See p. 37 Ken Russell

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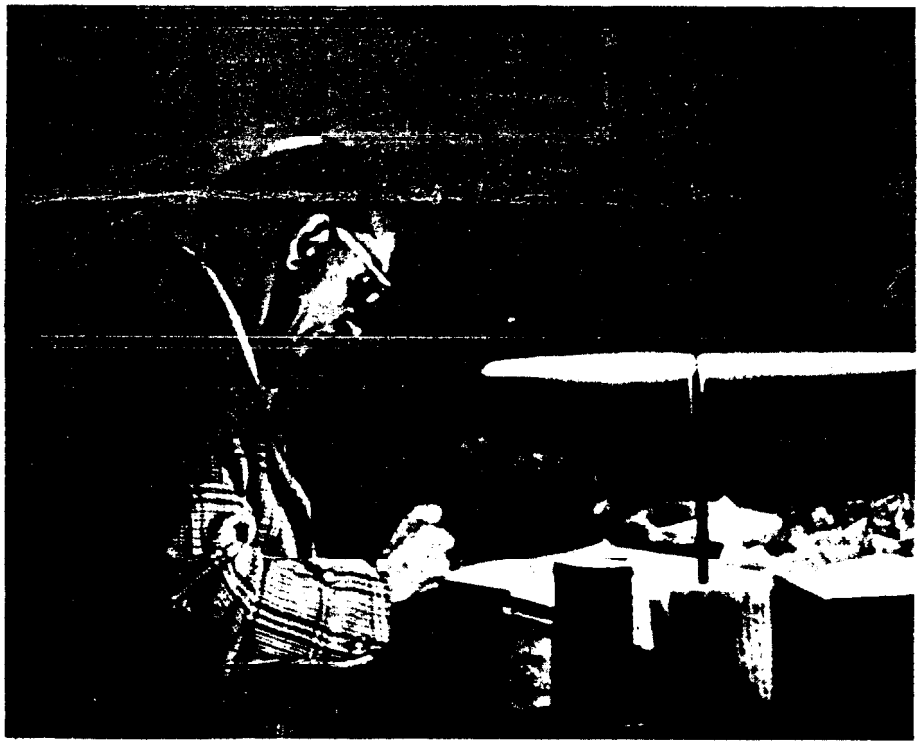

*In memory of a fellow who loved mushrooms, but not for dinner.*

Russell

species in antibiosis ability.

Positive feedback further affects the mushroom picture in the woods. Ectomycorrhizae assist in nutrient uptake, particularly phosphorus, and generally increase the autobiont's overall growth. Larger healthy trees mean more carbohydrates are available for roots and fungi. Defoliation or impaired leaf function has been shown in birch significantly to reduce sporophore production of attached mycorrhizal fungi. Both during the infection and the fully established condition, ectomycorrhizal fungi probably secrete regulatory compounds which affect the release of autobiont substances, antibiotics, compounds by which the plant recognizes the fungus as a suitable mycorrhiza-former. Each of these classes of compounds could modify the environment surrounding particular roots. Auxins secreted by the fungus could conceivably stimulate the production and secondary thickening of laterals, thereby drawing more carbohydrates to the roots. This higher flow of nutrients could favor a larger species which dominates in high-nutrient environments. Little research, however, has been done on these fungus-secreted substances.

Thus the variation among species of ectomycorrhizal fungi in their requirements and their capabilities makes for a diversity of strategies that could help explain why they and their fruitbodies appear where they do. The concept of mycorrhizal succession may be useful in ordering and organizing this information and may lead to some generalizations. But it is unlikely that so complex a system, which is overwhelmingly difficult to study in the field, will be fully understood for a long while.

## WHAT WE NEED TO KNOW ABOUT COMMERCIAL HARVESTING

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Is unregulated and continuous commercial cropping of wild edible mushrooms endangering their survival? Can we manage this "new" and increasingly popular natural resource? Do we know what a specific mushroom habitat is? Can we create better wild mushroom habitats through forest management? Could overharvest of mycorrhiza-forming mushrooms lead to long term forest damage? Can we learn to culture the non-traditional, good-flavored mycorrhizal mushrooms in a controlled environment? Should we regulate edible mushroom harvesting in some way? These and dozens of similar questions are being asked about wild edible mushrooms in Washington State. There are not many answers...

Commercial wild edible mushroom harvesting has earned a solid place in the seasonal parade of products from Washington's forests. This fledgling industry made its first significant impact about 1980 and grew steadily to about 500 harvested tons of mostly chanterelles in 1984. An unknown portion of the annual harvest may be purchased from pickers in northern California, Oregon, and British Columbia as well as Washington. Most are processed and exported with only a small portion going to fresh markets.

Recreational pickers, scientists, and mycological societies became concerned about possible chanterelle depletion after the rather poor crop in 1985. This began the movement toward regulation of wild edible mushroom harvesting. Three bills concerning commercial wild edible mushroom harvesting, licensing, and regulation were brought before the Washington legislature in 1987. All three subsequently died in committee but will probably be back in modified form in later sessions. Commercial groups countered that regulation would be premature since there is little data to support whether continuous picking destroys the mushrooms.

The harvest of wild edible mushrooms by commercial and recreational pickers in Washington is currently unregulated. During the last two or three years, increases in commercial harvest and export of chanterelles have raised concerns about continuing unregulated harvesting. Heightened interest in both recreational and commercial use of mushrooms and disagreement on whether or not to manage the resource have made them a natural resource issue of concern in Washington.

As a means for dealing with the issues, the "Wild Edible Mushroom Task Group" was convened in October, 1985 at the request of Brian Boyle, Commissioner of Public Lands for the Department of Natural Resources. The Task Group was asked to study issues surrounding wild edible mushrooms and make recommendations for possible regulation of the resource.

One of the most serious problems in dealing with the commercial harvesting of wild edible mushrooms is the lack of scientific information about the resource. Even the annual harvest figures are best estimates. There are no records of mushroom sales compiled by government agencies as in many other crops. Locations of mushroom patches are closely guarded secrets and mushrooms are often sold to roadside buyers without knowledge of origin.

Perhaps the research that comes closest to dealing with the questions is that done on the mycorrhizal fungi. Unfortunately, the research often stops short of the fruiting body. It would be quite logical to expand such research to include the total fungus, not just its relationship with tree roots.

An informal wild edible mushroom research group met in Ellensburg, Washington in February, 1986 to begin looking at ways to improve the knowledge base. Representatives from universities and research groups from around Washington including a forest pathologist, mycologists, mushroom grower, botanist, ecologist, and others roughed out some ideas for research which are outlined below.

**Baseline Studies**

Baseline information is needed in order to learn how mushrooms perform in the undisturbed habitat. Research Natural Areas on federal lands, Natural Area Preserves on state lands, and closed watershed forests managed by larger cities are ideal sites for such studies. These are places where people are generally excluded and entry is granted only by permission. Baseline studies should be carried out for a minimum of ten to fifteen years without disturbance. Persons desiring to establish research on these sites normally make application and present a work plan subject to review before proceeding.

One such baseline study on chanterelles, now well into its first year, is in Bull Run Watershed, located east of Portland, Oregon in the Mt. Hood National Forest. The cooperative study with the Forest Service, U.S.D.A., was designed by members of the Oregon Mycological Society to run for ten years in an area of the watershed where vehicular, foot traffic, or other disturbance will be minimal or prohibited. In addition to monitoring the natural dynamics of fruiting chanterelle patches, production of sporocarps on plots in undisturbed patches will be compared to adjoining harvested plots.

Plants and mushrooms on the plots will be identified and precisely located in relation to trees and other vegetation. Succession of mushroom and plant species, weather, including air quality factors such as acid rain, soil moisture, and other changes will be observed over the ten-year study. Correlation of the many site factors and variations in climate will be made with mushroom emergence and quality. Harvested plots will be both cut and plucked, either completely or partially, at different mushroom ages. Impact on fruiting-body production by harvesting traffic will be noted. Tree growth rates will be observed for differences between harvested and unharvested plots.

Other studies aimed at annual production of sporocarps are being established in Washington. Dr. Joe Ammirati (University of Washington) established a study in the fall of 1986 that looks at the long-term spatial and temporal distribution of sporocarps. He is locating emerging bodies of about 15 mycorrhizal fungus species each spring and fall. Such studies are labor-intense and could take considerable time.

Similar studies are being conducted at Central Washington University at Ellensburg by Dr. David Hosford on the matsutake or pine mushrooms. Some of the work at Ellensburg has been in cooperation with Professor Hiroyuki Ohara of the Doshisha Women's University in Kyoto, Japan.

**Picker Profiles, Perceptions and Opinions**

It is important to learn more about persons collecting mushrooms, whether for recreational or commercial purposes. Information can be collected from voluntary survey forms or interviews at buying stations. Some mycological societies routinely gather such information from their members and could be assumed to be reliable. Type of information can vary from personal profiles of pickers to biological items such as species collected and location, picker perceptions of mushroom scarcity, and whether or not they think forest management helps or hinders production, etc. Information from pickers could be substantial, but may not always be truthful because of the secrecy surrounding known mushroom-producing areas. Nevertheless, such information once sifted, could be valuable.

**Determining the Crop**

Parallel to baseline studies, is accurate determination of mushroom crop magnitude and where it is coming from. One of the best places to collect this information is at the buying station through which most mushrooms funnel on their way to processors. It was unfortunate that a bill to license mushroom buyers died in the 1987 Washington State Legislature. This bill would have been of immense benefit in providing data to measure the volume of the annual wild mushroom crop. It would have required buyers to supply species picked, location, weight by species, date picked, price, and other special information as required.

**Ecological Research**

Ecological research on mushrooms includes site studies to determine precise habitat types for the various mushroom species. Forest habitat and soil types should be rated for mushroom production and combined with meteorological and moisture requirement studies in order to define specific mushroom habitats. These kinds of studies could ultimately lead to site enhancement for maximum mushroom production.

In 1986 in Japan, I visited with Japanese scientists in the Kyoto Prefecture Experimental Forest where they have determined the parameters for optimum site for the delectable matsutake. There, they have created a matsutake habitat by opening the forest canopy to sunlight and removing part of the duff. The soil was inoculated by planting matsutake-infected mycorrhizal pine seedlings. Emerging mushrooms in the "shiro" or fairy ring are plotted and measured. The Japanese workers are confident they can create special habitats for growing matsutake (I. Takeshi and M. Ogawa, *Journal of the Japanese Forestry Society 61*:163-173 (1979)).

Forest timber management undoubtedly has impact on edible mushroom production. In some cases mushroom growth may be enhanced after a harvest, and in others there may be a setback in production until the new forest reaches a juvenile age. For example, morels often proliferate after fires or in the disturbed soil of the shelterwood method of harvesting on the east slopes of the Cascades and Inland Empire.

Applied research studies to see if various timber management methods could enhance mushroom production might provide early income from the forest to offset establishment costs. Would it be possible to have forest sites in the Pacific Northwest that are managed for mushroom production? The Japanese studies have demonstrated that it can be done for matsutake. Studies on mushroom production and timber management could be tied to mycorrhizal research.

There is considerable controversy and speculation about whether mushrooms should be picked (or pulled) or cut. Harvesting studies are easy to set up and should be replicated throughout the region as soon as possible. Another area needing immediate study is site disturbance that might affect next season's fruiting — not disturbance from forest management but that done by pickers when the mushrooms are harvested. Disturbance ranges from a casual footprint to significant compaction and raking of the forest duff layer. Harvesting method and site disturbance studies are matters where mycological societies could be of immense help. Organized groups of far-ranging members could establish replicated studies in the widest possible reaches of the region.

More information is needed on the relationship of the mushrooms to insects and other organisms. For example, what is the impact to small animals if their mushroom food source is harvested? Mushrooms are seasonal supplements to normal diet for certain small mammals like squirrels and others.

Research must examine concerns that mushrooms are often harvested before significant release of mature spores. Could such continuous harvesting harm gene-pool diversity? Studies on spore-germination requirements for moisture, nutrients, heat, light, and physical space will not only fill gaps in knowledge of the forest environment but will also provide information for learning to culture some species artificially.

**Research Costs**

Funding sources for research on wild edible mushrooms may be in short supply now, but keeping this "new" natural resource in the forefront will eventually attract interested scientists. (Wild edible mushrooms are very popular news items.) Sources of funds could come from licensing of buyers, assessment on mushrooms sold through buying stations, grants from industry or mycological societies, or appropriations by the legislature. Researchers working through other grants may also be able to pass important spin-off contributions along.

Funds from several sources would spread the load and make it fair for the various interest groups. A single researcher in a mid-salary range costs about $50,000 per year, which could be a realistic goal for the near-term future. Long-term research would require much more. Since there are a few scientists at Washington universities now working with edible mushrooms, available funds could also be distributed to them directly.

**Work Conference**

I propose the formation of an annual regional Wild Edible Mushroom Work Conference for Washington, Idaho, Oregon, and British Columbia to further the knowledge, basic and applied, of the wild edible mushrooms.

There are similar work conferences for forest diseases, forest insects, and forest nurseries. They have been instrumental in bringing technological and biological knowledge from crude beginnings to the sophistication of today. Even more important, they encourage ongoing contact and friendship among participants that creates a strong network within the discipline. A work conference is better than a symposium or annual meeting because the very name stresses informality. Formal "papers" are generally discouraged in work conferences. Emphasis is on practical application.

There is merit in forming a working conference to begin tackling some of the many questions surrounding the wild edible mushroom resource. Harvesting was done in limited and most likely undamaging quantities for generations. Now this resource is certainly undergoing dramatic change. There was a similar knowledge deficit in the Pacific Northwest when the Christmas-tree industry began, first as natural trees, then evolving to the intensely managed trees of today.

The Christmas-tree industry thrives because of early and organized research driven by industry needs. The burgeoning wild edible mushroom industry needs a similar approach. It is only a matter of time before this industry too, switches to intensive culture, perhaps away from the forest. I propose a first meeting of a Wild Edible Mushroom Work conference in the winter of 1988.