Express – PRA[1)] for *Thekopsora minima* - Occurrence -

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Initiation: Occurrence of blueberry rust on blueberries (*Vaccinium corymbosum*) in a nursery in Lower Saxony

Express - PRA	***Thekopsora minima* P. Syd. & Syd. 1915**		
Phytosanitary Risk for Germany	**high** ☒	**medium** ☐	**low** ☐
Phytosanitary Risk for EU-MS	**high** ☒	**medium** ☐	**low** ☐
Certainty of Assessment	**high** ☐	**medium** ☒	**low** ☐
Conclusion	The fungus *Thekopsora minima* is endemic in eastern North America and Japan and is not yet established in Germany. In 2002, it presumably was found for the first time in the EU in Southwest Spain but was wrongly identified as the endemic *Pucciniastrum vaccinii* (*Naohidemyces vaccinii*). Up to now *T. minima* is neither listed in the Annexes of the Dir. 2000/29/EC nor by EPPO. *Thekopsora minima* infests the highbush blueberry *Vaccinium corymbosum* which is native to North America and various Rhododendrons and Azaleae as well as various further genera of Ericaceae. Two *Tsuga*-species are alternating hosts. It can be assumed that due to suitable climate conditions *Thekopsora minima* is capable to establish outdoors in Germany. An establishment in South European EU-Member States would also be possible. Due to its damage potential for cultivated blueberries, Rhododendrons and other Ericaceae, *Thekopsora minima* poses a considerable phytosanitary risk for Germany and other EU-Member States. Based on this risk analysis, it can be assumed that the pest is able to establish and cause considerable damage in Germany or other Member States. Thus measures on the control and prevention of introduction of this potential quarantine pest should be taken according to § 4a of the Plant Inspection Order. Thus the infestation must be controlled and eradicated according to § 4a of the Plant Inspection Order.		
Taxonomy[2)]	Fungi, Basidiomycota, Pucciniomycetes, Pucciniales (=Uredinales), Pucciniastraceae, *Thekopsora* The fungus shows considerable similarity to two other blueberry rusts, *Naohidemyces vaccinii* (occurs in Europe on native blueberries and cowberries) and *N. fujisanensis* (endemic in Japan) (Sato et al. 1993).		
Trivial names	Blueberry rust; Blaubeerrost		
Synonyms	*Uredo minima* Schwein. 1822		

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	Uredo azaleae (Schwein.) Sacc. *Pucciniastrum minimum* (Schwein.) Arthur 1906 *Peridermium peckii* Thüm. 1880
Does a relevant earlier PRA exist?	No
Biology	The teliospores hibernate on blueberry leaves on the ground and after germination in late spring they infest their alternating host, the Hemlock-fir *Tsuga canadensis* (resp. *T. diversifolia*) via basidiospores. Then the aeciospores which are produced there infest the blueberries resp. the other host plants. The urediniospores which are produced there are able to spread the infestation throughout the crop during the whole growing season. Systemic hibernating of the mycelium in the buds of the host plants and direct production of the urediniospores in spring has also been proved for the closely related native blueberry rusts. In this case the alternate host would not be needed which had considerable impact on the risk potential.
Is the pest a vector?[3)]	No
Is a vector needed?[4)]	No
Host plants	Species from the genera *Azalea*, *Gaylussacia*, *Lyonia*, *Rhododendron* (f. e. *R. ponticum*), *Tsuga* (*T.canadensis*, *T. diversifolia*), *Vaccinium* (*V. angustifolium*, *V. corymbosum*), Sato et al. (1993). It is not yet known to which extent the domestic blueberry (*V. myrtillus*) is susceptible for an infestation with *T. minima*. However, this species carries the endemic blueberry rust fungus, *Naohidemyces vaccinii*.
Symptoms[5)]	Initially, small yellow chlorotic leaf spots on the surface of young leaves. In the cause of proceeding infestation these grow and turn to rusty brown. Yellowish-orange powdery hymenium develops on the undersurface of the leaf. Similar hymenium can also appear on the fruits. In case of a more severe infestation leaves drop early (Biosecurity Tasmania Fact Sheet, 2014).
Presence of host plants in Germany[6)]	Blueberry crops (*Vaccinium corymbosum*): Currently a total of 6 to 8 tons per hectare is harvested in Germany from July to September on a cultivation area of 800 hectare. Main cultivation regions are the Luneburg Heath, Brandenburg, parts of Oldenburg as well as regions in the South of Germany and Central Baden (BDH, 2015) In Germany plants of Rhododendron and Azalea are wide spread as ornamentals. *Tsuga canadensis* is cultivated in some parts of Germany (floraweb.de) and is present in gardens.
Presence of host plants in the MS[7)]	*V. corymbosum* is also cultivated in other Member States. In the EU Rhododendron and Azalea are wide spread as ornamentals. *Tsuga canadensis* is also present in other EU-Member States.
Known infested areas[8)]	Endemic in North Eastern America and Japan (Sydow & Sydow 1915, Gäumann 1959, Sato et al. 1993, Kobayashi, 2007).

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	T. minima was introduced and established on *Vaccinium corymbosum* in South Africa (Mostert et al. 2010), Mexico (Rebollar-Alviter et al. 2011), Australia (McTaggart et al. 2013). First establishments of rust on *V. corymbosum* were also reported from the following countries (but most likely wrongly identified as *Pucciniastrum vaccinii*): Argentinia (Dal Bello & Perelló 1998), Spain (Barrau et al. 2002) and Hawaii (Keith et al. 2008).
Pathways[9)]	Import of infested plants (for planting) and possibly also fruits, dispersal via persons (f. e. clothes; Biosecurity Tasmania Fact Sheet, 2014)
Natural spread[10)]	Anemochory (over medium-length distances).
Expected establishment and spread in Germany[11)]	The fungus was found in one location in Lower Saxony. As the necessary climate conditions are given, host plants are wide spread and alternating hosts are at least sporadically present, further spread has to be expected. Furthermore it is likely that the alternating hosts are not necessarily required.
Expected establishment and spread in the MS[12)]	In the EU the climatic conditions for an establishment and spread are given, host plants are wide spread, alternating hosts are, at least sporadically, present. Hibernating of the Uredolager on highbush blueberry was proved in South Western Spain (Dal Bello & Perelló 1998; probably false identification as *Pucciniastrum vaccinii*).
Known damage in infested areas[13)]	Early leaf fall and defoliation as well as hymenium on fruits lead to crop loss (Biosecurity Tasmania Fact Sheet, 2014, Schilder and Miles, 2011)
Limitation of the endangered area in Germany	Overall Germany
Expected damage in the endangered area in Germany[14)]	Damage on highbush blueberry with crop loss, (cosmetical) damage on Rhododendrons and Azalea. It is not known whether also native blueberries could be infested by this fungus. It can be assumed that a hybridization of the introduced *T. minima* with the native *N. vaccinii*, was possible. This could lead to new virulent types (cp. willow rusts in North America: Hybridization with European willow rusts and formation of a new species with broader host spectrum and stronger virulence (Newcombe et al. 2000).
Expected damage in the endangered area in MS[15)]	See above
Control feasibility and measures[16)]	Extraction, fungicides at least for reducing the spread.
Detection and diagnosis[17)]	With practical experience symptoms can easily be identified; morphological (microscopical) species diagnosis is very difficult but clear via DNA-sequencing of the LSU and/or the ITS-region of the ribosomal DNA (see Maier et al. 2003, Schoch et al. 2012). The Aeciospore-hymenium on *Tsuga* is not distinct and is similar to the Uredinio-hymenium on blueberry-leaves.
Remarks	The certainty of the assessment is medium as it is not known if the alternating host is necessarily needed, if a hybridization of the

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	fungus with the endemic *N. vaccinii* would be possible and if the fungus could also infest the native blueberries.
Literature	Barrau, C. de los Santos, B., and Romero, F. 2002. First report of leaf rust of southern high-bush blueberry caused by *Pucciniastrum vaccinii* in southwestern Spain. Plant Disease 86: 1178. BDH, 2015. http://www.bund-deutscher-heidelbeeranbauer.de/heidelbeeren.html (Website accessed on 4 June, 2015) Biosecurity Tasmania Fact Sheet, 2014. http://dpipwe.tas.gov.au/biosecurity/current-biosecurity-threats (Website accessed on 4 June, 2015) Dal Bello, G., Perelló, A. 1998. First report of leaf rust of blueberry aused by *Pucciniastrum vaccinii* in Argentina. Plant Disease 82: 1062. Gäumann, E. 1959. Die Rostpilze Mitteleuropas. Kommisionsverlag Buchdruckerei Büchler, Bern, Switzerland. Keith, L., Sugiyama, L., Strauss, A., Kai, R., Zee, F., Hamasaki, R., Yamasaki, M., and Nakamoto, S. 2008. First report of leaf rust of blueberry caused by Pucciniastrum vaccinii in Hawaii. Kobayashi T. 2007. Index of Fungi Inhabiting Woody Plants in Japan. Host, Distribution and Literature. Zenkoku-Noson-Kyoiku Kyokai Publishing Co., Tokyo, p. 1227. Maier W, Begerow D, Weiß M, Oberwinkler F (2003). Phylogeny of the rust fungi: an approach using nuclear large subunit ribosomal DNA sequences. Canadian Journal of Botany 81: 12-23. McTaggart, A.R., Geering, A.D.W., and Shivas, R.G. 2013. *Thekopsora minima* causes blueberry rust in south-eastern Queensland and northern New South Wales. Australasian Plant Disease Notes 8: 81-83. Mostert, L., Bester, W., Jensen, T., Coertze, S., van Hoorn, A., Le Roux, J., Retief, E., Wood, A., and Aime, M.C. 2010. First report of leaf rust of blueberry caused by *Thekopsora minima* on *Vaccinium corymbosum* in the Western Cape, South Africa. Pl. Dis. 94: 478. Newcombe, G., Stirling, B., McDonald, S., and Bradshaw jr., H. D. 2000. *Melampsora* x *columbiana*, a natural hybrid of *M. medusae* and *M. occidentalis.* Mycological Research 104: 261-274. Rebollar-Alviter, A., Minnis, A.M., Dixon, L.J., Castlebury, L.A., Ramirez-Mendoza, M.R., Silva-Rojas, H.V., and Valdovinos-Ponce, G. 2011. First report of leaf rust of blueberry caused by *Thekopsora minima* in Mexico. Pl. Dis. 95: 772. Sato, S., Katsuya, K., and Hiratsuka, Y. 1993. Morphology, taxonomy and nomenclature of Tsuga-Ericaceae rusts. Trans. Mycol. Soc. Japan 34: 47-62. Schilder, A.M.C., and Miles, T.D. 2011. First report of blueberry leaf rust caused by *Thekopsora minima* on *Vaccinium corymbosum* in Michigan. Pl. Dis. 95: 768. Schoch C.L. and Fungal Barcoding Consortium 2012. Nuclear ribosomal internal transcribed spacer (ITS) region as a universal

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	DNA barcode marker for fungi. PNAS 109 (16) 6241-6246 Sydow, P. and Sydow, H. Monographia Uredinearum. Vol. III. Fratres Borntraeger, Leipzig, Germany, 1915.

Explanation

[1)] Compilation of the most important and directly available information that renders possible a first preliminary evaluation of the phytosanitary risk. This short evaluation is necessary for the decision on a notification to EU and EPPO as well as the preparation of a complete risk analysis, to inform the countries and as the basis for the possible initiation of eradication measures. In the case of phytosanitary risk especially the possibility of the introduction and spread in Germany and in the Member States as well as possible damage are taken into account.

[2)] Taxonomic classification - also subspecies - as the case may be; in the case that the taxonomic classification is uncertain the JKI-scientist initiates the taxonomic classification as far as possible.

[3)] If so, which organism (organisms) is (are) transmitted and does it (do they) occur in Germany / the MS?

[4)] If so, which organism serves as a vector and does it occur in Germany/ the MS?

[5)] Description of the pattern of damage and the strength of the symptoms/damage on the different host plants

[6)] Appearance of the host plants in protected cultivation, open field, public gardens, forest,....; where, in which regions do the host plants appear and to which extent?
How important are the host plants (economic, ecological, ...)?

[7)] Appearance of the host plants in protected cultivation, open field, public gardens, forest,....; Where, in which regions do the host plants appear and to which extent?
How important are the host plants (economic, ecological, ...)?, possible origin

[8)] f. e. acc. to CABI, EPPO, PQR, EPPO Datasheets

[9)] Which ways of introduction and pathways are known for the pest and how important are they for the probability of introduction. Primarily the transport of the pest over long distances is meant, normally with infested traded plants, plants products or other contaminated articles. This does not comprise the natural spread resulting from introduction.

[10)] Which pathways are known for the pest and of which relevance are they in respect of the probability of the spread? In this case the natural spread resulting from introduction is meant.

[11)] under the given/prevalent environmental conditions

[12)] under the given /prevalent environmental conditions (domestic areas and areas of introduction)

[13)] Description of the economic, ecological /environmental relevant and social damage in the area of origin resp. areas of occurrence up to now

[14)] Description of the economic, ecological /environmental relevant and social damage to be expected in Germany, as far as possible and required, differentiated between regions

[15)] Description of economic, ecological/ environmental relevant and social damage to be expected in the EU / other Member States, as far as possible and required, differentiated between regions

[16)] Can the pest be controlled? Which possibilities of control are given? Are plant health measures conducted in respect to this pest (in the areas of its appearance at present resp. by third countries)?

[17)] Description of possibilities and methods of detection. Detection by visual inspections? Latency? Uneven distribution in the plant (sampling)?