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First Report of *Phragmidium violaceum* Infecting Himalaya and Evergreen Blackberries in North America

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In May and June of 2004, ranchers in Curry Co., Oregon observed dieback in Himalaya blackberry [*Rubus armeniacus* Focke (= *R. fruticosus* L.)] growing in the wild (Fig. 1). In April 2005, rust-like symptoms were observed on affected plants in the field and samples were collected for laboratory diagnosis. Foliar symptoms on recent plant growth included circular purplish leaf spots 1.5 to 2 mm in diameter on the adaxial leaf surface, usually with yellow to tan centers, and hypophyllous yellowish-orange aecia and uredinia on the abaxial surface. Aeciospores were globose or ellipsoid, 25 to 30 microns in diameter, with hyaline walls 1 to 2 microns thick and echinulate with spines 2.5 microns thick by 1.5 microns high. Uredinia were similar in appearance to aecia, but slightly smaller (1 to 2 mm in diameter) on average (Fig. 2). Urediniospores were similar in size and appearance to aeciospores, but more broadly ellipsoid and with slightly thicker walls (2.5 microns). Paraphyses observed in aecia and uredinia (Fig. 3) were hyaline, clavate-capitate, incurved, and 53 to 75 microns by 8 to 25 microns in size. Telia were observed on older infected leaves from the previous year. The telia were similar to uredinia, but were black instead of yellowish-orange and slightly smaller (1 to 1.5 mm in diameter). Teliospores were cylindrical, 3- to 5-celled (Fig. 4), not or slightly constricted at the septa, and rounded at the apex with a rounded hyaline papilla 3 to 9 microns long by 5 to 8 microns wide. Three-celled teliospores excluding the papilla were 50 to 58 microns long by 30 to 33 microns wide, four-celled teliospores were 65 to 72 microns long by 30 to 31 microns wide, and five-celled teliospores were 90 to 93 microns long by 28 to 29 microns wide. Teliospore walls were dark brown, heavily warted, and 5 to 6 microns thick. Pedicels were hyaline, 68 to 103 microns long by 8 to 10 microns thick at the neck and swollen below to 13 to 20 microns. Based on morphological characteristics, the rust fungus most closely resembled *Phragmidium violaceum* (Schultz) G. Winter (3). A specimen of the rust was sent to the USDA Systematic Botany and Mycology Laboratory for official confirmation of the morphological identification. To further confirm the identification, a 1,532-bp section of ribosomal DNA spanning two nuclear gene regions [the ribosomal internal transcribed spacer region-2 (ITS-2) and the ribosomal 28S large subunit] was amplified and sequenced with rust-specific primers (Aime, *unpublished*) (GenBank Accession No. DQ142910). The resulting

sequence was 100% homologous to an already published 519-bp 28S sequence of *P. violaceum* (GenBank Accession No. AF426214) (4) and to an ITS-2 and 28S sequence of *P. violaceum* collected in France (Coll. No. MCA2782, GenBank Accession No. DQ142909), thus verifying the morphological identification of the rust as *P. violaceum*.

Fig. 1. Dieback on *Rubus armeniacus* in Curry Co., Oregon caused by *Phragmidium violaceum* (photo by K. French).

Fig. 2. Uredinia and urediniospores of *Phragmidium violaceum* infecting flower buds and leaves of *Rubus armeniacus* (photo by A. Trippe).

Fig. 3. Uredinia, urediniospores, and paraphyses of *Phragmidium violaceum* (photo by N. Osterbauer). The presence of paraphyses distinguishes *P. violaceum* uredinia and aecia from those of *Kuehneola uredinis*, the native caneberry rust.

Fig. 4. Four-celled teliospore of *Phragmidium violaceum* (photo by M. C. Aime).

Caneberry growers in western Oregon first noticed a rust-like fungus infecting the commercially-grown evergreen blackberry (*Rubus laciniatus* Willd.) 'Ever Thornless' in the late summer of 2004. In June 2005, in response to a report of *P. violaceum* infecting Himalaya blackberries in Oregon (5), samples of infected evergreen blackberry were collected for diagnosis in the laboratory. Circular, purplish leaf spots like those seen on Himalaya blackberry were observed on the recent plant growth of the evergreen blackberry. The aecial stage was not observed on the samples submitted and the uredinia observed were non-paraphysate, making them indistinguishable from those of *Kuehneola uredinis* (Link) Arthur, a native North American rust that infects *Rubus* spp. However, telia (Fig. 5) and teliospores typical of *P. violaceum* were observed on symptomatic leaves collected in Multnomah Co. in the northwestern part of the state. Teliospores were cylindrical, 3- to 5-celled, not or slightly constricted at the septa, and rounded at the apex, each tipped with a rounded papillum 7.5 to 10 microns long by 2.5 to 5 microns wide. Three-celled teliospores excluding the papilla were an average of 56.7 microns long by 30 microns wide, four-celled teliospores 71.7 microns long by 30.8 microns wide, and five-celled teliospores 83.3 microns long by 30.8 microns wide. Spore walls were dark brown, heavily warted, and 3 to 5 microns thick. Pedicels were an average of 109 microns long by 12.2 microns thick at the neck and swollen below to up to 13.8 microns. As

with the rust on the Himalaya blackberry, the morphological identification was confirmed by the USDA and by sequencing the ribosomal DNA and comparing the resulting DNA sequence to other sequences of *P. violaceum* as described.

Fig. 5. Telia of *Phragmidium violaceum* on evergreen blackberry at 40x magnification (photo by N. Osterbauer).

Phragmidium violaceum occurs on several species of *Rubus*, including *R. armeniacus*, *R. fruticosus* agg., and *R. laciniatus*, in Europe, South Africa, Iran, and Iraq (2), and has been introduced as a biological control agent for invasive blackberries in Australia, New Zealand, and Chile (1). To our knowledge, this is the first official report of *P. violaceum* infecting Himalaya and evergreen blackberries in North America. Herbarium specimens of this rust have been deposited with the U.S. National Fungus Collection in Beltsville, MD (BPI Nos. 871510, 871511, and 871825). Experiments are underway in Oregon and at the USDA-ARS laboratory in Fort Detrick, MD, to determine the potential impact of *P. violaceum* on native *Rubus* species and on other commercially-grown *Rubus* cultivars in the U.S. A monitoring effort to determine the extent of the infestation in Oregon is underway and OSU researchers are exploring disease management options for commercial evergreen blackberry growers.

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