MUSHROOM PESTS AND HOW TO CONTROL THEM

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IN THE construction of a mushroom house, care should be taken to make the building as tight as possible, with outlets capable of being tightly closed. All windows and ventilators should be screened with fine wire gauze; this forms an excellent prevention against the entrance of both fungus gnats and the mites which they carry.

Mushroom spawn should be purchased only from reliable dealers.

The preparation of the compost should be careful and thorough, and the temperature of the house should be kept as low as possible, preferably below 55° F., thus reducing to a minimum the multiplication of any insects which may be present.

If the manure is carefully selected and properly composted and the temperature and moisture conditions are right, it should seldom be necessary to resort to such radical measures as fumigation, sterilization, or the destruction of the beds.

MUSHROOM PESTS AND HOW TO CONTROL THEM.

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INTRODUCTION.

CULTIVATED mushrooms are subject to attack by a variety of pests, especially during warm weather. Some of these may be brought into the house in the compost of which the beds are composed, attacking the mushrooms through preference, while others feed normally upon mushrooms, and are attracted from the wild forms outside through the greater abundance of their natural food plant in the cultivated beds. Injury by these pests frequently becomes serious. This bulletin treats of the measures for the protection of the crop from such injury.

The insect and other pests which usually attack cultivated mushrooms, and those of which complaints are most frequently made, may be divided roughly into four classes, namely, mushroom maggots, mites, springtails, and sowbugs. Of these the maggots are the most generally injurious, the mites following in order of importance, owing to the difficulty with which their eradication is accomplished, and then come springtails and sowbugs in the order named.

MUSHROOM MAGGOTS.

The injurious forms commonly known as "mushroom maggots" are small, whitish or yellowish-white maggots, usually having black heads. They are the larvæ, or young, of certain small, two-winged fungus gnats or flies, usually black or blackish in color, and belonging to several species.[1] They are minute, measuring only about one-tenth inch in length and about one-eighth inch in spread of wings. They are rapid and prolific breeders, especially during warm weather,

[1] The species attracting the most attention as pests are *Sciara multiseta* Felt, *Sciara agraria* Felt, and *Aphiochaeta albidihalteris* Felt (see fig. 1). They belong to the two families of flies known as Mycetophilidae and Phoridae.

frequently occurring in mushroom houses so abundantly as to darken the windows. They may be readily confused, however, with gnats of the same genus which breed in manure or in greenhouse soil, and determinations of the species should always be made by a specialist.

The life history of a mushroom maggot is about as follows:

The eggs, of which each female is capable of laying nearly 1,000, generally are deposited at the juncture of the stem and cap of the mushroom or in the manure or soil at its base. In a warm temperature they may hatch within 3 days, but in colder weather this time is considerably extended. Upon hatching, the larvæ bore at once into the stem or cap of the mushroom, soon riddling the cap and causing the "breaking down" of the mushroom. On account of the perishable nature of their host they must necessarily pass through their transformations quickly. The larvæ feed from 7 to 10 days, by which time the entire cap is destroyed; they then enter the ground, each spinning a slight silken cocoon just beneath the surface, and pupate. The pupa stage lasts from 4 to 7 days, after which the insects emerge as adults and soon pair and lay eggs for the next generation. Owing to the immense number of eggs deposited and to the short life cycle, the rapidity of their increase is remarkable, so that the presence of only a few insects in the mushroom house at the beginning of the season may result in millions after the beginning of warm weather, thus effectually preventing the cultivation of mushrooms.

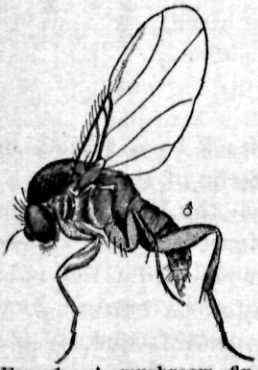

FIG. 1.—A mushroom fly, *Aphiochaeta albidihalteris:* Male. Much enlarged. (Author's illustration.)

CONTROL.

Where it is possible to keep the temperature of the mushroom house at 55° F. or to reduce it to that temperature upon indications of attack by maggots, damage by these pests is easily controlled. Otherwise it is evident that, in the control of the mushroom maggots, measures should be undertaken early in the season for their elimination from the mushroom house and precautions observed against their subsequent entrance. These precautions should begin with the construction of the house or cellar. The building should be so constructed as to permit of effective fumigation and should be fitted with tight screens of fine wire gauze, suitable to prevent the ingress of the fungus gnats. The gnats may also be brought into the house through the agency of the manure used in the beds, especially if the compost is carelessly prepared. In large commercial houses the

care taken to secure uniformity in the fermentation of the compost renders improbable any danger from this source, since a uniform heat of 150° F. or more is frequently attained in the process, this being sufficient to destroy maggots and other pests which may be present. In case of serious infestation of the compost before planting, however, it may be well to disinfect or sterilize this substance by means of steam heat. This may be accomplished for small houses by placing the manure or soil in vats or boxes through which steam pipes are conducted. (See fig. 2.) In large mushroom houses, which are heated by steam, a number of pipes may be laid beneath the surface of the beds, in a manner similar to that used in greenhouses for sterilizing the soil of the benches. The manure should be heated to a temperature of 150° F., which will destroy all animal life occurring therein without injury to its capacity for producing mushrooms. Fumigation with carbon disulphid just previous to spawning is also productive of good results in destroying maggots in the compost. The disulphid should be used at a strength of 2 to 4 pounds to 1,000 cubic feet of space and should be evaporated in shallow pans placed in the highest part of the house. *Carbon disulphid is very inflammable and the liberated gas is explosive when brought into contact with fire or sparks, so that care should be used to avoid bringing any fire into the building during the process of fumigation.*

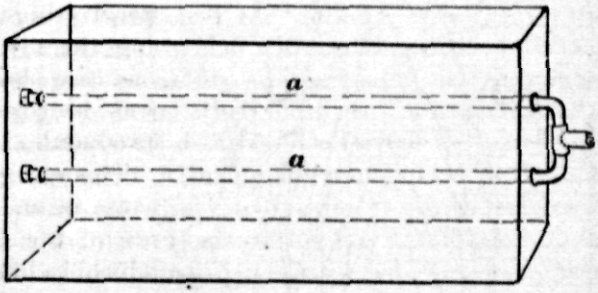

FIG. 2.—Steaming box, or sterilizer, for the treatment of compost. (Author's illustration.)

One of the best methods for the destruction of the adults or flies in their occurrence in mushroom houses is fumigation with tobacco or nicotine preparations, such as are used in greenhouses. These should be used in accordance with the directions indicated on the package for a medium or heavy fumigation.[1] Used in this manner and applied once a week during the bearing season of the mushroom bed, this method has been so successful in reducing the number of flies that very little damage, if any, resulted from the larvæ.

Fumigation with best quality fresh pyrethrum insect powder or dusting the powder over the beds is also effective against the mush-

[1] The proportion of nicotine in the several preparations varies to such an extent that no standard dose has as yet been formulated.

room maggots if taken in time, but tobacco fumigation may be considered standard for this use.

THE MUSHROOM MITE.

The mushroom mite[1] (fig. 3) is a minute, soft-bodied mite, smooth skinned, and white or whitish in color. It is closely allied to the common cheese mite[2] and resembles that species in appearance. It is, if anything, more prolific, becoming at times so abundant in mushroom beds as to cover the surface of the compost; when present in such numbers it is extremely destructive, feeding upon the mushrooms in all stages and penetrating the beds and destroying the mycelium.[3] Indeed, in one case observed, the mycelium was destroyed as fast as it was produced.

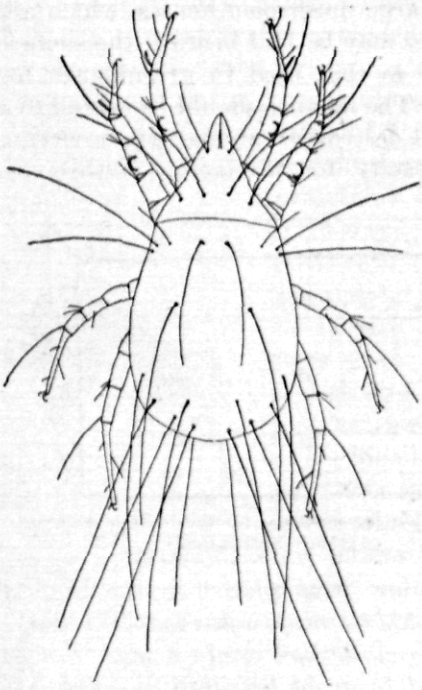

FIG. 3.—The mushroom mite (*Tyroglyphus lintneri*). Highly magnified. (Banks.)

This species is undoubtedly the cause in many cases of the failure of the spawn to propagate, which is likely to be attributed to poor or weak spawn or to defective cultural conditions. The minute size of the mites causes their presence to be overlooked and the failure of the spawn to produce mycelium is not understood. Even under conditions favorable to the growth of the mycelium it is possible for the mites to increase to such an extent that the entire bed may be killed out.

Besides the injury to the mycelium, mushroom mites cause damage to the fruiting bodies by eating into them, distorting or destroying the young growth. In the more mature mushrooms the mites may be found clustered in groups consisting of individuals of many sizes, usually hidden in the folds between the gills, where they burrow into the tissue, causing the caps to break down.

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[1] *Tyroglyphus lintneri* Osb.

[2] *Tyroglyphus siro* L.

[3] The term mycelium, as used herein, is applied to the new growth of spawn through the compost, as differentiated from the original insertions of spawn.

No direct observations on the life history of this species have been made, but judging from that of related species it is about as follows: The eggs, which are large in proportion to the size of the mites, are laid in or about the mycelium or on the young developing caps. They hatch in a short time into the characteristic 6-legged young, which soon become mature. The time from the deposition of the egg to the maturity of the mite has not, so far as the writer knows, been worked out accurately, but it undoubtedly occupies only a few days. It is on this account that the mite is able to increase so rapidly, apparently as if by magic, and thus give rise to the theory of spontaneous generation sometimes advanced to explain this condition.

Under certain conditions the hypopus or migratory stage is produced. This stage, so far as known, is peculiar to the family Tyroglyphidae, to which this mite belongs, and is very remarkable. The mite develops a hard, chitinous covering, has no mouth parts, and is provided with short legs insufficient for walking. On the ventral surface of the body is an area provided with sucking disks, by means of which the hypopus attaches itself to an insect and is so transported to suitable breeding grounds in other localities. On arrival at a suitable breeding place the mite detaches itself from its insect host, molts, and soon becomes adult. During the hypopus stage the mite takes no food and causes no injury to the insect which carries it. This peculiar stage is the natural means for the distribution of the mite to new localities, and is in many cases responsible for its appearance in localities far from previously infested beds.

In addition to the means mentioned above, the mite may obtain access to mushroom houses in infested compost or in spawn from infested houses. The greater part of the infestation, however, probably takes place through the agency of the small flies which frequent mushroom houses and which carry the hypopus stage of the mite from one house to another.

REMEDIES.

Little can be recommended for the control of the mushroom mite after it has once become established in a house. Owing to the absence of breathing pores it is practically unaffected by fumigants suitable for the control of other mushroom pests, while applications of sulphur, tobacco dust, and other insecticides to the beds seem only to prove slightly inconvenient to the mite. It is one of the most stubborn pests encountered in mushroom culture, and may be brought into the house in almost any manure that is used for the bed. When in the hypopus stage it is capable of prolonged suspension of vitality and is likely to remain in the house for an almost unlimited time without death. The only measures, therefore, that may be considered are those of prevention.

When a house becomes infested all compost should be gathered with the utmost care, removed to the outside, and thoroughly disinfected by drenching with boiling water, or it may be hauled to a distance and spread upon the ground as fertilizer or destroyed by burning. The ground occupied by the mushroom beds should be thoroughly scalded, and the woodwork of the mushroom house treated to a wash of creosote or crude carbolic acid, either of which is repellent to the mites. After complete disinfection has been accomplished the house should be screened, to guard against subsequent introduction of the pest by means of flies. All manure forming the beds should be steamed, according to the directions under the head of "Mushroom maggots." Care should be used to purchase spawn coming from reliable sources. With these precautions it is unlikely that trouble will be experienced from the attacks of mushroom mites. Close watch should be kept, however, for any signs of their presence in the beds, and the compost destroyed upon their first abundant appearance, as it is impossible to secure good results with mushrooms when they are once thoroughly infested by these mites. All applications of sufficient strength to destroy the mites are likewise injurious to the mushrooms, and it is futile to attempt to control them by any artificial means once the mushroom bed has become infested, as the mites are buried so deeply in the compost that no insecticide will reach them.

A predacious mite, which belongs to another family,[1] frequently occurs in beds infested by the mushroom mite, feeding upon the latter, and at times becoming so numerous as entirely to wipe out the pest. This predacious mite may be known by its longer legs and its manner of running swiftly over the compost or the mushrooms. Cases have been observed where it has occurred in such abundance as greatly to outnumber its host. It does not attack the mushrooms after the destruction of the mushroom mite, but seeks other feeding grounds or dies of starvation.

SPRINGTAILS.

At times the surface of a mushroom bed becomes alive with minute brown or black insects which, when disturbed, leap about like fleas in an extremely erratic manner. These are known as springtails,[2] since the springing is performed by the aid of two short bristles situated on the end segment of the abdomen. These insects (see fig. 4) are often attracted to the manure used as compost, where they feed on the decaying vegetable matter present, but on occasion they may become very injurious in mushroom houses. A correspondent in St. Louis, Mo., reported that in one of his mushroom houses a bed 150

[1] Gamasidae.
[2] *Achorcutes armatum* Nicolet et al.

feet in length had been completely destroyed by these pests, which attacked the mushrooms as fast as they appeared, honeycombing them and rendering them unfit for use. The method of attack of this insect is to feed upon the fruiting bodies of the mushrooms, destroying both the gills and the cap. Hundreds may be found clustered upon a single mushroom and eating large cavities in the gills. It appears to be a habit of these insects to congregate in large numbers on caps which have been slightly injured, in which case they rapidly destroy mushrooms which would be readily salable if the injury were not continued. When they occur in large numbers they are likely to attack even the perfect mushrooms, in aggravated cases destroying whole beds.

Insects of this group pass through no larval transformation, the form of the newly hatched young being similar to that of the adult. They are thus likely to be injurious in the same manner throughout their life history.

FIG. 4.—A common injurious springtail, *Achorcutes armatum*. Much enlarged (Author's illustration.)

REMEDIES.

The remedial measures applicable to the control of springtails are to a large extent preventive, as these insects are somewhat difficult to destroy when once established in a mushroom bed. Springtails are quite resistant to tobacco powders, but applications of "buhach" or pyrethrum insect powder to the beds are productive of some good. As they usually congregate near the surface of the beds, fumigation with hydrocyanic-acid gas according to the directions given in Farmers' Bulletin 699 will prove effective in reducing their numbers. The cyanid should be used at a strength of from 3 to 6 ounces to each 1,000 cubic feet of air space, which will not prove injurious to the mycelium. The fumigation should be applied after picking, as the gas "burns" the caps severely, causing them to turn brown.

By way of prevention, steaming all manure, as previously suggested for other species, will destroy springtails. Where possible it is better to grow the mushrooms at a temperature of about 55° F. than higher, since at low temperatures the springtails breed more slowly. Dusting the tops of the beds with powdered lime is also said to discourage attack by springtails.

SOWBUGS.

Considerable injury is often accomplished to mushroom beds through the attacks of oval, grayish or slate-colored creatures bearing seven pairs of legs. These creatures are not true insects,

although known variously by the terms "woodlice," sowbugs, and "pillbugs." Two species, the greenhouse pillbug[1] and the dooryard sowbug,[2] are illustrated in figures 5, 6, and 7.

Sowbugs frequent damp, dark places, such as those beneath boards, in cellars, and in the cracks of sidewalks. When disturbed, many species roll up to form a ball, lying quite still until the danger is past. (See fig. 6.) During the night they issue from their hiding places to feed upon decaying vegetable matter, molds, and other material present in damp soils, although at times the roots of plants and even the green leaves are not eschewed.

FIG. 5.—The greenhouse pillbug (*Armadillidium vulgare*) extended. Much enlarged. (Author's illustration.)

The young are carried about in a pouch, formed by several modified anal plates on the abdomen of the female, until able to shift for themselves. When released by the female the young are similar in appearance to the adults, although much smaller, and are likewise capable of damage. There is probably only one generation annually, the young making their appearance in the spring and requiring one summer to reach maturity.

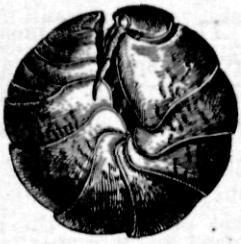

FIG. 6.—The greenhouse pillbug (*Armadillidium vulgare*) contracted. Much enlarged. (Author's illustration.)

The destruction occasioned by sowbugs is due to their attacks on the caps or fruiting bodies of mushrooms. These they attack while quite small, destroying them or injuring their appearance. They do not, as a rule, attack the mycelium, but eat holes in the young "buttons," which, on the completion of the growth, become much larger and disfigure the product.

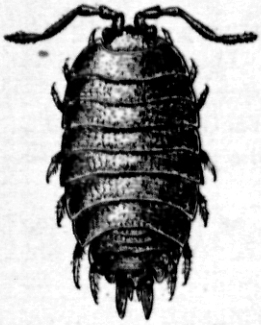

FIG. 7.—Dooryard sowbug (*Porcellio laevis*). Much enlarged. (Author's illustration.)

Sowbugs are frequently carried into the mushroom house in compost which has been allowed to stand outside. The heat of the manure is relished by them, and they collect in numbers, remaining throughout the growth of the spawn and becoming injurious with the first growth of the mushrooms. The writer has seen sowbugs collected in manure piles to such an extent that

[1] *Armadillidium vulgare* Latreille.
[2] *Porcellio laevis* Koch.

numbers aggregating a pint or more in quantity might have been collected from a shovelful of material.

REMEDIES.

Where the mushroom house is small in extent it is possible materially to reduce the numbers of sowbugs by means of hand picking. The house may be visited at night, when by the aid of a lantern numbers of sowbugs may be seen crawling about on the earthen casing of the beds and upon the boards and supports of the benches. These may be destroyed with a small wooden paddle.

It is also possible to secure good results by pouring hot water along the cracks in the boards and in other places where the "bugs" may be concealed by day. This is effective in small establishments, but is somewhat difficult of application in large houses. In such a case fumigation with hydrocyanic-acid gas is an effective remedy.

Another method is to cut small pieces of raw potato, plastering the wet surface with Paris green, and laying them about on the beds in the localities affected by the sowbugs. This method is frequently successful in entirely ridding houses of this pest.

A modification of this treatment successfully used by the writer in the destruction of sowbugs in greenhouse benches is the application of the ordinary poisoned-bran mash commonly recommended for the destruction of cutworms and grasshoppers. This bait is prepared as follows:

Bran	pounds	25
Paris green or white arsenic	do	1
Oranges or lemons	do	6
Cheap sirup or molasses	quarts	2
Water	gallons	4

The bran should be placed in a washtub or similar container and the poison added while dry. These should be thoroughly mixed and then the water, to which has been added the sirup and the finely chopped fruit, should be stirred into the mixture until a wet mash is formed. After the mash is allowed to stand an hour or two, it may be scattered thinly on the infested beds.

SLUGS.

The appearance of conspicuous, ragged holes eaten into the caps of mushrooms (see illustration on title page) during the night may often be traced to the presence of the large imported garden slug.[1] These unpleasant creatures are extremly fond of mushrooms, issuing from their hiding places toward evening, and, leaving a trail of slime behind them, proceeding in search of their favorite food.

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[1] *Limax maximus* L.

The damage to mushrooms is not confined to the cultivated species, but may frequently be observed to those growing in woods and fields. It is characterized by the rough, gouged-out appearance of the holes, which seem as though excavated by a mouse or rat. The creature itself resembles a shell-less snail from 2 to 7 inches in length and is grayish brown to pitchy black in color, usually with numerous elongate black spots. The eyes are borne on two pedicels or stalks which are retracted within the body when the mollusk is disturbed.

The imported garden slug deposits its large, round, transparent, yellowish eggs in gelatinous clusters beneath boards or refuse over moist earth. There is one brood each year, the young hatching in the spring and becoming half grown by fall. As with other mollusks, life extends over a period of several years. The individuals usually frequent moist spots in gardens or lawns and feed on the herbage, but frequently they invade mushroom houses, where their injury becomes almost immediately noticeable.

REMEDIES.

The usual remedies for slugs, trapping by means of poisoned or other baits, are inapplicable when these creatures occur in mushroom houses, since they prefer fresh mushrooms to any other food which might be used. It is therefore necessary to use hand methods of collection, such as are mentioned under the head of "Sowbugs." Such measures should be undertaken as soon as the injury is noticed, for if individuals are allowed to breed in the house their elimination will be much more difficult. Advantage may be taken of the habit of these slugs of returning to the same place of concealment each day, and they may be sought out with a lantern and destroyed or captured during the night while engaged in feeding. They are repelled by dust, powdered lime, or ashes and will not cross a line composed of one of these substances. Small beds may thus be protected from their ravages—for a time at least. Pulverized salt is another valuable deterrent.

CRICKETS.

Among other injurious forms which at times attack mushroom beds, certain crickets are reported as eating into the caps of the mushrooms.[1]

The remedies for crickets in their injurious occurrence are the same as those recommended for sowbugs. Potatoes and carrots may be minced before the Paris green is applied, in order that a somewhat thicker coat may be secured.

[1] On the Pacific coast a species known scientifically as *Ceuthophilus pacificus* Thom. has been reported as causing extensive injury to cultivated mushroom beds.

GENERAL SUMMARY.

In the construction of a mushroom house, care should be taken to make the building as tight as possible, with outlets capable of being tightly closed. All windows and ventilators should be screened with fine wire gauze; this forms an excellent prevention against the entrance of both fungus gnats and the mites which they carry, as previously mentioned. The importance of purchasing spawn from reliable dealers may be emphasized here. The preparation of the compost should be careful and thorough, and the temperature of the house should be kept as low as possible, preferably below 55° F., as at a low temperature all insects are more or less dormant, and their otherwise rapid multiplication is thereby reduced to a minimum, with corresponding reduction in infestation. Using carefully selected manure, properly composted, and with proper temperature and moisture conditions, there should be little necessity for the radical measures of fumigation, sterilization, or destruction of the beds.

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Four Edible Mushrooms. (*In* Report Department of Agriculture for 1893.) Price, 80 cents.

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