A version of this report appeared in
Hsiang T. 2004. Getting to know your snow moulds. GreenMaster 39(5):24-26.

Amazing facts about snow molds
By Tom Hsiang

As the snow is melting after a long winter, you can see circular patches of dead grass often matted together with fungal growth. These symptoms are caused by snow molds, but how did the snow mold get there and what is it doing there under the snow? An article on snow molds last year in GreenMaster (February 2003, pages 46-49) discussed diagnosis of grey and pink snow moulds. This article will examine the life cycle of the grey snow mould fungi, and explore the biology of these organisms.

Gray snow mold is caused by two closely related species of fungi: *Typhula ishikariensis* which more common in areas with more than two months of snow cover, and *Typhula incarnata* which is more common in areas with less than two months of snow cover. These organisms are active in the winter, but dormant during the summer. Throughout most of the year and all of the regular growing season, these organisms persist in the form of sclerotia. These sclerotia are small dark compact bodies resembling poppy seeds or small mouse dropping (Figures 1 and 2) that are built to survive conditions unfavorable for fungal growth. They may also be moved around by footwear or equipment.

Gray snow mold sclerotia are formed in winter on colonized plant tissues, and then at snowmelt, they fall into the thatch to wait for cool (<10 C), wet conditions in autumn to begin growth. Under such conditions, the sclerotia will germinate to produce stalks that bear spores (Figure 3). Each stalk is a sexually reproductive body and can produce thousands upon thousands of spores. Each spore then must make its way into the world and find a compatible mate. For *Typhula* fungi, each spore can mate only with a spore of a different sex, but since there are potentially thousands of different sexes in the gene pool, nearly every spore encountered will be compatible. However, the limitation is that the compatible spores need to land within a very short distance of each other, and this is one reason that the thousands of spores from one stalk do not all lead to snow mold infections.

After compatible spores have landed on the appropriate grass host, they do not initiate infections right away. Spore production is timed to coincide with snowfall, since the snow provides a dark, wet, and protected environment that is just right for snow mold growth. During this time under the snow, the fungus needs to feed on dead organic matter and be prepared to infect plant tissue when the tissue becomes vulnerable, which is when the plant begins to exhaust its food reserves. Fungi mount their attack on their plant hosts by secreting enzymes. The enzymes would be immobilized and inactive if they were frozen. Amazingly, these snow mold fungi have been found to produce compounds that can moderate their environment by reducing the temperature at which ice formation occurs. These compounds, called antifreeze proteins, are able to suppress ice crystal growth, and may aid fungal growth by preventing explosive expansive of ice crystals that could cause injury to fungal cells. Ice crystals which form in water look like coins (Figure 4A), whereas ice crystals which are inhibited by snow mold antifreeze proteins develop fancy shapes such as this double starfish (Figure 4B) or this maple leaf (Figure 4C). Under snow cover, the temperature at the soil surface remains near 0C. But if the snow layer is reduced by wind, snowmelt or sublimination (snow crystals becoming water vapour directly), or if the insulative capacity of the snow layer is compromised by rainfall, then temperatures may drop below 0C. The antifreeze proteins then give the fungus a small edge by slightly decreasing the temperature at which ice crystals form.

This article has described how the grey snow mold fungi travel (by spores or by sclerotia being moved around), and what they do under snow cover (moderate their environment with antifreeze proteins and wait for the grass plants to weaken). If you would like to learn more about the fascinating activities of snow mold fungi, please visit this website: http://www.uoguelph.ca/~thsiang/snow/snow.htm.

Dr. Tom Hsiang is a professor in the Department of Environmental Biology at the University of Guelph. He began his research on snow molds as an adaption to the cold winter conditions (a reason to look forward to winter?) after being transplanted from the west coast. He can be reached at thsiang@uoguelphca.

Figure 1. The gray snow mold fungus *Typhula incarnata* produces reddish brown sclerotia up to 5 mm (0.04 in) across. Here it is attached to a dried leaf blade of creeping bentgrass at a magnification of 10X (assuming it is printed at a column width of 8.5 cm)

Figure 2. The other gray snow mold fungus, *Typhula ishikariensis*, which is favored by longer duration snow cover, produces small, black, round sclerotia less than 2 mm (0.08 in) across. Here it is embedded among decayed leaf blades of creeping bentgrass at a magnification of 10X (assuming it is printed at a column width of 8.5 cm).

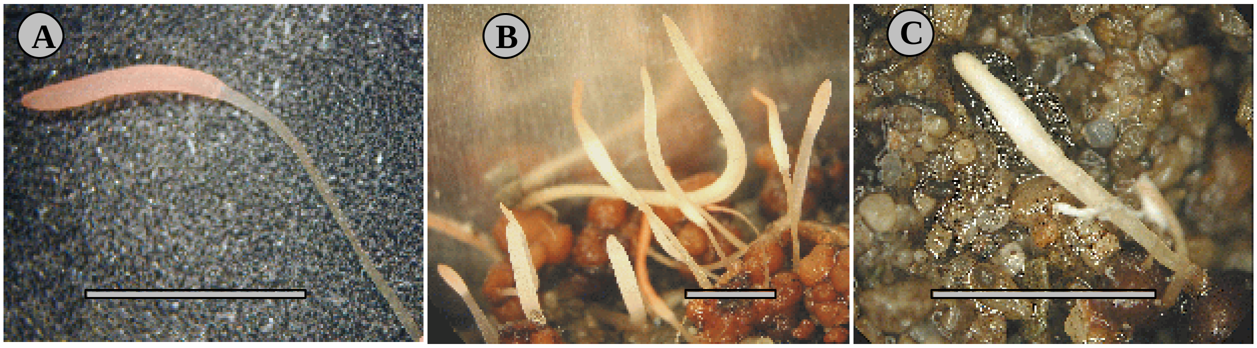

Figure 3. Spore producing stalks of (A) *Typhula incarnata*, (B) *Typhula phacorrhiza*, and (C) *Typhula ishikariensis*, with scalebar at bottom of each picture representing 5 mm. The stalks grow out of sclerotia under wet cool conditions. *Typhula incarnata* and *Typhula ishikariensis* cause gray snow mold, while *Typhula phacorrhiza* is known as a biological control agent for snow molds (see GreenMaster Oct/Nov 2000, pages 12-15).

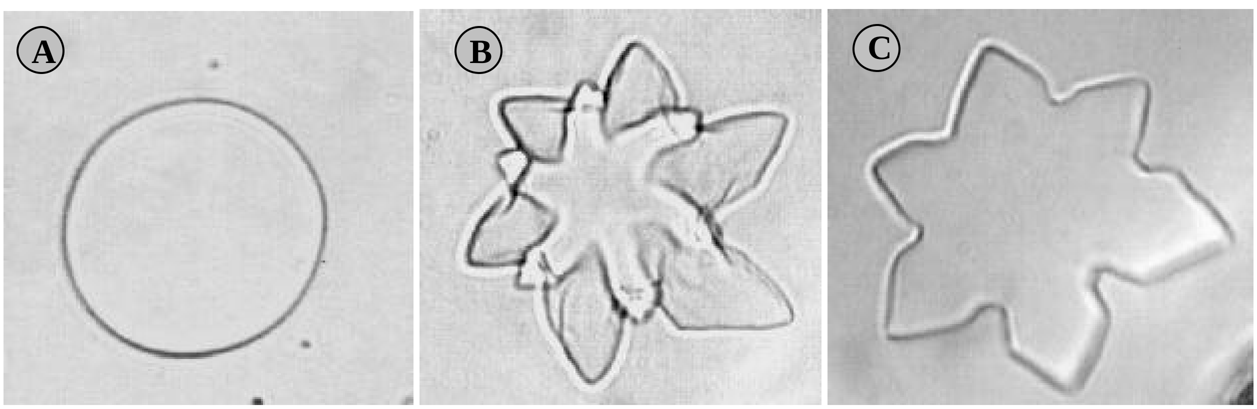

Figure 4. Ice crystals formed (A) in the absence of antifreeze proteins or (B,C) with *Typhula* antifreeze proteins. The odd shapes indicate that the proteins are inhibiting normal growth of the ice crystals. Each crystal is approximately 30 um across.