

# Odd Fruits: Gall and Leaf Spot Diseases Caused by *Exobasidium* Fungi<sup>1</sup>

C. Benton Willis, Michael Goodnight, Jessica Velte, Marin T. Brewer, and Matthew E. Smith<sup>2</sup>

## Summary

*Exobasidium* fungi are plant pathogens that primarily infect plants in the Ericaceae family, including blueberries and azaleas. Rather than producing typical fungal reproductive structures (mushrooms), infections by these fungi cause plant cells to proliferate (hyperplasia) and expand (hypertrophy). The fungi then use the increased surface area to produce their spores on the surface of the plant tissue. These changes manifest as symptoms on the host plant, and the symptoms vary depending on the species of *Exobasidium*. The range of symptoms include leaf and fruit spots, blisters, shoot proliferation (witches' broom), and galls. Infected plant tissues can also become swollen and distorted as well as chlorotic (yellow) or discolored (reddish to pink). As this infected tissue matures, the surface becomes white and powdery from the production of spores by the fungus. *Exobasidium* fungi tend to cause symptoms on the plant during ideal weather conditions but can likely survive on the leaf surface or other available substrates year-round. However, the lifecycles of most species of *Exobasidium* fungi in nature are still poorly understood. Management of diseases caused by *Exobasidium* fungi includes chemical applications and cultural practices, such as pruning before the spores have the chance to mature.

## Introduction

*Exobasidium* is a genus of plant-pathogenic fungi. *Exobasidium* fungi affect plants in select families of the order Ericales (Heaths and Allies), which includes Ericaceae, Theaceae, and Symplocaceae (Nannfeldt 1981). Most *Exobasidium* fungi affect members of Ericaceae and are therefore pathogens of important ornamental and crop species, such as azaleas, blueberries, and cranberries (Newell et al. 2023). However, several species of *Exobasidium* are known to cause diseases on tea and ornamental camellias (*Camellia* spp.) (Shirai 1896). Symptoms, or changes in the host plants, caused by *Exobasidium* vary by fungal species. Most notably, some *Exobasidium* species cause large galls that are discolored, turning red, pink, yellow, or white (Figure 1) (Callan and Carris 2004).

While *Exobasidium* fungi do not directly kill the host plant, infections can lead to decreased reproductive success and reduced plant growth and health (Hildebrand et al. 2000; Wolfe and Rissler 2000). Yearly repeated infections can lead to declining plant vigor and size due to branch and leaf death. *Exobasidium* symptoms also decrease flowering and fruiting, which result in the loss of aesthetic value and reduced agricultural yield, particularly on ornamental or edible hosts. On fruits, such as blueberries, symptoms make the crop unmarketable. *Exobasidium* disease on berries negatively affects taste, texture, and appearance, but sorting and removing them by hand is not economically viable, resulting in the loss of the entire harvest (Brewer et al. 2014; Newell et al. 2023). Depending on the host and environmental conditions, symptoms can be present during one season or persist over multiple years if the spores remain in the environment (perennial infection) or the fungus has established itself throughout the entire plant (systemic infection) (Brewer et al. 2014; Wolfe and Rissler 2000). This publication aims to help residents and growers recognize symptoms caused by *Exobasidium* fungi and offers solutions for disease prevention and removal.

## Symptoms and Morphology

*Exobasidium* fungi cause a variety of symptoms on the host plant depending on the species. Some *Exobasidium* species cause galls (Figure 1), while other species cause small leaf spots, blisters, blights, or witches' brooms (Figure 2) (Nannfeldt 1981; Shibata and Hirooka 2022). These symptoms occur on the stems, leaves, flowers, fruits, and shoots of various host plants in the order Ericales (Kennedy et al. 2012). Symptoms are usually manifestations of the organism's sexual spore-producing stage. During this stage, the fungus obtains nutrients from the host and uses these nutrients to grow and reproduce. To obtain nutrients from the plant, the fungus will cause hypertrophy and hyperplasia, increasing the size and number of cells. This hypertrophy and hyperplasia distort the leaves or other tissues, resulting in galls and blisters. At maturity, impacted tissues appear white and powdery, or felt-like, on the underside of leaves or the entire surface of the infected plant tissue (Brewer et al. 2014). This felt-like

appearance is a sign of spore production and another indication that the infection is caused by a fungus, not some other type of gall-forming organism. It is important to note that galls or other strange growths on host plants

from outside the order Ericales are not formed by *Exobasidium* fungi and, instead, are likely caused by insects or other gall-forming organisms, such as gall midges or mites (Dale et al. 2021; Day and Dellinger 2022).

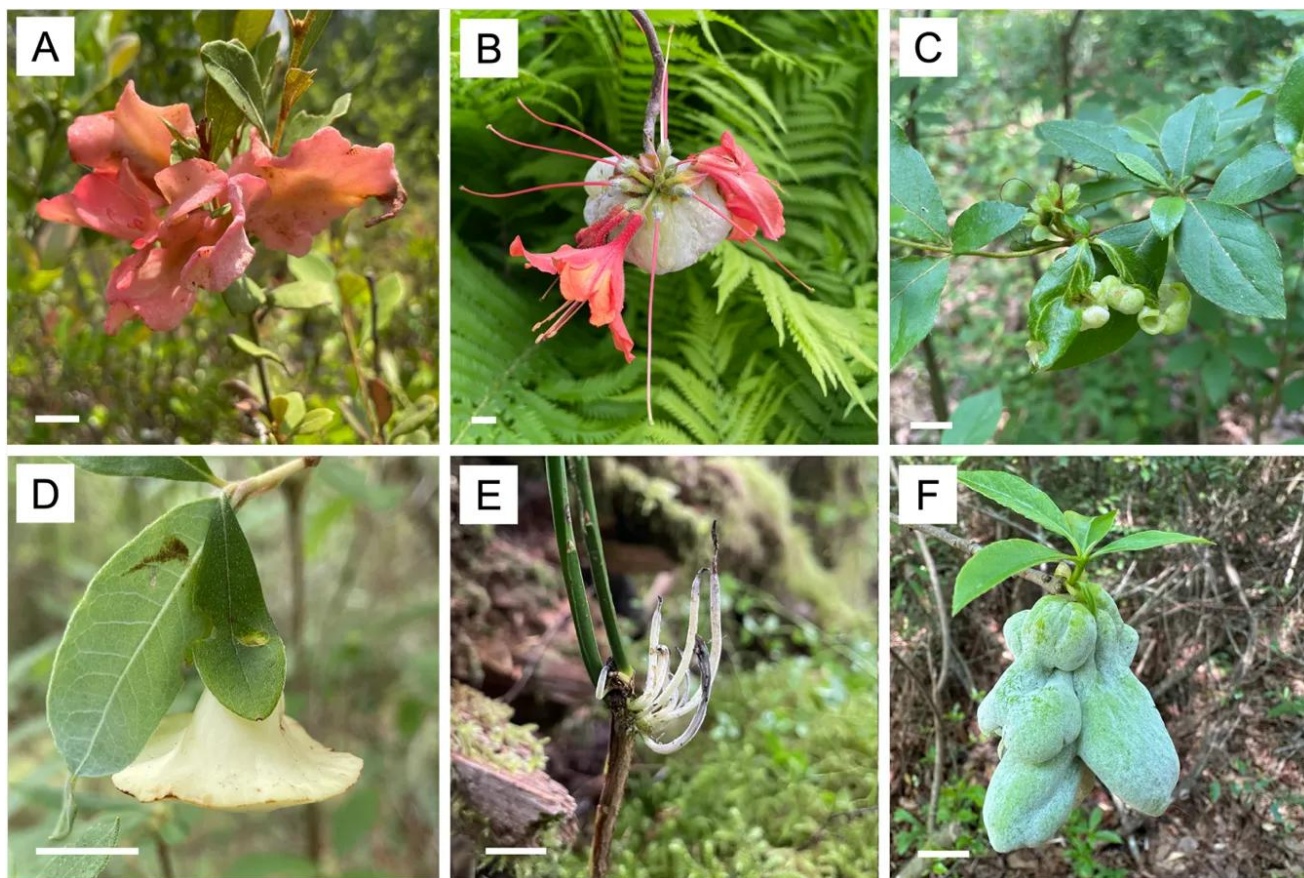


Figure 1 . Galls caused by *Exobasidium* fungi. (A) Reddened shoot gall caused by *Exobasidium ferrugineae* on *Lyonia fruticosa*; (B) flower gall caused by *Exobasidium azaleae* on an azalea hybrid variety; (C) leaf galls caused by an unknown species of *Exobasidium* on torch azalea (*Rhododendron kaempferi*); (D) leaf gall caused by an unknown species of *Exobasidium* on *Rhododendron canescens*; (E) *Exobasidium parvifolii* causing shoestring galls on red huckleberry (*Va*)  
Credit: C. B. Willis, UF/IFAS (A–E), and Philip Mayhair, UWF Historic Trust (F)

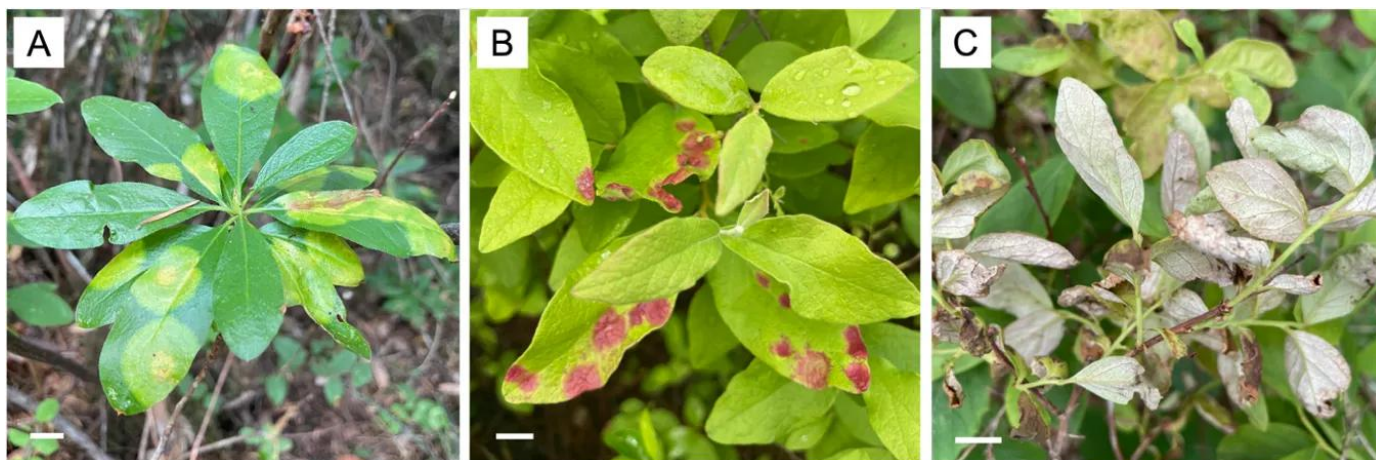


Figure 2. **Other symptoms caused by *Exobasidium* fungi.** (A) Yellow (chlorotic) leaf spots caused by *Exobasidium decolorans* on *Rhododendron occidentale*, (B) reddened leaf blisters caused by an unknown species of *Exobasidium* on *Gaylussacia*, and (C) leaf blight caused by an unknown *Exobasidium* species on *Vaccinium*. Scale bars indicate 1 centimeter.  
Credit: C. B. Willis, UF/IFAS

*Exobasidium* fungi can have two different growth forms (often referred to in fungi as “dimorphism”). In the pathogenic phase, *Exobasidium* fungi grow as filamentous hyphae to penetrate plant tissues and enter cells (Mims and Nickerson 1986). During the rest of their life cycle, *Exobasidium* species often grow as yeasts, a single-celled growth form whereby individual cells reproduce asexually via budding (Newell et al. 2023). The yeast phase of these fungi does not seem to cause plant disease, and it is hypothesized that *Exobasidium* fungi growing in this phase act as saprobes (i.e., decomposers that depend on dead material rather than on the host plant).

When a plant has been infected with *Exobasidium* during the right environmental conditions, the fungus forms a spore-producing layer or hymenium, which appears as a thin white layer over the plant tissues. Some *Exobasidium* species can produce both conidiospores (asexual) and basidiospores (sexual) in this hymenium layer. Thick spore layers form on the outer surface of the infected host tissues and protrude from and in between plant cells (Callan and Carris 2004). Basidia (cells that produce sexual spores) are typically cylindrical to club-shaped, and the hyaline (colorless) basidiospores protrude from their distal ends. The basidiospores are fusiform to musiform (spindle-shaped to banana-shaped). The asexual conidia are also hyaline and generally rod-shaped to elliptical (Kennedy et al. 2012). Basidiospores of *Exobasidium* species may contain one or multiple septations (walls that divide the cells), although these characteristics can only be viewed under a light microscope and may only be apparent at germination.

## Ecology and Distribution

*Exobasidium* species can be found worldwide (GBIF 2025), ranging from boreal, subarctic regions to the Neotropics (Pehkonen and Tolvanen 2008; Kisimova-Horovitz and Gómez 1997). However, *Exobasidium* species appear to have a narrow temperature tolerance during the pathogenic growth phase, ranging from 23°C–29°C (73.4°F–84.2°F) (Nannfeldt 1981; Ingram et al. 2019). These fungi are typically noticeable during the temperate months and are most prevalent in habitats with high diversity and density of plants in the family Ericaceae. *Exobasidium* species appear to have co-evolved with their plant hosts and are thought to be specific to one or a few closely related host plant species (Nannfeldt 1981; Brewer et al. 2014). Many disease occurrences are attributed to the species *Exobasidium vaccinii*, but recent studies have shown *E. vaccinii* is restricted to a single host, *Vaccinium vitis-idaea*, and, therefore, is likely not present in Florida (Kennedy et al. 2012; Brewer et al. 2014).

*Exobasidium* fungi are obligate biotrophic pathogens. Obligate biotrophy means the fungi must infect living plants to complete their life cycles, and the infection does

not typically kill the plant (Brewer et al. 2014). However, most *Exobasidium* species grow readily on simple culture media in the lab, suggesting that they live a significant portion of their life cycles as saprobes. Evidence from epidemiological studies supports this hypothesis: studies have shown *Exobasidium* fungi survive harsh environmental conditions by living inside the bud scales of host plants prior to initiating infection (Graafland 1960; Ingram et al. 2019). Additionally, environmental surveys have isolated *Exobasidium* fungi from unexpected sources, such as mosses or bird feet (Kausercuci et al. 2008; Johansson et al. 2025). These findings suggest that *Exobasidium* fungi may be much more widespread in the environment than previously thought.

On the east coast of North America, agriculturally important host species of *Exobasidium* include blueberries and cranberries (*Vaccinium* species). *Exobasidium* leaf and fruit spot of blueberry, caused by *Exobasidium maculosum*, is a sporadic disease that affects blueberry production (Figure 3) (Brewer et al. 2014). So far, *E. maculosum* has only caused issues for blueberry production in north Florida, and the pathogen is more problematic in Georgia and other parts of the southeastern United States (Harmon et al. 2024). A few different species of *Exobasidium* (*E. oxycocci*, *E. perenne*, and *E. rostrupii*) are known to infect wild and cultivated cranberries (*Vaccinium oxycocci* and *V. macrocarpon*), but large outbreaks are rarely a problem, especially with improved fungicide use and cultural practices over the last century (Shear 1907, 1920; Nickerson 1984; Caruso 1998). In the Middle East and Southeast Asia, *Exobasidium* blister blight caused by *Exobasidium vexans* is a serious disease in tea production (de Weille 1960). *Exobasidium* diseases are also noteworthy in the horticultural trade, as many *Exobasidium* species are well-known to cause large galls on ornamental camellias and azaleas (Wolf and Wolf 1952; Graafland 1960). Native shrubs such as staggerbushes (*Lyonia* spp.) and sweetleaf (*Symplocos tinctoria*) are also common hosts to *Exobasidium* fungi (Kennedy et al. 2012; American Society of Naturalists 1867). Wild *Vaccinium* species could also serve as disease reservoirs for the agricultural production of blueberries, but this possibility has not been closely studied in the genus *Exobasidium* (Power and Mitchell 2004).

While *Exobasidium* spores are well-known to survive tough environmental conditions in the bud scales of their host plants prior to causing disease (Graafland 1960; Ingram et al. 2017), a recent study provided evidence that insects may also play an important role in pathogen dispersal and disease transmission (Newell et al. 2023). However, this area of research has not been well studied, warranting more work to illuminate the potentially complex biology of *Exobasidium* fungi, insect vectors, and other insect-dispersed organisms.

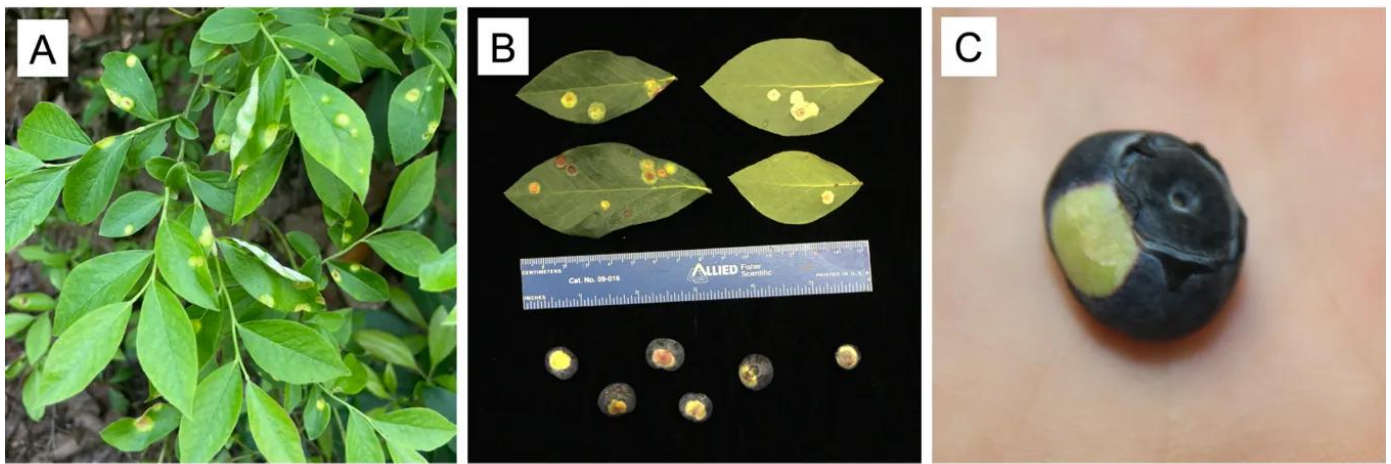


Figure 3 . Symptoms caused by *Exobasidium* leaf and fruit spot on blueberry plants. (A) Chlorotic leaf spots on the leaves of lowbush blueberry (*Vaccinium angustifolium*), (B) leaf and fruit spots on commercial blueberry caused by *Exobasidium maculosum*, and (C) fruit spot on a blueberry fruit.

Credit: C. B. Willis, UF/IFAS (A), and M. T. Brewer, UGA (B and C)

## Disease Management

Cultural and chemical control practices are the two main management strategies for diseases caused by *Exobasidium* species. Homeowners may commonly encounter galls on ornamental azaleas caused by *Exobasidium* fungi.

*Exobasidium* galls on azaleas do not pose an immediate threat to the plant, but they may be considered unsightly. If left untreated for many years, the pathogen may weaken the host plant enough to reduce vigor (Douglas 2011). Thus, homeowners can manage galls by plucking infected leaves or pruning infected branches prior to spore production (Brazee 2024). While the efficacy of pruning and removal has not been tested, galls are best removed when small and before they have developed a white, powdery appearance. Infected material should be removed from the area to avoid reinfection, and pruning may need to be employed for multiple consecutive years to reduce the existing spore bank. If the problem persists, the application of a commercially available fungicide like Mancozeb in the early spring prior to bud opening, a heavier prune, or the removal of the entire affected plant may be necessary (Graafland 1960; Brazee 2024).

General management of *Exobasidium maculosum* on blueberries for commercial production generally divides fungicide applications into four events: pre-bloom, post-bloom, preharvest, and postharvest (Brannen et al. 2016; Ingram et al. 2017). The two most popular fungicides for managing *E. maculosum* are calcium polysulfide (lime sulfur) and Captan. Lime sulfur is a primary choice for many commercial producers because it is labeled for organic production and is a broad-spectrum fungicide. Research has shown that early-season applications (pre-bloom) are more effective than late-season treatments (post-bloom) (Brannen et al. 2016). Growers should plan cultural control methods well before establishing a blueberry grove, as spacing and plant density will affect

the risk of *Exobasidium* and other diseases on blueberries. While denser plantings can provide a greater return on investment in terms of blueberry production, close spacing allows *Exobasidium* spores and other fungi to spread more easily from plant to plant. Denser canopies also increase humidity and retain leaf moisture, which provides favorable conditions for pathogens (Howard 1996). Drip irrigation should be used in place of overhead irrigation methods because overhead watering leads to prolonged leaf wetness, thereby contributing to the proliferation of fungal pathogens. Finally, scouting is the most important component of cultural control. Producers should monitor their groves for any signs of *Exobasidium* or other pathogens and should remove infected plants early to reduce the risk of perennial and systemic infection (Ingram et al. 2017).

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<sup>2</sup> C. Benton Willis, graduate research assistant, UF/IFAS Department of Plant Pathology, Gainesville, FL; Michael Goodnight, graduate research assistant, Department of Entomology and Nematology, UF/IFAS Doctor of Plant Medicine Program; Jessica Velte, graduate research assistant, UF/IFAS Department of Plant Pathology, Gainesville, FL; Marin T. Brewer, department head and distinguished professor, Department of Plant Pathology, University of Georgia, Athens, GA; Matthew E. Smith, professor, Department of Plant Pathology and curator of the UF Fungal Herbarium (FLAS); UF/IFAS Extension, Gainesville, FL 32611.

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