CALIFORNIA OAK MORTALITY TASK FORCE REPORT
APRIL 2007

NURSERIES

Three *P. ramorum* isolates from a nursery in Humboldt County, CA were determined to be of the European *P. ramorum* lineage. This is the first time the European *P. ramorum* strain has been confirmed in California. CDFA was notified of this find in early March as part of a genetic study of *P. ramorum*, including several isolates from the California Department of Food and Agriculture's (CDFA) Plant Pest Diagnostics Center that were sent to Nik Grunwald's USDA Agricultural Research Service lab in Corvallis, OR for genotyping.

The European isolate confirmations were originally taken from a Humboldt County retail nursery where samples were collected in the spring of 2006. The nursery is strictly a retail facility, is not under a *P. ramorum* compliance agreement, and does not ship interstate or out of the quarantined counties.

After notification of the European isolate confirmation, the Humboldt County Agricultural Commissioner's office conducted an extensive inspection of both the nursery and its perimeter in early March 2007. Two nursery samples collected during this follow-up inspection were confirmed positive for *P. ramorum* and have been sent to the USDA for genotyping. An extensive trace-back list was provided by the nursery for all suppliers of plants to this nursery between 2002 and 2007. This list has been forwarded to the USDA for trace-back investigations.

The nursery is very conscientious and proactive, and voluntarily implemented Best Management Practices* at the time they were determined positive in 2006 (before the European lineage determination was made). Additionally, they began working with UC Davis researchers to determine positive soil areas and the best method of treatment. The nursery is continuing to voluntarily go beyond what is required in the state and federal regulations.

*BMPs implemented: Moved all host and associated host plant material from known soil positive areas; Raised potted plants off ground onto elevated pallets; Fungicide usage was discontinued in spring 2006, after the disease was discovered to eliminate any possible masking of symptoms; The nursery has discontinued purchases of *Viburnum*; Much of the nursery grounds have been tarped and graveled.

To date in 2007, Washington has had three *P. ramorum* positive nursery confirmations. The first two positive nurseries were found in King and Snohomish counties, and were discovered as the result of the new trace-back protocol*. Both site visits were conducted because they received material from a trace-back nursery that was inspected and found not to be infested with *P. ramorum*. The third *P. ramorum*-positive nursery was in Cowlitz County (near the Oregon border) and was discovered as the result of a Compliance Certification Inspection for host and associated host interstate shippers.

*With some positive nursery confirmations, trace-back inspections fail to find *P. ramorum*-positive plants. This is believed to be the case because either the subject plants were infected in the identified nursery, though they came from another nursery, or the subject plants were indeed shipped infected from the originating nursery, but that nursery either shipped out all its infected plants, or recognized they had diseased plants and discarded them, or the disease has gone 'dormant' at the nursery so symptoms are not visible. To effectively address this, USDA APHIS Plant Protection and Quarantine (PPQ) implemented a trace-back policy in 2006 to address detections that do not successfully trace back to a nursery. The Trace-Back Protocol specifies that the trace-back nursery supplies trace-forward information for a period of 30 days prior and 30 days after the shipment(s) was/were sent to the positive nursery. Per the Trace-Back Protocol, this trace-forward information consists of all plants shipped from the trace-back nursery that are of the same variety, hybrid, species, or cultivar as the *P. ramorum*-positive plants found in the infested nursery. Once gathered, the information is sent to the regulatory officials in the affected states via the regional PPQ office and State Plant Health Directors of the affected state(s). It is important to note that these notices are not comparable to trace forwards coming from a positive nursery. There is no requirement for inspection based on these notices; however, the nurseries in the recipient states that received these plants would be considered of higher risk and higher priority in terms of the state surveys for *P. ramorum*.

A Hinds County, Mississippi nursery was found to have a *P. ramorum*-positive *Camellia* sp. March 23, 2007. Consequently, the nursery is under an emergency action notification and is currently being delimited. The inspection was a follow-up inspection to the eradication performed last year.

REGULATIONS

Due to recent discoveries of new *P. ramorum* infection centers in Curry County, Oregon, the Oregon Department of Agriculture (ODA) has increased the size of the quarantine area to 24.25 sq. mi. There are now three areas under quarantine; two small areas that are 1 sq. mi. each in size and the original area that has increased to 22.25 sq. mi. Eradication efforts are ongoing in all three quarantine areas. In addition, ODA updated the state quarantine and nursery certification rules to reflect changes in the official host list and in federally mandated protocols. For more information, contact Nancy Osterbauer, ODA, at nosterba@oda.state.or.us.

The EU published a new Decision on *Phytophthora ramorum* in March. Changes to the regulation include: updates to the host list; requiring an additional inspection of production nurseries each year; destruction of associated growing media and plant debris (when destroying infected plants and all susceptible plants within a 2 m radius of confirmed infected plants); and assuring that appropriate phytosanitary measures have been taken on growing surfaces within a 2 m radius of infected plants. For more information on the new Decision, go to http://eur-lex.europa.eu/LexUriServ/site/en/oj/2007/l_090/l_09020070330en00830085.pdf or contact David Slawson, DEFRA at: david.slawson@defra.gsi.gov.uk.

RESEARCH

Condeso, T. Emiko and Meentemeyer, Ross K. 2007. Effects of landscape heterogeneity on the emerging forest disease sudden oak death. Journal of Ecology 95: 364–375. DOI: 10.1111/j.1365-2745.2006.01206.x.

Summary: **1)** Sudden Oak Death is an emerging forest disease caused by the pathogen *Phytophthora ramorum* that is invading the west coast of the United States and semi-natural areas in Europe. This disease causes lethal stem infections in oaks (*Quercus* spp.) and tanoak (*Lithocarpus densiflorus*), as well as non-lethal foliar infections in a range of other species. **2)** We investigated two questions to evaluate the effect of landscape structure on the spread of *P. ramorum*: (i) does the spatial pattern of forested habitat predict *P. ramorum* disease severity, and is this relationship scale-dependent; and (ii) what influence does spatial pattern have on the optimal microclimate conditions for *P. ramorum* reproduction? **3)** We mapped the spatial distribution of suitable forest habitat for *P. ramorum* and established 86 randomly located field plots within a 20-km 2 region of northern California. For each plot, we quantified *P. ramorum* disease severity and measured the abundance of woody species. Disease severity in each plot was examined in relation to the surrounding landscape structure measured for nested landscapes of increasing scale. **4)** *P. ramorum* disease severity was greatest in plots surrounded by a high proportion of contiguous forest, after accounting for plot-level variables of host abundance, elevation, canopy cover and microclimate. The explanatory power of the model increased with increasing scale up to 200 m, but was not significant at scales less than 50 m. **5)** High disease severity was associated with lower temperatures in the field than the laboratory-determined optimal range for pathogen reproduction. Variation in microclimate conditions was explained by elevation, not the pattern of host vegetation, indicating that spatially varying disease severity was not a function of microclimate-related edge effects on pathogen growth and survival. **6)** Both landscape-scale configuration and local composition of host habitat are related to the severity of this destructive forest disease. Increased disease severity within contiguous woodlands may have a considerable impact on the composition of such woodlands, with cascading effects on the population dynamics of both host and pathogen.

Jeger, Mike J.; Pautasso, Marco; Holdenrieder, Ottmar; and Shaw, Mike W. 2007. Modelling disease spread and control in networks: implications for plant sciences. New Phytologist DOI: 10.1111/j.1469-8137.2007.02028.x.

Summary: Networks are ubiquitous in natural, technological and social systems. They are of increasing relevance for improved understanding and control of infectious diseases of plants, animals and humans, given the interconnectedness of today's world. Recent modelling work on disease development in complex networks shows: the relative rapidity of pathogen spread in scale-free compared with random networks, unless there is high local clustering; the theoretical absence of an epidemic threshold in scale-free networks of infinite size, which implies that diseases with low infection rates can spread in them, but the emergence of a threshold when realistic features are added to networks (e.g. finite size, household structure or deactivation of links); and the influence on epidemic

dynamics of asymmetrical interactions. Models suggest that control of pathogens spreading in scale-free networks should focus on highly connected individuals rather than on mass random immunization. A growing number of empirical applications of network theory in human medicine and animal disease ecology confirm the potential of the approach, and suggest that network thinking could also benefit plant epidemiology and forest pathology, particularly in human-modified pathosystems linked by commercial transport of plant and disease propagules. Potential consequences for the study and management of plant and tree diseases are discussed.

Magarey, R.D.; Fowler, G.A.; Borchert, D.M.; Sutton, T.B.; Colunga-Garcia, M.; and Simpson, J.A. 2007. NAPPFAST: An Internet System for the Weather-Based Mapping of Plant Pathogens. Plant Disease Vol. 91 No. 4. DOI: 10.1094/PDIS-91-4-0336.

Martin, Frank N.; Bensasson, Douda; Tyler, Brett M.; Boore, JeVrey L. 2007. Mitochondrial genome sequences and comparative genomics of *Phytophthora ramorum* and *P. sojae*. Curr Genet DOI: 10.1007/s00294-007-0121-6

Abstract: The sequences of the mitochondrial genomes of the oomycetes *Phytophthora ramorum* and *P. sojae* were determined during the course of complete nuclear genome sequencing (Tyler et al., Science, 313:1261,2006). Both mitochondrial genomes are circular mapping, with sizes of 39,314 bp for *P. ramorum* and 42,977 bp for *P. sojae*. Each contains a total of 37 recognizable protein-encoding genes, 26 or 25 tRNAs (*P. ramorum* and *P. sojae*, respectively) specifying 19 amino acids, six more open reading frames (ORFs) that are conserved, presumably due to functional constraint, across *Phytophthora* species (*P. sojae*, *P. ramorum*, and *P. infestans*), six ORFs that are unique for *P. sojae* and one that is unique for *P. ramorum*. Non-coding regions comprise about 11.5 and 18.4% of the genomes of *P. ramorum* and *P. sojae*, respectively. Relative to *P. sojae*, there is an inverted repeat of 1,150 bp in *P. ramorum* that includes an unassigned unique ORF, a tRNA gene, and adjacent non-coding sequences, but otherwise the gene order in both species is identical. Comparisons of these genomes with published sequences of the *P. infestans* mitochondrial genome reveals a number of similarities, but the gene order in *P. infestans* differed in two adjacent locations due to inversions and specific regions of the genomes exhibited greater divergence than others. For example, the breakpoints for the inversions observed in *P. infestans* corresponded to regions of high sequence divergence in comparisons between *P. ramorum* and *P. sojae* and the location of a hypervariable microsatellite sequence (eight repeats of 24 bp) in the *P. sojae* genome corresponds to a site of major length variation in *P. infestans*. Although the overwhelming majority of each genome is conserved (81–92%), there are a number of genes that evolve more rapidly than others. Some of these rapidly evolving genes appear specific to *Phytophthora*, arose recently, and future evaluation of their function and the effects of their loss could prove fruitful for understanding the phylogeny of these devastating plant pathogens.

Ockels, F.S., DiLeo, M.V., and Bonello, P. 2007. Desiccation at ambient temperature effectively preserves plant tissues infected with *Phytophthoras*. Online. Plant Health Progress DOI: 10.1094/PHP-2007-0302-01-RS.

Abstract: Conventionally, plant samples collected in the course of field surveys for *Phytophthora* spp. (e.g., in the context of the US Forest Service-sponsored national *P. ramorum* survey of forest environments) are either processed immediately or stored at low temperatures and processed as soon as possible for detection by molecular methods. In order to extend the useful life of the sample, a method involving tissue desiccation was explored for effectively storing *Phytophthora*-infected plant leaves. In one experiment, rhododendron leaves inoculated with an unknown *Phytophthora* sp. and desiccated for seven days yielded DNA of sufficient quality for species identification via sequencing of the ITS region. In a second experiment, *P. ramorum* was successfully detected byPCR in inoculated leaves of California bay laurel, California buckeye, bigleaf maple, rhododendron, and viburnum that were desiccated and stored at room temperature for four months. Therefore, desiccation might be a viable, reliable, and less expensive alternative to storing foliar samples at low temperature.

Tooley, P.W. and Kyde, K.L. 2007. Susceptibility of some Eastern forest species to *Phytophthora ramorum.* Plant Dis. 91:435-438. DOI: 10.1094/PDIS-91-4-0435.

Abstract: We tested some common Eastern forest species for their reaction to stem and leaf inoculation with *Phytophthora ramorum*, the pathogen that causes sudden oak death. Stem lesions were produced on inoculated seedlings of 12 Eastern forest species following 72 to 76 days of incubation in a containment greenhouse cubicle at 20ºC. Chestnut oak (*Quercus prinus*) and white oak (*Q. alba*) were followed by northern red oak (*Q. rubra*) in susceptibility to stem inoculation. Sugar maple (*Acer saccharum*) and black walnut (*Juglans nigra*) were more resistant to stem inoculation than most of the oak species tested. *P. ramorum* was isolated on selective medium at distances of up to 8 mm from stem lesion margins. Foliar lesions were observed within 7 days when seedlings were inoculated with 5,000 sporangia/ml followed by incubation at 20ºC in a dew chamber. Chestnut oak was followed by tanoak (*Lithocarpus densiflorus*) and coast live oak (*Q. agrifolia*) in susceptibility to *P. ramorum* by foliar inoculation. Chestnut oak, an ecologically important species in parts of the Eastern United States, emerged as the most susceptible host tested in both stem and foliar inoculations. The results indicate that, under controlled conditions, *P. ramorum* is able to infect some important Eastern forest species and cause lesions on stems and foliage. It remains to be determined whether infection of these species by *P. ramorum* would occur under natural conditions.

SUDDEN OAK DEATH SCIENCE SYMPOSIUM III

More than 250 people, representing 11 countries, 24 states, and Washington, DC, attended the March 2007 Sudden Oak Death Science Symposium III in Santa Rosa, CA. The 5-day conference included 65 oral presentations and 60 posters. Presentations on asymptomatic plant infections, the identification of new hosts, new findings on modes of pathogen dispersal, and pathogen presence in the wood of bole hosts, along with other

important discoveries, facilitated dynamic discussions, future projects, increased collaboration, and provided new science-based information for improved regulations as well as education, early detection, management, and suppression efforts. Presentations and posters will be available on the Symposium website soon at http://nature.berkeley.edu/comtf/sodsymposium/index.html. Proceeding papers and extended abstracts for all oral presentations and posters are past due, but will be accepted until April 30, 2007. See the Symposium website for more details.

PERSONNEL

Russ Bulluck left his position as National Program Staff Scientist with the USDA Animal and Plant Health Inspection Service (APHIS) to take a Plant Pathologist position with USDA APHIS Plant Protection and Quarantine (PPQ) Emergency and Domestic Programs. As part of the Emergency Planning and Preparedness staff, his responsibilities include developing New Pest Response Guidelines for exotic plant pathogens. Russ can still be reached at (919) 855-7646 or via email at Russ.Bulluck@aphis.usda.gov.

Walter Gutierrez has replaced Russ Bullock as the USDA APHIS National Program Staff Scientist working on *P. ramorum*. Walter's prior work includes research involving Cereal Crop Breeding as well as tobacco plant research and disease management strategies. He can be reached in Raleigh, North Carolina at (919) 855-7529 or via email at Walter.A.Gutierrez@aphis.usda.gov.

RESOURCES

USDA APHIS has changed their web address for *Phytophthora ramorum*. Please make note that the new address is http://www.aphis.usda.gov/plant_health/plant_pest_info/pram/index.shtml.

The Proceedings from the 3rd IUFRO *Phytophthoras* in Forests and Natural Ecosystems meeting are now available. Copies may be purchased for £ 22 ($43 US) by contacting Clarie Sabin, Tree Health Division, Forest Research, Alice Holt Lodge, Farnham, Surrey, UK at claire.sabin@forestry.gsi.gov.uk. Shipping charges to the US will be an additional $7.85.

The citation for the Proceedings is:
Brasier C., Jung T., and Osswald W., eds. 2006. Progress in Research on *Phytophthora* Diseases of Forest Trees. Proceedings of the Third International IUFRO Working Party 07.02.09. September 11-18, 2004, Freising, Germany. Forest Research, Farnham, UK.188 pgs.

EDUCATION

Space is still available for the April 24th and May 1st free one-day Sudden Oak Death/*P. ramorum* Wildland Training Sessions. See the Calendar of Events below for more information.

CALENDAR OF EVENTS

4/24 – Free one-day Sudden Oak Death/*P. ramorum* Wildland Training Session; Pt. Reyes National Seashore, Red Barn Classroom; 1 Bear Valley Road, Pt. Reyes Station, CA 94956; More information can be found on the COMTF website at: www.suddenoakdeath.org. For questions, contact Janice Alexander at: JAlexander@co.marin.ca.us or (415) 499-3041.

4/25 – Registration Deadline for the Third Annual Bringing Back the Natives Garden Tour; This FREE tour will take place Sunday, May 6, 2007, from 10 a.m. – 5 p.m. The self-guided tour showcases 60 pesticide-free, water-conserving East Bay gardens that provide habitat for wildlife and contain 30% or more native plants. Sudden Oak Death presentations and materials will be available at select gardens throughout the day. For more information, go to www.BringingBackTheNatives.net or contact Janice Alexander at jalexander@ucdavis.edu.

5/1 – Free one-day Sudden Oak Death/*P. ramorum* Wildland Training Session; Presentation Center; 19480 Bear Creek Road, Los Gatos, CA 95033; More information can be found on the COMTF website at: www.suddenoakdeath.org. For questions, contact Katie Palmieri at: Palmieri@nature.berkeley.edu or (916) 435-3230.

10/15 – 10/18 - XVI International Plant Protection Congress 2007, Glasgow, UK; Full details on the recently announced call for papers can be found at: http://www.bcpc.org/IPPC2007/Call%5Ffor%5FPapers/. For more information, contact Dr. Slawson, PHSI DEFRA, at: david.slawson@defra.gsi.gov.uk.

8/23 – 24/2008 – "3rd International *Phytophthora* and *Pythium* Workshop: Integration of Traditional and Modern Approaches for Investigating the Taxonomy and Evolution of *Phytophthora, Pythium* and Related Genera" in association with the 9th International Congress of Plant Pathology; Turin, Italy; For more information, go to http://www.aphis.usda.gov/plant_health/identification/phytophthora/index.shtml.