

## PHYLLACTINIA HIPPOPHAËS (ERYSIPHALES) REDISCOVERED IN GERMANY\*

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**Abstract.** The Erysiphales species *Phyllactinia hippophaës* Thüm. ex S. Blumer was found for the first time on cultivated Sea Buckthorn (*Hippophaë rhamnoides* L.) near Großkayna (Saxony-Anhalt) in October 2009. This fungus was considered to be extinct in Germany. Intensive searching in Saxony-Anhalt and the Potsdam area (Brandenburg) yielded many additional records, most of them from former brown coal mining areas or in Sea Buckthorn plantations.

**Key words:** powdery mildew, *Phyllactinia*, *Hippophaë rhamnoides*, Brandenburg, Saxony-Anhalt

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### INTRODUCTION

Members of the Erysiphales genus *Phyllactinia* Lév. clearly differ in the appearance of infestations from most of the other powdery mildew species. They produce their anamorphs (*Ovulariopsis* Pat. & Har.) predominantly or exclusively on the underside of leaves. The teleomorph only appears on the underside of leaves. It is also characterized by having rather large chasmothecia, acicular appendages with bulbous basal swelling, and penicillate cells in the upper half (Fig. 1). Whereas the widespread and common *Ph. guttata* (Wallr.) Lév. and *Ph. fraxini* (DC.) Fuss produce anamorphs as a thick mycelium layer, the anamorph stages of *Ph. hippophaës* Thüm. ex S. Blumer and of *Ph. roboris* (Gachet) S. Blumer, extinct in Germany, are very delicate and rarely formed. The chasmothecia of *Ph. hippophaës* are among the largest fruiting bodies

of the powdery mildews in Europe. According to Blumer (1933, 1967) they attain 246–272 µm average diameter, sometimes reaching 300 µm. Braun (1995) reported 245–310 µm diameter. This means that the chasmothecia are about three times larger than those of most other powdery mildew species. Among the European *Phyllactinia* species their size is exceeded only by the chasmothecia of *Ph. roboris*, up to 350 µm diameter (Braun 1995). This species is also distinguished from *Ph. hippophaës* by the distinct morphology of the conidia (Blumer 1967).

*Phyllactinia hippophaës* was validly described by Blumer (1933) after examination of various herbarium specimens. Two of them originated from Thümen's exsiccate *Fungi austriaci exsiccati*, collected in October 1871 near Krems (Lower Austria). Specimens No. 124–129 of this exsiccate were considered to be *Ph. guttata*, but Thümen had already noted that specimens No. 126 and 129 issued as *Ph. guttata* f. *hippophaës* could be

\* This paper is dedicated to Professor Tomasz Majewski on the occasion of his 70<sup>th</sup> birthday.

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a different species (Hohenbühel-Heufler 1872; Braun 1995). Rabenhorst (1872) integrated the material of No. 126 of Thümen's exsiccata as No. 1519 into Centurie XVI of his exsiccata *Fungi europaei exsiccati*. A. Boller – not Bolle as published by Blumer (1967) – collected new material of this fungus at a location near Krems in autumn 1874. This collection was integrated and issued as *Ph. guttata* f. *hippophæes* by Thümen in his exsiccata *Mycotheca universalis* as No. 157.\*\*\*

However, Blumer (1933, 1967) did not designate a particular type collection among the herbarium specimens analyzed; this was done by Braun (1987), who formally designated a lectotype.

Besides Austria, occurrences of *Ph. hippophæes* are known from the Netherlands, France, Italy, Switzerland, Germany, Hungary, Ukraine (Crimea), Georgia, Central Asia (Kazakhstan, Kirghizia, Uzbekistan) and the Siberian part of Russia (Vasyagina *et al.* 1961; Amano 1986; Braun 1987, 1995; Heluta 1989; Karis 1995; Bolay 2005; Nagy & Kiss 2006).

According to Blumer (1933), the few collections he examined dated from before 1905, often even much earlier, from the 19<sup>th</sup> century. From Switzerland only one collection exists (Bolay 2005), collected in Canton Graubünden (15 Oct. 1900, *leg. A. Volkert*). This record was already published by Blumer (1933). The Hungarian collection originated from 1885\*\*\*\*. The few records from Kazakhstan date back to between 1927 and 1938 (Vasyagina *et al.* 1961).

The only information about the occurrence of *Ph. hippophæes* in Germany refers to a record of *Ph. corylea* (Pers.) P. Karst. on *Hippophæe rhamnoides* by Neger (1905: 135): 'Rügen (Neger)' (Fig. 2). Buhr (1958) and Foitzik (1996) cited this record as well, and Scholler (1996) tried to date this not exactly localized information (? Aug. 1903). September 1899 is possible as well, because Neger (1900) noted that he stayed during this time in Sassnitz on Rügen Island. There is no

herbarium specimen, at least not in B (H. Sipman, pers. comm.). Later searches to re-collect this species were not successful (Scholler 1996).

Up to now *Ph. hippophæes* is recorded only from Sea Buckthorn (*Hippophæe rhamnoides* L., Elaeagnaceae) in Europe. In Germany this host comprises three different subspecies occurring in the Alps and their foreland, in the floodplains of the Isar and at Donau Rivers, and the North Sea and Baltic Sea coasts (Jäger & Werner 2005). In the former German Democratic Republic, Sea Buckthorn was planted in Central Germany and Lusatia for reforestation of bare areas resulting from brown coal mining, and for planting shelterbelts in agrarian landscapes and at edges of mining areas. The ability of *H. rhamnoides* to produce stolons was used to stabilize excavated material. Another reason for planting Sea Buckthorn is that it lives in symbiosis with nitrogen-fixing actinomycetes of the genus *Frankia* (Bacteria). These plantations were made in Lusatia mainly between 1975 and the mid 1980s. In addition to Sea Buckthorn some other dry-resistant woody plants such as *Elaeagnus angustifolia* L., *Colutea arborescens* L., *Caragana arborescens* Lam., *Robinia pseudoacacia* L. and *Amorpha fruticosa* L. were planted, and also *Acer negundo* L. and *Populus* hybrids. The nursery material of *H. rhamnoides* cultivated was almost exclusively from seeds collected from Sea Buckthorn populations on eastern Germany's Baltic Sea coast or extracted from material after juice pressing (H.-J. Albrecht, pers. comm.). Since the middle of the 1980s this so-called *Fremdländerphase* of mining area reclamation has gradually given way to a phase of planting more and more indigenous woody species. Today only indigenous shrubs and trees are planted (I. Landeck, pers. comm.).

In the fruit-growing area around Werder/Havel west of Potsdam (Brandenburg), *H. rhamnoides* is grown on plantations for various uses of the juice since the mid 1980s. Only German varieties are planted (D. Berger, pers. comm.). During the 1960s and 1970s Sea Buckthorn was cultivated in this area for land restoration as well (W. Pfannenstiel, pers. comm.).

In former brown coal mining areas, *H. rhamnoides* is now considered an established neophyte.

\*\*\* For original label see [http://pictures.snsb.info/BSMeryscoll/web/M-0017/M-0017040\\_20050920\\_191318.jpg](http://pictures.snsb.info/BSMeryscoll/web/M-0017/M-0017040_20050920_191318.jpg).

\*\*\*\* For original label see [http://pictures.snsb.info/BSMeryscoll/web/M-0017/M-0017041\\_20050920\\_191320.jpg](http://pictures.snsb.info/BSMeryscoll/web/M-0017/M-0017041_20050920_191320.jpg).

## MATERIALS AND METHODS

Dried herbarium specimens were examined by light microscopy; 30 chasmothecia, 30 asci and 50 spores were measured from the studied collections using a Zeiss Axioscope light microscope. LM micrographs were taken with a Nikon Coolpix 4500 camera.

## RESULTS AND DISCUSSION

### DESCRIPTION OF *PHYLLACTINIA HIPPOPHAËS* BASED ON HERBARIUM MATERIAL COLLECTED AND EXAMINED BY THE AUTHORS

Infected leaves often with partial discoloration (getting brown) of small to large areas of the upper side (Fig. 1). Infected leaves easily fall from the branches, so they can usually be found on the ground in late autumn, although we also found leaves with *Ph. hippophaës* still attached to *H. rhamnoides* branches with only a few leaves, in Petzow (see below) even at the end of January.

Chasmothecia hypophyllous, scattered, often in mass, dark brown to black, clearly flattened, 215–290 µm diameter; appendages 8–14, about as long as the chasmothecial diameter, sometimes up to twice as long as diameter, 200–425 µm long, inserted slightly below the median, without septum, hyaline, apically somewhat browning, wall thick, 1.5–4.5 µm thick, base with spherical to subglobose swellings, 35–48 µm diameter, in this part especially thick-walled, towards the apex gradually reducing to 5 µm, apically obtuse; asci numerous, cylindrical to broadly ellipsoid, base short-stalked, somewhat thick-walled, 2-spored, 80–125 × 30–45(–52) µm; spores without septum, cylindrical to ellipsoid but also ellipsoid ovoid or slightly allantoid, partially somewhat constricted at median, smooth, with many guttules, yellowish, (34–)38–55(–58) × (19–)20–27(–30) µm, length/width ratio 1.6–2.3.

### CURRENT RECORDS OF *PHYLLACTINIA* *HIPPOPHAËS* IN GERMANY

Our observations of the powdery mildew on Sea Buckthorn are restricted to Saxony-Anhalt and

Brandenburg (Fig. 2). After a first rather random record near Großkayna it quickly became clear that *Ph. hippophaës* probably has been overlooked and is likely a widespread but not common fungus on *H. rhamnoides* in the former brown coal mining areas. The fungus was also recorded several times on Sea Buckthorn planted outside of settlements and far away from areas affected by brown coal mining, and in urban gardens and public parks, where *H. rhamnoides* is cultivated as an ornamental plant. The fungus could not be found at all localities investigated. Sometimes it took a long time to find the fungus. In some localities, chasmothecia were even found on leaves of solitary growing shrubs.

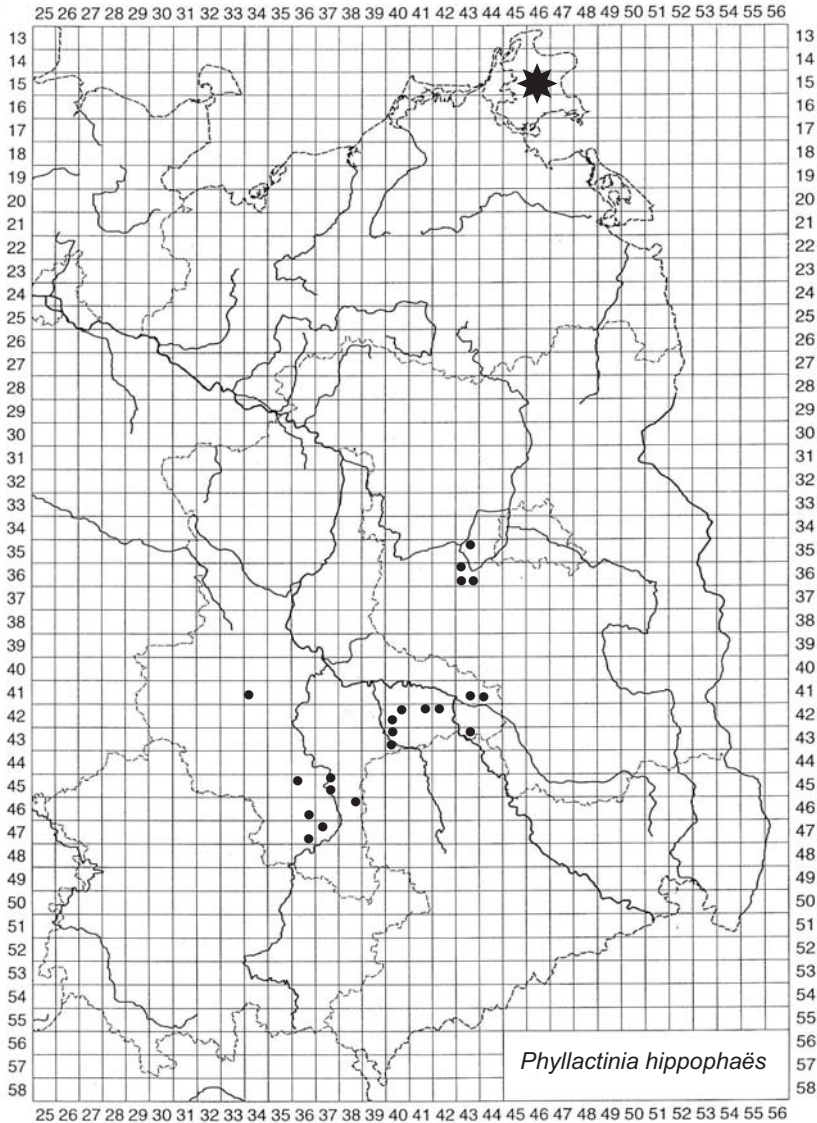
In the Potsdam area, *Ph. hippophaës* was found at different places. One record originated from a former plantation of Sea Buckthorn, one from a recent fruit production plantation, and several from ornamental plantings, each consisting of a few shrubs (see below). In the shrub collection of the Federal Office for Plant Varieties in Potsdam-Marquardt, all Sea Buckthorn cultivars were infected by *Ph. hippophaës* regardless of the size, age, provenance, genetic lineage or sex of the plants. Besides growing on tall-growing German varieties, this fungus also occurs on shorter cultivars originating from Finland. Infection with the fungus was also identified on a variety only ca 1 m in height, growing as a very dense and spherical shrub with very small and elongated leaves. This variety is used for such purposes as soil cover or planting along roadsides. Only sex-related differences in infection intensity were noticed during this single and short visit. On three of the five male Sea Buckthorn cultivars of the plantation of the Federal Office for Plant Varieties in Potsdam-Marquardt we noted only very weak infection. On one of these varieties we found only one weakly infected leaf among the many leaves we examined on different shrubs. All other female and male shrubs of the various varieties growing in Potsdam-Marquardt showed partial heavy infestations. In contrast, two other Sea Buckthorn populations with many male and female individuals and growing at a roadside ca 500 m away from the Federal Office for Plant Varieties showed no infection.



**Fig. 1.** a – leaves of *Hippophaë rhamnoides* L. with *Phyllactinia hippophaës* Thüm. ex S. Blumer infection, b – chasmothecia, c – two-spored ascus. Photo: a – U. Richter, b & c – V. Kummer.

All the records on both male and female individuals during this investigation clearly show that *Ph. hippophaës* infection is dependent – if at all – rather on host variety than on shrub sex (see below). The extent to which cultivation methods affect the rates of shrub infection is not clear. No infestation was apparent on any of the many female plants in a Sea Buckthorn

plantation examined in detail along the road from Glindow to Plötzin. These female plants are partially cut each year for fruit harvesting and were abundantly fruiting in autumn 2009. However, leaves of nearby male plants exhibited heavy *Ph. hippophaës* infection. These shrubs reached *ca* 4 m height and were not cut back, serving as mating plants.



**Fig. 2.** Records of *Phyllactinia hippophaës* Thüm. ex S. Blumer in Germany (• – current records, ★ – information by Neger 1905).

In view of the records in Central Germany and Brandenburg, searches for *Ph. hippophaës* were conducted in indigenous populations of Sea Buckthorn at the Baltic Sea coast (Neustädter Bucht), on the banks of the Trave River near Lübeck, and in the vicinity of Bodensee near Konstanz in October and November 2009, but no infections were found (A. Schmidt, V. Hellmann, pers. comm.). Nor were

any found in sporadic searches along the Polish coast of the Baltic Sea near Jastrzębia Góra in August 2009 (V. Kummer).

On leaves of Russian olive (*Elaeagnus angustifolia* L.), often planted in former brown coal mining areas, no *Phyllactinia* infections have been found in Europe so far, and our own sporadic searches in autumn 2009 gave the same result.

Amano (1986) and Karis (1995) published this fungus-host-combination from Central Asia (Kazakhstan, Uzbekistan), for *Ph. suffulta* (Rebent.) Sacc. and *Ph. guttata* (Wallr.) Lév., respectively, so attention should be paid to potential occurrences of this combination in Central Europe.

In the U.S.A., Amano (1986) reported *Ph. suffulta* on *Elaeagnus commutata* Bernh. ex Rydb. (= *E. argentea* Pursh) and on *Shepherdia argentea* (Pursh) Nutt., whereas Farr *et al.* (1995) published *Ph. guttata* on both hosts. Both authors also reported the occurrence of *Ph. elaeagni* Linder on *E. commutata*. Braun (1987) allocated the *Phyllactinia* taxon from *E. commutata* to *Ph. elaeagni*, but he emphasized that 'The status of *P. elaeagni* is somewhat obscure, especially the relation to the European *P. hippophaës*. The anamorphic state of *P. elaeagni* is unfortunately unknown' (Braun 1987: 591). He did not cite the information about *Phyllactinia* infection on *E. angustifolia* and *S. argentea* noted in Amano (1986) and Vasyagina *et al.* (1961).

*Elaeagnus* spp. can also be infected by *Leveillula elaeagni* (Jacz.) Simonyan & Heluta. Amano (1986) reported this species as *L. taurica* (Lév.) G. Arnaud from Asia, Ukraine and Italy. Distinctive microscopic features enable this powdery mildew species to be distinguished easily from *Ph. hippophaës*. Moreover, *L. elaeagni* is found on the upper side of leaves (Braun 1995).

#### RECORD LIST

In this list the particular records (see also Fig. 2) are arranged according to the different biotopes, preceded by the grid number of a 1:25,000 topographical map based on the system in Benkert *et al.* (1996). The following abbreviations are used: H.HA – Herbarium D. Hanelt, H.JA – Herbarium H. Jage, H.KU – Herbarium V. Kummer, H.RI – Herbarium U. Richter.

#### FORMER BROWN COAL DISTRICTS

1. Former brown coal mining area near Nachterstedt (northern foreland of Harz Mts)

4134/3 – SE Neu-Königsau, eastern edge of König-

sauer See, 15 Nov. 2009, D. & P. Hanelt & H. Jage (H.HA., H.JA 1151/09), sometimes together with *Phellinus hippophaëcola* H. Jahn on the same shrub.

2. Former brown coal mining area between Bitterfeld and Zschornowitz

4240/2 – NNW Gräfenhainichen: SW Ferropolis (at Gremminer See), 18 Oct. 2009, H. Jage (H.JA 1022/09).

4240/3 – near Zschornowitz, 14 Nov. 2009, B. Schultz (H.JA 100/10).

4340/1 – Burgkernitz: near Untermühle, 14 Nov. 2009, B. Schultz (H.JA 101/10).

4340/3 – ENE Bitterfeld: slopes to water reservoirs near Mühlbeck (Goitzsche-See) and Pouch (Mulde-Stausee), 7 Nov. & 8 Nov. 2009, B. Schultz (H.JA 1145/09 & 1146/09).

3. Geiseltal and Elster-Luppe-Aue

4636/4 – Southern edge of Geiseltalsee between Neubiendorf and Mücheln, 15 Oct. 2009, H. & U. Richter (H.RI).

4638/2 – SW Raßnitz: reforested heaps on northern bank of Raßnitz-See, 15 Oct. 2009, H. & U. Richter (H.RI).

4737/1 – SW Großkayna, 'Vestahalde', 12 Oct. 2009, H. & U. Richter (H.RI, H.JA 1029/09), first record in Saxony-Anhalt.

#### LARGER PLANTATIONS OUTSIDE SETTLEMENTS

3543/2 – Potsdam-Marquardt, Federal Office for Plant Varieties SW of Sandhaarberg, heavy infection of most of the cultivated Sea Buckthorn varieties, 1 Dec. 2009, V. Kummer & A. Klatt-Gärtner (H.KU 0780/4).

3643/1 – Central Brandenburg: ca 2.5 km ESE Plötzin, Sea Buckthorn plantation near Lange Str. vis-à-vis the pump station of a sewage works, 1 Dec. 2009, V. Kummer (H.KU 0780/6).

3643/3 – Central Brandenburg: Glindow-Elisabethhöhe, Elisabethstr., former Sea Buckthorn plantation, moderate infestation of the few shrubs growing here, 24 Nov. 2009, V. Kummer (H.KU 0780/2), first record in Brandenburg.

4144/3 – Fläming: N Dixförda, Badeseelake (former gravel pit), 23 Nov. 2009, H. Jage (H.JA 1188/09).

4242/1 – Elbaue E Kemberg: NE Schnellin, ca 40-year-old shelterbelt plantation, 17 Oct. 2009, H. Jage (H.JA 1007/09).

4536/1 – Mansfelder Land: exit of B 80 road to Seeburg, 21 Oct. 2009, H. John (H.JA 1083/09).

4537/4 – Saaleaue S Halle/S.: between Korbetha and Buna-Werk, 3 Nov. 2009, *H. & U. Richter* (H.RI.).

#### SMALL PLANTATIONS WITHIN SETTLEMENTS

3643/1 – Central Brandenburg: Plötzin, ca 400 m E, roadside of street to Glindow, heavy infection of the few male shrubs growing here, 1 Dec. 2009, *V. Kummer* (H.KU 0780/5).

3643/1 – Central Brandenburg: Petzow, Resort Schwielowsee near Baumgartenbrück, heavy infection of the few plants growing in a woody hedge, 26 Nov. 2009, *V. Kummer* (H.KU 0780/3).

3643/4 – Central Brandenburg: Petzow, roadside near the Fruchthof Berger company, strong infection on the few shrubs growing near the garden fence, 24 Nov. 2009, *V. Kummer* (H.KU 0780/1).

4143/4 – Fläming: Arnsdorfer Berge on the northern margin of Jessen, garden, 3 infected shrubs, 22 Nov. 2009, *H. Jage* (H.JA 1183/09).

4241/2 – Dübener Heide: Kemberg, 3 strongly infected shrubs growing in a woody hedge and garden. 1 Nov. & 12 Nov. 2009, *H. Jage* (H.JA 1096/09 & 1149/09).

4343/2 – Annaburger Heide: Prettin, woody hedge in settlement, 15 infected shrubs (planted ca 4 years ago), 21 Nov. 2009, *H. Jage* (H.JA 1168/09).

4537/2 – Halle/S., next to of the botanical garden, 31 Oct. 2009, *D. & P. Hanelt* (H.HA, H.JA 1072/09).

4736/4 – Unstrutgebiet: Freyburg, in city, few infected shrubs, 12 Oct. 2009, *H. & U. Richter* (H.RI.).

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