CALIFORNIA OAK MORTALITY TASK FORCE REPORT
JUNE 2011

MONITORING

Washington had two repeat *P. ramorum*-positive waterway detections in May. One of the sites has been positive since 2009 and the other since 2010. Each positive stream feeds into the Sammamish River. Both sites have had positive samples recovered upstream from the confluence of the water course and the Sammamish (baiting by WSDA and WA DNR); the inoculum source for each is unknown.

Survey work for 2011 National *P. ramorum* Early Detection Survey of Forests is underway in all 17 participating states (same as 2010). Many of the southern state cooperators have completed spring baiting. To date, no new positive sites have been reported; however, all eight previously positive southeast sites (MS, GA, FL, NC, and AL-4 sites) have been found positive again, with most sites having had multiple pathogen detections. For more information, contact Steve Oak at soak@fs.fed.us.

The British Forestry Commission has completed seven *P. ramorum*-infected larch woodland survey flights this year in Wales and England's southwest, South Coast, and Peak District. Aerial surveys of northern England and Scotland have just begun, with Northern Ireland to follow. To date, the flyovers have detected fewer suspected infected larch than the previous two years. All areas most strongly suspected appear to be contiguous with, or in close proximity to, previously infected woodlands. Follow-up ground-check surveys are underway. For more information, contact Charlton Clark at charlton.clark@forestry.gsi.gov.uk.

NURSERIES

California had four *P. ramorum*-positive nurseries confirmed in May. On May 2nd, a production nursery in San Joaquin County was found to have a positive *Pieris forrestii* during an Annual Compliance Agreement inspection. The nursery has not previously been positive, and no interstate shipments have been made. A second production nursery was identified in Santa Cruz County on May 3rd when *P. ramorum*-positive *Rhododendron* was found during a Nursery Stock Standards of Cleanliness inspection. The nursery was also positive in 2003, 2004, 2005, and 2006. It is not under compliance and does not ship outside of the quarantined area**.** On May 13th, a Sacramento County retail nursery was found to have positive *Camellia japonica* during a general nursery inspection. The facility has not been found positive before and does not ship interstate. The last nursery was identified on May 18th. The Sacramento County production facility was found to have positive *Camellia japonica* 'Mathotiana,' *Trachelospermum jasminoides, Magnolia grandiflora, and Camellia japonica* 'Debutante' during a compliance agreement inspection. The nursery does ship interstate and was also found positive in 2009 and 2010. Trace-forward information has been provided to the USDA.

A South Carolina retail nursery was found to have *P. ramorum*-positive soil on April 6th. Clemson University and the nursery owner are working to clean up the site and will soon be installing a sand filtration system in an effort to keep pathogen spores from entering the environment (see story below for additional details). The nursery was also found positive in 2009 with infested plants and in 2010 with positive soil. The nursery does not ship interstate.

A Snohomish County wholesale/production nursery was confirmed *P. ramorum* positive on May 27th during an Annual Compliance Inspection. The nursery was previously positive in 2008 and 2010. The Confirmed Nursery Protocol, including delimitation of all stock and collection of trace-forward and trace-back information is underway. Though they are under compliance agreement as an interstate host shipper, the nursery has not made an interstate shipment in the past 12 months. Positive species include *Mahonia aquifolium, Gaultheria shallon* and *Arctostaphylos uva-ursi.*

To date, the Oregon Department of Agriculture has completed testing for the 2011 *P. ramorum* Federal Order Survey on 7,574 samples collected from 182 nursery grower locations. Four Oregon nurseries were found positive for the pathogen in May. On May 9th, *P. ramorum* was confirmed at two wholesale nurseries in Clackamas County. At one nursery, *Rhododendron* sp., *Rhododendron* cultivars 'Balalaika' and 'Hellikii,' *Camellia* sp., and *Viburnum tinus* were found infected. This nursery was previously positive in 2010. At the second nursery, *Rhododendron* 'Chinoides' was found infected. This nursery was also positive in 2005, 2008, and 2010. Both nurseries are interstate shippers. On May 13th, *P. ramorum* was found infecting plants at a Lincoln County retail nursery and a Lane County wholesale nursery. *Rhododendron* sp. were found infected at the Lincoln County nursery. This is the first time this nursery has been positive. It does not ship interstate. At the Lane County facility, *Camellia japonica* 'Blood of China' and *Camellia* 'April Tryst' were found infected. This nursery was also positive in 2006 and 2009, and does ship interstate. The USDA Retail Confirmed Nursery Protocol (CNP) has been enacted at the Lincoln County facility, and the USDA CNP at the three positive wholesale nurseries.

MANAGEMENT

Slow Sand Filtration Project for South Carolina *P. ramorum*-Positive Nursery - The Clemson University Department of Plant Industry strives to protect SC's agricultural resources and natural ecosystems from the introduction and spread of invasive species such as *P. ramorum.* One nursery in SC has had positive detections of *P. ramorum* for three consecutive years. While surveys indicate that eradication efforts have eliminated *P. ramorum* from nursery stock, the pathogen continues to be found in the nursery's water and soil; however, perimeter forest surveys and stream baiting of the river associated with this nursery have all been negative to date.

In an effort to maintain the pathogen-free status of the natural area outside of the nursery, Clemson University researchers and the nursery owner are installing a slow sand filtration system in which all runoff will be directed into a vegetated ditch that will lead

to a small retention pond for sediment dispersal. The water from the pond will be pumped into a slow sand filtration system and then drain to another vegetated area for diffusion before entering the river. Each component of the system will be monitored by Clemson University researchers. The nursery and river will continue to be tested for *P. ramorum* according to USDA CNP protocol and the state compliance agreement. For more information, contact Christel Harden at CHARDEN@clemson.edu.

The UK is continuing to offer grants in 2011-12 to help woodland owners in England and Wales needing to comply with requirements to fell *P. ramorum*-infected trees. There are two grants available: one to help with the costs associated with the compulsory clearance of infected immature larch, and the other with the costs of hiring an agent for advice on complying with the requirements when felling and marketing older larch. Funding for the grants is made possible by the UK's *Phytophthora* Program Fund managed by the Food and Environment Research Agency. Enhanced Forestry Commission restocking (replanting) grants have also been announced this year and will be made available to help owners in England replant their sites after felling infected woodlands.

RESEARCH

Demon, I.; Cunniffe, N.J.; Marchant, B.P.; Gilligan, C.A.; and van den Bosch, F. 2011. Spatial sampling to detect an invasive pathogen outside of an eradication zone. Phytopathology 101:725-731.

Abstract: Invasive pathogens are known to cause major damage to the environments they invade. Effective control of such invasive pathogens depends on early detection. In this paper we focus on sampling with the aim of detecting an invasive pathogen. To that end, we introduce the concept of optimized spatial sampling, using spatial simulated annealing, to plant pathology. It has been mathematically proven (15) that this optimization method converges to the optimum allocation of sampling points that give the largest detection probability. We show the benefits of the method to plant pathology by (i) first illustrating that optimized spatial sampling can easily be applied for disease detection, and then we show that (ii) combining it with a spatially explicit epidemic model, we can develop optimum sample schemes, i.e., optimum locations to sample that maximize the probability of detecting an invasive pathogen. This method is then used as baseline against which other sampling methods can be tested for their accuracy. For the specific example case of this paper, we test (i) random sampling, (ii) stratified sampling as well as (iii) sampling based on the output of the simulation model (using the most frequently infected hosts as sample points), and (iv) sampling the hosts closest to the outbreak point.

Grünwald, N.J. and Goss, E.M. 2011. Evolution and Population Genetics of Exotic and Re-Emerging Pathogens: Novel Tools and Approaches. Annual Review of Phytopathology 49:5.1–5.19. DOI: 10.1146/annurev-phyto-072910-095246.

Abstract: Given human population growth and accelerated global trade, the rate of emergence of exotic plant pathogens is bound to increase. Understanding the processes that lead to the emergence of new pathogens can help manage emerging epidemics. Novel tools for analyzing population genetic variation can be used to infer the evolutionary history of populations or species, allowing for the unprecedented reconstruction of the demographic history of pathogens. Specifically, recent advances in the application of coalescent, maximum likelihood (ML), and Bayesian methods to population genetic data combined with increasing availability of affordable sequencing and parallel computing has created the opportunity to apply these methods to a broad range of questions regarding the evolution of emerging pathogens. These approaches are particularly powerful when used to test multiple competing hypotheses. We provide several examples illustrating how coalescent analysis provides critical insights into understanding migration pathways as well as processes of divergence, speciation, and recombination.

Kay, J.; Meijer, H. J.G.; ten Have, A.; and van Kan, J.A.L. 2011. The Aspartic Proteinase family of three *Phytophthora* species. *BMC Genomics* 2011, 12:254. DOI: 10.1186/1471-2164-12-254.

Abstract - Background: *Phytophthora* species are oomycete plant pathogens with such major social and economic impact that genome sequences have been determined for *Phytophthora infestans*, *P. sojae,* and *P. ramorum.* Pepsin-like aspartic proteinases (APs) are produced in a wide variety of species (from bacteria to humans) and contain conserved motifs and landmark residues. APs fulfill critical roles in infectious organisms and their host cells. Annotation of *Phytophthora* APs would provide invaluable information for studies into their roles in the physiology of *Phytophthora* species and interactions with their hosts.

Results: Genomes of *Phytophthora infestans*, *P. sojae* and *P. ramorum* contain 11-12 genes encoding APs. Nine of the original gene models in the *P. infestans* database and several in *P. sojae* and *P. ramorum* (three and four, respectively) were erroneous. Gene models were corrected on the basis of EST data, consistent positioning of introns between orthologues and conservation of hallmark motifs. Phylogenetic analysis resolved the *Phytophthora* APs into 5 clades. Of the 12 sub-families, several contained an unconventional architecture, as they either lacked a signal peptide or a propart region. Remarkably, almost all APs are predicted to be membrane bound.

Conclusions: One of the twelve *Phytophthora* APs is an unprecedented fusion protein with a putative Gprotein coupled receptor as the C-terminal partner. The others appear to be related to well-documented enzymes from other species, including a vacuolar enzyme that is encoded in every fungal genome sequenced to date. Unexpectedly, however, the oomycetes were found to have both active and probably-inactive forms of an AP similar to vertebrate BACE, the enzyme responsible for initiating the processing cascade that generates the Aβ peptide central to Alzheimer's Disease. The oomycetes also encode enzymes similar to plasmepsin V, a membrane-bound AP that cleaves effector proteins of

the malaria parasite *Plasmodium falciparum* during their translocation into the host red blood cell. Since the translocation of *Phytophthora* effector proteins is currently a topic of intense research activity, the identification in *Phytophthora* of potential functional homologues of plasmepsin V would appear worthy of investigation. Indeed, elucidation of the physiological roles of the APs identified here offers areas for future study. The significant revision of gene models and detailed annotation presented here should significantly facilitate experimental design.

Kovacs, K.; Václavík, T.; Haight, R.G.; Pang, A.; Cunniffe, N.J.; Gilligan, C.A.; and Meentemeyer, R.K. 2011. Predicting the economic costs and property value losses attributed to sudden oak death damage in California (2010-2020). Journal of Environmental Management 92:1292-1302.

Abstract: *Phytophthora ramorum*, cause of sudden oak death, is a quarantined, non-native, invasive forest pathogen resulting in substantial mortality in coastal live oak (*Quercus agrifolia*) and several other related tree species on the Pacific Coast of the United States. We estimate the discounted cost of oak treatment, removal, and replacement on developed land in California communities using simulations of *P. ramorum* spread and infection risk over the next decade (2010-2020). An estimated 734,000 oak trees occur on developed land in communities in the analysis area. The simulations predict an expanding sudden oak death (SOD) infestation that will likely encompass most of northwestern California and warrant treatment, removal, and replacement of more than 10 thousand oak trees with discounted cost of $7.5 million. In addition, we estimate the discounted property losses to single family homes of $135 million. Expanding the land base to include developed land outside as well as inside communities doubles the estimates of the number of oak trees killed and the associated costs and losses. The predicted costs and property value losses are substantial, but many of the damages in urban areas (e.g. potential losses from increased fire and safety risks of the dead trees and the loss of ecosystem service values) are not included.

Noblea, R.; Blackburnb, J.; Thorpb, G.; Dobrovin-Penningtona, A.; Pietravalleb, S.; Kerinsb, G.; Allnuttb, T.R.; and Henry, C.M. 2011. Potential for eradication of the exotic plant pathogens *Phytophthora kernoviae* and *Phytophthora ramorum* during composting. Plant Pathology. DOI: 10.1111/j.1365-3059.2011.02476.x.

Abstract: Temperature and exposure time effects on *Phytophthora kernoviae* and *Phytophthora ramorum* viability were examined in flasks of compost and in a large-scale composting system containing plant waste. Cellophane, rhododendron leaf and peatbased inoculum of *P. kernoviae* and *P. ramorum* isolates were used in flasks; naturally infected leaves were inserted into a large-scale system. Exposures of 5 and 10 days respectively at a mean temperature of 35°C in flask and large-scale composts reduced *P. kernoviae* and *P. ramorum* inocula to below detection limits using semi-selective culturing. Although *P. ramorum* was undetectable after a 1-day exposure of inoculum to compost at 40°C in flasks, it survived on leaves exposed to a mean temperature of 40·9°C for 5 days in a large-scale composting system. No survival of *P. ramorum* was detected after exposure

of infected leaves for 5 days to a mean temperature of ≥41·9°C (32·8°C for *P. kernoviae*) or for 10 days at ≥31·8°C (25·9°C for *Phytophthora pseudosyringae* on infected bilberry stems) in large-scale systems. Fitted survival probabilities of *P. ramorum* on infected leaves exposed in a large-scale system for 5 days at 45°C or for 10 days at 35°C were <3%, for an average initial infection level of leaves of 59·2%. RNA quantification to measure viability was shown to be unreliable in environments that favour RNA preservation: high levels of ITS1 RNA were recovered from *P. kernoviae*- and *P. ramorum*-infected leaves exposed to composting plant wastes at >53°C, when all culture results were negative.

Tooley, P.W. and Carras, M.M. 2011. Enhanced Recovery of *Phytophthora ramorum* from Soil Following 30 Days of Storage at 4°C. Journal of Phytopathology, 159: no. DOI: 10.1111/j.1439-0434.2011.01810.x.

Chlamydospores of *Phytophthora ramorum* were used to infest field soil at densities ranging from 0.2 to 42 chlamydospores/cm^3 soil. Recovery was determined by baiting with rhododendron leaf discs and dilution plating at time 0 and after 30 days of storage at 4°C, as recommended by USDA-APHIS. Baiting was slightly more sensitive than dilution plating in recovering *P. ramorum* immediately following infestation of soil and allowed detection from samples infested with as little as 0.2 chlamydospores/cm^3 compared with 1 chlamydospore/cm^3 for dilution plating. After 30 days of infested soil storage at 4°C, *P. ramorum* was detected at significantly (P = 0.05) higher levels than at time 0 with both recovery methods. The results indicate that storage of *P. ramorum*-infested soil at 4°C may allow for pathogen activity, such as sporangia production, which may enhance recovery from soil.

Vercauteren, A.; Larsen, M.; Goss, E.; Grunwald, N.; Maes, M.; and Heungens, K. 2011. Identification of new polymorphic microsatellite markers in the NA1 and NA2 lineages of *Phytophthora ramorum*. Mycologia. DOI: 10.3852/10-420.

Phytophthora ramorum is a recently introduced pathogen in Europe and North America consisting of three clonal lineages. Due to the very limited intra-lineage genetic variation, only a few polymorphic markers are available for use in studies involving the epidemiology and evolution of *P. ramorum*. A total of 159 primer pairs for candidate polymorphic SSR loci were tested with universal labeling. Four polymorphic microsatellite loci were identified within the NA1 lineage and one within the NA2 lineage, demonstrating the power and flexibility of the screening technique. The markers may significantly increase the number of genotypes that can be identified, and as such can help better characterize the North American lineages of *P. ramorum*.

RELATED RESEARCH

Collins, S.; McComb, J.A.; Howard, K.; Shearer, B.L.; Colquhoun, I.J.; and St. J. Hardy, G.E. 2011. The long-term survival of *Phytophthora cinnamomi* in mature *Banksia grandis* killed by the pathogen. Forest Pathology. DOI: 10.1111/j.1439-0329.2011.00718.x.

Tsopelas, P.; **Paplomatas, E.J.; Tjamos, S. E.**; and **Elena, K. 2011. First Record of** *Phytophthora nicotianae* Causing Leaf Blight on Rhododendron in Greece. Plant Disease. June 2011, Volume 95, Number 6. Page 777. DOI: 10.1094/PDIS-02-11-0096.

RESOURCES

The Forest Pathology and Mycology Laboratory at UC Berkeley has launched a new tool intended to assist scientists, land managers, and property owners in furthering the understanding of Sudden Oak Death (SOD) epidemiology and selecting the most appropriate disease management options for a given area. SOD-MAP will complement and interface with OAKMAPPER, the other popular SOD mapping tool hosted at UC Berkeley, which has provided excellent outreach and opportunities for public interaction. SOD-MAP will fill a different purpose, and will only include *P. ramorum* reports confirmed by an official laboratory, including negative findings, with the intention of sharing known distribution information gathered by public agencies and research groups across the country. The maps will be publicly accessible at www.matteolab.org and will replace the current SOD-blitz maps beginning October 2011. Five unique features of SOD-MAP are:

- It will facilitate information sharing among scientists as well as scientists and the public.
- Data will be updated each year in September and will provide a picture of the known distribution of *P. ramorum* on an annual basis in California as well as North America and Europe.
- Lab confirmations for all host plants will be included. Isolation results from baiting stations on rivers or lakes may also be posted. *NOTE*: Providing datasets that include lab-confirmed negative sampling results is strongly encouraged.
- Nursery data will not be included in SOD-MAP data, but SOD records both from wildland and urban settings throughout the country will be.
- Data will be shared with current mapping efforts such as the OAKMAPPER.

Researchers across the United States are encouraged to share their lab-confirmed *P. ramorum* datasets. Deadline for inclusion in the 2011 SOD-MAP is **September 15th**. Although priority will be given to results from 2010-2011, data cumulatively generated prior to 2008 independent of year will be accepted, as will yearly results from 2008, 2009, and 2010. Datasets need to be in TAB DELIMITED Excel format and must include the following seven columns, in the following order:

Name: a composite of sender and sample name (e.g., Smith-Pr1)
Project that generated data to be mapped (e.g., SOD-blitz)
Latitude in decimal format (rather than in hours, minutes, and seconds) using Datum 84

Longitude in decimal format (rather than in hours, minutes, and seconds) using Datum 84
Description: any note associated with sample (e.g., host health, stand disease incidence)
Plant Host
Method of confirmation (e.g., CDFA laboratory, PCR)

SOD-MAP is being funded by the US Forest Service, State and Private Forestry and the Gordon and Betty Moore Foundation, and will be managed by the Forest Pathology and Mycology Laboratory at UC Berkeley. Please email datasets at your earliest convenience to Doug Schmidt: dschmidt@berkeley.edu. For questions and comments, contact Matteo Garbelotto at matteog@berkeley.edu.

RELATED TOPICS

Western Australia's Environmental Protection Agency (EPA) rejected a bid by the Department of Environment and Conservation to build a walking trail through Fitzgerald River National Park for fear of exposing the park to *Phytophthora cinnamomi*. However, the EPA has said it would support a proposal that does not include traversing the Park's wilderness management zone between Point Charles and Quoin Head.

PERSONNEL

Franny Healey will be retiring on June 29th after nearly seven years as the COMTF webmaster and administrative assistant. Franny first started working with the UC Cooperative Extension, Marin office in 2002 and began managing the COMTF website in 2004. Her technical knowledge and pleasant demeanor made her an asset in both the office and onsite at meetings. While no one can replace Franny, UCCE Marin is hoping to fill her position with a new staff member by July. We wish her the best in her retirement! She will be missed.

The UK's Food and Environment Research Agency and the University of Exeter are looking to hire a doctoral student for a three-year project to commence October 1, 2011. The position will include tuition fees (UK/EU rate only) and an annual stipend of $22,252. Applications are due by June 30th. This project will consist of whole-genome and whole-transcriptome analysis of a collection of *P. ramorum* isolates with the objective understanding the genetic variation and molecular basis for recent epidemics and colonization of new hosts. The majority of this project will be bioinformatics analysis of large quantities of data generated using 'next generation' DNA sequencing technologies. Experience in statistics and computer programming, as well as an interest in plant pathology, are desirable. For more information, go to http://www.nature.com/naturejobs/science/jobs/197982-Comparative-Genomics-of-Phytophthora-Ramorum.

CALENDAR OF EVENTS

6/21 – 6/23 - Coast Redwood Forests in a Changing California: A Symposium for Scientists and Managers; University of California, Santa Cruz; For more information, go to http://ucanr.org/sites/redwood.

6/24 - "Using genomics to manage healthy oak populations" meeting; Alpha Gamma Rho Room, Buehler Alumni and Visitor Center, UC Davis; 1-5 p.m.; Registration is free, but required by June 15, 2011. This meeting is intended for western oak woodland land managers and decision makers. A no-host picnic dinner will follow the discussion. For more information, contact Jessica Wright at jessicawwright@fs.fed.us or (530) 759-1742.

6/30 - Sudden Oak Death in Humboldt County, Free Workshop; Veterans' Hall, 483 Conger Street, Garberville; 4-6 p.m.; The workshop is an update oriented toward landowners, the general public, and anyone else concerned about SOD and forest health in our region. Those who register for the workshop will receive materials and instructions for collecting samples from their properties, and they can bring them in to the workshop to be tested by the lab at UC Berkeley. Preregistration required by calling (707) 445-7351 or email cale@ucdavis.edu.

6/30 - Guidelines for Managing Oak Rangelands; webinar series field trip to Avenales Ranch, Pozo, San Luis Obispo County; 10:00 a.m. - 2:30 p.m. This series is intended for oak woodland landowners, certified range managers, and registered professional foresters. It is designed to create an awareness of the importance of managing oak woodlands and to present alternative management strategies. Registration is $25. To register, go to http://ucanr.org/oakwebinar. Registered participants will receive follow-up log-in instructions. For more information, contact Richard Standiford at (510) 643-5428 or standifo@berkeley.edu. Note: As the webinar series has already started, those who register now will get access to a recording of already completed sessions, and a link for the upcoming sessions.

7/13 – 7/14 - California Forest Pest Council Summer Weed Tour; Murphys, Calaveras County. To register or for more information, go to http://caforestpestcouncil.org/2011/04/2011-cfpc-weedinsectdiseaseanimal-damage-tour-and-golf-tournament/. For questions, contact Tim Collins at tcollins@spi-ind.com or (530) 272-2297, or Patricia Raggio at praggio@parks.ca.gov or (209) 795-8270.

7/26 - California Forest Pest Council Summer Insect, Disease, and Animal Damage Tour; Fort Bragg, Mendocino County; For more information, contact Tom Smith at (916) 599-6882 or tom.smith@fire.ca.gov.

7/31 – 8/5 – Disease and Insect Resistance in Forest Trees: Fourth International Workshop on the Genetics of Host-Parasite Interactions in Forestry; Valley River Inn; 1000 Valley River Way; Eugene, OR 97401; To register, or for more information, go to http://ucanr.org/sites/tree_resistance_2011conference/. For questions, contact Richard Sniezko at rsniezko@fs.fed.us; Katie Palmieri at (510) 847-5482 or kpalmieri@berkeley.edu; or Janice Alexander at (415) 499-3041 or jalexander@ucdavis.edu.

9/15 – 9/17 - California Urban and Community Forests Conference; Crown Plaza Hotel in Palo Alto; For more information, go to http://www.caufc.org/Annual%20Conference.

10/5 – 10/6 – The Seventh Meeting of the Continental Dialogue on Non-Native

Forest Insects and Diseases; Boulder, Colorado; For more information, contact Debbie Lee at dlee@resolv.org or (202) 965-6381 or Beth Weaver at bweaver@resolv.org or (202) 965-6211. For more information about the Dialogue go to: www.continentalforestdialogue.org.

10/10 – 10/14 - The 59th Western International Forest Disease Work Conference; Enzian Hotel, Leavenworth, WA. This meeting is intended for forest pathologists from western North America (and beyond); For more information, go to www.fs.fed.us/foresthealth/technology/wif/index.htm. For questions, contact Greg Filip at gmfilip@fs.fed.us or (503) 808-2997.

11/8 – 11/11 - 2011 IUFRO Forest Protection Joint Meeting, Research Groups 7.02 – 7.03; Colonia del Sacramento, Uruguay; More information will be forthcoming. For questions, contact Alina Greslebin at agreslebin@ciefap.org.ar.

6/18 – 6/22/12 – Sudden Oak Death Fifth Science Symposium; More information will be forthcoming.