NOBANIS –Invasive Alien Species Fact Sheet

Melampsoridium hiratsukanum

Authors of this fact sheet: Jarkko Hantula[1] and Markus Scholler[2],
[1]Finnish Forest Research Institute, Vantaa Research Unit, PO Box 18, 01301 Vantaa, Finland; +358 10 211 2620; jarkko.hantula@metla.fi,
[2]Staatliches Museum f. Naturkunde, Erbprinzenstr. 13, D-76133 Karlsruhe, Germany; phone: +49 (0)721 175 2810; scholler@naturkundeka-bw.de

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Species description

Scientific names: *Melampsoridium hiratsukanum* S. Ito ex Hirats. f., Pucciniastraceae, Pucciniales (rust fungi)
Synonyms: None
Common names: Alder rust (GB), lepänruoste (FI), Erlenblatt-Rost (DE), ellerust (DK), Hariliku lepa leherooste (EE).

Fig. 1 *Melampsoridium hiratsukanum* on *Alnus incana*, photo by Metla/Erkki Oksanen.

Fig. 2 Spermogonia and aecia of *Melampsoridium hiratsukanum* on *Larix dahurica* after artificial infection with basidiospores, photo by Metla/Timo Kurkela.

Species identification
A combination of features of the urediniospores (size, echinulation, position of germ pores) can be used to tell the species from similar species in Europe. These are *Melampsoridium alni* (Thüm.) Dietel, *Melampsoridium betulinum* (Pers.) Kleb. and *M. carpini* (Nees) Dietel. The three species were found either on *Alnus* or on related Betulaceae in Europe (Arthur 1962, Kuprevich and Tranzschel 1957, Gäumann 1959, Kaneko and Hiratsuka 1981, Roll-Hansen and Roll-Hansen 1981, Wilson and Henderson 1966, Riegler-Hager *et al.* 2003, Hantula et al., 2009).

Native range
Melampsoridium hiratsukanum occurs naturally in Eastern Asia on several *Alnus* and *Larix* spp. (Kuprevich and Tranzschel 1957, Hiratsuka *et al.* 1992) but has been introduced all over the Americas (*e.g.* for more details see Riegler-Hager *et al.* 2003, Hantula et al., 2012).

Alien distribution

History of introduction and geographical spread
Since *M. hiratsukanum* is established in Europe and has spread to form new populations within the past 10 years, it is a neomycete according to the definition of Kreisel and Scholler (1994) and Scholler (1999). The first records of the species from Europe were found in Estonia, Lithuania (Põldmaa 1997) and Latvia (E. Vimba, pers. comm.) in 1996 on *A. incana*. In Finland it was first recorded in 1997 (Kurkela *et al.* 1999), as well as in Poland (Wołczańska 1999, Piątek *et al.* 2001, Mułenko *et al.* in press), Austria (Riegler-Hager et al. 2003) and Germany (Sachsen-Anhalt, Dübener Heide, Hohenlubast, 3.10.1997, on *Alnus incana*; voucher specimen in herbarium GLM no. 055053, leg. H. Jage). In Norway (Gjaerum *et al.* 2004) and Hungary (Szabo 2002) in 2001 and in Switzerland in 2002 (Meier *et al.* 2003) and in Denmark in 2004 (M. Gammelgaard pers. com. 2012), and finally in Slovakia (Mułenko *et al.*, 2006) and UK (Hantula et al., 2012). Possibly, the species is meanwhile established in all continental European countries where the two major hosts, *Alnus incana* and *A. glutinosa*, occur.

Pathways of introduction
The cause of the original introduction of this fungus to Europe is unknown. As mentioned above, the species is a native of Eastern Asia and found for the first time in the Baltic states. No continuous progress from Eastern Asia to Europe is documented and hardly possibly because there is no closed area of *Alnus* spp. in Eurasia (there are no alder populations east and west of the Ural). So it might be possible that the fungus has been introduced by man, *e.g.* over the Baltic sea in ships containing contaminated seedlings of ornamental (*Alnus* spp.) or forest trees (*Larix* spp.) from overseas.

Alien status in region
The spread of *M. hiratsukanum* through Europe seems to have been very rapid, but since the original dispersal in the late 1990s, the degree of rust infection has varied considerably from year to year (see also table 1). Thus, there seems to be no general trend in the frequency of the fungus from year to year in areas where it has been established. The species is common now probably all over eastern and central Europe. In the British Isles, the rust co-occurs with a native *M. betulinum*-related alder rust (Wilson and Henderson 1966, Hantula et al., 2012).

Country	Not found	Not established	Rare	Local	Common	Very common	Not known
Austria					X		
Belgium							X
Czech republic					X		
Denmark					X		
Estonia					X		
European part of Russia					X		
Finland					X		
Faroe Islands							X
Germany					X		
Greenland							X
Iceland							X
Ireland							X
Latvia					X		
Lithuania							X
Netherlands							X
Norway					X		
Poland					X		
Slovakia							X
Sweden					X		

Table 1. The frequency and establishment of *Melampsoridium hiratsukanum*, please refer also to the information provided for this species at www.nobanis.org/search.asp. Legend for this table: **Not found** –The species is not found in the country; **Not established** - The species has not formed self-reproducing populations (but is found as a casual or incidental species); **Rare** - Few sites where it is found in the country; **Local** - Locally abundant, many individuals in some areas of the country; **Common** - Many sites in the country; **Very common** - Many sites and many individuals; **Not known** – No information was available.

Ecology

Habitat description
Melampsoridium hiratsukanum can be found on the leaves of alder trees wherever they grow. The major host plant is *Alnus incana*, but *A. glutinosa* is also frequently infected. Humid weather conditions and proximity to larch trees seems to increase its frequency (personal observations in Finland by J. Hantula).

Reproduction and life cycle
Melampsoridium hiratsukanum is a biotrophic pathogen, with a macrocyclic host-alternating life cycle. Basidiospores infect young needles of *Larix*, the aecial host, in which developing mycelium forms spermogonia (spore state 0 forming pycniospores) and aecia (state I forming aeciospores). Aeciospores may infect the telial host, *Alnus* spp., but not other *Larix* needles. On *Alnus* leaves uredinia (state II forming urediniospores or summerspores) are repeatedly formed. This state is the major state for reproduction and dispersal and urediniospores are the only spores that infect the host they are formed on. At the end of the vegetation period, an overwintering state called telia (III) with thick-walled teliospores is formed. The next spring teliospores may germinate with a basidium (IV) to form haploid basidiospores after meiosis. Basidiospores may infect the aecial host (*Larix* spp.). A shortcut life cycle restricted to the telial host is known for many host-alternating rust fungi and it is assumed for *M. hiratsukanum* as well (Riegler-Hager *et al.* 2003).

The fungus has been found on the aecial host in Finland, it was able to produce aecia in artificial inoculations on all tested larch species (*Larix sibirica*, *L. decidua*, *L. dahurica*, *L. laricina*), and the most severe infections in Finland occur where introduced larch trees are grown (Hantula et al., 2009). In East Asia *L. dahurica* is known to serve as an aecial host (*e.g.* Hiratsuka *et al.* 1992). Provided that the fungus infects *Larix* in Europe, one of the reasons for the spread of the rust could be the widespread plantation of this aecial host. But the fungus may not necessarily need the aecial host to spread as could be documented for other host-alternating rust neomycetes in Europe (*Tranzschelia discolor*, *Uromyces silphii*). These species reproduce and propagate only by the help of urediniospores.

Dispersal and spread
As mentioned above, alder may be infected by aeciospores from larch or with urediniospores from alder individuals. In the latter case the fungus may have survived with mycelium in buds or with urediniospores. This second option is assumed for Austria, because the fungus has been found numerous times on alder, but not a single time on Larch (Riegler-Hager *et al.* 2003). Both aeciospores and urediniospores may be good for long distance dispersal and re-appearance of the disease. The severity of disease as it is documented on *A. incana* for Austria (Riegler-Hager *et al.* 2003) and Hungary (Szabo 2002), however, is most probably a consequence of heavy urediniospore infection. Urediniospores are formed repeatedly over a long period and in great masses. In addition, short distance dispersal from tree to tree in alder stands may have supported the severity of the disease and its spread. The role of the aecial host (non-native *Larix* forest trees) in the life cycle, spread and dispersal of the rust species is almost unknown in Europe.

A study of dried herbarium specimens from Central Europe revealed, that almost only uredinia are formed on Alnus, even in late autumn. And if there are no telia, no basidia may be formed either and, consequently, no Larix infection with basidiospores is possible. Therefore we assume that the fungus predominantly exists in its non-sexual short version in most parts of Europe with spore transfer from Alnus to Alnus only (M. Scholler, pers. comm.).

Impact

Affected habitats and indigenous organisms
The species is a relatively aggressive pathogen especially on grey alder (*Alnus incana*). On the alternate host its effect is negligible. It may become a problem in alder nurseries and even in nature the rust may affect other organisms (mycorrhiza, insects) dependent on natural alder stands.

Melampsoridium hiratsukanum may compete with the native European *Melampsoridium* spp. which occur or may occur on alder leaves as well. These species, however, are naturally very rare and only few records exist from Europe. Of the leaf-inhabiting obligate-parasitic fungi other than rust fungi restricted to *Alnus* particularly *Taphrina spp*., various anamorphic Ascomycetes and the powdery mildew *Erysiphe penicillata* (Wallr.) Fr. may be concerned. In Europe, the last-named species is as common on *Alnus incana* as is *M. hiratsukanum*.

Genetic effects
No genetic effects have been reported.

Human health effects
No human health effects have been reported.

Economic and societal effects (positive/negative)
Alders are sometimes damaged strongly as it was reported from Hungary (Szabo 2002) and Austria (Riegler-Hager *et al.* 2003). In Austria the fungus was found in "copious quantity" on *A. incana*. Trees may already be defoliated in August and this may negatively influence the visual appearance and the functioning of the whole ecosystem. If nursery epidemics occur, the rust may cause problems to the production of alder seedlings.

Management approaches

Prevention methods
Growing natural forest trees. The spread of the rust to new geographical areas by the plant trade should be avoided.

Eradication, control and monitoring efforts
There are no eradication, control or monitoring efforts. If it is a problem in seedling production, eliminating infected plants or basidiomycete-specific fungicides should be useful.

Information and awareness
The life cycle and relative aggressiveness of *M. hiratsukanum* should be considered when tree species are selected for both economic and/or ornamental usage. If alder is planned to be grown, no susceptible larch species should be in close vicinity.

Knowledge and research
The genetic differences of the rusts on alder are being studied in the Finnish Forest Research Institute and its collaborators.

References and other resources

Contact persons

Thomas Kirisits (AT) Institut für Forstentomologie, Forstpathologie und Forstschutz, IFFF, Dept. f. Wald- und Bodenwissenschaften, Univ. f. Bodenkultur Wien, Hasenauerstraße 38, 1190 Wien, E-mail: thomas.kirisits@boku.ac.at

Mgr. Karel Černý (CZ), Department of Phytopatology, VUKOZ, Květnové náměstí 391, 252 43 Průhonice, cerny@vukoz.cz

Markus Scholler (DE) Staatliches Museum f. Naturkunde, Erbprinzenstr. 13, D-76133 Karlsruhe, Germany; phone: +49 (0)721 175 2810, E-mail: scholler@naturkundeka-bw.de

Iben M. Thomsen (DK) Institut for Geovidenskab og Naturforvaltning, Københavns Universitet Rolighedsvej 23, 1958 Frederiksberg C, Phone +4535331664 or -4522270500, E-mail: imt@life.ku.dk

Kadri Põldmaa (EE), University of Tartu, Institute of Ecology and Earth Sciences, Vanemuise 46 EE51014 Tartu, Estonia, Tel.: +372 7376173, E-mail: kadri.poldmaa@ut.ee

Jarkko Hantula (FI) Finnish Forest Research Institute, Vantaa Research Unit, PO Box 18, 01301 Vantaa, Finland, Phone +35810211 2620, E-mail: jarkko.hantula@metla.fi

Halldór Sverrisson (IS) Agricultural University of Iceland Keldnaholti, 112 Reykjavik, Iceland, Tel.: (354) 433 5000, E-mail: halldors@lbhi.is

Edgars Vimba (LV) University of Latvia, Department of Botany and Ecology, 4 Kronvalda Boulevard, Riga, LV-1586, E-mail: evimba@lanet.lv

Marcin Piątek (PL) Department of Mycology, W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland, E-mail: mpiatek@ib-pan.krakow.pl

Pia Barklund (SE) Swedish University of Agricultural Sciences (SLU), Dep. of Forest Mycology and Pathology, P.O. Box 7026, SE 75007 Uppsala, Sweden., Phone +46 18 671874, E-mail: pia.barklund@mykopat.slu.se

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