

The Natural Farmer

Permaculture with a Mycological Twist - Spring 2002 Special Supplement on AgroForestry

by Paul Stamets

When edible and medicinal mushrooms are involved as key organisms in agriculture and forestry, the productivity of these agricultural systems can soar to extraordinary levels. Not only are mushrooms a protein-rich food source for humans but the byproducts of mushroom cultivation unlock nutrients for other members of the ecological community. The rapid return of nutrients to the ecosystem by mushrooms boosts the life cycles of plants, animals, insects (bees), and soil microflora.

What follows is a short list of some of the ways mushrooms can participate in permaculture and agroforestry systems:

1. Oyster Mushrooms

Oyster mushrooms can be grown indoors on pasteurized corn-stalks, on straw from wheat, rice, and rye, and on a wide range of other materials, including paper and pulp by-products. Soaking the bulk substrate in cold water creates a residual "tea" that is a nutritious fertilizer and potent insecticide. Submerging the bulk substrate in hot water produces a different brew of "tea" that is a naturally potent herbicide.

Oyster mushrooms can also be grown on hardwood stumps and logs. Some strains of oyster mushrooms (*Pleurotus pulmonarius* for example) even grow on conifer wood. *Pleurotus* species thrive in complex compost piles, and are easy to grow outside with minimum care.

The water substrate from oyster mushroom production is useful as fodder for cows, chickens, and pigs. Since half of the mass of dry straw is liberated as gaseous carbon dioxide when it is used as substrate, pumping this CO₂ from mushroom growing rooms into greenhouses to enhance plant production makes good sense. (Cultivators filter the air stream from the mushroom growing rooms so spores are eliminated.)

Furthermore, the waste straw can be mulched into soils, not only to provide structure and nutrition but to reduce the populations of nematodes which are costly to gardeners and farmers

2. King Stropharia

The king stropharia (*Stropharia rugoso-annulata*) is an ideal player in the recycling of complex wood debris and garden wastes and it thrives in complex environments. While it will vigorously attack wood

(sawdust, chips, twigs, branches), the king stropharia also grows in wood-free substrates, particularly soils supplemented with chopped straw. I have seen this mushroom flourish in gardens devoid of wood debris, benefiting the growth of neighboring plants. Acclimated to northern latitudes, this mushroom fruits when summer temperatures range between 70-90 degrees F.

For six weeks one summer our bees attacked a king stropharia bed, exposing the mycelium to the air, and suckled from the wounds the sugar-rich cytoplasm. From morning to evening, bees continuously flew from our beehives to the mushroom patch until the bed of king stropharia literally collapsed. When a report of this phenomenon was published in Harrowsmith Magazine, beekeepers wrote me to explain that they had long been mystified by bees' attraction to sawdust piles. Now it is clear the bees were seeking the underlying sweet mushroom mycelium.

King stropharia is an excellent edible mushroom when young, but its edibility quickly declines with maturity. Fly larvae proliferate inside the developing mushrooms. In raising silver salmon, I found that when I threw mature mushrooms into the fish-holding tank, they would float. Fly larvae soon emerged from the mushrooms, struggling for air.

Soon the fish were striking the large mushrooms to dislodge the swollen larvae into the water where they were eagerly consumed. After several days of feeding mushrooms to the fish, I found the salmon would excitedly strike at the king stropharia as soon as they hit the water in anticipation of the succulent, squirming larvae. Inadvertently, I had discovered that king stropharia is a good base medium for generating fish food.

Growing king stropharia can have other beneficial applications in permaculture. The mushroom depends upon bacteria for growth. At our farm which included a small herd of Black Angus cows, I established two king stropharia beds at the heads of ravines which drained onto a saltwater beach where my neighbor commercially cultivates oysters and clams.

Prior to installing these mushroom beds, fecal coliform bacteria seriously threatened the water quality. Once the mycelium fully permeated the sawdust/chip beds, downstream fecal bacteria were largely eliminated. The mycelium in effect became a micro-filtration membrane.

I had discovered that by properly locating mushroom beds, greywater runoff could be cleaned of bacteria and nitrogen-rich effluent. Overall water quality improved. Massive mushrooms formed. After three to four years chunks of wood were totally reduced into a rich, peat-like soil. For nearly eight years I have continued to install king stropharia beds in depressions leading into sensitive watersheds.

Government agencies, typically slow to react to good ideas, have finally recognized the potential benefits of mycofiltration. Test plots are currently being implanted and monitored to more precisely determine the effects on water quality. If the testing is successful, I envision the widespread installation of king stropharia beds in basins leading into rivers, lakes and bodies of saltwater.

3. Shiitake/Nameko/Lion's Manes

Outdoors, inoculated logs can be partially buried or lined up in fence-like rows. Once the logs have stopped producing, the softened wood can be broken up, sterilized and re-inoculated. Indoors, these mushrooms can be grown on sterilized substrates or on logs using the methods described in my new book (see link below).

Once the indoor substrates cease production, they can be recycled and re-inoculated with another mushroom, a process I call "species sequencing". Later, the expired production blocks can be buried in sawdust or soil to elicit bonus crops outdoors.

4. Maitake, Reishi, and Clustered Wood-lovers

Several species can be incorporated into the management of a sustainable multistage forest. The greatest opportunities for stump culture occur in regions of the world where hardwoods predominate. Few gourmet and medicinal mushrooms can make use of coniferous woods.

Nevertheless, enokitake (*Flammulina velutipes*), reishi (*Ganoderma lucidum*), clustered woodlovers (*Hypholoma capnoides*), chicken of the woods (*Laetiporus sulphureus*) and oyster mushrooms (*Pleurotus* spp.) are good candidates for conifer or hardwood stump decomposition.

5. Shaggy Manes

As cosmopolitan mushrooms, shaggy manes (*Coprinus comatus*) will grow in rich manured soils, disturbed habitats, in and around compost piles, and in grassy and gravel areas. Shaggy manes are extremely adaptive and tend to wander. Shaggy mane patches behave much like king stropharia and morels, travelling great distances from the place of inoculation in their search for fruiting niches.

6. Morels

Morels grow in a variety of habitats, from abandoned apple orchards and among diseased elms to gravelly roads and streambeds. However, the habitat that can be reproduced easily is the burn-site. Burn-sites, though increasingly restricted because of air pollution ordinances, are common out in the country where residents dispose of flammable trash.

If a burn-site is not possible, there are alternatives. The complex habitat of a garden compost pile also supports morel growth. When planting cottonwood trees you can introduce spawn around the root zones in hopes of creating a perennial morel patch. Cultivators should note that morels are fickle and elusive by nature, compared to more predictable species like king stropharia, oysters, and shiitake.

7. Mycorrhizal species

Mycorrhizal species can be introduced via several techniques. The age old, proven method of satellite planting is probably the simplest. By planting young seedlings around the base of trees naturally producing chanterelles, king boletes, matsutake, truffles, or other desirable species, you may establish satellite colonies by replanting the young trees elsewhere after several years of association.

These are but a few mushroom species that can be incorporated into systems which involve trees or other woody perennials. Clearly the integration of mushrooms enhances these systems to a level which is unattainable without them. I hope readers will develop these concepts further.

Web Links

- MycoWeb—Mushrooms, Fungi, Mycology has an excellent links page at <http://www.mykoweb.com/links.html>

- Mycology Resources summarizes internet resources of interest to mycologists - <http://www.keil.ukans.edu/~fungi/>
- USDA Forest Service study on sustainable harvest and production of edible forest mushrooms in the Pacific Northwest - <http://mgd.nacse.org/fsl/pilzPoster/>
- Earth's Natural Internet by Paul Stamets - <http://www.wholeearthmag.com/ArticleBin/275.html>

*The above was adapted from the original appearing (with photos and illustrations) as "Permaculture with a Mycological Twist" in Paul Stamets's book **Growing Gourmet and Medicinal Mushrooms**, copyright 1994 Paul Stamets. This book as well as other books, equipment, cultures, information and mycotechnology is available from Paul Stamets's company, Fungi Perfecti, P.O. Box 7634, Olympia, WA, 98507 USA - <http://www.fungi.com/index.html>*

*Reprinted by Wilkinson, K. M. and Elevitch, C. R. in **The Overstory** #33, 1999, Permanent Agriculture Resources, P.O. Box 428, Holualoa, HI 96725, Web site: <http://www.overstory.org>*