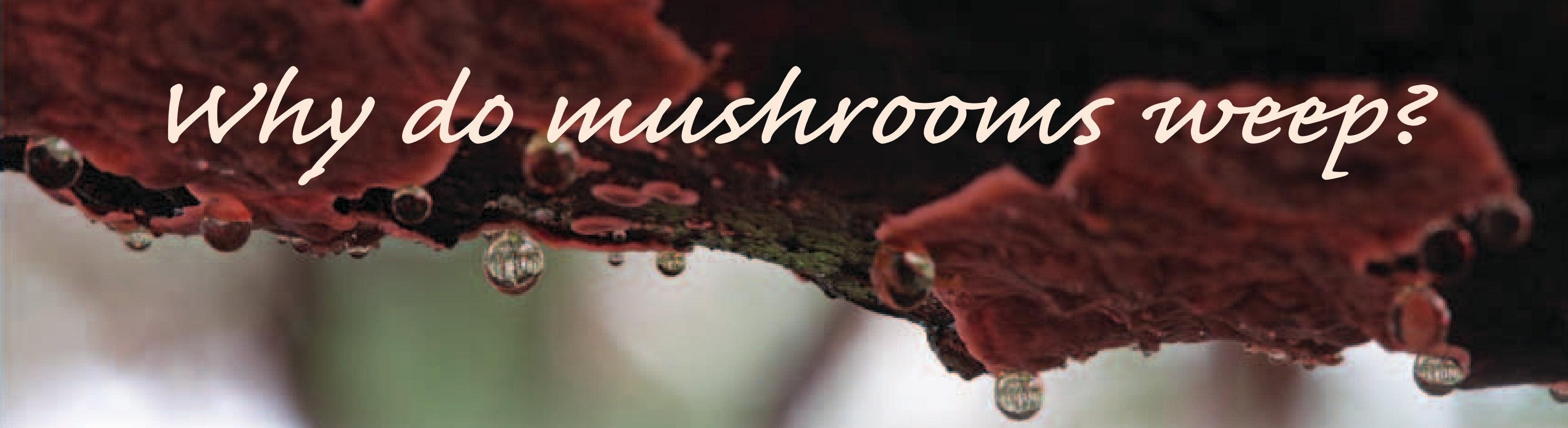

Why do mushrooms weep?

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All life is energy dependent. Most large multicellular organisms break down their food into simple sugars, which are used to release the energy required for life. This is the catabolic part of metabolism. Its other end products, if following an oxidative pathway, are carbon dioxide and water. We breathe out not only carbon dioxide, but also a large amount of water as a gas into the atmosphere. This is why we can see our breath on cold days: the warm water vapor condenses on contact with the colder outside air, and becomes visible as a cloud of small water droplets. On really cold days these droplets freeze into solid ice when they come into contact with colder surfaces, accounting for frost on clothing and hair during subzero weather. The amount of frost increases if we increase our metabolic rate by physical activity (Figure 1).

Figure 1. Water from breath, settling as ice crystals on clothing and hair after skiing for two hours at -47°C; Inuvik, NWT, Canada.

Carbon dioxide and water are metabolic products for many fungi as well, which several exude invisibly from their surface. During periods of rapid growth, metabolism speeds up. In those periods some mushrooms form visible drops on their surface.

Figure 2. Rapidly growing very young fruitbody of the European *Fomitopsis pinicola*, showing copious water droplets; Kesselaid Forest, Estonia. Photo: Kristiina Veltmander. Guttation is characteristic for this species in northern Europe, but not in Newfoundland.

This is called guttation, a term used in botany to describe the process by which plants excrete excess water through drops from their leaves. For some mushrooms this is so common that it is a reliable identification feature, while for others it is virtually unknown. Guttation is common among several corticioid and many bracket fungi, as well as some stipitate hydnoids, but relatively uncommon among gilled fungi and boletes, excepting a few Suilli. Differences in handling excess water by genetically different fungi should not be surprising, because chemical reactions directing physiological pathways are genetically programmed. An interesting example of this might be provided by the familiar *Fomitopsis pinicola*. In Estonia it is common for this polypore to weep weakly acid water during growth (Figure 2). In Newfoundland guttation by growing *F. pinicola* is uncommon. Breeding studies suggest that *F. pinicola* is a species complex of at least three morphologically similar species, one in Europe and two in North America. Is it possible that the genetic programming for guttation is present in the European species, but not in that found in Newfoundland? Guttation may provide macroscopic means to differentiate some cryptic species.

Figure 3. Actively growing *Hydnellum peckii* with red droplets; Gros Morne National Park, Newfoundland and Labrador, Canada. The light color and soft texture of the fruitbody indicates that it is actively growing.

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Figure 4. Actively growing *Hydnellum multiceps*; Gros Morne National Park, Newfoundland and Labrador, Canada. Again, the light color and soft texture of the fruitbody indicate that it is growing rapidly.

Hydnellum peckii is well known for its droplets (Figure 3). These are usually colored red by terphenylquinone dye (or a derivative), a pigment produced by this genus of mushrooms. Under favorable temperature and humidity, red droplets can also be seen in other members of the genus during active growth (Figure 4). Most guttating mushrooms produce clear droplets, often more viscid than water, suggesting that they also excrete other chemicals. Thus, under the right conditions *Stereum sanguinolentum* forms copious clear droplets (title banner); although it contains red latex, the pigment is not exuded with guttation.

Just as we make frost when exhaling water vapor in subzero air, rapidly metabolizing mushrooms that have developed during periods of winter thaw can also form ice under certain temperature fluctuations. As the air cools after sunset, metabolism slows down. The mushroom's surface cools

Figure 5. Young *Auricularia americana* photographed on an early February morning; Humber Village, Newfoundland and Labrador, Canada. Note thin sheet of ice covering underside and a 20% rim of the upper surface.

before its core and if some metabolism continues in the core, exuded water vapor might condense to liquid water on contact with this cooler surface. Because humidity is high during a thaw and saturation increases as air cools, there is little evaporation, and as the temperature drops below freezing, the water freezes. This can be documented in the early morning, before the sun has warmed the air enough to melt the ice (Figure 5).

Very little investigation of fungal guttation has been done. There may be many reasons for droplet formation, but the association of this phenomenon with rapid growth is well known, albeit a causal relationship has not been confirmed scientifically. Without such studies, the question of the title must be considered unanswered. In the interim, ascribing the water to an increased metabolic rate offers a felicitous and plausible explanation, inviting to be tested.

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