Blackberry Rust Fungus: Possible New Biological Control
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Background
Blackberry (Rubus species) is one of the most widespread and devastating invasive weeds on the west coast. Himalayan blackberry (R. armeniacus), and wild evergreen blackberry (also referred to as cut-leaf blackberry or wild R. laciniatus), are major weed pests of the Pacific Northwest (PNW) and northern California. Recently, a rust fungus, Phragmidium violaceum, was discovered on Himalayan blackberry plants in Oregon. Plants of both species are now known to occur from south of San Francisco Bay in California to the Canadian border in Washington and west of the Sierra Nevada and Cascade mountains. Economic losses are estimated in the millions of dollars. Blackberry encroachment results in lost acreage on cattle ranches, reduced range and pasture productivity, displacement of native species, and reduced overall watershed health. Nearly every section of waterway in western Oregon has been impacted by blackberry thickets smothering other important plant species. Available cultural, chemical, and mechanical control treatments are effective on a small scale and will continue to be part of an integrated pest management program for blackberry. Biological control is an important addition to currently available control methods to significantly reduce landscape-level impacts by this aggressive weed.

Biological Control
Biological control works by importing natural predators of invasive plants to Oregon, and letting them reduce the invasive plant’s population over time. When invasive plants were brought to the US from their native countries, their natural enemies were generally not brought with them. Where invasive plants and their predators exist together in their native range, the invasive plant is kept in check by the predator. Without the invasive plant’s predator, non-native plants can dominate landscapes, as is the case with many of our problem noxious weeds. Biological control efforts are focused on finding these predators, testing to make sure they are not a threat to agriculturally important, native, or threatened and endangered plant species, and then carefully introducing them into the environment to help control weedy plants. Biocontrol agents destroy plant tissues and cause stress to the weeds, making them less competitive against desirable flora. An example of a successful biological control program in Oregon is utilization of predators tansy flea beetle (Longitarsus jacobaeae) and cinnabar moth (Tyria jacobaeae) for control of the noxious weed, tansy ragwort (Senecio jacobea).
**Rust Discovery**

In 2005, southwest Oregon ranchers noticed something different with the blackberry plants. They reported that large areas of blackberry looked as if they had been sprayed with an herbicide (Fig. 1) with entire stands full of dead, gray canes. Confirmation of the blackberry leaf rust fungus (*Phragmidium violaceum*) was the first report of this disease in North America. This raised the possibility for blackberry biological control in the US. The introduction of the rust fungus into the United States seems to have been accidental. This fungal plant disease is native to wild blackberry in Africa, the Middle East, and Europe. Certain strains of the rust have been used to successfully control invasive blackberry in Chile, Australia, and New Zealand.

**How Does It Affect Blackberry Plants?**

Blackberry Rust Fungus is a plant disease that mainly attacks the leaves of blackberry and causes them to fall off. Research has shown that it attacks the youngest leaves first, but it also appears to be able to infect the buds, unripe fruit, and green growing parts of the cane (Fig. 2).

In late spring and summer, blackberry plants infected with the rust fungus will have yellow, powdery clumps or “pustules” on the underside of the leaves. These are termed “summer” spores. On the top of the leaf, corresponding directly with the yellow clumps will be a purple spot (Fig. 3). In late summer through fall, the yellow summer spores change to black “winter” spores, called teliospores, which remain attached to the underside of the leaves through the winter, or are deposited on the soil when the leaves fall. These “winter” spores can either remain dormant in the soil, or they can germinate in the spring to start a new cycle of infection. When enough “summer” spores build up, all the leaves of susceptible plants can fall off. Normally, blackberry remains in leaf all year but when infected with the rust fungus, the leaves fall off because of the impacts of the rust. If the infestation is large enough, opening of the blackberry thickets allows for more desirable species such as grasses and forbs to establish.

Research has shown that *P. violaceum* does best with moisture on the leaves for several hours and in areas of high rainfall and moderate temperature. When the rust is exposed to temperatures over 85°F for several days in a row, it stops growing, and switches from the active “summer” spore stage to the dormant “winter” spore stage.

When blackberry plants are infected with the rust fungus, tip rooting (also called “daughter caning”) decreases. Tip rooting is when the end of a blackberry cane bends over and touches the ground, develops roots, and grows into a new plant. Because the blackberry rust fungus can reduce tip rooting, it has the potential to dramatically impact the competitive advantage blackberry has in taking over entire systems. The rust fungus may, indeed, help reduce blackberry. However, although rust infections look very effective and seem like they should be a quick fix to a big problem, blackberry is a very vigorous plant which requires many rust attacks over a number of years to impact the root system for long-term control.

**Recent Studies**

Initially, there was considerable interest and concern about non-target impacts to both the native blackberry populations and commercial blackberry production. In Coos and Curry
Counties, OSU Extension and Oregon Department of Agriculture established trap gardens which are field plots that included Himalaya blackberry, native blackberry, and related commercial berries, all grown in pots. We found that the rust fungus had minimal to no impact on native blackberry populations but did affect Himalayan blackberry, invasive wild evergreen blackberry (wild *R. lanciniatus*), and one commercial variety of thornless evergreen blackberry (*R. lanciniatus*). It was not found to affect any other cultivated varieties. OSU Extension Service worked closely with commercial growers to develop practical control strategies to combat the rust. In commercial plantings, lime sulfur applied as a delayed dormant treatment suppressed the rust fungus. Over two seasons, one application of fungicide in early May provided effective control of summer rust damage. We also incorporated low-level aerial photography of blackberry patches to document possible widespread rust impacts. An interesting observation in areas with blackberry rust fungus was that the rust was detrimental to some blackberry patches but did not affect others. This led to further studies to learn more about the rust fungus.

Another recent study was an extension of the trap garden experiment. Greenhouse studies examined all cultivated and native varieties of blackberry and its relatives that were inoculated with the rust fungus to determine the potential of each variety to host the rust fungus.

The scientific community has relatively limited information on blackberry genetics in North America and even less information on the rust fungus; i.e. which blackberry species is susceptible and if there is more than one strain of the fungus. Current studies are examining which blackberry genotypes are present in Oregon. Samples of blackberry and rust have been collected and used in a comparative disease study. This included survey and collection of healthy and diseased plants west of the Cascades in Oregon. Plant samples were sent to the US Department of Agriculture lab in Beltsville, Maryland, which is the lab where all foreign diseases must be studied prior to release in the US.

A USDA study found many genotypes, or genetic varieties, of Himalayan Blackberry in the PNW and northern California. Samples from California differed genetically from the most common types of blackberry in Oregon. Current work in Oregon has determined that not all the blackberry genotypes are affected by the one strain of rust fungus found here. We have found, however, that rust from one of the Oregon regions sampled can kill blackberry from several other regions of the state. We have also observed variability in the amount of disease in blackberry populations in the PNW and California (Figs. 2 and 3). The cause of this has not been established, but the genetic differences in the host or the pathogen may be major factors.

Results from a graduate student dissertation at UC Davis have shown that that there are two invasive clones in the Western United States, where previously it had been thought to consist of a single asexual lineage. The most common clone was genetically identical to plants from the native range of Germany (*R. armeniacus*). The second clone was identical to plants in the invaded range of Australia (*R. anglocandicans*) and was closely related to samples from the native ranges of England and Serbia.
Previous work on the blackberry rust fungus in Australia is helpful as we continue to work toward biological control in the US. In addition to partnerships in Australia, researchers in Poland and Chile have also been collaborating with us on blackberry studies. In Australia, both European blackberry (*Rubus fruticosus Aggregate*) and the rust disease caused by *P. violaceum* have been studied extensively. Although *P. violaceum* is regarded as a successful biological control agent, it has not been fully satisfactory in controlling the target. Recent studies indicate that “blackberry” is very complex in Australia: at least 15 types of blackberry have been identified. The Australians recently released a complex of rust fungus isolates, which is a group of different rust strains, in order to improve management of this important pest. It is believed that additional isolates will broaden the genetic base and facilitate genetic recombination with the pathogen for greater aggressiveness on blackberry.

**What Does This All Mean?**
The accidental introduction of *P. violaceum* to the Pacific Northwest presents exciting possibilities for Himalayan blackberry control and the re-establishment of preferred vegetation in landscapes. It is projected that biological control will be available for use in the US in the near future.

Fig. 1. Dieback on *Rubus armeniacus* in Curry Co., Oregon caused by *Phragmidium violaceum* (photo by K. French).
Fig. 2. *Phragmidium violaceum* infecting flower buds and leaves of *Rubus armeniacus* (photo by A. Trippe).

Fig. 3. Purple spots and corresponding yellow pustules indicative of blackberry rust (*P. violaceum*). Note the mirror-image placement of the yellow pustules with the purple rust spots. Each pustule corresponds exactly with each purple spot (photo by K. French).

References available on request.