Exserohilum rostratum, The Killing Fungus

Danny Haelewaters
Harvard University Herbaria,
Farlow Herbarium
Email: dhaelewaters@fas.harvard.edu

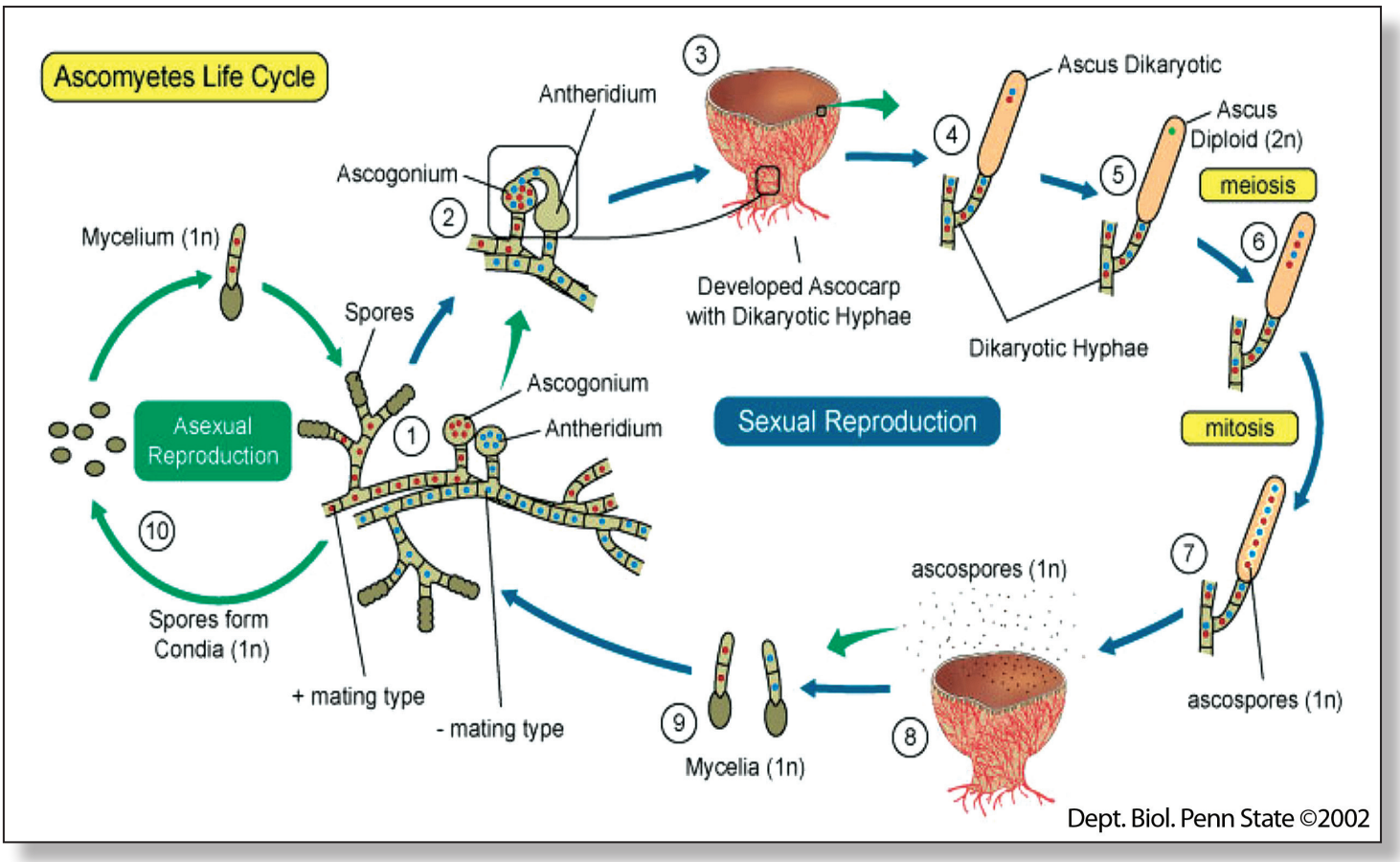
There are hundreds of topics I could write about for my very first contribution to FUNGI. The hardest part about writing is choosing a suitable topic and sticking with it until the end. This time, however, it was a little easier than typically due to the interesting nature of Exserohilum rostratum*. Ever heard of it? It's a fungus that seems to cause fatal meningitis, right now. Wait, right now?! Let's find out what is going on.*

It's been a while since Charles Frank Drechsler (1923) described the ascomycete fungus *Helminthosporium rostratum*. Then Stanley J. Hughes (1958) excluded from the genus *Helminthosporium*, a group of graminicolous species corresponding to another genus, Ito's (1930) *Drechslera*. In 1959, Robert A. Shoemaker even described a third genus, *Bipolaris*, to exclude species that were not like *Drechslera* from *Helminthosporium*. These genera have been rejected by different authors for various reasons and likewise, they have been accepted for various other reasons. Anyway, to make a long story short: the current accepted name for what we are talking about right now is *Exserohilum rostratum*.

It is interesting to consider that this fungus belongs to the Ascomycota. Members of this phylum go through asexual (anamorphic) phases during which they reproduce rapidly by mitospores or conidia (generated through the cellular process of mitosis). The sexual phase with the asci is called the teleomorph (see Ascomycetes Life Cycle illustration, courtesy Pennsylvania State University Department of Biology, and used here with permission).

Back to *Exserohilum rostratum*, is this the anamorph or teleomorph? Let's have a look at the original description of *Helminthosporium rostratum* (Drechsler, 1923):

Occurring on the dry leaves of *Eragrostis major*, host [current name: *Eragrostis cilianensis*, stinkgrass].
Conidiophores dark olivaceous, emerging singly or in groups of 2 to 5 from stomata or between epidermal cells, the swollen bases more or less united; measuring 6 to 8 by 40 to 180 µm; 1 to 6 septate, the septa separated by intervals of 15 to 40 µm; proliferating the first spore 40 to 140 µm from the base, and successive spores at intervals of 10 to 30 µm, at the apices of well-defined geniculations.
Conidia, when mature, dark olivaceous; straight or less frequently somewhat curved; often short, widest at or somewhat below the middle, tapering moderately or more markedly towards both ends, the hemispherical apex abruptly rounded off, the basal end somewhat more acute, often exhibiting a rounded conical contour; or less frequently produced at the tip into a more



or less elongated rostrate prolongation.

There it is: *Exserohilum rostratum* (= *Helminthosporium rostratum*) is the asexual state, the anamorph, since its description is almost purely based on conidial characteristics. An anaomorph/teleomorph connection for this fungus was only made in 1976, when *Setosphaeria rostrata* K.J. Leonard was described and recognized as teleomorph of *Exserohilum rostratum*.

Biocontrol agent

Human impact on the natural environment has expanded tremendously over the past century. Rapid population growth and a globalized economy have caused widespread pollution, habitat destruction and climate change. One major but often little appreciated problem in our increasingly interconnected global biosphere, is the ecological disturbance caused by animals and plants invading new ecosystems. Often these invasions occur unintentionally, for example through ships releasing their ballast water into foreign waters, or through worldwide trade in agricultural and horticultural products. Many other invasions result from deliberate introductions, which have run out of control.

Invading species disrupt the normal functioning of ecosystems by directly outcompeting native species, destabilizing food webs or affecting the cycling of nutrients through the ecosystem. Invasive species may drive native species to extinction through simple food competition, by using available food resources more efficiently, or by mating with native species to which they are closely related (hybridization). Invasive "alien" species are now considered one of the top drivers for global biodiversity loss.

Now, our fungus of interest, *E. rostratum*, has recently been demonstrated to work as a biocontrol agent against one such invasive weed—red sprangletop (Yamaguchi et al., 2009). Red sprangletop, *Leptochloa chinensi* (Linnaeus) Nees, is a grassy weed originating from tropical Asia. It is distributed throughout Southeast Asia, from East Asia to South Africa, Burma, Sri Lanka, India, Australia, and Japan, where it is an alien species. The weed has adapted to moist, swampy places in open habitats and is a huge seed producer (with more than 40,000 seeds per plant). Therefore, it is a significant problem in rice, corn, sorghum, and soybean fields. This weed is a serious strain on rice yield. Annual worldwide rice yield loss caused by this weed is estimated to be 15–21%.

Two sides to every coin

On October 14, 2012 Federal officials reported contaminated injections had sickened 214 people in fifteen states. So far [November 19], 478 people have been diagnosed with meningitis after having had steroid injections into the epidural space as a treatment for back pain. Worse, 36 of them have died.

The injections were found to be contaminated with *Exserohilum rostratum*. This fungus thus seems to have some characteristics that we should take into account when considering using it as a biocontrol agent.

Exserohilum includes several saprobic species in the bark, leaves, and stems of both woody and herbaceous plants, but there's also a large number of parasitic species. Those affecting graminaceous hosts are pretty well known, because of their possible use as effective biocontrol. Next to these economically important forms, many other species of *Exserohilum* are recorded as thriving on various members of the grass family, but have remained more or less obscure because either the hosts affected were of little economic value, or their parasitism caused little or no observable damage.

Although ubiquitous, members of the genus *Exserohilum* are rarely pathogenic in humans. Only three species have been shown to parasitize humans: *E. rostratum*, *E. longirostratum* and *E. macginnisii* (Saint-Jean et al., 2007). The most common type of infections are sinusitis and skin infections, although a few cases of cerebral abscesses, keratitis, osteomyelitis, prosthetic valve endocarditis and disseminated infection have been described. In 2007 a child undergoing treatment for acute lymphoblastic leukemia (ALL) was infected by *E. rostratum*, causing cutaneous phaeohyphomycosis. The infection was due to contaminated intravenous dressings. In total, only ten cases of primary cutaneous skin infections due to *Exserohilum* have been described in the English literature. The problems with these reports are the incomplete data on follow-up and the lack of discussion of the potential use of newer antifungal agents. However, treatment of these cutaneous infections is primarily based on aggressive surgical removal combined with antifungal therapy.

The *Centre Hospitalier Universitaire Saint-Justine* (Montreal) decided after the 2007 *E. rostratum* case to replace all wooden boards used to secure intravenous lines by Plexiglas covered with sterile gauze. The replacement occurred as part of an infection control policy and is said to be potentially lifesaving (Saint-Jean et al., 2007). However, no fungal traces were found, although certain tapes and wooden devices have been reported to be linked with fungal infection.

Since October, 19 states reported cases with fungal meningitis. The outbreak was traced back to *Exserohilum rostratum* contaminated medication for epidural steroid injections, packaged and marketed by the New England Compounding Center (Framingham, MA). It is estimated that more than 14,000 people may have been exposed to the contaminated medication—they are not necessarily infected.

Conclusion

As a conclusion we may want to limit working with *Exserohilum rostratum*. If this invasive *Leptochloa* weed is still bothering you, I suggest trying to raise a green manuring legume in the summer in crop fields that would be ploughed *in situ* at the time of preparing fields (Kathiresan, 2006). I'm sure this won't kill you.

Acknowledgements

This article has been adapted with permission from a blog post published by the author on SciLogs.com. Many thanks go to Sarah Verhaeghen, Rachel Engstrand and Donald H. Pfister for their valuable comments.

References Cited

Drechsler, C.F. 1923. Some graminicolous species of *Helminthosporium*. *Journal of Agricultural Research* 24: 641-740.

Kathiresan, K.R. 2006. Effect of Global Warming on invasion of alien plants in Asia. NIAES Symposium, Japan.

Leonard, K.J. 1976. Synonymy of *Exserohilum halodes* with *E. rostratum*, and induction of the ascigerous state, *Setosphaeria rostrata*. *Mycologia* 68(2): 402-411.

Saint-Jean, M., G. St-Germain, C. Lafarrière, and B. Tapiero. 2007. Hospital-acquired phaeohyphomycosis due to *Exserohilum rostratum* in a child with leukemia. *Canadian Journal of Infectious Diseases and Medical Microbiology* 18(3): 200-202.

Yamaguchi, K., K. Nagai, and E. Matsumoto. 2009. Conidia production of *Exserohilum rostratum*, a biocontrol agent against red sprangletop (*Leptochlora chinensis*), by a two-phase system using sponge matrix. *Bulletin of Minamikyushu University* 39A: 73-77.

Last but not least, here's some pretty awesome taxonomy (from Leonard, 1976), just because many of you, as well as myself, like to explore the history of names:

Exserohilum rostratum (Drechsler) K.J. Leonard & Suggs, 1974, *Mycologia* 66: 290.

= *Helminthosporium rostratum* Drechsler, 1923, *J. Agric. Res.* 24: 724.

= *Bipolaris rostrata* (Drechsler) Shoemaker, 1959, *Canad. J. Bot.* 37: 883.

= *Drechslera rostrata* (Drechsler) Richardson & Fraser, 1968, *Trans. Brit. Mycol. Soc.* 51: 148.

= *Exserohilum halodes* (Drechsler) K.J. Leonard & Suggs, 1974, *Mycologia* 66: 290.

= *Helminthosporium halodes* Drechsler, 1923, *J. Agric. Res.* 24: 709.

= *Bipolaris halodes* (Drechsl.) Shoemaker, 1959, *Canad. J. Bot.* 37: 883.

= *Drechslera halodes* (Drechsl.) Subramanian & Jain, 1966, *Current Sci.* 35: 354.

= *Helminthosporium halodes* Drechsler var. *tritici* Mitra, 1931, *Trans. Brit. Mycol. Soc.* 15: 287.

= *Helminthosporium halodes* Drechsler var. *elaeicola* Kovachich, 1954, *Trans. Brit. Mycol. Soc.* 37: 423.