Phytophthora on Castanea sativa Mill. (sweet chestnut)
Imprint

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Managing Editor: Dr. Olaf Hering, Information Centre and Library
Julius Kühn-Institut
Königin-Luise-Str. 19
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Importance of *Castanea sativa*

European (or sweet) chestnut (*Castanea sativa* Mill.) is the only native species of the genus *Castanea* in Europe. The natural distribution range of *C. sativa* is probably located in the region of Asia Minor jutting out across the Black Sea region to the western Caucasus. Currently, this species is widely distributed from Western to Eastern Europe (http://www.discoverlife.org) in areas with mean annual precipitation higher than 600 mm, short drought season, and slightly acidic soils (pH 4.5-6.5) (Urbisz & Urbisz, 2007).

In Europe, the cultivation of *C. sativa* has a long tradition (Conedera et al., 2004). This species has a great rural economic value due to its edible fruits and excellent wood with optimal technological characteristics. Moreover, chestnut stands play an important agro-ecological role, e.g. protection against fire and erosion, habitat for wildlife, and recreation areas.

For commercial nut production, different cultivars (cultivated varieties) have been developed, including hybrids between European and Japanese chestnut (*C. crenata*). Cultivars differ in many characteristics as, for example, size and organoleptic properties of the nuts.

**Phytophthora species**

From European chestnut trees in forests and nurseries affected by ink disease several *Phytophthora* species have been isolated, either from tissue of symptomatic trees, from the soil, or from streams draining the stands. However, *P. cambivora* and *P. cinnamomi* are the two species most commonly associated with the disease in Europe and considered the most pathogenic to *C. sativa*.

<table>
<thead>
<tr>
<th><em>Phytophthora</em> species</th>
<th>Recovered from</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>cambivora</em></td>
<td>Symptomatic trees, soil</td>
<td>Akilli et al., 2012; Černý et al., 2008; Vettraino et al., 2001; Vettraino et al., 2005</td>
</tr>
<tr>
<td><em>cinnamomi</em></td>
<td>Symptomatic trees, soil</td>
<td>Akilli et al., 2012; Crandall et al., 1945, Vettraino et al., 2001; Vettraino et al., 2005</td>
</tr>
<tr>
<td><em>cactorum</em></td>
<td>Soil</td>
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<td><em>cryptogea</em></td>
<td>Symptomatic trees, soil</td>
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<td><em>gonapodyides</em></td>
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<td><em>megasperma</em></td>
<td>Soil</td>
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<tr>
<td><em>nicotianae</em></td>
<td>Soil</td>
<td>Vannini et al., 2010</td>
</tr>
<tr>
<td><em>plurivora</em>(^1)</td>
<td>Soil</td>
<td>Akilli et al., 2012; Vettraino et al., 2001, Vettraino et al., 2005</td>
</tr>
<tr>
<td><em>pseudosyringae</em></td>
<td>Symptomatic trees, soil</td>
<td>Pintos Varela et al., 2007; Scanu et al., 2010; Vannini et al., 2010</td>
</tr>
<tr>
<td><em>syringae</em></td>
<td>Soil</td>
<td>Vettraino et al., 2005</td>
</tr>
</tbody>
</table>

\(^1\)Previously reported as *P. citricola*

Most *Phytophthora* species isolated from European chestnut stands affected by ink disease have a wide host range. Therefore, it cannot be excluded that they infect other tree species in the surroundings.
Disease symptoms (see figures)

Ink disease caused by *Phytophthora* species is one of the most destructive diseases affecting European chestnut (Vannini & Vettraino, 2001). It causes root and collar rot of adult trees and of seedlings in nurseries, plantations, and forests. Symptoms and dieback occur both on single plants and in groups of trees. The most common symptoms are:

**Crown:** chlorotic leaves reduced in size, thinning of the crown, and immature husks remaining on the tree after leaf-fall. Wilting can be followed by a quick or a progressive death depending on the environmental conditions

**Stem:** flame shaped dark necrosis evident on the root collar under the bark. On young trees the flame shape is visible as depressed, slightly cracked areas at the base of the stem without debarking. Cortical lesions can be associated to black exudates which gave the name to the disease

**Roots:** root rot

Possibility of Symptom Confusion

Symptoms caused by the ink disease can be easily distinguished from those induced by *Cryptonectria parasitica*, the causal agent of chestnut blight (Heiniger & Rigling, 1994). Unlike Phytophthoras, *C. parasitica* is mostly associated with extensive necrosis (cankers) of the bark of trunk and branches and does not affect the roots. The plant part distal to the canker wilts and dies and below the cankers trees typically produce numerous epicormic shoots. Adventitious shoots may also develop from the basis of chestnut trees killed by *C. parasitica* but not by Phytophthoras.

Disease development

Usually, the first symptoms are visible in the crown, followed sometimes by bleeding, mainly at the stem base.

In adult trees, disease symptoms can develop over years and can remain undetected at the beginning of the disease. In contrast, infected seedlings in nurseries or plantations undergo a rapid or gradual wilting of the leaves.

The impact of ink disease depends not only on host susceptibility but also on the environmental conditions influencing the spread and survival of the pathogens as well as host predisposition. High precipitation (above 1000 mm/year) could be a useful index in order to classify areas at risk for ink disease.

*P. cinnamomi* is a thermophilic species (Benson, 1982) and its winter survival is severely endangered by cold temperatures. Global warming could result in a better survival of the pathogen and, thus, in a higher impact of ink disease.
It is not possible to identify a *Phytophthora* infection only by disease symptoms. Different diagnostic techniques like direct isolation, molecular and serological methods help to identify *Phytophthora* as the cause of the tree disease and to specify the *Phytophthora* species. Information on *Phytophthora* diagnosis on trees or in general are given for example in http://forestphytophthoras.org/key-to-species, http://www.phytophthoradb.org, http://phytophthora-id.org/ and in Martin et al. (2012). Please contact your national authorities (see next chapter) for help with diagnosis.

**What to do in case trees are suspected to be infected?**

Contact your responsible national authorities, for example:

**Austria:**
- Bundesforschungs- und Ausbildungszentrum für Wald, Naturgefahren und Landschaft (BWF)  
  Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW)  
  Seckendorff-Gudent-Weg 8, 1131 Vienna, Austria; [http://www.bfw.ac.at/](http://www.bfw.ac.at/)
- Österreichische Agentur für Gesundheit und Ernährungssicherheit  
  Austrian Agency for Health and Food Safety, Institute for Sustainable Plant Production  
  Spargelfeldstraße 191, 1220 Vienna; [http://www.ages.at](http://www.ages.at)

**Belgium:**
- Département Sciences du Vivant, Centre Wallon de Recherches Agronomiques  
  Life Sciences Department, Walloon Agricultural Research Centre  
  Rue de Lioux 4, B-5030 Gembloux;  
  Anne CHANDELIER | a.chandelier@cra.wallonie.be
- Instituut voor Landbouw- en Visserijonderzoek (ILVO), Eenheid Plant -Gewasbescherming  
  Institute for Agricultural and Fisheries Research, Plant Sciences Unit – Crop Protection - Gewasbescherming  
  Burg. van Gansberghelaan 96 bus 2, 9820 Merelbeke  
  Kurt HEUNGENS | kurt.heungens@ilvo.vlaanderen.be

**Bulgaria:**
- Българска Агенция по безопасност на храните:  
  Централна лаборатория по карантина на растенията  
- Агроbióинститут, Селскостопанска Академия  
  бул 8, Драган Цанков № 8, София 1164  
  Biotic Stress Group, AgroBioInstitute, Agricultural Academy  
  8 Dragan Tsankov Blvd., 1164 Sofia  
  Славчо Славов, sbslavov@abi.bg  
  Slavtcho SLAVOV | sbslavov@abi.bg

**Czech Republik:**
- Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, v.v.i  
  The Silva Tarouca Research Institute for Landscape and Ornamental Gardening, Publ. Res. Institute  
  Květnové náměstí 391, Průhonice, 252 67, Praha západ  
  Matěj PANEK | panek@vukoz.cz
Denmark:
- NaturErhvervstyrelsen, Ministeriet for Fødevarer, Landbrug og Fiskeri
  The Danish AgriFish Agency, http://www.naturerhverv.fvm.dk
- Skov & Landskab, Det Biovidenskabelige Fakultet, Københavns Universitet
  Forest and Landscape, Faculty of Science, University of Copenhagen
  http://www.sl.life.ku.dk

Finland:
- Elintarviketurvallisuusvirasto Evira, Kasvinterveysyksikkö
  Finnish Food Safety Authority Evira, Plant Health
  Mustialankatu 3, FI-00790 Helsinki
  http://www.evira.fi/portal/fi/kasvit/viljely JA_Tuotanto/metsanviljely/valvonta/
- Metsäntutkimuslaitos
  Finnish Forest Research Institute
  P.O. Box 18, FI-01301 Vantaa
  Anna RYTKÖNEN | anna.rytkonen@metla.fi
- Maa- ja elintarviketalouden tutkimuskeskus MTT
  Agrifood Research, MTT
  FI-31600 Jokioinen
  Päivi PARIKKA | paivi.parikka@mtt.fi

France:
- Services Régionaux de l'Alimentation (SRAL) des Directions Régionales de l'Alimentation, de l'Agriculture et de la Forêt (DRAAF)
  Regional Plant Protection services
  http://agriculture.gouv.fr/suivi-de-la-sante-des-forets
  http://agriculture.gouv.fr/services-deconcentres
- Laboratoire de Santé végétaux, unite de Mycologie, ANSES
  French Agency for Food, Environmental and Occupational Health & Safety (ANSES)- Plant Health Laboratory, unit of mycology
  Domaine de Pixérécourt Bat E., 54220 Malzéville, France; http://www.anses.fr/PNTC01.htm;
  Nathalie SCHENCK | Nathalie.schenck@anses.fr
  Renaud IOOS | renaud.ioos@anses.fr
- Pôle interrégionaux du Département de la santé des forêts:
  Regional forest health survey organisation:
  http://agriculture.gouv.fr/departement-de-la-sante-des-forets

Germany:
- Pflanzenschutzdienstellen der Bundesländer, Adressenliste siehe:
  regional plant protection services, address list see: http://www.jki.bund.de/de/startseite/unser-service/linksammlung.html
- Julius Kühn Institut – Bundesforschungsanstalt für Kulturpflanzen (JKI), Institut für Pflanzen- schutz in Gartenbau und Forst (JKI-GF)
  Julius Kühn Institut - Federal Research Center for Cultivated Plants (JKI), Institute for Plant Protection in Horticulture and Forestry (JKI-GF)
  Messeweg 11/12, 38104 Braunschweig, Germany
  http://www.jki.bund.de
  Sabine WERRES | sabine.werres@jki.bund.de
Greece:
- Ινστιτούτο Δασικών Ερευνών, 570 06 Βασιλικά, Θεσσαλονίκη, Ελλάς
  Forest Research Institute, 570 06 Vassilika, Thessaloniki, Greece
  http://www.fri.gr, info@fri.gr
- Ινστιτούτο Μεσογειακών Δασικών Οικοσυστημάτων & Τεχνολογίας Δασικών Προϊόντων,
  Τέρμα Άλκμάνος, 115 28 Ιλίσα, Αθήνα, Ελλάς
  Institute of Mediterranean Forest Ecosystems & Forest Products Technology,
  Terma Alkmanos, 115 28 Ilisia, Athens, Greece
  http://fria.gr, tsop@fria.gr

Hungary:
- Megyei Kormányhivatalok Növény- és Talajvédelmi Igazgatóságai
  Regional offices of NFCSO, Directorate of Plant Protection and Soil Conservation
  http://www.nebih.gov.hu/elerhetosegek
- MTA ATK Növényvédelmi Intézet
  Plant Protection Institute, Centre for Agricultural Research, Hungarian Academy of Sciences
  Herman Ottó u. 15, H-1022 Budapest, Hungary;
  József BAKONYI | bakonyi.jozsef@agrar.mta.hu

Ireland:
- Department of Agriculture, Food and the Marine, Horticulture and Plant Health Division
  Backweston Agri-Campus, Celbridge, Co. Kildare, Ireland
  oliver.mcevoy@agriculture.gov.ie

Italy:
- COSVIR XI - Servizio fitosanitario centrale
  Italian Phytosanitary Service
  cosvir11@pec.politicheagricole.gov.it, http://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/2341
- Dipartimento per la Innovazione nei sistemi Biologici, Agroalimentari e Forestali, Università
degli Studi della Tuscia
  DIBAF-Department for Innovation in Biological, Agro-food and Forest systems, University of Tuscia
  Via S. Camillo de Lellis snc
  01100 Viterbo- Italy
  Anna Maria VETTRAINO | vettrain@unitus.it
- Dipartimento di Gestione dei Sistemi Agroalimentari e Ambientali
  Sezione Patologia vegetale, Università di Catania
  Department of Agri-food and Environmental Systems Management, University of Catania
  Via Santa Sofia, 100 95123 Catania Italy
  Santa Olga CACCIOLA | olgacacciola@unict.it

Latvia:
Valsts augu aizsardzibas dienests
Slovenia:
Kmetijski inštitut Slovenije
Agricultural Institute of Slovenia
Hacquetova 17, 1001 Ljubljana, Slovenia
Alenka MUNDA | alenka.munda@kis.si

Spain:
Grupo de Investigación en Hongos Fitopatógenos, Instituto Agroforestal Mediterráneo, Universitat Politècnica de València
Polytechnic University of Valencia (UPV), Mediterranean Agroforestal Institute (IAM), Research group on Plant Pathogenic fungi
Camino de Vera s/n, 46022 Valencia, Spain
Ana Mª PÉREZ-SIERRA | aperesi@eaf.upv.es

Sweden:
SLU, Institutionen för Skoglig Mykologi och Växtpatologi
Dept. of Forest Mycology and Plant Pathology
Box 7026, 750 07 Uppsala
Jan STENLID | Jan.Stenlid@slu.se

Switzerland:
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL)
Competence Center of Forest Protection (WSL)
http://www.wsl.ch/dienstleistungen/waldschutz/index_EN

Turkey:
- Çankırı Karatekin Üniversitesi, Fen Fakültesi, Biyoloji Bölümü, Çankırı, Türkiye
Çankırı Karatekin University, Faculty of Science, Department of Biology, Çankırı, Turkey
Seçil AKILLI | secilakilli@gmail.com
- Ankara Üniversitesi, Ziraat Fakültesi, Bitki Koruma Bölümü, 06100, Kalaba, Ankara, Türkiye
Agricultural Faculty of Ankara University, Department of Plant Protection 06100, Kalaba, Ankara, Turkey
Salih MADEN | salihmaden@hotmail.com

United Kingdom:
- Tree Health Diagnostic & Advisory Service, Forest Research, Northern Research Station, Roslin, Midlothian EH25 9SY; ddas.nrs@forestry.gsi.gov.uk
- Tree Health Diagnostic & Advisory Service, Forest Research, Alice Holt Lodge, Wrecclesham, Farnham, Surrey GU10 4LH; ddas.ah@forestry.gsi.gov.uk
**Management and control**

Water (i.e. rainfall, dew deposition, and irrigation) is the main environmental factor favoring the spread of ink disease. Therefore, disease management requires, whenever possible, an accurate water management. For example, on sites subjected to waterlogging, drainage and aeration of the soil should be improved (Turchetti & Maresi, 2008). Silvicultural (e.g. reduction of competition among trees) and horticultural (e.g. optimum nutrition) practices aiming to improve health of the trees have also shown to be beneficial for controlling ink disease. To reduce the spread of *Phytophthora* species through contaminated soil, the access to infected chestnut stands may be limited, especially during wet periods.

In Italy, the use of an integrated control protocol including the injection of potassium phosphonate water solution in trunks of healthy or slightly infected chestnut trees has proven to prevent infection or reduce the severity of symptoms (Gentile et al., 2009; Vettraino et al., 2010). Before using any kind of chemicals please contact your national authorities (e.g. plant health service).

In several European countries, hybridization programs have been initiated in order to select hybrids (using *C. sativa*, *C. crenata* and *C. mollissima*) that are highly tolerant to ink disease (Ramos Guedes-Lafargue et al., 2005). The most common French hybrid cultivars are “Marsol” (CA07), “Maraval” (CA74), “Ferosacre” (CA90), “Marigoule” (CA15) and “Marlhac” (CA118) (Salesses et al., 1993).

**EPPO quarantine recommendation**

The *Phytophthora* species associated with ink disease of European chestnut are not listed on the European and Mediterranean Plant Protection Organisation (EPPO) lists (http://www.eppo.int/QUARANTINE/quarantine.htm).
Literature used


**Links to further information**


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**Authors**

Simone PROSPERO¹, Andrea VANNINI², Anna Maria VETTRAINO²

¹ Swiss Federal Research Institute WSL, Zuercherstrasse 111, CH-8903 Birmensdorf, Switzerland; simone.prospero@wsl.ch

² DIBAF-University of Tuscia, S.Camillo de Lellis, 01100 Viterbo, Italy; vettrain@unitus.it
Disease symptoms of *Phytophthora* on *Castanea sativa* (sweet chestnut)

**Left:** Chestnut coppice stand heavily affected by ink disease (*P. cambivora*) (1)

**Right:** Thinned crown of a young chestnut tree (1)

Dark necrosis on the basis of a young chestnut tree (2)

Photos: (1) – S. PROSPERO, (2) – A.M. VETTRAINO