2010, 1
ISSN 2191-1398
DOI 10.5073/jkidspdd.2010.001

Julius Kühn-Institut
Bundesforschungsinstitut für Kulturpflanzen
Federal Research Centre for Cultivated Plants

JKI Data Sheets
Plant Diseases and Diagnosis

Sabine Werres / Stefan Wagner

Phytophthora lateralis
Tucker & Milbrath (1942)

Julius Kühn-Institut, Federal Research Centre for Cultivated Plants

Imprint

The open access series „JKI Data Sheets – Plant Diseases and Diagnosis„ is a English-language publication that publishes original papers, pathogen descriptions, findings and reports on biotic and abiotic causes of crop diseases and crop damage.

The series is also published in German under the title „JKI Datenblätter – Pflanzenkrankheiten und Diagnose".

All manuscripts submitted for publication in the JKI Data Sheets are peer-reviewed by at least two independent referees while the anonymity of author(s) is preserved.

Publisher/Editor-in-Chief:
Dr. Georg F. Backhaus, Präsident und Professor
Julius Kühn-Institut, Federal Research Centre for Cultivated Plants
Erwin-Baur-Str. 27
D-06484 Quedlinburg

Managing Editor:
Dr. Olaf Hering, Information Centre and Library
Julius Kühn-Institut
Königin-Luise-Str. 19
D-14195 Berlin
E-Mail: redaktion.datasheets@jki.bund.de

Submission of manuscripts:
Please go to the journal's website at **http://pub.jki.bund.de/**

ISSN:
2191-1398

DOI
10.5073/jkidspdd.2010.00

Status in the EU

EPPO A1 List of pests recommended for regulation as quarantine pests (version 2009-09), http://www.eppo.org/QUARANTINE/listA1.htm

History

Chamaecyparis lawsoniana (Lawson Cypress) is an important tree species in town, suburban gardens and parks in the USA. It is economically and ecologically valuable in forests in west California and south-west Oregon. In 1854 when seed was imported from the USA to Europe for the first time, the selection and breeding of numerous cultivars started. Cultivars from Europe and additional selection from the US were propagated as ornamental plants in nurseries on the west coast of the US. In 1923 a serious root rot of *Chamaecyparis lawsoniana* which killed the trees was observed in nurseries and landscape plantings near Seattle (USA). The causal agent was determined as *Phytophthora lateralis* in 1943. In 1952 first attacks of *Chamaecyparis lawsoniana* trees in the forest could be observed in the USA. Today *P. lateralis* is widely distributed in western North America although it has not been confirmed in other parts of the continent.
In Europe *P. lateralis* was detected for the first time on *C. lawsoniana* in a French nursery in 1999. There were no further findings until 2005 when the pathogen was isolated from diseased *Chamaecyparis* plants for planting in a nursery in the Netherlands. Since 2005 the pathogen has also been detected on several *C. lawsoniana* hedges in France. In 2010 new findings were reported from The Netherlands and for the first time from Scotland.

Geographical distribution

North America: Canada (British Columbia), USA (California, Oregon, Washington)

Europa:
- France 1999 (nursery, only a single detection), 2005, 2009 (hedges, Bretagne); Status: detected, not established
- Netherlands 2005 (nursery), status: detected, not established; 2010 (nursery), status: transient, under eradication
- United Kingdom (Scotland) 2010 (park), status: present under eradication

Eurasia:
- Taiwan 2008 (in soil of a park with asymptomatic *Chamaecyparis obtusa* var. *formosana*)

Host range

- *Chamaecyparis lawsoniana* (main host, highly susceptible)
- *Taxus brevifolia* (less susceptible, death of trees was only observed in the USA in areas with infected *Chamaecyparis lawsoniana*)

Disease symptoms (Fig.1)

Root rot, cambium necrosis starting at the stem base, bleeding, needle discoloration, death of the plants.

Attention: Disease symptoms are not specific only for *P. lateralis*! To specify the cause of the disease samples must be examined in the laboratory.

Biology/Morphology (Tab. 1, Fig. 2)

- First description by Tucker and Milbrath (1942)
- *P. lateralis* belongs to morphological group V (Stamps et al., 1990). It is genetically closely related to *P. hibernalis* and *P. ramorum*

Specifics: *P. lateralis* is suspected not only to be soilborne but also to be airborne because sporangia can be caducous under specific conditions (Everett Hansen, personal communication)

Table 1: Morphological characteristics of *Phytophthora lateralis*

	According to Erwin & Ribeiro (1996)	According to Gallegly & Hong (2008)	Isolate BBA 368 on Carrot Piece Agar (n = 50)
Vegetative growth:			
Temperature (°C)			
Minimum	3	—	2
Optimum	20	—	20
Maximum	<26	25	25
Growth rate at optimum temperature (mm/24 h):	—	—	1.7
Sporangia	nonpapillate noncaducous ovate, obovate, obpyriform, often elongate or distorted in shape	nonpapillate noncaducous mostly elipsoid	nonpapillate noncaducous mostly ovate-elipsoid, often elongate in shape
Length x width (range)	20 - 60 x 2-20	50 x 25	44 - 68 x 24 - 36
Length x width (Ø)	26 x 15	—	54.6 - 28.4
Length : width (range)	1.6 - 1.91 : 1	—	1.5 - 2.2 : 1
Length : width (Ø)	1.71 : 1	—	1.9 : 1
Sporangiphores	simple sympodial	simple simpodial	simple simpodial
Chlamydospores	terminal or intercalary cinnamon brown when produced in cedar foliage agar	lateral, terminal, intercalary, cinnamon brown when mature	lateral, terminal, intercalary cinnamon brown when mature
Diameter (range, µm)	20 - 77	30 - 50	32 - 60
(Ø, µm)	40	—	47.8
Gametangia (rarely observed on agar media)	homothallic	homothallic	none produced
Oogonia	smooth, spherical and terminal	spherical	—
Diameter (range, µm))	33 - 50	31 - 55	
(Ø, µm)	—	—	
Antheridia	paragynous	paragynous	—
Length x width (range, µm)	12 - 18 x 13 - 16	—	
Length x width (Ø, µm)	—	—	
Oospores	plerotic, pigmented (colour depends on the medium)	plerotic, pigmented (colour depends on the medium)	—
Diameter (range, µm)	28 - 46	28 - 50	
(Ø, µm)	40	—	
Wall thickness (µm)	6	5 - 6	

— = no data available

Diagnosis

- **Direct Isolation**
  Easy with samples from the roots and from the stem base, although is slow growing.
  Attention: Selective media with hymexazol can suppress *P. lateralis*! (Everett Hansen, personal communication)

- **Bait test for soil and water**
  - With needles of *C. lawsoniana* as baits
  - Studies with Rhododendron leaves as baits are in progress at JKI-GF

- **Serological methods (e.g. on site tests)**
  There are references telling that genus specific antibodies in commercially available test kits can detect *P. lateralis* in infected plant samples (Lane et al. 2003, Kox et al. 2007).

- **Molecular methods (PCR)**

Primer specific for *P. lateralis*	**Cross reaction with** according to the literature	according to studies at JKI-GF*
Platf-Platr[1] Ylat3F-Ylat2R[2]	*P. ramorum*[1] none[2]	*P. ramorum* none
Primer specific for *P. ramorum*	**Cross reaction with** according to the literature	according to studies at JKI-GF**
Phyto1-4 / Phyto2-3[3]	*P. lateralis, P. cambivora, P. syringae, P. hibernalis*[4,5,6]	*P. lateralis, P. cambivora, P. gonapodyides, P. megasperma, P. pseudosyringae* with a DNA concentration >50 - 100pg/µL
PramF1-PramR1[7]	none[7]	*P. lateralis* with a DNA concentration >100pg/µL
Ypram4F- Ypram3R[8]	none[8]	none
FMPr-1a-FMPr-7[9]	none[9]	none
Primer specific for *P. kernoviae*	**Cross reaction with** according to the literature	according to studies at JKI-GF*
Yptc3F-Yptc 4R[7]	none[7]	none
1 – Winton & Hansen, 2001 2 – Schena et al., 2008 3 – Davidson et al., 2003 4 – Bloomquist et al., 2005 5 – Levy & Mavrodieva, 2003 6 – Blomquist & Kubisiak, 2003 7 – Lane et al., 2003 8 – Schena et al., 2006 9 – Martin et al. 2004 — = no information		Tested *Phytophthora* species (studies will be continued): * *P. cactorum, P. cambivora, P. cinnamomi, P. cryptogea, P. drechsleri, P. hibernalis, P. kernoviae, P. quercina, P. ramorum* ** see * and *P. boemeriae, P. capsici, P. citrophthora, P. gonapodyides, P. megasperma, P. nicotianae, P. pseudosyringae*

- **Recommendation of JKI**
  - Examination of samples with at least two different diagnostic techniques, e.g. for plant samples: Direct isolation and PCR
  - Determination of the *Phytophthora* species in pure agar cultures by morphology, by sequence analysis and/or PCR.

  Attention: The morphological characteristics of *P. lateralis* can be easily mistaken for other *Phytophthora* species, e.g. *P. cinnamomi*, *P. drechlseri/cryptogea* and *P.* species "Pg chlamydo".

- **Help with diagnosis**
  Dr. Sabine Werres
  sabine.werres@jki.bund.de

What to do in case plants are suspected to be infected?

Contact your responsible authorities (in Germany: plant protection services; address list see

http://www.jki.bund.de/de/startseite/unser-service/linksammlung.html

Risk analysis

For United Kingdom (2006):

http://www.fera.defra.gov.uk/plants/plantHealth/pestsDiseases/documents/lateralis.pdf

Literature sourced used

1. Anonymous. EPPO Reporting Service 2010/032 http://archives.eppo.org/EPPOReporting/2010/GGTSPU-styx2.bba.de-17806-7486152-DAT/Rse-1002.pdf
2. Anonymous. EPPO Reporting Service: 2011/026, 2011/027, 2011/028, 2011/029 http://www.eppo.org/PUBLICATIONS/reporting/reporting_service.htm
3. Blomquist C., Kubisiak T., 2003. Laboratory diagnosis of Phytophthora ramorum from field samples. APS Sudden Oak Death Online Symposium. 21 April - 12 May 2003.
4. Bloomquist C., Irving T., Osterbauer N., Reeser P, 2005. Phytophthora hibernalis: A new pathogen on Rhododendron and evidence of cross amplification with two PCR detection assays for Phytophthora ramorum. Plant Health Progress doi:10.1094/PHP-2005-0728-01-HN
5. Brasier C. M., Vettraino A. M., Chang T. T., Vannini A., 2010. Phytophthora lateralis discovered in an old growth Chamaecyparis forest in Taiwan. Plant Pathology Doi: 10.1111/j.1365-3059.2010.02278.x http://www3.interscience.wiley.com/journal/123304084/abstract?CRETRY=1&SRETRY=0
6. Davidson J.M.; Werres S., Garbelotto M.; Hansen M., Rizzo D.M., 2003. Sudden Oak Death and Associated Diseases Caused by Phytophthora ramorum. Plant Management Network http://www.plantmanagementnetwork.org/pub/php/diagnosticguide/2003/sod/
7. DeNitto G.A., Kliejunas J.T., 1991. First report of Phytophthora lateralis on Pacific yew. Plant Disease, 75(9), p 968.
8. Erwin D.C., Ribeiro O.K., 1996. Phytophthora lateralis. In: Phytophthora diseases worldwide. American Phytopathological Society, St. Paul (US), pp 365-367.
9. Gallegly M., Hong C., 2008. Phytophthora – Identifying Species by Morphology and DNA Fingerprints. The American Phytopathological Society, St. Paul, Minnesota USA, pp.86-87
10. Hansen E.M., Streito J.C., Delatour C., 1999. First confirmation of Phytophthora lateralis in Europe. Plant Disease, 83(6), p 587.
11. Hansen E.M., Goheen D.J., Jules E.S., Ullian B., 2000. Managing Port-Orford-Cedar and the introduced pathogen Phytophthora lateralis.Plant Disease, 84(1), 4-14.
12. Kox L.F.F.; van Brouwershaven I.R., van de Vossenberg B.T.L.H., van den Beld H.E., Bonants P.J.M., de Gruyter J., 2007. Source Diagnostic values and utility of immunological, morphological, and molecular methods for in planta detection of Phytophthora ramorum. Phytopathology 97, 1119-1129.
13. Lane C.R., Barnes A.V., Beales P.A., Griffin R.L., Hughes K.J.D., Inman A.J., Townend V.C., Brasier C.M., Webber J.F., 2003. First report of Phytophthora ramorum in the UK. ICPP Paper 19.35, 8th International Congress of Plant Pathology, Christchurch, New Zealand, 2-7th February 2003, pp 265. ISBN 086476 151-1
14. Levy L., Mavrodieva V., May 2003. Evaluation of the PCR detection and DNA isolation methods for use in the Phytophthora ramorum National Pilot Survey (laboratory manual). http://ceris.purdue.edu/napis/pests/sod/natplan/may03-pcr.doc .
15. Martin F.N., Tooley P.W., Blomquist C.,2004. Molecular Detection of Phytophthora ramorum, the causal Agent of Sudden Oak Death in California, and the Two Additional Species Commonly Recovered from Diseased Plant Material. Phytopathology 94, 621-631.
16. Murray M.S.; Hansen E.M., 1997. Susceptibility of Pacific Yew to Phytophthora lateralis. Plant Disease, 81(12), 1400-1404.
17. Robin C, Piou D, Feau N, Douzon G, Schenck N, Hansen EM (2011) Root and aerial infections of Chamaecyparis lawsoniana by Phytophthora lateralis: a new threat for European countries. Forest Pathology (in press). Article first published online: doi: 10.1111/j.1439-0329.2010.00688.xSchena L., Hughes K.J.D., Cooke D.E.L., 2006. Detection and quantification of Phytophthora ramorum, P. kernoviae, P. citricola and P. quercina in symptomatic leaves by multiplex real-time PCR. Molecular Plant Pathology, 7 (5), 365-379
18. Schena L., Duncun J.M., Cooke, D.E.L., 2008. Development and application of a PCR-based „molecular tool box" for the identification of Phytophthora species damaging forests and natural ecosystems. Plant Pathology, 57, 64-75
19. Smith I.M., 2009. Phytophthora lateralis. EPPO Bulletin 39(1), 43-47 http://www3.interscience.wiley.com/journal/122250243/abstract?CRETRY=1&SRETRY=0

Literature sourced used

20. Stamps D.J., Waterhouse G.M., Newhook F.J., Hall G.S. 1990. Revised Tabular key to the Species of Phytophthora. Mycol.Pap. 162. CAB International, Commonwealth Mycological Institute. Kew, Surrey, England.
21. Tucker C. M., Milbrath J.A. 1942. Root rot of Chamaecyparis caused by a species of Phytophthora. Mycologia. 34: 94-103
22. Winton L.M., Hansen E.M., 2001. Molecular diagnosis of Phytophthora lateralis in trees, water, and foliage baits using multiplex polymerase chain reaction. Forest Pathology, 31(5), 275-283.

Internet

- USDA. Forest Service. Pacific Northwest Region. Ecology and management of Port-Orford-cedar. http://www.fs.fed.us/r6/siskiyou/poc1.htm http://www.fs.fed.us/r6/nr/fid/fidls/poc.htm
- USDA. Forest Service. Pacific Northwest Region. Port-Orford-Cedar root disease by Roth, L.W.; Harvey Jr, R.D., Kliejunas, J.T. http://www.fs.fed.us/r6/nr/fid/fidls/poc.htm
- Resistance breeding program (*Chamaecyparis lawsoniana*): http://www.fs.fed.us/r6/dorena/publications/poc

Acknowledgement

We thank Everett Hansen (USA), Cécile Robin and Dominique Piout (France) for the symptom photos and for information. We also would like to thank Everett Hansen for his helpful information on diagnosis for *P. lateralis* and for the reference isolate. We are gratefull for the excellent technical assistance of Julia Hauffe, Anne Haverlah and Petra Mitschke.

Authors

Dr. Sabine Werres / Dr. Stefan Wagner
Julius Kühn-Institut, Research Centre for Cultivated Plants (JKI)
Institute for Plant Protection in Horticulture and Forestry (GF)
Messeweg 11/12
D – 38104 Braunschweig
Germany

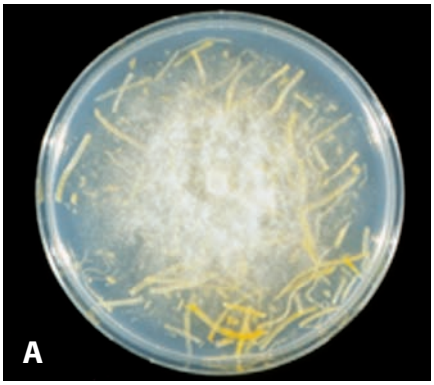
sabine.werres@jki.bund.de

Figure 1: Disease symptoms of *P. lateralis* on *Chamaecyparis lawsoniana*

Photos:
Dominique Piou, INRA, Frankreich

Photos:
Everett Hansen, Oregon State University, USA

Figure 2: *Phytophthora lateralis* BBA 368



A Colony pattern on carrot piece agar (incubation in the dark at 20°C)
B Hyphal swelling and chlamydospores
C Lateral chlamydospore
D Intercalary chlamydospores
E Sporangium, chlamydospore, empty sporangium

F Chlamydopsore and sporangium after zoospore release
G Sporangia of normal shape and size on simple sympodial sporangiophores
H Sporangium after evacuating zoospores
I Elongated sporangium (from left to right):
- starting to develop zoospores
- immediately before zoospore release
- releasing zoospores