1980's with two inclusive species. Intensive collecting in South Africa has yielded four more undescribed species and immature life stages. The results of this revision will be published in 2009.



Stenogephyra sp.

V. California Fruit Fly digitalization project

An ongoing effort between Steve Gaimari and Martin Hauser, aims to provide habitus and wing pictures of all Fruit Fly species known from California. These pictures will be available on the web and will also be used in an interactive key to the Californian Fruit Flies.



Zonosemata vittigera



Rhagoletis basiola



Trupanea nigriconia

PPDB Entomologists: Editorial Responsibilities and Scientific Service

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

Chuck Bellamy

English Language Editor: *Folia Heyrovskyana* (2002 – present)

Subject Editor (Coleoptera: Buprestoidea): *Zootaxa* (2001 – 2004, 2007 – present)

Manuscript Referee: *The Coleopterists Bulletin*, *European Journal of Entomology*,
Folia Heyrovskyana, *Zootaxa*

Webmaster: Pacific Coast Entomological Society (<http://www.pcentsoc.org>)

Andrew Cline

Councilor: The Coleopterists Society (2006 – 2008)

Membership Secretary: *The Coleopterists Society* (2007 – 2010)

Chair, Program Committee: Pacific Coast Entomological Society (2007-present)

Subject Editor: Bostrichiformia, Lymexyloidea, Cucujoidea: *Zootaxa* (2007–present)

Nominating Committee: *The Pacific Coast Entomological Society* (2008)

Manuscript Referee: *Acta Entomologica Musei Nationalis Pragae*, *European Journal of Entomology*, *Insecta Mundi*, *Proceedings of the Entomological Society of Washington*,
ZooKeys, *Zootaxa*

Grant Reviewer: National Science Foundation

Marc Epstein

Chairman: Archives and Records Committee, *The Lepidopterists' Society* (2004 – present)

Lepidoptera Subject Editor: *Pan Pacific Entomologist* (2004 – present)

Steve Gaimari

Diptera Subject Editor: *Annals of the Entomological Society of America* (2001 – present)

Editor: *California Plant Pest and Disease Report* (2005 – present)

Editor: Fly Times, newsletter of the North American Dipterists Society (2007 – present)

Member: Diagnostics Committee, Lab Accreditation Subcommittee, Ad Hoc Entomology
Committee, *National Plant Diagnostics Network* (2006 – present)

Editorial Advisory Board: *African Invertebrates*

Organizing Committee: 7th International Congress of Dipterology, San Jose, Costa Rica
(August 2010)

Rosser Garrison

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

Odonata Subject Editor: *Zootaxa* (2006 – present)

Editor: *Odonatologica* (1997 – present)

Peter Kerr

Diptera: Sciaroidea Subject Editor: *Zootaxa* (2008 – present)

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

Martin Hauser

Diptera Subject Editor: *Pan Pacific Entomologist* (2007 – present)

Proceedings of the Entomological Society of Washington (2008 – present)

Studia Dipterologica (2006 – present)

ZooKeys (2007– present)

Reviewer in 2008 for *Annals of the Entomological Society of America*, *Cladistics*, and *Zootaxa*.

LIGHT BROWN APPLE MOTH LUCID KEY

In 2008, PPDB Entomologist Marc Epstein collaborated with Todd Giligan to compose a LUCID Key for the identification of the Light Brown Apple Moth (LBAM). A description and announcement of the key follows on page 43–44. Release of the Key is expected in April of 2009.

LBAM ID

Tools for diagnosing light brown apple moth and related western U.S. leafrollers
(Tortricidae: Archipini)

Authors: Todd M. Gilligan & Marc E. Epstein

CPHST is pleased to announce the release of its newest identification resource, *LBAM ID: Tools for diagnosing light brown apple moth and related western U.S. leafrollers (Tortricidae: Archipini)*.

The light brown apple moth (LBAM), *Epiphyas postvittana* (Walker), is a highly polyphagous species that is an important pest of apple and citrus in many parts of the world, primarily Australia and New Zealand. LBAM was first discovered in Berkeley, California in 2006 and subsequent surveys have trapped over 70,000 individuals from 16 counties.

LBAM ID is designed to aid in the identification of adult or larval Lepidoptera encountered during LBAM surveys in California. This resource includes interactive identification keys, images, diagrams, fact sheets, and a DNA sequence database. LBAM ID was created through a federal-state collaboration among USDA/APHIS/PPQ/CPHST, California Department of Food and Agriculture (CDFA), and Colorado State University (CSU).

LBAM ID was developed and released in Lucid version 3.4 software and uploaded to the Internet to support easy access by USDA, CDFA and other identifiers. LBAM ID can be accessed at:

<http://www.lucidcentral.org/keys/v3/LBAM>

LBAM ID is cross-platform and is compatible with all major operating systems, including Windows, Macintosh, and Unix. The interactive key component of this identification resource requires that your computer has Java Runtime Environment version 1.4.2 or greater installed; Lucid software is not necessary.

LBAM ID includes four separate interactive Lucid keys. Lepidoptera family keys allow users to identify adult and larval specimens to family. Tortricid adult and larval keys allow users to reliably eliminate LBAM as a possibility when examining non-target taxa or to positively confirm LBAM or the possibility of LBAM when examining target specimens. Features and states are depicted in each key with diagrammatic illustrations. The keys are linked to fact sheets that provide information about each species, including notes on recognition, biology, and taxonomy. Additional photos of adults, larvae, and male and female genitalia are included on each fact sheet.

LBAM ID
Tools for diagnosing light brown apple moth
and related western U.S. leafrollers
(Tortricidae: Archipini)

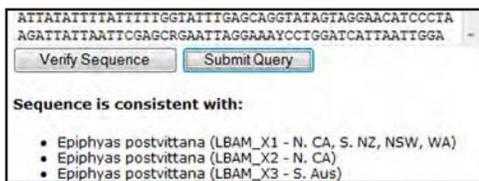
Todd M. Gilligan
Marc E. Epstein

USDA APHIS Colorado State University CDFA Lucid

Keys developed in Lucid 3.4. Last modified 24 March 2009.

The LBAM ID homepage provides links to keys, fact sheets, and other important resources.

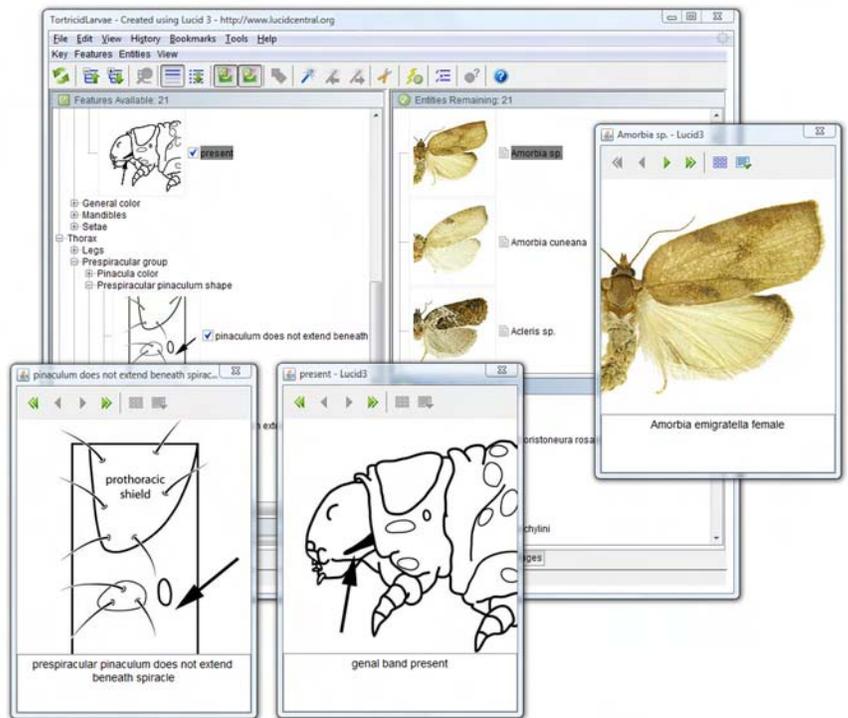
Some tortricid larvae cannot be positively identified to species using only morphological characters. LBAM ID includes a DNA sequence search tool that is designed to assist users in verifying the identity of LBAM adults or larvae. The tool searches for an exact match between an input sequence and the reference database, which contains all currently known LBAM haplotypes from around the world. The sequence search tool uses a 657bp sequence of the Folmer region of COI, commonly known as the DNA barcode region. A "Verify Sequence" button allows users to check for problems in the DNA sequence before submitting it to the database.



Fact sheets provide users with information on recognition, biology, and taxonomy of each species.

LBAM ID includes several other resources designed to aid users in identifying tortricid adults and larvae. Identification plates provide a quick visual reference for comparing wing patterns, genitalia, or representatives from different Lepidopteran families. A full glossary defines terms used in the fact sheets and keys. Information and links are provided for processing and screening specimens from sticky traps.

The authors of LBAM ID, Todd M. Gilligan (CSU) and Marc E. Epstein (CDFA) would appreciate receiving any comments about the value and usefulness of this tool and learning of any problems you encounter when accessing or using the tool. Please contact Todd via email (todd.gilligan@colostate.edu) with any comments or questions.



Interactive Lucid keys are fully illustrated with diagrammatic drawings of features and states.

To learn more about Lucid software and other Lucid tools, visit www.lucidcentral.org. For information concerning identification tools and resources for plant protection and quarantine activities, contact Terrence Walters (terrence.w.walters@aphis.usda.gov).

2008 ANNUAL REPORT OF THE NEMATOLOGY LABORATORY

John Chitambar, Ke Dong, Sergei Subbotin and René Luna

2008 NEMATOLOGY LABORATORY STAFF

JOHN CHITAMBAR
KE DONG
SERGEI SUBBOTIN
RENE LUNA
ROWENA DELEON
JENNIFER HAYNES

DONNA IMES
MYRA BALLESTEROS
LATASHA PHIEFER
CHRISTI SANCHEZ
DUANNA CHALLENGER
MATT BEYERS

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:

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

NEMATOLOGY LABORATORY STAFF

The Nematology Laboratory comprises three Senior Nematologists, one Senior Agricultural Biological Technician and a support staff of five Scientific Aides.

ROLE AND RESPONSIBILITIES

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

- Identification of plant parasitic nematodes in regulatory and survey samples. Diagnosis of nematode related agricultural problems.
- Professional consultations provided to state, federal, university, industry, commercial and private agency personnel.
- Training in nematode sampling, processing, and preliminary identifications provided to county and state personnel.
- Education of students and other groups in nematology topics (Figure 1)
- 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.

REGULATORY SAMPLE PROCESSING

During 2008 a total of 5,870 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 (35 seed bulb samples), strawberries (1,360 foliage and root samples), grape and stone fruits (504 root and soil samples) collected through the State's Registration and Certification, and Nematode Control programs.

DETECTIONS OF INTEREST AND SIGNIFICANCE:

Two Quarantine pests namely, white-tip of rice nematode (*Aphelenchoides besseyi*) and burrowing nematode (*Radopholus similis*) were detected.

The white tip of rice nematode was detected from Paddy Rice seed grown in Sutter County and sampled from shipments intended for export. The nematode species is of very limited distribution within California. The capability of the species to infest and reside dormant in paddy rice glumes and husk makes it a non-desired target pest of several countries that import paddy rice from California.

The burrowing nematode was detected in imported quarantine shipments to San Diego County. The species is not present in California and is a migratory endo-parasite. CDFA's external quarantine program has successfully prevented the long-term establishment of this devastating nematode pest within California agriculture.

Table 1. Total number of samples per program received by the CDFA Nematology Laboratory in 2008

Nematode Detection Program	No. of samples
Quarantine (total)	2,722
- Incoming External Quarantine	1,948
- Border Station Interceptions	121
- Export Phytosanitary Certification	653
Nursery (total)	1,899
- Registration and Certification (includes garlic & strawberry)	1,481
- Nematode Control (includes stone-fruit & nut trees)	418
Commercial	1,225
- Golden Nematode Trace-forward Survey	461
- CAPS California Nematode Survey	756
- Others	24
Dooryard/Residential	8
Total	5,870

STATUS OF SURVEY PROJECTS:

In addition to nematode regulatory detection, in 2008 CDFA's Nematology Laboratory was involved in two projects that were sponsored by the United States Department of Agriculture (USDA). 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.]

1. Statewide Nematode Survey. This survey, commonly known as the CAPS survey was funded by the National Cooperative Agricultural Pest Survey (CAPS) of USDA-APHIS. The survey was re-funded and continued in 2008 having commenced in spring 2005 and funded through 2006, although the work continued well into 2007. Target nematode species of interest included the same twenty-two species targeted in 2006 and listed below.

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

The main goals in 2008 were 1) fill the deficit of samples not collected in 2006-2007, due to a sudden stop in funding of the project, 2) collect samples from locations (exact or neighboring) where few of the target pests, namely, *Ditylenchus destructor*, *Xiphinema coxi* and *X. diversicaudatum* were historically detected according to CDFA-Nematology detection archive records, and 3) State-wide sampling of twenty-four major plant hosts for twenty-two target nematode species at minimal rate of 20 composite samples per host per county. Where possible, new sampling sites were selected in 2008 than in the previous years.

A total of 736 CAPS survey samples were processed and diagnosed in 2008. Of those 736 samples, 411 were deficit samples of the 2005-2006 surveys and 325 were from new sample sites. Forty-two nematode species belonging to 16 nematode genera were detected in the 2008 survey (Table 2). Nine hundred and eleven detections of plant parasitic nematodes were made of which *Macroposthonia* (= *Mesocriconema*) *xenoplax* and *Xiphinema americanum sensu lato* ranked the highest, followed collectively by over six *Paratylenchus* spp. Table 3 lists the plant parasitic nematodes

that were found associated with the selected host plants. Similar but fewer nematode species were found associated with weed hosts when compared with their respective field host plants. Table 4 lists the distribution of those plant parasitic nematode species within California counties.

Only two of the target nematode species, namely, *Meloidogyne hapla* and *M. javanica* already known to be present in California's agricultural production sites, have been detected thus far in the 2008 CAPS survey. The California dagger nematode, *Xiphinema index* was found in Fresno County. This species was not detected in Fresno County in the 2005-2006 CAPS surveys and is of regulatory concern (B-rated pest) to CDFA. All other plant parasitic nematode species are already known to be present and commonly detected to varying degrees in California.

Table 2. Nematode Species detected in the 2008 CAPS survey only.

Nematode Species	Number of Detections	CA Pest Rate
<i>Criconema</i> sp.	1	D
<i>Criconemella</i> sp.	5	D
<i>Helicotylenchus digonicus</i>	29	D
<i>Helicotylenchus dihystra</i>	27	D
<i>Helicotylenchus pseudorobustus</i>	9	D
<i>Helicotylenchus</i> sp.	3	D
<i>Hemicycliophora vidua</i>	1	D
<i>Heterodera cruciferae</i>	2	C
<i>Heterodera schachtii</i>	16	C
<i>Longidorus</i> sp.	5	D
<i>Macroposthonia (Mesocriconema) xenoplax</i>	147	D
<i>Meloidogyne arenaria</i>	1	C
<i>Meloidogyne hapla</i>	13	C
<i>Meloidogyne incognita</i>	10	C
<i>Meloidogyne javanica</i>	33	C
<i>Meloidogyne</i> sp.	3	Q
<i>Merlinius brevidens</i>	74	D
<i>Merlinius</i> sp.	3	D
<i>Paratrichodorus</i> sp.	16	D
<i>Paratylenchus bukowinensis</i>	15	D
<i>Paratylenchus dianthus</i>	3	D
<i>Paratylenchus hamatus</i>	116	D
<i>Paratylenchus holdemani</i>	1	D
<i>Paratylenchus neoamblycephalus</i>	6	D
<i>Paratylenchus similis</i>	1	D
<i>Paratylenchus</i> sp.	3	D
<i>Pratylenchus brachyurus</i>	12	C
<i>Pratylenchus neglectus</i>	41	D
<i>Pratylenchus penetrans</i>	10	C
<i>Pratylenchus scribneri</i>	2	D
<i>Pratylenchus thornei</i>	41	D
<i>Pratylenchus vulnus</i>	54	C
<i>Quinisulcius capitatus</i>	19	D
<i>Scutellonema clathricaudatum</i>	1	D
<i>Scutellonema conicephalum</i>	2	D
<i>Tylenchorhynchus clarus</i>	2	D
<i>Tylenchorhynchus elegans</i>	9	D

(Table 2, Continued)

<i>Tylenchorhynchus mashhoodi</i>	28	D
<i>Tylenchorhynchus</i> sp.	8	D
<i>Xiphinema americanum</i>	146	C
<i>Xiphinema index</i>	1	B
No Plant Parasitic Nematode Found	250	
Total Survey Sample Detections	1,161	

Table 3. Plant parasitic nematodes associated with agricultural crops, fruit trees and vegetables in California agricultural production acreage: CAPS 2008 survey.

Plant host common name	Genus	Species	Rating	Total sp /host /county
Alfalfa	NPPN ¹		N	46
	<i>Criconemella</i>	sp.	D	3
	<i>Helicotylenchus</i>	<i>digonicus</i>	D	11
	<i>Helicotylenchus</i>	<i>dihystera</i>	D	4
	<i>Helicotylenchus</i>	<i>pseudorobustus</i>	D	2
	<i>Helicotylenchus</i>	sp.	D	1
	<i>Hemicycliophora</i>	<i>vidua</i>	D	1
	<i>Macroposthonia/M²</i>	<i>xenoplax</i>	D	6
	<i>Meloidogyne</i>	<i>hapla</i>	C	10
	<i>Merlinius</i>	<i>brevidens</i>	D	28
	<i>Merlinius</i>	sp.	D	2
	<i>Paratrichodorus</i>	sp.	D	8
	<i>Paratylenchus</i>	<i>bukowinensis</i>	D	4
	<i>Paratylenchus</i>	<i>hamatus</i>	D	14
	<i>Paratylenchus</i>	<i>similis</i>	D	1
	<i>Pratylenchus</i>	<i>brachyurus</i>	C	4
	<i>Pratylenchus</i>	<i>neglectus</i>	D	5
	<i>Pratylenchus</i>	<i>thornei</i>	D	22
	<i>Tylenchorhynchus</i>	<i>clarus</i>	D	2
	<i>Tylenchorhynchus</i>	<i>mashhoodi</i>	D	21
	<i>Tylenchorhynchus</i>	sp.	D	2
	<i>Xiphinema</i>	<i>americanum</i>	C	25
		Total diagnostics:		
Alfalfa Weed	<i>Criconemella</i>	sp.	D	1
	<i>Macroposthonia</i>	<i>xenoplax</i>	D	1
	<i>Merlinius</i>	<i>brevidens</i>	D	1
	<i>Pratylenchus</i>	<i>neglectus</i>	D	2
	<i>Pratylenchus</i>	<i>thornei</i>	D	2
		Total diagnostics:		
Almond	NPPN		N	1
	<i>Helicotylenchus</i>	<i>digonicus</i>	D	1
	<i>Helicotylenchus</i>	sp.	D	1
	<i>Paratylenchus</i>	<i>hamatus</i>	D	19
	<i>Paratylenchus</i>	<i>neoamblycephalus</i>	D	5
	<i>Pratylenchus</i>	<i>neglectus</i>	D	1
	<i>Pratylenchus</i>	<i>thornei</i>	D	3
	<i>Pratylenchus</i>	<i>vulnus</i>	C	5
	<i>Xiphinema</i>	<i>americanum</i>	C	4
	Total diagnostics:			40
Almond field weed	NPPN		N	2
	<i>Paratylenchus</i>	<i>hamatus</i>	D	1
		Total diagnostics		

Apricot	NPPN		N	4
	<i>Macroposthonia/M</i>	<i>xenoplax</i>	D	1
	<i>Paratylenchus</i>	<i>hamatus</i>	D	3
	<i>Pratylenchus</i>	<i>penetrans</i>	C	2
	<i>Pratylenchus</i>	<i>thornei</i>	D	1
	<i>Xiphinema</i>	<i>americanum</i>	C	2
	Total diagnostics:			13
Bean	NPPN		N	3
	<i>Merlinius</i>	<i>brevidens</i>	D	1
	<i>Paratrichodorus</i>	sp.	D	1
	<i>Helicotylenchus</i>	<i>digonicus</i>	D	1
	<i>Helicotylenchus</i>	<i>dihystera</i>	D	9
	<i>Meloidogyne</i>	<i>incognita</i>	C	6
	<i>Meloidogyne</i>	<i>javanica</i>	C	30
	<i>Meloidogyne</i>	sp.	C	1
	<i>Merlinius</i>	<i>brevidens</i>	D	9
	<i>Merlinius</i>	sp.	D	1
	<i>Mesocriconema</i>	<i>xenoplax</i>	D	1
	<i>Pratylenchus</i>	<i>neglectus</i>	D	25
	<i>Pratylenchus</i>	<i>thornei</i>	D	3
	<i>Quinsulcius</i>	<i>capitatus</i>	D	19
	<i>Xiphinema</i>	<i>americanum</i>	C	4
	Total diagnostics:			114
Broccoli	NPPN		N	2
	<i>Heterodera</i>	<i>schachtii</i>	C	3
	<i>Merlinius</i>	<i>brevidens</i>	D	1
	Total diagnostics:			6
Cabbage	NPPN		N	11
	<i>Heterodera</i>	<i>schachtii</i>	C	9
	<i>Macroposthonia</i>	<i>xenoplax</i>	D	1
	Total diagnostics:			21
Carrot	NPPN		N	3
Cauliflower	<i>Heterodera</i>	<i>schachtii</i>	C	4
Cherry	NPPN		N	7
	<i>Criconemella</i>	sp.	D	1
	<i>Helicotylenchus</i>	<i>digonicus</i>	D	2
	<i>Helicotylenchus</i>	<i>dihystera</i>	D	1
	<i>Helicotylenchus</i>	<i>pseudorobustus</i>	D	1
	<i>Macroposthonia/M</i>	<i>xenoplax</i>	D	15
	<i>Merlinius</i>	<i>brevidens</i>	D	1
	<i>Paratrichodorus</i>	sp.	D	3
	<i>Paratylenchus</i>	<i>hamatus</i>	D	7
	<i>Paratylenchus</i>	<i>holdemani</i>	D	1
	<i>Paratylenchus</i>	<i>neoamblycephalus</i>	D	1
	<i>Pratylenchus</i>	<i>neglectus</i>	D	2
	<i>Pratylenchus</i>	<i>penetrans</i>	C	6
	<i>Pratylenchus</i>	<i>thornei</i>	D	3

	<i>Pratylenchus</i>	<i>vulnus</i>	C	16
	<i>Tylenchorhynchus</i>	<i>elegans</i>	D	1
	<i>Tylenchorhynchus</i>	<i>mashhoodi</i>	D	3
	<i>Tylenchorhynchus</i>	sp.	D	1
	<i>Xiphinema</i>	<i>americanum</i>	C	21
	Total diagnostics:			93
Cotton	NPPN		N	16
	<i>Macroposthonia</i>	<i>xenoplax</i>	D	1
	<i>Meloidogyne</i>	<i>incognita</i>	C	3
	<i>Meloidogyne</i>	<i>javanica</i>	C	1
	<i>Meloidogyne</i>	sp.	C	2
	<i>Merlinius</i>	<i>brevidens</i>	D	2
	<i>Paratrichodorus</i>	sp.	D	2
	<i>Paratylenchus</i>	<i>hamatus</i>	D	2
	<i>Pratylenchus</i>	<i>brachyurus</i>	C	1
Cucumber	NPPN		N	17
	<i>Merlinius</i>	<i>brevidens</i>	D	1
	Total diagnostics:			48
Nectarine	<i>Macroposthonia</i>	<i>xenoplax</i>	D	2
	<i>Meloidogyne</i>	<i>arenaria</i>	C	1
	Total diagnostics:			3
Oat	NPPN		N	34
	<i>Macroposthonia/M</i>	<i>xenoplax</i>	D	3
	<i>Merlinius</i>	<i>brevidens</i>	D	19
	<i>Pratylenchus</i>	<i>neglectus</i>	D	2
	<i>Pratylenchus</i>	<i>thornei</i>	D	1
	<i>Tylenchorhynchus</i>	<i>mashhoodi</i>	D	1
	Total diagnostics:			60
Onion	NPPN		N	1
Orange	<i>Xiphinema</i>	<i>americanum</i>	C	1
Peach	NPPN		N	23
	<i>Criconema</i>	sp.	D	1
	<i>Helicotylenchus</i>	<i>digonicus</i>	D	8
	<i>Helicotylenchus</i>	<i>dihystera</i>	D	11
	<i>Helicotylenchus</i>	sp.	D	1
	<i>Heterodera</i>	<i>cruciferae</i>	C	2
	<i>Macroposthonia/M</i>	<i>xenoplax</i>	D	36
	<i>Merlinius</i>	<i>brevidens</i>	D	2
	<i>Paratrichodorus</i>	sp.	D	2
	<i>Paratylenchus</i>	<i>bukowinensis</i>	D	11
	<i>Paratylenchus</i>	<i>dianthus</i>	D	3
	<i>Paratylenchus</i>	<i>hamatus</i>	D	41
	<i>Paratylenchus</i>	sp.	D	2
	<i>Paratylenchus</i>	<i>penetrans</i>	C	2
	<i>Paratylenchus</i>	<i>scribneri</i>	D	1
	<i>Paratylenchus</i>	<i>thornei</i>	D	1
	<i>Paratylenchus</i>	<i>vulnus</i>	C	13

	<i>Xiphinema</i>	<i>americanum</i>	C	29
	<i>Xiphinema</i>	<i>index</i>	B	1
	Total diagnostics:			190
Peach orchard weed	NPPN		N	2
Pecan	NPPN		N	6
	<i>Helicotylenchus</i>	<i>pseudorobustus</i>	D	3
	<i>Mesocriconema/M</i>	<i>xenoplax</i>	D	17
	<i>Tylenchorhynchus</i>	sp.	D	1
	<i>Xiphinema</i>	<i>americanum</i>	C	7
	Total diagnostics:			34
Plum	NPPN		N	12
	<i>Helicotylenchus</i>	<i>dihystera</i>	D	2
	<i>Macroposthonia/M</i>	<i>xenoplax</i>	D	13
	<i>Merlinius</i>	<i>brevidens</i>	D	1
	<i>Paratylenchus</i>	<i>hamatus</i>	D	13
	<i>Pratylenchus</i>	<i>scribneri</i>	D	1
	<i>Pratylenchus</i>	<i>vulnus</i>	C	1
	<i>Scutellonema</i>	<i>clathricaudatum</i>	D	1
	<i>Scutellonema</i>	<i>conicephalum</i>	D	2
	<i>Tylenchorhynchus</i>	sp.	D	1
	<i>Xiphinema</i>	<i>americanum</i>	C	10
	Total diagnostics:			57
Prune	NPPN		N	7
	<i>Hemicycliophora</i>	sp.	D	1
	<i>Macroposthonia/M</i>	<i>xenoplax</i>	D	5
	<i>Paratylenchus</i>	<i>hamatus</i>	D	12
	<i>Pratylenchus</i>	<i>neglectus</i>	D	1
	<i>Pratylenchus</i>	<i>vulnus</i>	C	1
	<i>Xiphinema</i>	<i>americanum</i>	C	10
	Total diagnostics:			37
Prune orchard weed	NPPN		N	1
Rose	NPPN		N	13
	<i>Xiphinema</i>	<i>americanum</i>	C	1
	Total diagnostics:			14
Tomato	NPPN		N	16
	<i>Meloidogyne</i>	<i>incognita</i>	C	1
	<i>Meloidogyne</i>	<i>javanica</i>	C	2
	<i>Merlinius</i>	<i>brevidens</i>	D	7
	<i>Pratylenchus</i>	<i>brachyurus</i>	C	7
	Total diagnostics:			33
Walnut	NPPN		N	11
	<i>Helicotylenchus</i>	<i>digonicus</i>	D	6
	<i>Helicotylenchus</i>	<i>pseudorobustus</i>	D	3
	<i>Longidorus</i>	sp.	D	5
	<i>Macroposthonia/M</i>	<i>xenoplax</i>	D	44
	<i>Meloidogyne</i>	<i>hapla</i>	C	3

	<i>Merlinius</i>	<i>brevidens</i>	D	1
	<i>Paratylenchus</i>	<i>hamatus</i>	D	1
	<i>Paratylenchus</i>	sp.	D	1
	<i>Pratylenchus</i>	<i>thornei</i>	D	5
	<i>Pratylenchus</i>	<i>vulnus</i>	C	18
	<i>Tylenchorhynchus</i>	<i>mashhoodi</i>	D	3
	<i>Tylenchorhynchus</i>	sp.	D	3
	<i>Xiphinema</i>	<i>americanum</i>	C	32
	Total diagnostics:			136
Walnut field weed	NPPN		N	2
Wheat	NPPN		N	7
	<i>Pratylenchus</i>	<i>neglectus</i>	D	2
	Total diagnostics:			9
Weed	<i>Pratylenchus</i>	<i>neglectus</i>	D	1

¹NPPN = No plant parasitic nematodes found

²*Macroposthonia/M* = *Macroposthonia*
(=*Mesocriconema*)

Table 4. Distribution of plant parasitic nematodes distributed in California counties: CAPS 2008 survey.

County	Genus	Species	Rating	Total sp /host /county
Butte	NPPN ¹		N	16
	<i>Criconemella</i>	sp.	D	4
	<i>Helicotylenchus</i>	<i>digonicus</i>	D	2
	<i>Helicotylenchus</i>	<i>pseudorobustus</i>	D	1
	<i>Helicotylenchus</i>	sp.	D	1
	<i>Hemicycliophora</i>	<i>vidua</i>	D	1
	<i>Heterodera</i>	<i>cruciferae</i>	C	2
	<i>Longidorus</i>	sp.	D	5
	<i>Macroposthonia/M²</i>	<i>xenoplax</i>	D	13
	<i>Meloidogyne</i>	<i>hapla</i>	C	4
	<i>Merlinius</i>	<i>brevidens</i>	D	6
	<i>Paratrichodorus</i>	sp.	D	2
	<i>Paratylenchus</i>	<i>bukowinensis</i>	D	15
	<i>Paratylenchus</i>	<i>dianthus</i>	D	3
	<i>Paratylenchus</i>	<i>hamatus</i>	D	7
	<i>Pratylenchus</i>	<i>neglectus</i>	D	5
	<i>Pratylenchus</i>	<i>penetrans</i>	C	1
	<i>Pratylenchus</i>	<i>thornei</i>	D	12
	<i>Pratylenchus</i>	<i>vulnus</i>	C	11
	<i>Tylenchorhynchus</i>	<i>mashhoodi</i>	D	11
	<i>Xiphinema</i>	<i>americanum</i>	C	14
		Total diagnostics:		136
	Fresno	NPPN		N
<i>Helicotylenchus</i>		<i>dihystera</i>	D	1
<i>Macroposthonia/M</i>		<i>xenoplax</i>	D	24
<i>Meloidogyne</i>		<i>hapla</i>	C	4
<i>Meloidogyne</i>		sp.	C	2
<i>Merlinius</i>		<i>brevidens</i>	D	9
<i>Paratrichodorus</i>		sp.	D	3
<i>Paratylenchus</i>		<i>hamatus</i>	D	43
<i>Pratylenchus</i>		<i>brachyurus</i>	C	3
<i>Pratylenchus</i>		<i>scribneri</i>	D	1
<i>Pratylenchus</i>		<i>vulnus</i>	C	5
<i>Xiphinema</i>		<i>americanum</i>	C	13
<i>Xiphinema</i>		<i>index</i>	B	1
		Total diagnostics:		127
Kern	NNPN		N	51
	<i>Helicotylenchus</i>	<i>dihystera</i>	D	1
	<i>Macroposthonia/M</i>	<i>xenoplax</i>	D	30
	<i>Meloidogyne</i>	<i>arenaria</i>	C	1
	<i>Meloidogyne</i>	<i>hapla</i>	C	3
	<i>Meloidogyne</i>	<i>incognita</i>	C	3
	<i>Meloidogyne</i>	<i>javanica</i>	C	1
	<i>Merlinius</i>	<i>brevidens</i>	D	2

	<i>Paratrichodorus</i>	sp.	D	2
	<i>Paratylenchus</i>	<i>hamatus</i>	D	11
	<i>Paratylenchus</i>	<i>holdemani</i>	D	1
	<i>Paratylenchus</i>	sp.	D	1
	<i>Pratylenchus</i>	<i>brachyurus</i>	C	2
	<i>Pratylenchus</i>	<i>penetrans</i>	C	3
	<i>Pratylenchus</i>	<i>thornei</i>	D	1
	<i>Pratylenchus</i>	<i>vulnus</i>	C	8
	<i>Tylenchorhynchus</i>	<i>mashhoodi</i>	D	4
	<i>Xiphinema</i>	<i>americanum</i>	C	30
	Total diagnostics:			155
Kings	NPPN		N	11
	<i>Macroposthonia/M</i>	<i>xenoplax</i>	D	5
	<i>Paratrichodorus</i>	sp.	D	1
	<i>Paratylenchus</i>	<i>hamatus</i>	D	8
	<i>Pratylenchus</i>	<i>vulnus</i>	C	3
	<i>Scutellonema</i>	<i>clathricaudatum</i>	D	1
	<i>Xiphinema</i>	<i>americanum</i>	C	4
	Total diagnostics:			33
Merced	NPPN		N	13
	<i>Merlinius</i>	<i>brevidens</i>	D	5
	Total diagnostics:			18
Placer	<i>Helicotylenchus</i>	<i>dihystera</i>	D	3
	<i>Macroposthonia</i>	<i>xenoplax</i>	D	2
	<i>Paratylenchus</i>	sp.	D	1
	<i>Xiphinema</i>	<i>americanum</i>	C	1
	Total diagnostics:			7
Riverside	NPPN		N	3
Sacramento	NPPN		N	12
	<i>Helicotylenchus</i>	<i>dihystera</i>	D	1
	<i>Helicotylenchus</i>	sp.	D	1
	<i>Merlinius</i>	<i>brevidens</i>	D	4
	<i>Xiphinema</i>	<i>americanum</i>	C	2
	Total diagnostics:			20
San Joaquin	NPPN		N	29
	<i>Helicotylenchus</i>	<i>pseudorobustus</i>	D	2
	<i>Merlinius</i>	<i>brevidens</i>	D	5
	<i>Paratrichodorus</i>	sp.	D	4
	<i>Paratylenchus</i>	<i>hamatus</i>	D	1
	<i>Tylenchorhynchus</i>	<i>clarus</i>	D	2
	<i>Tylenchorhynchus</i>	<i>mashhoodi</i>	D	2
	<i>Xiphinema</i>	<i>americanum</i>	C	1
	Total diagnostics:			46
San Luis Obispo	NPPN		N	4
	<i>Heterodera</i>	<i>schachtii</i>	C	14
	Total diagnostics:			18

Solano	NPPN		N	23
	<i>Helicotylenchus</i>	<i>digonicus</i>	D	10
	<i>Helicotylenchus</i>	<i>pseudorobustus</i>	D	2
	<i>Meloidogyne</i>	<i>hapla</i>	C	1
	<i>Meloidogyne</i>	<i>javanica</i>	C	1
	<i>Merlinius</i>	<i>brevidens</i>	D	5
	<i>Macroposthonia/M</i>	<i>xenoplax</i>	D	17
	<i>Pratylenchus</i>	<i>thornei</i>	D	7
	<i>Pratylenchus</i>	<i>vulnus</i>	C	4
	<i>Tylenchorhynchus</i>	<i>mashhoodi</i>	D	7
	<i>Tylenchorhynchus</i>	sp.	D	3
	<i>Xiphinema</i>	<i>americanum</i>	C	17
	Total diagnostics:			
Stanislaus	NPPN		N	16
	<i>Criconema</i>	sp.	D	1
	<i>Helicotylenchus</i>	<i>digonicus</i>	D	11
	<i>Helicotylenchus</i>	<i>dihystera</i>	D	17
	<i>Helicotylenchus</i>	<i>pseudorobustus</i>	D	1
	<i>Macroposthonia</i>	<i>xenoplax</i>	D	5
	<i>Meloidogyne</i>	<i>incognita</i>	C	7
	<i>Meloidogyne</i>	<i>javanica</i>	C	31
	<i>Meloidogyne</i>	sp.	C	1
	<i>Merlinius</i>	<i>brevidens</i>	D	18
	<i>Merlinius</i>	sp.	D	1
	<i>Paratrichodorus</i>	sp.	D	2
	<i>Paratylenchus</i>	<i>hamatus</i>	D	3
	<i>Paratylenchus</i>	<i>neoamblycephalus</i>	D	1
	<i>Paratylenchus</i>	sp.	D	1
	<i>Pratylenchus</i>	<i>brachyurus</i>	C	7
	<i>Pratylenchus</i>	<i>neglectus</i>	D	25
	<i>Pratylenchus</i>	<i>thornei</i>	D	6
	<i>Pratylenchus</i>	<i>vulnus</i>	C	4
	<i>Quinsulcius</i>	<i>capitatus</i>	D	19
	<i>Tylenchorhynchus</i>	<i>elegans</i>	D	1
<i>Tylenchorhynchus</i>	<i>mashhoodi</i>	D	1	
<i>Xiphinema</i>	<i>americanum</i>	C	17	
Total diagnostics:				196
Tulare	NPPN		N	17
	<i>Helicotylenchus</i>	<i>pseudorobustus</i>	D	3
	<i>Macroposthonia</i>	<i>xenoplax</i>	D	4
	<i>Merlinius</i>	<i>brevidens</i>	D	10
	<i>Mesocriconema</i>	<i>xenoplax</i>	D	15
	<i>Paratylenchus</i>	<i>hamatus</i>	D	3
	<i>Pratylenchus</i>	<i>neglectus</i>	D	4
	<i>Pratylenchus</i>	<i>penetrans</i>	C	6
	<i>Pratylenchus</i>	<i>vulnus</i>	C	1
	<i>Scutellonema</i>	<i>conicephalum</i>	D	2
	<i>Tylenchorhynchus</i>	<i>mashhoodi</i>	D	3
	<i>Tylenchorhynchus</i>	sp.	D	2
	<i>Xiphinema</i>	<i>americanum</i>	C	23
Total diagnostics:				93

Ventura	NPPN		N	10
	<i>Heterodera</i>	<i>schachtii</i>	C	2
	Total diagnostics:			12
Yuba	NPPN		N	24
	<i>Criconemella</i>	sp.	D	1
	<i>Helicotylenchus</i>	<i>digonicus</i>	D	6
	<i>Helicotylenchus</i>	<i>dihystera</i>	D	4
	<i>Helicotylenchus</i>	sp.	D	1
	<i>Hemicycliophora</i>	sp.	D	1
	<i>Macroposthonia</i>	<i>xenoplax</i>	D	21
	<i>Meloidogyne</i>	<i>hapla</i>	C	1
	<i>Merlinius</i>	<i>brevidens</i>	D	10
	<i>Merlinius</i>	sp.	D	2
	<i>Paratrichodorus</i>	sp.	D	1
	<i>Paratrichodorus</i>	sp.	D	1
	<i>Paratylenchus</i>	<i>hamatus</i>	D	29
	<i>Paratylenchus</i>	<i>neoamblycephalus</i>	D	5
	<i>Paratylenchus</i>	<i>similis</i>	D	1
	<i>Pratylenchus</i>	<i>hamatus</i>	D	8
	<i>Pratylenchus</i>	<i>neglectus</i>	D	7
	<i>Pratylenchus</i>	<i>scribneri</i>	D	1
	<i>Pratylenchus</i>	<i>thornei</i>	D	15
	<i>Pratylenchus</i>	<i>vulnus</i>	C	18
<i>Tylenchorhynchus</i>	sp.	D	3	
<i>Xiphinema</i>	<i>americanum</i>	C	24	
Total diagnostics:			184	

¹NPPN = No plant parasitic nematodes found

²*Macroposthonia/M* = *Macroposthonia* (= *Mesocriconema*)

2. Golden Nematode Trace-forward Survey. The 2007 detection of the Golden nematode in two potato fields in Alberta, Canada led to the development of USDA-APHIS sponsored “Golden Nematode Trace-forward Survey” of US states that received seed and/or production potatoes from Alberta, possibly traceable from 1998 and forward, or at least, three years back for seed and one year back for commercial production. The objective was to determine whether or not potato cyst nematodes had spread from Alberta, Canada to US soils. The survey was necessary in order to achieve early detection of possible GN introductions into California. This would allow CDFA and it’s cooperators to respond quickly and effectively, and eradicate the pest before it spreads to large areas of the state. Pest-free samples would validate the assumption that California is free of GN, and boost confidence of trading partners in California agriculture.

Details of California fields that were planted to Alberta seed potato, year and number of potato shipments from Alberta, field acreage, number of fields, receiving counties and growers in California, and disposition of shipments were worked out by USDA-Surveillance and Internal Trade Compliance (SITC) and communicated to CDFA. Twelve fields belonging to three California counties (Kern, San Joaquin, and Tulare), had received seed potato from the two infested farms in Alberta. CDFA commenced survey of targeted California potato fields in spring 2008. Entire fields were sampled in accordance to USDA protocol and thereby, resulted in a greater collection of soil per acre for seed potato fields (5lb/acre) than production fields (1lb/acre). A total of 462

potato soil samples were collected and diagnosed for the golden nematode, pale cyst nematode and any other cyst-forming nematode species associated with potato. No cyst nematodes of any kind were found in the survey.

Table 5: California Golden Nematode Trace-forward Summary, 2008

County	Number of Fields Sampled	Total Area in Acres	Number of Samples Processed	Results for Golden Nematode
Kern	9	1,183	333	Negative
San Joaquin*	2	12	121	Negative
Tulare	1	40	8	Negative
Total	12	1,235	462	

* Both fields in San Joaquin were in seed potato. All other fields were in production potato.

In addition to the Golden nematode trace-forward survey, the potato cyst nematode survey conducted in 2006-2007, resulted in a total of 2,016 California potato soil samples that were found free of any kind of cysts nematodes.

3. Regulatory Detection Samples. Regulatory samples comprised of quarantine (incoming and outgoing), nursery (fruit and nut tree nematode control, garlic and strawberry phytosanitary certification), commercial and residential samples. Approximately 3,000 samples were processed and diagnosed by October 2008. This total does not include the number of samples generated in the above two survey projects.

WORKSHOPS, CONFERENCES AND ANNUAL MEETINGS

State nematologists participated in several professional meetings in 2008. These included mainly: 1) 40th Annual California Nematology Workshop held in Davis, 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; 2) Annual meeting of the University of California Division of Agriculture and Natural Resources (DANR) Nematology Workgroup in Parlier, 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; 3) 2008 Joint Meeting of the International Society of Parasitologists and the Society of Nematologists in Brisbane, Australia. State nematologists also served as special task committee members at the annual meeting. Presentations were made by State nematologists at each event. In addition, State nematologists actively participated in several USDA-APHIS and CDFA teleconference meetings related to survey projects, and a USDA potato cyst nematode diagnostics workshop in Beltsville, Maryland.

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 1. Above left: Scientific Aide Duanna Challenger oversees a student observing live nematodes through a compound microscope at a PPDB “Scientists’ Day” booth at the State Capitol. Above right: Nematologist John Chitambar answers students’ questions about parasitology at “Scientists’ Day.” Lower photo: Nematologist Ke Dong instructs grammar school students in the Nematology Lab in one of his specialties—the root knot nematodes.

Research on Molecular Diagnostics and Phylogeny of Nematodes

Sergei A. Subbotin

Sergei Subbotin's research devotes to different aspects of molecular and traditional diagnostics and systematics of plant parasitic nematodes.

A. RESEARCH PAPERS PUBLISHED IN 2008.

Mundo-Ocampo M., Troccoli A., **Subbotin S.A.**, Del Cid J., Baldwin J.G. & Inserra R.N. **2008.** Synonymy of *Afenestrata* with *Heterodera* supported by phylogenetics with molecular and morphological characterisation of *H. koreana* comb. n. and *H. orientalis* comb. n. (Tylenchida: Heteroderidae). *Nematology* 10: 611-632.

Phylogenetic analysis of five gene fragments: ITS-rRNA, D2 and D3 of 28S rRNA, 18S rRNA, Hsp90 and actin, of *Heterodera* species and two representative *Afenestrata* species, *A. koreana* and *A. orientalis*, form a clade with *H. cynodontis*, *H. bifenestra* and an unidentified *Heterodera* sp. infecting grasses. Based on these results and the consideration that the key diagnostic characters of *Afenestrata* are convergent and do not define a clade, synonymisation of *Afenestrata* with *Heterodera* is proposed. The following new combinations are made: *H. africana* comb. n., *H. axonopi* comb. n., *H. koreana* comb. n., and *H. orientalis* comb. n. Furthermore, *H. (= Afenestrata) sacchari* is renamed as *H. saccharophila* nom. nov. to avoid homonymy. All these species, together with *H. bamboosi*, are regarded as members of a paraphyletic 'Afenestrata group' within *Heterodera*. Morphological and molecular characterisation of populations of *H. koreana* comb. n. from Florida and *H. orientalis* comb. n. from Florida and Guatemala verify the identification of these populations as valid representatives for molecular studies of the species. Light and SEM observations also provide new detail and a broader understanding of the morphological range of both species. The ITS-rRNA gene sequences of *H. orientalis* comb. n. populations from Florida and Guatemala were similar to those from the Russian type locality. Diagnostic PCR-RFLP of ITS-rRNA profiles with six enzymes for *H. orientalis* comb. n. and *H. koreana* comb. n. are given. A key for the morphological identification of species of the *Afenestrata* group is provided.

Vovlas N., **Subbotin S.A.**, Troccoli A., Liebanas G. & Castillo P. **2008.** Molecular phylogeny of the genus *Rotylenchus* (Nematoda, Tylenchida) and description of a new species. *Zoologica Scripta* 37, 521-537.

A description of a new species *Rotylenchus montanus* sp. n. of plant parasitic nematodes from the family Hoplolaimidae is given and a recognition of *Rotylenchus jaeni* comb. n., previously known as subspecies *R. magnus jaeni*, as separate species is proposed. Molecular characterization of *R. montanus* sp. n. and other *Rotylenchus* species are provided using D2–D3 expansion segments of 28S and the ITS1 of rRNA genes. The D2–D3 of 28S rRNA and the ITS1–rRNA sequences of *R. montanus* sp. n. differed in one nucleotide and in 16–20 nucleotides from those of an unidentified *Rotylenchus* species from Russia, respectively. Molecular analysis of populations of *R. magnus* and *R. jaeni* comb. n. demonstrated differences in the D2–D3 and the ITS1–rRNA sequences. These genetic differences together with some minor morphological characters support that both subspecies should be considered as two cryptic sibling species and warranted their elevation to species rank. The result of phylogenetic analysis of Hoplolaimidae for 45 sequences of the D2 and D3 expansion regions of 28S rRNA gene using Bayesian inference analysis under the complex model is presented.

Palomares-Rius J., **Subbotin S.A.**, Landa B.B., Vovlas N. & Castillo P. **2008**. Description and molecular characterisation of *Paralongidorus litoralis* sp. n. and *P. paramaximus* Heyns, 1965 (Nematoda: Longidoridae) from Spain. *Nematology* 10: 87-101.

Paralongidorus litoralis sp. n., a new bisexual species of the genus, is described and illustrated by light microscopy, scanning electron microscopy and molecular studies from specimens collected in a coastal sand dune soil around roots of lentisc (*Pistacia lentiscus* L.) from Zahara de los Atunes (Cadiz), southern Spain. *Paralongidorus litoralis* sp. n. is characterised by the large body size, a rounded lip region, clearly offset from the body by a collar-like constriction, and bearing a very large stirrup-shaped, amphidial fovea, with conspicuous slit-like aperture, a very long and flexible odontostyle. The 18S rRNA and D2 and D3 expansion regions of 28S rRNA gene sequences were obtained for *P. litoralis* sp. n. and *P. paramaximus*. In phylogenetic trees generated from the 18S data set *Paralongidorus* clustered as an external clade from *Longidorus*, and in trees generated from D2-D3 of 28S dataset *Paralongidorus* was monophyletic and nested within *Longidorus*. Maximum likelihood test supported the hypothesis of validity of the *Paralongidorus* genus.

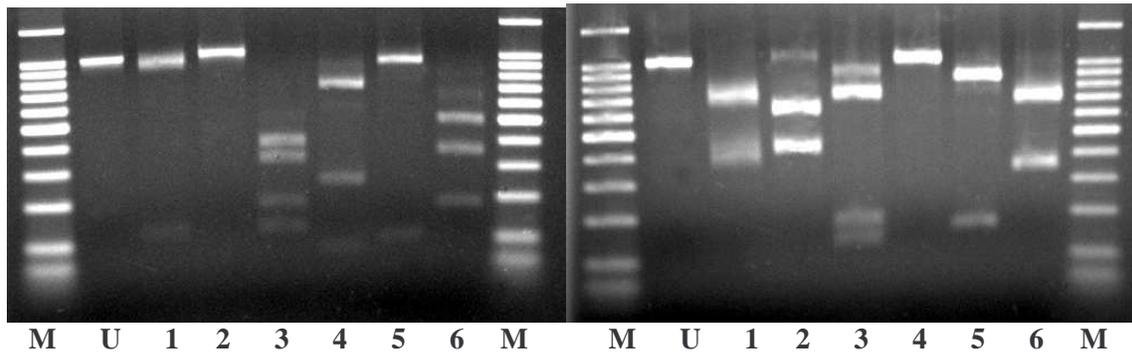
Subbotin S.A., Ragsdale E.J., Mullens T., Roberts P.A., Mundo-Ocampo M. & Baldwin J.G. **2008**. A phylogenetic framework for root lesion nematodes of the genus *Pratylenchus* (Nematoda): evidence from 18S and D2-D3 expansion segments of 28S ribosomal RNA genes and morphological characters. *Molecular Phylogenetics and Evolution* 48: 491-505.

The root lesion nematodes of the genus *Pratylenchus* Filipjev, 1936 are migratory endoparasites of plant roots, considered among the most widespread and important nematode parasites in a variety of crops. We obtained gene sequences from the D2 and D3 expansion segments of 28S rRNA partial and 18S rRNA from 31 populations belonging to 11 valid and two unidentified species of root lesion nematodes and five outgroup taxa. These datasets were analyzed using maximum parsimony and Bayesian inference under the standard models and the complex model, considering helices under the doublet model and loops and bulges under the general time reversible model. The phylogenetic informativeness of morphological characters is tested by reconstruction of their histories on rRNA based trees using parallel parsimony and Bayesian approaches. Phylogenetic and sequence analyses of the 28S D2–D3 dataset with 145 accessions for 28 species and 18S dataset with 68 accessions for 15 species confirmed among large numbers of geographical diverse isolates that most classical morphospecies are monophyletic. Phylogenetic analyses revealed at least six distinct major clades of examined *Pratylenchus* species and these clades are generally congruent with those defined by characters derived from lip patterns, numbers of lip annules, and spermatheca shape.

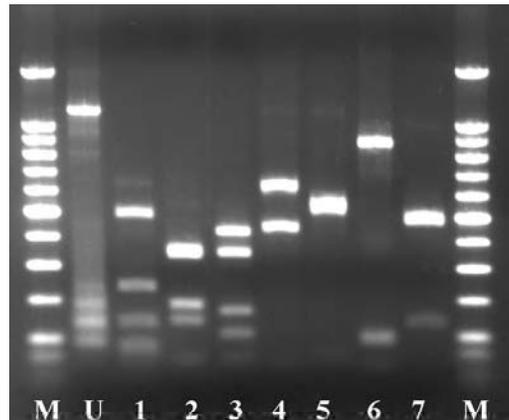
Ma H., Overstreet R.M. & **Subbotin S.A.** **2008**. ITS2 secondary structure and phylogeny of cyst-forming nematodes of the genus *Heterodera* (Tylenchida: Heteroderidae). *Organisms, Diversity & Evolution* 8: 182-193.

The internal transcribed spacer 2 (ITS2) of the ribosomal RNA gene is a double-edged tool for eukaryote evolutionary comparison. In this paper, we re-evaluate the putative ITS2 secondary structures proposed for 29 species of cyst-forming nematodes in the genus *Heterodera* and resent optimized variants. Using the MARNAs program taking into consideration both the primary sequence and the secondary structure, we generated an optimal alignment for *Heterodera* sequences. The alignment was analyzed by Bayesian inference under a general-time-reversible model and the complex models, and by a maximum parsimony approach using original data and sequence data converted according to secondary-structure information. Application of the secondary ITS2

structure data allows a more resolved and realistic picture of relationships within Heteroderidae.



PCR-ITS-RFLP diagnostic profiles for two species of cyst nematodes. A: *Heterodera koreana*; B: *Heterodera orientalis*. Lines: M – 100bp DNA ladder (Promega); U – unrestricted PCR product, 1 - AluI, 2 – EcoRI; 3 – MspI; 4 – MvaI; 5 – NdeI; 6 – PstI (After Mundo-Ocampo *et al.*, 2008).



PCR-ITS-RFLP diagnostic profile for *Heterodera sinensis*. Lines: M: 100bp DNA ladder (Promega); U: unrestricted PCR product; 1: AluI; 2: Bsh1236I; 3: CfoI; 4: DdeI; 5: HinfI; 6: MspI; 7: RsaI. (After Zheng *et al.*, 2008).

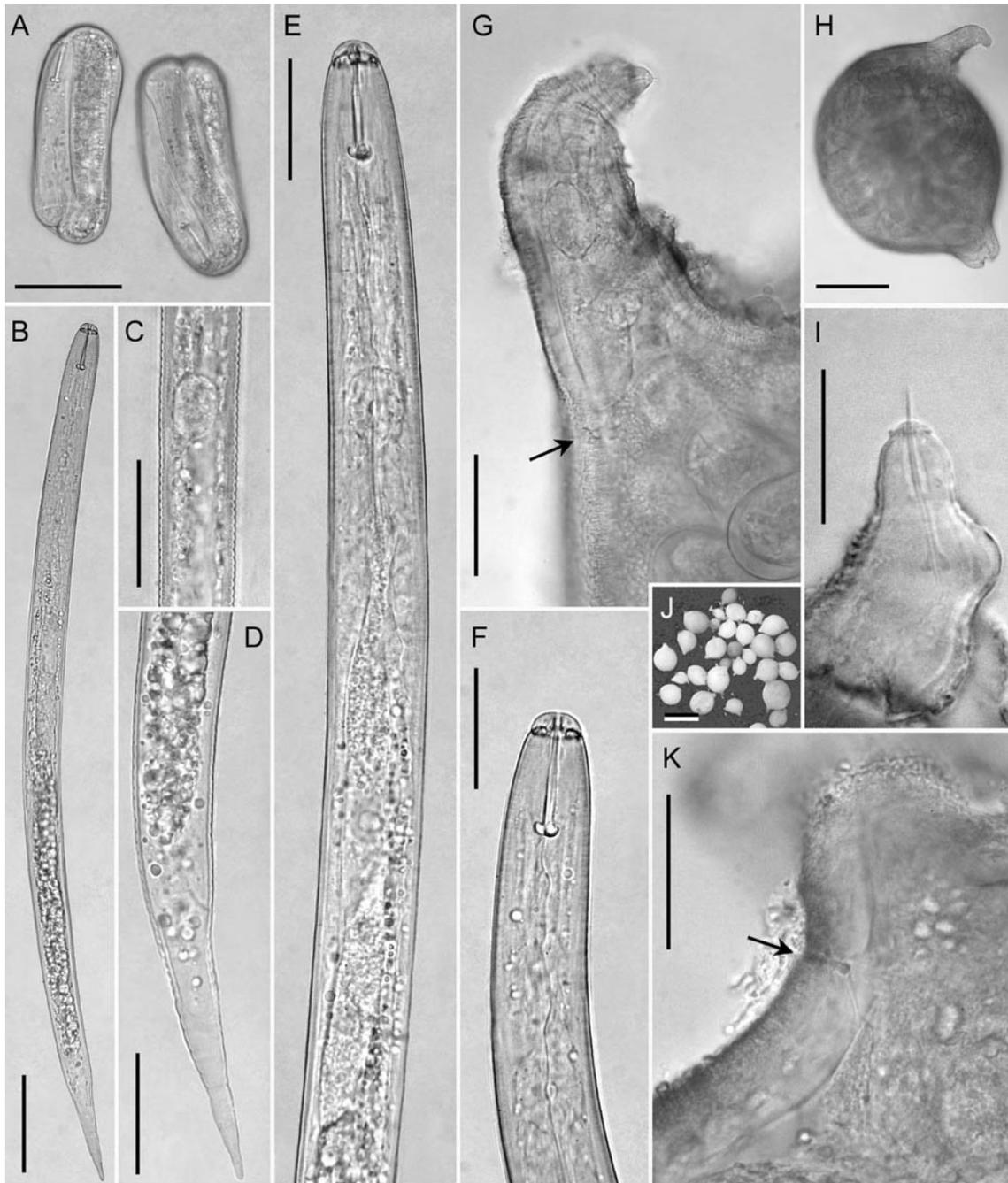
Zheng, J. Li, X., Zhang, Y. & **Subbotin, S.A. 2008.** Molecular characterization of cyst forming nematode *Heterodera sinensis* Chen & Zheng, 1994 from China. *Russian Journal of Nematology* 16: 159-162.

Heterodera sinensis parasitizing *Imperata cylindrical* L. was the first species of the genus *Heterodera*, which has been described in China as a new species. PCR-ITS-RFLP diagnostic profile and ITS sequence are presented for this species. Phylogenetic and morphological analyses revealed that *H. sinensis* belongs to the *Sacchari* group.

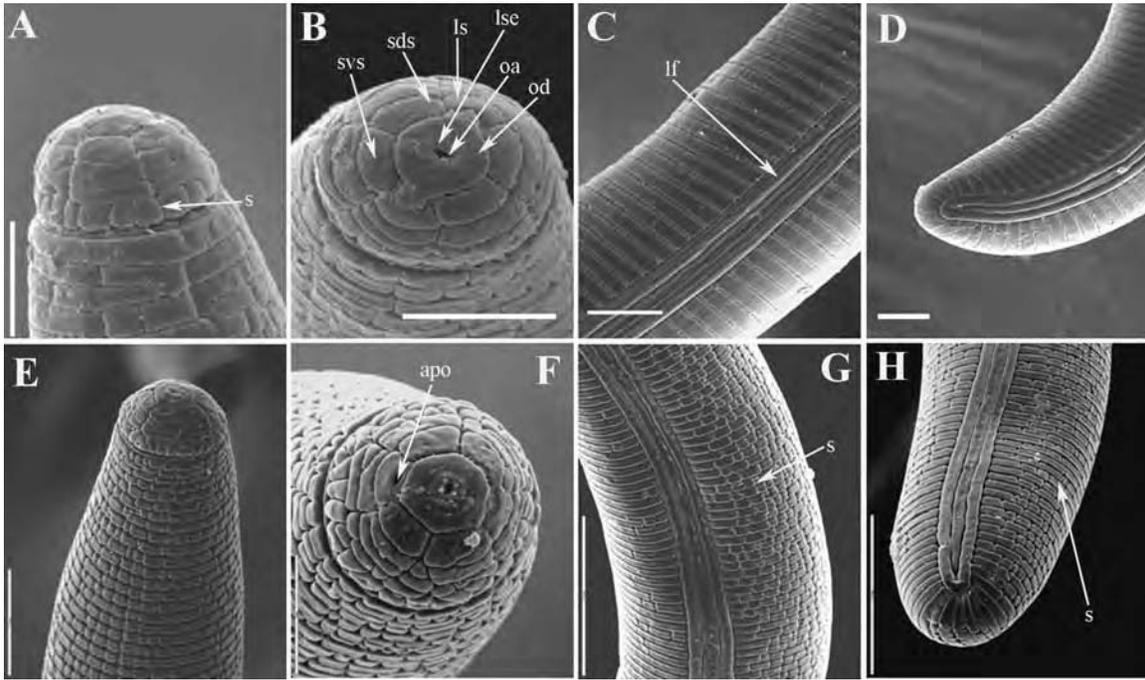
B. ARTICLES SUBMITTED IN 2008 AND NOW IN PRESS.

Van den Berg E., **Subbotin S.A.**, Handoo Z.A. & Tiedt L.R. 2009. Morphological characterization of *Hirschmanniella kwazuna* sp. n. from South Africa with notes on a new record of *H. spinicaudata* (Schuurmans Stekhoven, 1944) Luc & Goodey, 1964 (Nematoda: Pratylenchidae) and molecular phylogeny of the genus *Hirschmanniella* Luc & Goodey, 1964. *Nematology* (in press).

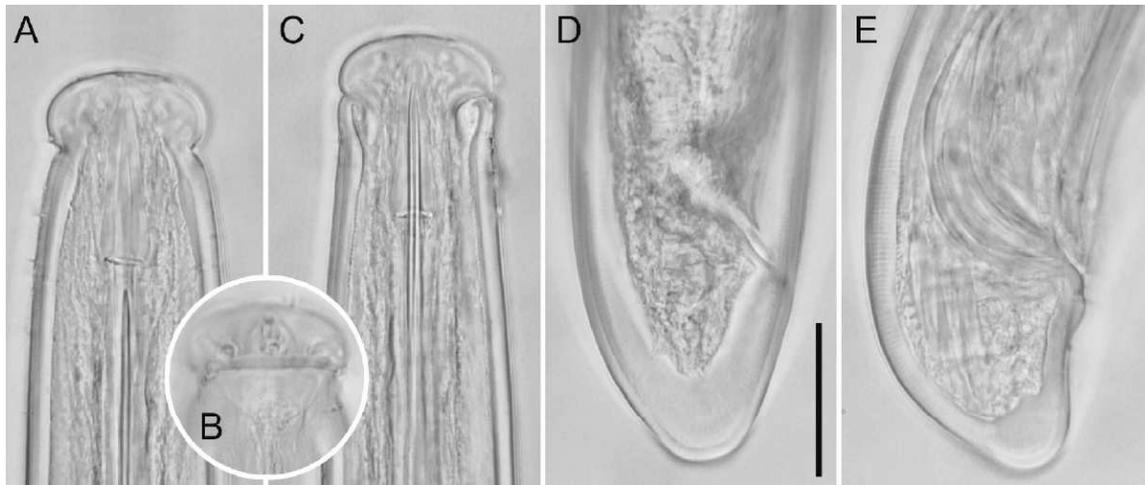
Palomareus-Rius J.E., **Subbotin S.A.**, Liebanas G., Landa B.B. & Castillo P. 2009. *Eutylenchus excretorius* Ebsary & Eveleigh, 1981 (Nematoda: Tylydorinae) from Spain with approaches to molecular phylogeny of related genera. *Nematology* (in press).



Light micrographs of *Heterodera orientalis*. A: Eggs enclosing developing juveniles. B-F: Second-stage juveniles. B: Right lateral view of entire body; C: Mid-region including genital primordium; D: Right lateral view of tail; E: Left lateral view of pharyngeal region; F: Right lateral view of anterior end showing stylet. G-K: Female and cysts. G: Anterior end including excretory pore (arrow); H: Entire body; I: Anterior end including stylet; J: Entire cysts and females; K: Excretory pore (arrow) opening into dilated chamber connected with excretory duct (After Mundo-Ocampo *et al.*, 2008).



Scanning electron microscope photographs of *Rotylenchus goodeyi* Loof & Oostenbrink 1958 (A-D) and *R. laurentinus* Scognamiglio & Talamé 1973 (E-H). A, Lip region showing longitudinal striations (s) on basal annulus; B, *En face* view showing oral aperture; D, Tail region; E, Pharyngeal region showing longitudinal striation; F, *En face* view showing oral disc, sectors and amphidial opening (apo); G, Longitudinal striations at mid-body. H, Tail region showing longitudinal striation (After Vovlas *et al.*, 2008).



Light micrographs of *Paralongidorus paramaximus* Heyns, 1965. A: Female anterior region, lateral view. B: Female anterior region, lateral view showing amphid. C: Female anterior region, ventral view showing amphidial pouches. D: Female tail region. E: Male tail (After Palomares-Rius *et al.*, 2008).

2008 ANNUAL REPORT OF THE SEED SCIENCE LABORATORY

2008 SEED LABORATORY STAFF

SEED BOTANISTS

Riad Baalbaki
Jim Effenberger
Don Joley
Deborah Meyer, Supervisor

TECHNICAL STAFF

Evelyn Ramos
Connie Weiner

SCIENTIFIC AIDES

Jeanette Deleon
Rowena Deleon

SEED LABORATORY RESPONSIBILITIES

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

BACKGROUND

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

The Seed Laboratory consists of two sections (Seed Taxonomy and Seed Physiology) and the majority of the samples received require processing through both sections of the laboratory for comprehensive analysis. In the Seed Taxonomy Laboratory, scientists identify seed, fruit and other plant propagules; examine quarantine and border station samples for noxious weed pest

propagules; evaluate the quality of seed lots for labeling purposes; examine seed lots in the marketplace for purity label integrity; and inspect feed mill samples for weed seed contaminants. The Seed Physiology Laboratory scientists perform germination and viability evaluations of seed lots for labeling purposes; examine commercial seed lots for germination label integrity; determine viability of weed seed contaminants for feed mill certification; and perform biochemical and seed vigor assessment procedures to detect structural damage of the seed that may result in seedling abnormalities, indicating the potential for crop failure in the field.

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

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

SAMPLE WORKLOAD

The Seed Laboratory sample workload is segregated into six general categories: (1) quarantine noxious weed seed examination in support of both interior and exterior quarantine inspection programs; (2) identification of unknown seeds and fruits submitted from a variety of sources, including federal, state, county, university, and private entities; (3) phytosanitary inspection to meet export requirements for phytosanitary certification; (4) inspection for viable weed seeds in livestock feed for feed mill certification; (5) fee-based service sample seed quality assessment testing; and (6) regulatory label compliance testing, also for seed quality assessment. The proportion of the 2008 sample workload devoted to each category is shown in Figure 1.

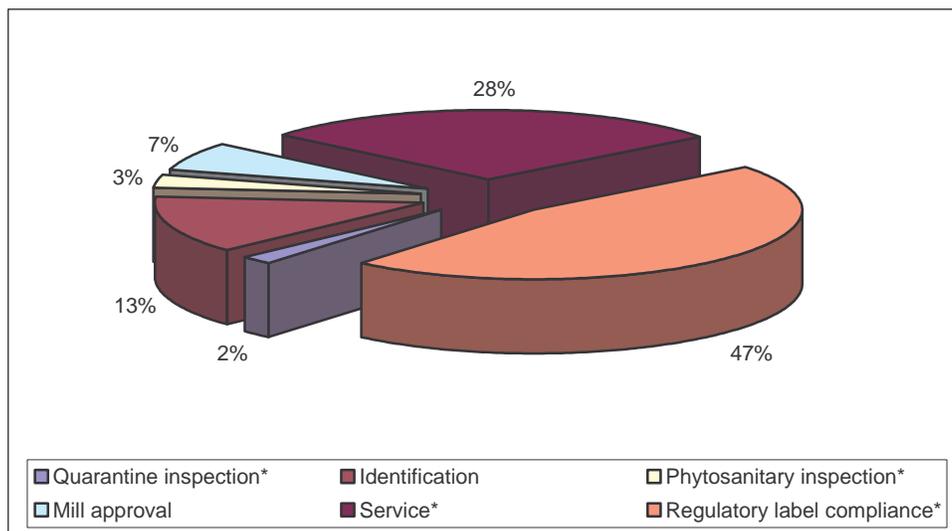


Figure 1. Seed Lab sample workload for 2008. * Note: Quarantine, phytosanitary and noxious weed seed examinations require identification of 25,000 seeds per sample. Purity analyses require identification of 2,500 seeds per sample. Total numbers of seed identifications are in excess of 18,600,000. Germination tests require the evaluation of 400 seedlings per sample; the total number of seedlings evaluated is in excess of 440,000.

WHAT DOES “SEED QUALITY ASSESSMENT TESTING” MEAN?

The purpose of seed quality assessment is to determine the value of the seed for planting. The 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 the examination of the seed sample to verify the identification of the kind of seed and examination for contaminants such as inert matter and plant propagules of other species, including species designated as noxious weeds. Such tests require microscopic examination of thousands of seeds within each sample. High quality seed lots contain few contaminants; low quality seed lots contain a higher percentage of contaminants. The assessment also evaluates the ability of the seed to produce well-developed seedlings. Hundreds of seedlings from each sample are individually evaluated to determine if the structures essential to produce a normal plant under favorable conditions are present. The tests used to assess seed quality are based on standardized protocols used by all seed laboratories worldwide. Examples of some seed quality problems encountered in laboratory testing are shown in Figures 2 through 6.

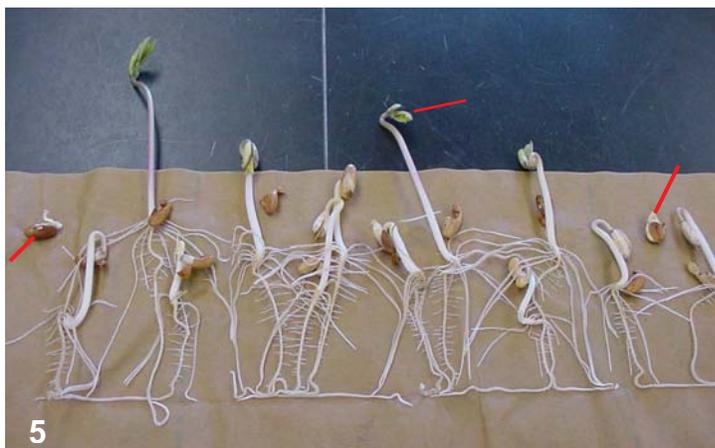


Figure 2. Oat sample contaminated with the noxious weed jointed goatgrass. **Figure 3.** Bean sample with insect damaged seed. This sample had a high percentage of pure seed, but because of the insect damage the germination percentage was low. **Figure 4.** Pasture mix containing several seed kinds requiring segregation of the kinds into separate categories during the purity analysis, as well as identification of contaminants, and separate germination tests for each kind of seed in the mix. **Figure 5.** Bean seedlings in a germination test demonstrating some types of abnormalities encountered including broken seed unable to produce a seedling (left), abnormally shaped primary leaves (center), and broken cotyledons (right). **Figure 6.** Annual ryegrass germination test containing abnormal seedlings without sufficient root development (left) and without shoot structures (right).

SEED WORKSHOPS AND TRAINING

Seeds are the propagules and reservoirs of plant germplasm that farmers rely upon. Scientists involved in seed lot quality assessment must possess an array of skills and knowledge in the areas of purity and germination testing, seed vigor and genetic purity testing. Laboratory analyses serve as the basis for seed trade and thus the exchange of millions of dollars in seed sales globally. Standardization of laboratory test procedures is key to the success of the seed industry. With the goal of promoting standardization among seed testing laboratories, providing training via workshops and supervision of individualized training programs in the field of seed technology is one of the missions of the CDFA Seed Laboratory.

In May 2008 the Seed Laboratory hosted a seed workshop. Topics for the workshop included: embryo and fruit development in the grass family (Poaceae) and how this affects seed quality assessment, presented by Deborah Meyer; morphological identification of various species of wheatgrass and wildrye (*Elymus* s.l.), presented by Jim Effenberger; seed vigor testing – why to test seeds for vigor, how to test seed vigor, how to interpret test results, and limitations of vigor testing, presented by Riad Baalbaki; and proposed changes to the standardized procedures for seed testing published by the Association of Official Seed Analysts (presented by D. Meyer).



Figure 7. The value of wheatgrass seed for planting is demonstrated by examining the development of the caryopsis (grain). Florets containing immature caryopses have no planting value (left); florets containing partially developed caryopses produce weak seedlings of low planting value (center); and florets containing fully mature caryopses will usually produce well developed seedlings of good planting value (right).

In conjunction with the Association of Official Seed Analysts and Society of Commercial Seed Technologists annual meeting held in St. Paul, Minnesota, June 2008, Dr. Baalbaki served as co-organizer and instructor at the Statistics Workshop. Topics for this workshop included: applications of experimental design, data analysis, and tolerances for seed testing.

The Seed Laboratory provided individualized training for the new seed technologist hired in 2008 by the California Crop Improvement Association. The individual had previously held the Registered Seed Technologist (RST) certification (granted by the Society of Commercial Seed Technologists, SCST), but they had not worked in the field of seed technology for several years. In order to restore the individual's RST certification status the SCST required the individual to complete additional training. With the approval of the SCST Executive Director, the CDFA Seed Laboratory designed and implemented a training program for the individual. Once the training was successfully completed RST certification status was restored.

SEED IDENTIFICATION

The Seed Laboratory receives seed specimens for identification from a variety of sources including county agricultural inspectors, border inspection stations, private seed testing laboratories, seed companies, government seed labs 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, is found in or on agricultural commodities, farm equipment, heavy equipment, recreational vehicles, or self movers, is found stuck to the side of a house or a landscape plant, is found in the stomach of a dead animal, is retrieved from the site of an ancient civilization, or is found in the excrement of an animal, we will attempt to identify it because the information is important to the person that submitted the specimen. This year one of the unusual items identified was seed of a Joshua Tree (*Yucca revifolia*) found in the excrement of a rattlesnake that had eaten a kangaroo rat that had eaten the seeds. The specimen was submitted by a person conducting research on the feeding habits of rattlesnakes in the western Mohave Desert. The seeds were in remarkably good shape after passing through the digestive tract of the snake (Figure 8). One common weed seed we often receive for identification is creeping woodsorrel (*Oxalis corniculata*) (Figure 9). This species produces tiny reddish-brown seeds that are forcibly expelled from the fruit at maturity. If the seeds land on a damp surface such as a landscape plant or the side of a house the moistened seeds will stick. These seeds are often mistaken for insects by homeowners and inspectors.



Figure 8. Seeds of Joshua Tree (*Yucca brevifolia*) found in the excrement of a rattlesnake. (Photo by Mike Cardwell)



Figure 9. Seeds of creeping woodsorrel, *Oxalis corniculata*. Scale = 1 mm

SEED IDENTIFICATION TOOLS

This year Deborah Meyer and Jim Effenberger developed a pictorial guide to the identification of noxious weed seeds entitled *California Noxious Weed Pest Propagules Identification Manual*. Noxious and invasive weeds infest over 20 million acres in California and result in control costs and lost agricultural productivity worth hundreds of millions of dollars (Schoenig 2005). Recognition of noxious weed propagules is critical in preventing the spread of plant species harmful to agriculture or the environment via seed used for agricultural and land reclamation plantings or seed based livestock feed. Plant propagules include such things as seed, fruit,

florets, spikelets, tubers, rhizomes, or any plant part capable of producing another plant. The manual is available for viewing or download on the CDFA website. For further information on noxious weed species in California and the California pest rating system please refer to the California Department of Food and Agriculture (CDFA) Encycloweedia website (Schoenig 2004). Also available at this website are the CDFA Botany Laboratory Weed Rating List (click on Noxious Weed Pest Rating.pdf) and the California Noxious and Invasive Weed Action Plan (Schoenig 2005) giving an overview of noxious and invasive weed impacts and management in California (click on IPC Home, then California Noxious Weed Action Plan).

As part of the seed identification workshop training provided by the Seed Laboratory, the scientific staff produces seed identification manuals as visual guides for the workshop participants. This year, Jim Effenberger and Deborah Meyer developed an identification manual for the florets of several types of wheatgrass and wildrye (*Elymus* spp.) common in seed trade (Figure 10). Identification of this group of species is problematic when the whole plant is available and the situation becomes more difficult when only the seeds (florets) are available to work with. By the time the seed sample comes into the laboratory for testing, often the distinguishing characteristics (e.g., hairs, awn, portion of the lemma and palea) are removed during the conditioning process (preparation of the seed lot for marketing). This makes the identification of individual seeds very difficult. The manual points out the key features necessary for separating these species morphologically.

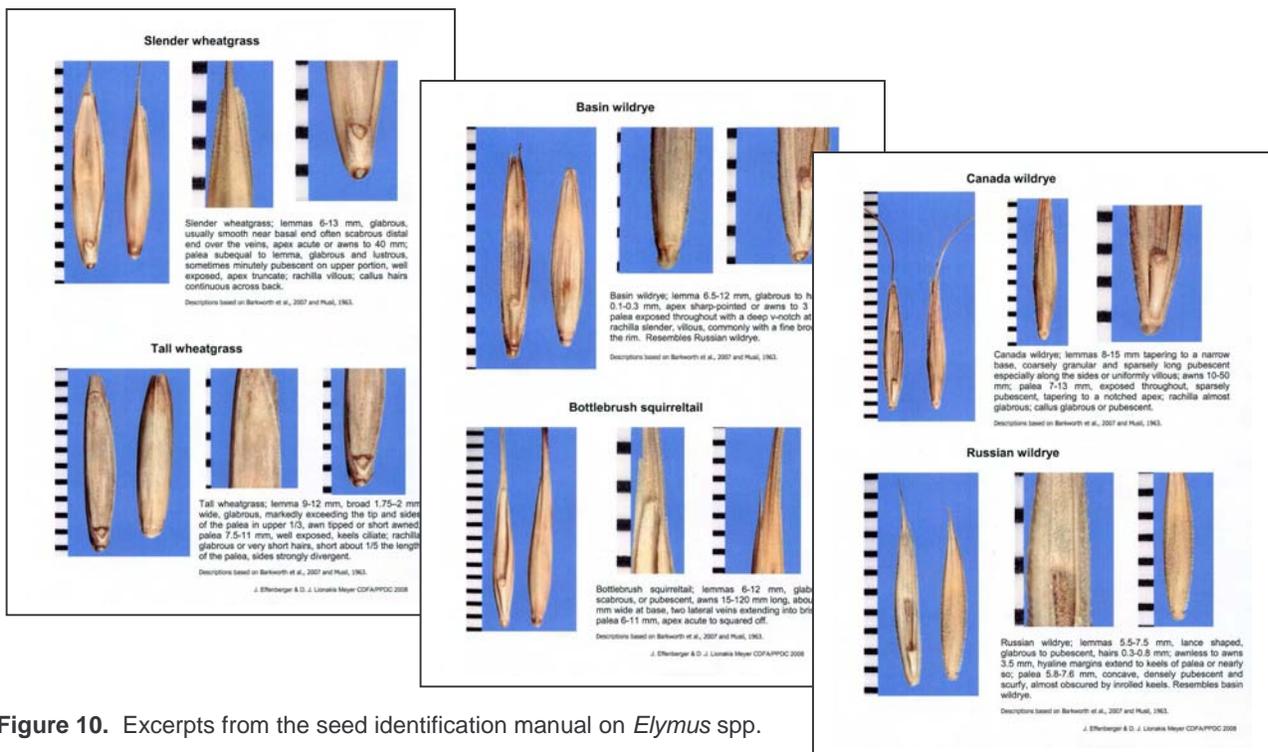
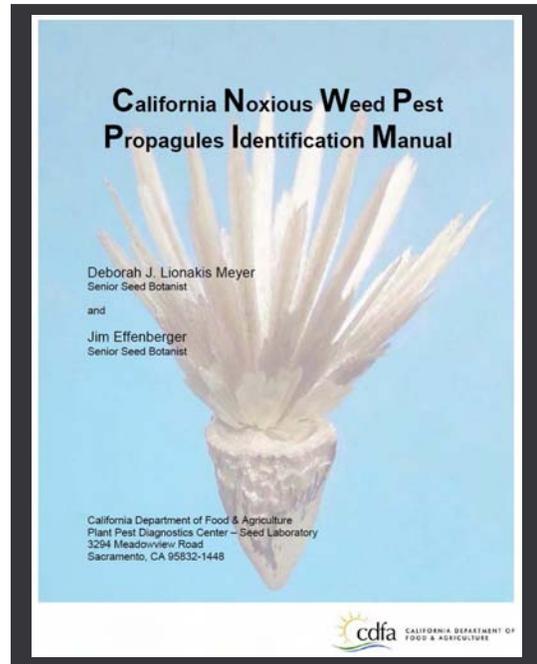


Figure 10. Excerpts from the seed identification manual on *Elymus* spp.

PUBLICATION DEVELOPMENT

A Revised Seed Vigor Testing Handbook

Seed vigor testing is an important diagnostic tool that compliments other seed quality assessments. Seed vigor test results provide important seed quality information beyond standard germination that relate directly to field performance. A recent survey of seed testing laboratories in the US (Baalbaki and Fiedler, 2008) showed that around 68 % of surveyed AOSA (Association of Official Seed Analysts) laboratories conduct vigor tests on regular basis, with a total of more than 85,000 samples tested annually. However, for vigor tests to become part of the official rules of seed testing, procedures have to be standardized among laboratories, and extraneous sources of variation must be identified and strictly controlled. The main objective of the updated version of the AOSA Seed Vigor Testing Handbook (Baalbaki et al., 2009), first published in 1983, is to achieve such a level of standardization.

The newly revised handbook provides updated and expanded descriptions of test methods, method standardization, inclusion of more illustrations and pictures, additions of used but undocumented tests, and a description of tests that cover a wide range of species. The first part of the handbook focuses on the history and importance of seed vigor testing. The second part is a consideration of general procedures involved in vigor testing, tolerances, presentation and interpretation of results, a discussion of issues associated with test standardization, as well as a general review of vigor testing and its application. The third part covers the principles of each vigor test as well as background and technical information concerning each. The last part

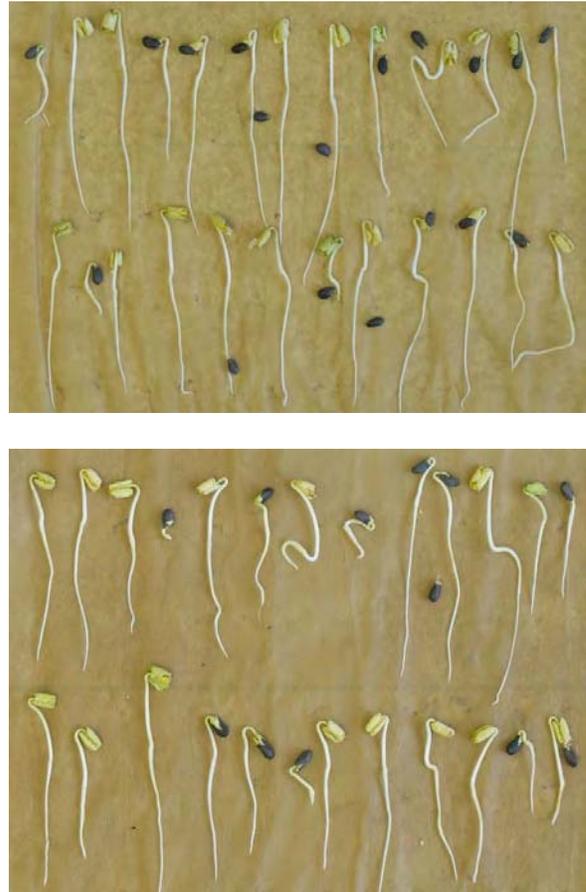


Figure 11. Cool germination test on cotton showing high (top) and low (bottom) vigor seed lots.



Figure 12. Assigning corn seeds to different vigor classes based on the tetrazolium vigor test. *Class 1* (left) is a viable and vigorous seed with a bright pink, superficial and uniform tetrazolium stain, without lesions or areas of intense coloring; *Class 2* (center) is a viable but non-vigorous seed, with a dark stained embryo indicating greater permeability of the tissues because of deterioration, and damage to the radicle area; *Class 3* (right) is a non-viable seed with the embryo stained, but with critical damage and pale areas on the plumule and radicle. Photograph by J. B. França-Neto

is a detailed description of procedures for conducting each vigor test (Figures 11 and 12). Seed vigor tests were grouped into five broad categories: aging tests, cold tests, conductivity tests, seedling performance tests and tetrazolium tests; each category includes many individual tests.

This handbook will serve as an important reference resource for seed analysts involved in seed quality control around the world. It should significantly contribute to improving vigor tests and how to conduct them under rigorous laboratory guidelines, as well as stimulating research activities to improve existing tests while simultaneously encouraging the development of new vigor tests.

References

Baalbaki, R., S. Elias, J. M. Filho, and M. B. McDonald. 2009. Seed Vigor Testing Handbook. Contribution No. 32 to the Handbook on Seed Testing, Association of Official Seed Analysts. *In press*.

Baalbaki, R., and K. Fiedler. 2008. Results of 2007 vigor testing survey of AOSA member labs. The Seed Technologist Newsletter 82 (1): 59–61.

Schoenig, S. (ed.). 2004. Encycloweedia. California department of Food and Agriculture. www.cdffa.ca.gov/phpps/ipc/encycloweedia

Schoenig, S. (ed.). 2005. California noxious and invasive weed action plan. California Department of Food and Agriculture and California Invasive Weed Awareness Coalition.

COOPERATIVE STUDIES

The Seed Laboratory participated in referee ring testing for validation of an alternative method for purity testing of tall fescue (*Festuca arundinaceae*). Tall fescue is a grass species commonly used for lawns. The current testing method is a labor-intensive visual inspection, while the proposed new method utilizing a calibrated seed blower is more efficient and less subjective. The proposed method has been successfully used on other grass species for several decades. An AOSA Rules change proposal co-authored by Deborah Meyer and Drs. Adriel Garay and Sabry Elias, Oregon State University, was submitted the Association of Official Seed Analysts and Society of Commercial Seed Technologists for consideration and possible adoption as an official method. Voting on the proposal will take place in June 2009.

SEED LABORATORY STAFF SERVICE TO PROFESSIONAL ORGANIZATIONS

Jim Effenberger

- Chairperson – Ethics Committee, Society of Commercial Seed Technologists (SCST) (2003 – present)
- Member – Purity Testing Research Subcommittee, Association of Official Seed Analysts (AOSA) (1994 – present)
- Member – AOSA/SCST Task Force studying the feasibility of merging the two organizations into one North American Seed Testing Organization (2006 – present).

Riad Baalbaki

- Chairperson – Germination and Dormancy Research Subcommittee, AOSA (2006 – present)
- Co-chairperson – Vigor Evaluation Research Subcommittee, AOSA (2007– present)
- Associate Editor – *Seed Technology*, 2007 – present

Deborah Meyer

- Associate Editor – *Seed Technology*, 2001 – present
- Chairperson – Rules Issues and Review Committee, AOSA (2006 – present)
- Chairperson – Purity Testing Research Subcommittee, AOSA (1994 – present)
- Member – Purity Committee, International Seed Testing Association (ISTA) (1995 – present)
- Member – Registered Seed Technologist Board of Examiners, SCST (2002 – present)
- Member – Community Advisory Council of the College of Natural Sciences and Mathematics, California State University, Sacramento (2005 – present)
- National Plant Board Representative – National Seed Health System – Seed Testing Working Group (2000 – present)
- Member – AOSA/SCST Task Force studying the feasibility of merging the two organizations into one North American Seed Testing Organization (2006 – present).

2008 ANNUAL REPORT OF THE PLANT PATHOLOGY LABORATORY

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DIAGNOSTIC SERVICES PROVIDED BY THE PLANT PATHOLOGY LABORATORY INCLUDE BUT ARE NOT LIMITED TO:

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

Plant Disease Samples handled by the plant pathology laboratory include those caused by fungal pathogens, viral pathogens, phytoplasmas, Stramenopiles (Oomycetes such as *Phytophthora*, *Pythium*, the Downy mildews), bacterial pathogens, and other organisms. Some samples have plant disorders that have a physiological, chemical, or genetic cause. In addition, many samples have no detectable pathogen and require further sampling and/or investigation. Lastly, some samples are the results of routine field inspections or seed health testing which are performed to confirm the pest-cleanliness of the commodity for phytosanitary purposes, particularly export. In addition, the Plant Pathology staff serves as a scientific resource to the Department of Food and Agriculture, California's County Departments of Agriculture, and others.

Sudden Oak Death Diagnostics 2008

Suzanne Rooney-Latham, Cheryl Blomquist,
Terra Irving-Walber, Erin Lovig, Monica Negrete,
Marinell Soriano, Jun-Jun Estoque and Allen Noguchi

CDFA's Plant Pest Diagnostics Branch (PPDB) Laboratory continued its *Phytophthora ramorum* diagnostics and scientific support activities, which included the following:

- The lab processed a total of 24,962 samples from both California Nurseries and forests.
- A total of 1267 California nursery sites were inspected and tested for *P. ramorum* in 2008. Of those nurseries, 618 contained regulated material and were sampled at the compliance agreement level (minimum of 40 samples per location). 649 nursery sites surveyed did not contain any *P. ramorum* host material, but were still visually inspected for symptoms of *P. ramorum*. Of the 1267 nursery sites surveyed, 13 were confirmed to have *P. ramorum* positive samples. Of those 13 sites, seven were located in non-infested counties (i.e. regulated counties) and six were in known infested counties (quarantined counties). At the 13 positive sites, 64 plant and soil samples tested positive for *P. ramorum* as follows:
 - *Camellia* spp. 41
 - *Leucothoe fontanesiana* 2
 - *Loropetalum* sp. 2
 - *Michelia* sp. 2
 - *Pieris japonica* 4
 - *Rhododendron* sp. 9
 - Soil samples 4
- The Lab hired nine seasonal employees to process SOD samples.
- The Lab temporarily assigned seven permanent employees to the SOD project, including three exclusively for molecular testing, and one exclusively for ELISA testing.
- PPDB Lab scientists gave numerous informational and training presentations to grower groups, nurseries, and county staff, *et al.* on recognition of symptoms of *P. ramorum*.
- PPDB Lab scientists participated in various meetings, workshops, and training sessions with USDA to learn protocols and techniques.
- PPDB Lab staff was called upon routinely to consult with County staff on specific samples and nurseries, instructions for re-sampling, soil sampling, etc.
- Five PPDB Lab personnel successfully performed and passed provisional laboratory tests as part of the APHIS Provisional Laboratory Accreditation process for nested and quantitative PCR.

PPDB scientists Suzanne Latham and Cheryl Blomquist with Tomas Pastalka (CDFA) and Larry Costello (UCCE) completed and submitted a research paper on the identification and characterization of a new *Phytophthora* disease causing cankers on alders in Foster City, California. This species, *P. siskiyouensis* was not known to be a pathogen before this detection. Citations: Rooney-Latham, S., Blomquist, C. L., Pastalka, T., and Costello, L. 2009. Collar rot on Italian alder trees in California caused by *Phytophthora siskiyouensis*. Online. Plant Health Progress doi:10.1094/PHP-2009-0413-01-RS. Rooney-Latham, S., Blomquist, C.L., Pastalka, T., Costello, L.R. "First report of *Phytophthora siskiyouensis* causing disease on Italian alder in Foster City, California", *Phytopathology* 97:S101

The PPDB also collaborated with, and gave laboratory support to, several SOD projects with other scientists and agencies outside of CDFA, including the following:

- Project with Frank Martin USDA, Mike Coffey UCR and others to test *Phytophthora ramorum* (*Pr*) PCR-based diagnostics using field samples. Citation: Evaluation of molecular markers for *Phytophthora ramorum* detection and identification; testing for specificity using a standardized library of isolates. Martin, F.N., Coffey, M.D., Zeller, K, Hamelin, R.C., Tooley, P., Garbelotto, M., Hughes, K.J.D., Bilodeau, G.J., Levy, L., Blomquist, C. L., Berger, P.H. Accepted to *Phytopathology* 12/08.
- Collaboration with Mike Coffey (UCR) to initially diagnose *Phytophthora siskiyouensis* in southern California.
- Project with Envirologix, Portland, ME to develop a new ELISA for detection of *Phytophthora ramorum* and other *Phytophthora* spp.
- Project with Agdia, Elkhart, IN to develop a new ELISA for detection of *Phytophthora ramorum* and *Phytophthora kernoviae*, as well as an ELISA to replace their existing general *Phytophthora* ELISA test.
- Continue characterizing *Phytophthora niederhauserii* with Gloria Abad, USDA APHIS.
- Performed site visits to infested nurseries in infested counties to educate them on proper cultural practices and how to best manage *Phytophthora ramorum* at their sites.
- Project with Lani Yakabe and Jim MacDonald at UCD Plant Pathology to describe other aerial *Phytophthoras* that are causing disease in California nurseries. Citation: Identification and frequency of *Phytophthora* species causing foliar diseases in California ornamental nurseries. Yakabe, L.E., Blomquist, C.L., Thomas, S.L., MacDonald, J.D. *Phytopathology* 97: S126. A research paper describing this work has been submitted to the journal *Plant Disease*.
- Collaboration with Niklaus Grünwald, ARS for genotyping of nursery isolates of *P. ramorum*. The A1 mating type was detected for the first time in California in a Humboldt county retail nursery as a result of this collaboration. Grünwald N.J., Goss E.M., Larsen M.M., Press C.M., McDonald V.T., Blomquist C.L, and Thomas S.L. 2008. *Plant Disease* 92: 314.

- Tested many oaks of private residences across the 14 infested counties —the bulk of them coming from Portola Valley in San Mateo County.
- Provided plant pathology expertise to Karen Suslow, Hines Horticulture and Dave Fujino, UCD in their guide to nursery best management practices. This best management guide provides a checklist for how each nursery can prevent the introduction of *Pr*.



Scientific aides process SOD nursery samples by culturing plant material for *Phytophthora ramorum*, and by testing by immunoassay (ELISA) for the presence of *Phytophthora* spp. Samples tested positive by immunoassay are further tested for *P. ramorum* by Real Time Polymerase Chain Reaction (PCR).

Phytobacteriology

Dan Opgenorth, Pathologist

The most interesting developments in Plant Bacteriology in 2008 were concerning the Citrus Greening (HLB) training and survey work. Five individuals were sent to the USDA facilities in Beltsville Md. for training and thus far two have passed the proficiency panel for USDA-accreditation. We hope to have all persons with training certified to perform the testing shortly, as our sample load has greatly increased. This is directly due to the find of Asian Citrus Psyllid (ACP) in San Diego County and Imperial County. Thus, the need for additional testing of plant and insect samples according to the approved protocol should continue to grow. This need, along with the usual HLB survey samples, should keep the laboratory very busy next year. Since passing the proficiency tests in September we have already tested 476 Plant samples and 120 Psyllid samples. Additional equipment has been ordered to help in the diagnostic work, however, the real need is for certified personnel to be able to perform the approved assay in a timely way.

With increased interest in HLB we need to be aware that Citrus Canker is still a significant threat to the industry. Field personnel should be reminded to look for symptoms of both diseases when doing survey and sampling.

We continued to work on Corn Stunt in the Central Valley in 2008 with Carol Frate (Farm Advisor Tulare) and Dr. Charles Summers (Entomologist Parlier). Since Carol is going on Sabbatical next year and plans to do research on Stunt, I provided some materials so that she could perform the Real Time PCR diagnosis at the Parlier facility. Hopefully, this will be a significant tool for the continued investigation of this disease, which can reduce yields and quality by approximately half.

A trip was made to work with Dr. Raymond Yocombi on the possibility of testing for Citrus Stubborn. This disease needs to be detected in repository materials prior to increase. In the future, we may be helping Mr. James Dias of Riverside with this project.

San Joaquin County requested some help this past spring in the diagnosis of Cherry Buckskin. It is important to remove old orchards having the Phytoplasma to prevent spread by insect (leafhopper) vectors. Plant materials and insects were collected and some positives identified. Hopefully, we will have our new Real Time assay operational so we can deal with this developing situation next year.

A postdoctoral fellow is also interested in bacteria from our collection to determine the efficacy of a new test for Crown Gall. This should be especially interesting since we just received samples from a nursery with great symptoms.

This work could not be accomplished without the help of Israfiel Mohammed, Terra Irving, Monica Negrete, Erin Lovig and Tim Tidwell.

Karnal Bunt 2008

T.E. Tidwell and YunPing Zhang

Following is a summary of the 2008 Karnal Bunt wheat-testing activities of the CDFA Plant Pest Diagnostics Branch for the 2008 Calendar Year in partial fulfillment of the Karnal Bunt Contract with the USDA APHIS. During the 2008 wheat-growing season a large number of wheat fields were planted in the Blythe region, which is still under federal quarantine and therefore monitored and tested locally for the presence of the pathogen before any wheat is permitted to leave the region. Thus, a total of eighty-nine samples were tested for the Karnal Bunt pathogen in the USDA/CDFA laboratory located at Blythe, CA. For the fourth consecutive year, the Karnal Bunt pathogen, *Tilletia indica*, was not detected in any of the Blythe wheat samples. We feel that this is at least partially attributable to two main factors. First, for several consecutive seasons we have consistently examined all wheat samples for bunted wheat kernels using a highly efficient seed examination machine, and we have consistently examined each wheat sample using a highly sensitive laboratory seed wash screening test¹ that detects even minute levels of teliospores in the wheat samples. Secondly, the success of this project is largely attributable to the outstanding on-site project management of USDA biologist Michael Hennessey and CDFA border station/field biologist Ben Mays, who, over the course of several seasons, have consistently enforced the biologically sound policy of permitting harvesting or sampling equipment to proceed from field to field *only* after wheat samples from the field in question have tested negative for the pathogen by laboratory testing. Harvesting equipment which collects wheat samples that test positive for the Karnal Bunt Pathogen are required to be disinfested before being allowed to proceed to a new field for sampling or harvesting. Implementing this practice for several seasons has been highly effective in preventing the inadvertent spread of the pathogen to other wheat fields via contaminated harvesting equipment.

National Karnal Bunt Survey activities and sample numbers were consistent with those of previous years. A total of fifty-four samples from California were tested for the Karnal Bunt pathogen as part of the annual National Karnal Bunt Survey. The Karnal Bunt pathogen was not detected in any of the fifty-four National KB wheat samples.

On the following pages the 2008 Calendar Year National Survey samples are listed by County and nearest City, as well as CDFA Pest and Damage Report number (Table 1). The samples are grouped by month to give an idea of the distribution of samples over the year.

¹ Peterson, G. L., M.R. Bonde and J.G. Phillips. 2000. Size-selective sieving for detecting teliospores of *Tilletia indica* in wheat seed samples. *Plant Disease* 84:999-1007.

National Karnal Bunt Survey for 2008

	County	City	PDR#	Determination	Samples tested
June	Alameda	Tracy	1430131	Negative	1
	Butte	Chico	1328787	Negative	1
	Fresno	Coalinga	1338338	Negative	1
	Fresno	Firebaugh	1338337	Negative	1
	Fresno	Five points	1338334	Negative	1
	Fresno	San Joaquin	1338335	Negative	1
	Fresno	San Joaquin	1338336	Negative	1
	Kern	Bakersfield	1398337	Negative	1
	Kern	Bakersfield	1398338	Negative	1
	Kern	Buttonwillow	1398336	Negative	1
	Kings	Corcoran	1520478	Negative	1
	Kings	Corcoran	1520481	Negative	1
	Kings	Corcoran	1520482	Negative	1
	Kings	Lemoore	1520479	Negative	1
	Kings	Stratford	1520480	Negative	1
	Merced	Dos Palos	1418380	Negative	1
	Placer	Lincoln	1379846	Negative	1
	Sacramento	Sacramento	1423332	Negative	1
	Sutter	Sutter	1305431	Negative	1
	Stanislaus	Patterson	1345542	Negative	1
	San Joaquin	Stockton	1432042	Negative	1
	San Joaquin	Stockton	1432043	Negative	1
	San Joaquin	Tracy	1432044	Negative	1
	Solano	Dixon	1519926	Negative	1
	Solano	Garnet	1519927	Negative	1
	Tehama	Tehama	1470032	Negative	1
	Yolo	Clarksburg	1520200	Negative	1
	Yolo	Dunnigan	1480783	Negative	1
	Yolo	West Sacramento	1520209	Negative	1
	Yolo	Winters	1480798	Negative	1

Table 1. 2008 Calendar Year National Survey samples listed by County and nearest City, as well as CDFA Pest and Damage Report number. The samples are grouped by month to reflect the distribution of samples over the year. Table continues on next page.

July	Colusa	Faxon Farms	1406678	Negative	1
	Colusa	Jack Dewit	1406679	Negative	1
	Contra Costa	Pleasanton	1327322	Negative	1
	Imperial	Calipatria	1263976	Negative	1
	Imperial	Imperial	1263977	Negative	1
	Imperial	Westmorland	1263978	Negative	1
	Imperial	Brawley	1263979	Negative	1
	Imperial	El Centro	1263980	Negative	1
	Imperial	Calexico	1263981	Negative	1
	Imperial	Brawley	1263982	Negative	1
	Imperial	Holtville	1263983	Negative	1
	Imperial	Bard	1263984	Negative	1
	Imperial	Winterhaven	1263985	Negative	1
	Madera	Chowchilla	1505852	Negative	1
	Riverside	Winchester	1473174	Negative	1
	Riverside	Sun City	1473250	Negative	1
August	Monterey	San Lucas	1364947	Negative	1
	Santa Barbara	Santa Ynez	1450938	Negative	1
	Shasta	Fall River Mills	1361197	Negative	1
September	Glenn	Willows	1374500	Negative	1
October	Tulare	Tipton	1411140	Negative	1
	Tulare	Visalia	1411141	Negative	1
	Tulare	Porterville	1411142	Negative	1
November	Siskiyou	Tulelake	1413943	Negative	1
Total number of samples tested for the year:					54

Table 1: National Karnal Bunt Survey for 2008 (Continued).



2008 PIPE Project

Tongyan Tian, Timothy Tidwell, Jesus Estoque,
Monica Negrete and Caroline DaSalla

The Legume *ipm*PIPE (PIPE = Pest Information Platform for Extension and Education) consists of a network of 160 Sentinel plots in 30 states, provinces and districts of the U.S., Canada and Mexico; The legume *ipm*PIPE is a spin-off from the successful Soybean PIPE which has monitored the progress of, and provided timely management strategies for, Soybean Rust and Soybean Aphid on Soybean in recent years. The threat to other legume crops such as common bean has been increasing annually as more soybeans become infected earlier each year in the U.S. USDA and industry specialists monitor and report on priority disease and insect pests in critical legume crops grown across North America. The PIPE enhances the role of Integrated Pest Management specialists by providing near real-time access to legume pest observations, model output, pest management information, as well as communication tools to support pest management decision-making by growers during that growing season. Funding for the PIPE project is provided through the USDA Risk Management Agency and other sources including legume check-off programs, agricultural experiment stations and extension projects.

SUMMARY OF 2008 CALIFORNIA IPM PIPE PROJECT

In 2008, our participation in the national PIPE project was much the same as it was in 2007. Bean leaves were collected twice (in August and September) over the course of the growing season by University of California Cooperative Extension Agronomist, Steven Temple from 5 sentinel fields. We evaluated individual leaves for virus symptoms and performed immuno-dot blot assays for alfalfa mosaic virus (AMV) and bean common mosaic virus (BCMV) using the protocol provided by the PIPE Project. Membranes blotted with the sap of the same samples were also submitted to Agdia to test for beet curly top virus (BCTV) using nucleic acid dot blot.

Test results interpreted directly from dot blots are summarized in Table 1. Two bean samples were positive for AMV, based on immuno-dot blots. One was from field #5 collected in August and the other from field #4 collected in September. The positive results of these two dot blot tests were confirmed by ELISA. BCMV was not detected in any of the samples collected in 2008. Overall, the immuno-dot blot test was satisfactory, with a minimum of background. The contrast between positive and healthy blots was clear.

The results of several BCTV dot blots, however, were difficult to interpret. As illustrated by Figure 1 (card# 1381) which contained leaf samples from field #1 collected in September, some dots appear to be only partial (half or less turned dark). Comparing suspect positive blots with those of positive controls, 6 samples (1C, 1D, 2E, 6E and 9A) were interpreted as positive for BCTV on this card. However, when the same leaf

samples were tested using PCR and BCTV specific primers, PCR test results indicated that those samples were, in fact, negative for BCTV (Right panel of Figure 1). The PCR test results suggest that BCTV positives based on the dot blot were false. We suspect that the likely cause of the false positives is too much plant sap applied to the membrane.

Legume IPM-PIPE 2008

	PDR	Location	Field	Type	Date Sampled	Sampler	Card Number	Date Blotted	Blotter	BCMV Results	AMV Results	Card Number	*BCTV Results
1	1504838	Davis	1	Bean	081208	S. Temple	1375	081508	MN	0/45	0/45	1611	0/45
2	1504839	Davis	2	Bean	081308	S. Temple	1376	081508	JE	0/45	0/45	1611	0/45
3	1504840	Davis	3	Bean	081308	S. Temple	1377	081508	JE	0/45	0/45	1612	0/45
4	1504841	Davis	4	Bean	082508	S. Temple	1379	082608	MN/JE	0/45	0/45	1615	1/45
5	1504842	Davis	5	Bean	082508	S. Temple	1378	082608	JE	0/45	1/45	1612	0/45
	PDR	Location	Field	Type	Date Sampled		Card Number	Date Blotted	Blotter	BCMV Results	AMV Results	Card Number	*BCTV Results
1	1504843	Davis	1	Bean	091108	S. Temple	1381	091608	JE	0/45	0/45	1614	6/45
2	1504844	Davis	2	Bean	091208	S. Temple	1382	091608	JE	0/45	0/45	614	1/45
3	1504845	Davis	3	Bean	091208	S. Temple	1383	091608	JE	0/45	0/45	1613	3/45
4	1504846	Davis	4	Bean	091208	S. Temple	1380	091608	JE	0/45	1/45	1615	1/45
5	1504847	Davis	5	Bean	091208	S. Temple	1384	091608	JE	0/45	0/45	1613	1/45

*BCTV Results	Tests run by Agdia	All positive BCTV samples were tested via PCR with negative results
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Table 1. Tabulated results of ipmPIPE bean samples tested for Alfalfa Mosaic Virus, Bean Common Mosaic Virus, and Beet Curly Top Virus.

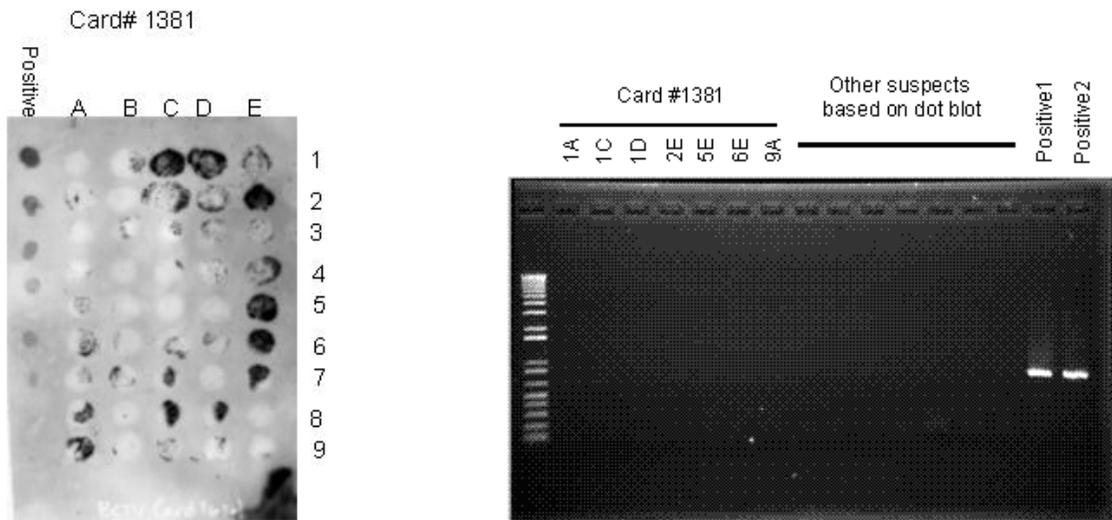


Figure 1: Left: Dot-Blot Card #1381 used to test for Beet Curly Top Virus (BCTV) showing apparently positive blots; Right: PCR test results indicated that the samples that yielded the questionable positive blots were, in fact, negative for BCTV.

We did not observe any obvious virus disease symptoms from any of the leaf samples. The collector suspected that some of the samples might be infected with BCTV. However, those specific samples were all negative for BCTV from both dot blot as well as PCR tests. One of them, however, was positive for AMV. We personally found it difficult to accurately identify specific virus disease symptoms on detached bean leaves. Nor did we notice any obvious virus disease symptoms on the two bean samples that were confirmed positive for AMV by dot blot and ELISA.

As was done in other states participating in the 2008 PIPE project, California PIPE samples were also examined for evidence of bean diseases other than the three virus diseases, including the following:

- White mold, *Sclerotinia sclerotiorum*
- Bean Rust, *Uromyces appendiculatus*
- Soybean Rust, *Phakopsora pachyrhizi*¹
- Cercospora Leaf spot, *Cercospora* spp.¹
- Common Blight, *Xanthomonas axonopodis* pv. *phaseoli*
- Bacterial Brown Spot, *Pseudomonas syringae* pv. *syringae*
- Halo Blight, *Pseudomonas syringae* pv. *phaseolicola*
- Bacterial Wilt, *Curtobacterium flaccumfaciens* subsp. *flaccumfaciens*¹
- Downy Mildew *Phytophthora phaseoli*¹
- Gray Mold, *Botrytis cinerea*
- Angular Leaf Spot *Phaeoisariopsis griseola*¹
- Bean Anthracnose, *Colletotrichum lindemuthianum*

¹ Not known to be present in California

None of the above-listed diseases were detected on the California PIPE samples.

Seed Health Testing 2008

YunPing Zhang and Timothy Tidwell

The Seed Health Testing laboratory of California Department of Food and Agriculture performs seed tests on samples officially drawn and sealed by the Agricultural Commissioner's office, which acts on behalf of USDA APHIS. The test service supports the foreign and domestic trading of various agricultural seeds as part of the phytosanitary requirements of different trading partners.

During the calendar year 2008, Seed Health testing laboratory staff conducted 569 seed tests, which is a 28.2% increase over the previous year of 444. These seed samples came from 30 different clients in California and other states.

The tests performed by the Seed Health Testing Laboratory involved 27 different types of agricultural or horticultural seeds (Table 1), some pesticide-treated and some untreated. The majority of the tests were performed on tomato, cotton, onion and alfalfa. These 4 crops accounted for 89.5% of the seed tests, and 23 other plant species accounted for 10.5% of the seed tests.

Seed	Number	Seed	Number	Seed	Number
Alfalfa	17	Corn	2	Pepper	2
Asparagus	9	Cotton	149	Pumpkin	3
Bean	1	Eggplant	1	Rye	1
Beet	2	Greens	3	Safflower	6
Bromus	1	Kohlrabi	1	Squash	3
Cabbage	1	Leek	1	Spinach	4
Cauliflower	6	Mustard	1	Sudan grass	3
Celery	4	Onion	31	Tomato	312
Clover	2	Parsley	1	Watermelon	2

Table 1. Types of seed tested for seed borne plant pathogens in 2008.

As in previous years, a significant number of cottonseed samples were tested for bacterial blight pathogen *Xanthomonas campestris* pv. *malvacearum* again this year. Based on the fact that this pathogen has not been detected in California for over 40 years and on a request from California Seed Association, the San Joaquin Valley Cotton Board agreed to drop the requirement to test for this pathogen next season.

Seed Health Testing laboratory staff conducted tests to detect a total of 49 different seed pathogens, which included 34 fungi, 7 bacteria, 6 viruses and 1 viroid (Table 2). Total revenue generated from fees charged to clients for this service was \$58,729.82, which was an 81% increase when compared to the previous year of \$32,440.

Fungi		Bacteria	
<i>Alternaria brassicicola</i>	12	<i>Clavibacter michiganensis</i>	4
<i>Alternaria brassicae</i>	1	<i>Clavibacter michiganensis</i> subsp. <i>insidiosus</i>	3
<i>Alternaria carthami</i>	4	<i>Clavibacter michiganensis</i> subsp. <i>michiganensis</i>	1
<i>Botrytis allii</i>	26	<i>Erwinia stewartii</i>	2
<i>Botrytis byssoidea</i>	1	<i>Erwinia tracheiphila</i>	3
<i>Cercospora carthami</i>	2	<i>Pseudomonas adropogoni</i>	1
<i>Claviceps africana</i>	1	<i>Pseudomonas syringae</i>	2
<i>Colletotrichum orbiculare</i>	1	<i>Pseudomonas syringae</i> pv. <i>maculicola</i>	1
<i>Didymella bryoniae</i>	1	<i>Pseudomonas marginalis</i> pv. <i>marginalis</i>	2
<i>Fusarium oxysporum</i>	2	<i>Pseudomonas viridiflava</i>	4
<i>Fusarium oxysporum</i> f.sp. <i>asparagi</i>	3	<i>Xanthomonas campestris</i> pv. <i>alfalfae</i>	3
<i>Fusarium oxysporum</i> f.sp. <i>radicis-lycopersici</i>	77	<i>Xanthomonas campestris</i> pv. <i>campestris</i>	3
<i>Fusarium oxysporum</i> f.sp. <i>carthami</i>	2	<i>Xanthomonas campestris</i> pv. <i>malvacearum</i>	141
<i>Glomerella gossypii</i>	8	<i>Xanthomonas campestris</i> pv. <i>phaseoli</i>	1
<i>Leptosphaeria maculans</i>	1	<i>Xanthomonas campestris</i> pv. <i>vesicatoria</i>	1
<i>Magnaporthe grisea</i>	1		
<i>Periconia circinata</i>	1	Viruses	
<i>Phoma lingam</i>	2	Alfalfa latent virus	5
<i>Phomopsis vexans</i>	1	Asparagus virus 2	6
<i>Puccinia allii</i>	2	Peanut stunt virus	1
<i>Sclerotinia spp.</i>	2	Pepino mosaic virus	1
<i>Tilletia controversa</i>	1	Strawberry latent ringspot virus	1
<i>Uromyces betae</i>	2	Tomato Ringspot Virus	108
<i>Urocystis cepulae</i>	1		
<i>Verticillium albo-atrum</i>	6	Viroids	
<i>Verticillium dahliae</i>	4	Potato spindle tuber viroid	111

Table 2. Seed pathogens tested at the PPDB in 2008.

RESEARCH

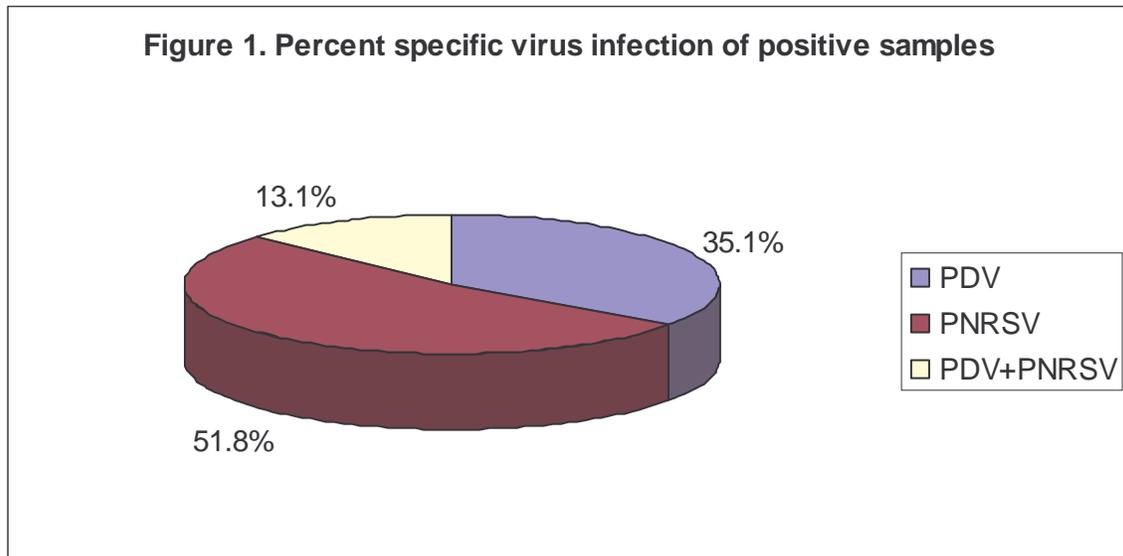
The PPDB Lab collaborated with Agdia Inc. researcher Dr. Francisco Assis Filho in the development of an improved ELISA test kit for Lettuce Mosaic Virus. Testing & validation of the new test system will take place in 2009 with April as a target date for availability of the improved test system from Agdia.

Nursery Annual Survey of Deciduous Fruit Tree, Nut Tree, and Grapevines 2008

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

The California Fruit Tree, Nut Tree and Grapevine Improvement Advisory Board (IAB) allocates funds each year for survey of fruit trees and grapevines for specific viruses. These trees are part of the registered increase block that is used to produce planting material for the industry. This survey is carried out by the staff of the Nursery, Seed and Cotton Program of Pest Exclusion branch, including the Plant Pathologists, field Agricultural Biologists, and Seasonal Agricultural Aides.

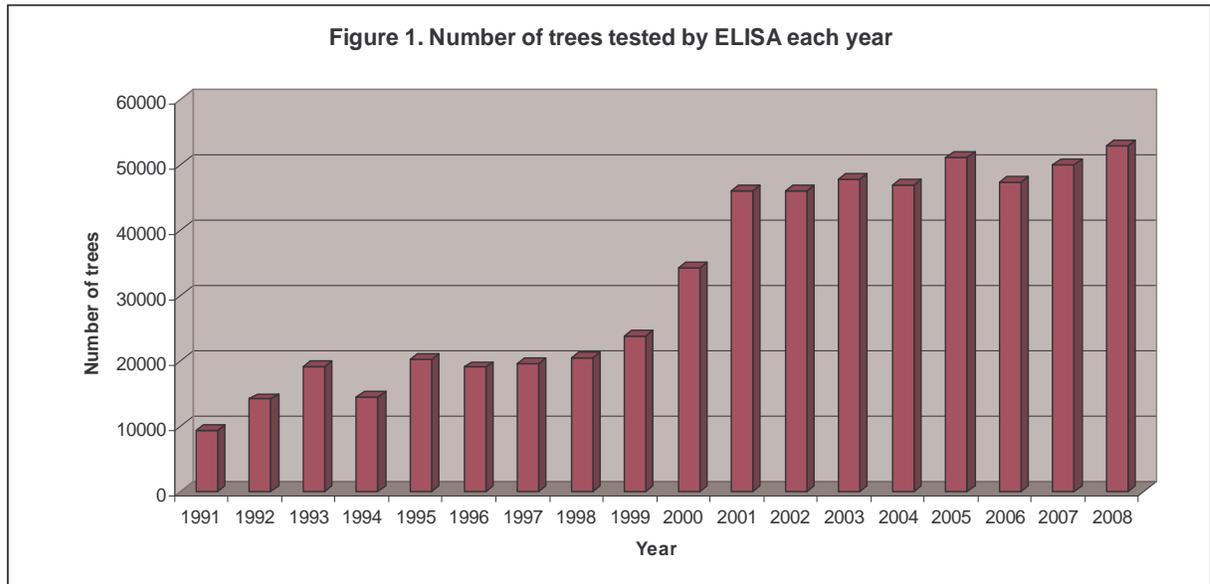
During calendar year 2008, a total of 52,781 stone fruit tree samples were tested for two ilarviruses, Prune dwarf virus (PDV) and Prunus necrotic ringspot virus (PNRSV), from 17 participating nurseries. The tests were performed in a combination Enzyme-Linked Immunosorbent Assay (ELISA) for both viruses. Most of the samples were from the nursery registration and certification program (43,721), of which 142 (0.32%) tested positive for PDV and/or PNRSV. There were also 9,060 service samples tested of which 652 (7.20%) were positive for PDV and/or PNRSV. Additional testing for specific viruses revealed that 279 (35.1%) were infected with PDV, 411 (51.8%) with PNRSV, and 104 (13.1%) with a mixed infection of both viruses (Figure 1).



Grapevines in the nursery program were surveyed for Grapevine Fanleaf Virus (GFV) for thirteen participating nurseries during the period of late April to early May 2008. Each sample was composed of young shoot tips from five vines and tested by ELISA. Of 1088 samples tested, none were found to be positive for GFV.

Grapevines were also surveyed for Grapevine leafroll associated viruses 2 and 3 from September to November. A total of 1573 grapevine samples from 10 participating nurseries were tested. None of these samples tested positive for Grapevine leafroll associated virus 2, but 56 samples tested positive for Grapevine leafroll associated virus 3. Removal of infected and adjacent vines in the certified blocks was advised.

The number of trees surveyed by the Nursery Registration and Certification program has increased significantly over the years, from less than 10,000 trees in 1991 to more than 50,000 trees in 2008 (Figure 2). 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 Advisory Board, Pest Exclusion biologists, and participating nurseries.

PATHOGENS OF SPECIAL INTEREST

Following are several tables that list various groups of pathogens diagnosed at the Plant Pest Diagnostics Branch in 2008. Included are tables listing the “Rust” fungi, The Downy Mildew Pathogens, and the “A” and “Q”-rated Pathogens. Note that the Rust Table does not include the specific rust pathogens of Chrysanthemum White Rust (CWR), *Puccinia horiana*, nor Gladiolus Rust, *Uromyces transversalis*. These two rust fungi are of particular interest in California since these two Q-rated pathogens still subject to USDA survey and quarantine action. Thus, separate tables are included in this report that feature just these two rust pathogens.

Detections of Gladiolus Rust in 2008

PPDB Plant Pathology Laboratory

County	City	Number of Detections
San Diego	Bonsall	2
San Diego	Carlsbad	10
San Diego	La Jolla	1
San Diego	Oceanside	15
San Diego	San Marcos	2
San Diego	Valley Center	1
San Diego	Vista	17
San Francisco	San Francisco	1
San Mateo	San Bruno	19
San Mateo	South San Francisco	18
Total		86

Gladiolus Rust

Cheryl Blomquist, Plant Pathologist

Introduction: Gladiolus rust, caused by the pathogen *Uromyces transversalis*, was first detected in California in a small gladiolus grower's plot in San Diego County, in 2006 (Blomquist 2007). As a result of this find, a survey was conducted within a one-mile radius and the pathogen was found in some residential areas. Gladiolus rust is thought to have been initially introduced into California on cut flowers from Mexico. In 2007, gladiolus rust was found by a homeowner in San Mateo County where it was reported to the county's plant pathology farm advisor, Dr. Colleen Warfield. Gladiolus rust is considered by the USDA to be a pathogen of quarantine significance, so a survey was undertaken to identify the extent of the infection in residential areas and nurseries in the San Francisco Bay area. This survey was a cooperative effort between the San Mateo County Department of Agriculture, USDA APHIS PPQ and CDFA.

Background: Gladiolus rust is native to Africa and was first reported in Europe in the late 1960's. The disease caused severe epidemics in Italy in the late 1970's, and was reported in Argentina and Brazil and finally in Mexico by 2005 (Rodriguez-Alvarado 2006). In 2004, the disease was intercepted in cut flower shipments from Mexico to ports in Texas and California. In 2006, the disease was confirmed to be present in Florida and in San Diego County, California. Commercial hybrid cultivars of gladiolus show varying levels of susceptibility to infection. Resistance to this rust is quantitative and not controlled by a single gene or by a small number of genes (Littlejohn 1997). The center of diversity of *Gladiolus* species is considered to be the southwestern area of South Africa.

Disease description: The disease symptoms are that of typical leaf rust with bright orange uredinial pustules present on the leaf blades, Unlike most rusts of monocots, where the rust pustules extend along the leaf veins, the rust pustules of *U. transversalis* tend to cross the veins of the leaf (Figure 1A, 1B). As the disease progresses, blackish-brown telia form under the epidermis, sometimes surrounding the uredia. Teliospores are single-celled, brown and smooth (Figure 1C). Although teliospores are typically thought of as overwintering spores that allow the pathogen to survive in harsh environmental conditions, it is not known what function they play in the disease cycle of this rust. The urediniospores (Figure 1D) are infectious, powdery, and can be spread by wind and water splash.

Biology: Urediniospores germinate at an optimum temperature of 15–20 °C and require between 6–12 hours of leaf wetness for infection to occur. It takes from 8–23 days for new lesions to develop after infection, depending on temperature (Garibaldi 1997). In South Africa the disease has been reported to reach epidemic proportions with temperatures between 16 and 23 °C with 1–2 days of fog (Ferreira 1989). The San Francisco Bay area has a climate ideal for this rust.

Results: No gladiolus rust was found in nurseries, but the rust was found to be widespread in private residences in the San Francisco Bay area. See map below (Figure 2).

References:

Blomquist, C.L. and Thomas, S.L., McKemy, J.M., Nolan, P.A., Luque-Williams, M. 2007. First report of *Uromyces transversalis* causal agent of gladiolus rust in San Diego County, California. *Plant Disease* 91:1202.

Ferreira, J.F. and W.G. Nevukk 1989. Evaluation and Bitertanol and Triadimefon for the control of Gladiolus Rust caused by *Uromyces transversalis* . *Plant Disease* 73:987-990.

Garibaldi, A. and Aloj, B. 1980. Observations on biology and control of *Uromyces transversalis* (Thum.) Winter on gladiolus in Southern Italy. *Acta Hortic.* 109:409-411.

Littlejohn, G.M. and Blomerus, L.M. 1997. Studies on Gladiolus resistance to transverse rust *Acta Hortic.* 430:509-514.

Rodriguez-Alvarado, G.,Fernandez-Pavia, S.P., Valenzuela-Vazquez, M., Loya-Ramirez, J.G. 2006. First report of Gladiolus Rust caused by *Uromyces transversalis* in Michoacan, Mexico. *Plant Disease* 90:687.

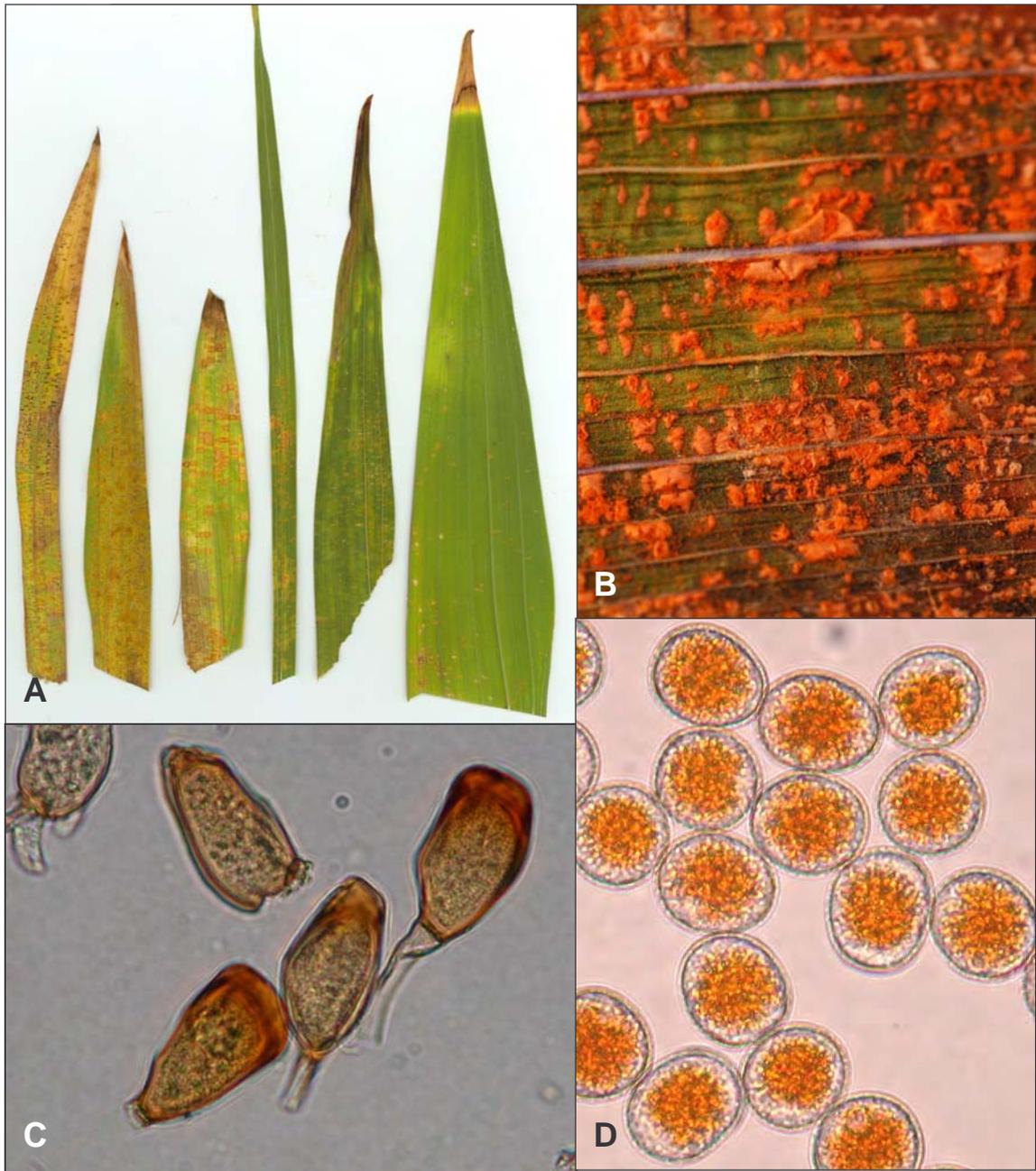


Figure 1: **A.** Typical leaf symptoms of *Uromyces transversalis* on *Gladiolus* leaves exhibiting bright orange uredinial pustules (sori). This rust is named for its characteristic transverse sori that develop horizontally across the veins of infected leaves. Conversely most rusts infecting monocots produce the sori longitudinally along the leaf veins. **B.** Characteristic transverse pattern of coalescing uredinial pustules. **C.** Single-celled, brown, smooth teliospores borne singly on pedicels, exhibiting apical wall thickening. As the disease progresses blackish-brown telia are formed under the leaf epidermis and may surround existing uredinia. **D.** Bright orange urediniospores are infectious, powdery and may be disseminated by wind and water. (Photographs and photomicrographs by Cheryl Blomquist, CDFA, CPPDB)

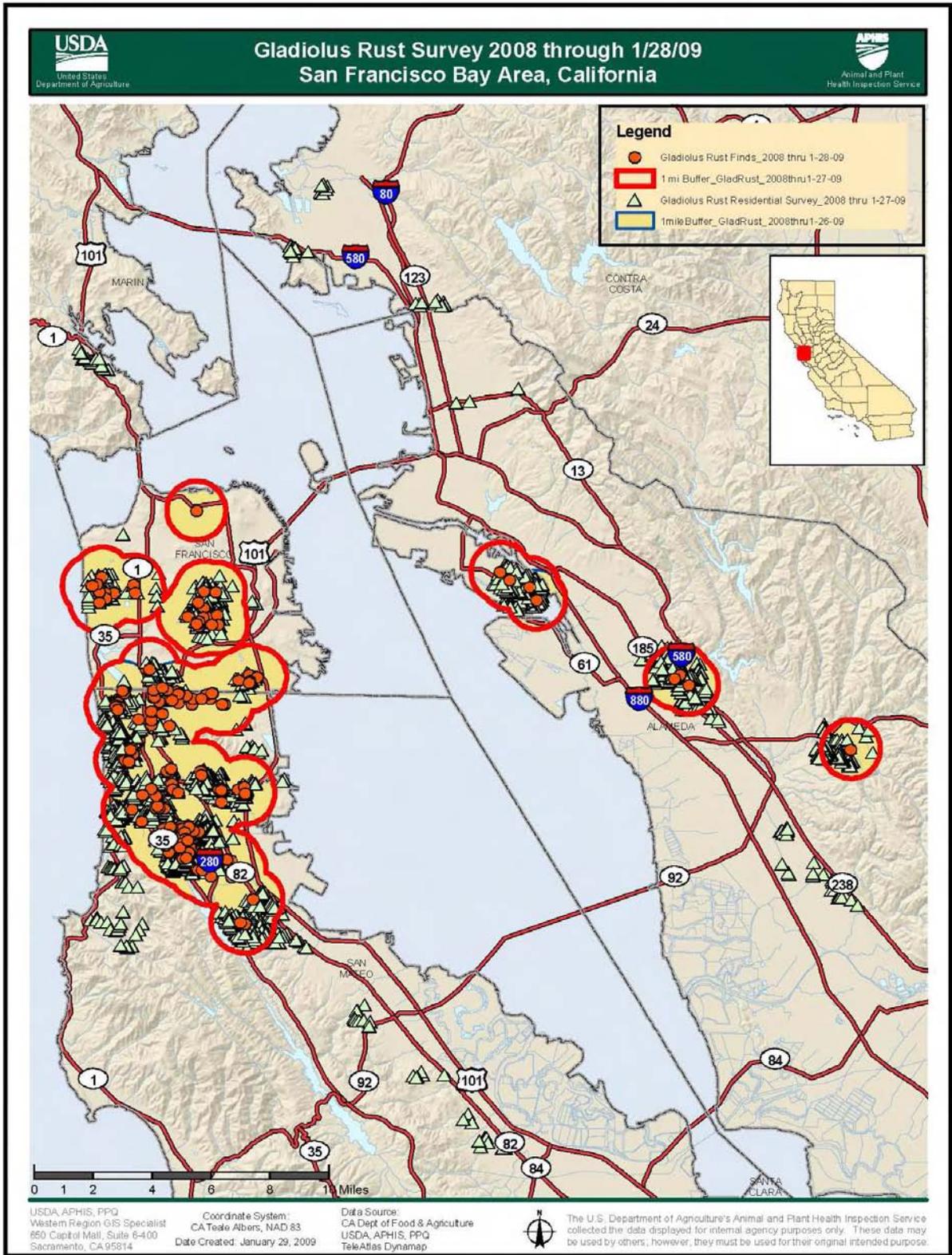


Figure 2: 2008 Distribution of Gladiolus Rust in the San Francisco Bay Areas of Northern California.

Detections of Chrysanthemum White Rust in 2008

PPDB Plant Pathology Laboratory

County	City	Number of Detections
Alameda	Fremont	1
Alameda	Livermore	1
Alameda	Pleasanton	1
Alameda	San Leandro	1
Kings	Hanford	1
Lake	Clearlake	1
Los Angeles	Pico Rivera	1
Merced	Los Banos	1
Monterey	Salinas	27
Napa	American Canyon	1
Napa	Napa	1
Riverside	Corona	1
Riverside	Hemet	1
Riverside	Lake Elsinore	1
Riverside	Riverside	1
Sacramento	Antelope	2
Sacramento	Citrus Heights	1
Sacramento	Elk Grove	1
Sacramento	Folsom	1
Sacramento	Rancho Cordova	1
Sacramento	Sacramento	3
San Diego	Chula Vista	2
San Diego	Fallbrook	1
San Diego	San Diego	1
San Diego	Santee	1
Santa Barbara	Lompoc	1
San Luis Obispo	San Luis Obispo	1
Santa Barbara	Santa Maria	4
Santa Clara	San Jose	1
Santa Clara	Sunnyvale	1
Shasta	Anderson	1
Sonoma	Rohnert Park	1
Sonoma	Windsor	1
Stanislaus	Modesto	1
Sutter	Yuba City	1
Yolo	West Sacramento	1
Total		69



Puccinia horiana, Chrysanthemum White Rust. Left: Underside of leaf with telial pustules turning white due to sporidia. (Photograph from Central Science Lab., Harpenden Archive, British Crown, www.Bugwood.org). Right: Upper leaf blister symptoms. (Photograph from Div. Of Plant Industry Archive, FL Dept. of Agric. and Consumer Services, www.Bugwood.org).



Left: Symptoms of Chrysanthemum White Rust on *Chrysanthemum sp.* (photograph by SRPV, Bourgogne Archive, Les Services Regionaux de la Protection des Vegetaux, www.Bugwood.org). Right: Typical white telial sorus on underside of leaf. (Photograph by John W. Dooley, USDA APHIS PPQ, www.Bugwood.org).

RUST PATHOGENS IDENTIFIED IN 2008

Pathogen	Rating	Common Name	Host	County	City
<i>Coleosporium asterum</i>	C	Rust of Aster and Pine	<i>Solidago sp.</i>	Fresno	Pinedale
<i>Coleosporium asterum</i>	C	Rust of Aster and Pine	<i>Pinus sp.</i>	San Diego	Arroyo Grande
<i>Coleosporium asterum</i>	C	Rust of Aster and Pine	<i>Pinus sp.</i>	San Diego	San Diego
<i>Coleosporium plumeriae</i>	C	Plumeria Rust	<i>Plumeria sp.</i>	Contra Costa	Oakley
<i>Cumminsia mirabilissima</i>	C	Rust on Mahonia	<i>Mahonia sp.</i>	Santa Barbara	Carpinteria
<i>Gymnoconia nitens</i>	C	Rust on Rubus spp.	<i>Rubus eubatus</i>	Madera	Madera
<i>Gymnosporangium libocedri</i>	C	Incense Cedar Rust; Pear Rust	<i>Cedrus sp.</i>	Amador	Jackson
<i>Gymnosporangium libocedri</i>	C	Incense Cedar Rust; Pear Rust	<i>Calocedrus decurrens</i>	Los Angeles	Glendora
* <i>Gymnosporangium juniperi-virginianae</i>	A	Cedar-Apple Rust	<i>Malus sp.</i>	Redwood Hwy Insp.Sta.	
* <i>Gymnosporangium juniperi-virginianae</i>	A	Cedar-Apple Rust	<i>Malus pumila</i>	Solano-Interception-NC	Vallejo
<i>Melampsora epitea</i>	C	Willow Conifer Rust	<i>Salix sp.</i>	San Luis Obispo	Arroyo Grande
<i>Melampsora epitea</i>	C	Willow Conifer Rust	<i>Salix sp.</i>	Santa Clara	Palo Alto
<i>Melampsora hypericorum</i>	C	Hypericum Rust	<i>Hypericum calycinum</i>	Santa Cruz	Watsonville
<i>Melampsora monticola</i>	C	Rust on Euphorbia sp.	<i>Euphorbia sp.</i>	San Diego	Bonsall
<i>Melampsora monticola</i>	C	Rust on Euphorbia sp.	<i>Euphorbia sp.</i>	San Mateo	S. San Francisco
<i>Melampsora occidentalis</i>	C	Rust on Populus spp.	<i>Populus fremontii</i>	Los Angeles	Woodland Hills
<i>Melampsora occidentalis</i>	C	Rust on Populus spp.	<i>Populus deltoides</i>	Santa Barbara	Santa Ynez
<i>Phragmidium rubi-idaei</i>	C	Rust on Rubus spp.(Yellow Rust)	<i>Rubus idaeus</i>	San Luis Obispo	Arroyo Grande
<i>Phragmidium rubi-idaei</i>	C	Rust on Rubus spp.(Yellow Rust)	<i>Rubus ursinus</i>	Santa Cruz	Watsonville
** <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	Contra Costa	Alamo
** <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	Monterey	Salinas
** <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	Orange	Santa Ana
** <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	Sacramento	Orangevale
** <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	San Diego	La Mesa
** <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	San Diego	Rancho Santa Fe
** <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	Santa Barbara	Carpinteria
** <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	Santa Barbara	Santa Barbara
** <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	Santa Barbara	Santa Ynez
** <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	Santa Barbara	Solvang
** <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	Santa Cruz	Soquel
** <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	Santa Cruz	Watsonville

RUST PATHOGENS IDENTIFIED IN 2008 (Continued)

Rust Pathogen	Rating	Common Name	Host	County	City
<i>Puccinia allii</i>	C	Onion Rust	<i>Allium sativum</i>	Monterey	Royal Oaks
<i>Puccinia antirrhini</i>	C	Snapdragon Rust	<i>Antirrhinum sp.</i>	Contra Costa	Richmond
<i>Puccinia antirrhini</i>	C	Snapdragon Rust	<i>Antirrhinum sp.</i>	Santa Cruz	Aptos
<i>Puccinia canaliculata</i>	C	Rust on Sedges	<i>Not listed</i>	Los Angeles	Rosemead
<i>Puccinia carthami</i>	C	Safflower Rust	<i>Carthamus tinctorious</i>	San Joaquin	Stockton
<i>Puccinia carthami</i>	C	Safflower Rust	<i>Carthamus tinctorious</i>	Yolo	Woodland
<i>Puccinia carthami</i>	C	Safflower Rust	<i>Carthamus tinctorious</i>	Yuba	Not listed
<i>Puccinia convolvuli</i>	C	Rust of Convolvulus spp.	<i>Convolvulus tricolor</i>	Contra Costa	Richmond
<i>Puccinia coronata</i>	C	Crown Rust of Grains	<i>Festuca sp.</i>	San Mateo	San Bruno
<i>Puccinia dioicae var. extensicola</i>	C	Rust of Carex	<i>Carex pansa</i>	Santa Barbara	Carpinteria
<i>Puccinia evadens</i>	C	Rust of Baccharis	<i>Baccharis pilularis</i>	Monterey	Salinas
<i>Puccinia farinacea</i>	Q	Salvia Rust	<i>Salvia greggii</i>	Santa Barbara	Carpinteria
<i>Puccinia farinacea</i>	Q	Salvia Rust	<i>Salvia greggii</i>	Santa Barbara	Goleta
<i>Puccinia farinacea</i>	Q	Salvia Rust	<i>Salvia greggii</i>	Santa Barbara	Santa Barbara
<i>Puccinia farinacea</i>	Q	Salvia Rust	<i>Salvia greggii</i>	Santa Clara	San Jose
<i>Puccinia farinacea</i>	Q	Salvia Rust	<i>Salvia greggii</i>	Santa Cruz	Santa Cruz
<i>Puccinia farinacea</i>	Q	Salvia Rust	<i>Salvia greggii</i>	Ventura	Ventura
<i>Puccinia farinacea</i>	Q	Salvia Rust	<i>Salvia microphylla</i>	Ventura	Ventura
<i>Puccinia hemerocallidis</i>	C	Daylilly Rust	<i>Hemerocallis sp.</i>	Santa Cruz	Watsonville
<i>Puccinia heucherae</i>	C	Heuchera Rust	<i>Heuchera sp.</i>	Santa Cruz	Aptos
<i>Puccinia iridis</i>	C	Rust of Iris	<i>Iris hexagone</i>	Mendocino	Fort Bragg
<i>Puccinia iridis</i>	C	Rust of Iris	<i>Iris sp.</i>	Mendocino	Fort Bragg
<i>Puccinia iridis</i>	C	Rust of Iris	<i>Iris sp.</i>	San Mateo	San Bruno
<i>Puccinia iridis</i>	C	Rust of Iris	<i>Iris germanica</i>	Santa Cruz	Watsonville
<i>Puccinia lagenophorae</i>	C	Rust of Senecio	<i>Bellis perennis</i>	Merced	Merced
<i>Puccinia malvacearum</i>	C	Rust of Hollyhock;/Malva Rust	<i>Malva sp. (weed)</i>	San Benito	Hollister
<i>Puccinia malvacearum</i>	C	Rust of Hollyhock;/Malva Rust	<i>Alcea sp.</i>	San Mateo	San Mateo
<i>Puccinia malvacearum</i>	C	Rust of Hollyhock;/Malva Rust	<i>Lavatera sp.</i>	Santa Cruz	Santa Cruz
<i>Puccinia menthae</i>	C	Mint Rust on Oregano	<i>Origanum vulgare</i>	San Mateo	S. San Francisco
<i>Puccinia psidii</i>	B	Rust of Eucalyptus and Guava	<i>Syzygium samarangense</i>	Orange	Anaheim

RUST PATHOGENS IDENTIFIED IN 2008 (Continued)

Rust Pathogen	Rating	Common Name	Host	County	City
<i>Puccinia sorghi</i>	C	Rust of Corn	<i>Zea mays</i>	San Bernardino	Chino Hills
<i>Puccinia striiformis</i>	C	Stripe Rust of Cereals/Grasses	<i>Festuca sp.</i>	Sacramento	Sacramento
<i>Puccinia striiformis</i>	C	Stripe Rust of Cereals/Grasses	<i>Poa sp.</i>	San Mateo	Daly City
<i>Puccinia vincae</i>	C	Rust of Vinca	<i>Vinca sp.</i>	Alameda	Oakland
<i>Puccinia vincae</i>	C	Rust of Vinca	<i>Vinca minor</i>	Contra Costa	San Ramon
<i>Pucciniastrum epilobii</i>	C	Fuchsia Rust; Fir/Fireweed Rust	<i>Fuchsia sp.</i>	Santa Cruz	Watsonville
<i>Tranzschelia discolor</i>	C	Rust of Prunus spp.and Anemone	<i>Prunus sp.</i>	Riverside	Riverside
<i>Tranzschelia discolor</i>	C	Rust of Prunus spp.and Anemone	<i>Prunus domestica</i>	San Luis Obispo	San Luis Obispo
<i>Uromyces dianthi</i>	C	Carnation Rust	<i>Dianthus sp.</i>	Santa Cruz	Watsonville
<i>Uromyces epicampis</i>	Q	Rust on Muhlenbergia	<i>Muhlenbergia rigens</i>	Santa Barbara	Lompoc
<i>Uromyces fabae</i>	C	Rust on Broadbean, Pea, and Vetch	<i>Vicia faba</i>	Fresno	San Joaquin
<i>Uromyces trifolii-repentis</i>	C	Rust of Clover	<i>Trifolium sp.</i>	Sacramento	Galt

Note: Report is exclusive of C.W.R.(Chrysanthemum White Rust) and Gladiolus Rust - both presented in individual reports.

*Intercepted Pests

**Currently under review to receive a "C" Rating

Table prepared by J. White

SELECTED PHOTOGRAPHS OF RUST FUNGI DETECTED IN 2008:



Coleosporium plumeriae – Plumeria Rust. Left: Infected *Plumeria* sp. with typical yellow-orange, powdery rust pustules (uredium) on undersides of leaves. Infections are caused by windborne urediniospores that adhere to moist leaves under wet and humid conditions. The rust fungus over winters on infected leaves and leaf debris. Right: Erumpent coalescing pustules (uredinia sori) full of powdery spores on underside of leaf. (Photographs from Hawaii Pest and Disease Image Gallery, Scott C. Nelson, U. of Hawaii, Manoa).



Coleosporium asterum – Pine-Aster Rust. Infection on Red pine, *Pinus resinosa*, exhibiting typical symptoms of needle cast and discoloration. Heavy infections may cause severe needle loss and resultant growth reduction. The rust fungus is heteroecious (requires two host plant species for life cycle completion) and macrocyclic (the life cycle includes all five spore states). (Photograph by Mike Ostry, USDA Forest Service, North Central Research Station, www.Bugwood.org).



Left: Aecial stage of *Coleosporium asterum* forming white aecium on pine needles commonly in late spring or early summer. The aecia produce yellow-orange colored aeciospores that are dispersed by wind and infect the alternate hosts, *Aster sp.* (Aster) and *Solidago sp.* (Goldenrod). (Photograph by Robert L. Anderson, USDA Forest Service, www.Bugwood.org) Right: Erumpent orange telium produced on the underside of an alternate host, big leaf Aster. Teliospores will eventually germinate producing basidia and basidiospores, which are dispersed by wind and will re-infect the needles of the primary *Pinus sp.* host. The uredium stage of the fungus is also produced on the alternate host. (Photograph by Mike Ostry, USDA Forest Service, www.Bugwood.org).



Coleosporium sp. on Scots Pine, *Pinus sylvestris*. Close-up of aecial pustules lining needles and producing yellow-orange aeciospores. (Photograph by Petr Kapitola, State Phytosanitary Administration, www.Bugwood.org).



Phragmidium tuberculatum, Rose Rust on stems and leaves. This rust fungus is autoecious (requiring only one host to complete a life cycle) and macrocyclic. The spermatogonial-aeial stage is short-lived and the rust survives in the uredial/telial stages during most of the growing season. Both the uredium(orange pustules) and telium (black fruiting structures) stages can be found during any part of the growing season on various *Rosa spp.* (Left: Photograph by Philip Northover, Crops Knowledge Centre, Manitoba Agriculture, Food and Rural Initiatives. Right: photograph by Brian D. Hudelson, Dept. of Plant Pathology, U. of Wisconsin-Madison/Extension/General Master Gardener Training).



Phragmidium rubi-idaei Yellow Rust on Raspberry, *Rubus idaeus*. Left: Infections in spring and early summer form small yellowish/orange raised pustules (spermatogonia) on upper leaf surfaces. (Photograph by T. Peerbolt, NWIPM, Peerbolt Crop Management). Right: Spore producing aecium develops in a ring around the spermatogonia as shown on the upper leaf surface. (Photograph by Peter R. Bristow, Oregon State U. Online Guide to Plant Disease Control). In the summer a third spore stage (uredial) develops on the lower leaf surfaces followed by the black over-wintering telial stage produced during harvest season.



Gymnoconia nitens, Orange Rust on Blackberry, *Rubus ursinus*. Bright orange aecia are produced on lower leaf surfaces in the spring. Aeciospores are disseminated by wind and infect mature berry leaves. The rust fungus becomes systemic in plants and infected canes will bear little or no fruit. (Photograph by Jay W. Pscheidt, Oregon State U. Online Guide to Plant Disease Control).



Gymnoconia nitens infecting *Rubus argutus* growing wild in pasture land. (Photograph from Pathogens of Plants of Hawaii, website by Kim and Forest Starr).

The Downy Mildew Report

An Overview of the Distinctive, Destructive Downy Mildews

Jeanenne White, Cheryl Blomquist and Suzanne Rooney-Latham

Downy mildews are organisms classified in the Kingdom Stramenopila, the order Peronosporales and family Peronosporaceae. They comprise one of the largest groups of phytopathogenic organisms on flowering plants. The mildews are more closely related to the water mold fungi (*Phytophthora spp.*) and brown algae than the true fungi (mushrooms and molds). Downy mildews produce hyphae similar to the true fungi and lead a “fungal lifestyle” therefore have historically been classified by plant pathologists as fungi. As a group, they are obligate, biotrophic, parasites that cause significant destruction and economic losses to a wide range of crops including alfalfa, corn, sorghum, lettuce, grapes, onion, sunflower, spinach, and numerous plant species in the Fabaceae and Brassicaceae plant families. Floricultural and herb crops such as rose, salvia, viola, snapdragon, coleus, coneflower, basil, and fenugreek, etc., are also susceptible to harmful infections by the downy mildews. These phytopathogens produce distinctive branched fruiting structures (conidiophores) and diverse asexual spores (conidia) features visible by microscopy (Figure 1). Specific species also produce thick-walled sexual spores (oospores), which over-winter on plant debris. Morphological characters such as these are critical for identifying a downy mildew to both the correct genus and species.

Downy mildews primarily infect Dicotyledonous plants, but may also cause disease on hosts in *Allium spp.* as well as the Poaceae family. They are biotrophic, typically evolving with specific host plants. In general, the downy mildews may be separated taxonomically by host-specificity, although recent studies have shown that frequent host-jumping between plant species rather than exclusive co-evolution with a single host plant, as typical in the rust fungi, also occurs. Consequently some species have only a narrow host range whereas others may infect a wide range of plants. Currently there are approximately 10 recognized genera of downy mildew fungi. Some names of the genera and their respective hosts include *Pseudoperonospora spp.* on cucurbits; *Peronosclerospora spp.* on sorghum and corn; *Sclerospora spp.* on grasses and millet; *Sclerophthora spp.* on corn, rice, and wheat; *Peronospora spp.* on alfalfa, onion, basil, fenugreek, and pea; *Bremia sp.* on lettuce; and *Hyaloperonospora sp.* on broccoli, cauliflower and other members of the family Brassicaceae.

Wild plants (e.g. weeds) may serve as collateral hosts of downy mildews providing reservoirs for the pathogen during unfavorable growth conditions and non-crop seasons. Destruction of wild host species near agricultural areas may be necessary to disrupt the source of primary inoculum as well as reduce field re-infection of the primary host/crop. Wild (native) hosts perform a significant role in the origin, development, and perpetuation of downy mildew diseases.

Symptoms of downy mildew infection vary depending on the species, host, disease severity, environmental conditions, and geographical location. Common symptoms include, chlorotic streaking, angular vein-delimited or blotchy leaf spots, leaf distortion and blistering, and foliar blight on upper leaf surfaces. Severe infections may become systemic within a host plant causing dwarfing (as in sunflower), defoliation, and even death of seedlings. The loss of photosynthetic tissue due to infection results in stunting of plants and reduction of fruit size and set. As the disease progresses, numerous fruiting

structures (conidiophores) emerge through stomata of the host plant to form “downy” cottony areas, which develop initially on lower leaf surfaces, a characteristic sign for which this group derives the common name, downy mildew (Figure 2). Characteristic colors of this “fungal matrix” range from white, tan, brown, to purple. Flowers, fruits, stems, and other aerial plant parts may also exhibit symptoms/signs of infection. Less frequently, infection of seeds may occur (e.g. fenugreek and sunflower). Infection of sunflower seed and ensuing spread of the pathogen in seed lots is a significant industry problem causing seed importing countries to impose expensive requirements such as seed health testing and phytosanitary field inspections. Infected seeds have the potential of causing long-range spread of downy mildews both domestically and internationally.

Optimum conditions for disease development include availability of susceptible host plants; high humidity and wet environments; conducive weather patterns (e.g. wind for dissemination); and over-wintering survival capabilities (e.g. plant debris and wild collateral hosts). Organisms in the Peronosporaceae require wet plant surfaces for infection. Prolonged periods of leaf wetness promote spore germination. Cool (50-75 degrees F), wet conditions with high relative humidity (85% or higher) are most conducive to disease outbreaks. The time from initial infection to the production of mature spores is generally seven to ten days, but may be as short as four days under optimal conditions and can vary between mildew species. Conidia germinate via germ tubes on leaves, petioles, etc., that grow thru leaf stomata into intercellular spaces within the leaf tissue eventually penetrating the plant cells by producing differentiated infection structures called haustoria. Subsequently conidiophores emerge thru leaf stomata expanding, branching, and reaching maturity to produce all of the conidia (spores) simultaneously forming the characteristic “downy” sign.

Conidia are primarily disseminated by wind, but may also be carried by water or insect pollinator vectors, to other parts of the same plant or to new host plants. Oospores over-winter in plant debris from the agricultural host or the weed host and can germinate to re-infect new host plants in the spring. Cultural and mechanical control of downy mildew includes crop rotation, utilization of different plant debris removal techniques, and suppression of wild host plants (e.g. deep plowing, mechanical cultivation, grazing, etc.). Various fungicides are registered for chemical control of disease depending on the mildew species and the host plant.

Laboratory analysis of downy mildew fungal species begins with the identification of the host plant, followed by examination of symptomatic tissue (e.g. necrotic tissue/lesions/spots, “downy” areas with fungal fruiting or infection structures), and preparation of slide mounts for examination with a compound microscope. Ultimate and terminal branching patterns, color, size and shape of conidiophores and color, size, shape, and cell wall morphology of conidia are all important characteristics of each genus with many variances between genera. *Peronospora spp.* form conidiophores exhibiting distinctive dichotomous branching patterns at acute angles and bear conidia on pointed, delicately recurved tips. *Plasmopara spp.* form random-patterned branched conidiophores where each branch terminates in two to four short, truncate branches. Conidia of all genera are deciduous and typically germinate by forming germ tubes visible via microscopy. Infection structures such as haustoria, when visible, are also morphological features that may aid identification. SEM (scanning electron microscopy) examination may be used as an additional tool to closely examine fungal fruiting and infection structures as well as clarify interactions between host and pathogen such as conidiophore elongation thru leaf stomata, branching and conidial development (Figure 3).

Traditionally the description, identification, taxonomy, and phylogeny of the downy mildews were based on morphological characteristics. As a result of DNA sequence information generated from the development of molecular biology techniques, new genera and species within genera have been described. Additionally, changes in genera and species have been implemented due to taxonomic studies based on nuclear ribosomal ITS sequence analysis combined with morphological characters and host specificity. ITS sequencing is a valuable tool used to differentiate species that lack distinct morphological features and to identify evolutionary relationships between species. New genera have been described and named to accommodate the most current evaluations and information. For example, *Peronospora spp.*, which infect Brassicaceae hosts, have been renamed *Hyaloperonospora spp.* (a newly recognized genus) as a result of ITS sequence analysis, as well as unique morphological features such as hyaline conidia, which are typical of this particular group that infect the Brassicaceae. Another recent change moved one of the traditional *Plasmopara* species, *Plasmopara oplismeni* (which infects grasses) to the new genus, *Viennotia*, based on differences in morphology and molecular analysis.

In 2008, two new species of downy mildews in California were detected at the Plant Pest Diagnostics Branch, CDFA: *Peronospora belbahrii*, downy mildew on basil, and *Peronospora trigonellae*, downy mildew on fenugreek (publication in press). In addition, a new race of *Peronospora farinosa f. sp. spinaceae* which causes downy mildew of spinach, was investigated by University of California Cooperative Extension (UCCE) Farm Advisor, Steve Koike in Monterey County. This new race was eventually designated as race eleven. The economically important downy mildew group offers great challenges in phylogenetic classification and identification.

REFERENCES:

Agrios, George N. Plant Pathology. 2005. Academic Press, N.Y. 922 pp.

Bryant, Dan. "New strain of spinach downy mildew found in Salinas Valley." Spinach Industry supported collaborative studies – Steve Koike, Plant pathologist, UCCE, Monterey County and James C. Correll, Plant pathologist, University of AZ. Western Farm Press. Jan. 9, 2009.

Goker, M., Voglmayr, H., Riethmuller, A., Weib, M., Oberwinkler, F. Taxonomic aspects Of Peronosporaceae inferred from Bayesian molecular phylogenetics. Canadian Journal of Botany 81: 672-683. 2003.

Koike, S. 2008. Personal Communication.

Spencer, D.M. The Downy Mildews. 1981. Academic Press, N.Y. 636 pp.

Voglmayr, Hermann. Phylogenetic relationships of *Peronospora* and related genera based on Nuclear ribosomal ITS sequences. Mycological Research 107(10): 1132-1142. 2003. The British Mycological Society.



Figure 1. Branched conidiophores producing ovoid conidia on terminal dichotomous branches, distinctive morphological characteristics of the downy mildew phytopathogens. *Peronospora belbahrii*, downy mildew on basil. Photomicrograph from Cornell U. Gallery of Greenhouse Pests and Diseases, by Margery Daughtrey and Dan Gilrein, Long Island Horticultural and Research Extension Center.



Figure 2. “Downy” cottony brownish-gray area composed of fruiting structures (conidiophores and conidia) colonizing the underside of a snapdragon leaf, a typical sign of downy mildew disease. *Peronospora antirrhini*, downy mildew on snapdragon, *Antirrhinum majus*. Photograph by T. Smith, Extension Floricultural Specialist, University of Massachusetts, Amherst, from Floriculture Greenhouse Update website.



Figure 3. *Peronospora belbahrii*, downy mildew on basil. Scanning electron micrograph of a conidiophore emerging through leaf stomata producing clustered conidia attached to short, dichotomous, terminal branches typical of *Peronospora* spp. SEM photograph by Scott Kinnee, PPDB, CDFA.

SELECTED PHOTOGRAPHS OF THE DOWNY MILDEWS:
(Includes 2008 PPDB Detections and other important Mildew pathogens)



Peronospora belbahrii, downy mildew on basil (*Ocimum basilicum*). Typical gray, fuzzy, “downy” areas of sporulation (conidiophores and conidia) on the abaxial leaf surface. Basil herb plants are grown in greenhouse as well as field sites. Photograph by P. Roberts, R. Raid, and P. Harmon from UF/FAS Pest Alert Website: <http://pestaalert.ifas.ufl.edu/>



Downy mildew on Basil. Typical foliar symptoms on the upper leaf surface are characteristic chlorotic areas often delineated by the veins, sometimes covering the the entire leaf surface. Photograph by Roberts, R. Raid, and P. Harmon from UF/IFAS Pest Alert Web site: <http://pestaalert.ifas.ufl.edu/>



Downy mildew on sunflower (*Helianthus annuus*) caused by *Plasmopara halstedii*. Sunflower exhibiting severe symptoms of infection including stunted growth, leaf chlorosis, necrosis and leaf spotting, and development of an atypical erect flower head which produces very little seed (top). Typical white fuzzy sporulation occurring thru leaf stomata on lower leaf surface (bottom). Photographs by Ferenc Viranyi, Godollo U. of Agric. Sciences and David Davison, FLA Dept of Agric. Div. Plant Industry, respectively, Bugwood.org



Lettuce downy mildew caused by *Bremia lactucae*. Foliar symptoms include angular, pale, areas that are delineated by veins (top). Sporulation through leaf stomata occurs as the disease progresses (top inset). Dichotomously branched conidiophores with swollen tips that form a vesicle (bottom). Each vesicle bears 3-5 sterigmata that produce a single conidium. Photograph and photomicrograph by Suzanne Latham, PPDB, CDFA.



Downy mildew on cabbage (*Brassica oleracea* var. *capitata*) caused by *Hyaloperonospora parasitica*. Typical tan-brown vein-delineated angular lesions on upper leaf surface. The *Hyaloperonospora* produce specialized oospores that can overwinter in soil and plant debris to re-infect new plants during subsequent growing seasons. Photograph by S. J. Colucci, Cc, NC State U., Cooperative Extension.



Typical sign of *Hyaloperonospora parasitica* downy mildew on cabbage exhibited by the cottony growth (conidia and conidiophores emerging thru leaf stomata) developing from necrotic angular lesion areas on the abaxial leaf surface. Photograph by S. J. Colucci, Cc, NC State U., Cooperative Extension.



Onion downy mildew caused by *Peronospora destructor*. Field infections may occur from systemically infected bulbs or windborne conidia germinating on wet leaves in humid weather. The pathogen attacks various species of onion and is very destructive to the common onion species (*Allium cepa*). Photograph by Howard F. Schwartz, Colorado State U., Bugwood.org.



Onion downy mildew symptoms on leaves of *Allium sp.* Lesions appear as pale chlorotic spots, oval to elongate in shape and variable in size. Under humid conditions spores germinate, conidiophores develop and emerge thru leaf stomata and the symptomatic areas become covered with a grayish, tan to violet, fine downy growth. Leaves may exhibit distortion, curling, shriveling, then collapse and die. Photographs by Howard F. Schwartz, Colorado State U., Bugwood.org.



Peronospora destructor downy mildew on onion (*Allium cepa*). Infected onion leaves exhibiting a varying range of typical symptoms. Oval, pale chlorotic lesions elongate, become necrotic and when wet conditions occur conidiophores and conidia cover the lesions giving them a grayish violet appearance. Elongated lesions with layers of downy mildew sporulation may appear zonate. Photograph by Cheryl Blomquist, PPDB, CDFA.



Peronospora farinose f. sp. spinaciae downy mildew on spinach (*Spinacia oleracea*). Foliar symptoms initially appear on upper leaf surfaces of cotyledons and leaves as light green to pale yellow areas. Conidia germinate when leaf surfaces become wet from substantial dew or rainfall and irrigation. Subsequently sporulation occurs thru leaf stomata as the disease progresses and a blue-gray downy growth (conidiophores and conidia) develops on abaxial leaf surfaces. Photograph by Melodie Putnam, Oregon State U. Online Guide to Plant Disease Control, Oregon State U. Extension.



Peronospora farinose f.sp. spinaciae downy mildew on spinach (*Spinacia oleracea*). Typical blue-gray downy areas on lower leaf surface composed of phytopathogen fruiting structures (conidiophores and conidia). This *Peronospora* species has a narrow host range, infecting only Spinach and a few *Chenopodium* weed species (wild hosts). Photograph by Melodie Putnam, Online Guide to Plant Disease Control, Oregon State U. Extension.



Downy mildew on alfalfa (*Medicago sativa*) caused by *Peronospora trifoliorum*. Foliar symptoms appear during cool, moist, wet weather as pale chlorotic areas on upper leaves. Entire leaves and shoots may become chlorotic when the infection becomes systemic in crown buds, cortex of crown branches and surviving shoots. Photograph by Paul Koepsell, Online Guide to Plant Disease Control, Oregon State U., Extension.



Peronospora trifoliorum downy mildew on alfalfa (*Medicago sativa*). Sporulation (conidiophores and conidia) thru leaf stomata forming a gray to pale violet downy mat on underside of a leaf, a typical sign of downy mildew disease on alfalfa. Photograph by Matt Montgomery, Sangamon-Menard Extension, U. of Illinois web.extension.



Downy mildew on *Salvia* caused by *Peronospora lamii*. Typical foliar symptoms on upper leaf of angular lesions formed between the leaf veins (vein delineated), usually brownish and chlorotic (top). Sporulation thru leaf stomata occurs with progression of the disease forming dark brown downy areas on the abaxial leaf surface (bottom). Dichotomously branched conidiophores bearing conidia on terminal branches, typical of *Peronospora spp.*, are visible with microscopic examination of the downy areas. Photographs by Leanne Pundt, Extension Educator, University of Connecticut, Integrated Pest Management: Greenhouse:Plant Diseases: Downy Mildew, website - <http://hort.unconn.edu/lpm/greenhs/downymldgh.htm>



Downy mildew of grape caused by *Plasmopara viticola*. Infections in *Vitis sp.* may affect all parts of a vine including leaves, petioles, tendrils and cluster stems. Typical foliar symptoms are chlorotic to reddish-brown angular vein delineated lesions that form on upper leaf surfaces (top). Sporulation thru leaf stomata produces a delicate, dense white cottony growth on the under surfaces of leaves (inset). Young berries are most susceptible to infection becoming more resistant when mature. White cottony sporulation on young berries (bottom). Due to limited rainfall in spring and summer and less humid conditions grape downy mildew is not a problem in California where isolated infections have occurred but are uncommon and limited to small areas. Top photograph and inset by Holly Thorton, U. of Georgia, Dept. of Plant Pathology Archive, and David Davison, FL Dept. of Agric., and Consumer Services Div. of Plant Industry, both from Bugwood.org. Bottom photograph from Department of Plant Pathology, New York State Agricultural Experiment Station, Geneva, NY, copyright free).

Downy Mildew Fungi Identified in 2008

Plant Pest Diagnostics Branch - Plant Pathology

Pathogen	Rating	Common Name	Host	County	City
Bremia lactucae	C	Downy Mildew on Lettuce	Lactuca sativa	Santa Cruz	Santa Cruz
Bremia lactucae	C	Downy Mildew on Lettuce	Lactuca sativa	Santa Cruz	Watsonville
Hyaloperonospora parasitica	C	Downy Mildew on Broccoli/Cauliflower	Brassica oleracea	Monterey	Monterey
Hyaloperonospora parasitica	C	Downy Mildew on Broccoli/Cauliflower	Brassica oleracea	San Luis Obispo	Arroyo Grande
Hyaloperonospora parasitica	C	Downy Mildew on Broccoli	Brassica oleracea	San Luis Obispo	Nipomo
Hyaloperonospora parasitica	C	Downy Mildew on Cauliflower	Brassica oleracea	Santa Barbara	Lompoc
Hyaloperonospora parasitica	C	Downy Mildew on Broccoli	Brassica oleracea	Santa Clara	Morgan Hill
Peronospora belbahrii	Q	Downy Mildew on Basil	Oscimum basilicum	San Diego	Escondido
Peronospora belbahrii	Q	Downy Mildew on Basil	Oscimum basilicum	San Diego	Ramona
Peronospora destructor	C	Downy Mildew on Onion	Allium cepa	Colusa	Colusa
Peronospora destructor	C	Downy Mildew on Onion	Allium cepa	San Benito	San Juan Batista
Peronospora destructor	C	Downy Mildew on Onion	Allium cepa	Santa Clara	Gilroy
Peronospora destructor	C	Downy Mildew on Onion	Allium cepa	Sutter	Parma
Peronospora lamii	C	Downy Mildew on Salvia	Salvia sp.	San Luis Obispo	Arroyo Grande
Peronospora lamii	C	Downy Mildew on Salvia	Salvia farinacea	Santa Barbara	Carpinteria
Peronospora lamii	C	Downy Mildew on Salvia	Salvia greggii	Santa Cruz	Santa Cruz
Peronospora lamii	C	Downy Mildew on Salvia	Salvia farinacea	Ventura	Santa Paula
Peronospora pulveracea	Q	Downy Mildew on Hellebore	Hellebore sp.	San Mateo	Half Moon Bay
Peronospora trifoliorum	C	Downy Mildew on Alfalfa	Medicago sativa	Fresno	Fresno
Peronospora trifoliorum	C	Downy Mildew on Alfalfa	Medicago sativa	Imperial	El Centro
Peronospora trifoliorum	C	Downy Mildew on Alfalfa	Medicago sativa	Imperial	Holtville
Peronospora trifoliorum	C	Downy Mildew on Alfalfa	Medicago sativa	Madera	Chowchilla
Peronospora trifoliorum	C	Downy Mildew on Alfalfa	Medicago sativa	Yolo	Woodland
Peronospora trigonellae	Q	Downy Mildew on Fenugreek	Trigonella foenum	Los Angeles	Bellflower
Peronospora viciae	C	Downy Mildew on Pea	Pisum sativum	Santa Clara	Morgan Hill

Prepared by J. White

A and Q Plant Pathology Pest Records for 2008

Pathogen	Rating	Common Name	Host	County
<i>Fusarium oxysporum f.sp. canariensis</i>	A	Palm Wilt	<i>Phoenix canariensis</i>	Marin, Riverside, San Deigo, Santa Barbara, Santa Clara, Ventura
<i>Fusarium oxysporum f.sp. canariensis</i>	A	Palm Wilt	<i>Phoenix reclinata</i>	Riverside, San Diego
** <i>Gymnosporangium juniperi-virginianae</i>	A	Cedar-Apple Rust	<i>Malus spp.</i>	Redwood Hwy. Insp. Station, Monterey
			<i>Malus pumila</i>	Solano-interception from NC
* <i>Botrytis hyacinthi</i>	Q	Botrytis Blight	<i>Eucomis sp.</i>	Monterey
<i>Corynespora cassicola</i>	Q	Leaf spot	<i>Mandevilla sp.</i>	Santa Barbara
Cucurbit Yellow Stunting Disorder	Q	Plant virus	<i>Cucumis melo</i>	Imperial
<i>Cylindrocladium spathulatum</i>	Q	Root rot	<i>Myrtus communis</i>	Santa Barbara
<i>Cytospora eucalypticola</i>	Q	Canker fungus	<i>Phoenix canariensis</i>	Ventura
<i>Discula destructiva</i>	Q	Dogwood Anthracnose	<i>Cornus sp.</i>	Santa Clara
<i>Fusarium thapsinum</i>	Q	Fusarium Stalk Rot	<i>Sorghum bicolor</i>	Tulare
* <i>Nimbya celosiae</i>	Q	Leaf spot	<i>Celosia sp.</i>	Madera
Pea Seed-borne virus	Q	Plant virus	<i>Pisum sativum</i>	Monterey
<i>Peronospora pulveracea</i>	Q	Downy Mildew	<i>Hellebore sp.</i>	San Mateo
<i>Peronospora trigonellae</i>	Q	Downy Mildew	<i>Trigonella foenum</i>	Los Angeles
* <i>Phragmidium tuberculatum</i>	Q	Rose Rust	<i>Rosa sp.</i>	Monterey, Orange, San Diego, Sacramento Santa Barbara, Santa Cruz
* <i>Puccinia farinacea</i>	Q	Salvia Rust	<i>Salvia greggii</i>	Santa Barbara, Santa Cruz, Santa Clara
Tomato Yellow Leaf Curl virus	Q	Plant virus	<i>Lycopersicon esculentum</i>	Riverside, Santa Barbara
<i>Uromyces epicampis</i>	Q	Muhlenbergia Rust	<i>Muhlenbergia nigens</i>	Santa Barbara

Note: Report is exclusive of S.O.D. (Sudden Oak Death), C.W.R. (Chrysanthemum White Rust) and Gladiolus Rust - all presented in individual reports.

*Submitted for evaluation as "C" pests for 2009

**Intercepted Pests

Prepared by J. White

A-Rated Palm Wilt Pathogen



A. Progressive decline of a *Phoenix canariensis* tree in Santa Clara Co., CA infected with *Fusarium oxysporum* f. sp. *canariensis*. Note how the disease has progressed from the oldest to the youngest leaves. **B.** Typical one-sided dieback of the leaflets of two fronds affected by palm wilt. **C.** Brown vascular streaking of the petiole from a frond exhibiting one-sided dieback (Inset: isolation plate from a tree infected with *F. oxysporum* f. sp. *canariensis*. Note that colonies of this strain can vary in color from white (shown) to pink to violet). (Photographs by Suzanne Rooney-Latham, CDFA).

Q-Rated Pest: Dogwood Anthracnose



A. Typical pattern of necrosis and foliar decline of *Discula destructiva*, Dogwood Anthracnose, on *Cornus* sp. The fungal pathogen is highly destructive to many species of Flowering and Pacific Dogwood. **B.** Irregular shaped brown lesions with distinctive smoky, purple-brown margins develop with Anthracnose disease that are visible on upper and lower leaf surfaces. **C.** *Cornus* flower bracts exhibiting reddish spots and blotches prevalent with wet conditions during flowering. (Photographs by Robert Anderson, USDA Forest Service, Bugwood.org)



A. *Discula destructiva* –the fungal pathogen also spreads into petioles, then small twigs and into larger branches causing multiple stem cankers. **B.** Trunk canker caused by advanced Dogwood Anthracnose disease which may cause death of the tree. The causal fungus may also invade a trunk from succulent young shoots, very prone to infection that may form directly on the trunk. (Photographs by D. Hoysa, Virginia Cooperative Extension). (Inset: Typical *Discula sp.* isolate fungal colony on Potato Dextrose Agar (PDA) after two weeks of culture. Colonies appear appressed, granular and white, darkening with age.) (Photograph from USDA Forest Service, Northeastern Area)

Pseudocercospora liquidambaricola, Fungal Leaf Spot of *Loropetalum chinense*

Cheryl Blomquist and Marinell Soriano

Loropetalum chinense, Chinese fringe flower, is an evergreen shrub native to the Southeastern United States and grown widely in California. It is popular for its neat, compact habit, colorful foliage and spring flowers. In late 2007, several shipments of Chinese fringe flower from a Georgia nursery to Santa Cruz County were found to be infected with *Pseudocercospora liquidambaricola*. Concurrently, a shipment from Florida to Santa Barbara County was also found infested with this pathogen. *P. liquidambaricola* is reported to be distributed throughout the Southeast as far north as Delaware and Maryland and south into Mexico as well as on the island of Taiwan. *P. liquidambaricola* infects both *Liquidambar* and *Loropetalum* species. It has never been reported in California on either host. Symptoms of infection are small angular necrotic spots from 2–10 mm in length scattered on the leaf. Fruiting structures typical of *Pseudocercospora* spp. are sometimes visible by microscopy on the leaf spot (Figure 1A). Conidiophores, which are present in dense fascicles, and conidia (spores) are pale olivaceous in color. Conidia are very long and thin, sometimes undulate or curved measuring 2–3.5 x 40–100 μ (Figure 1B.).

To address the question of how common this pathogen may be in California nurseries, Chinese fringe flower that had been collected for *Phytophthora ramorum* testing was examined for *Pseudocercospora liquidambaricola* by isolation onto acidified potato dextrose agar from the margins of leaf spots, and cultures were examined approximately a week later. Samples were collected from December 2007–May 2008. Out of 319 samples examined, *P. liquidambaricola* was detected on two, one from San Diego County and one from Solano County (Table 1). It is unclear if the numbers of plants found infected were so low because this pathogen has been introduced infrequently into California or because the environmental conditions present in California are not conducive to disease development. This leaf spot disease has never become serious in the natural environment where the disease is endemic and has been controlled with fungicides and good sanitation practices in the nurseries of the Southeast.

County	Number of Lots	Results
Alameda	1	Not detected
Contra Costa	3	Not detected
Fresno	7	Not detected
Los Angeles	82	Not detected
Orange	10	Not detected
Riverside	3	Not detected
Sacramento	18	Not detected
San Diego	86	1 detected
Santa Barbara	32	Not detected
Santa Cruz	70	Not detected
Solano	6	1 detected
Stanislaus	1	Not detected
Total	319	2 detected

Table 1. Counties and numbers of samples of *Loropetalum chinense* examined for fungal fruiting structures and conidia (spores) of *Pseudocercospora liquidambaricola*.

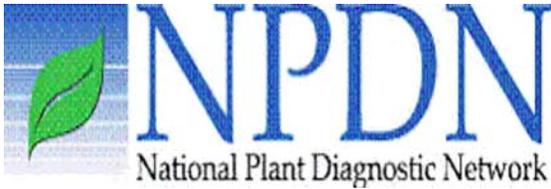
References:

Chupp, Charles. A Monograph of the Fungus Genus *Cercospora*. 1954. Ithaca, New York.

Crous, Pedro W. and Braun, Uwe. *Mycosphaerella* and its Anamorphs: 1. Names published in *Cercospora* and *Passalora* 2003. Centraalbureau voor Schimmelcultures, Ad Utrecht, The Netherlands.



Figure 1. (A) *Pseudocercospora liquidambaricola* conidiophores, present in fascicles bearing spores on a leaf of *Loropetalum* sp. (B) Olivaceous conidiophores and conidia of *Pseudocercospora liquidambaricola*. Conidia are long, thin and curved measuring 2-3.5 x 40-100 μ m.



2008 NPDN activities of the CDFA Plant Pest Diagnostics Branch

The Mission of the National Plant Diagnostic Network (NPDN) (an arm of the US Department of Homeland Security) is to enhance national agricultural security by quickly detecting introduced pests and pathogens. The NPDN functions as a nationwide network of public agricultural institutions with a cohesive distributed system to quickly detect high consequence, biological pests and pathogens deliberately or inadvertently introduced into our agricultural and natural ecosystems. This is done by providing a means of quick determinations and establishing protocols for immediate responders and decision-makers. The NPDN provides a way for university diagnosticians, state regulatory scientists and personnel, and others to efficiently communicate information, including pest and disease images and maps throughout the system in a timely manner.

As the "Hub" Laboratory for the Western Plant Diagnostic Network (WPDN), representing the Western Region's ten states & 2 US territories, the PPDC Laboratory's NPDN activities included the following service and accomplishments:

TRAINING:

PPDB Lab scientists participated in various meetings, workshops, and training sessions with USDA to learn protocols and techniques to diagnose NPDN-identified high profile pathogens and plant pests:

- Two PPDB pathologists and three technicians received training from the USDA Center for Plant Health Testing (CPHST) in Beltsville, MD in the Real-time PCR protocol for the identification of the Huanglongbing (HLB) Citrus Greening Disease Pathogen.
- Three PPDB nematologists received training from the USDA Center for Plant Health Testing (CPHST) in Beltsville, MD in the Real-time PCR protocol for the identification of the Potato Cyst Nematode (PCN).
- Plans and Financial commitments by the NPDN were made to send two PPDB pathologists to CPHST for training in the Real-time PCR protocol for the identification of *Phytophthora kernoviae* in 2009.

PROVISIONAL ACCREDITATION:

- Two PPDB pathologists and Three Agricultural Biological Technicians successfully performed and passed provisional laboratory tests as part of the APHIS Provisional Laboratory Accreditation process for *Phytophthora ramorum* diagnostics.

- Two PPDB pathologists successfully performed and passed provisional laboratory tests as part of the APHIS Provisional Laboratory Accreditation process for HLB diagnostics. Three technicians who received CPHST training began the process of performing provisional laboratory tests as part of the APHIS Provisional Laboratory Accreditation process for HLB diagnostics.

MEETING PARTICIPATION:

Four PPDC scientists participated in the 2008 WPDN National Meetings at Phoenix, AZ in January 2008, and in Reno, NV in November 2008.

OTHER NPDN SERVICE:

Two PPDC scientists served on the NPDN Diagnostics Subcommittee (Tidwell & Gaimari).

Two PPDC scientists served on the NPDN Laboratory Accreditation Subcommittee (Tidwell & Gaimari).

One CDFA Scientist and one CDFA IT specialist served on the NPDN Database Subcommittee (Tidwell & Estep).

One PPDC scientist served on the NPDN Ad-hoc Entomology Committee (Gaimari).

SELECT AGENT / HIGH PROFILE SAMPLES:

461 Potato Cyst Nematode samples were processed and examined. The nematode was not detected.

498 Legume samples were examined for Soybean Rust (No rust was detected). In addition, as an adjunct function to the soybean rust samples, 450 samples were processed and tested for plant viruses (2 samples were confirmed as positive for alfalfa mosaic virus) as part of the national plant disease sentinel plot and diagnostic program known as the "Pest Information Platform for Education & Extension" (PIPE).

2000 stone fruit trees were tested for Plum Pox Virus as part of phytosanitary compliance for a nursery stock sale to Canada. The virus was not detected.

476 Plant samples and 120 Psyllid samples were tested for the Huanglongbing (HLB) Citrus Greening pathogen. The pathogen was not detected in any of the plant or psyllid samples.

2008 HOLIDAY PROJECT

The Meadowview region of South Sacramento is an inner-city area of Sacramento that is known for gangs, violence, and poverty. It is also the neighborhood where the California Department of Food and Agriculture's Plant Pest Diagnostic Center (PPDC) Laboratory is located. For the Lab's 2008 Christmas Holiday Project, the Laboratory staff "adopted" Mark Hopkins Elementary School, a local grammar school within walking distance of the Lab in which, according to Principal Laura Reed, 97% of the 400 plus students are from families at or below poverty level. Building good character is a high priority at Mark Hopkins Elementary, and one particular program at the school that is especially successful in accomplishing this is the "Caught you being good" program in which good behavior is recognized and affirmed by awarding students "Husky Bucks" (the Husky is the school mascot) for situations in which they are covertly "caught" by teachers or staff in the act of demonstrating good behavior such as showing courtesy, being helpful, or voluntarily doing something positive for the school such as picking up trash. Periodically the students have opportunities to redeem their Husky Bucks in the school store for various toys and other items. Unfortunately, the store items used for these rewards are not funded by the school's frugal budget. Consequently, the school relies on donations, or the teachers themselves purchase items to keep this and other such proven incentive programs afloat. The PPDC Lab staff responded by decorating this year's Lab Christmas tree (nicknamed the "Giving Tree") with much needed school supplies as well as toys and games to re-stock the shelves of the school store so that programs like "Caught you being good" can continue to affirm students' good behavior.

In addition to the Giving Tree, The PPDC Lab also gave the school the gift of learning, by providing the school's 6th grade science students a tour of the PPDC Laboratory that included interaction with the Lab's scientists and technical staff in a fascinating environment of Insect, Plant, and Seed collections. Among other experiences, students got a first-hand look at a two million specimen insect collection, an up-close-and-personal view of viruses through an electron microscope, and unique opportunity to handle live giant Madagascar cockroaches. Students also learned that by staying in school, and getting a few science classes under their belt at the local Junior College, they could qualify to come and work in the PPDC laboratory themselves in a few short years.



(Left) Entomologist Martin Hauser introduces students to his pet Giant Madagascar Hissing Cockroaches in the PPDB Lab's two million specimen arthropod collection. (Right) Seed Botanist Jim Effenberger teaches students about the biology of seeds and fruits using the 2nd largest seed herbarium in the United States as a classroom.

2008 PUBLICATIONS AND PRESENTATIONS

2008 PUBLICATIONS

Audisio P., A.H. Kirk-Spriggs, A.R. Cline, M. Trizzino, G. Antonini, E. Mancini and A. De Biase. 2008. A new genus of pollen-beetle from South Africa (Coleoptera: Nitidulidae), with discussion of the generic classification of the subfamily Meligethinae. *Insect Systematics and Evolution* 39: 419–430.

Baalbaki, R., and K. Fiedler. 2008. Results of 2007 vigor testing survey of AOSA member labs. *The Seed Technologist Newsletter* 82 (1): 59–61.

Bellamy, C. L. 2008. A new monotypic genus of ant-mimicking Coraebini (Coleoptera: Buprestidae: Agrilinae) from Madagascar. *Zootaxa* 1817:65–68.

Bellamy, C. L. 2008. *A World Catalogue and Bibliography of the Jewel Beetles* (Coleoptera: Buprestoidea). Volume 1: Introduction; Fossil Taxa; Schizopodidae; Buprestidae: Julodinae - Chrysochroinae: Poecilonotini. *Pensoft Series Faunistica* No. 76, 625 pp. Pensoft Publishers, Sofia–Moscow.

Bellamy, C.L. 2008. *A World Catalogue and Bibliography of the Jewel Beetles* (Coleoptera: Buprestoidea), Volume 2: Chrysochroinae: Sphenopterini through Buprestinae: Stigmoderini, *Pensoft Series Faunistica* No. 77, pp. 626–1260, Pensoft Publishers, Sofia–Moscow.

Bellamy, C.L. 2008. *A World Catalogue and Bibliography of the Jewel Beetles* (Coleoptera: Buprestoidea), Volume 3: Buprestinae: Pterobothrini through Agrilinae: Rhaeboscelina, *Pensoft Series Faunistica* No. 78, pp. 1261–1931, Pensoft Publishers, Sofia–Moscow.

Bellamy, C.L. 2008. *A World Catalogue and Bibliography of the Jewel Beetles* (Coleoptera: Buprestoidea), Volume 4: Agrilinae: Agrilina through Trachyini, *Pensoft Series Faunistica* No. 79, pp. 1932–2684, Pensoft Publishers, Sofia–Moscow.

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

Bellamy, C. L. 2008. The genus *Maoraxia* Obenberger in Fiji (Coleoptera: Buprestidae: Maoraxiini). *In*: N. L. Evenhuis and D. J. Bickle (Eds.): *Fiji Arthropods X*, Bishop Museum Occasional Papers 97:3–12.

Bellamy, C. L. 2008. New Coraebini Bedel, 1921 from West Africa (Coleoptera: Buprestidae: Agrilinae). *The Coleopterists Bulletin* 61(4)(2007): 560–566.

Bellamy, C. L. 2008. Delayed, or prolonged, emergence of three uncommon California Buprestidae (Coleoptera). *The Pan-Pacific Entomologist* 83(4)(2007): 366–368.

- Bellamy, C. L. 2008. A new replacement name in *Lampetis* Dejean, 1833 (Coleoptera: Buprestidae). *Zootaxa* 1733:68.
- Bellamy, C. L. 2008. A replacement genus-group name in Buprestidae (Coleoptera). *Zootaxa* 1791:68.
- Bellamy, C. L. 2008. New taxa, distribution and biological records of Afrotropical Coraebini Bedel, 1921 (Coleoptera: Buprestidae: Agrilinae). *Zootaxa* 1848:1–15.
- Bellamy, C. L. and T. Lander. 2008. The synonymy of *Cyalithoides fulgida* Fisher, 1922 with *Chrysodema robusta* Deyrolle, 1864 (Coleoptera: Buprestidae: Chrysochroinae). *Zootaxa* 1811:34–36.
- Bellamy, C. L. and T. Weir. 2008. The reinstatement of *Julodimorpha saundersii* Thomson 1879 (Coleoptera: Buprestidae) as a valid species. *Zootaxa* 1751:46–54.
- Brown, J.W., M.E. Epstein, K. Vann, R.A. Watkins, S.M. Bahr, II, and E. Kolski. 2008. An overview of the Lepidoptera (Insecta) of Plummers Island, Maryland. *Bulletin of the Biological Society of Washington*. 15: 65–74.
- Chitambar, J. J., K. Dong and S. A. Subbotin. 2008. Phytoparasitic nematode infestations of California's grape, citrus and stone fruit crop. 5th International Congress of Nematology, 2008: 323 (Abstract).
- Chitambar, John J. 2008. Status of ten quarantined "A" nematode pests in California. *California Plant Pest and Disease Report*, 24: 62–74.
- Cline, A.R. 2008. Revision of the Sap Beetle Genus *Pocadius* Erichson, 1843 (Coleoptera: Nitidulidae: Nitidulinae). *Zootaxa* 1799: 1–120.
- Cline, A.R., M. A. Ivie, C. L. Bellamy, and J. Scher. 2008. *Wood Boring Beetles of the World: Wood Boring Beetle Families*, Lucid v. 3.4. USDA/APHIS/PPQ Center for Plant Health Science and Technology, California Department of Food and Agriculture, and Montana State University. <http://keys.lucidcentral.org/keys/v3/WBB/Home.htm>
- Dean, Ellen, G.F. Hrusa, Gordon Leppig, Andrew Sanders, and Barbara Ertter, 2008. *Madrono* 55(1): 93-112. Catalogue of nonnative vascular plants occurring spontaneously in California beyond those addressed in the Jepson manual – part II
- Deimi, A.M. J. J. Chitambar and Z. T. Maafi. Nematodes associated with flowering ornamental plants in Mahallat, Iran. *Nematologia Mediterranea*, 2008, 36: 115–123.
- Effenberger, J. and D. J. Lionakis Meyer. 2008. Identification of commercial florets of basin wildrye, bottlebrush squirreltail, canada wildrye, Russian wildrye, slender wheatgrass and tall wheatgrass (*Elymus* s.l.). CDFA Plant Pest Diagnostics Center. 6 pp.
- Elias, S. G. and D. J. Lionakis Meyer. 2008. Statistical bases for tolerances of noxious weed seeds. *Seed Technology Newsletter* 82(2):32–36.

- Ellis, J.D., K.S. Delaplane, A.R. Cline, and J.V. McHugh. 2008. The association of multiple sap beetle species (Coleoptera: Nitidulidae) with western honeybee (*Apis mellifera*) colonies in North America. *Journal of Apicultural Research* 47(3):188–189.
- Gaimari, S.D., P. Milonas and C. Souliotis. 2008 (2007). Notes on the taxonomy, biology and distribution of *Neoleucopis kartliana* (Diptera: Chamaemyiidae) *Folia Heyrovskyana, Series A* 15(1): 7–16.
- Gaimari, S.D. 2008. Comments on the proposed conservation of *Drosophila* Fallen, 1823 (Insecta, Diptera). (comment 5). *Bulletin of Zoological Nomenclature* 65 (2): 146–147.
- Garrison, R.W. 2008. 100 Years of the *Biologia Centrali-Americana*, Neuroptera. *ARGIA. The News Journal of the Dragonfly society of the Americas* 20(4): 5–8.
- Garrison, R. W. and N. von Ellenrieder. 2008. *Dolonagrion* nov. gen. for *Telagrion fulvellum* (Selys, 1876) nov. comb. from South America (Odonata: Coenagrionidae). *International Journal of Odonatology* 11(2): 173–183.
- Ghahari, H., C. L. Bellamy, H. Sakenin and R. Patterson. 2008. A contribution to new records of Iranian Buprestidae (Coleoptera). *Munis Entomology and Zoology* 3(2):636–642.
- Grünwald N.J., E.M. Goss, M.M. Larsen, C.M. Press, V.T. McDonald, C.L. Blomquist and S.L. Thomas. 2008. First report of the European lineage of *Phytophthora ramorum* on *Viburnum* and *Osmanthus* spp. in a California nursery. *Plant Disease* 92: 314.
- Hauser, M. (2008): Order Diptera, family Stratiomyidae, pp 591–601. In: van Harten, A. (ed.): *Arthropod Fauna of the United Arab Emirates*. Volume 1, 754 pp.
- Hrusa, G.F. and J. F. Gaskin 2008. The *Salsola tragus* complex in California (Chenopodiaceae): Characterization and status of *Salsola australis* and the autochthonous allopolyploid *Salsola ryanii* sp. nov. *Madrono* 55(1): 113–131.
- Ismail, B., I. Haffar, R. Baalbaki, and J. Henry. 2008. Physico-chemical characteristics and sensory quality of two date varieties under commercial and industrial storage conditions. *LWT-Food Science and Technology* 41: 896–904.
- Kerr, P.H. (2008) Fungus gnats (Diptera: Mycetophilidae and others). Pp 1551-1554, in Capinera, J.L. (Ed.), *Encyclopedia of Entomology*, 2nd Edition. Springer.
- Kerr, P.H. and Winterton, S.L. (2008) Do parasitic flies attack mites? Evidence in Baltic amber. *Biological Journal of the Linnean Society* 93:9-13.
- Kerr, P.H., Fisher, E.M., & Buffington, M.L. (2008) Dome lighting for insect imaging under a microscope. *American Entomologist* 54 (4): 198-200.
- Ma H., Overstreet R.M. and Subbotin S.A. 2008. ITS2 secondary structure and phylogeny of cyst-forming nematodes of the genus *Heterodera* (Tylenchida: Heteroderidae). *Organisms, Diversity and Evolution* 8, 182–193.

- MacFadyen, D. N., B. K. Reilly, C. L. Bellamy and R. J. Eiselen. 2008. Morphological differences between three South Africa species of *Evides* Dejean, 1833 (Coleoptera: Buprestidae). *The Coleopterists Bulletin* 61(4)(2007): 509–517.
- Majka, C.G., R. Webster and A.R. Cline. 2008. New Records of Nitidulidae and Kateretidae (Coleoptera) from New Brunswick, Canada. *Zookeys* 2:337–356.
- Meyer, D. J. L. and Wiersema, J. H. (Eds.). 2008. Uniform classification of weed and crop seeds: contribution no. 25 to the handbook on seed testing. 7th ed. Association of Official Seed Analysts, Stillwater, OK. 280 pp.
- Meyer, D. J. L. and J. Effenberger. 2008. Grass caryopses and the AOSA rules. CDFA Plant Pest Diagnostics Center. 12 pp.
- Meyer, D. J. L. and J. Effenberger. 2008. California Noxious Weed Pest Propagules Identification Manual. California Department of Food and Agriculture. Sacramento, CA. 88 pp.
- Mishler, B. D. and D. G. Kelch. 2008. Phylogenomics and early land plant evolution. Chapter 4, in J. Shaw and B. Goffinet (eds.), *Bryophyte Biology*, 2nd ed. Cambridge Press.
- Mundo-Ocampo M., Troccoli A., Subbotin S.A., Del Cid J., Baldwin J.G. and Inserra R.N. 2008. Synonymy of *Afenestrata* with *Heterodera* supported by phylogenetics with molecular and morphological characterisation of *H. koreana* comb. n. and *H. orientalis* comb. n. (Tylenchida: Heteroderidae). *Nematology* 10, 611–632.
- Nelson, G. H., G. C. Walters, Jr., R. D. Haines and C. L. Bellamy. 2008. A catalog and bibliography of the Buprestoidea of America North of Mexico. *The Coleopterists Society, Special Publication No. 4*, pp. iv + 1–274.
- Nunes, E.S., Brown J.K., Moreira, A.G., Watson, G., Lourenção, A.L., Piedade, S.M.S., Rezende, J.A.M., and M.L.C. Vieira (2008) First report and differential colonization of *Passiflora* species by the B Biotype of *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) in Brazil. *Neotropical Entomology* 37(6): 744–746.
- Palomares-Rius J., Subbotin S.A., Landa B.B., Vovlas N. and Castillo P. 2008. Description and molecular characterisation of *Paralongidorus litoralis* sp. n. and *P. paramaximus* Heyns, 1965 (Nematoda: Longidoridae) from Spain. *Nematology* 10, 87–101.
- Peng, D., Zheng, J., Moens, M. and Subbotin, S.A. 2008. Molecular characterization and diagnosis of the important plant parasitic nematodes in China. 5th International Congress of Nematology, 98 (Abstract).
- Rooney-Latham, S., Janousek, C.N., Eskalen, A., and W. D. Gubler. 2008. First report of *Aspergillus carbonarius* causing sour rot of table grapes (*Vitis vinifera*) in California. *Plant Disease* 92: 651.

- Rung, A., Scheffer, S.J., Evans, G. and Miller, D. 2008. Molecular identification of two closely related species of mealybugs of the genus *Planococcus* (Hemiptera: Pseudococcidae). *Annals of the Entomological Society of America*, 101(3): 525–532.
- Subbotin, S.A., Adams, B., Bert, W., Castillo, P., Chizhov, V.N., Inserra, R.N., Powers, T., Sturhan, D., Van Den Berg, E., Vovlas, N., Ye, W., Yeates, G. and Baldwin, J.G. Molecular systematics of the order Tylenchida: from ribosomal RNA gene to genome analysis. 5th International Congress of Nematology, 113.
- Subbotin, S.A., Mundo-Ocampo, M., Mullens, T., Roberts, P.A. and Baldwin, J.G. 2008. Diagnostics and management to protect California Agriculture from invasion of false root-knot nematode (*Nacobbus* spp.) 5th International Congress of Nematology, 333.
- Subbotin S.A., Ragsdale E.J., Mullens T., Roberts P.A., Mundo-Ocampo M. and Baldwin J.G. 2008. A phylogenetic framework for root lesion nematodes of the genus *Pratylenchus* (Nematoda): evidence from 18S and D2-D3 expansion segments of 28S ribosomal RNA genes and morphological characters. *Molecular Phylogenetics and Evolution* 48, 491–505.
- Summers, C.G., A. S. Newton, and D. C. Opgenorth. 2008. Distribution of *Spiroplasma kunkelli* and *Dalbulus maidis* in the San Joaquin Valley, California–2007. *UC Plant Protection Quarterly*. 18(1): uckac.edu/ppq.
- Talhouk, R.S., W. El-Jouni, R. Baalbaki, H. Gali-Muhtasib, J. Kogan and S.N. Talhouk. 2008. Anti-inflammatory bio-activities in water extract of *Centaurea ainetensis*. *Journal of Medicinal Plants Research* 2(2): 24–33.
- Tidwell, T.E. 2008. Japanese Dodder, a New Phanerogamic Pathogen in California. *National Plant Diagnostic Network News*. (June) 3:7–10.
- Tishechkin, A.K. and A.R. Cline. 2008. The beetle (Coleoptera) fauna of pocket gopher burrows in Louisiana. *Proceedings of the Entomological Society of Washington* 110: 331–339.
- von Ellenrieder, N. and R.W. Garrison. 2008. A redefinition of *Telagrion* Selys and *Aceratobasis* Kennedy stat. rev. and the description of *Schistolobos* gen. nov. for *Telagrion boliviense* Daigle (Odonata: Coenagrionidae) *Transactions of the American Entomological Society* 134(1+2): 1–22.
- von Ellenrieder, N. and R.W. Garrison. 2008. *Drepanoneura* gen. nov. for *Epipleoneura letitia* and *Protoneura peruviansis*, with description of eight new Protoneuridae from South America (Odonata: Protoneuridae). *Zootaxa* 1842:1–34.
- von Ellenrieder, N. and R.W. Garrison. 2008. *Oreiallagma* gen. nov. with a redefinition of *Cyanallagma* Kennedy 1920 and *Mesamphiagrion* Kennedy 1920, and the description of *M. dunklei* sp. nov. and *M. ecuatoriale* sp. nov. from Ecuador (Odonata: Coenagrionidae). *Zootaxa* 1805:1–51.

von Ellenrieder, N. and R.W. Garrison. 2008. The genus *Oligoclada* in Argentina, with description of *O. rubribasalis* (Odonata: Libellulidae). *International Journal of Odonatology* 11(2): 249–260.

Vovlas N., Subbotin S.A., Troccoli A., Liebanas G. and Castillo P. 2008. Molecular phylogeny of the genus *Rotylenchus* (Nematoda, Tylenchida) and description of a new species. *Zoologica Scripta* 37, 521–537.

Westcott, R. L., H. A. Hespenheide, J. Romero N., A. Burgos Solorio, C. L. Bellamy and A. Equihua M. 2008. The Buprestidae (Coleoptera) of Morelos, Mexico, with description of six new species, and a partially annotated checklist. *Zootaxa* 1830:1–20.

White, J.B. and C. L. Blomquist. 2008. The Rusts – A Unique Group of Fungi. *California Plant Pest and Disease Report* 24: 47–53.

Zheng, J. Li, X., Zhang, Y. and Subbotin, S.A. 2008. Molecular characterization of cyst forming nematode *Heterodera sinensis* Chen and Zheng, 1994 from China. *Russian Journal of Nematology* 16, 159–162.

2008 PRESENTATIONS

Baalbaki, R. “Overview of the AOSA Seed Vigor Testing Handbook, Co-edited by Drs. Elias (Oregon State University), Filho (University of Sao Paulo) and McDonald (Ohio State University).” International Conference; Association of Official Seed Analysts and Society of Commercial Seed Technologists; St. Paul, MN. June 10, 2008.

Baalbaki, R. Statistics Workshop (co-organizer and instructor). Topics include: applications of experimental design, data analysis, and tolerances for seed testing. International Conference; Association of Official Seed Analysts and Society of Commercial Seed Technologists; St. Paul, MN. June 6, 2008.

Baalbaki, R. “Seed Vigor Testing.” CDFA Seed Testing Workshop. California Department of Food and Agriculture, Plant Pest Diagnostics Center, Sacramento, CA. May 13, 2008.

Baalbaki, R. Annual report of the AOSA Seed Germination and Dormancy Research Subcommittee. International Conference; Association of Official Seed Analysts and Society of Commercial Seed Technologists; St. Paul, MN. June 2008

Baalbaki, R. “Plants, Pests, Energy Budgets and Global Warming.” California Department of Food and Agriculture, Plant Pest Diagnostics Branch Seminar Series. October 23, 2008.

Chitambar, J. “*Globodera pallida* in the United States – Current Status January 2008.” Department of Nematology, University of California, Davis. February 4, 2008.

Chitambar, J. “How to collect and prepare nematode samples for submission to the CDFA Laboratory.” Pest Prevention University – Northern California. Three 2-day workshops held in Sacramento, Dublin and Redding organized by Pest Exclusion, California Department of Food and Agriculture.

Cline, A.R. 2008. Systematics and Diversity of Nitidulidae (Coleoptera: Cucujoidea). Annual Meeting of the Entomological Society of America; Invited Talk.

Cline, A.R., Bellamy, C., O'Donnell, M., Ivie, M., and Evans, A. 2008. The LUCID wood-boring beetle project, Phase II: World Genera of Bostrichidae and Buprestidae (Coleoptera). Annual Meeting of the Entomological Society of America; Poster.

Effenberger, J. "Annual Report of the SCST Professional Ethics Committee." International Conference; Association of Official Seed Analysts and Society of Commercial Seed Technologists; St. Paul, MN. June 2008.

Effenberger, J. "Identification of the florets of basin wildrye, bottlebrush squirreltail, Canada wildrye, Russian Wildrye, slender whestagrass and tall wheatgrass (*Elymus* s.l.)." CDFA Seed Testing Workshop. California Department of Food and Agriculture, Plant Pest Diagnostics Center, Sacramento, CA. May 13, 2008.

Epstein, M. E. "Visual morphological identifications of the Light Brown Apple Moth and other Tortricidae in California (with Todd Gilligan). National Meeting of Entomological Society of America, Reno, Nevada. November 16, 2008.

Epstein, M. E. and Todd Gilligan. "Diagnostics Development for LIGHT BROWN APPLE MOTH Identification" Light Brown Apple Moth Research Conference. Foster City, CA. July 22, 2008.

Epstein, M. E. False Codling Moth and Light Brown Apple Moth Workshop. Plant Pest Diagnostics Laboratory, June 10, 2008.

Epstein, M. E. Light Brown Apple Moth Identification training Workshop. Santa Barbara Co. Dept of Agriculture. February 20, 2008.

Garrison, R.W. "Research on the Neotropical Odonata: Current results and challenges ahead." Pacific-Coast Entomological Society, University of California, Davis. December 12, 2008.

Hauser, M. Insect exhibition at the "Earth Day" in Saluda Shoals Park. Columbia, SC, May 10, 2008.

Hauser, M. "Madagascar: People and Nature on the 8th Continent" Northern California Entomology Society meeting. Concord, CA, November 6, 2008.

Hauser, M. "Desert diversity – arthropod inventory in the United Arab Emirates." CDFA Plant Pest Diagnostics Center Seminar Series. November 2008.

Hidayat, P. & Watson, G.W. (2008) Recognition of giant whitefly, *Aleurodicus dugesii* Cockerell (Hemiptera: Aleyrodidae), a potential pest newly introduced to Indonesia. Entomological Society of Indonesia at Bogor, Western Java, Indonesia, on 20 March 2008.

Kelch, D. G. "Jepson Herbarium Workshop: 51 Plant Families in the Field." Botanists' Workshop. Multiple sites in several San Francisco Bay Area counties. March 2008.

Kelch, D. G. "Jepson Herbarium Workshop: 51 Plant Families in the Field." Workshop for California Department of Transportation Biologists. Multiple sites in several San Francisco Bay Area counties. April 2008.

Kerr, P. "Collections management: vouchering for the future." Plant Pest Diagnostic Center Seminar Series, CDFA, Sacramento, CA. February 2008.

Kerr, P.H. California Academy of Sciences: 20 May 2008, Title: "Collections management at the CDFA."

Kerr, P.H., Norrbom, A.L., Gaimari, S.D., Woods, P.W., Korytkowski, C. 2008. Molecular Phylogeny of *Anastrepha* (Diptera: Tephritidae). Poster Presentation, Fourth International Meeting on Taxonomy and Natural History of Tephritoidea. Knoxville, TN, June 9-14.

Kerr, P.H. University of Oslo, Norway: 15 December 2008, Title: "Collection and Curation in California."

Meyer, D. J. L. "CDFA Seed Laboratory Overview and Status Report." California Seed Advisory Board Meeting. California Department of Food and Agriculture, Plant Pest Diagnostics Center, Sacramento, CA. November 6, 2008.

Meyer, D. J. L. "Annual Report of AOSA Purity Testing Research Subcommittee." International Conference; Association of Official Seed Analysts and Society of Commercial Seed Technologists; St. Paul, MN. June 2008

Meyer, D. J. L. "Grass embryo and fruit development (Poaceae)." CDFA Seed Testing Workshop. California Department of Food and Agriculture, Plant Pest Diagnostics Center, Sacramento, CA. May 13, 2008.

Rooney-Latham, S. "Fungi: the Good, the Bad and the Ugly." CDFA Plant Pest Diagnostics Center Seminar Series. September 2008.

Subbotin, S. "Phylogenetics and Phylogenomics, Illustrated by Nematode Examples." Seminar Series Plant Pest Diagnostic Center, CDFA, April 2008, Sacramento, USA

Subbotin, S. "Molecular Systematics of the Order Tylenchida: from Ribosomal RNA Gene to Genome Analysis". Plenary talk, 5th International Congress of Nematology, 13-18 July 2008, Brisbane, Australia.

Subbotin, S. "Molecular phylogeny and genomes of plant parasitic nematodes". Plenary talk, Annual Meeting of Russian Society of Parasitologists, Center of Parasitology, A.N. Severtsov Institute of Ecology and Evolution, 9-12 December, 2008, Moscow, Russia.

Tidwell, T. "Diagnosing Plant Pathogens." Plumas-Sierra County Department of Agriculture Continuing Education in Pest Management 2008. Quincy, CA. January 2008.

Tidwell, T. "Plant Disease Diagnostics." Sacramento County Master Gardeners Training. CDFA PPDC, Sacramento, CA. March 2008.

Tidwell, T. "Plant Disease Diagnostics for Horticultural Crops" Lecture for University of CA, Davis, Dept. of Plant Sciences Environmental Horticulture Course. CDFA PPDC, Sacramento, CA. April 2008.

Tidwell, T. "Plant Disease Diagnostics and Sampling Techniques" Lecture for Modesto Junior College Integrated Pest Management Course. CDFA PPDC, Sacramento, CA. September 2008.

Tidwell, T. "Plant Disease Diagnostics and Sampling Techniques" Lecture for Santa Rosa Junior College Integrated Pest Management Course. CDFA PPDC, Sacramento, CA. November 2008.