# Observations on post-fire black morel ascocarp development in an Israeli burnt forest site and their preferred micro-sites

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Short communication

# Observations on post-fire black morel ascocarp development in an Israeli burnt forest site and their preferred micro-sites

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ABSTRACT

*Morchella* species ascocarps (morels) are sought-after edible mushrooms that exhibit pyrophilous behavior, proliferating in fire-affected soils of certain types of forests. The factors governing fruiting in this habitat are poorly understood. An observational approach was used to determine the spatial distribution on preferred micro-sites of black morel fruiting in a forest after a summer fire, subjected to different post-fire forestry management activities. Clearing the burnt tree stumps from the site, compaction of the burnt soil by heavy machinery (bulldozers) and covering the soil with chopped wood created preferred micro-sites for black morel fruiting. Fewer fruit bodies developed on untouched burnt soil, and almost none on non-burnt soil at the same site. These observations enhance understanding the ecological principles underlying the distribution and abundance of morel ascocarp development in natural habitats; such an understanding could contribute to conservation and management of morel fruiting in the wild.



Edible species of the genus *Morchella* (morels) (*Pezizales*, *Ascomycota*) are an important non-timber forest product. Morels exhibit pyrophilous behavior, pioneering burnt wild sites: they proliferate mainly in coniferous forests in the spring or summer following a wildfire, usually for 1 or 2 yr, after which the population rapidly declines (Peterson 1970; Apfelbaum *et al.* 1984; Schlosser & Blatner 1995; Pilz *et al.* 2004; Wurtz *et al.* 2005). Due to high harvesting loads of the mushrooms from burnt sites, an understanding of the ecological principles underlying their distribution and abundance in post-fire sites is needed for their conservation, and maintaining their population density. This has led to publications aimed at delineating the triggers for morel proliferation in this type of habitat (Winder & Keefer 2008; Greene *et al.* 2010), but not all of them are yet known.

To increase our understanding of factors controlling morel ascocarp production in post-fire forests, we used an observational approach to study their production in a post-fire area subjected to different management activities. The study site was a pine (*Pinus halepensis*) plantation forest exposed to an intensive fire event in the summer (Aug.) of 2006 in northern Israel (Masaphy *et al.* 2009). Immediately after the fire, the forest was subjected to intensive forest management by the Israeli Forestry Authority: massive cutting and clearing of the

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burnt trees and mechanical chopping of the wood debris, which was then used as either compost or a cover layer on the burnt soil. Another activity consisted of disrupting the soil with heavy machinery, cleaning the surface and digging holes for replanting. The site was scanned for morels weekly from the first rain event the following autumn (Nov. 2006) throughout the rainy season in this region, which usually ends in May. The first wave of morels was spotted in early Mar. 2007, with only a few young ascocarps. When they matured they were identified as black morels, members of the *Morchella elata* clade as defined morphologically by Kuo *et al.* (2012). A week later, there was a high abundance of fruit bodies, and mushrooms were counted to find the micro-site with the highest density of morels following the various forestry management activities. The scanned field of study (240 000 $m^2$ overall) was composed of different micro-site patches categorized into four types according to disruption conditions: (1) non-burnt field within the burnt forest; (2) burnt forest without forest management (untouched burnt site); (3) burnt forest with heavy machinery work (bulldozers) for stump clearing and hole digging; and (4) burnt forest with heavy machinery work for stump clearing, then layering the chopped wood debris over the soil or in composting piles. Three 500-$m^2$ plots for each type of micro-site were monitored and all ascocarps were counted in each plot. These plots were not clustered together but rather dispersed randomly throughout the field.

Around 2 000 ascocarps of black morel were counted in 1 d at the observation site in the spring 2007 mushroom proliferation event. The morels belonged to the black morel group. The highest quantities of mushroom appeared on the burnt forest soil after it had been subjected to massive heavy machinery activity, and covered with chopped wood (Table 1). Fewer mushrooms were found on the burnt, bare soil after heavy machinery work for hole digging, where many of the ascocarps were found clinging to the walls of the still-empty holes prepared for planting. Even fewer ascocarps were found on the untouched burnt and non-burnt soils.

Black morel ascocarp density was higher in micro-sites exposed to a combination of disturbances, probably as a result of the following favorable conditions for fruiting: (1) no competition with other organisms; (2) initial increase in soil surface mineral content (due to burning of the plant biomass) and increasing nitrogen availability (Raison 1979), which may provide nutrients for mycelial growth to support ascocarp production; (3) physical compaction of the soil which might limit aeration (Beylich *et al.* 2010); and (4) covering of the soil with chopped wood, which may have a dual effect – release of organic soluble compounds from the chopped wood into the soil surface provides nutrients for the fungal mycelium growing beneath the wood, and provision of protection and humidity for the young ascocarps as they emerge. The chopped wood might also increase the soil's water-holding capacity (Mulumba & Lal 2008). Protection and maintenance of humidity may also explain why the plantation holes supported ascocarp persistence and development. Higher soil moisture was measured in the precise soil in which the morel fruit bodies developed as compared with soil with no fruit bodies in the same field (Masaphy *et al.* 2009). Maintaining soil moisture is important during the Israeli winter due to the weather conditions, which may comprise many sunny and dry days. Soil surface conditions in a post-fire site were also found to be important to morel production by Greene *et al.* (2010), who reported that the spatial distribution of morel ascocarps was strongly biased toward micro-sites with thin post-fire duff (forest floor organic layer) and proximity to standing burnt tree trunks. Winder & Keefer (2008) also found higher morel abundance at a site with the highest level of duff burning up but the abundance was also related to the plant species at the site. These observations support other reports suggesting that forest management activities undertaken after fire events, to accelerate rehabilitation of the burnt habitat, may also produce more short-term disturbances, with an impact on the soil's physical, chemical and biological properties, including the life cycles of soil fungi (McMullan-Fisher *et al.* 2011; Jennings *et al.* 2012).

We found only a few morels when visiting the same forest the following year, and they appeared only on the edges of the chopped wood debris piles, where no vegetation was growing. In this same year, no morels were found where rich or fresh vegetation had appeared on the burnt soil. The year after that, i.e. 2 yr after the fire event, no morels were found in the observed field. The production of morels for only one or two seasons after a fire is a well-known phenomenon worldwide.

In summary, we describe the preferred micro-sites for black morel ascocarp growth in a particular field after a massive fire event in Israel. Black and gray morels are the main groups of morels growing in post-fire sites worldwide (Pilz *et al.* 2004; McFarlane *et al.* 2005; Winder & Keefer 2008). Use of an *in vitro* system was not successful at identifying post-fire environmental factors that trigger fruiting initiation in *Morchella elata* (Winder 2006). Nevertheless, *in vitro* studies focusing on the effects of the different environmental parameters of burnt soil on mycelial growth and ascocarp initiation in morel species should be continued, to understand their tolerance of fire-affected sites. Moreover, since species in the genus *Morchella* exhibit varying trophic states with varying degrees of mycorrhizal interactions with plants (Buscot 1992), different morel species are expected to be affected differently by fire events (Pilz *et al.* 2004). The different micro-sites in the present work represented micro-habitats that differ in their

**Table 1 – Morel fruit body quantities in the different burnt forest microhabitats. Results are presented as mean ± SD**

| | Field description | Actions | Morels (no. per 500 $m^2$) |
|---|---|---|---|
| 1 | Non-burnt field within the burnt area | | 4.6 (4.7) |
| 2 | Burnt forest without forest management | | 34.0 (26.4) |
| 3 | Burnt forest with forest management | Tree stump clearing and bulldozer work, new planting holes | 170.0 (141.4) |
| 4 | Burnt forest with forest management | Tree stump clearing and bulldozer work, with chopped wood debris layered over the soil or in composting piles | 424.7 (222.6) |

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physicochemical and biological characteristics. More observational studies on the micro-site preferences of morels in other burnt forests should be conducted to gain better knowledge and understanding of the ecological behavior of the morel populations.

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