Chapter 5

MUSHROOM DISEASES and PESTS

If the cultivation of mushrooms is an art, then we must give them the best care we can, as an artist cares for his pictures. If it is a science, we must learn how to care for them, so that we get the highest yields. Those two aims are clearly compatible, in either case we need to understand what is required to give the best result.

Diseases and pests often happen by themselves. A growers job is to keep them from happening. Fungicides, insecticides and other chemicals may help, but as Benjamin Franklin said, “an ounce (28 g) of prevention is worth a pound (454g) of cure.” We might say, prevention is worth 16 times as much as a cure.

Before we can understand what is needed for prevention we need to understand how diseases and pests get into our crop and how they are spread.

There are five primary ways that things get in and are spread:

1.Air
2.Water
3.People
4.Substrate
5.Spawn

Fungal spores, bacteria and viruses can all be blown in with our required air supply and insects can fly in, sometimes even against the flow of air. Viruses may be carried, by fungal spores and the insects can carry all of the other problems.

Water can carry almost the same things air carries, but insects may only arrive as eggs, in water. Water may also carry nematodes.

All of our problems can hitch a ride on people. Clean hands and clothing are particularly important. It is wise to keep those who do the pasteurization and spawning away from growing rooms, especially as the crop gets older. It is also wise to keep those who work in growing rooms away from the spawning area.

If substrate is properly pasteurized, it will start out free of diseases and pests. Proper pasteurization assumes that the material used was not already heavily contaminated with microorganisms before it was pasteurized. Although freshly pasteurized substrate should never be a source of diseases and pests, if any diseases or pests get started growing in it, the substrate becomes a source of more problems. If you have problems with pests or diseases, your substrate is a problem.

Spawn should never be a source of problems, but sometimes it is. The best spawn makers are very careful to keep out all diseases. If spawn does not look good, it should certainly be rejected. It should never have insects, but some diseases are difficult to detect. Viruses are particularly difficult and will probably not be detected by any, but the most sophisticated suppliers of spawn. Spawn is where the crop starts, so growers must be careful to only get the best.

HOW TO KEEP DISEASES AND PESTS OUT

While most diseases and pests happen by themselves, we know how most happen and we know that if we pay close attention to sanitation or, if you prefer hygiene, we can prevent them. The simplest description of sanitation is keeping everything clean. What I mean is that plus a little more.

We can break it down into the important parts:

1.Clean water
2.Filtered air
3.Careful pasteurization
4.Clean workers
5.Clean surroundings

CLEAN WATER

Clean water is needed for every other sanitation need. Water that is not clean can carry diseases and even pest eggs. Obtaining clean water can be difficult. In most places a deep well (ca 30 m or more) will be good. Surface water (river, lake, etc.) should be filtered and chlorinated. The best and proper way to install a good water supply using surface water is really the job for someone well trained in water treatment. However, anything that can be done to have clean water is desirable. Clean water is probably less important for pasteurization than for any other growing need! That might suggest a way to treat water for other purposes.

WATERING

Even clean water can spread disease if it is sprayed on a diseased area and it splashes. While the Rose-head sprinkler is often recommended, it does splash. A mist sprayer will not splash, so it is better.

CLEAN AIR

All air coming into spawning and growing areas must be clean. The only way we have to make it clean is through filtering. Various filters have been used in the past. Today, the best filters are High Efficiency Particle Air (HEPA) filters. If HEPA filters are not available, forced air furnace filters of various descriptions are possible. Three layers of muslin cloth is a possibility if commercial filters are not available.

Building as Protection

1.Filter air into building
2.Screens of filters at air exits
3.“Air-lock” entrance room
4.Foot bath
5.“Air-tight”

We must pay attention to all places where air can leave the room as well as the places it enters. It is good to have filters in the air exits. It should be remembered that every hole or crack is a place where air exits. It is wise to caulk all cracks and unwanted holes.

It is necessary to provide humid air in the growing rooms, clean water is needed, although, if the room must be heated, steam is a good way to add humidity. If cooling is required “swamp coolers” which are devices that blow air over a continually wetted loose packing can be helpful. However, that wet packing must be carefully maintained. If it is not, it can destroy your sanitation efforts. There are many other good humidifying devices, but they must all be kept clean.

CAREFUL PASTEURIZATION

Many believe that if a little is good, more is better. In the case of diseases and pests, that is almost always wrong. Pasteurization, is the process of holding

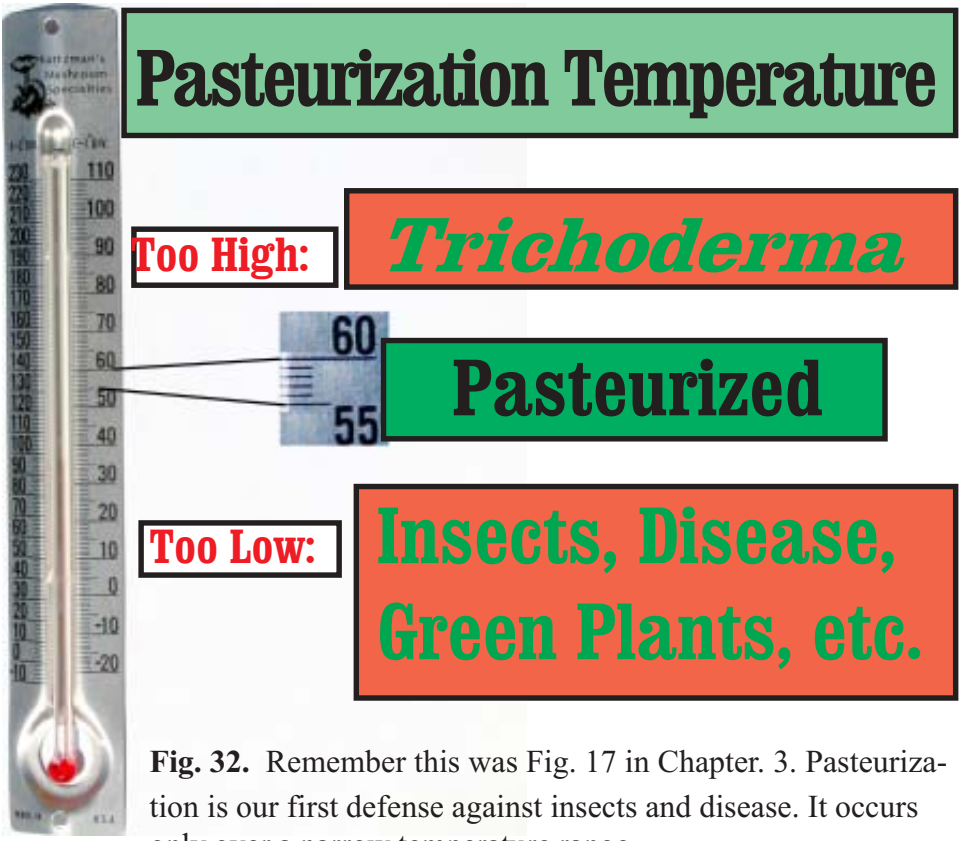


Fig. 32. Remember this was Fig. 17 in Chapter. 3. Pasteurization is our first defense against insects and disease. It occurs only over a narrow temperature range.

ALL THE MATERIAL to be pasteurized at 55-60°C (131-140°F) for 30 to 60 minutes. If there is plenty of oxygen the time can be extended, but **NEVER** increase the temperature **ABOVE 60°C (140**°F**),** and generally it should not be more than 55°C (131°F) for more than 15 minutes. It is also the general practice to cool slowly so that it requires 12 to 20 hours to decrease to 25°C (77°F) (**Fig. 32**).

I hope my temperature specifications are what you expected. People who use 55-60°C (131-140°F) generally have little problem. However, if my times seem strange, you may not yet be aware that there are two common

methods of pasteurization. I like to refer to them as the steam method and the hot water method. The steam method is used for *Agaricus* and *Pleurotus.* When used for *Agaricus* composting supplies part of the heat and cooling is slower. My descriptions today are for *Pleurotus.*

The Steam Method requires that we first wet the substrate thoroughly. Wetting may be difficult, but it must be done in a very few days, or our substrate will begin to rot and may be nearly impossible to adequately pasteurize. Once wetted it is placed in a chamber, possibly a room where steam is injected until it is 55-60°C (131-140°F). It is wise to stir it, and the temperature should be measured in many places to be sure that it is all warm and none too warm. Although one is very careful to measure the temperature, small spots may not reach the desired temperature. For that reason, it is customary to hold the temperature at about 55°C (131°F) for four hours. Then it is allowed to cool slowly.

The Hot Water Method is intended to begin with dry substrate. Water is placed in a container and the temperature is raised to 55-60°C (131-140°F). The dry substrate is added and the temperature is checked to be certain that it remains at 55-60°C (131-140°F). If the substrate is dry, and it is wetted by the hot water, it will **ALL** be at the temperature of the water. There will be little problem with wetting, because the heat melts the natural wax and helps penetration. If the substrate has gotten moist, 60°C (140°F) would be recommended and the substrate should be added very slowly while the water temperature is monitored closely, being certain that it is never less than 55°C (131°F). The substrate is held in the water for 30-60 minutes. Then the water is drained off. It is important that it not be held more than 60 minutes because it will become anaerobic and bad for the mushroom. Then it is allowed to cool slowly. Heating may be done with steam or direct fire. The problem with this method is that the resulting water is generally a disposal problem.

CLEAN WORKERS

Clean workers does not mean that they should be dressed for a fancy event, but rather that they should not be carrying any diseases or pests. If they have

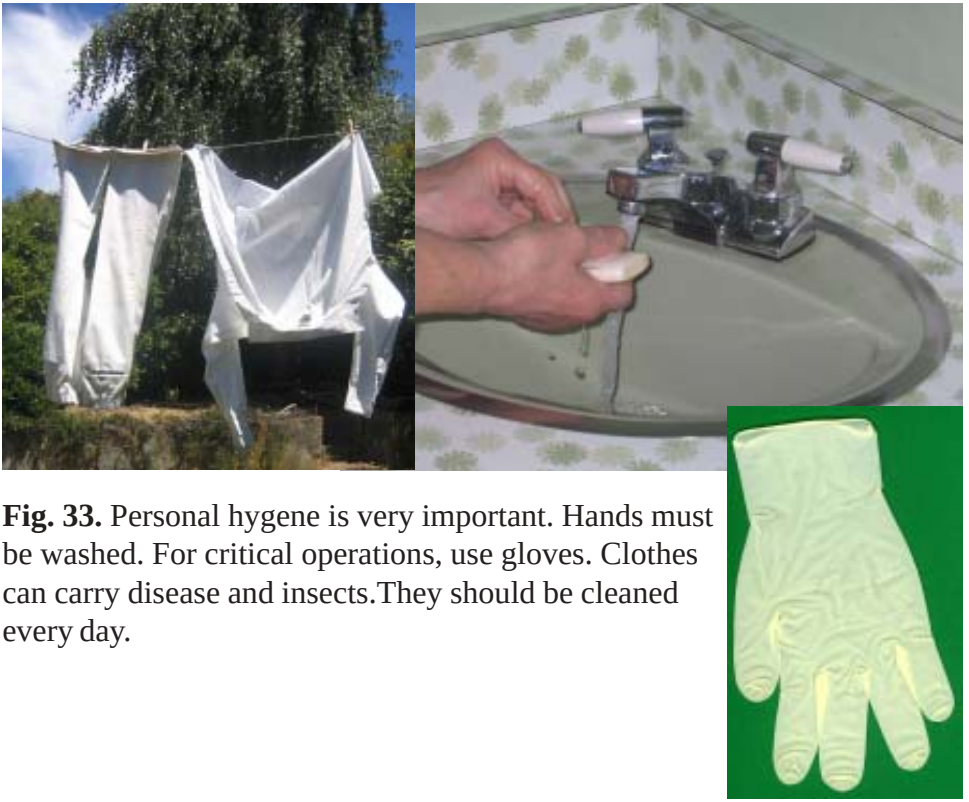


Fig. 33. Personal hygene is very important. Hands must be washed. For critical operations, use gloves. Clothes can carry disease and insects.They should be cleaned every day.

been in a place where there is a problem it should be assumed that they are carrying it with them. Minimum cleaning should mean that they will dip their boots in a shallow bath of saturated salt or dilute hypochlorite when they enter a growing area. Hands should be washed with soap and water.

In the spawning area, special care should be taken. Those mixing the spawn with substrate and packing it, **must** wash their hands and anything that will touch the spawn or substrate. They should also wear latex gloves. Hair should be restrained and their outer clothing should be very clean; if possible it should be kept just for that work (**Fig. 33**).

Face masks are not of much value in protecting the crop, but during harvest, they are recommended in growing houses There is always a chance that some spores have been discharged into the air and may cause asthmatic

or hay-fever in the workers.

Workers must enter through a door and can provide an entry for diseases and pests. The problem can be reduced by providing a air-lock room. The room can be built inside the growing or spawning room and very inexpensively with black plastic sheet. It should have an outside entry door and a second door into the growing or spawning room. It can provide a place for workers to clean-up and change clothes.

CLEAN SURROUNDINGS

The areas around growing houses and spawning areas can provide excellent

Fig. 34. Weeds, brush and rotting materials near growing facilities will harbor diseases and pests.

places for problems to hide. If wild mushrooms are growing just outside the door, the problems are at you door. Brush, weeds, stumps and old logs should be cleaned back to about 100 meters if possible. No rotting material, from animals or plants should be allowed in the area.

More important than all other things, the spent substrate must me taken as far away as possible, at least several kilometers. Before it is removed the growing area should be "cooked out." Cook out is best done by using steam to heat the room to at least 60° for at least 6 hours. Unlike pasteurization, higher temperatures will not cause problems. We need to get rid of everything that might cause trouble. After cook out, the room should be thoroughly cleaned. Methyl bromide and formaldehyde are sometimes used instead of steam. However, both are very dangerous and should only be used by people

Fig. 35. *Trichoderma,* Green mold, is the most common disease of oyster mushrooms. It most generally comes in the air or from human handling. Generally, the substrate was over-heated at pasteurization time. **60°C Maximum!**

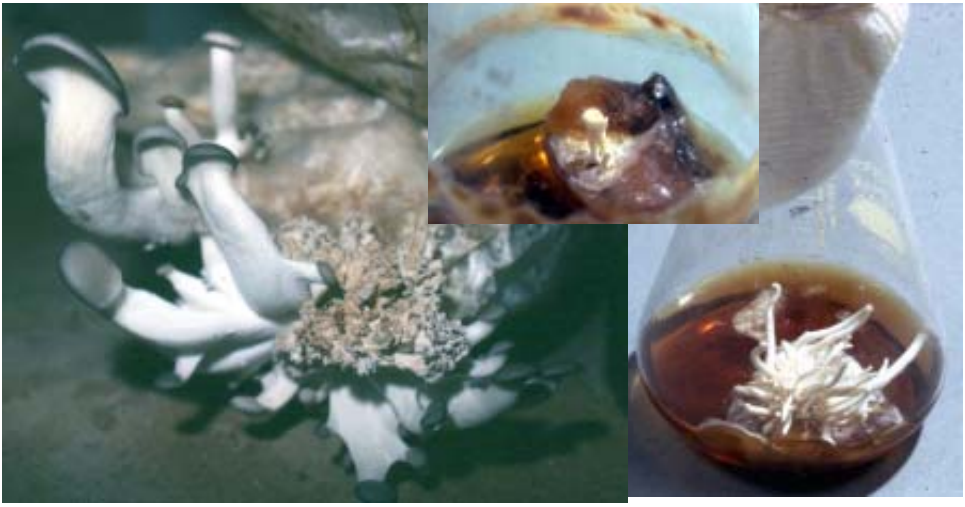


Fig. 36. Long stipes or stems is the most common physiological disease. It is usually caused by carbon dioxide, due to inadequate ventilation, but it may also be caused by inadequate blue light.

Fig. 37. Fat stems with almost no cap. The cause of this problem is not adequately studied, but it appears to be a natural poison in the substrate. Occurs on first flush, second flush is normal.

with training and experience.

WHAT TROUBLE LOOKS LIKE

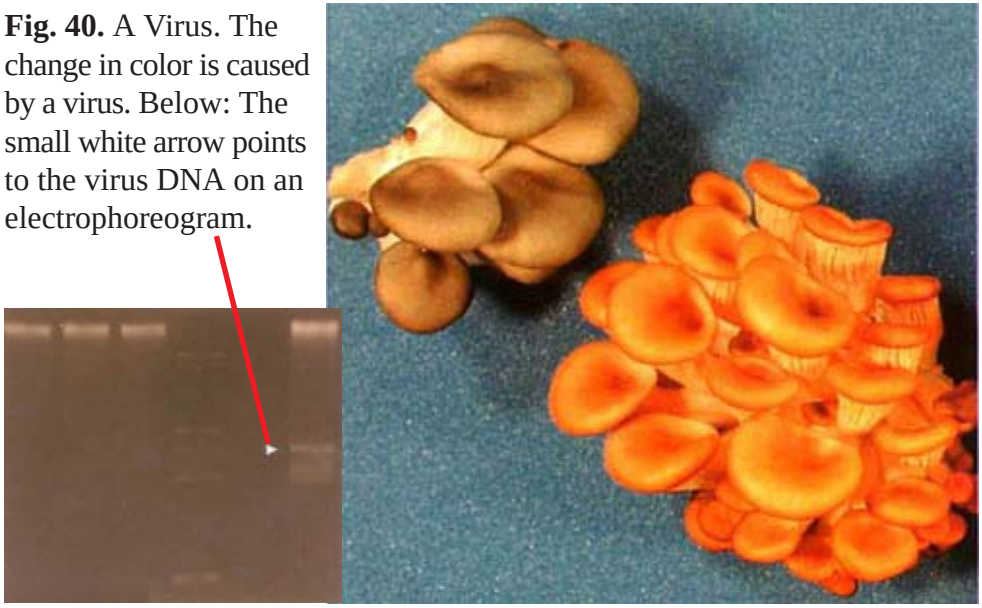
I have said much about how to avoid problems and if you follow everything I said, you **MAY** never see disease or pests. Unfortunately, I can not guarantee that you will not. So I will to show you what such problems will look like so that you will notice them if they do appear.

Sanitation will help avoid problems, but things can still go wrong. You need to be constantly on the lookout for problems. If you do see diseased or infested materials, as soon a possible, they should be removed as far as possible from your growing area and destroyed.

Fig. 38. *Verticillium* = Dry bubble
Dry bubble causes distortion and spotting.
Above: *Pleurotus.* Right: *Agaricus.*

Fig. 39. *Pseudomonas tolaasii.* Left: *Pleurotus.* Right: *Agaricus*

Fig. 40. A Virus. The change in color is caused by a virus. Below: The small white arrow points to the virus DNA on an electrophoreogram.



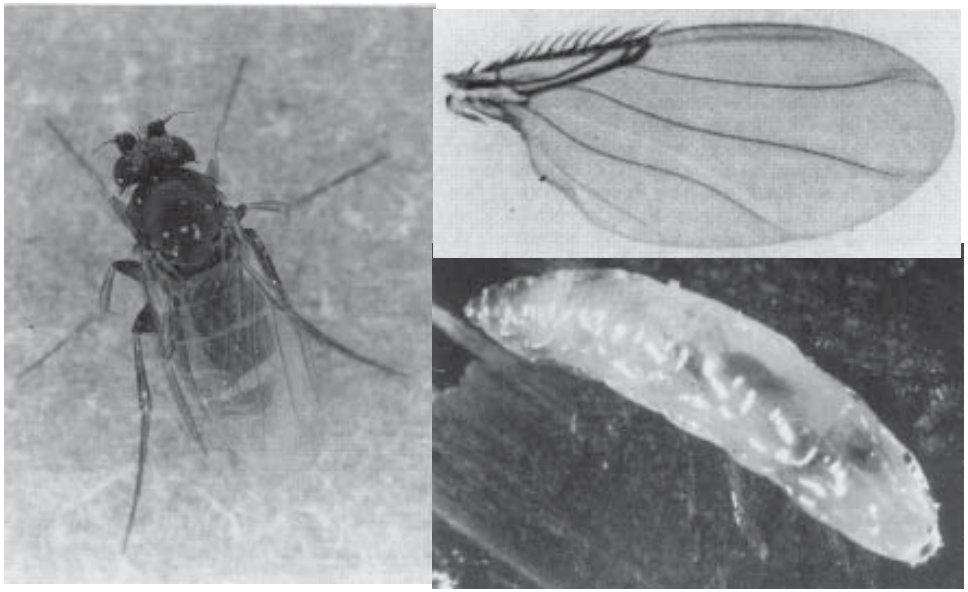


Fig. 41. Phorid fly = *Megaselia.* The larvae of the genus *Megaselia* like to. eat mushrooms and can cause great damage.

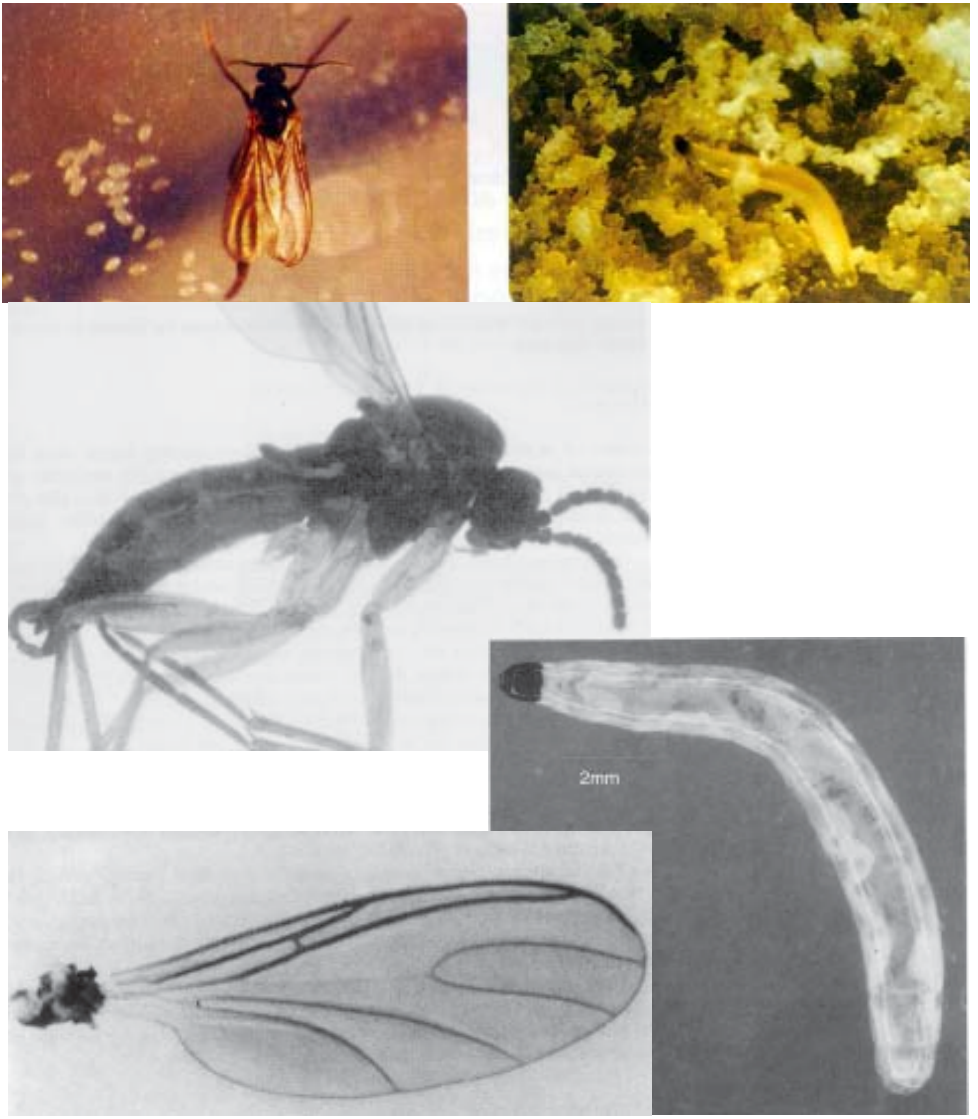


Fig. 42. Sciarid fly = *Lycoriella.* A major problem. The larvae (maggots) do the real damage. The genus *Lycoriella* is easily identified: black head of larva and wing pattern. Most will arrive in the air or are left from the previous crop. Wild mushrooms are their natural food.

Fig. 43. The genus *Heteropeza* has white larvae and the genus *Mycophila* (top) has orange larvae. The adults are very small. Larva size is variable.

Fig. 44. Slime molds make mushrooms unappealing. Left: *Physarum compressum.*Right: *Stemonitis herbatica.*

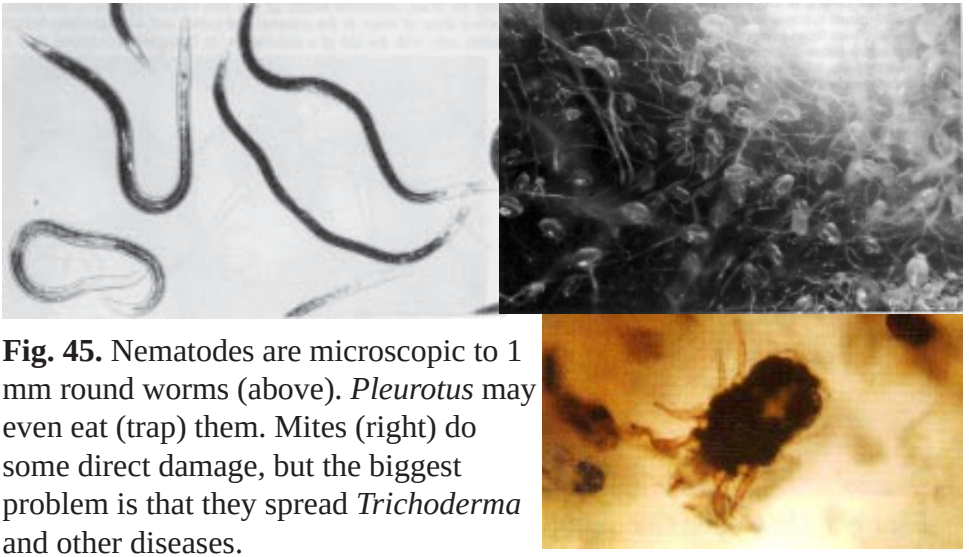


Fig. 45. Nematodes are microscopic to 1 mm round worms (above). *Pleurotus* may even eat (trap) them. Mites (right) do some direct damage, but the biggest problem is that they spread *Trichoderma* and other diseases.

Fig 46. *Mycogone pernicious,* Wet Bubble. Bubble causes distortion of the fruit body in *Agaricus.* Chlamydospores are characteristic of *Mycogone.*

Fig. 47. *Mortierella,* Shaggy stipe, a disease, caused by a. On *Agaricus,*

Fig. 48. Rosecome. A disease caused by petroleum products in the air or wather. May be fumes from a diesel or gasoline engine on equipment. On *Agaricus.*

Fig. 49a. Lipstick. *Sporendonema*. **Fig. 49b.** Pink *Neurospora.*
These may appear on bad spawn or on substrate

OTHER POSSIBLE PROBELEMS

There are a number of other problems that can occur. For many the required management will be quite apparent.

Slugs and Snails can eat mushrooms and substrate.
Rats and Mice can eat mushrooms and spread disease quickly.
Excess water will keep air from reaching part of the substrate, the mycelium will not be able to reach the over wetted substrate.
Additional viruses
Coprinus It may leave mushrooms covered with its black "ink."

Several additional diseases known in *Agaricus,* but are not likey to cause problems with *Pleurotus.*

Cobweb, *Dactylium*
Diehlomyces, "Truffle"