

**2005
PLANT PEST
DIAGNOSTICS
LABORATORY REPORT**

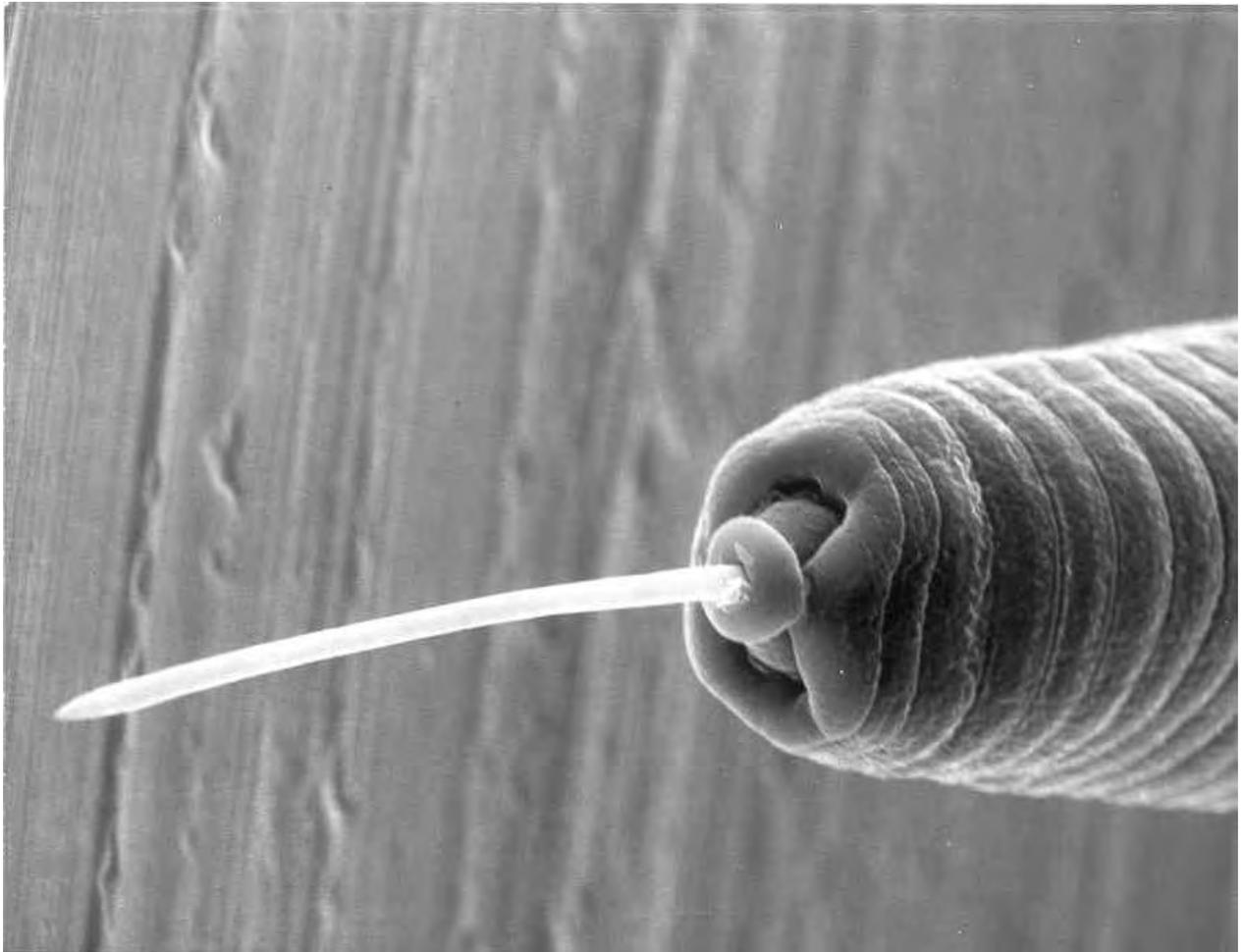


Table of Contents

From the Branch Chief.....	3
Mission.....	3
Research.....	4
California State Collection of Arthropods.....	4
Seminar Series.....	4
Staffing Changes.....	5
Retirements.....	5
Necrologies.....	8
 New Faces at the Plant Pest Diagnostics Laboratory.....	 9
 Botany.....	 12
 Nematology.....	 16
 Seed Science.....	 36
 Entomology.....	 50
 Plant Pathology.....	 69
 2005 Presentations by Plant Pest Diagnostics Laboratory staff...	 93
 2005 Publications by Plant Pest Diagnostics Laboratory staff.....	 95

Cover illustration: *Hemicycliophora poranga* Monteiro & Lordello, 1978, sheath nematode, female anterior body end with extruded stylet, magnified 2200x. Scanning electron micrograph taken by John J. Chitambar, 1994.

**PLANT PEST DIAGNOSTICS BRANCH
ANNUAL REPORT 2005
Umesh C. Kodira, Branch Chief**

From the Branch Chief

Mission:

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

This annual report is a summary of accomplishments from 2005. It provides updates on projects and highlights critical areas of research and new methodology in diagnostics and is by no means inclusive of all work performed at the PPDC.

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

PPDC Sample Processed Data (4-Years)				
Labs / Programs	2002	2003	2004	2005
Botany	4,150	3,284	1,008	1,000
Entomology*	41,529	36,146	45,000+	50,000+
Nematology	5,042	4,782	3,874	4,923
Plant Pathology*	88,402	88,233	109,398	103,451
Seed Science	3,861	3,067	6,923	3,166
Total	142, 984	135,512	166,203	162,540
* Includes special projects				
Please note that the numbers cannot be compared among the different disciplines (labs/programs) as an accurate indication of workload.				

The sample numbers listed are in no way representative of the amount of time or labor required to complete any given sample. Nor can sample numbers be compared among the different disciplines (labs) as a measure of workload. Note for example, that the number of plant taxonomy or seed samples does not reflect the number of actual identifications made for a given sample in these labs. It is common for a single plant or seed sample to require multiple identifications of all the material in a sample. Thus a more accurate representation of the true workload for plant taxonomy and seed taxonomy would be several times these numbers. In a similar way, sample numbers alone do not differentiate between an insect identification that is an immediate recognition and identification, from one requiring lengthy study, possibly collaboration with other experts, or even a new published description. Likewise sample numbers of plant pathology do not differentiate those requiring only a simple, quick serological test, from a sample requiring days to weeks of culturing, microscopy, greenhouse testing, etc. in order to arrive at a diagnosis. And, of course, the same line of reasoning is true for Nematology samples as well.

Research

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

The California State Collection of Arthropods

The Entomology Laboratory's arthropod collection, a significant resource of more than 1.5 million specimens, is utilized for comparative specimens in diagnostics by our staff, and as a resource for scientists worldwide. Our staff has added more than 30,000 specimens to the collection this year, and an inventory of the species held is about 1/3 completed. As far as specimen usage, 32 loans were issued in 2005, representing nearly 14,000 specimens, and more than 35 visitors from the local, national, and international communities have come in to study our collections, including four who studied in our collection for extended periods of one to several weeks.

Seminar Series

The Plant Pest Diagnostics Center seminar series began in 2004 to enable scientists to present research data and discuss on-going research and pest issues of general importance, and has continued throughout 2005 with enthusiasm and participation by many from within and outside of our branch. The speakers have included scientists from the PPDC, USDA, UC Davis, and visiting scientists from other universities and agencies. The focus of the seminar series has been to share information on any aspect of basic or applied research

or diagnostics and includes invited speakers from other institutions. Dr. Shaun Winterton, Associate Insect Biosystematist, coordinates the seminar series.

Staffing Changes

Drs. Martin Hauser and Matt Buffington have joined our branch in the Entomology Laboratory as Post-Doctoral Researchers in 2005. Dr. Hauser's area of specialization is Diptera (Stratiomyidae, Tephritidae, Therevidae), and molecular systematics. Dr. Buffington's area of specialization is Hymenoptera (parasitoids). We welcome both of them to our laboratory and look forward to a productive year.

In addition, Erin Lovig and Monica Negrete joined the Plant Pathology Laboratory as Agricultural Biological Technicians. Likewise, Saraah Kantner and Randall Plant joined the Entomology Laboratory as Agricultural Biological Technicians.

Retirements

Four PPDB staff retired in 2005 after collectively serving nearly 100 years in the PPDB Laboratory.

Mr. Khiet Le retired after 20 years as Librarian. Khiet's career with CDFA was a real success story and an inspiration to many. One of the original Viet Nam refugees in the aftermath of the Vietnam War, i.e. one of the famous "boat refugees," Khiet came to America and eventually carved out a successful career as a librarian for the PPDB Laboratory. He now resides in the Sacramento area, and is an author, writing in both English and Vietnamese.



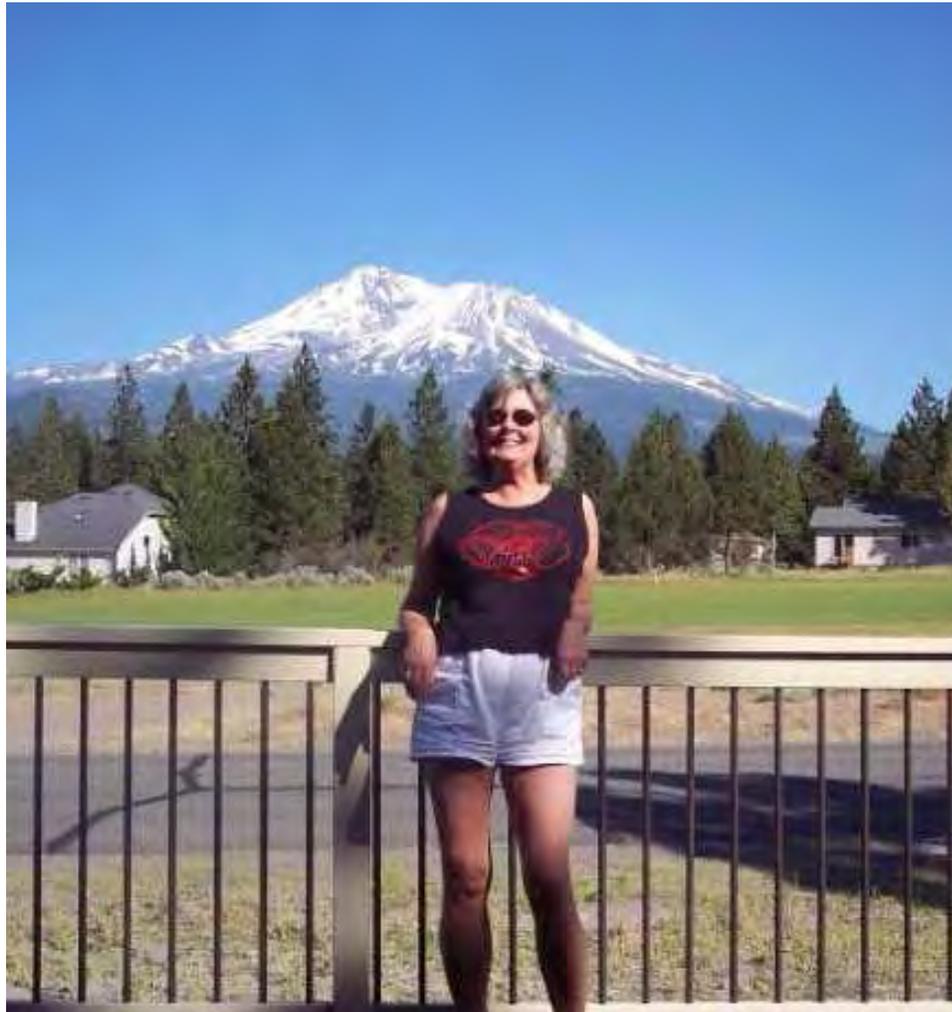
Librarian, Khiet Le

Dr. Marian Stephenson retired as a Senior Seed Botanist with the PPDB Seed Laboratory after 18 years of service. Marian was responsible for regulatory seed physiology testing, regulatory data system management, and seed physiology research. In recent years she served as a very active member of the Association of Official Seed Analysts (AOSA) Tetrazolium Testing Research Committee, as well as the AOSA Germination Testing Research Committee. Marian is a Registered Seed Technologist with the Society of Commercial Seed Technologists as well as an International Seed Technologist with the International Society of Seed Technologists. She contributed many hours in the training of other Registered Professional Seed Technologists as well as other seed testing professionals in the areas of her expertise. She also represented CDFA by serving on professional seed science committees with various national professional seed associations. Marian now resides in Davis, California.



Senior Seed Botanist, Marian Stephenson

Ms. Diana Fogle served the PPDB laboratory as a mycologist, identifying fungi for over 20 years, after serving in a similar position at the Plant Pathology Department of the University of California, Davis (UCD). Ms. Fogle co-authored a number of scientific papers, trained several diagnosticians in the finer points of classical mycology, and served as an invaluable resource to CDFA, as well as to scientists of the University of California Cooperative Extension and the Department of Plant Pathology at UCD. Diana has a world-class reputation for expertise in several groups of fungi, particularly in the genus *Verticillium*. In fact, at one point Diana designed and validated a seed health testing procedure, including a special selective culture medium, for the detection of *Verticillium albo-atrum* in alfalfa seed. This method was ultimately adopted by the Agriculture Ministry of Australia as its standard method of testing alfalfa seed for this pathogen. Diana now makes her home in the Northern California mountain community of Weed, in the shadow of Mount Shasta.



Mycologist, Diana Fogle

Dr. Robert Hackney retired as a senior nematologist after 32 years of service. Bob specialized in the taxonomic identification of plant pathogenic nematodes. Bob also played a key role for many years in the annual California Nematology Workshop, sponsored by CDFA and UC Davis for professional nematologists. Bob now makes his home in Southern California.



Nematologist, Robert Hackney

Necrologies

Dr. Thomas Fuller passed away in April, 2005. Tom retired in 1982, after serving as a Botanist and Supervisor of the Botany and the Seed Laboratories for 25 years. He received his B.S. from Northwestern Univ., Evanston, IL., his M.S. from the Univ. of New Mexico, Albuquerque, and his Ph.D. from the Univ. of Chicago. He was an active member of the California Botanical Society (Past President), the California Weed Science Society (Past President) and the Asian-Pacific Weed Science Society. Following retirement, he co-authored "Poisonous Plants of California" published in 1986 by U.C. Berkeley Press. Earlier, he taught Botany and related courses for a number of years at the Univ. of R.I., Kingston, Hanover College, Hanover, IN. and at the Univ. of Southern California, L.A. Dr. Fuller is remembered as an outstanding scientist, supervisor, teacher, and mentor, earning the respect and admiration of everyone in CDFA, as well as all the clients whom he served.

Mr. Sam Gotan passed away in December, 2005. Sam served the CDFA PPDB laboratory as a Plant Pathologist and Program Supervisor, during the 1960s through the 1980s. After graduating from UC Davis with a graduate degree in Plant Pathology, Sam was a plant disease diagnostician for the PPDB laboratory for several years, specializing in diseases caused by fungal pathogens. As program supervisor he was instrumental in acquiring the laboratory's first electron microscope, and for years he navigated and led the PPDB laboratory through very difficult budgetary times.

New Faces at the CDFA Plant Pest Diagnostics Center

Dr. Matthew Buffington is a postdoctoral scientist working for Fredrik Ronquist (Florida State University) on the NSF funded Hymenoptera Tree of Life project (www.hymatol.org). In this capacity, Matt is responsible for studying the phylogenetics and evolution of the superfamilies Cynipoidea and Proctotrupeoidea. In the course of his work, Matt spends much time curating the Hymenoptera (ants, bees and wasps) of the California State Collection of Arthropods. With his expertise in parasitic wasps, Matt also helps with identifications of these parasites sent to PPD for identification, which is important for California agriculture since the most successful of all biological control agents are parasitic Hymenoptera. Matt has published research on Hymenopteran taxonomy (including new species), phylogenetics, morphology and evolution, with a focus on the Cynipoidea (gall wasps and relatives). Matt is also interested in improving curatorial techniques, imaging techniques for scientific illustrations, and image databasing. Matt is also part of the MorphBank Consortium (www.morphbank.com) working to improve image databasing in the 21st century.



Matthew Buffington



Martin Hauser

Dr. Martin Hauser currently serves as a Postdoctoral researcher in the entomology laboratory doing research on Tephritidae fruit fly systematics under the direction of Entomology laboratory supervisor, Dr. Steve Gaimari. Martin, who is originally from Germany, earned an MS degree in Zoology from the University of Darmstadt (Germany) and worked 2 years in the Insect collection of the Natural History Museum in Stuttgart (Germany). He moved to the Midwest seven years ago after meeting his eventual thesis advisor, Professor Mike Irwin, by accident in the Negev desert of Israel. They struck up a conversation, after noticing that they were both carrying insect nets, and were both collecting flies in the desert. This meeting ultimately led to a MS and PhD in Entomology from the University of Illinois at Urbana-Champaign. Dr. Hauser's thesis dealt with the evolution and systematics of Stiletto Flies. These are widely unknown flies that prefer dry and sandy habitats, because their larvae are living in sand as underground predators of other insects. The goal of his thesis was to shed light on the relationships of the basal lineages of these flies, reconstructing an ancient family tree, using morphological characters as well as DNA data. His work involves molecular studies, taxonomic and descriptive work on fossils as well as recent therevid flies. He also works on other Diptera families, including Syrphidae and Stratiomyidae, and has published more than 20 research papers on these families. One of Dr. Hauser's other great interests is travel. Through his research activities, Martin has visited many countries around the world collecting flies and other insects and visiting museums. Among his immediate plans is a thorough exploration of the beautiful western United States.

Saraah Kantner is the Collection Manager for the California State Collection of Arthropods, in addition to her other duties as an Agricultural Biological Technician for the Entomology Laboratory. She came here after successfully completing an undergraduate degree in Environmental Sciences and Biodiversity, with a double minor in Entomology and Invertebrate Zoology, at the University of California, Davis. Saraah formerly worked as a seasonal technician in this branch, as well as in the state's Biological Control program. After entering UC Davis, she worked as an assistant on a graduate research project studying feeding preferences in *Culex pipiens* mosquitoes. To broaden her experience, she also spent time as a student assistant on a project studying the microfauna associated with Atlantic Ocean deep water sediments.



Saraah Kantner



Randall Plant

Randall Plant has served as a seasonal technician in the Entomology Lab for the last several years, and was recently appointed to an Agricultural Biological Technician position. Prior to his position as a seasonal technician, he was the staff entomologist for Orchard Supply Co. in Sacramento, California for more than twenty years. While in the PPDB Lab, Randall has worked on such major projects as Exotic Pest, Vine mealybug, Plum Pox Virus, Pierce's Disease, and Purple Loosestrife, and so brings an excellent level of experience to his new post.

Monica Negrete graduated from the University of California Davis with a degree in Neurophysiology Behavior. Monica began working for CDFA in the PPDB Nematology Laboratory processing garlic, strawberry, and grape samples for nematodes, while maintaining nematode populations in nematode-inoculated tomato plants. She currently serves in the Plant Pathology Laboratory as an Agricultural Biological Technician, primarily conducting serological and molecular diagnostic tests for Sudden Oak Death disease. When not in the plant pathology laboratory, she enjoys crocheting, cooking and baking.



Monica Negrete



Erin Lovig

Erin Lovig joined the plant pathology diagnostic team as an Agricultural Biological Technician. Erin originally graduated with a Bachelor's degree in biochemistry from California Polytechnic State University, San Luis Obispo. She recently came to us after working at the Genentech Corporation, performing protein purification, validation studies and employee training. These days she spends much of her time working on the molecular aspects of Sudden Oak Death Diagnostics, under the direction of Dr. Cheryl Blomquist. Originally from Vermont, one of her true passions is international travel. In fact, she will be visiting the Czech Republic and France this spring.

BOTANY

2005 Botany Laboratory Staff

**Fred Hrusa
Johanna Naughton
Yoshiko Kinmonth
Irene Wibawa**

Botany Laboratory

The Botany Laboratory provides plant identification services, noxious weed distribution information, and biological support data to the county agricultural Commissioners offices, the general public, CDFA programs, and various other State and Federal agencies. These activities function to help prevent the introduction and spread of serious weed pests and to identify host plants of insects, plant diseases, and plant parasitic nematodes. Plant identification is an integral part of weed pest exclusion, detection, control, and eradication. It is also important to other units of the Department, such as the Animal Health & Food Safety Services, Inspection Services and to county departments of agriculture, which require prompt and accurate botanical information in pursuit of their goals. The herbarium (CDA) contains approximately 35,000 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. Plans for 2006 include the hiring of a second botanist and expansion of the herbarium.

Part 2: Catalogue of Non-Native Vascular Plants Occurring Spontaneously in California Beyond Those Addressed in *The Jepson Manual*, with a preliminary analysis of the relative importance of reported horticultural taxa as escapes in California

Fred Hrusa
California Department of Food and Agriculture,
Plant Pest Diagnostics Center,
3294 Meadowview Rd., Sacramento, CA 95832-1448

Barbara Ertter
University and Jepson Herbaria,
University of California, Berkeley, CA 94720-2465

Andrew Sanders
Botany and Plant Sciences Department,
University of California, Riverside, CA 92521-0124

Gordon Leppig
Calif. Dept. of Fish and Game,
Coastal Timberland Planning Program,
619 2nd Street, Eureka, CA 95501.

Ellen Dean
UC Davis Herbarium,
Section of Plant Biology,
University of California, Davis, CA 95616

Summary

A catalogue of 108 non-native vascular plant taxa documented as occurring spontaneously in California beyond those addressed in *The Jepson Manual: Higher Plants of California* and in Hrusa et al. (2002) is presented. The catalogue was compiled from new collections by the authors and others, previously existing herbarium specimens, formal publications, other printed reports, and direct communications with field botanists. Only reports backed by herbarium vouchers are accepted as adequately documented. Of the 108 species, 38 are fully or sparingly naturalized in relatively undisturbed wildland habitats, 19 are naturalized in disturbed areas, 5 are tenuously established or locally persisting, 20 are non-escaped weeds of greenhouse or similarly cultivated environments, 7 are presumed to be non-persisting casuals (waifs), and for 19 there is no current information or observations available. Taxa highlighted as already being fully naturalized or potential pests are *Berberoa incana*, *Brachypodium sylvaticum*, *Cuscuta japonica*, *Impatiens glandulifera*, *Juncus gerardii*, *Juncus usitatis*, *Medicago scutellata*, *Medicago muricata*, *Rytidosperma penicillatum*, *Solanum mauritianum*, and *Zostera asiatica*.

Comparison to Part 1 (Hrusa et al., 2002) shows that relatively more species were found naturalized in wild areas, while a relatively smaller percentage are known only as old herbarium specimens for which current naturalization information is not available. The following table (Table FH-1) compares naturalization category frequency for the 315 taxa listed in Part 1 to the 108 for the current Part 2. It is suggestive that among plant specimens made available to the authors, species naturalized in wild areas and those occurring only in greenhouses or other highly cultivated areas were under-reported in Part 1. The former is probably the result of so many old herbarium specimens with no current naturalization information being available during the period in which Part 1 was compiled. Taxa comprising the "Greenhouse, nursery, garden weed" category are largely the result of submissions to the Botany Laboratory of CDFA over the past four years, and are a category of weedy plants seldom encountered in herbaria. The low percentage of cultivation-only weeds in Part 1 again reflects the relative abundance of old herbarium specimens comprising the taxonomic list in that report. The reduction in number of casual or waif species reported in Part 2 may reflect realistically the relative rarity of this category in nature; the higher percentage in Part 1 reflects the long period of sampling recorded in Part 1 in which old herbarium specimens were a prominent source of data.

The continuing and perhaps increasing importance of horticultural escapes in the weed and pest flora of California is well illustrated in both Parts 1 and Part 2. Comparing horticultural species with new detections post- 1990-only to total horticultural escapes, Part 2 recent detections comprise 33 of 61 total horticultural taxa (~54%). Using the same criteria, pre-1990-only (i.e. not collected after 1990) horticultural detections reported in Part 2 are 12 of 61 horticultural taxa (~20%). The same data for Part 1 are 64 of 182 horticultural taxa (~35%) and 71 pre-1990-only of 182 (~39%) total horticultural species reported. Combining Parts 1 and 2 gives 97 post-1990-only of 243 total detections (~40%) and 83 pre-1990-only of 243 total (~34%). Although appearing largely comparable, it should be remembered that the post-1990 detections cover only a period of 10-15 years, a detection rate of approximately 7.5 species/yr., while pre-1990 detections include reports from approximately 1880 to 1989, a period of over 100 yrs. and a detection rate of approximately 0.8 species/yr. These data include only taxa that were detected pre-1990-only, and post-1990-only; a majority of horticultural escapes in both these two reports and the total weed flora of California were first detected before 1990 and new detections continue to this day. Although suggestive of a pattern of increasing horticultural escapes into the flora of California, these data are preliminary and incomplete relative to the total weed flora of California, as they include only plants not included in the 1993 Jepson Manual. Obviously, collections post-Jepson would not have been included in that Manual, while pre-Jepson collections that were not included would have been only those overlooked for one reason or another. Thus, a complete analysis comparing the relative frequency of pre-1990 horticultural escapes to post- 1990 detections, as California weeds would be desirable before conclusions as to the relative rate of horticultural escapes into the flora were drawn. In addition, an analysis that considers the

actual dates of escape rather than detection only would be useful, although perhaps not possible, given that our knowledge of the composition of the California weed flora is primarily based on herbarium specimens, not observations of plant behavior.

Table FH-1. Comparison of Hrusa et al. Part 1 and Part 2 naturalization categories. Number in parentheses indicates percentage for each category.

Naturalization Category	Part 2	Part 1
Total	108	315
Naturalized in wildlands	38 (35.2)	58 (18.4)
Naturalized (disturbed areas only)	19 (17.6)	53 (16.8)
Tenuous/locally persisting	5 (4.6)	34 (10.7)
Greenhouse, nursery, garden weed:		
Casual	20 (18.5)	13 (4.1)
	7 (6.5)	43 (13.7)
No current information	19 (17.6)	110 (35)
Weeds originating as horticultural escapes	61 (56.5)	182 (57.8)

Citation:

HRUSA, F., B. ERTTER, A. SANDERS, G. LEPPIG, E. DEAN, 2002. *Madrono* 49 (2); 61-98.

NEMATOTOLOGY

2005 Nematology Laboratory Staff

John Chitambar

Ke Dong

Robert Hackney

Rene Luna

Mirasol Ballesteros

Jennifer Haynes

LaTasha Phiefer

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

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

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

Incorporating Molecular Identification of *Meloidogyne* spp. into a Statewide Nematode Survey

Ke Dong, John Chitambar, Robert Hackney, and Rene Luna

Nematology Laboratory
Plant Pest Diagnostics Branch
California Department of Food and Agriculture

The Nematology Laboratory, Plant Pest Diagnostics Branch (PPDB) and Pest Detection Program (PDEP) of California Department of Food and Agriculture (CDFA) initiated a statewide nematode survey project in 2005. The project was cooperative with the US Department of Agriculture Animal and Plant Health Inspection Service (USDA-APHIS) and funded by the National Cooperative Agricultural Pest Survey (CAPS) Program. The objective of this project was to obtain current information on the occurrence and distribution of economically harmful plant parasitic nematodes in the major cropping and nursery production areas of California. The target species in the survey included four root-knot nematodes: *Meloidogyne chitwoodi*, *M. hapla*, *M. javanica*, and *M. partityla*. In order to identify the root-knot nematode second stage larvae (J2) from soil samples to the species level, specific PCR reaction had to be conducted. This report provides a brief description of test procedure and results.

Materials and Methods

Several major plant hosts were selected for the survey based on the host ranges of the target nematode species, e.g. alfalfa was sampled for *M. hapla* and *M. chitwoodi*; potato was mainly tested for *M. chitwoodi*; grapevine, and tomato were surveyed as major hosts for *M. javanica*; pecans and walnuts were tested for the pecan root-knot nematode (*M. partityla*).

Surveys were conducted statewide in the major production areas of hosts for each target nematode species. Composite samples were collected from different fields/nurseries for a given host within each county. A minimum of 20 composite samples per host per county was collected. For counties with larger production acreage, the collection of more samples (> 20) was strongly encouraged. Sampling was performed near crop maturity in late summer/fall or during harvest or post harvest, depending on the crop. Soil and root/tuber samples were collected from commercial fields, rows, and orchard plants. Samples were a composite of 15-20 sub-samples per field or (partial field) of 2 hectares (5 acres) or less unit. A composite sample was thoroughly mixed and about 600 cc (volume) each of soil and root was collected for laboratory analyses. Approximately two tubers were collected per sub-sample and the entire sample was analyzed in the laboratory analyses. Nursery plants were sampled according to guidelines established in the Nursery Integrated Pest Manual (NIPM item 7.1). A soil and root sample was a composite of 28 sub-samples collected on a 40 x

40 ft grid per acre of field grown nursery stock. For container, flat and frame grown nursery stock, one composite sample of soil and roots comprised of collections made from one randomly selected plant in every 100 square feet (10 x 10 ft) of bench or frame space. In 2005, sampling was initiated in several counties in southern California (Imperial, Los Angeles, Riverside, San Bernardino, San Diego, Santa Barbara and Ventura), and 13 counties in central and northern CA (Fresno, Butte, Glenn, Kern, Kings, Merced, Sacramento, San Joaquin, Shasta, Sonoma, Stanislaus, Tulare, Yolo).

Root-knot nematode larvae were extracted by gravity sieving/elutriation plus mist extraction techniques for soil and plant tissue samples. Nematodes were examined using a dissection microscope at a magnification of 250X that allows preliminary assignment to genus. *Meloidogyne* J2s were further identified by light microscopy on temporary glass slides. A minimum of 5 infective juveniles was analyzed from each sample. An individual J2 was placed in a 15µl drop of 0.1M Tris-HCl (pH8.0) on a slide and crushed with a dental file. The solution containing the crushed nematode was placed in individual PCR reaction tubes. A 10 µl portion of the solution served as DNA template for PCR reaction.

The PCR amplification is conducted with primer set located in the COII and 16S ribosomal mitochondrial genes respectively (Powers and Harris, JON 25(1): 1-6; Stanton, et al., Fundam. Appl. Nematol. 20(3): 261-268). The C2F3 primer (5' GGTC AATGTT CAGAAATTTGTGG 3') from Powers was chosen as up-stream primer, and the MRH106 from Stanton was used as down-stream primer (5' AATTTCTAAAGACTTTTCTTAGT 3').

PCR reaction master mix consisted of 1.5 units of Taq Polymerase (Promega) in a 1x dilution of the 10x stock buffer, Mg⁺² at 3.0mM final concentration, dNTPs each at 200µM final concentration, and each primer at 0.36µM final concentration. From the master mix, 15µl was added to a PCR tube containing 10µl nematode template and mixed thoroughly. Amplification conditions included an initial denaturation at 94°C for 5 minutes, followed by 45 cycles of denaturation at 94°C for 1 minute, annealed at 50°C for 1 minute, and extension at 72°C for 2 minutes. A final extension step was conducted for 10 minutes at 72°C. The C2F3/ MRH106 PCR amplification products (10µl of each mixed with 1.0µl loading buffer) were separated on a 1.0% agarose gel made in 1.0x TAE buffer.

The root-knot nematode species identifications were made by the size of amplification PCR (or PCR-RFLP) products.

- The amplification product of ~1,300bp was designated as *M. arenaria*.
- The amplification products of approximately 1,800bp were further digested with *Hinf*I.
 - If products of 1400bp and 400bp were produced the specimen was designated *M. incognita*.
 - If no digestion occurred the specimen was designated *M. javanica*.

- If the amplification products were about 650bp. The PCR products were subjected to a *DraI* digestion:
 - If the digestion products were 258bp, 119bp, 40bp, 18bp, and 156bp, the species was *M. chitwoodi*.
 - If the digestion products were 246bp, 198bp, 51bp and 103bp; or 444bp, 51bp and 103bp due to a single nucleotide mutant, the species was *M. hapla*.
 - If the digestion products were 365bp, 78bp and 145bp, the species was *M. partityla*.

For *M. chitwoodi* and *M. hapla*, the IGS region PCR tests were further conducted to confirm the species identification (Wishart, et al. *Phytopathology* 92:884-892). In addition to the PCR tests, when root galls were available in some samples, *Meloidogyne* adult females were isolated for morphological and isozyme analyses as supplementary techniques for identification. All samples were analyzed at the CDFA, Plant Pest Diagnostics Nematology Lab.

Results

A total of 363 soil and plant samples were processed and examined in the laboratory. 119 samples were detected with *Meloidogyne* J2s. Among these root-knot nematode samples, nine samples were identified as *M. arenaria* and eight samples as *M. hapla*. *Meloidogyne incognita* was found in 76 samples, and 16 samples were positive detections of *M. javanica*. There were four soil samples with multiple infestations, e.g. both *M. incognita* and *M. javanica* were detected. In addition, three samples produced novel PCR products, which were not identical to the available published information on the common *Meloidogyne* species. These nematode isolates have been inoculated on tomato var. Rutgers in the Nematology laboratory for further investigation. Due to the sample quality, PCR tests failed in three samples with *Meloidogyne* J2s. There was no positive detection for the species of *M. chitwoodi* and *M. partityla* in the survey.

References

- Wishart, J., Philips, M.S., and Blok, V. C. 2002. Ribosomal intergenic spacer: a polymerase chain reaction diagnostic for *Meloidogyne chitwoodi*, *M. fallax*, and *M. hapla*. *Phytopathology* 92: 884-892.
- Powers, T. O., and Harris, T. S. 1993. A polymerase chain reaction method for identification of five major *Meloidogyne* species. *Journal of Nematology* 25(1): 1-6.
- Stanton, J., Hugall, H., and Moritz, C. 1997. Nucleotide polymorphism and an improved PCR-based mtDNA diagnostic for parthenogenetic root-knot nematodes (*Meloidogyne* spp.). *Fundamental and Applied Nematology* 20(3):261-268.

Mohammed Alzubaidy¹, John Chitambar² and Ke Dong²

Introduction

With over 350 commodities, California agriculture is, without a doubt, the most diverse in the nation. This crop diversity provides a wide range of environments that favor many agricultural pests including plant parasitic nematodes. Such pests, domestic and exotic, have the potential to greatly reduce crop productivity, and adversely impact California economy and way of life. The CAPS survey is a proactive cooperative endeavor by the United State Department of Agriculture (USDA) and the California Department of Food and Agriculture (CDFA) that supplements ongoing state funded surveys and improves ability for earlier detection of incipient nematode infestations. Discovery of certain plant parasitic nematode pests would prompt the State of California to implement appropriate eradication and regulatory strategies. Negative survey data would validate existing state and federal regulations and promote California's agricultural export.

The survey was conducted on a statewide basis between June and December 2005. Survey activities were concentrated in areas with high risk of pest introduction. Such areas were mostly nurseries and rural agricultural land with relatively high production acreage of major crops. Based on the plant hosts of 15 target nematode species, initially 6 major crops were targeted for survey, namely alfalfa, grape, pecan, potato, tomato, and walnut. Four more crops were added during the course of the survey. These were almond, cotton, rice, and zucchini.

Below is a list of 15 nematode pests targeted in the survey:

Potato rot nematode, *Ditylenchus destructor*
Onion stem and bulb nematode, *Ditylenchus dipsaci*
Potato cyst nematode, *Globodera pallida*
Golden nematode, *Globodera rostochiensis*
Soybean cyst nematode, *Heterodera glycines*
Columbia root-knot nematode, *Meloidogyne chitwoodi*
Northern root-knot nematode, *Meloidogyne hapla*
Javanese root-knot nematode, *Meloidogyne javanica*
Pecan root-knot nematode, *Meloidogyne partityla*
False root-knot nematode, *Nacobbus aberrans*
Stubby root nematode, *Paratrichodorus spp*
Reniform nematode, *Rotylenchulus reniformis*
Dagger nematode, *Xiphinema bakeri*, *X. diversicaudatum*, *X. coxi*

According to nematode detection records of the CDFA Plant Pest Diagnostic Branch (PPDB) for the past 17 years (Table 2; attached) four of the target nematode species (*Ditylenchus dipsaci*, *Meloidogyne chitwoodi*, *M. hapla*, and *Paratrichodorus sp*) had been detected in California prior to the 2005 CAPS survey.

Materials and Methods

The state of California was divided into three geographical regions (northern, central, and southern). Field survey of each region was conducted by a CDFA Pest Detection/Emergency Project (PD/EP) team of 3 – 4 members including the team coordinator, a plant pathologist.

Major Hosts

Six major plant hosts were selected for the survey based on the host ranges of the target nematode species. Potato and tomato were surveyed as major hosts of the golden nematode, potato cyst nematode, Javanese root-knot nematode, northern root-knot nematode, Columbia root-knot nematode and false root-knot nematode. Grapevine was surveyed for the Javanese root-knot nematode, dagger nematodes, reniform nematode and stubby root nematodes. Pecans and walnuts were surveyed for the pecan root-knot nematode. Alfalfa was surveyed for the stem and bulb nematode.

Sampling

Surveys were conducted statewide in the major production areas of hosts for each target nematode species. These major crop production sites and sampling times for survey plant hosts were based on California Agricultural Statistics published in October 2004, County Agricultural Commissioners records, and CDFA-PPDB Nematology's Pest and Damage records. Plant pathologists worked with county agricultural commissioners to identify specific locations and background information of production sites, and maturity/harvest times of survey crops. Whenever possible, background information of production sites included soil type/texture, cropping history, previous nematicide/pesticide treatment, plant symptoms, field topography and date of sample collection. Areas with elevated risks of pest introduction, including nurseries, were also identified.

The sampling plan addressed, time of collection, sampling method, sample size, and care and handling of samples. On-site training was provided by the Nematology Laboratory to the field teams. Composite samples were collected from different fields/nurseries for a given host within each county. A minimum of 20 composite samples per host per county was collected. For those counties with large production acreage, the collection of more samples (greater than 20 per host) was strongly encouraged. Sampling was also encouraged in those counties not listed but known to be minor producers of survey plants. Field samples from plant hosts that were not listed in the table, but existed as important crops in a given county, were also included in the statewide survey.

Sampling was performed near crop maturity in late summer/fall or during harvest or post harvest, depending on the crop. Soil and root/tuber samples were collected from commercial fields, rows, and orchard plants. Samples were a composite of 15-20 cores per field (or partial field unit) of 1-5 acres. Composite samples were thoroughly mixed and a 600 cc (volume) sub-sample was collected for laboratory analyses. Nursery plants grown in containers, flats or fields, were sampled according to guidelines established in the Nursery Integrated Pest Manual (NIPM item 7.1).

For field and row crops, soil and root samples were collected to a depth of 18 inches. Depths of up to 36 inches were reached when sampling vineyard, orchard, and deep-rooted perennials.

Soil and root samples were collected from within rows, where root growth is not disturbed by tillage and cultural practices. Samples were collected in a random zigzag pattern across the stratum so that the field was adequately covered. For orchard trees, soil and root samples were collected at the tree drip line.

Samples were taken from plants/areas that showed symptoms (unhealthy) and from plants/areas that did not show symptoms (healthy). A shovel or 1-inch internal diameter Oakfield Core Sampling tube was used for taking the sample. Soil and plant material from the ground surface up to the recommended depth were included in the sample.

Samples were put in durable plastic bags. To avoid rapid decomposition, above ground plant parts were collected in separate bags from soil and root. Bags were clearly labeled and kept cool at around 50 F in insulated cooler at sampling site and thereafter. Frozen refrigerant package was used to keep samples cool during transportation to the laboratory.

Nematode Extraction and Identification

C DFA-PPDB Nematology Laboratory processed collected samples. Nematode extraction was done using gravity sieving/elutriation, sugar centrifugation, and/or mist extraction techniques. Nematodes were identified using morphological and DNA analyses. For *Meloidogyne* species identification, nematode J2s were examined using a dissection microscope at a magnification of 250X that allow preliminary assignment to genus. A minimum of 5 infective juveniles was analyzed from each sample. An individual J2 was placed in a 15µl drop of 0.1M Tris-HCl (pH8.0) on a slide and crushed with a dental file. A 10 µl portion of the solution serves as DNA template for PCR reaction. The PCR amplification was conducted with primer sets from mitochondrial genes (Powers and Harris, JON25: 1-6; Stanton, et al. F & A Nematology 20:261-268). For *M. chitwoodi* and *M. hapla*, the IGS region PCR tests were further conducted to confirm the species identification (Wishart, et al. Phytopathology 92:884-892). The PCR-RFLP products were separated on a 1.0% agarose gel, the *Meloidogyne* species identifications were made by the size of DNA bands. When root galls were available in some samples, *Meloidogyne* adult females were isolated for

morphological and isozyme analyses as supplementary techniques for identification. All samples were analyzed at the CDFA, Plant Pest Diagnostics Nematology Lab.

Results and Discussion

Data of the 2005 survey are shown in Table 1. A total of 363 survey samples were processed and examined in the laboratory. Of the total number of samples, 58% contained plant parasitic nematodes belonging to 33 species. One hundred and six samples were detected with *Meloidogyne* second stage larvae. Among these root-knot nematode samples, six samples were identified with *M. arenaria*, seven with *M. hapla*, seventy-one with *M. incognita*, and seventeen with *M. javanica*. In addition, five samples produced novel PCR products, which were not identical to the available published information on the common *Meloidogyne* species (*M. arenaria*, *M. incognita*, *M. javanica*). These nematode isolates are under further investigation. Other nematode species found in varying frequencies included, *Ditylenchus dipsaci* (Stem and bulb nematode), *Helicotylenchus* spp. (Spiral nematode), *Macroposthonia* (= *Mesocriconema*) *xenoplax* (Ring nematode), *Merlinius brevidens* (Stunt nematode), *Paratrichodorus* spp. (Stubby root nematode), *Paratylenchus* spp. (Pin nematode), *Pratylenchus thornei*, *P. coffeae*, *P. scribneri*, *P. neglectus*, *P. penetrans*, *P. vulnus* (Lesion nematodes), *Scutellonema* spp. (Shield nematode), *Tylenchorhynchus* spp. (Stunt nematode), *Xiphinema americanum*, and *X. index* (Dagger nematodes).

Only four of the 15 target species were detected in the survey, namely, *Ditylenchus dipsaci*, *Meloidogyne hapla*, *M. javanica* and *Paratrichodorus* spp. These species have been detected earlier by the State Laboratory and are rated by CDFA as C or D pests due to their common distribution in California. With the exception of *Xiphinema index*, Dagger nematode, that is rated a B pest because of its limited distribution within California, the remaining species found in the survey are also commonly distributed in the State with either a C or D rating. As a supplement to the 2005 survey, a record of the five target nematode species (including *M. chitwoodi*) detected in California agricultural production sites by CDFA-PPD Nematology Laboratory over the past seventeen years (including 2005) is listed in Table 2. With one exception, the remaining target species listed for the 2005 survey have not been detected in California agricultural production soils according to CDFA-PPD Nematology detection records. The exception, *Ditylenchus destructor*, potato rot nematode, was detected in potato, prior to 1988. Earlier laboratory records, 1982-1987, also document the detection of *Meloidogyne chitwoodi* in Modoc, Siskiyou, Tulare, Tuolumne and Monterey counties. Further survey can only establish the current status of these finds more than eighteen years later.

Nineteen counties were surveyed representing major and lesser production acreage of the selected survey crops. However, these may not represent all

areas where those crops are grown within the State, thereby indicating the need for further surveys of yet non-sampled lands.

Acknowledgments

This survey was made possible through funding from USDA and by the cooperation from County Agricultural Commissioners throughout California. CDFA-PD/EP plant pathologists Magally Luque-Williams, Jennifer Romero, and Kathy Kosta respectively conducted field surveys in Southern, Central, and Northern California.

¹ CDFA, PD/EP
935 E. Discovery Lane
Anaheim, CA 92801

² CDFA, PPDB
3294 Meadowview Road
Sacramento, CA 95832

Table 1. 2005 Survey for plant parasitic nematodes in agricultural production sites in California, 2005* (Continued)

Host	County	Nematode species	Total no. of samples per species	CDFA Pest Rating	Total no. of samples per host
Alfalfa	Fresno	Non Plant Parasitic Nematodes	9		
		Macroposthonia (=Mesocroconema) xenoplax	1	D	
		Meloidogyne hapla	3	C	
		M. incognita	1	C	
		Paratylenchus sp.	1	D	
		Pratylenchus brachyurus	1	C	
		P. neglectus	1	D	
		Tylenchorhynchus elegans	1	D	
		T. mashhoodi	1	D	
		Xiphinema americanum	5	C	
				15	
	Kings	Non Plant Parasitic Nematodes	3		
		Helicotylenchus dihystera	2	D	
		Meloidogyne javanica	1	C	
		Pratylenchus thornei	1	D	
		Tylenchorhynchus elegans	2	D	
		6		9	
	Los Angeles	Non Plant Parasitic Nematodes	2		
		Ditylenchus dipsaci	6	C	
		Meloidogyne hapla	1	C	
		Merlinius brevidens	1	D	
		Tylenchorhynchus graciliformis	1	D	
		9		11	
	Riverside	Non Plant Parasitic Nematodes	8		
		Helicotylenchus sp.	1	D	
		Merlinius brevidens	3	D	
		Pratylenchus neglectus	2	D	
		Tylenchorhynchus sp.	1	D	
		Xiphinema americanum	1	C	
		8		15	
	Sacramento	Non Plant Parasitic Nematodes	10		
		Xiphinema americanum	1	C	
		1		11	

Table 1. 2005 Survey for plant parasitic nematodes in agricultural production sites in California, 2005* (Continued)

Host	County	Nematode species	Total no. of samples per species	CDFA Pest Rating	Total no. of samples per host
Alfalfa	San Bernardino	Non Plant Parasitic Nematodes	8		17
		Meloidogyne hapla	1	C	
		Pratylenchus neglectus	5	D	
		Tylenchorhynchus sp.	2	D	
		Tylenchorhynchus mashhoodi	1	D	
	Shasta	Non Plant Parasitic Nematodes	4		6
		Ditylenchus dipsaci	1	C	
		Pratylenchus coffeae	1		
	Yolo	Tylenchorhynchus sp.	1	D	1
Almond**	Riverside	Non Plant Parasitic Nematodes	1		5
		Paratylenchus hamatus	1	D	
		Tylenchorhynchus sp.	2	D	
		Xiphinema americanum	1	C	
			4		
Cotton**	Kings	Non Plant Parasitic Nematodes	1		1
Grape	Fresno	Non Plant Parasitic Nematodes	4		90
		Helicotylenchus pseudorobustus	2	D	
		Macroposthonia (=Mesocriconema) xenoplax	20	D	
		Meloidogyne arenaria	2	C	
		M. incognita	21	C	
		M. javanica	3	C	
		Paratylenchus sp.	2	D	
		Pratylenchus neglectus	7	D	
		P. penetrans	1	C	
		P. thornei	2	D	
		P. vulnus	1	C	
		Tylenchorhynchus mashhoodi	1	D	
		Xiphinema americanum	21	C	
		X. index	3	B	
			86		

Table 1. 2005 Survey for plant parasitic nematodes in agricultural production sites in California, 2005* (Continued)

Host County Nematode species			Total no. of samples per species	CDFA Pest Rating	Total no. of samples per host
Grape	Imperial	Non Plant Parasitic Nematodes	0		
		Longidorus sp.	1	D	
		Xiphinema americanum	1	C	
			2		2
	Kern	Non Plant Parasitic Nematodes	2		
		Helicotylenchus sp.	1	D	
		Macroposthonia (=Mesocriconema) xenoplax	14	D	
		Meloidogyne arenaria	1	C	
		M. incognita	15	C	
		M. javanica	1	C	
		Pratylenchus neglectus	2	D	
		Xiphinema americanum	4	C	
		38		40	
	Kings	Non Plant Parasitic Nematodes	2		
		Helicotylenchus pseudorobustus	1	D	
		Meloidogyne javanica	1	C	
		Scutellonema conicephalum	1	D	
		3		5	
	Los Angeles	Non Plant Parasitic Nematodes	4		
		Meloidogyne sp.	1	C	
Paratylenchus sp.		1	D		
Pratylenchus neglectus		1	D		
Xiphinema americanum		4	C		
7		10			

Table 1. 2005 Survey for plant parasitic nematodes in agricultural production sites in California, 2005* (Continued)

Host	County	Nematode species	Total no. of samples per species	CDFA Pest Rating	Total no. of samples per host	
Grape	Riverside	Non Plant Parasitic Nematodes	2			
		Helicotylenchus sp.	1	D		
		H. dihystra	2	D		
		H. pseudorobustus	1	D		
		H. solani	1	D		
		Macroposthonia (=Mesocriconema) xenoplax	3	D		
		Meloidogyne sp.	1	C		
		Meloidogyne arenaria	3	C		
		M. incognita	14	C		
		M. javanica	6	C		
		Pratylenchus hexincisus	1	D		
		Pratylenchus penetrans	3	D		
		Scutellonema sp.	1	D		
		Tylenchorhynchus sp.	1	D		
		Xiphinema americanum	7	C		
				45		47
			San Bernardino	Non Plant Parasitic Nematodes	4	
Criconemella sp.	1			D		
Meloidogyne sp.	1			C		
M. hapla	1			C		
M. incognita	3			C		
Pratylenchus zeae	1			C		
Tylenchorhynchus sp.	1			D		
Xiphinema americanum	2			C		
		10		14		

Table 1. 2005 Survey for plant parasitic nematodes in agricultural production sites in California, 2005* (Continued)

Host County Nematode species			Total no. of samples per species	CDFA Pest Rating	Total no. of samples per host
Grape	Santa Barbara	Non Plant Parasitic Nematodes	8		
		Criconemella sp.	1	D	
		Criconemella macrodora	1	D	
		Helicotylenchus sp.	3	D	
		H. dihystra	2	D	
		Macroposthonia (=Mesocriconema) xenoplax	1	D	
		Meloidogyne sp.	1	C	
		M. incognita	2	C	
		Paratylenchus sp.	5	D	
		Pratylenchus neglectus	4	D	
		P. thornei	4	D	
		Scutellonema clathricaudatum	1	D	
		Tylenchorhynchus sp.	1	D	
		Xiphinema americanum	7	C	
					33
Pecans	Fresno	Non Plant Parasitic Nematodes	0		
		Macroposthonia (=Mesocriconema) xenoplax	1	D	
				1	1
	Tulare	Non Plant Parasitic Nematodes	0		
		Macroposthonia (Mesocriconema) xenoplax	1	D	
Pratylenchus vulnus		1	C		
			2		2

Table 1. 2005 Survey for plant parasitic nematodes in agricultural production sites in California, 2005* (Continued)

Host County Nematode species			Total no. of samples per species	CDFA Pest Rating	Total no. of samples per host	
Potato	Los Angeles	Non Plant Parasitic Nematodes	12			
		<i>Meloidogyne hapla</i>	1	C		
				1		13
	Riverside	Non Plant Parasitic Nematodes	10			
						10
	San Bernardino	Non Plant Parasitic Nematodes	1			
					1	
	San Joaquin	Non Plant Parasitic Nematodes	11			
		<i>Tylenchorhynchus elegans</i>	1	D		
				1		12
Santa Barbara	Non Plant Parasitic Nematodes	0				
	<i>Paratylenchus</i> sp.	1	D			
	<i>Tylenchorhynchus</i> sp.	1	D			
			2		1	
Rice**	Butte	Non Plant Parasitic Nematodes	1			
					1	
	Glenn	Non Plant Parasitic Nematodes	1			
					1	
Tomato	Fresno	Non Plant Parasitic Nematodes	2			
		<i>Helicotylenchus dihystera</i>	1	D		
		<i>Meloidogyne incognita</i>	1	C		
		<i>M. javanica</i>	2	C		
		<i>Pratylenchus scribneri</i>	4	D		
		<i>Xiphinema americanum</i>	1	C		
					9	

Table 1. 2005 Survey for plant parasitic nematodes in agricultural production sites in California, 2005* (Continued)

Host	County	Nematode species	Total no. of samples per species	CDFA Pest Rating	Total no. of samples per host	
Tomato	Imperial	Non Plant Parasitic Nematodes	8		11	
		Longidorus sp.	1	D		
		Meloidogyne javanica	1	C		
		Xiphinema americanum	1	C		
				3		
	Merced	Non Plant Parasitic Nematodes	2		13	
		Helicotylenchus sp.	4	D		
		Meloidogyne incognita	2	C		
		Paratrichodorus sp.	1	D		
		Pratylenchus penetrans	1	C		
		P. scribneri	3	D		
				11		
	Riverside	Non Plant Parasitic Nematodes	0		4	
		Meloidogyne sp.	1	C		
		M. incognita	1	C		
		M. javanica	1	C		
		Tylenchorynchus sp.	1	D		
			4			
	Sacramento	Non Plant Parasitic Nematodes	1		9	
		Helicotylenchus sp.	5	D		
		Meloidogyne incognita	1	C		
		Tylenchorhynchus sp.	1	D		
		Xiphinema americanum	1	C		
			8			
	San Bernardino	Non Plant Parasitic Nematodes	3		5	
		Meloidogyne incognita	1	C		
		Pratylenchus zaeae	1	C		
		2				
San Diego	Non Plant Parasitic Nematodes	5		32		
	Helicotylenchus sp.	5	D			
	Meloidogyne incognita	7	C			
	M. javanica	1	C			
	Paratrichodorus sp.	3	D			
	Pratylenchus neglectus	6	D			
	P. zaeae	4	C			
	Scutellonema sp.	1	D			
		27				

Table 1. 2005 Survey for plant parasitic nematodes in agricultural production sites in California, 2005* (Continued)

Host	County	Nematode species	Total no. of samples per species	CDFA Pest Rating	Total no. of samples per host
Tomato	San Joaquin	Non Plant Parasitic Nematodes	0		
		Meloidogyne hapla	1	C	
		Merlinius brevidens	1	D	
		Pratylenchus thornei	1	D	
		Tylenchorhynchus elegans	1	D	
		Xiphinema americanum	1	C	
			5		5
	Santa Barbara	Non Plant Parasitic Nematodes	0		
		Pratylenchus brachyurus	1	C	
		Tylenchorhynchus sp.	1	D	
		2		2	
Ventura	Non Plant Parasitic Nematodes	17			
	Meloidogyne incognita	1	C		
		1		18	
Walnut	Butte	Non Plant Parasitic Nematodes	3		
		Macroposthonia (=Mesocriconema) xenoplax	3	D	
		Pratylenchus vulnus	4		
			7		10
	Fresno	Non Plant Parasitic Nematodes	0		
		Criconemella sp.	1	D	
		Paratrichodorus sp.	1	D	
		Pratylenchus sp.	1	C	
		Pratylenchus vulnus	2	C	
		Tylenchorhynchus mashhoodi	1	D	
		Xiphinema americanum	1	C	
			7		7
	Riverside	Non Plant Parasitic Nematodes	0		
		Pratylenchus vulnus	2	C	
			2		2
	San Joaquin	Non Plant Parasitic Nematodes	1		
					1
	Santa Barbara	Non Plant Parasitic Nematodes	0		
		Xiphinema americanum	1	C	
		1		1	
Shasta	Non Plant Parasitic Nematodes	1			
	Pratylenchus penetrans	1	C		
	P. vulnus	2	C		
		3		4	

Table 1. 2005 Survey for plant parasitic nematodes in agricultural production sites in California, 2005* (Continued)

Host	County	Nematode species	Total no. of samples per species	CDFA Pest Rating	Total no. of samples per host
Walnut	Stanislaus	Non Plant Parasitic Nematodes	0		
		Paratylenchus sp.	1	D	
		Pratylenchus vulnus	2	C	
		Xiphinema americanum	1	C	
			4		4
	Tulare	Non Plant Parasitic Nematodes	3		
		Pratylenchus vulnus	1	C	
			1		4
	Yolo	Non Plant Parasitic Nematodes	0		
		Xiphinema americanum	1	C	
		1		1	
Zucchini**	Sacramento	Non Plant Parasitic Nematodes	0		
		Helicotylenchus sp.	1	D	
		Meloidogyne incognita	1	C	
			2		2

* Results of partial sampling completed in 2005

** Extra hosts sampled in 2005

Table 2. 1988 - 2005 Record of certain plant parasitic nematodes targeted in the 2005 survey and detected in agricultural production sites (nursery and commercial) in California*

Nematode species	CDFA Pest Rating	County	Host	Year	Total no. of positive samples per host per year	Total no. of samples per species	
Ditylenchus dipsaci	C	Los Angeles	Alfalfa	2005	6		
		Sacramento	Clover	1995	1		
			Phlox	1988	1		
		Shasta	Alfalfa	2005	1		
		Humboldt	Daffodil	1988	1		
				1992	1		
				1995	1		
			Narcissus	1992	3		
San Joaquin	Plants (unknown)	1999	1				
					16		
Meloidogyne chitwoodi	B	Modoc	Potato	1988	1		
							1
M. hapla	C	Fresno	Alfalfa	2005	3		
		Los Angeles	Alfalfa	2005	1		
			Potato	2005	1		
		San Bernardino	Alfalfa	2005	1		
			Grape	2005	1		
		San Joaquin	Strawberry	1998	1		
		Santa Cruz	Weed	1990	1		
					9		
M. javanica	C	Fresno	Grape	2005	3		
			Tomato	2005	2		
		Imperial	Tomato	2005	1		
		Kern	Tomato	2005	1		
		Kings	Alfalfa	2005	1		
			Grape	2005	1		
		Riverside	Grape	2005	7		
			Tomato	2005	1		
		San Bernardino	Alfalfa	2005	1		
			Grape	2005	1		
		San Diego	Tomato	2005	1		
Paratrichodorus sp.	D	Butte	Kiwi	1988	1		
				1997	1		
				2001	1		
		El Dorado	Blueberries	1999	4		

Table 2. 1988 - 2005 Record of certain plant parasitic nematodes targeted in the 2005 survey and detected in agricultural production sites (nursery and commercial) in California* (Continued)

Nematode species	CDFA Pest Rating	County	Host	Year	Total no. of positive samples per host per year	Total no. of samples per species
Paratrichodorus sp.		Fresno	Grape	1995	1	
				1996	5	
				1997	12	
				1998	11	
			Walnut	2005	1	
		Lassen	Strawberry	1990	1	
		Madera	Grape	1996	2	
				1998	1	
				1999	8	
				2000	1	
		Merced	Strawberry	1992	4	
			Tomato	2005	1	
		Riverside	Citrus (Navel)	1998	1	
			Turf (Poa sp.)	2005	1	
		San Diego	Tomato	2005	3	
		San Joaquin	Strawberry	1992	1	
			Grape	1994	2	
				1995	2	
				1996	4	
		1999	4			
		Santa Cruz	Zantedeschia sp.	2000	2	
		Shasta	Strawberry	1996	1	
		Solano	Grape	1997	4	
		Sonoma	Lily	1991	1	
			Apple	1992	1	
			Grape	1993	1	
		Stanislaus	Nursery soil	1994	4	
		Sutter	Kiwi	1988	1	
		Tulare	Citrus	1991	3	
				1995	3	
1996	1					
						95

* Includes data from 2005 nematode survey

SEED SCIENCE

2005 Seed Laboratory Staff

Jim Effenberger
Don Joley
Deborah Meyer, Supervisor
Paul Peterson
Marian Stephenson
Elaine Harris
Evelyn Ramos
Connie Weiner
Ronnie Harley
Chris Fernandez
Aaron Langenbeck

The objectives of the Seed Laboratory are to:

- Provide identification and quality assessments of agricultural, vegetable, flower, weed and other seed
- Substantiate label information on seed lots
- Provide testing for exported seed
- Help prevent introduction and dissemination of noxious weed pests
- Serve as a repository for seed and fruit specimens and associated literature
- Serve as a resource of scientific expertise in seed identification and seed quality assessment for the Department of Food and Agriculture.

The Seed Laboratory identifies and evaluates seed samples and other plant propagules submitted by Department representatives (primarily through the Pest Exclusion Branch), seed producers and distributors, commercial and private laboratories, other state and federal agencies, academic institutions, and private individuals. The laboratory is considered an impartial authority and the information provided is often utilized in resolving contract disputes. The Seed Laboratory consists of two sections (Seed Taxonomy and Seed Physiology) and the majority of the samples require processing through both sections for analysis. The Seed Taxonomy Laboratory scientists identify seed, fruit and other plant propagules; examine quarantine and border station samples for noxious weed pests; evaluate quality of seed lots for labeling purposes; examine seed lots for label integrity; and inspect feed mill samples for weed seed contaminants. The Seed Physiology Laboratory scientists perform germination and viability evaluation of seed lots for labeling purposes, examine seed lots for germination label integrity, determine viability of weed seed contaminants for feed mill approval, perform biochemical and seed vigor analysis techniques to discern structural damage of the seed that may result in seedling abnormalities indicating the potential for crop failure in the field. Scientists in the Seed Laboratory are members of several professional certification organizations, including the Association of Official Seed Analysts (AOSA), the Society of Commercial Seed Technologists (SCST) and the International Society of Seed Technologists (ISST).

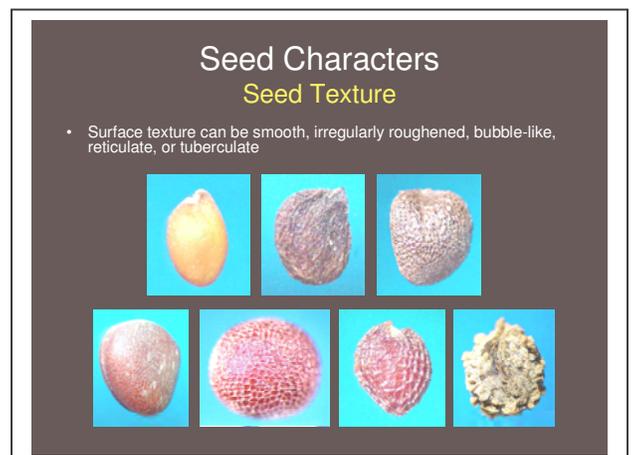
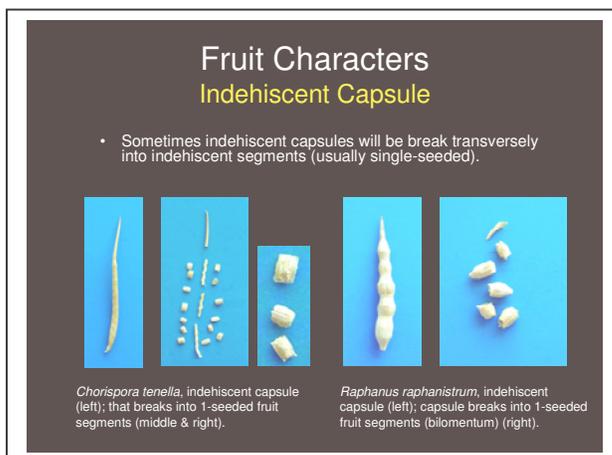
Seed Technologist Training

Jim Effenberger, Elaine Harris, Deborah Meyer, Paul Peterson, Evelyn Ramos, and Connie Weiner

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. Many individuals that have received training from the CDFA Seed Laboratory staff have become Registered Seed Technologists (RSTs) following passage of a nationally administered examination.

This year members of the Seed Laboratory staff served as instructors at three seed workshops. The first was the annual seed workshop hosted by the CDFA Plant Pest Diagnostics Center, Sacramento, California. The Seed Laboratory technical staff was involved in preparation of hands-on materials for workshop participants to examine. The Seed Laboratory scientific staff made the following presentations:

- Paul Peterson, Senior Seed Botanist – Cotyledon evaluation of Cucurbitaceae (*Cucumis*, *Cucurbita*, and *Citrullus*); Seedling evaluation of pepper (*Capsicum* spp.); Seedling evaluation of Asteraceae (*Lactuca*, *Cichorium*, *Carthamus tinctorius*, *Helianthus*); Seedling evaluation of radish (*Raphanus sativus*).
- Senior Seed Botanists Deborah Meyer - A virtual purity analysis: A review of the Association of Official Seed Analysts (AOSA) Rules for Testing Seeds; Seed and fruit identification of 27 species of the Brassicaceae.



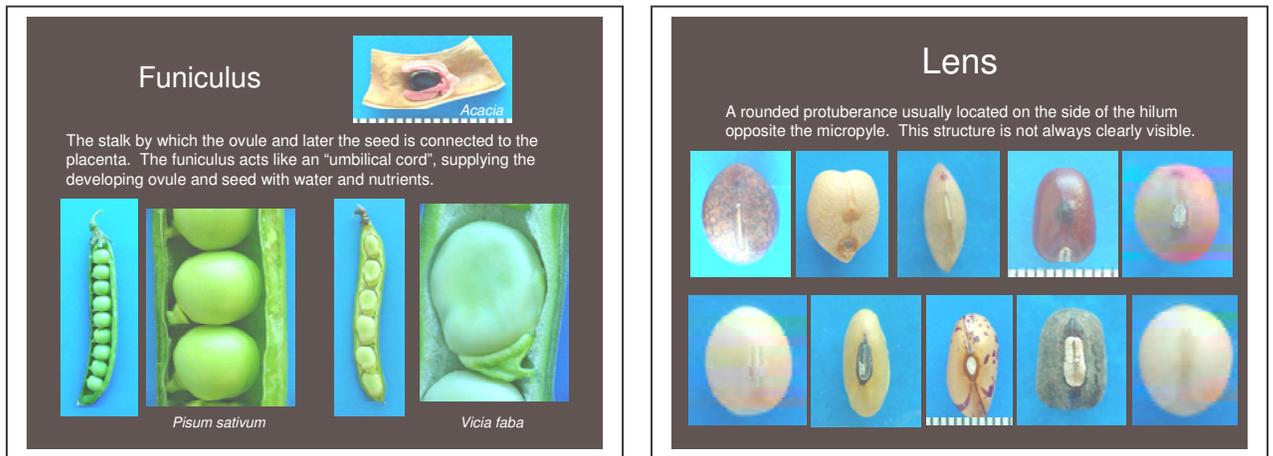
Examples of PowerPoint slides taken from the presentation on *Seed and Fruit Identification of the Brassicaceae*.

- Jim Effenberger – Seed identification of *Brassica* and *Sinapis* (Brassicaceae); Floret identification of *Agropyron*, *Elymus*, *Elytrigia*, *Pascopyrum*, *Psathyrostachys*, and *Pseudoroegneria* (Poaceae).

Workshop participants received various publications produced by the Seed Laboratory staff containing valuable information and personal observations on seed and fruit identification, seeding morphology, seedling abnormalities and quality evaluations.

These publications contained diagnostic keys and more than 500 color photographs and illustrations highlighting key structures of seeds fruits and seedlings critical for seed quality assessment.

The Idaho Seed Analysts Association hosted the second workshop. Ms. Meyer was invited to provide instruction on seed and fruit morphology in the Fabaceae and the identification of 19 species of large-seeded legume crops.



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

The third workshop was held in Saskatoon Saskatchewan in conjunction with the Association of Official Seed Analysts (AOSA)/ Society of Commercial Seed Technologists (SCST)/ Commercial Seed Analysts Association of Canada (CSAAC) Annual Meeting. Ms. Meyer was one of three instructors at the 2-day workshop. Topics covered by Ms. Meyer include: Comparison of the AOSA, ISTA (International Seed Testing Association) and CFIA (Canadian Food Inspection Agency) procedures for laboratory seed lot purity testing; How to use *AOSA Handbook 25 Uniform Classification of Weed and Crop Seeds* to determine classification of contaminating species in an AOSA purity test; AOSA procedures for reporting laboratory results; Testing seed mixtures – a review of the AOSA Rules and the CFIA Methods and Procedures (co-presenter Joanne Hinke, Canadian Food Inspection Agency, Saskatoon Seed Laboratory).

Weed Seed vs. Inert Matter

M&P 3.2.6 Individual seeds of *Juncus tenuis* or other species of *Juncus* having seeds of a similar size shall be considered inert matter. Clusters or capsules of *Juncus* spp. shall be left intact, counted and included with the weed seeds.

AOSA 2.9 Weed seed. – Individual seeds and seed-like structures are to be removed from fruiting structures



M&P: Capsule containing seeds = 1 weed seed



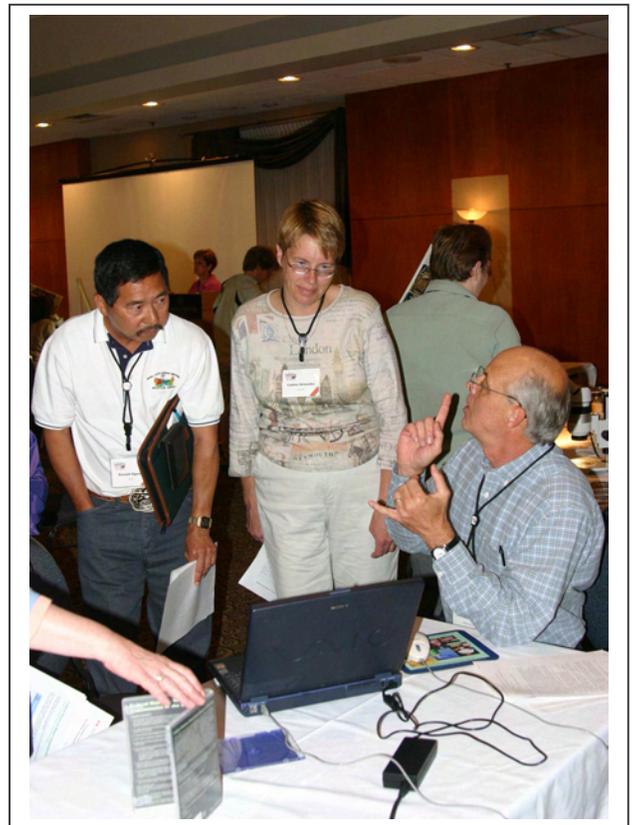
AOSA: Empty *Juncus* capsule = inert matter



AOSA: Undamaged *Juncus* seeds = 19 weed seeds

Excerpt from the PowerPoint show demonstrating the differences between the AOSA Rules for Testing Seeds and CFIA Methods and Procedures for Testing Seeds when determining the number of weed seeds found in a purity test. The green text indicates CFIA M& P and the red text indicates AOSA Rules.

Mr. Effenberger and Ms. Meyer participated in the Seed Issues Forum at the AOSA/SCST/CSAAC Annual Meeting, in Saskatoon, Saskatchewan. They demonstrated the LUCID computer-based seed key for the Federal Noxious Weed Disseminules of the U. S. Julia Scher, USDA, constructed the diagnostic key in cooperation with CDFA. This is an interactive, computer-based key, now available on CD and on the Internet. It is richly illustrated with images and drawings of all the Federal noxious weed seeds and fruits, as well as similar looking species.



Scientific Service to Professional Organizations and Editorial Responsibilities by PPDB Seed Botanists

Jim Effenberger

- Member – Executive Board, Association of Official Seed Analysts (AOSA) (2005 – present)
- Chairman – Bylaws Committee, AOSA (1995 – 2005)
- Chairman – Ethics Committee, Society of Commercial Seed Technologists (2003 – present)
- Member – Purity Testing Subcommittee of the Research Committee, AOSA (1994 – Present)
- Ethics Committee, Society of Commercial Seed Technologists (2003 – present)

Deborah Meyer

- Associate Editor – *Seed Technology*, 2001 – present
- Chairperson – Rules Committee, Association of Official Seed Analysts (AOSA) (2001 – present)
- Chairperson – Purity Testing Subcommittee of the Research Committee, AOSA (1994 – present)
- Member – Seed Testing Standardization and Research Funding Committee, AOSA (2001 – present)
- Member – Purity Committee, International Seed Testing Association (ISTA) (1995 – present)
- Member – Rules Committee, ISTA (2005 – present)
- Member – Registered Seed Technologist Board of Examiners, Society of Commercial Seed Technologists (2002 – present)
- National Plant Board Representative – National Seed health System – Seed Testing Working Group (2000 – present)
- Member, Community Advisory Council of the College of Natural Sciences and Mathematics, California State University, Sacramento (2005 – present)

Marian Stephenson

- Member – Tetrazolium Testing Subcommittee of the Research Committee, AOSA (2000 – 2005)

The Identification Of Seeds Found In Cropland Soil

Jim Effenberger, Johanna Naughton, and Connie Weiner

The Seed Laboratory was requested by CDFA Pest Exclusion to analyze field soil samples from a northern California crop field for seed content. This field was planted with oat seed in the spring and by harvest time the oat hay was infested with *Lathyrus hirsutus* L., hairy vetchling and *Vicia sativa* L. subsp. *sativa*, common vetch. Both hairy vetchling and common vetch seeds in high concentration are toxic to livestock and therefore are undesirable in hay (Kingsbury, 1964). Seed samples from the oat seed lot used to plant this field were analyzed at the laboratory and the two contaminants stated above in the oat hay were not found. An assumption was made that the contaminating species may have been in the soil before the field was planted.

Soil can be an excellent storage container for seeds. Studies have shown that seeds can remain viable in soil for long periods of time. The life span of seeds can be more than a thousand years depending on the species and the environmental conditions they are stored under. Seeds of Fabaceae are notoriously long-lived often because of very hard seed coats. Some South American species of Fabaceae have germinated after 158 years in storage (Cronquist, 1961). The two contaminating species in the oat hay are members of Fabaceae and produce seeds that have very hard seed coats.

Seeds can be disseminated into the soil in a number of ways including wind, water, animals and man. One of the main sources for the introduction of undesirable plants into crop fields comes from planting seed that is contaminated with seeds of undesirable plants. In a study conducted in Kansas, wheat drill boxes were inspected for undesirable seeds. This study indicated that 29% of the 662 wheat drill box samples inspected contained undesirable seeds (Wilson and Furrer, 1996). These seeds can remain in the soil for years before they germinate and become problem pests in the field.



Example of soil sample taken from oat field and sent to the seed laboratory for analysis. Soil particles in this sample are approximately the same size as hairy vetchling and common vetch seeds.

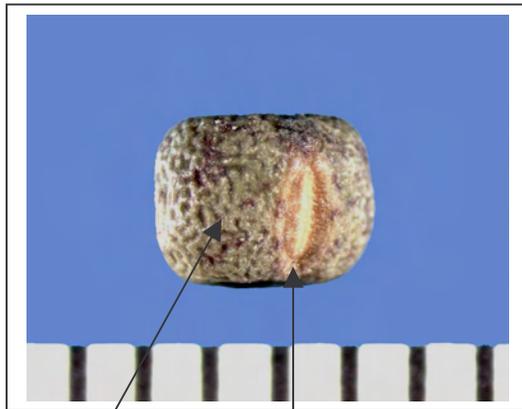
The laboratory received 16 field soil samples for testing. The soil samples contained 168 undesirable seeds representing 19 taxa. Seeds of the target pests were found, eight seeds of hairy vetching and two seeds of common vetch.

The seeds of hairy vetchling are approximately 3 mm in length and compressed at the ends. Close spaced tubercles or ridges roughen the surface of the seed. The hilum is oval in shape, less than 2 mm long, and 1 to 1 ½ mm wide.

The seeds of common vetch are basically spherical, 3.5 mm to 6 mm in diameter. The hilum of the seed is narrowly wedge shaped 3 to 4 times longer than wide, with depressed edges and a distinctly raised light colored split down the center.

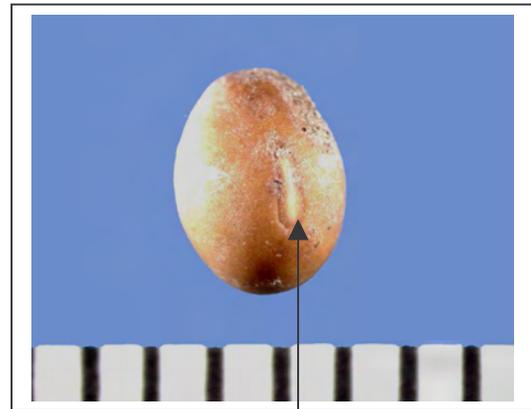
Lathyrus hirsutus L., hairy vetchling

Vicia sativa L. subsp. *sativa*, common vetch



Tubercles

Hilum



Hilum

REFERENCE

Cronquist, A. 1961. Introductory Botany. Harper & Row, Publishers, New York and Evanston.

Kingsbury, J.M. 1964. Poisonous Plants of The United States and Canada. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

Wilson, R.G. and Furrer, J. 1996. Where Do Weeds Come From? Cooperative Extension, University of Nebraska, Electronic version.

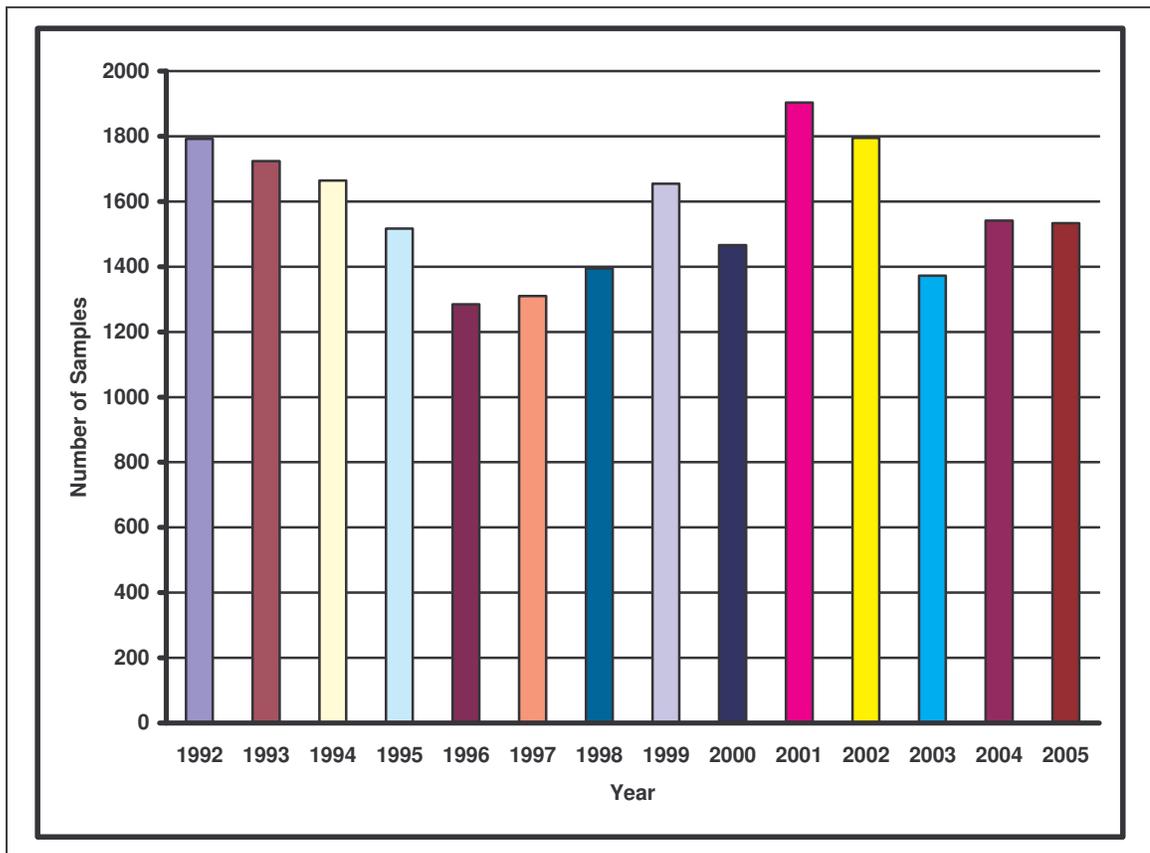
Annual Quarantine Seed Samples, 1992-2005

Donald B. Joley

Quarantine tests are performed on seed moving across state and county lines and are an important part of the pest exclusion, detection and eradication programs. The quarantine test requires the examination of a minimum 25,000 seeds from each submitted sample to detect the presence of noxious weed seeds.

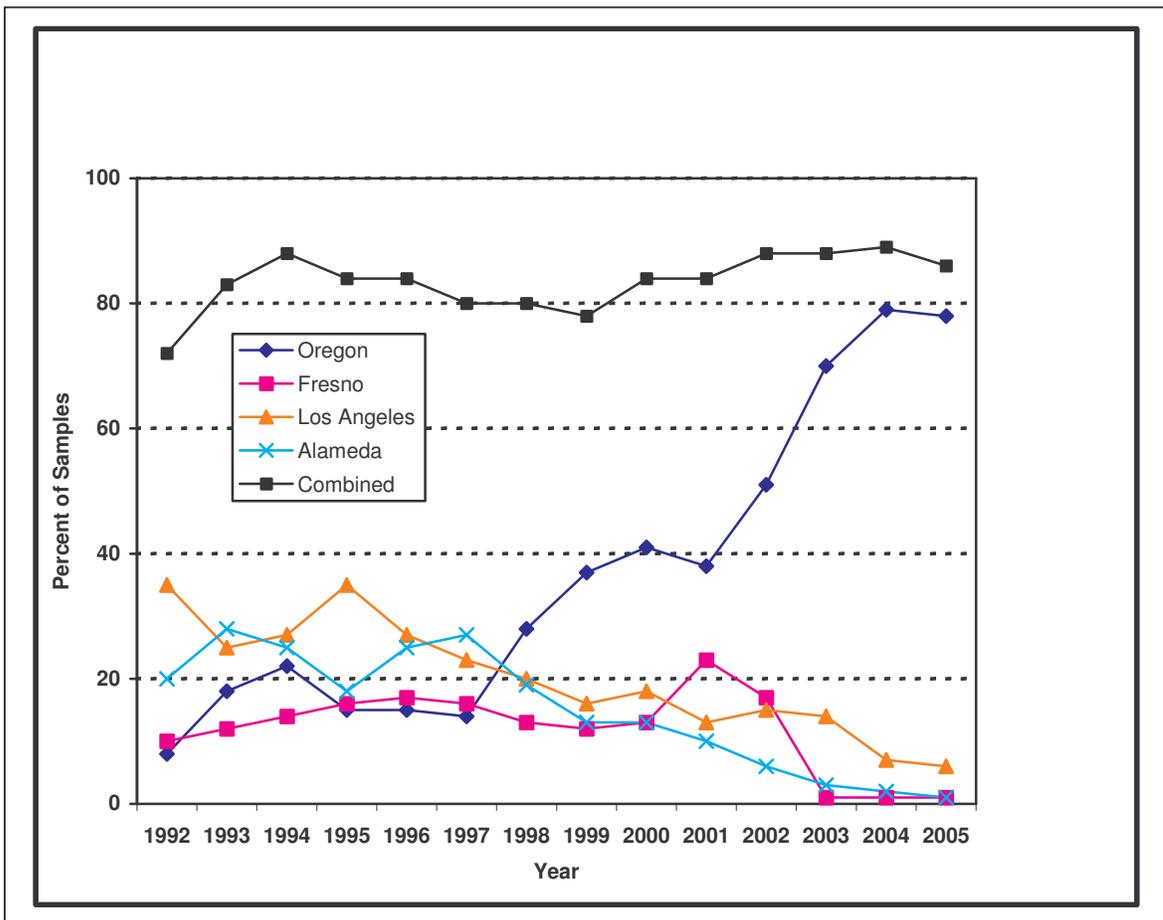
The number of annual quarantine samples submitted to the State Seed Laboratory from 1992 through 2005 showed no major trend (Fig. 1).

Figure 1. Annual Quarantine Seed Sample Totals, 1992-2005.



However, there was a major shift in responsibility for collecting and submitting samples for noxious weed examinations. Prior to 1997, most quarantine seed samples were submitted to the State Laboratory from four sources in roughly uniform proportions (Fig 2). Since 1997, samples submitted by the three California counties have decreased to very low levels while those from the State of Oregon have increased correspondingly to a high level. Samples from Oregon are collected at the seed companies and submitted by the Oregon Department of Agriculture through the Origin Inspection Program (OIP). Infested seed lots are barred from shipment into California, thereby avoiding return shipment costs.

Figure 2. Percentage of annual quarantine seed samples submitted for noxious weed testing from four primary sources, 1992-2005.



Annual Report of Seed Laboratory Sample Workload 2005

Jim Effenberger, Elaine Harris, Don Joley, Deborah Meyer, Paul Peterson,
Evelyn Ramos, Marian Stephenson and Connie Weiner

The staff of the Seed Laboratory of the Plant Pest Diagnostics Branch consists of five Seed Botanists, two Agricultural Biological Technicians, one Senior Laboratory Assistant and additional support from temporary, part-time Scientific Aides. During 2005, approximately 63% of the workload consisted of seed quality assessment testing, seed/fruit identification and professional consultations, 27% was devoted to laboratory quality assurance (i.e., equipment maintenance and calibration, database entry, document preparation, database management, Q.A. system development, seed herbarium curation, etc.) and 10% was devoted to professional enhancement activities (i.e., research, professional meeting attendance, workshop and seminar presentations, professional organization committee work, etc.).

Types of Samples Processed by the Seed Laboratory

The Seed Laboratory routinely handles categories of samples as described below. Table 1 indicates the numbers of samples processed and tests completed during 2005 for each sample type. The percentages of tests completed for each sample type are shown in Figure 1.

- **Quarantine** – Tests on quarantine samples require examination of a minimum of 25,000 seed units from each submitted sample to detect the presence of noxious weed seeds. Quarantine samples are drawn from seed lots moving across state and county lines and are an important part of the pest exclusion, detection and eradication program.
- **Regulatory** -Tests on regulatory label compliance samples include a noxious weed seed examination of a minimum of 25,000 seed units, a purity examination of a minimum of 2,500 seed units, and a germination test of 400 pure crop seed, from each submitted sample to determine label integrity. Laboratory procedures used for these tests are those prescribed in the Federal Seed Act. The noxious weed seed examination is similar to that of a quarantine test. The purity examination determines the physical composition of a seed sample and consists of separation of the pure crop seed kind or kinds (in the case of mixtures of 2 or more species) under consideration from the following contaminants: inert matter, other crop seeds, and weed seeds. The components are reported as percentages based on weight, and all contaminating species are identified. The germination test estimates the percentage of normal seedlings a seed lot can produce. Four hundred seed units are planted on various types of artificial media, and are subjected to various environmental conditions

deemed appropriate for the species being tested, in an effort to determine the number of normal seedlings produced under optimum conditions. Laboratory results from the noxious weed seed examination, purity examination, and germination test are compared to the seed lot label; if the results are determined to be out of tolerance with the seed lot label, appropriate action is taken by Nursery and Seed Service. The percentages of the types of regulatory samples released to the Seed Laboratory in 2005 are shown in Figure 2.

- **Service** – Tests on service samples include examinations similar to those described for regulatory tests, as well as specialized tests based on client needs. Service samples are processed on a fee for service basis. The test results are reported directly to the client on formal certificates of analysis and are confidential. These documents are the basis for seed commerce throughout the world. Laboratory procedures used in service testing follow those prescribed in the Federal Seed Act, the Association of Official Seed Analysts Rules for Testing Seed, the International Seed Testing Association Rules for Seed Testing, and the Canadian Methods and Procedures for Testing Seed. Results of these tests may also be used for resolving contractual disputes. The percentages of the types of crops submitted as service samples in 2005 are shown in Figure 3.
- **Feed Mill Approval** - Feed mill approval tests include the removal, identification, and determination of viability of all weed seed found in processed livestock feed samples. Testing of these samples regulates the certification of feed mills and stops the spread of weed seed throughout the state.
- **Identification** - These samples include identifications of specimens submitted to the laboratory by border stations, counties, other government agencies, commercial seed laboratories, medical doctors, veterinarians, archaeologists, and other researchers. These identifications are not only critical in preventing the spread of hazardous weeds, but are often necessary for expediting importation and exportation of agricultural products, are required as evidence in criminal court cases, and are necessary for medical and veterinary diagnoses of poisoning cases.

Table 1. Total number of samples processed and tests completed by the Seed Laboratory in 2005 for each sample type. Each sample received by the Seed Lab may require more than one test, with the type of test(s) dependent on the sample type.

Type of Sample	# Samples completed	# Tests completed
Quarantine noxious	1533	1533
Identification	23	26
Mill Approval	94	94
Service	589	1232
Regulatory label compliance	927	3138
TOTALS	3166	6023

Figure 1. The percentages of tests completed by the Seed Laboratory in 2005 for each sample type. Pie areas represent percentages of the numbers of samples completed, not the time required to complete each type of sample.

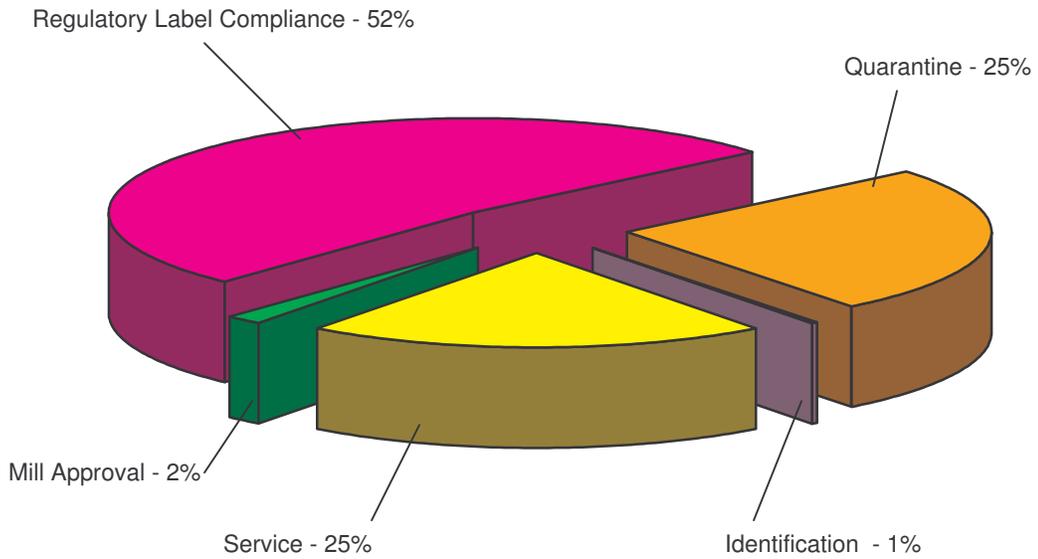
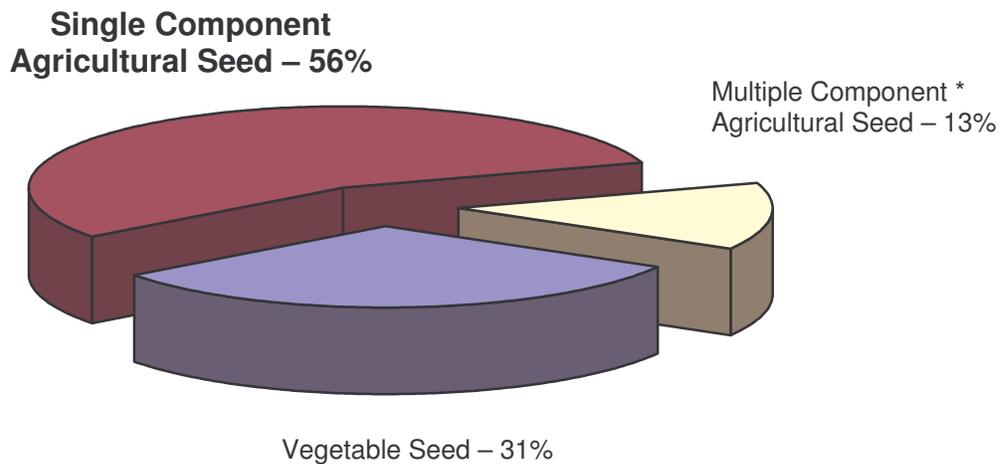
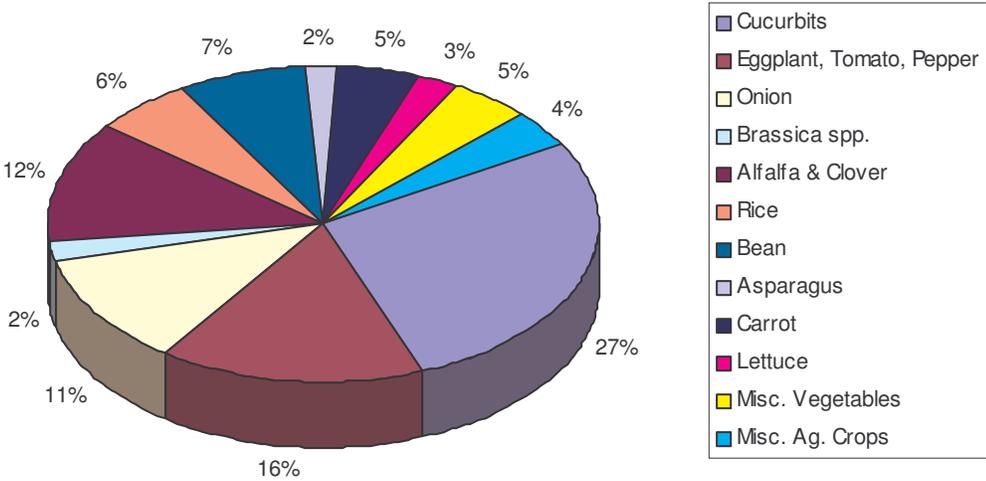


Figure 2. Percentages of the generalized crop types of regulatory samples released to the Seed Laboratory in 2005.



* Multiple component agricultural seed samples contain mixtures of 2 or more kinds of seeds requiring separation of each kind of seed during the purity analysis and separate germination tests on each kind.

Figure 3. Percentages of the types of crops submitted as service samples in 2005.



ENTOMOLOGY

Entomology Laboratory Staff

Entomologists

Charles Bellamy

Matthew Buffington

Andrew Cline

Marc Epstein

Eric Fisher

Stephen Gaimari, Supervisor

Rosser Garrison

Martin Hauser

Peter Kerr

John Sorensen

Gillian Watson

Shawn Winterton

Agricultural Biological Technicians

Saraah Kantner

Scott Kinnee

Randall Plant

Ramona Randolph

Mary-Jean Sawyer

Entomology Laboratory Staff, continued

Agricultural/Scientific Aides

Jenny Chau
Robert Copsey
Jeanette DeLeon
Rowena DeLeon
Matthew Fossum
Rachel Guzzetta
Wei-min Li
Caleb Marion
Israfiel Mohammed
Kara Noyes
Dominique Orozco
Joe Posadas
Lindsay Rains
Ernie Riberal
Jo Viray
Steve Vu
Scott White
Dennis Whitley
Kevin Williams
Patrick Woods

Emeritus Scientists

Fred Andrews
Raymond Gill
Terry Seenno
Ron Somerby

The primary objectives of the Insect Biosystematics Laboratory are to:

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

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

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

Scales, mealybugs, whiteflies and thrips, 2005

Gillian W. Watson

Identifying unknown species

In November 2005, I visited the Entomology Department of the Natural History Museum (London, UK) (BM (NH)). One of the aims of this visit was to see if any of the unidentified species being intercepted on plant material entering California were described species.

An armored scale species that has been intercepted from Hawaii periodically on cut *Protea* flowers since 1992 was identified as *Pseudaulacaspis brimblecombei* Williams, a species native to Australia that had previously only been recorded on *Macadamia*. Subsequent correspondence with Dr Bernarr Kumashiro (Hawaii Department of Agriculture) indicated that this species is present in nurseries on the island of Maui and possibly also on the island of Hawaii. HDOA are carrying out surveys and eradication action.

No described species were found to match the mealybug (*Nipaecoccus* sp.) that continues to be found periodically in nurseries in Los Angeles, Orange and Madera counties, mostly feeding on palms; or the species of whiteflies (*Aleurotrachelus* spp.) that are found periodically on betel and palm leaves shipped from Hawaii (but which possibly originate from Tahiti or elsewhere in the Pacific islands). These species appear to be new to science.

Building the California State Arthropod Collection

While at the (BM (NH)), the opportunity was taken to negotiate an exchange of material between their collection and the California State Arthropod Collection (CSAC). The BM (NH) has numerous specimens of Old World pest species that are not represented in the CSAC collection, and we have specimens of New World species that are not represented in their collection. Over 500 slides from CSAC were successfully exchanged for an approximately equal number of slides from the BM (NH) collection. The exchange leaves PPDB better equipped to identify serious pests like the aphid *Toxoptera citricida*, the main vector of citrus tristeza closterovirus. This pest was not represented in the CSAC collection before the exchange.

Some rare literature from the BM (NH) entomology library was copied for research use by PPDB insect biosystematists.

Research on *Bemisia* whitefly taxonomy

While visiting the BM (NH), the opportunity was taken to discuss with Dr. Jon Martin (a whitefly expert), forthcoming USDA-funded collaborative research on the taxonomy of the whitefly genus *Bemisia*, and to borrow specimens of *Bemisia* from the BM (NH) collection for morphological studies. This work will involve an international multidisciplinary group including Jon Martin, Ray Gill, Prof. Judy Brown (U. of Arizona), Dr. George Roderick (U.C. Berkeley) and myself.

Lepidoptera Report for 2005

Marc E. Epstein

Asian Gypsy Moth (*Lymatria dispar* (Linnaeus)). Two male gypsy moth of the "Far Asian" strain were found in pheromone traps since 2003. They were diagnosed at the PPDC by Scott Kinnee using one nuclear and two mitochondrial DNA markers. The first moth of this strain was from near Long Beach Harbor at what has been referred to as the Wilmington site in the summer of 2003 and the second was found in July 2005 a short distance away in San Pedro near the U.S. Navy Fuel Depot.

Lineodes elcodes Dyar. This species is a pest on Night Jessamine (*Cestrum nocturnum*). The caterpillars were first discovered in the vicinity of Santa Barbara by Guy Tingos and Jerry Davidson in 2003. It is a new U.S. record in addition to being new for California. *Lineodes elcodes* has had a continued presence on the host plant in the Santa Barbara area ever since, with populations in backyards and in a local canyon near a nursery (J. Davidson, pers comm.). In late 2005 adults of the species were found in Alameda Co (J. Powell, pers comm.). This species was previously only known from Mexico and not known for its caterpillar or host plant. The species was identified from the adult stage by pyraloid specialist M. Alma Solis of the Systematic Entomology Laboratory (USDA).

Duponchelia fovealis Zeller. This crambid species (Pyraloidea) was found on Begonia at a nursery in San Marcos in the San Diego area in 2004 and has not been reported in 2005. *Duponchelia fovealis* has been intercepted by APHIS over the last two years from Europe (especially The Netherlands) on a variety of ornamental and vegetable crops. The caterpillars were identified by pyraloid specialist M. Alma Solis of the Systematic Entomology Laboratory (USDA).

Darna pallivitta (Moore). The stinging caterpillars and cocoons of this invasive Asian limacodid species were imported to California from Hawaii in 2003-2005. On the Big Island of Hawaii *Darna pallivitta* continues to expand its range from the Panaewa nursery near Hilo. At present, *D. pallivitta* has not been found on other Hawaiian islands, but the occurrence of the caterpillars on no fewer than 45 plant species in 22 families is cause for concern in Hawaii and California. In collaboration with Arnold Hara (U. Hawaii) and Walter Nagamine (Hawaii Dept. of Agriculture), M. Epstein observed the spiny caterpillars and adults of the species at the Quarantine facility of the Hawaii Dept. of Agriculture in Oahu and in the field on the Big Island. It was noted that the females moths come to lights early compared to the males, an observation first noted by U. Hawaii graduate student C. Kishimoto. Epstein noted that the flights of the females appear to be unusually strong and the unusually large numbers of female moths at lights near the Panaewa nursery. During visits to both Oahu and the Big Island, Epstein

gave lectures on the biology of Limacodidae, including an invasive Central American species, *Acharia apicalis*, which is now known as the IKEA slug moth in Europe because it has frequently been found on Kentia palms in the retail stores.

False Codling Moth (*Thaumatotibia leucotreta* (Meyrick)). The larval stages of the False Codling moth were found in Spanish Clementine Oranges imported to California from South African in June 2005. They were first identified by R. Garrison (PPDC) and verified by J. Brown (SEL) and M. Epstein (PPDC) in June 2005. Throughout the summer and early fall a number of dead samples have been identified on Clementine Oranges.

Asciodes gordialis Guenee. This species of pyraustine (Crambidae: Pyraloidea) is new to California, with the Bougainvillea feeding caterpillars found by Eric Natwick in Holtville (Imperial Co.) in June 2005. This species was previously known from French Guiana, Jamaica, Central America, Florida, and South Carolina.

Systematics of the Buprestoidea Leach, 1815 (Coleoptera): Progress report for 2005

C. L. Bellamy

As detailed in the 2004 annual report, my research continues in several of the same main directions:

1. The Madagascan Coraebini

www.cdfa.ca.gov/phpps/ppd/Entomology/Coleoptera/Buprestidae/MadCor/intro.html

The publication of Coleoptera Buprestidae of Madagascar and adjacent islands: an Annotated Catalogue, *Fauna de Madagascar series*, is now planned for March 2006.

2. The Buprestidae of Mexico

www.cdfa.ca.gov/phpps/ppd/Entomology/Coleoptera/Buprestidae/Mexico/index.html

One trip was taken to southern Mexico (Michoacan, Oaxaca, Puebla) from July 25 to August 5.

3. The World Catalogue of Buprestoidea

www.cdfa.ca.gov/phpps/ppd/Entomology/Coleoptera/Buprestidae/WorldCat/intro.html

The page-formatted catalogue files currently stand at near 3200 pages and was essentially complete at the end of 2005. The index is currently being assembled and the publication is planned for 2006 still awaiting the publication of several significant monographs or regional catalogues expected later this year. The effort to complete this catalogue has resulted in the following publications:

Bellamy, C. L. 2005. New synonymy in Buprestidae (Coleoptera). *The Coleopterists Bulletin* 59(1): 26.

Bellamy, C. L. 2005. Clarification of synonymy in three species of *Temognatha* Solier, 1833 (Coleoptera: Buprestidae). *The Pan-Pacific Entomologist* 81(1-2): 99-100.

Bellamy, C. L. 2005. Justified emendation in Buprestidae (Coleoptera). *The Coleopterists Bulletin* 59(3): 309.

The International Commission of Zoological Nomenclature ruled on three applications submitted in 2003:

- Bellamy, C. L. 2003. Case 3194. *Lius* Deyrolle, 1865 (Insecta, Coleoptera): proposed conservation. *Bulletin of Zoological Nomenclature* 60(2): 132-133.
- Bellamy, C. L. & M. G. Volkovitsh. 2003. Case 3258. *Acmaeodera* Eschscholtz, 1829 and *Acmaeoderella* Cobos, 1955 (Insecta, Coleoptera): proposed conservation. *Bulletin of Zoological Nomenclature* 60(1): 31-33.
- Bellamy, C. L. & R. L. Westcott. 2003. Case 3257. *Acmaeodera oaxacae* Fisher, 1949 and *Polycesta deserticola* Barr, 1974 (Insecta, Coleoptera): proposed precedence of the specific names over those of *Acmaeodera philippinensis* Obenberger, 1923 and *Polycesta aruensis* Obenberger, 1924 respectively. *Bulletin of Zoological Nomenclature* 60(2): 124-126.
- ICZN. 2005a. Opinion 2100 (Case 3258). *Acmaeodera* Eschscholtz, 1829 and *Acmaeoderella* Cobos, 1955 (Insecta, Coleoptera): usage conserved by designation of *Buprestis cylindrica* Fabricius, 1775 as the type species of *Acmaeodera*. *Bulletin of Zoological Nomenclature* 62(1): 47-48.
- ICZN. 2005b. Opinion 2112 (Case 3194). *Lius* Deyrolle, 1865 (Insecta, Coleoptera): conserved. *Bulletin of Zoological Nomenclature* 62(2): 104-105.
- ICZN. 2005c. Opinion 2114 (Case 3257). *Acmaeodera philippinensis* Obenberger, 1924 and *Polycesta aruensis* Obenberger, 1924 (Insecta, Coleoptera): priority maintained over *Acmaeodera oaxacae* Fisher, 1949 and *Polycesta deserticola* Barr, 1974 respectively. *Bulletin of Zoological Nomenclature* 62(2): 108-109.

4. Beetle Tree of Life Project

This new project was funded by the National Science Foundation in 2005. I am serving as one of the nine **T**axonomic **W**orking **G**roup (TWiG) leaders.

www.beetletree.org

New taxa proposed during 2005:

Agrilus aliciae Bellamy, 2005 – Oaxaca, Mexico
Agrilus pulex Curletti & Bellamy, 2005 – South Africa
Bellamyus opacus Curletti & Bellamy, 2005 – Cameroon
Brachycoraebus basilanensis Bellamy, 2005 – Basilan, Philippines
Brachycoraebus mindanaoensis Bellamy, 2005 – Mindanao, Philippines
Brachycoraebus minutus Bellamy, 2005 – Basilan, Philippines
Lumawigia, new genus, Bellamy, 2005
Lumawigia, gibbicephala Bellamy, 2005 – Luzon, Philippines
Philippscelus panayensis Bellamy, 2005 – Panay Island, Philippines
Richtersveldia, new genus, Bellamy, 2005
Richtersveldia insperata Bellamy, 2005 – South Africa
Sibuyanella boudanti Bellamy, 2005 – Bokol Island, Philippines
Sibuyanella mimica Bellamy, 2005 – Marinduque & Mindoro Islands, Philippines

PPDB and The Coleopterists Society

C. L. Bellamy

During 2005, the relationship between the lab and The Coleopterists Society continued to evolve.

Society Past-President Chuck Bellamy chaired the nomination committee, which presented the ballot for 2006-2007 Councilors. Andy Cline was elected as one of three councilors.

Terry Seeno remains the editor of the Society's Special Publications series.

Andy and Chuck attended the Entomological Society of America annual meeting in Ft. Lauderdale, December 15-18, with the Coleopterists Society holding their traditional concurrent meetings. Both attended the Society Executive Council meeting on the Monday morning and the general business meeting on Tuesday evening.

In further evolutionary steps, Andy will take over the responsibility of shipping the various volumes and back issues stored at PPDB and Chuck will take over as the webmaster for the Society's website.

www.coleopsoc.org

California State Collection of Arthropods: 2005 Progress Report.

Stephen D. Gaimari, Charles L. Bellamy, and Peter H. Kerr

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

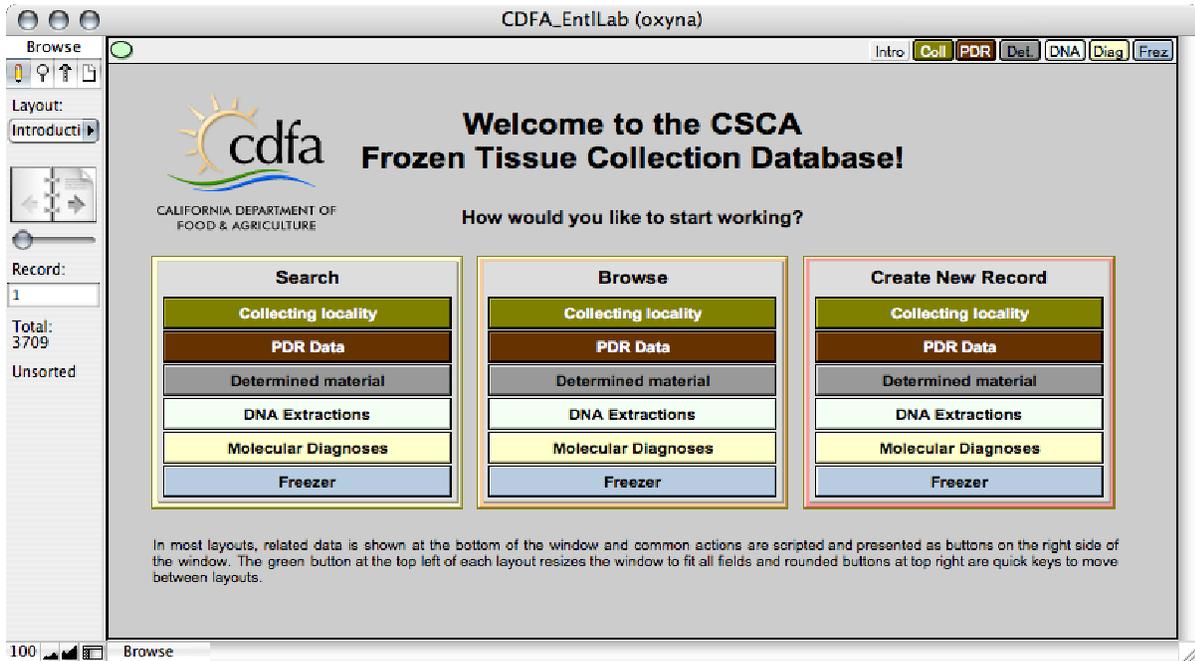
The total number of prepared specimens exceeds 1.5 million, with more than 30,000 prepared specimens accessioned in 2005. Six holotypes and numerous paratypes were deposited in CSCA in 2005, and the collection has been recognized as an important repository for certain groups of arthropods. With the decision to house primary types in the CSCA, we believe that these will need to be available, in perpetuity, for study by the scientific community and thus our need to adequately protect them. While personal examination may always be necessary, we plan to add multiple-view close-up digital images to the CSCA web pages for each type we hold. The entire collection is being inventoried, so far with over 500,000 specimens accounted for in nearly 20,000 species.

Frozen Tissue Collection

The CSCA has also recently developed a fully functional state-of-the-art Frozen Tissue Collection (CSCA-FTC) for the long-term preservation of arthropod DNA. This was established to meet the needs of the newly-developed and ever-growing number of diagnostic and systematic entomology research activities that employ DNA-based (i.e., molecular) methods. The proper curation and long-term preservation of specimens and their DNA is critical for DNA-based services that are now routinely provided by the lab, and are likely to become an even greater part of PPDB lab activities in the future.

The CSCA-FTC has the capacity to store over 13,000 samples at -80° Celsius. Already preserved in the collection are over 1,000 DNA samples and over 1,400 samples of DNA voucher specimens (specimens from which DNA has been extracted) or whole identified specimens (whose DNA may be extracted in the future). The exact location within the freezer and specific information associated with these samples is saved in a custom Filemaker Pro v8 database. The databasing of this material is critical for maintaining information regarding the collection and easy access to the specimens themselves. Below is the welcome screen to the database,

which is available through the local network to all PPDB Insect Biosystematists and the appropriate technical staff.



The structure of the CSCA-FTC database is optimized so that data input is simple and efficient, with a minimal exposure to common errors- such as typos and variations of the same name- that may compromise future database queries. Pull-down menus allow a series of click-throughs instead of typing to fill in most record fields with options that are logically dependent on previous entries. After choosing 'San Bernardino' for the county field, for example, the pull-down menu for the city field only lists cities within San Bernardino County. Logical data-type constraints are also built into the database to reject unreasonable dates, rating values, etc. Typing is further minimized by scripts that automate procedural steps (after user confirmation), such as finding the next available empty space in the freezer, printing determination labels, and so on.

The database can handle all material destined for the CSCA-FTC, whether the samples originate as PDRs, donations, or research material and assigns exact freezer spaces for deposition as the material is acquired. No PCR products are kept in the CSCA-FTC in order to reduce the risk of genetic contamination. Sample spaces in the freezer are defined by the freezer number, rack number, box number, and the specific alphanumeric coordinates of their exact space. For example, a sample space of 'AB06.a4' indicates that it is in freezer A, rack B, box 6, in space 'a4' which is the fourth column of the first row ('a'). For all samples in the freezer, the collecting locality/PDR information is retained as well as specific information regarding its determination (determiner, date of determination, etc.). This data is linked to all information regarding DNA extraction and molecular diagnoses that have been made. The data is also linked, of course, to corresponding voucher material, with exact locations in the freezer for the DNA, DNA specimen voucher,

and remaining samples from the same collecting event, if present. These series of links allow quick retrieval of the samples from the freezer and/or quick reference to further information regarding the samples.

Below is an example of a PDR sample that has been processed into the CSCA-FTC system. The original PDR information is shown in the upper left light gray box. To the right, are square buttons that enable commonly used scripts to process the sample. At the bottom, are views into related portions of the database which show what is kept (and its location) in the freezer. The DNA voucher specimen for this particular PDR sample is stored in AA02.c3 (freezer A, rack A, box 2, space c3). The DNA extraction of this sample is in space AC07.b6. Furthermore, a molecular diagnosis of this sample has been made and it is determined 'AAAB.' Further information (including comments, etc.) regarding the species determination, DNA extraction, and/or the molecular diagnosis are available by clicking buttons below the related information. Any of the fields on this page, included related data fields, are available for use in queries.

Locality Lot 05LOT653

Collection (non-PDR)

PDR Number 1363142
 Location 36 Activity 12 Situation 63 Rating A
 Date Collected 10/1/2005
 County San Bernardino
 City Rancho Cucamonga
 Address 7855 Sierra Vista St.
 Owner
 Order Diptera
 Family Tephritidae
 Genus *Ceratitis*
 Species *capitata* Sex 1 F
 Species Author Wiedemann
 Host Common Name Tangerine
 Trap IPM Trap
 Determiner J.W. Leathers Date Determined 10/2/2005
 Remarks 1 undyed wild female, sexually immature; mated. Confirmed by S.D. Galmari on 10/3/2005 with this added note: Ovaries poorly developed—borderline. Sent ovaries to Don McInnis 10/2/2005

PDR

PDR SAMPLE PROCESSING (step 1)
 Click to create determination record and deposit single PDR vial into Frozen Tissue Collection

Click to add additional vials into the freezer from this same PDR

MOLECULAR DIAGNOSTICS PROCESSING (step 2, if necessary)
 Change Det. Record to DNA Voucher Record and create records, spaces, & printouts as necessary for DNA extraction (for samples of 1 indiv only)

Make DNA record for PDR samples having more than one indiv

See records in List View

For non-PDR samples, the fields above are blank

Data Related to This Lot

Freezer		Determined Material / DNA Voucher				DNA Extractions	
Lot location	Family	Species	Type	Det/Voucher Number	Det/Vouch Location	DNA Extract Number	DNA location
	Tephritidae	<i>Ceratitis capitata</i>	DNA voucher	05V672	AA02.c3	05V672a	AC07.b6

See Records in Freezer

See Det./Voucher records from this lot

See Det./Voucher records from this found set

Molecular Diagnosis
AAAB

Open diagnosis list of found set

Lot Record Created By mjs Date Created 10/3/2005 Modified By phk Date Modified 3/10/2006

The CSCA-FTC also houses Mediterranean fruit fly DNA samples generated by Bruce McPheron and his lab at Penn State University. The data for these samples, originally created by the McPheron lab, has been integrated into the CSCA-FTC database and now information regarding each of these samples can be queried in a number of different ways and their exact location in the freezer is known.

Identification labels for vials containing samples other than DNA extractions (PDR samples, DNA voucher specimens, whole insect samples, etc.) are generated from the CSCA-FTC database and placed within the vials. The database also generates original collection locality labels for the vials, as necessary. For vials containing DNA extraction material, labels are created using a Brother PT-3600 thermal printer that prints on 3/8" tape in size 5 font with extremely resistant adhesive that is able to withstand very cold temperatures. These labels are standardized so that information regarding each sample is consistent, complete, and easily read (as opposed to hand-written vial labels). The labels are affixed to the outside of each DNA-containing vial.

Overall, the CSCA-FTC is designed to work in tandem with the rest of the CSCA collection, employing basic tools that are essential to modern collection management. This will allow the CSCA to continue to provide for the citizens and business interests of California, while serving the scientific community at large.

Specimen Usage

As far as specimen usage, the CSCA issued 32 loans in 2005, representing nearly 14,000 specimens, and more than 35 visitors from the local, national, and international communities have come in to study our collections. These visitors included several longer-term visitors: Dr. Sergio de Freitas (Universidade Estadual Paulista, Jaboticabal, São Paulo, Brazil), studying Neuroptera with Shaun Winterton; Dr. Vera C. Silva (Universidade Estadual Paulista, Assis, São Paulo, Brazil) studying Diptera with Steve Gaimari; and Drs. Charles and Lois O'Brien (retired), studying Curculionidae (Coleoptera) and Fulgoroidea (Hemiptera) respectively. Additionally, numerous client groups have been given tours of the collection.

Research Associates

The Research Associate program has grown with the appointment of eight new associates in 2005:

Ron Alten, Alta Loma, California
Jerry M. Davidson, Arizona
Penny Gullan, Davis, California
Michael Irwin, Arizona
Charles O'Brien, Arizona
Lois O'Brien, Arizona
Jacques Rifkind, Valley Village, California
George Walters, Jr., La Puente, California

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

PPDB ENTOMOLOGISTS: GRADUATE STUDENT COMMITTEES

Three of the PPDB entomologists serve or served on graduate student committees (research, exam) or as external examiners in 2005, as follows:

Chuck Bellamy

Angelica Corona, Universidad Nacional Autonoma de Mexico, Mexico
Amanda Evans, Harvard University, Cambridge

Steve Gaimari

Scott Brooks, University of Guelph, Ontario, Canada (2004)
Danielle Ducharme, University of California, Davis
Nate Hardy, University of California, Davis
Cory Unruh, University of California, Davis

Shaun Winterton

Cory Unruh, University of California, Davis
Imelda Menchaca Armento, Universidad Autonoma Estado de Hidalgo, Mexico

Research on flies (Diptera)

Stephen D. Gaimari

Steve's research program has covered many groups of flies (Empidoidea, Lauxanioidea, Asiloidea, Opomyzoidea), in addition to some work on fleas, and has forged many collaborations, including several foreign scientists. Included in his published (and in press) work in 2005 are papers with Belgian, Chinese, Brazilian, Turkish, and American entomologists. For those published in 2005, these works have covered inventory and biology work (A1) and systematics of Empididae (A2-6). The works finished (in press or submitted in 2005) include new parasitic flea records (B1), studies of biology of predatory flies (B7), cataloging the Odiniidae (B6), revisionary work on Lauxaniidae (C1-2) and Odiniidae (B6), and book chapters providing faunistic overviews for Therevidae (B4), Lauxaniidae (B5), Chamaemyiidae (B2) and Odiniidae (B3).

A. The following papers were published in 2005, with a brief comment for each:

1. Noma, T., M.J. Brewer, K.S. Pike, & **S.D. Gaimari**. 2005. Hymenopteran parasitoids and dipteran predators of *Diuraphis noxia* in the west-central Great Plains of North America: Species records and geographic range. *Biocontrol* 50: 97-111.

Parasitoids and predatory flies were sampled in the wheat production region of the west-central Great Plains (southeastern Wyoming, western Nebraska, and northcentral Colorado) from plant material infested with the Russian wheat aphid, *Diuraphis noxia* (Mordvilko) (Hemiptera: Aphididae). The natural enemies detected were (in order of high to low detection frequencies): *Aphelinus albipodus* Hayat and Fatima (Hymenoptera: Aphelinidae), *Eupeodes volucris* Osten Sacken (Diptera: Syrphidae), *Lysiphlebus testaceipes* (Cresson) (Hymenoptera: Braconidae), *Leucopis gaimarii* Tanasijtshuk (Diptera: Chamaemyiidae), *Aphidius avenaphis* (Fitch), *Aphidius matricariae* Haliday, *Diaeretiella rapae* (M'Intosh), *Aphidius ervi* Haliday, *Praon yakimanum* Pike and Stary' (Hymenoptera: Braconidae), and *Aphelinus asychis* Walker (Hymenoptera: Aphelinidae). Some of these species were previously known from the western US, but the recognized distributions have increased for *A. avenaphis*, *L. gaimarii*, and *P. yakimanum*.

2. Yang, D., & **S.D. Gaimari**. 2005. Notes on the species of the genus *Ocydromia* Meigen from China (Diptera: Empididae). *Pan-Pacific Entomologist* 80 (1): 62-66.

The genus *Ocydromia* Meigen previously had two species known from the Palearctic Region, of which one is also distributed in the Nearctic. One additional species is found in the Neotropical, two in the Afrotropical, and two in the Oriental Regions. In this paper, the genus is recorded from China for the first time, with one

new species, *Ocydromia xiaowutaiensis*, described and illustrated from Hebei Province, which has a subtemperate climate and belongs to the Palearctic part of northern China. A key to the species of the genus from the Palearctic Region is also presented.

3. Yang, D., & **S.D. Gaimari**. 2005. Review of the species of *Elaphropeza* Macquart (Diptera: Empididae: Tachydromiinae) from the Chinese mainland. *Proceedings of the Entomological Society of Washington* 107 (1): 49-54.

In this paper, the genus *Elaphropeza* Macquart was elevated from its previous status as a subgenus of *Drapetis* Meigen. Consequently, 21 species had their combinations changed from *Drapetis* to *Elaphropeza*. In addition, two new species, *E. liui* and *E. anae*, were described and illustrated, and a key to the species of the genus from the Chinese mainland was presented for the first time.

4. Yang, D., **S.D. Gaimari**, & P. Grootaert. 2005 (2004). A new genus and species of Tachydromiinae (Diptera: Empididae) from the Oriental Realm. *Transactions of the American Entomological Society* 130 (4): 487-492.

In this paper, a new genus and species, *Sinodrapetis basiflava*, was described and illustrated from the Oriental realm, and its relationships with the closely related genera *Drapetis* Meigen and *Elaphropeza* Macquart (Drapetini) were discussed.

5. Yang, D., **S.D. Gaimari**, & P. Grootaert. 2005. New species of *Hybos* Meigen from Guangdong Province, South China (Diptera: Empididae). *Zootaxa* 912: 1-7. (Freely available at <http://www.mapress.com/zootaxa/2005f/zt00912.pdf>)

In this paper, three new species of the cosmopolitan genus *Hybos* Meigen were described and illustrated: *H. mangshanensis*, *H. nankunshanensis*, and *H. xiaohuangshanensis*. When last catalogued, 37 species were known from the Oriental realm and nine from the Palearctic. Since then, for China alone, that number has increased to 85 described species. The species described in this paper are all from the Guangdong Province, with a subtropical to tropical climate in the southern region of China (in the Oriental realm), increasing the number known from that area to eight.

6. Yang, D., **S.D. Gaimari**, & P. Grootaert. 2005 (2004). Review of the species of *Drapetis* Meigen from China (Diptera: Empididae: Tachydromiinae). *Journal of the New York Entomological Society* 112 (2-3): 106-110.

In this paper, the species of the genus *Drapetis* Meigen from China were reviewed. Two new species were described and illustrated: *D. guangdongensis* and *D. nanlingensis*, and a key to the 10 species of the genus from China was presented for the first time.

B. The following papers are *in press*, and will likely be published early in 2006:

1. Clark, H.O., Jr., H.S. Shellhammer, & **S.D. Gaimari**. Ectoparasites found on salt marsh harvest mice in the northern salt marshes of Grizzly Bay, California. *California Fish and Game Journal*.
2. **Gaimari, S.D.** Chamaemyiidae. In Brown, B.V., Borkent, A., Wood, D.M. and Zumbado, M. (ed.), *Manual of Central American Diptera*. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia.
3. **Gaimari, S.D.** Odiniidae. In Brown, B.V., Borkent, A., Wood, D.M. and Zumbado, M. (ed.), *Manual of Central American Diptera*. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia.
4. **Gaimari, S.D.**, & D.W. Webb. Therevidae. In Brown, B.V., Borkent, A., Wood, D.M. and Zumbado, M. (ed.), *Manual of Central American Diptera*. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia.
5. **Gaimari, S.D.**, & V.C. Silva. Lauxaniidae. In Brown, B.V., Borkent, A., Wood, D.M. and Zumbado, M. (ed.), *Manual of Central American Diptera*. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia.
6. **Gaimari, S.D.**, & W.N. Mathis. World catalog and conspectus of the family Odiniidae (Diptera: Schizophora). *Myia*.
7. Kaydan, M.B., N. Kiliçer, N. Uygun, G. Japoshvili, & **S. Gaimari**. Parasitoids and predators of Pseudococcidae (Homoptera: Coccoidea) in Ankara, Turkey. *Phytoparasitica*.

PPDB ENTOMOLOGISTS: EDITORIAL RESPONSIBILITIES AND SCIENTIFIC SERVICE

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

Chuck Bellamy

Coleoptera Subject Editor: *Zootaxa* (2001-2004)
Editor-in-Chief*: *The Pan-Pacific Entomologist* (2004 - present)
English Language Editor: *Folia Heyrovskyana* (2002 - present)
President: *The Coleopterists Society* (2003 - 2004)
Past-President: *The Coleopterists Society* (2005 - 2006)

Matthew Buffington

Parasitic Hymenoptera subject editor: *Zootaxa* (2005 - present)
Hymenoptera subject editor: *Pan-Pacific Entomologist* (2005 - present)

Andrew Cline

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

Marc Epstein

Chairman, Archives and Records Committee, *The Lepidopterists' Society* (2004 - present)
Lepidoptera Subject Editor: *Pan Pacific Entomologist* (2004 - present)
Vice President (for North America): *The Lepidopterists' Society* (2004 - 2005)

Steve Gaimari

Diptera Subject Editor: *Annals of the Entomological Society of America* (2001 - present); *The Pan-Pacific Entomologist* (2004 - present)
Editorial Board: *Dipteron, Zeitschrift für Dipterologie* (1999 - present)
Publications Committee: *The Pan-Pacific Entomologist* (2001 - 2005)
Pacific Branch representative, Standing Committee on Systematic Resources: *Entomological Society of America* (2004 - 2005)
Member, Section A subcommittee - Committee on Systematics Resources: *Entomological Society of America* (2005 - present)

Rosser Garrison

Minor Orders Subject Editor: *The Pan Pacific Entomologist* (2004 - present)
Editor: *Odonatologica* (1997 - present)

Peter Kerr

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

Shaun Winterton

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

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

PLANT PATHOLOGY
2005 Plant Pathology Laboratory Staff

Cheryl Blomquist
Barry Hill
Dan Opgenorth
Samantha Thomas
Tongyan Tian
Timothy Tidwell, Supervisor
YunPing Zhang
Diana Fogle
Terra Irving
Erin Lovig
Monica Negrete
Allen Noguchi
Jeanenne White
Wency Luke
Steven Vu

2005 Plant Pathology Sudden Oak Death Staff

Lydia Cam	Jun-Jun Estoque
Angel Chan	Khalida Hamid
Marayal Concepcion	Nosa Ihegie
Vina Da	Karah Leung
Caroline DaSalla	Blake Lim
Jeanette DeLeon	Malay Mey
Rowena DeLeon	Israfiel Mohammed
Dagne Demisse	Lindsay Rains
David Emojong	Marinell Soriano

Diagnostic services provided by the Plant Pathology Laboratory include:

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

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

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

Phytobacteriology

Dan Opgenorth

In October of this year, Citrus Greening was determined to be in Florida. This disease is the single factor limiting commercial production of Citrus in Asia, Africa and South America. The pathogen is a fastidious phloem-limited bacterium in the genus *Liberibacter*, known to have three distinct strains based on the continent of origin. Symptoms are usually a yellowing and distortion of young branches described as “Yellow Dragon” (Huanglongbing). A confirmatory PCR test is used to make a positive identification. Disease spread occurs through plant propagation, or the bacteria can be vectored by the citrus psyllid. While good symptoms take about two years to develop, the fruit usually becomes small and hard with the bottom portion remaining green. Trees usually are killed in five to six years.

It is believed that the Greening disease entered Florida through the importation of pummello (*Citrus maxima*) bud wood by recent Asian immigrants. Additional trees were presumably propagated and distributed to others. Upon arrival of the insect vector five years ago, further distribution was inevitable. The psyllids prefer to feed on several ornamental hosts used in landscapes and have thus been easily distributed throughout the state of Florida. While over 500 individual finds have occurred, the total extent of the problem has not as yet been defined.

At this time California does not have the psyllid vector. However, we have a similar situation with respect to the importation of plant materials by individuals. It is therefore important for us to provide information concerning the disease and conduct a vigorous survey to prevent establishment, should the vector ever be found. Our laboratory is in the process of developing PCR assay methods for confirmation of the pathogen. As in the case of the Florida situation, we will be using the Real Time Primers of Dr. Wen Bin Lei. Positive DNA materials will be obtained from workers in Florida or the Citrus Germplasm Repository in Riverside, California.

Citrus canker continues to be important to the California Citrus Industry. While we have not had any new finds this year, previous action has resulted in the incarceration of smugglers. It is therefore very important to continue our efforts in the development of detection techniques and having the experience to use them with some degree of confidence. As per some recent work on shipments of Mexican limes, I feel it is essential to be able to attempt to culture the bacteria to establish a positive diagnosis. While we have two separate Real Time assays, one is not entirely specific and the other is extremely sensitive. Thus, we are susceptible to the pitfalls of misidentification or contamination when using these techniques. In the case of such high risk and high profile pathogens, the prudent thing to do is a classical culture of the pathogen. Anything less may result in a false positive and unwarranted action or expenditures as occurred in Florida in the late 1980s.

I have been working on methods to extract, preserve, and archive DNA from suspect citrus samples, so that the Real Time assay can be conducted at the PPDB Laboratory. Two techniques now show promise and will need further evaluation on actual sample materials. Previous contacts have been reestablished to provide this opportunity at the Port of San Francisco and Los Angeles. Hopefully, we will have the time to do this work during the next year.

Angular Leaf Spot of Strawberry has been of interest because of the potential marketing of plants to the European market. The bacterial disease caused by *Xanthomonas fragariae* has been of great concern because of numerous situations in the past where plants had harbored the pathogen. In the wet European climates, what is a normally an inconsequential disease in California can cause enormous problems of plant survival and fruit rot.

Our laboratory was asked to provide a test that would satisfy the European requirements. We have decided to use leaf symptoms, microscopic streaming, ELISA, and PCR to confirm a positive diagnosis. This is appropriate when plants are inspected in the field; however, when plants are trimmed for shipment the obvious symptoms are removed. This means that only the systemic infection in crowns can be used as a sample without the benefit of looking for obvious symptoms. This situation makes detection of the disease very difficult because of the limited amount of sampling and testing that can be done. We are investigating the potential of using ELISA and PCR techniques to perform an assay on plants that have been trimmed and boxed for shipment. The ELISA immunoassay has previously been used to confirm positive leaf symptoms and has not been shown to be very sensitive. While the PCR assay has shown to be sensitive, it may not have the necessary selectivity to confirm a positive diagnosis. Recently, Steven Vu has been working with the Roberts Primers and has good evidence that they actually detect several different *Xanthomonas* species. Preliminary work with a second set of nested primers by Pooler has shown them to be somewhat more specific without reduced sensitivity. Additional work needs to be done concerning the specificity and sensitivity of the various primer sets used for diagnosis. Strides have been made to further extract and purify the target bacterial DNA and free it from the plant material which contains many PCR inhibitors. A protocol for identification should be forthcoming next year and we hope to publish at least a portion of this work.

Spiroplasma kunkelii, which causes Corn Stunt, is still a major consideration of my research program. Last year we were able to show that over-wintering leafhoppers could continue to carry the pathogen into the next planting season. Another consideration was that volunteer corn could provide a winter habitat for the vector and may also prove to be a source of the pathogen via seed transmission in the absence of the vector. Experiments concerning this work and vector transmission are being conducted by Dr. Charles Summers at the Parlier Experiment station. The ELISA and PCR testing done in our laboratory provides confirmatory data for all the over-wintering and transmission studies. A second joint laboratory publication concerning this work should be accepted for publication shortly. Our laboratory has

also provided plant materials and has developed extraction methods necessary for other workers interested in the development of more sensitive assays for Corn Stunt. These USDA workers in Beltsville have recently submitted an article for publication, which will utilize a Real Time PCR technique. I am hopeful that this can be implemented in our laboratory next year to improve the sensitivity of our assay and decrease the labor and time taken to process samples.

Crown gall of grapevine nursery stock remains a problem because of the systemic nature of the bacterial disease. If nurserymen were able to detect the bacteria in symptomless materials used for propagation, a significant reduction of the disease in the nursery could result. At the urging of a concerned nurseryman, our laboratory is now involved in a project with STA Labs in Gilroy, California. Since this lab does a considerable amount of work with nurseries, I urged them to develop PCR testing on propagation materials. Our cooperative effort involves the identification of some of the bacterial isolates taken from their samples and verification of various controls using our BIOLOG bacterial identification system. If a good testing protocol can be developed, it could potentially save the viticulture industry considerable time and expense.

Of concern to our colleagues in the permits office at headquarters was the use of synonyms of bacterial names. In many instances the common names are still used by growers, but scientists have split the bacterial genera into numerous species and totally renamed others. This makes it difficult to understand exactly what we are trying to identify and regulate; and may also pose a problem when code enforcement is required. Thus, a new list of bacterial plant pathogens, synonyms, common names and current ratings was generated. I believe this should help to clarify the confusion of our bacterial nomenclature that has evolved over the last several decades (Table DO-1).

I would like to acknowledge the help of my co-workers in Plant Pathology at the CDFA PPDB Laboratory including Wency Luke, Dana Lee, Steven Vu, and Tracy Kwan, who have helped along the way during the past year. A special acknowledgement also goes to my colleagues in Parlier (Dr. Charles Summers), to those at the USDA in Beltsville (Dr. Norman Schaad and Dr. Y. Zhao), and to Dr. Judit Monis of STA Labs in Gilroy, California.

Nomenclature of Plant Pathogenic Bacteria

Original Name	Synonyms	Common Name	Rating
AGROBACTERIUM (Genus)			
Agrobacterium rhizogenes	RHIZOBIUM (Genus) Rhizobium rhizogenes	hairy roots	C
Agrobacterium rubi	Rhizobium rubi	cane gall of Rubus	C
CORYNEBACTERIUM (Genus)			
Corynebacterium fascians	RHODOCOCCUS (Genus) Rhodococcus fascians	faciation	C
Corynebacterium insidiosum	CLAVIBACTER (Genus) Clavibacter michiganensis (subsp.) insidiosus	bacterial wilt of alfalfa	C
Corynebacterium michiganense	Clavibacter michiganensis (subsp.) michiganensis	bacterial canker of tomato	B
Corynebacterium michiganense (subsp.) tessellarius	Clavibacter michiganensis (subsp.) Clavibacter michiganensis subs		
Corynebacterium sepedonicum	Clavibacter michiganensis (subsp.) sepedonicus	ring rot of potato	B

Table DO-1. Nomenclature of Plant Pathogenic Bacteria

Original Name	Synonyms	Common Name	Rating
ERWINIA (Genus)			
Erwinia amylovora		fireblight	C
Erwinia aroideae		bacterial soft rot	C
Erwinia atroseptica		potato black leg, bacteria soft rot	C
Erwinia carotovora		bacterial soft rot	C
carotovora (subsp.)	PECTOBACTERIUM (Genus)		
atroseptica	Pectobacterium atrosepticum		C
betavasculorum	Pectobacterium betavasculorum		C
caratovora	Pectobacterium carotovorum (subsp.)		C
	carotovo		
	odoriferu		
wasabiae	Pectobacterium wasabiae		
Erwinia chrysanthemi	Pectobacterium chrysanthemi	bacterial blight of chrysanthemum	C
	chrysanthemi var. philodendra	leaf spot and leaf rot of philodendron	
Erwinia cyripedii	Pectobacterium cyripedii	bacterial brown rot cyripedium orchids	C
Erwinia dieffenbachiae		bacterial leaf rot of dieffenbachiae	C
ERWINIA (Genus) (Continued)			
	BRENNERIA (Genus)		
Erwinia nigrifluens	Brenneria nigrifluens	bark canker of walnut	C
Erwinia quercina	Brenneria quercina	drippy nut disease of live oak	C
Erwinia rubifaciens	Brenneria rubifaciens	pholem canker of walnuts	C
	ENTEROBACTER (Genus)		
Erwinia nimipressuralis	Enterobacter nimipressuralis	wet wood disease of elm	C

Table DO-1. Nomenclature of Plant Pathogenic Bacteria (Continued)

Original Name	Synonyms	Common Name	Rating
PSEUDOMONAS (Genus)			
<i>Pseudomonas aceris</i>		bacterial leaf spot of maple	C
<i>Pseudomonas aptata</i>		bacterial blight of leaves	C
BURKHOLDERIA (Genus)			
<i>Pseudomonas caryophylli</i>	<i>Burkholderia caryophylli</i>	carnation wilt	C
ACIDOVORAX (Genus)			
<i>Pseudomonas cattleyae</i>	<i>Acidovorax avenae</i> (subsp.) <i>Acid cattleyae</i>	bacterial blight of orchids	C
<i>Pseudomonas cichorii</i>		bacterial blight of chicory	C
<i>Pseudomonas coronafaciens</i>		halo blight of oats	C
<i>Pseudomonas delphini</i>		black spots of delphinium	C
<i>Pseudomonas eriobotryae</i>		loquat canker	C
<i>Pseudomonas lachrymans</i>		angular leaf spot of curcurbits	C
<i>Pseudomonas lapsa</i>		stalk rot of corn	C
<i>Pseudomonas maculicola</i>		bacterial leaf spot of cauliflower	C
<i>Pseudomonas marginalis</i>		marginal blight of lettuce	C
<i>Pseudomonas marginata</i>		gladiolus scab	C
<i>Pseudomonas mori</i>		bacterial blight of lettuce	C
<i>Pseudomonas phaseolicola</i>		halo blight of bean	C
<i>Pseudomonas pisi</i>		bacterial blight of bean	C
<i>Pseudomonas primulae</i>		bacterial leaf spot of primrose	C
<i>Pseudomonas savastanoi</i>		olive knot, oleander knot	C
<i>Pseudomonas solanacearum</i>	RALSTONIA (Genus) <i>Ralstonia Solanacearum</i>	southern wilt, bacterial wilt	C
PSEDUDOMONAS (Genus)			
<i>Pseudomonas syringae</i>		bacterial canker of stone fruit blast	C
<i>Pseudomonas tomato</i>		bacterial speck of tomato	C

Table DO-1. Nomenclature of Plant Pathogenic Bacteria (Continued)

Original Name	Synonyms	Common Name	Rating
XANTHOMONAS (Genus)			
<i>Xanthomonas bagoniae</i>		leaf spot of begonia	C
<i>Xanthomonas beticola</i>		bacterial pocket of beets	C
<i>Xanthomonas campestris</i>		black rot of crucifers	B
<i>Xanthomonas carotae</i>		bacterial blight of carrot, carrot scab	C
<i>Xanthomonas citri</i>	XANTHOMONAS (Genus)	citrus canker	A
	axonopodis pv. Citri	A. Asiatic Citrus Canker	
		D. On Mexican Lime (Mexico)	
	axonopodis pv. Aurantifolia	B. Cancrosis South America	
		C. Mexican Lime Brazil	
<i>Xanthomonas dieffenbachiae</i>		bacterial leaf spot of dieffenbachia	C
<i>Xanthomonas fragariae</i>		angular leaf spot of strawberry	C
<i>Xanthomonas geranii</i>		bacterial leaf spot of geranium	C
<i>Xanthomonas hederæ</i>		bacterial leaf spot of English ivy	C
<i>Xanthomonas incanae</i>		Bacterial blight of garden stocks	C
<i>Xanthomonas kuglandis</i>		walnut bight	C
<i>Xanthomonas maculifoliigardeniae</i>		bacterial leaf spot of gardenia	C
<i>Xanthomonas malvacearum</i>		angular leaf spot of cotton	B
<i>Xanthomonas pelargonii</i>		bacterial leaf spot of Pelargonium	C
<i>Xanthomonas pruni</i>		bacterial blight of stone fruits	Q
<i>Xanthomonas tardicrescens</i>		bacterial blight of iris	C
<i>Xanthomonas translucens</i>		bacterial stripe of wheat and barley	C
<i>Xanthomonas vesicatoria</i>		bacterial spot of tomato and pepper	C
<i>Xanthomonas vitians</i>		angular leaf spot of lettuce	C

Table DO-1. Nomenclature of Plant Pathogenic Bacteria (Continued)

Listed Biological Agents'		
1. <i>Ralstonia solanacearum</i> Race 3:	Bacterial Wilt of Potato	
2. <i>Xanthomonas oryzae</i> pv. <i>Oryzicola</i> :	Bacterial Leaf Streak of Rice	
3. <i>Liberobacter africanus</i> ; <i>asiaticus</i> :	Citrus Greening	
4. <i>Xyella fastidiosa</i> :	Citrus Variegated Chlorosis	

Table DO-1. Nomenclature of Plant Pathogenic Bacteria (Continued)

2005 Sudden Oak Death Diagnostics Highlights

- Plant Pest Diagnostics Branch (PPDB) Laboratory hired 17 seasonal employees to process the SOD laboratory samples, including 1 exclusively for molecular testing, and 1 exclusively for ELISA testing.
- Temporarily reassigned 5 permanent employees to SOD project, including 3 exclusively for molecular testing, and 1 exclusively for ELISA testing
- Temporarily dedicated 9 laboratory rooms to accommodate SOD project for activities such as initial sample processing, molecular sample processing, molecular sample testing, ELISA testing, culture plate reading, data entry, as well as general office and meeting space.
- Completed first phase of expansion of molecular diagnostics laboratory to accommodate USDA protocols for SOD testing, while still providing adequate space for other ongoing, mandated, PPDB molecular diagnostics projects.
- PPDB Lab scientists gave numerous informational and training presentations to grower groups, nurseries, and county staff, *et al.*
- PPDB Lab scientists participated in various meetings, workshops, and training sessions with USDA to learn protocols and techniques, as well as to prepare for Provisional Laboratory Accreditation of PPDB by APHIS for SOD diagnostics.
- PPDB lab staff was called upon routinely to consult with County staff on specific samples and nurseries, instructions for re-sampling, soil sampling, etc.
- PPDB successfully performed and passed provisional laboratory tests as part of the APHIS Provisional Laboratory Accreditation process.
- PPDB collaborated with, and gave laboratory support to, several SOD projects with other scientists and agencies outside of CDFA, including the following:
 - Identification and characterization of 4 new *Phytophthora* species, 2 of which can be mistaken for *P. ramorum* using the SOD molecular diagnostic protocol; Collaboration with University of Tennessee, Oregon Department of Agriculture, and University of California, Davis (UCD).
 - “SOD Busters” waste disposal research project in infested area.
 - Statewide Detection & Risk Modeling project with Sonoma State University.
 - Real-time PCR Ring Test with CPHST (APHIS).
 - Project with University of California Cooperative Extension (UCCE) involving seasonal timing of sampling activities for best chances of detection.
 - Project with UCD involving management and disposition of *P. ramorum*-infested soil in nurseries.
 - Forest Inventory Analysis (FIA) project with USFS.
 - Improved SOD diagnostics methods with USDA ARS.

Oak Leaf Spots Cause Public Concern

Californians living in the Sierras and along the coast witnessed a severe outbreak of oak leaf spot diseases caused by fungi during the excessively wet 2005 spring. In some cases, entire hillsides of oaks exhibited masses of brown leaf canopies, and even premature defoliation, sending many residents into panic, thinking that the Sudden Oak Death (SOD) disease had suddenly appeared in their communities. Several samples were submitted to the PPDB laboratory from various locations and counties, and three fungi were consistently detected: *Septoria quercicola*, *Cylindrosporium kelloggii* (Figure TT-1), and *Discula umbrinella*. The *Septoria* and *Cylindrosporium* cause leaf spot diseases, and the *Discula* causes a foliar disease usually referred to as “oak anthracnose.” While these pathogens are all normally present in low inoculum levels in any given year, doing a minimal to moderate amount of damage, the 2005 season was so excessively and consistently wet that these leaf spot pathogens had ample opportunity for infection, as well as production of abundant secondary inoculum for further spread and infection. The result was severe and widespread outbreaks of oak leaf diseases. Fortunately, additional damage is unlikely since the warmer, dryer weather is not conducive to these and other fungal leaf spot diseases. Thus, infected oak trees, if not abnormally weak due to other stress factors, should be able to put out a new crop of leaves to replace the diseased ones after they fall off. Reports on this phenomenon by UC Cooperative Extension as well as articles in local newspapers were published to explain the situation and to quell the public concern.



Figure TT-1. Leaf Spot fungi such as *Cylindrosporium kelloggii*, shown here infecting a black oak leaf, resulted in severe cases of leaf spotting to outright defoliation of large oak trees throughout Northern California. The small dark spots on the leaf are sites housing the fungal fruiting bodies, which produce numerous sticky, rain-splashed spores.

Chrysanthemum White Rust Found in Napa County Landscape

Chrysanthemum white rust (CWR) caused by Q-rated rust fungus, *Puccinia horiana*, was detected by Napa County Agriculture staff biologist, Vicki Kemmerer, in Napa, CA, in July 2005. What makes this detection so significant is that (1) it was detected for the first time in Napa County, and (2) rather than in a nursery, it was detected in a dooryard plant that had been growing in the landscape for many years (Figure TT-2). Another plant, which the owner reportedly just purchased in 2005 from a nursery outside the Napa area, also manifested symptoms and signs of the disease. Circumstantial evidence suggests that the older landscape plant became infected as a result of the disease being recently introduced via the newly purchased plant. Surveys are in progress to determine the extent of the disease in the Napa area. The nursery from which the new plant was purportedly purchased is also being investigated to see if there might be an infestation at the nursery.



Figure TT-2. Dooryard specimen of Chrysanthemum collected by Napa County biologist Vicki Kemmerer, severely infected by CWR pathogen, *Puccinia horiana*.

New Blackberry Rust to California

A species of rust fungus new to California was confirmed from weedy Himalayan blackberry in Del Norte and Humboldt counties on July 25, 2005. The rust had previously been found in southern Oregon in April 2005. Prior to the Oregon finds, the rust was not known in North America. The fungus, *Phragmidium violaceum*, can be quite virulent on certain species/varieties of blackberry. The rust has been used as a biological control of weedy blackberries in Australia, New Zealand and Chile. It is believed to be quite specific to blackberries as laboratory and field-testing overseas demonstrated that other plant species and even most commercial varieties are not susceptible.

The first detection in Oregon was on the weedy Himalayan blackberry near Gold Beach. Early survey found the rust spread along 100 square miles north of Gold Beach, Oregon. Limited survey during June in Northern California did not detect the rust in Humboldt or Del Norte Counties. Subsequently the rust has spread rapidly across Oregon and has been found as far north as Washington state and south to California. The disease was initially confined to Himalayan blackberry but is now widespread and has now been found severely infecting several commercial plantings of Evergreen Blackberry in Oregon.

Symptoms include circular purple spots on the top of leaves (Figure TT-3) with corresponding yellowish pustules on the under side of the leaf. As the rust matures, an additional spore type develops on the leaf. These black pustules (Figure TT-4) help to distinguish the rust from other native blackberry rusts, including the endemic rust disease *Kuehneola uredinis* that was quite severe in 2005. Severely infected plants have cupped leaves and Oregon infestations experienced premature dying of fruit.

The California samples were collected in Crescent City and Arcata by county Agriculture commissioner staff, and identified by PPDB Plant Pathologist, Samatha Thomas.



Figure TT-3. Circular “ringspot”-like symptoms (arrow) typical of *Phragmidium violaceum* infection on upper surface of Himalayan blackberry leaves.

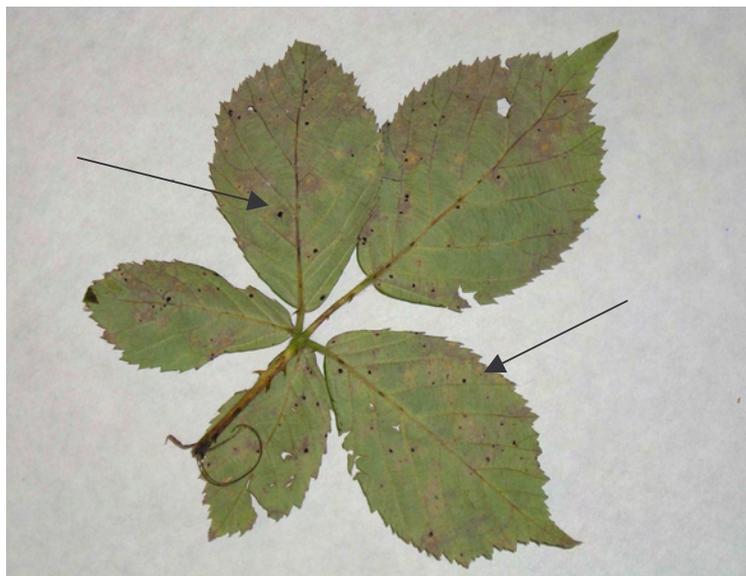


Figure TT-4. Black *Phragmidium violaceum* telial pustules (arrows) on underside of Himalaya blackberry leaves, diagnostic for the rust disease on this host.

Additional Photos of the disease can be found at http://oregon.gov/ODA/PLANT/gallery_bbr.shtml

SEED HEALTH TESTING

Timothy Tidwell, YunPing Zhang, Allen Noguchi, Diana Fogle,
Jeanenne White, and Alex Ballesteros

Approximately 246 seed health tests were performed in 2005. This involved testing for 35 different pathogens, in 16 different types of agricultural, horticultural, and tree seeds, representing 25 different seed clients.

Revenue for this program is generated from fees charged to clients for seed health testing performed by the PPDB. The seed health testing service supports foreign and domestic seed commerce of the California seed industry. These foreign and domestic trading partners require seed from California Seed Companies to first be tested for specific pathogens and/or nematodes. Thus, the PPDB laboratory performs these required seed health tests on seed samples officially drawn and sealed by the Agricultural Commissioner's office, which acts on behalf of USDA APHIS. If the results of the seed health tests confirm that the seed is indeed free of the pathogens and/or nematodes of concern, the County Agriculture Commissioner's office then issues a Federal Phytosanitary Certificate declaring the seed to have been tested and found free of the specific list of pathogens and/or nematodes, and the seed can then be exported from California to the importing country. The seed company clients are charged fees for the seed health testing done by PPDB.

In addition, Plant Pathologist, Tim Tidwell, also serves as a certified auditor for the National Seed Health System (NSHS), a program involving the USDA that accredits private laboratories to test seed for the purpose of meeting the requirements for Phytosanitary certificates. Three private laboratories were audited and subsequently USDA/NSHS-accredited to run specific seed health tests in 2005.

Wheat was again tested this past year for the Karnal Bunt (KB) Pathogen, *Tilletia indica* at the USDA laboratory facility in Blythe, CA. The total area of regulation was substantially reduced from that of previous years. The laboratory tested wheat seed from a total of 28 fields but *Tilletia indica* was not detected from any fields in the regulated area in 2005. Thirty-nine wheat seed samples collected throughout California, representing 17 counties, were also tested as part of the ongoing USDA national KB survey, but fortunately the pathogen was not detected in any of these fields and counties either. Thus, despite sampling and testing in both the regulated area and the state at large, no *Tilletia indica* was detected in California in 2005.

In the latter part of 2005, Dr. YunPing Zhang took over as the director of the PPDB seed health testing program, replacing Tim Tidwell, who had developed and grown the program over the past ten years into an effective service to the California seed industry. Dr. Zhang, who is an expert in molecular diagnostics, took over the day-to-day seed testing operations, and also began a research program to develop new seed tests as well as to improve on existing seed health testing methodology.

NURSERY ANNUAL SURVEY OF FRUIT TREE, NUT TREE AND GRAPEVINE VIRUSES

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

The Nursery Diagnostics Laboratory tested a total of 51,082 fruit and nut trees for Prune dwarf virus and Prunus necrotic ringspot virus, 4,755 grapevines for grapevine fanleaf virus, and 1,482 grapevines for grapevine leafroll associated viruses type 2 and 3 during the year 2005. These samples were submitted from 16 participating fruit and nut tree nurseries and 11 grapevine nurseries and tested by Enzyme-Linked Immunosorbent Assay (ELISA). There was a significant increase in the number of samples surveyed this year that is 8.8% more than the year before.



Figure YPZ-1. Seasonal employee processing samples from participating nurseries for ELISA test of targeted viruses.

Prune dwarf virus and Prunus necrotic ringspot virus were again tested separately in our laboratory (Figure YPZ-1) to determine the field distribution of these two individual ilarviruses. The result has showed that 296 (77.9%) positive samples were infected with PNRSV while only 75 (19.7%) were infected with PDV and 9 (2.4%) were mixed infection by both viruses. This distribution is similar to previous year with a slight increase in PDV infection (6.8% in 2004) and a decrease in mixed infection by both viruses (13.5% in 2004).

Grapevine leafroll associated virus 3 has been detected from one of the nurseries in Fresno district which has resulted in removal of large number of vines in

the registered block. This result also confirmed recent findings that GLRaV 3 has been spreading in vineyards in an accelerated speed. GLRaV 3 has been reported to be transmitted by mealybugs (Golino et al. 1998). Four mealybugs species commonly found in California vineyards, longtailed mealybug (*Pseudococcus longispinus*), obscure mealybug (*Pseudococcus viburni*), grape mealybug (*Pseudococcus maritimus*), and citrus mealybug (*Planococcus citri*) were reported to transmit the virus. Our biologists have detected the presence of mealybugs in the virus affected vineyards. As a result, more vigorous mealybug control measures have been proposed for future nursery practices.

This annual virus survey of the Nursery Registration and Certification program is supported by the California Fruit tree, Nut tree and Grapevine Improvement Advisory Board (IAB) which allocates funds annually. The program has been a very valuable tool and played an important role in reducing and keeping the virus infection in fruit trees and grapevines in California at a very low level (Fig. YPZ-2).

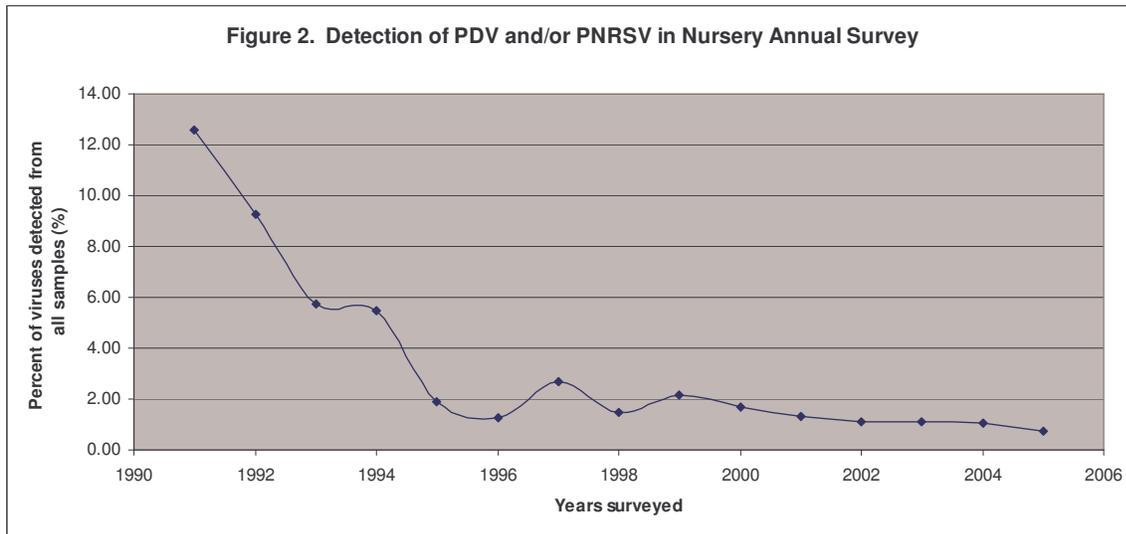


Figure YPZ-2 Detection of PDV and/or PNRSV in Nursery Annual Survey

Reference

Golino D.A., Sim, S.T., Gill, R., and Rowhani, A. 1998. Transmission studies of grapevine closteroviruses by four species of mealybugs. *Phytopathology* 88 (9 Suppl.):S32.

Acknowledgements

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

The Effect of Dormant Season Survival of *Xylella fastidiosa* in Grapevines on Pierce's Disease Epidemics in California

Principal Investigator: Barry L. Hill, Senior Plant Pathologist

CDFA: Pierce's Disease Control Project and Plant Pest Diagnostics Branch

Cooperators:

Jennifer Hashim, viticulture advisor
U. C. Cooperative Extension, Kern
County

William Peacock, Viticulture Advisor
U. C. Cooperative Extension, Tulare
County

Abstract: The two California Pierce's Disease (PD) epidemics associated with population outbreaks of Glassy-winged Sharpshooter, at Temecula in the mid 1990s and in Kern County peaking in 2002, differed dramatically in the number of vineyards lost and the grapevine varieties effected. It is postulated that vine-to-vine (secondary spread) of infections occurred throughout all vineyards in both areas but the survival and progression to disease of these infections differed between the two areas. In Temecula many of the resulting infections survived vine dormancy and progressed to chronic disease resulting in the loss of half or more of the area's vineyards of all varieties within about three years. In Kern county only some of the infections in only two varieties, Redglobe and Crimson Seedless, survived vine dormancy and progressed to disease, and vineyards of all other varieties were unaffected. A hypothetical explanation of this epidemiological pattern is presented and experiments are begun to test this hypothesis. The benefit to grape growers in the southern San Joaquin valley will be to provide reliable ways to reduce risk of loss by PD epidemics.

Introduction: Following the appearance in the mid 1980s of the Glassy-winged sharpshooter (GWSS) in California, there have been two major epidemics of Pierce's Disease (PD) associated with large populations outbreaks of GWSS, first in Temecula in the mid 1990s, and second in the General Beale area of Kern County peaking in 2002. The patterns of PD incidence and vineyard loss differed dramatically between these two epidemics. In Temecula, the site with the milder winter climate and shorter dormant season, more than half of the region's vineyards were severely damaged or lost, and most or all the varieties had substantial losses resulting in removal of vineyards. In Kern county (which has a colder winter climate and longer dormant season), only a small percentage of the vineyards were lost, and all of the lost vineyards were in only 2 of the 6 varieties in the area, Redglobe and Crimson Seedless. The losses to vineyards of the other 4 varieties were very small, in most cases less than 1 in 10,000 vines. By contrast, all 12 of the Redglobe vineyards in the General Beale area that we surveyed were significantly damaged, with from 2% to more than 50% of the vines lost (Hashim, et.al., 2003), and some of these vineyards were ultimately removed.

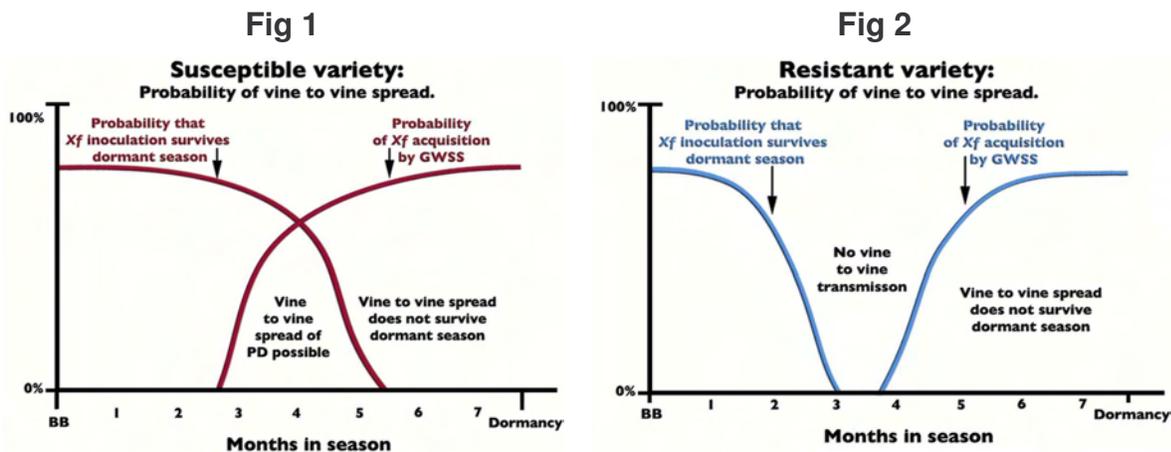
Grapevines acquire new *Xylella fastidiosa* (*Xf*) infections either by primary spread or secondary spread. Primary spread occurs when vector insects acquire the bacterium from source plants outside the vineyard, then fly into the vineyard to infect vines. Secondary spread occurs when vector insects acquire *Xf* from an infected

vine in the vineyard and then spread the infection to other vines, vine-to-vine spread. The risk associated with these two kinds of spread is different. The patterns of spread associated with primary spread are linear, that is a typically small and relatively constant number of vines per year become infected, and the accumulation of infected vines increases additively. The result is usually small but manageable losses each year. The patterns of spread associated with secondary spread is typically logarithmic, and the accumulation of infected vines increases as a multiple of the infected source vines that are present. The result can be the rapid loss of entire vineyards within just a few years.

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

Our hypothesis is that in the General Beale area secondary spread of infection occurred in all varieties, possibly infecting large numbers of vines in every vineyard. The rate of *Xf* multiplication and movement varies within plant hosts (Hill and Purcell, 1995), and presumably varies between grapevine varieties. In the most susceptible varieties, Redglobe and Crimson, the rate of bacterial multiplication and spread was faster and the result was that the bacteria had a window of opportunity sometime in mid season when secondary spread could progress to disease. Secondary spread infections could not occur before this time window, and secondary spread infections after this time window did not survive vine dormancy. Thus in the two susceptible varieties some, but not all, of the secondary infections progressed to chronic disease. In the resistant varieties however, by the time secondary spread could begin, it was too late for the infections to become well enough established to survive vine dormancy, and virtually all of those infections died out leaving the vines free of disease the following year. This is illustrated in the two hypothetical figures below. The position and shape of the left hand curves in each of the figures, labeled "Probability that *Xf* inoculation survives dormant season," is affected by the rate of multiplication and movement of the bacterium as influenced by the characteristics of the variety. The position and shape of the right hand curves in the figures, labeled "Probability of *Xf* acquisition by GWSS," is also affected by the varietal's characteristic rate of multiplication and movement of the bacterium. The position and shape of these curves can also be influenced by the severity of winter climate and the length of the dormant season. A milder and shorter dormant season would

move the curves for all varieties toward each other, resulting in a greater probability of overlap and thus a greater window of opportunity when secondary spread could result in chronic disease. A colder and longer dormant season would move the curves further apart, thereby reducing overlap and reducing or eliminating the possibility of secondary spread. This would account for the dramatic difference between the epidemiological patterns observed in the Temecula vs. the General Beale epidemics. In the General Beale area most of the varieties would be “resistant” to secondary spread of PD, and thus the vineyards were not lost to disease. Those same varieties, if grown in the Temecula area, would have a shift in their probability curves such that the curves would overlap, the varieties would then be “susceptible” to secondary spread, and the vineyards would be lost.



Current research efforts on PD being funded by the viticulture industry and by government are directed toward finding a solution to the threat of PD to viticulture in California, a cure if possible. While a cure is desirable, it is also likely to be a long-term effort, expensive, and possibly impractical. The risk from PD, even in the presence of GWSS is not uniform throughout the state because the epidemiology characteristics are different in various areas. If the epidemiological risk could be reliably defined for each area and effective control measures devised and adopted to reduce or eliminate risk, the threat could be reduced to economic unimportance. Ideally we could know enough specific epidemiology to provide the following advice to growers in each area: “Your risk of loss from primary spread is X, and by adopting these control measures at cost Y your risk can be reduced to Z. Furthermore your risk of loss from secondary spread is A, and by adopting these control measures at cost B, your risk can be reduced to C.” This knowledge would satisfy the need of almost all California grape growers.

Our ongoing research addresses the risk of loss from secondary spread in the southern San Joaquin area, and should identify a window of vulnerability when protections against secondary spread would be most effective. These experiments will provide actual data to help convert the hypothetical curves proposed here, to real curves for susceptible and resistant varieties in the southern San Joaquin. If the timing and duration of the time window when susceptible varieties are vulnerable to secondary spread is identified, then chemical protections, such as systemic

insecticides, may reduce the risk during that window of time to economic unimportance.

Based on historical experience the risk from primary spread appears to be negligible in Kern County and is confined to localized pockets in Tulare and Fresno counties (pers. com. W. Peacock, J. Hashim). Primary spread during the General Beale GWSS/PD epidemic would have affected all the varieties, but there is no epidemiological evidence that this occurred (Hashim et.al., 2003). Areas of southern Kern county where GWSS has been present in low numbers for more than 5 years have rates of new PD infections that are less than 1 vine in 10,000 in all varieties.

Ideally the same kind of experiments should be conducted in various regions of California. However there are both practical and political impediments to conducting such experiments, and it is beyond the capacity of this laboratory to expand into other areas. The magnitude of these experiments require plots with several hundred mature grapevines that are being cultivated as a commercial vineyard, and there are concerns about experimentally introducing PD into viticulture areas close to commercial production. This project was delayed due to these concerns and was eventually located in a mature vineyard in the Kerney Agricultural Field station near Parlier, California. Other similar safe and acceptable locations are yet to be located in other major viticulture areas.

Objectives: The hypothesis regarding differences among varieties regarding susceptibility to secondary spread will be experimentally tested by: 1. Determining the “Probability that *Xf* inoculation survives dormant season” curves for 4 different varieties, a resistant, a susceptible, and three unknowns, and 2. Determining the “Probability of *Xf* acquisition by GWSS” curves for the same 4 varieties.

Objective one will involve needle inoculations of 20 to 35 vines at a time, of each variety, at twice a month intervals for 4 months beginning at the end of April. Systemic infections will be confirmed by ELISA testing of each vine during the year that they are inoculated. The following year they will be tested to see whether the infections persisted over the dormant season. Objective two will involve inoculating 50 vines of each variety early in the season, then testing the vines at various time intervals the following year to determine when the bacterium appears in the new foliage such that GWSS could acquire the bacterium by feeding on the foliage. The experiments for objective one have been done previously, but not with sample sizes and frequencies that would allow the reliable depiction of bacterial survival curves. Objective two has not been done before, nor has the combination of the two curves been done together to determine the possibility and timing of a potential window of time when secondary spread would be possible.

Results: The inoculation and monitoring experiments are being done at the University of California Kearney Research and Extension Center at Parlier California on a 3.2-acre plot that had 1260 mature (ca.10 year old) Thompson Seedless vines. On 180 of these vines two grafts each of another variety (Selma Pete) were grafted 3 years ago on the mature Thompson roots. These 180 Selma Pete vines (now in their 4th season) and another 320 Thompson Seedless vines were needle-inoculated this year at twice per month intervals beginning the end of April through the middle

of August, 8 total inoculations. The vines inoculated in May and June (4 inoculation times, 220vines) have been tested so far, and 100% of the inoculations have resulted in *Xf* infections that have multiplied and moved beyond the inoculation site. The remaining vines will be tested before the vines go dormant this year.

The remaining 760 mature Thompson Seedless vines that were not involved in inoculation experiments this year were cut off about 30 cm above the soil and grafted with Redglobe, Thompson Seedless, or Princess cuttings in early April of this year. About 80% of these grafts were successful, and are therefore now near the end of their first year of growth. In three years these vines will be ready for the same kind of experiments that are being conducted this year with the currently mature Thompson's and Selma Pete vines. It was unfortunate that a site could not be obtained this year with sufficient mature Redglobe and Thompson vines to enable the experiments to be done now without waiting for three years, but the concerns of the PD control programs in the southern San Joaquin prevented obtaining such a site.

Each needle inoculation introduced a droplet with at least 10,000 viable *Xf* cells into the plant xylem. Each plant was needle inoculated at two different sites, on shoots that were on different scaffolds or branches of the vine, and the inoculation sites were flagged so that they could be found again. The inoculations were near the base of the shoots, about 3 internodes (usually about 15 to 20 cm) from the mature wood. At each inoculation site both the stem and the closest petiole were inoculated. The intent was to make the inoculations with many thousands more cells than a vector insect would transmit, and at sites comparable to where a feeding GWSS might inoculate close to the old wood. The idea was to maximize the probability that the needle inoculation would result in infections that might survive the dormant season. If this intensive needle inoculation does not result in infections that survive the dormant season, then surely inoculations by GWSS would not result in infections that survive.

Conclusions: These experiments have just begun. We have established that the inoculation protocol is at or close to 100% effective at producing infections of *Xf*. There have been many speculative theories about why GWSS inoculations would be more likely than traditional California vectors to produce *Xf* infections that survived vine dormancy and progressed to disease. These experiments are even more likely than GWSS to produce infections that survive. If under these circumstances it is found that secondary spread in resistant varieties in the southern San Joaquin cannot begin until after the time when the new infections can survive the dormant season (i.e. the curves do not overlap) then it could be asserted that the risk of secondary spread in this region in resistant varieties with GWSS as a vector is not economically significant.

References:

Feil, H., Feil, W. S., Purcell, A. H. (2003). *Effects of date of inoculation on the within-plant movement of Xylella fastidiosa and persistence of Pierce's Disease within field grapevines*. Phytopath. 93: 244-251.

Hashim, J.; Hill, B.L.; Kelly, M; Shaari, D; Purcell, A.H.. 2003. *Monitoring and Control Measures for Pierce's Disease In Kern County, and Epidemiological Assessments of Pierce's Disease*. Proceedings, 2003, Pierce's Disease Research Symposium, Calif. Dept. of Food and Ag. Sacramento, CA

Hill, B. L., Purcell, A. H. (1995). *Multiplication and movement of Xylella fastidiosa within grape and four other plants*. Phytopath. 85: 1368-1372

Funding Agencies: This research is being funded by the Pierce's Disease/Glassy-winged Sharpshooter Board.

2005 Presentations

Blomquist, C. “*Phytophthora* problems in California Nurseries.” CDFA Seminar, Sacramento.

Buffington, M. “The phylogenetics and evolution of the Figitidae (Hymenoptera: Cynipoidea).” Invited speaker, “Lunch Bunch”, Dept. of Biology, UC Riverside. 27 Jan 2005.

Buffington, M. “The phylogenetics and evolution of the Figitidae (Hymenoptera: Cynipoidea).” Invited speaker, CDFA, Plant Pest Diagnostics Lecture Series. 06 Oct 2005.

Buffington, M. “Uncle PEET appreciates Parasitoids: How the National Science Foundation is shaping the future of research on Parasitic Hymenoptera (Insecta).” Invited speaker, Australian Entomological Society Annual Meeting, Canberra, Australia 06 Dec 2005.

Buffington, M., Johan Nylander, and Fred Ronquist. “Phylogeny and Evolution of Cynipoids” Invited speaker(s), International Society of Hymenopterists 6th Congress, Sun City, South Africa, 22-27 Jan 2006.

Chitambar, John. “Sampling for California’s Regulatory Plant Parasitic Nematodes”. John Chitambar, guest speaker at four Plant Pest University Workshops organized by CDFA Pest Exclusion for County Agricultural Commissioner field inspectors and biologists. Los Angeles, Santa Maria, Modesto, Fresno.

Cline, A. R. “The Sap Beetles (Coleoptera: Nitidulidae) of Great Smoky Mountains National Park.” Annual meeting of the Discover Life in America meeting for the Great Smoky Mountain National Park All Taxa Biodiversity Initiative.

Cline, A.R. Carlton, C. & Victoria Bayless. “The Sap Beetles (Coleoptera: Nitidulidae) of Great Smoky Mountains National Park.” Annual meeting of the Entomological Society of America.

Effenberger, J. “Seed identification of *Brassica* and *Sinapis* (Brassicaceae); Floret identification of *Agropyron*, *Elymus*, *Elytrigia*, *Pascopyrum*, *Psathyrostachys*, and *Pseudoroegneria* (Poaceae). 2005 Annual CDFA Seed Workshop, Plant Pest Diagnostics Center, Sacramento.

Epstein, M. “Slug caterpillars of Costa Rica and Beyond.” University of Minnesota, University of Hawaii, Hawaii Department of Agriculture, and CDFA Seminar, Sacramento.

Milonas, Souliotis, and **S. Gaimari**. *Neoleucopis kartliana*, the major natural enemy of *Marchalina hellenica*: Morphology-Biology. Poster presented at the 11th Panhellenic Entomological Society, Plastira Lake, Greece.

Gaimari, S. "Evolutionary relationships of the enigmatic superfamily Lauxanioidea (Insecta: Diptera)" CDFA-PPD seminar series, Sacramento

Garrison, R. "An illustrated guide to some recent insect pests introduced into Southern California. " California Department of Food and Agriculture Seminar Series, Sacramento.

Hauser, M. "Fossil Therevidae (Diptera, Asiloidea) – How the past can change our view of the present – Fossils X3" Poster presented at the 3rd International Congress of Palaeoentomology. Feb 2005 Pretoria, South Africa.

Hauser, M. "Flies, Fossils, and Phylogenies." Poster presented at North Carolina State University, Raleigh, NC.

Hauser, M. "The Basal Lineages of Stiletto-Flies (Diptera: Therevidae)" Seminar, Department of Entomology, University of Illinois at Urbana-Champaign.

Hauser, M. "Fossils, Molecular Clocks, and Evolution of Therevidae." Entomological Society of America meeting, Fort Lauderdale, FL.

Hill, Barry L, Hashim-Buckey, Jennifer; and Peacock, William. 2005. "The Effect of Dormant Season Survival of *Xylella fastidiosa* in Grapevines on Pierce's Disease Epidemics in Temecula and Kern County." Proceedings, 2005 Pierce's Disease Research Symposium.

Hill, Barry L, Hashim-Buckey, Jennifer. 2005. "Dormant Season Survival of Xf and the Temecula and General Beale PD Epidemics." Presented at 2005 Pierce's Disease Research Symposium, San Diego, CA.

Kerr, Peter. February 4, 2004. "Evolutionary relationships Snipe-flies and their relatives (Insecta: Diptera: Rhagionidae)" presented to the Northern Californian Entomologist Club annual meeting, Fairfield, CA.

Meyer, D. J. L. and J. Effenberger, and J. Scher. "Demonstration of the LUCID computer-based seed key for the Federal Noxious Weed Disseminules of the U. S." Seed Issues Forum of the Annual meeting of the AOSA/SCST/CSAAC.

Meyer, D. J. L. "A virtual purity analysis: A review of the Association of Official Seed Analysts (AOSA) Rules for Testing Seeds; Seed and fruit identification of 27 species of the Brassicaceae 2005 Annual CDFA Seed Workshop, Plant Pest Diagnostics Center, Sacramento.

Meyer, D. J. L. “Seed and fruit morphology in the Fabaceae and the identification of 19 species of large-seed legume crops.” Idaho Seed Analysts Association Seed Workshop, Idaho.

Meyer, D. J. L. & J. Hinke. “Comparison of the AOSA, ISTA (International Seed Testing Association) and CFIA (Canadian Food Inspection Agency) procedures for laboratory seed lot purity testing; How to use *AOSA Handbook 25 Uniform Classification of Weed and Crop Seeds* to determine classification of contaminating species in an AOSA purity test; AOSA procedures for reporting laboratory results; Testing seed mixtures – a review of the AOSA Rules and the CFIA Methods and Procedures. Association of Official Seed Analysts (AOSA)/ Society of Commercial Seed Technologists (SCST)/ Commercial Seed Analysts Association of Canada (CSAAC) Annual Meeting, Saskatoon Saskatchewan.

Peterson, P. “Cotyledon evaluation of Cucurbitaceae (*Cucumis*, *Cucurbita*, and *Citrullus*); Seedling evaluation of pepper (*Capsicum* spp.); Seedling evaluation of Asteraceae (*Lactuca*, *Cichorium*, *Carthamus tinctorius*, *Helianthus*); Seedling evaluation of radish (*Raphanus sativus*). 2005 Annual CDFA Seed Workshop, Plant Pest Diagnostics Center, Sacramento.

Tidwell, T.E. “*Phytophthora ramorum* in California Nurseries.” California, Florida, and Idaho Nurserymen and Regulatory Agricultural Officials, Anaheim, CA, January 2005.

Tidwell, T.E. “Sudden Oak Death.” Annual meeting of California Agricultural Commissioners and Sealers Association, Redding, CA, May 2005.

Watson, G. “The FAO-EU IPM program for Cotton in Asia.” Northern California Entomologists’ Club, May 6, 2005.

2005 Publications

Bellamy, C. L. 2005. New synonymy in Buprestidae (Coleoptera). *The Coleopterists Bulletin* 59(1): 26.

Bellamy, C. L. 2005. Clarification of synonymy in three species of *Temognatha* Solier, 1833 (Coleoptera: Buprestidae). *The Pan-Pacific Entomologist* 81(1-2): 99-100.

Bellamy, C. L. 2005. Justified emendation in Buprestidae (Coleoptera). *The Coleopterists Bulletin* 59(3): 309.

Bellamy, C. L. 2005. A new genus and species of Nothomorpha Cobos, 1955 from northwestern South Africa (Coleoptera: Buprestidae: Polycestinae). *Zootaxa* 900:1-8.

- Bellamy, C. L.** 2005. The Philippine Coraebini Bedel, 1921 (Coleoptera: Buprestidae) Part 6: new and resurrected genera and new species. *Zootaxa* 1038:23-40.
- Bellamy, C. L.** 2005. Clarification of the type locality of *Coraebosoma indicum* Bellamy (Coleoptera: Buprestidae). *The Coleopterists Bulletin* 59(3): 327.
- Bellamy, C. L.** 2005. A new species of *Agrilus* Curtis, 1825 from Oaxaca (Coleoptera: Buprestidae). *Folia Entomologica Mexicana* 44 (Supl. 1): 15-19.
- Bellamy, C. L.** & M. G. Volkovitsh. 2005. Chapter 17. Buprestoidea Crowson, 1955, pp. 461-468. In: R. G. Beutel & R. A. B. Leschen (Eds.). *Handbuch der Zoologie/Handbook of Zoology*, Volume IV, Arthropoda: Insecta, Part 38, Coleoptera, Beetles, Volume 1: Morphology and Systematics. W. de Gruyter, Berlin, New York, 567 pp.
- Curletti, G. & **C. L. Bellamy**. 2005. Two new species of African Agrilini (Coleoptera: Buprestidae: Agrilinae). *Folia Heyrovskyana* 12(4)(2004): 175-178.
- Buffington, M.** (2005) The Occurrence and Phylogenetic Implications of the Ovipositor Clip within the Figitidae (Insect: Hymenoptera: Cynipoidea) *Submitted to the Zoological Journal of the Linnean Society*.
- Buffington M.**, Johan A.A. Nylander and John M. Heraty (2005) The Phylogeny, Evolution And Divergence Time Estimation Of Figitidae (Hymenoptera: Cynipoidea) *Submitted to Systematic Biology*.
- Buffington, M.** and R. Burks (2005) Chapter XX in Häuser, C.L., Steiner, A., Holstein, J. & Scoble, M. J. (eds) 2005. Digital Imaging of Biological Type Specimens. A Manual of Best Practice. Results from a study of the European Network for Biodiversity Information. Stuttgart.
- Blomquist, C., Irving, T., Osterbauer, N., Reeser, P.** July 28, 2005. *Phytophthora hibernalis*: a new pathogen of Rhododendron and evidence of *Cross* amplification with two PCR detection assays for *Phytophthora ramorum*. Online. Plant Health Progress doi: 10.1094/PHP-2005-0728-01-HN.
- Chitambar, John J.** and Howard Ferris. 2005. "*Geocenamus angelescresti* n. sp., a diagnostic key and compendium to the species of the genus *Geocenamus* Thorne & Malek, 1968 (Nematoda: Belonolaimidae)." *Journal of Nematology*, 37 (4): (In press).

Chitambar, John J. 2005 "Protocol for collecting and handling plant and soil samples for the detection of plant parasitic nematodes at the Nematology Laboratory, Plant Pest Diagnostics Branch, California Department of Food and Agriculture."

www.cdffa.ca.gov/phpps/ppd/SampleProcedures/Nematology/SamplingandHandlingProtocol.htm

Cline, A.R. and R.A.B. Leschen 2005. Coleoptera associated with the Oyster Mushroom, *Pleurotus ostreatus* Fries, in North America. *Southeastern Naturalist* 4(3): 409-420.

Ewing, C.P. and **A.R. Cline.** 2005. Key to Adventive Sap Beetles (Coleoptera Nitidulidae) in Hawaii, with Notes on Records and Habits. *The Coleopterists Bulletin* 59(2): 167-183.

Dong, K., Barker, K. R., and Opperman, C. H. 2005. Virulence Genes in *Heterodera glycines*: Allele Frequencies and Ror Gene Groups Among Field Isolates and Inbred Lines. *Phytopathology* 95:186-191.

Dong, K., Chitambar, John, Hackney, Robert, and Rene Luna. 2005. "California statewide nematode survey project." *California Plant Pest and Pest Disease Report*, 22 (1): 38-41.

Noma, T., M.J. Brewer, K.S. Pike, & **S.D. Gaimari.** 2005. Hymenopteran parasitoids and Dipteran predators of *Diuraphis noxia* in the west-central Great Plains of North America: Species records and geographic range. *Biocontrol* 50: 97-111.

Yang, D., & **S.D. Gaimari.** 2005. Notes on the species of the genus *Ocydromia* Meigen from China (Diptera: Empididae). *Pan-Pacific Entomologist* 80 (1): 62-66.

Yang, D., & **S.D. Gaimari.** 2005. Review of the species of *Elaphropeza* Macquart (Diptera: Empididae: Tachydromiinae) from the Chinese mainland. *Proceedings of the Entomological Society of Washington* 107 (1): 49-54.

Yang, D., **S.D. Gaimari,** & P. Grootaert. 2005 (2004). A new genus and species of Tachydromiinae (Diptera: Empididae) from the Oriental Realm. *Transactions of the American Entomological Society* 130 (4): 487-492.

Yang, D., **S.D. Gaimari,** & P. Grootaert. 2005. New species of *Hybos* Meigen from Guangdong Province, South China (Diptera: Empididae). *Zootaxa* 912: 1-7.

Yang, D., **S.D. Gaimari,** & P. Grootaert. 2005 (2004). Review of the species of *Drapetis* Meigen from China (Diptera: Empididae: Tachydromiinae). *Journal of the New York Entomological Society* 112 (2-3): 106-110.

Garrison, R.W. and N. von Ellenrieder. 2005. *Othemis sibylla* a junior synonym of *O. ambirufa* (Odonata: Libellulidae). *International Journal of Odonatology* 7(3) 467-470.

Garrison, R.W. and N. von Ellenrieder. 2005. *Neuragrion mysticum* (Odonata Megapodagrionidae) demystified. *Canadian Entomologist* 137:169-173.

De Marmels, J. and **R.W. Garrison**. 2005. Review of the genus *Leptagrion* in Venezuela with new synonymies and description of a new genus *Bromeliagrion*, and a new species, *B. rehni* (Zygoptera: Coenagrionidae). *Canadian Entomologist* 137:1-17.

Von Ellenrieder, N. and **R.W. Garrison**. 2005. A synopsis of the South American genus *Gomphomacromia* (Odonata: Gomphomacromiinae). *International Journal of Odonatology* 8(1): 81-96.

Von Ellenrieder, N. and **R.W. Garrison**. 2005. Case 3294: *Triacanthagyna* Selys, 1883 and *Gynacantha Rambur*, 1842 (Insecta, Odonota) proposed conservation of usage by designation of *Gynacantha nervosa* Rambur, 1842 as type species of *Gynacantha*. *Bulletin of Zoological Nomenclature* 62(1): 14-17.

Hauser, M. & M. E. Irwin. 2005. A new remarkable Xestomyzinae (Insecta, Diptera, Therevidae) genus from Mexican Amber. *Zootaxa* **1008**: 39-45.

Reemer, M., **M. Hauser** & M. C. D. Speight (2005): The genus *Myolepta* Newman in the West-Palaeartic region (Diptera, Syrphidae). *Studia Dipterologica* **11**(2): 553-580.

Grund, M. & **Hauser, M.** (2005): *Pachygaster hymenaea* sp. nov. and *P. antique* James, 1971 (Diptera: Stratiomyidae) in Neotropical ambers. *Zootaxa*. **1061**: 29-34.

Hauser, M. and M.E. Irwin (2005). The subfamily Xestomyzinae (Diptera: Therevidae) new to Madagascar, with description of four new species. *African invertebrates* 46:181 - 202.

Hauser, M. and M.E. Irwin (2005). The Florissant fossil Therevidae (Insecta: Diptera) revisited. *Journal of Systematic Palaeontology* 3 (4): 393-401.

Hill, Barry L; Hashim-Buckey, Jennifer; and Peacock, William. 2005. *The Effect of Dormant Season Survival of Xylella fastidiosa in Grapevines on Pierce's Disease Epidemics in California*. Proceedings, 2005 Pierce's Disease Research Symposium, Calif Dept. of Food and Agriculture, Sacramento, CA.

Hrusa, G.F. Book Review: Beidleman, L.H. and Kozloff, E.N. (2003) Plants of the San Francisco Bay region: Mendocino to Monterey. University of California Press, Berkeley, USA. in *Journal of Global Ecology and Biogeography*, Vol. 14 No. 6. 2005.

Meyer, D. J. L. and J. M. Effenberger. 2005. Identification of Large-seeded Members of the Subfamily Faboideae (Fabaceae). Plant Pest Diagnostics Center, Calif. Dept. of Food & Agriculture.

Meyer, D. J. L. and J. M. Effenberger. 2005. Brassicaceae Seed Identification. Plant Pest Diagnostics Center, Calif. Dept. of Food & Agriculture.

Meyer, D. J. L. (AOSA Rules Committee Chairperson and Editor) Preparation and CD publication of the AOSA Rules for Testing Seeds, AOSA Seedling Evaluation Handbook, AOSA Uniform Blowing Procedure – AOSA Handbook 24, and Uniform Classification of Weed and Crop Seeds – AOSA Handbook 25. All four of these AOSA publications were completely revised. These revisions include the insertion of all changes that were adopted at the June 2005 AOSA business meeting and revision of all nomenclature based on updates to the USDA Germplasm Resource Information Network (GRIN) Database.

Meyer, D. J. L. *Capsicum* spp. seedling. Cover illustration for the international journal *Seed Technology* Volume 27(1).

Medina V., Sudarshana, M.R., **Tian, T.**, Ralston, K.S., Yeh, H.H., Falk, B.W. The Lettuce infectious yellows virus (LIYV)-encoded P26 is associated with plasmalemma deposits within LIYV-infected cells. *Virology*. 2005 Mar 15; 333(2): 367-73.

Nagata, T, Alves, D.M., Inoue-Nagata, A.K., **Tian, T.Y.**, Kitajima, E.W., Cardoso, J.E., de Avila, A.C. A novel melon flexivirus transmitted by whitefly. *Arch Virol*. 2005 Feb; 150(2): 379-87.

Watson, G.W. & Kubiriba, J. (2005) Identification of mealybugs (Hemiptera: Pseudococcidae) on banana and plantain in Africa. *African Entomology* 13(1): 35-47.

Pasiecznik, N.M., Smith, I.M., **Watson, G.W.**, Brunt, A.A., Ritchie, B. & Charles, L.M.F. (2005) CABI/EPPO distribution maps of plant pests and plant diseases and their important role in plant quarantine. *EPPO Bulletin* 35: 1-7.

Godfrey, K., Gill, R., **Watson, G.** & Daane, K. (2005) Vine mealybug distribution and biological control. California Department of Food and Agriculture Biological Control Program 2004 Annual Report: 16.

Winterton, S.L. & Metz (2005) *Cyrtosathe* gen.n.: the first non-scenopinine Window-fly from sub-Saharan Africa (Diptera: Scenopinidae). *Zootaxa* 975: 1-12.

Winterton, S.L. (2005) A new species of *Propebrevitrichia* Kelsey (Diptera: Scenopinidae: Scenopininae) from Botswana. *Zootaxa* 818: 1-8.

Winterton, S.L., Skevington, J.H. & Lambkin, C.L. (2005) '*Stiletto flies of Australasia (Diptera: Therevidae)*'. Online Lucid3 key. California Department of Food, Agriculture, Agriculture Canada and CSIRO. Ver 1. [An Interactive key to genera of Therevidae throughout Australia, New Zealand and the Pacific Islands]. Link: <http://www.cdfa.ca.gov/phpps/ppd/therevidopen.htm>.