Effects of Fire on Hypogeous Fungi, Spore Dispersal and Dependent Flora Establishment in Soils

Steven L. Miller ✦ Department of Botany
Nancy L. Stanton ✦ Zoology Department
Stephen E. Williams ✦ Plant, Soil and Insect Sciences
University of Wyoming
Laramie

✦ Objectives

In our initial survey of dispersal of spores into areas disturbed by the 1988 Huckleberry burn, in the John D. Rockefeller Memorial Parkway, we focused on small mammal dispersal of hypogeous ectomycorrhizal fungi which had been touted as a primary means of dispersal (Trappe and Maser 1977, Ure and Maser 1982), and the recruitment and physiognomy of conifer seedlings germinating in the burned areas. Interestingly, the small mammals captured at the Huck burn sites were feeding on both epigeous and hypogeous, as well as, mycorrhizal and non-mycorrhizal fungi. The seedlings that had germinated in the burned areas were non-mycorrhizal until late in the season. These results are somewhat contradictory to hypotheses offered in the literature. For these reasons, additional objectives, such as including both hypogeous and epigeous ectomycorrhizal fungi, were established to examine the process of ectomycorrhizal colonization more closely.

✦ Methods

During the spring and summer of 1990, field work was continued at the two permanent study sites established on the Huck burn. Sampling included collection and analysis of fecal pellets from live-trapped small mammals, examination of conifer seedling recruitment and mycorrhizal formation and extraction of spores and sclerotia from soils. Methods were similar to those reported for the 1989 field season (Miller et al. 1990a) and will not be presented in detail here. However, we initiated a new study to determine how long spores remain in the soil, and whether they move through the soil horizon with time. In August, we flagged individual basidiomes of five species of epigeous ectomycorrhizal fungi associated with lodgepole pine. One month later, we collected surface litter and soil cores from 0-3 cm and 3-6 cm in the mineral soil directly under the position of each sporocarp. Spores were then extracted from each of the three fractions and counted with haemocytometer.

✦ Results

The technique for extracting spores and sclerotia directly appears to be 90-100% effective at recovering fungal spores when slurries of spores in water are tested. When slurries are introduced into soil and then extracted, the recovery efficiency decreases to 30-40%. We interpret this to mean that the surface charge of spores, the presence of ornamentation and the density of the different populations of spores influence how they interact with the physical properties of soil. Additional experimentation will allow us to improve on the technique.

Basidiocarps of five species of epigeous ectomycorrhizal fungi including *Suillus brevipes, Suillus tomentosus, Russula brevipes, Tricholoma zelleri* and *Lactarius* sp. appeared to discharge most of their spores directly onto the surface litter during the life of individual basidiocarps. After one month, most spores were still recovered from the litter, with no or few spores found in the mineral soil at either 0-3 or 3-6 cm in depth. The spores of several species appeared to be parasitized by a conidiogenous imperfect fungus, which indicates that spores of some ectomycorrhizal fungi, once discharged, may be parasitized by other fungi. A second collection of soil cores will be taken from the same area in the spring and should demonstrate whether spores remain resident in the soil over the winter.

Sclerotia of two fungal species, *Cenococcum geophilum,* an ectomycorrhizal ascomycete, and *Morchella* sp., a facultative ascomycete, were extracted from the soil. More *C. geophilum* sclerotia were recovered from subsoil fractions taken from the burned areas than from the unburned control sites. Sclerotia of *Morchella* sp. appeared to be most abundant in soils with high ash content, including soil from beneath downed logs. This correlates well with the location of sporocarp production by *Morchella.* Sclerotia formation may be stimulated by disturbance, and may be a mechanism whereby ectomycorrhizal fungi are able to recolonize seedlings during secondary succession.

Two species of conifer seedlings were encountered during the second year following fire in the Huck burn. Little mortality occurred on flagged seedlings between the September 1989 collecting trip and June 1990 (Fig. 1). Most mortality that did occur was due to large mammal disturbance and not seedling

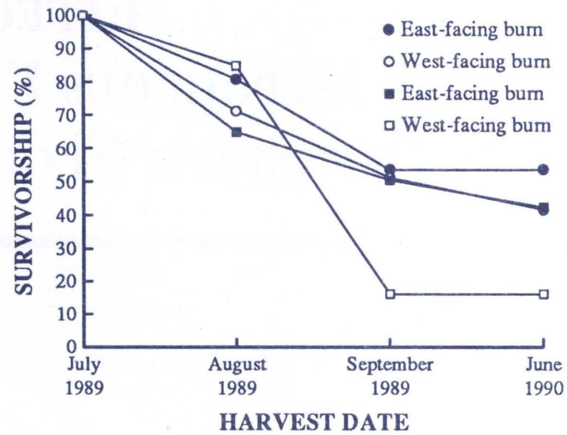

Figure 1. Survivorship of first year Pinus contorta seedlings at the Huck fire sites.

physiognomy. During the summer of 1989, Lodgepole pine *(Pinus contorta)* exhibited the greatest recruitment in the east-facing edge treatment, and the least in the east-facing burn. However, because recruitment was highly variable between plots, few significant differences could be noted between treatments (Fig. 2). Recruitment of lodgepole pine seedlings during the summer of 1990 was about an order of magnitude less than recorded for 1989 (Fig. 2). This indicates that establishment of lodgepole pine immediately after fire is crucial for maintaining conifer dominance during early secondary succession (Miller et al. 1990b). Subalpine fir *(Abies lasiocarpa)* was rarely encountered in either 1989 or 1990 at our sites.

As in the first year of sampling, three species of small mammals were commonly trapped including the southern red-backed vole *(Clethrionomys gapperi),* the white-footed deer mouse *(Peromyscus maniculatus),* and the least chipmunk *(Tamias minimus).* The southern red-backed vole again consumed many species of mycorrhizal as well as non-mycorrhizal fungi but unlike the first field season, several individuals moved from the unburned forest into the burns. Fecal pellets of red-backed voles that moved into the burned areas contained spores of ectomycorrhizal fungi. These voles presumably served as a source of inoculum, although the red-backed vole remained primarily in the unburned forest where ectomycorrhizal fungi already reside. The white-footed deer mouse, which commonly inhabited the burns, continued to feed primarily on vascular plant seeds. The least chipmunk, a generalist that fed on

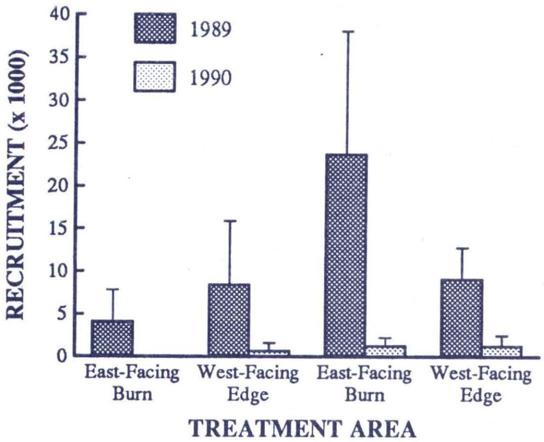

Figure 2. Recruitment of Pinus contorta seedlings at the Huck fire sites in numbers of seedlings per hectare.

both plants and fungi and moved between unburned forest and the burns, also exhibited potential for dispersing spores.

Fecal pellets contained both hypogeous and epigeous ectomycorrhizal fungal species as well as saprophytes and facultative ectendomycorrhizal species. The large number of spores from epigeous ectomycorrhizal and saprophytic fungi contained in the pellets again disproved the hypothesis that small mammals near the Huck burn sites feed primarily on hypogeous ectomycorrhizal species.

Ongoing research includes the greenhouse soil bioassay for both ectomycorrhizal and vesicular-arbuscular fungi, soil chemical analysis, identification of fungal species from fecal pellets, spore extractions from soil and identification of insects from pitfall traps.

✦ Conclusions

It is evident from our second year of study that mycorrhizal fungi affect the timing and trajectory of secondary succession in Grand Teton National Park and the Rockefeller Parkway by directly influencing conifer seedling physiognomy, recruitment and survivorship. It is also clear that like many vascular plants adapted to respond quickly to fire, there are fungi that may be adapted to colonize quickly after fire events. Further understanding the strategies for persistence, propagation and survival of ectomycorrhizal fungi is required before responses of forest ecosystems to fire and other disturbance can be properly managed.

✦ Literature Cited

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