Appalachia-Science in the Public Interest
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ASPI TECHNICAL SERIES TP 36

# MUSHROOM GATHERING & CULTURING IN APPALACHIA

Mushrooms are a nutritious, native Appalachian food that can be carefully gathered from the wild, or can be cultured. In many parts of Appalachia people make the distinction between mushrooms, which they consider edible, and toadstools, which they consider poisonous. Biologically, however, they are the same thing. They are produced by **fungi**, and are the **fruiting-bodies** (reproductive bodies) formed to produce and distribute **spores**.

These fruiting-bodies are similar to, but not quite the same as, rose buds, apples, and other fruit that produce seeds. The bulk of the fungus consists of almost invisible threads called **mycelium**, which run through the soil, wood or other substrate on, or in, which the fungus feeds and grows. The mycelium (also called the **spawn**) consist of a mass of even finer thread-like structures called **hyphae**, through which nutrients and water are obtained from the surrounding environment.

There are more kinds of mushrooms believed to be growing in the southeastern United States than in any other region of comparable size in North America. Exactly how many varieties occur in Appalachia is unknown; however, it is thought that between 3,000 to 5,000 different kinds of mushrooms can be found in the south. Like most edible crops, people have their favorites, and in Appalachia, there has been a tradition of passing down foraging knowledge, especially for the morels, land fish, and dry land fish.

How many mushrooms are edible out of the huge variety that exists in Appalachia also is unknown. There may be hundreds, maybe more. What is generally true though, is that the edible species are generally short-lived, lasting only for a few days, and so foraging traditions may have more to do with what is known than anything else.

It is usually easy to tell the edible mushrooms from the poisonous ones; however, since some in-edible and poisonous species may grow among the edible species, caution needs to be used when gathering them from the wild. It is not as easy to tell the in-edible from the edible though, and as is true with poisonous species, caution needs to be used. On the positive side, there are probably only 5 or 6 varieties that are deadly poisonous out of the thousands that exist.

The life of fungi varies considerably -- some last for only one or two years, while others will last for several years. However, the mycelia of **mycorrhizal fungi** which live in symbiosis with the roots of green plants, will usually live as long as the host plant. Another phenomenon worth noting is that the association of certain species of mushroom producing fungi with particular kinds of trees is so predictable that a mushroom hunter looking for a particular type of mushroom should first look for the appropriate tree or shrub.

Some examples of this phenomena in Appalachia include looking for *Boletus variipes* and the **Chantarelle** (*Cantharellus cibarius*) on mossy, sloping hardwood forests, especially those with oaks and pines. In rich hardwood forests, especially in floodplains the **Thick-footed Morel** (*Morchella crassipes*) can be found. In pine forests in late autumn the **Short-stemmed Bolete** (*Suillus brevipes*) often appears, and field mushrooms, also called **Champignons** (*Agaricus campestris*) and **Fairy-ring mushrooms**, or **Scotch Bonnets** (*Marasmius oreades*), can often be found growing in fertilized meadows and pastures.

## Gathering Mushrooms

The best way to learn about gathering and harvesting mushrooms is to join a local mushroom group, go out on their outings, and learn from more experienced collectors. If a group can not be conveniently found, then try to find an individual to help you learn. The use of field guides, which are

always a good idea, are helpful, but the education that comes from some form of apprenticeship can not be equaled by book learning.

The basic equipment needed for collecting mushrooms from the wild includes an open basket for carrying the collection; a knife or trowel for detaching mushrooms from their substrate; and waxed paper (or small paper bags), in which to wrap them up. One should carefully collect each specimen, being sure to include the base of the stalk, and then roll wax paper to form a cylinder into which the mushrooms are placed with the ends twisted

Plastic wrap and plastic bags should be avoided because the plastic holds moisture too well; allows heat to build up; and, the mushrooms often stew in their own juices. It is also easier to pick and keep mushrooms clean than it is to clean them later. When collecting in the wild one should never over collect. It is also important to try not to disturb the habitat since the fungus mycelium needs to remain undisturbed in order to produce mushrooms in the future. Picking mushroom should not endanger the fungus.

How much harvesting of mushrooms for sale can be done from the wild depends upon what is called the carrying capacity of the environment. Unfortunately, no one really knows what that capacity is, and so an area can quite easily be overharvested which means that it will no long produce mushrooms for either sale, or simply for personal enjoyment! Although it might be possible to assist native species to grow in the wild, not enough is known about the process to recommend it as a procedure.

Mushroom culturing and harvesting can provide both gourmet mushrooms, and mushrooms which can not be bought because they have too short a shelf-life (such as the shaggy mane which may only last for 2-days), or because they are too expensive. Mushroom culturing might also provide a good economic potential for a family farm as an additional (alternative) crop. If it is to become an enjoyable experience, however, what level one becomes involved at requires a realistic evaluation of time and resources available for the endeavor.

If you manage to acquire or produce a significant quantity of mushrooms, at some point there might be the need to preserve what can not be consumed or sold. The usual means of preservation include drying, canning, and freezing, with freeze drying being the best and most expensive. Fresh mushrooms are best for frying, stuffing and baking, and mushrooms that have been preserved by drying can be powdered and used in soups.

Nutritionally, fresh mushrooms on the average contain 8% fat as a percentage of calories; 25% folic acid in micrograms (ug)/100g; 38% protein as a percentage of calories, and usually contain 8 or 9 amino acids. They also can provide 0.46 milligrams Riboflavin (Vitamin B2)/100g; 2.2 milligrams Pantothenic Acid (Vitamin B5)/100g; and 16 micrograms Biotin/100g. Mushrooms when raw are approximately 90% water, and when dried their water content is about 15%. Depending on the species they can also contain carbohydrates, fiber, calcium, phosphorus, iron, sodium, potassium, Thiamine, Niacin, and occasionally Vitamin C, and on the whole are a fairly nutritious food.

In the book **A Field Guide to Southern Mushrooms**, by N.S. Weber and A.H. Smith, the following edible species of mushrooms were recommended for begining collectors:

*Agaricus campestris* -- **Field Mushrooms, Pink Bottom** (Basidiomycetes), can be found in meadows, lawns and pastures, often abundant and forming fairy rings or arcs from spring to fall.

*Agaricus porphyrocephalus* (Basidiomycetes), are found late in the fall in lawns and mowed areas.

*Agaricus solidipes* (Basidiomycetes), can be found from late spring through the summer scattered in grassy areas and lawns.

*Boletus griseus* (Basidiomycetes), can be found during the summer and fall as widely distributed and sometimes abundant specimens that are generally associated with oaks and open oak woods.

*Boletus pinophilus* (Basidiomycetes), can be found during the summer, scattered to gregarious under pines in the coastal plain.

*Boletus variipes* (Basidiomycetes), is widely distributed typically under hardwoods, and occasionally with pine, and found during the late spring into fall.

*Bovistella radicata* (Gasteromycetes), is also widely distributed, and found on thin sandy soil, in open places and on cultivated and disturbed ground during the summer and fall.

*Calvatia cyathiformis* (Gasteromycetes), is widely distributed in meadows, grassy areas, lawns, and open woods during the summer and fall.

*Cantharellus cibarius* -- **Chanterelle** (Gasteromycetes), is usually found in groups in mixed woods, especially oak and pine.

*Cantharellus cinnabarinus* -- **Cinnabar Chanterelle** (Gasteromycetes), is often found in large drifts on mossy banks of streams and paths in mixed woods.

*Craterellus fallax* -- **Black Trumpet Chanterelle** (Gasteromycetes) is found during the summer and fall, widely distributed and often abundant, scattered or in arcs on the ground in deciduous and mixed woods, and is common and often in large numbers on damp, mossy banks in those woods.

*Flammulina velutipes* -- **Velvet Foot** (Basidiomycetes), is found during the late fall to early spring during wet cool weather, and is widely distributed in dense clusters on logs, stumps and standing dead trees, especially elms, aspen and willow.

*Hericium erinaceus* -- **Hedgehog Mushroom, Lion's Mane** (Gasteromycetes), is usually solitary, arising from trees, stumps, and logs of broad-leaved trees, particularly oak, beech, maple and sycamore during the summer and fall and into early winter.

*Hydnum repandum* (Gasteromycetes), are often found in large numbers in leaf-litter under mixed trees especially where oak and/or blueberries occur during the summer and fall.

*Lactarius corrugis* (Basidiomycetes), is found during hot wet weather in the summer and early fall, scattered to gregarious in deciduous and pine-oak woods and in shaded lawns with oaks.

*Lactarius hygrophoroides* (Basidiomycetes), is widely distributed in deciduous or mixed woods from late spring to early fall.

*Lactarius indigo* -- **Blue Lactarious** (Basidiomycetes), is found during the summer and fall, or early winter, scattered to gregarious in mixed woods, especially under or near oaks.

*Lactarius paradoxus* (Basidiomycetes), is solitary to gregarious and found under 2- and 3-needle pines in late summer to early winter, and is often abundant and conspicuous in shaded lawns in late fall

*Lactarius volemus* (Basidiomycetes), is found during hot wet weather in the summer and early fall, scattered to gregarious in deciduous and pine-oak woods and in shaded lawns with oaks.

*Laetiporus sulphureus* -- **Sulfur Shelf, Chicken Mushroom** (Gasteromycetes), grows on dead or dying trees, both deciduous and conifers, but especially oak and willow. It can form huge clusters weighing many pounds, and is found from summer to early winter.

*Morchella crassipes* -- **Thick-footed Morel** (Ascomycetes), is found in early spring, sometimes around dead elms, under old apple trees, and in rich hardwood forests, but especially in floodplains.

*Morchella elata* -- **Black Morel** (Ascomycetes), is found during the spring near conifers, ash and apple trees, and also in mixed woods, or possibly under hardwoods.

*Pleurotus ostreatus* -- **Oyster Caps, Oyster Mushroom** -- (Basidiomycetes), are widely distributed and common, and can be found clustered, scattered, or in shelving masses on a variety of hardwoods, both living and dead from the fall on into the spring.

*Suillus brevipes* -- **Short-stemmed Bolete** (Basidiomycetes), are found from the late fall through the winter, and are scattered to gregarious under pines, especially 2- and 3-needle pines.

*Suillus decipiens* (Basidiomycetes), are found in dry pine woods and pine-oak woods from the summer into winter.

*Suillus pictus* (Basidiomycetes), are found during the summer and fall, and are associated with eastern white pine and common only in the mountains.

*Volvariella bombycina* -- (Basidiomycetes), are found in the summer and fall during hot weather, and are solitary to gregarious, often growing from wounds on living trees as well as on dead trees and logs of hardwoods, particularly elm, maple, magnolia, beech and water tupelo.

*Volvariella volvacea* -- **Straw Mushroom, Patty Straw** (Basidiomycetes), are found during warm to hot wet weather, and are quite gregarious on piles of decaying vegetable matter such as stable sweepings, piles of leaves, and compost heaps.

**Culturing Mushrooms**

The majority of mushrooms which seem to be successfully cultured are those whose growing conditions fit narrowly defined parameters. **Shiitake** mushrooms are in vogue, in part because they grow quite well on freshly cut oak logs. The **Shiitake** mushrooms mycelium is a primary decomposer, and after two year of growth, the **Oyster** mushrooms, which are secondary type decomposers, can be cultivated quite nicely on the same logs. The button-type or *Agaricus* mushrooms thrive on horse manure and other bedding materials and also do well in caves.

What type of mushroom one cultures has a lot to do with what type of growing material is available. Indoor cultured mushrooms require large amounts of water as well as temperature control, which makes large scale culturing an expensive and perhaps not an environmentally appropriate undertaking. Culturing mushrooms also requires the availability of spawn which is then introduced into the growing medium, and most small mushroom operations choose to purchase spawn of a given type rather than produce their own.

To produce spawn requires that the desired fungi be isolated in order to make a standard inoculum. One then selects the substrate on which to produce the spawn, which at this point is the mycelium growing on a prepared medium. Having produced the spawn, one then innoculates the growing medium and waits to see if the process is successful. The undertaking of a commercial mushroom operation has serious financial considerations, and anyone thinking about becoming involved should be certain that they can afford to do so.

The number of mushrooms available both for culturing and in markets is limited because of the complexity of the operation and limited success with mushroom culturing; however, there are a number of native and other mushrooms worth considering as possible edible species for culturing in Appalachia, such as:

*Agaricus campestris* -- **Field Mushrooms, Pink Bottom** -- (Basidiomycetes, native)

*Agaricus porphyrocephalus* -- (Basidiomycetes, native)

*Agaricus solidipes* -- (Basidiomycetes, native)

*Coprinus comatus* -- **Shaggy Mane** -- (Basidiomycetes, native)

*Flammulina velutipes* -- **Velvet Foot** -- (Basidiomycetes, native)

*Ganoderma lucidum* -- **Reishi** (Oriental, medicinal); *G. cuttisii* (Basidiomycetes, native)

*Grifola frondosa* -- **Hen of the Woods, Maitake** -- (Basidiomycetes, native); see also *Polyporus frondosus* and *Meripilus giganteus* (Giant Polypore)

*Hericium erinaceus* -- **Hedgehog Mushroom, Lion's Mane** -- (Gasteromycetes, native)

*Laetiporus sulphureus* -- **Sulfur Shelf, Chicken Mushroom, Chicken of the Woods** -- (Gasteromycetes, native)

*Pleurotus ostreatus* -- **Oyster Caps, Oyster Mushroom** -- (Basidiomycetes, native)

*Stropharia rugoso-annulata* -- **King Stropharia** (Basidiomycetes, native); see also *S. melanosperma*

*Volvariella volvacea* -- **Straw Mushroom, Patty Straw** -- (Basidiomycetes, native)

Getting into the mushroom business is not something one should do without planning and market research. For one thing, you need to know if there is a large enough market for your product, and if there might be, will you be able to sell enough at a price above your cost of production to make it worthwhile. Also worth considering is whether the mushroom operation is a new enterprise consistent with your other goals, and if you have the resources needed to be successful. These resources include: land, soils, water, buildings, equipment, skills, labor and management time, sources of information, assistance and credit, input supplies, processors and a distribution network. Also of concern is whether you can afford to get into a new enterprise that may take up to several years to become profitable!

In a document titled **Shiitake Mushrooms: An Alternative Enterprise Guidebook**, which was produced by The Harlem Valley Planning Partnership in Dutchess County, New York in 1991, it was shown that a 200-log Shiitake farm was not a profitable undertaking. They also estimated that a 3000-log Shiitake operation, grown in a Controlled Environment Chamber, would become profitable in about 3-years, but that it also would require an initial investment of $ 85,700.

Nereide G. Ellis, a consulting mycologist in Arlington, Virginia who grows mushrooms for sale, estimates that a 1000-log Shiitake operation would cost between $1400 to $1800 the first year if the logs were free and all equipment and supplies had to be purchased new. While there would be no profit the first year, in year two one could expect a $2000 to $3000 profit, and in year three a $1000 to $2000 profit. If a new set of 1000 logs were begun each year, then the major cost would be the cost of spawn ($400 for paste, $750 for plugs), labor, and miscellaneous supplies, and the production would be continuous.

The above costs do not include the cost of marketing and transportation expenses, but one could tie in with a vegetable wholesaler to minimize these costs (and profit), or one could participate in a farmers market in an urban area where prices would be higher and the demand probably greater. Nereide Ellis also pointed out that outdoor grown mushrooms also lend themselves to organic production, which might be a niche that is worth some extra money. Spent logs are also a good source of garden compost material which would bring in additional money.

**Fungal and Mushroom Growing Conditions**

The distribution of fungi throughout the world is closely related to the distribution of green plants. Fungi, in combination with bacteria, play an active part in the natural decomposition of organic matter. In addition, soil fungi store carbon dioxide and cause various chemical reactions, and water fungi contribute to the purification of polluted waters.

Fungi grow in many diverse environments, and common to all of their growing conditions is the necessity of ground water and moisture. Since the fungi in many cases also play a key role in the decomposition of organic matter, an available source of organic materialm is also necessary. Different fungi will also grow on matter in different stages of decay, and so what species can be found in a certain location also depends upon the type of decomposing matter available, and its current state of decomposition.

The fact that different species of fungi and their fruiting bodies are associated with different plant associations would indicate that soil porosity, soil type and pH, as well as nutrient availability also determine the species of fungus that will be found in a certain location. Mushrooms act like a sponge in that they hold water for the forests. If the forest cover or sod or normally diverse biological associations in which they are living is altered, then their ability to reproduce and survive becomes doubtful.

Like most symbiotic relationships, the balance between a favorable environment and one in which species disappear is not well understood. Since mushrooms make micro-nutrients available as food for the trees and other plants with which they coexist, and since those trees and other plants provide nutrients for the fungi, acid rain and the changes that occur in ecosystems because of the acidity, seem to create problems for the fungi. In the top four to eight inches of the forest floor, acid rain adversely affects the natural pH of the environment, which in turn adversely affects the fungi's ability to convert nutrients into useful forms.

Radically changing an ecosystem, as is done with clearcutting and so many other financially driven environmental policies, also adversely affect the survival of fungi and their fruiting bodies. Fungal ecology, as concerns the majority of species, has more to do with sustainable land use

practices, than it does with currently fashionable agricultural and forest methodologies. A majority of species of fungi, including many good edible ones, have not been successfully cultivated, because it is not feasible to simply re-create their growing conditions in isolation from their normal environment.

## Literature on Mushrooms


Aurora, David. **Mushrooms Demystified.** 1979. Ten Speed Press, Berkeley, CA, 959pp.

Chang, S.T., and W.A. Hayes. **The Biology and Cultivation of Edible Mushrooms.** 1978. Academic Press, New York, N.Y., 819pp.

Chang, S.T. and P.G. Miles. **Edible Mushrooms and Their Cultivation.** 1989. CRC Press, Boca Raton, FL, 345pp.

Harris, B. **Growing Wild Mushrooms.** 1976. Wingbow Press, Berkeley, CA.

Kibby, Geoffrey. **An Illustrated Guide to Mushrooms and Other Fungi of North America.** 1993. Longmeadow Press, Stamford, CT, 192pp.

Miller, Hope. **Hope's Mushroom Cookbook.** 1993. Mad River Press, Eureka, CA, 220pp.

Oei, Peter. **Manual on Mushroom Cultivation.** 1991. Tool Publications, Sarphatistraat 650, 1018 AV Amsterdam, The Netherlands, 249pp.

Phillips, Rodger. **Mushrooms of North America.** 1991. Little, Brown and Co., New York, 319pp.

Royse, D.J. and L.C. Schisler. *Mushrooms: their consumption, production and culture development.* 1980. **Interdiscip. Sci. Rev.**, 5:324-332.

Smith, A.H. and N.S. Weber. **Mushroom Hunters Field Guide.** 1980. University of Michigan Press, Ann Arbor, MI, 316pp.

Stamets, P. and J.S. Chilton. **The Mushroom Cultivator.** 1983. Agarikon Press, Olympia, WA, 415pp.

Weber, N.S. and A.H. Smith, **A Field Guide to Southern Mushrooms.** 1985. The University of Michigan Press, Ann Arbor, MI, 280pp.


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*Funded by a grant from* ***The Educational Foundation of America***

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*Printed on Recycled Paper*