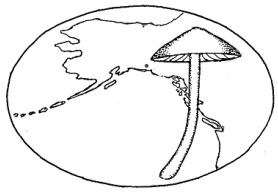
Pacific Northwest Fungi



Volume 2, Number 8, Pages 1-5
Published December 15, 2007

New records for powdery mildews and *Taphrina* species in Idaho and Washington

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Dugan, F. M., and G. Newcombe. 2007. New records for powdery mildews and *Taphrina* species in Idaho and Washington. *Pacific Northwest Fungi* 2(8): 1-5. doi: 10.2509/pnwf.2007.002.008

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Abstract: *Podosphaera* (*Sphaerotheca*) *euphorbiae* on *Euphorbia epithymoides* (= *E. polychroma*, cushion spurge) is reported for the first time in North America. *Neoerysiphe* (*Erysiphe*) *galeopsidis* on *Lamium amplexicaule* (henbit), *Blumeria* (*Erysiphe*) *graminis* on *Festuca idahoenis* (Idaho fescue), *Taphrina johansonii* on *Populus tremuloides* (trembling aspen), and *Taphrina occidentalis* on *Alnus rubra* (red alder) are reported for the first time from Idaho. Reports of *Erysiphe cichoracearum* on henbit may reflect misdetermined *Neoerysiphe galeopsidis*.

Key words: *Alnus rubra*, *Blumeria graminis*, cushion spurge, *Erysiphe cichoracearum*, *Erysiphe galeopsidis*, *Erysiphe graminis*, *Euphorbia epithymoides*, *Euphorbia polychroma*, *Festuca idahoenis*, henbit, Idaho fescue, *Lamium amplexicaule*, *Neoerysiphe galeopsidis*, *Podosphaeara euphorbiae*, *Populus tremuloides*, red alder, *Sphaerotheca euphorbiae*, *Taphrina johansonii*, *Taphrina occidentalis*, trembling aspen.

Introduction: New fungus-host records are of interest to plant disease diagnosticians, agricultural extension agents, Master Gardeners, regulatory officials, and other plant health professionals. Documenting particular fungus-host occurrences in geographic locales where they were previously unrecorded assists in routine diagnoses. Below are such new records for economically important plants, including a popular ornamental shrub, a cosmopolitan weed, a forage grass common in the inland Pacific Northwest, and two forest trees often abundant in mesic or riparian environments.

Materials and methods: Observations of microscopic characters of powdery mildews were made and photomicrographs taken with an Olympus BH2 research microscope equipped with an Olympus DP11 digital camera. Observations of microscopic characters of *Taphrina* spp. were made with a Zeiss Axioscope. Microscopic structures were measured at ca. 100-1000x while mounted in distilled water (for spore measurements), lactic acid (for other structures) or air (for chains of conidia). One percent aniline blue in lactic acid was applied directly to whole mounts of leaves for staining of haustoria within host tissue; photographs were taken immediately after application of stain. Fungi were identified according to the monographs of Braun (1987), Mix (1949) or Ray (1939). Powdery mildew genus concepts follow Braun et al., (2002). Hosts were identified according to DiTomaso and Healy (2007), Hitchcock and Cronquist (1973), or in the case of cushion spurge, by the staff of Lawson Gardens, Pullman, WA. Specimens were deposited with the Mycological Herbarium of Department of Plant Pathology, Washington State University, Pullman (WSP) or the Stillinger Herbarium at University of Idaho (ID). Details on collectors, dates and location of samples are provided below.

***Podosphaera euphorbiae* (Castagne) U. Braun & S. Takam. [≡ *Sphaerotheca euphorbiae* (Castagne) E.S. Salmon] on *Euphorbia epithymoides* L. (= *E. polychroma* A. Kerner, cushion spurge), Lawson Gardens, Pullman, Whitman Co., Washington USA, 20 June 2007, collector F.M. Dugan.** Conidia with fibrosin bodies (Fig. 1) were (20-)23-31 x (11-)12-14 µm; born in chains (Fig. 2) on conidiophores with foot cells 31-76 x 9-10 µm and with 2-3 cells in addition to the foot cell. Appressoria (Fig. 3) were inconspicuous, slightly lobed. The teleomorph was not seen. Braun (1987) described mycelium of *P. euphorbiae* (as *S. euphorbiae*) as amphigenous on leaves, but in our specimens mycelium was mostly adaxial (dorsal). Tortuous, brown, pannose mycelium was present as described by Braun, but hyphae were not as thick-walled as illustrated in Braun's figure. A specimen has been deposited as WSP 71385.

Of the several species described from Euphorbiaceae in Braun's (1987) world monograph, those in *Erysiphe* lack fibrosin bodies, *Microsphaera euphorbiae* Berk. & Curt. produces conidia singly, as does *Ovulariopsis erysiphoides* Rat. & Har. Species in *Leveillula* form conidia with morphology differing strongly from those in our specimens. *Oidium cyparissiae* Syd. forms conidia much larger than those of our specimens (and conidia of *O. erysiphoides* are much larger as well, and clavate). Of the other two species in *Sphaerotheca*, *S. euphorbiae-helioscopiae* S. Tanda & Y. Nomura, is reported only from Japan, with only the teleomorph described by Braun; and *S. euphorbiae-hirtae* U. Braun & R.B. Somani produces conidia larger than those of our specimens and appears more restricted in host and geographic range than *P. euphorbiae*. *Podosphaera euphorbiae* has been twice reported (as *S. euphorbiae*) from *E. epithymoides* in Romania (Farr et al. n.d.). The powdery mildew most frequently reported from *Euphorbia* spp. in North America is *M. euphorbiae* (Farr et al. n.d.), which in addition to the formation of single conidia mentioned above, exhibits foot cells far shorter than those in our specimens or those given for *S. euphorbiae*. Braun (1987) examined the type of *M. euphorbiae* and confirmed its conidia as forming singly, so our specimen differs from that species. *Euphorbia epithymoides* is a popular ornamental plant advertised on many web sites, usually as its synonym, *E. polychroma.* As of this writing (20 September 2007), the primary host-fungus database for North America (Farr et al. n.d.) contained numerous records for *P. euphorbiae* (many as *S. euphorbiae*) on *Euphorbia* spp. and other hosts, mostly from Europe, but none for North America.

***Neoerysiphe galeopsidis* (DC.) U. Braun (≡ *Erysiphe galeopsidis* DC.) on *Lamium amplexicaule* L. (henbit), University of Idaho Arboretum, Moscow, Latah Co., Idaho USA, 18 June 2007, collector F.M. Dugan.** Conidia lacking fibrosin bodies (Fig. 4) were 24-36.5 x 13-21 µm; born in chains (Fig. 5) on conidiophores with foot cells 22-46 x 8-9 µm and with 2-4 cells in addition to the foot cell. Appressoria (Fig. 6) were moderately lobed. The amphigenous, powdery white colonies of the anamorph were often densely distributed on leaves and stems, but the teleomorph was not seen. This fungus-host combination was previously reported from Washington State (Glawe n.d.); it was collected by Charles Gardiner Shaw, and is represented in WSP as specimen number 23739. This fungus is reported on henbit from numerous locales in Europe, and in the United States is also reported on various *Stachys* spp. (Farr et al. n.d.). *Erysiphe cichoracearum*

DC. [current name, *Golovinomyces cichoracearum* (DC.) Heluta] is the name most commonly applied to powdery mildew on henbit in the United States (California, Kansas, Oklahoma, and South Carolina) (Farr et al. n.d.). This binomial has been applied to a very broad range of powdery mildews in the past, many now segregated from *G. cichoracearum* (Braun 1987). We have not examined specimens reported on henbit as *E. cichoracearum*, but it is worth noting that Braun (1987) restricted *E. cichoracearum* to hosts in the Asteraceae. Foot cells of *E. cichoracearum* are given by Braun as mostly 50-80 µm long, and conidia as up to 5 µm longer than in our specimens, so our specimens are incongruent with *E. cichoracearum* on morphological grounds and by host range. Within the United States, we believe this to be the first report of *N. galeopsidis* on henbit outside Washington State, but given the ambiguity of the reports involving *E. cichoracearum*, and given the reports from Europe above, it is possible that *N. galeopsidis* is more widely distributed in North America. A specimen has been deposited as WSP 71386.

***Blumeria graminis* (DC.) Speer (≡ *Erysiphe graminis* DC.) on *Festuca idahoensis* Elmer (Idaho fescue), Moscow, Latah Co., Idaho USA, 8 May 2007, collector G. Newcombe.** Conidia lacking fibrosin bodies, 21-32 x 13.5-17 µm, born in chains on conidiophores with foot cells 29-35 x 6-8 µm and with a bulbous base 12-13 µm wide (Fig. 7). Appressoria were inconspicuous and nipple-shaped. Haustoria (Fig. 8) were characteristically multi-digitate. To our knowledge, this is the first report for *B. graminis* on *F. idahoensis* for Idaho. *B. graminis* has been recorded on Idaho fescue from Washington state (Farr et al. n.d.) and on other miscellaneous *Festuca* species in the United States and elsewhere (Farr et al. n.d.). A specimen as been deposited as WSP 71342.

***Taphrina johansonii* Sadebeck on *Populus tremuloides* Michx. (trembling aspen), Moscow, Latah Co., Idaho USA, 1 May 2007, collector G. Newcombe.** Female trees bore catkins comprised of a mix of both healthy, green capsules and hypertrophied, yellow or orange capsules (Fig. 9). The sizes of asci, 60-125 µm long and 16-26 µm wide, were within the range reported by Mix (1949) for *T. johansonii* on *P. tremuloides*. A specimen was deposited in the Stillinger Herbarium as ID 139,485.

This disease of female capsules has been reported on *P. tremuloides* in various states across the U.S. (Farr et al.), but not previously from Idaho. Callan (1998) reported *Taphrina populina* Fries on *P. tremuloides* in British Columbia, but the dimensions she provided for asci, precisely congruent with Mix (1949), are shorter than those of our specimen, and the symptoms were deformations of leaves (as opposed to deformation of catkins). Rodrigues and Fonseca (2003) also noted this difference in symptoms, although *T. johansonii* and *T. populina* clustered closely together in their phylogenetic analysis. Occurring each spring during the past three years in Moscow, the disease has varied in severity among female trees.

***Taphrina occidentalis* W.W. Ray on *Alnus rubra* Bongard (red alder), confluence of Selway River and O'Hara Creek, Idaho Co., Idaho USA, 11 Aug. 2007, collector G. Newcombe.** Bracts of female catkins of *A. rubra* were red, and hypertrophied (Fig. 10). Cylindrical asci of *T. occidentalis* were 37-50 µm long and 10-18 µm wide, with basal cells. A specimen has been deposited in the Stillinger Herbarium as ID 139,486.

Ray (1939) described *Taphrina occidentalis* from a specimen of *Alnus rubra* collected by J.A. Weir at Grants Pass, Oregon. Additional specimens of *T. occidentalis* Ray have since been collected in the western U.S. and Canada on *A. rhombifolia* Nutt., *Alnus rugosa* (Du Roi) Spreng., *Alnus sinuata* (Regel) Rydb., and *Alnus incana* (L.) Moench ssp. *tenuifolia* (Nutt.) Breitung (Farr et al. n.d.). Other *Taphrina* spp. documented on *Alnus rubra* include *Taphrina amentorum* (Sadeb.) Rostrup, *T. japonica* Kusano, and *T. macrophylla* Ray (Farr et al. n.d.). *T. japonica* and *T. macrophylla* cause leaf curl, not hypertrophy of catkin bracts (Mix 1940, Ray 1940). Ray (1939) reviewed specimens, literature and nomenclature, and concluded that exclusive of *T. amentorum* from Alaska, "only one species [*T. occidentalis*] is the cause of catkin disease of *Alnus* in western United States." Farr et al. (n.d.) also recorded specimens of *T. amentorum* from Alaska, but not from the lower west coast of the United States. As of this writing, GenBank contains entries for *T. amentorum* (see Weber et al. 2002, where it was used for an outgroup in phylogenetic analysis) but none under the name *T. occidentalis*. The relation between *T. amentorum* and *T. occidentalis* appears not substantially investigated since the publications of Mix (1940) and Ray (1939). Rodrigues and Fonseca (2003)

conducted molecular-genetic analyses of some other species on *Alnus*, including *T. robinsoniana* Giesenhagen, a name applied to the causal agent of catkin disease of *A. incana* and *A. rugosa* in eastern North America (Mix 1940). The dimensions of asci of our specimen were more in accord with those of *T. occidentalis* than those of *T. amentorum* according to Mix (1949), and exhibited basal cells, whereas those of *T. amentorum* do not (Ray 1939). Accordingly, we provisionally accept Ray's (1939) opinion and use the name *T. occidentalis*. Neither Ray nor subsequent collectors reported *T. amentorum* nor *T. occidentalis* on *A. rubra* in Idaho (Farr et al. n.d.). In spite of being isolated from other red alder populations (Johnson 1995), the catkin disease was common in the Selway population of *A. rubra*.

Acknowledgements: The authors thank Philip Hamm and Carl Strausbaugh for helpful review of the manuscript, and Varnel Williams of Lawson Gardens for assistance with host identification as *Euphorbia polychroma.*

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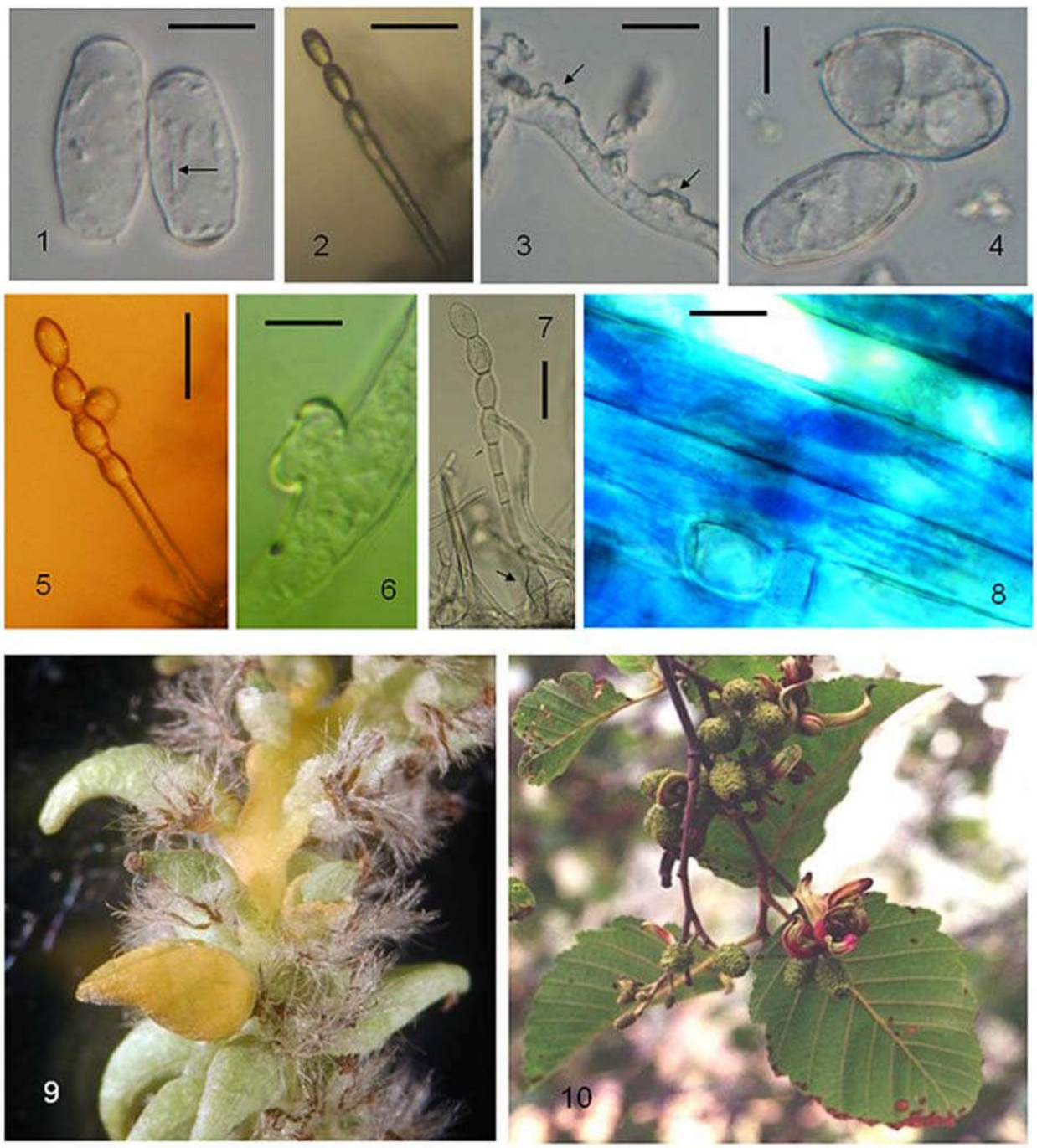

Fig. 1. Conidia of *Podosphaera euphorbiae* with fibrosin bodies (arrow) on *Euphorbia epithymoides*. Differential interference contrast microscopy (DIC). Bar = 10 µm. Fig. 2. Chain of conidia of *P. euphorbiae*. Bright field, in air. Bar = 50 µm. Fig. 3. Appressoria (arrows) of *P. euphorbiae*. DIC. Bar = 10 µm. Fig. 4. Conidia of *Neoerysiphe galeopsidis* on *Lamium amplexicaule*. DIC. Bar = 10 µm. Fig. 5. Chain of conidia of *N. galeopsidis*. Bright field, in air. Bar = 50 µm. Fig. 6. Appressorium of *N. galeopsidis*. DIC. Bar = 5 µm. Fig. 7. *Blumeria graminis* conidiophore, with bulbous base (arrow) and chain of conidia of on *Festuca idahoensis*. Bright field. Bar = 50 µm. Fig. 8. Haustoria of *B. graminis* in host. Bright field, aniline blue stain. Bar = 10 µm. Fig. 9. *Taphrina johansonii* on *Populus tremuloides*. Infection results in hypertrophied, yellow or orange capsules. Fig. 10. *Taphrina occidentalis* on *Alnus rubra*. Infection results in red and hypertrophied catkins.