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Fungus Creates Zombie Insects on Dogwood

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Fungus Creates Zombie Insects on Dogwood

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I have something I need to get off my chest. I have an obsession with, of all things, a fungus! And not just any fungus, but a fungus that infects, I am embarrassed to admit, Flowering Dogwood, the VNPS Wildflower of the Year for 2018. Yes, maybe I've gone off my rocker. But this fungus is so cool, so devious, so elegantly convoluted and weird—in a creepy sort of way—that I find myself utterly enthralled. Perhaps sharing my obsession with this fungus will prove therapeutic and permit me to return to my more socially respectable obsessive fascination with plants.

No, I am not writing about Dogwood Anthracnose, *Discula destructiva*, which certainly is a severe problem for *Cornus florida*. Though serious, Dogwood Anthracnose is a rather ordinary parasite; it infects (in effect, it consumes) leaves and floral bracts of Flowering Dogwood. Under cool and moist conditions favorable to *Discula*, it can also spread to stems and even the main trunk, in which case it can prove lethal. But there are thousands of parasitic fungi that go about their plant-destroying life cycle in a generally similar way, i.e., by mounting direct attacks on the cells and tissues of their hosts—nothing special there.

It is not *Discula* but the genus *Septobasidium* that has seized my imagination. If you spend time in nature observing plants, you may have encountered one or more species of this fungus and not given it a second thought. To the naked eye, *Septobasidium* appears to be nothing more than a fuzzy, discolored patch on the surface of relatively small twigs and branchlets. Some species can be mistaken for harmless lichens. Colors range from white to tan, brown, or charcoal black; species that form dark patches tend to have distinct white margins. The fungal body (thallus) may be just a fraction of an inch in size, but large specimens may extend across several inches of stem surface. Sometimes *Septobasidium* completely encircles the branch upon which it lives.

Paradoxically, *Septobasidium* never enters the host plant. Rather than feed directly on the plant, *Septobasidium* parasitizes scale insects that parasitize the plant. The creepy and convoluted part of the story is how this fungus manipulates the scales that feed it. But first, let's review how scale insects feed on plants. At maturity, scale insects look like minuscule turtles clamped onto the surface of plant stems or leaves. Immobile, adult scales have tubelike mouthparts that extend several cells deep into the plant stem, often terminating inside cells in or near the nutrient-rich cambial layer. Once its food source has been secured, the life of the scale consists of sucking up nutritious plant sap and making little baby scales, which, by the way, are born live from their mothers. Locked in place by their mouthparts, adult scales can neither flee nor hide from predatory birds or insects. They are, so to speak, highly nutritious sitting ducks.

Patches of *Septobasidium* hyphae are always found in association with scale insects. Tangled mats of fungal hyphae (threadlike chains of cells) cover the scales, effectively hiding them from view. Careful dissection of the fungal mat reveals distinct chambers in which the scales reside. But it is not a life of protected luxury for all the scale insects in a colony, because some scales are infected with *Septobasidium*. The infection process starts with fungal spores that germinate on the surface of newly hatched scales. Hyphae force entrance into the body of the scale insect and quickly form specialized absorptive cells called haustoria. By means of these haustoria, nutrients pass from the scale to the rest of the *Septobasidium* thallus. In summary, the scale insect steals nutrients from the plant and the fungus takes what it needs from some of the scales that it protects. Infected scales lose the capacity for reproduction and become, in essence, zombie-like food pumps for the fungus. Other, luckier, scales under the protective fungal blanket are uninfected and remain capable of reproduction, a regular supply of new baby scales being crucial for the long-term survival of both the insect and the fungus.

As I was first learning about *Septobasidium* and their scale insect associates, I pondered how such simple organisms could effectively manipulate each other or coordinate with each other in order to achieve the appropriate balance of uninfected, reproductively competent insects and sterile fungus feeders. The answer turns out to be quite simple. Scales are born throughout the warm months; in that same period, the fungus makes its infective basidiospores. Scales born during rainy and humid times succumb at high frequency to infection by *Septobasidium* as they disperse from their mothers. Scales born during dry weather disperse and establish themselves unimpeded by *Septobasidium*. In the Southeast,

then, many scales born in late spring and early summer become zombies, but those born in late summer and fall tend to settle down to fecund lives under their protective fungal mantle.

Ah, but this is not just a story about scales and fungi. There is another devious player in this microcosm that adds another ghastly twist to the tale. As many readers of *Sempervirens* already know, there are parasitic wasps that prey on all sorts of other insects. It turns out that certain parasitic wasps specialize on scale insects. Female wasps of these species penetrate the scale insect's exoskeleton and oviposit directly inside the scale's body cavity; wasp larvae grow by eating their scale hosts from the inside. There are wasps that parasitize free-living scales, and others that parasitize scale species protected by *Septobasidium*. The protection provided to scales by *Septobasidium* is not total!

So how did these intricate parasitic relationships come about? Apparently not much is known about the details, but one conclusion about the origin of *Septobasidium* is undisputed. The closest relatives of this fungus are parasitic rusts, fungi that attack a variety of host plant species. Hollyhock Rust and Black Stem Rust of Wheat are two well-known examples. Their close relationship with *Septobasidium* is revealed in shared details of their spore-producing structures and has been confirmed by DNA sequence data. Presumably, then, fungi ancestral to *Septobasidium* were plant parasites that evolved to exploit the feeding habits of scale insects.

Having told this devious tale, I do feel better; sharing these insights does seem to have lessened my obsession with *Septobasidium*. I can now move on to other matters. But I may never look at Flowering Dogwood the same way. Who could have imagined that our handsome and beloved Dogwoods could host such a cunning den of parasites? To paraphrase Hamlet, "There are more things in our beloved Dogwoods, Horatio, than are dreamt of ..."❖

MOST OF THE INFORMATION IN THIS ARTICLE IS BASED ON:

Couch, J. 1938. The genus *Septobasidium*. University of North Carolina Press, Chapel Hill. 480 pp.