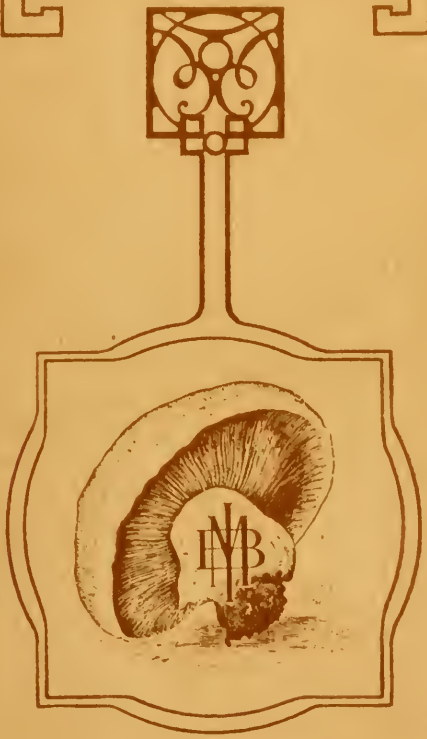
The CULTIVATED MUSHROOM



PRICE, ONE DOLLAR

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BUREAU OF MUSHROOM INDUSTRY
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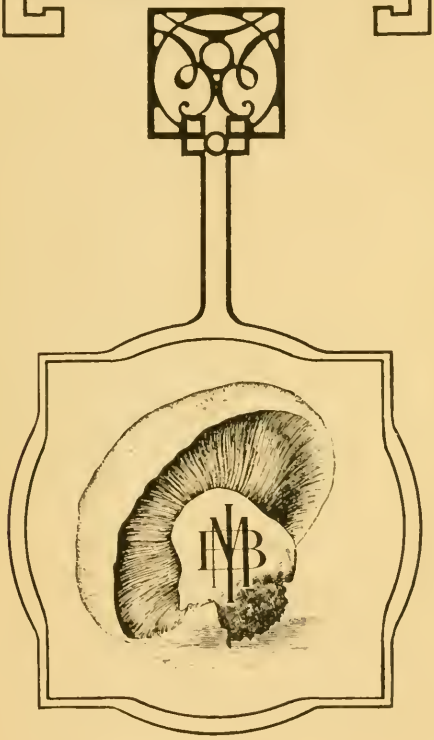
The CULTIVATED MUSHROOM



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THE CULTIVATED MUSHROOM

(Illustrated)

PRICE, ONE DOLLAR

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PREFACE

Up to a comparatively recent period the various methods of raising mushrooms were based on "blind customs." Groping in the dark, guided only by custom, and probably by many failures, mushroom growers would, each for himself, evolve some method of raising mushrooms. The natural laws governing the bacterial and chemical reactions in the compost, mycelial growth, parasitic molds, etc., were little understood. Methods were based on observations of effect without definite relation to cause, and, in some cases, even on superstitious traditions. The old text books dealing with the subject merely reflect the obsolete ideas of mushroom growers then prevailing; they contain little information on the underlying principles of mushroom culture, and therefore offer no suggestions of improvement in cultural methods. These books are reprinted from time to time, without change, and, with a new date, are again placed on the market.

Meanwhile, science has invaded the domain of mushroom culture and, within the last few years, has made wonderful progress. The secrets of nature have to a large extent been exposed, and the way has been paved for rational improvement in cultural methods and for the intelligent control of essential conditions. The element of uncertainty has been greatly reduced, and uniform results are now possible.

The object of this book is to collate and present to the public the latest discoveries of science in mushroom culture. Exploded fallacies and superstitious ideas are omitted from its pages; modern methods, tested by our most progressive growers, alone are given. Quotations are from the leading scientists on the various subjects.

We are indebted for much valuable material to the U. S. Department of Agriculture, the staff of the American Spawn Company and the various scientists named in the notes.

BUREAU OF MUSHROOM INDUSTRY

ACKNOWLEDGMENT

We are indebted to the American Spawn Company and their several publications for many illustrations contained in this book. All mushrooms shown in the halftones following this page were raised from "Lambert's Pure Culture Spawn." We make this statement in view of the fact that some of these illustrations have been copied and used without authority by persons advertising other grades of spawn.

B. M. I.

PART I
PRACTICAL CONSIDERATIONS

THE CULTIVATED MUSHROOM

While nature produces countless varieties of fungi, a comparatively small number are well known, and but one or two species are cultivated. The edible variety universally known to epicures is **Agaricus or Pratella campestris,** so called because of its habit of growing in meadows and pastures. It is to this fleshy species that the commercial term "mushroom" generally has reference.

The mushroom has been cultivated for many centuries in all parts of the civilized world; and, in its fresh state or in canned form, it has become a very important article of diet. In the United States it may be said that the mushroom industry is still in its infancy, although millions of pounds of canned mushrooms are annually imported. However, within the last few years, a steady and ever increasing demand for fresh mushrooms at good prices has induced many people of moderate means to devote some of their spare time in producing mushrooms for the market.

Extracts from the reports of Dr. B. M. Duggar, of the Department of Agriculture:

THE CULTIVATED MUSHROOM

In the United States the term "mushroom" refers commercially to but a single species (Agaricus campestris) of the fleshy fungi, a plant common throughout most of the temperate regions of the world, and one everywhere recognized as edible. From the time of Pliny, and perhaps much earlier, this plant has been sought as an article of diet, and it has been cultivated for many centuries. In the vicinity of Paris it has certainly been cultivated in some quantity since the sixteenth century; and, in paintings of market-scenes by old masters of the seventeenth century, a basket of mushrooms frequently finds a place in the composition, thus showing that at that time the sale of mushrooms was generally recognized in a commercial way

The cultivated mushroom belongs to a class of **Crytogams;** it is a member of the gill-fungus group, which is itself a subdivision of the group of basidium fungi. The mushroom assimilates oxygen and throws off carbonic acid gas; it differs in that respect from other plants. This important distinction plays an important part in cultural methods, and should be carefully noted. (See article on "Ventilation.")

ESSENTIAL CONDITIONS

Contrary to a prevailing opinion, there is nothing mysterious in the cultivation of the mushroom. Any one with a fair understanding of its cultural requirements can grow this plant successfully. As stated in a previous publication, mushrooms may be grown anywhere, at any time and by any one where the following conditions fairly obtain:

1. Good fresh spawn.

2. A properly prepared bed with reasonable protection against weather extremes.

3 A temperature not greatly exceeding 60° F., nor much lower than 50° F.

The fully expanded plant, or mature mushroom (sporophore), of Agaricus campestris is well known to every one. It consists of a centrally placed stock or stipe of from 2 to 6 inches in height, usually not more than one inch in diameter, and on the end of this stipe there is borne an umbrella-shaped or cap-shaped portion known as the cap or pileus. The diameter and thickness of this pileus vary in different races or varieties of the cultivated form, and also with the conditions of the environment under which it is produced. The general color of the plant varies in the different varieties from an almost pure white, or cream, to the forms which are deep brown, at least with reference to the upper surface of the cap. The stem is usually cream or white, and bears on its upper extremity near the cap a ring known as the annulus, which annulus forms a covering and a protecting layer for the delicate under-surface of the cap, to the edges of which it was attached previous to the rapid expansion and maturity of the latter. The under surface of the cap is provided with leaf-like or gill-like projections, reaching for the most part from the stem to the periphery of the cap. These are termed gills, or "lamellæ." They are constantly pink in color in the white or cream-colored species up to the time of (and sometimes even a day after) the separation of the ring from the cap. Subsequently, these gills turn brown and even a deep brownish black. In the brown variety the gills are at first grayish brown but they also become almost black with age.

GENERAL CONSIDERATIONS

In the United States, fresh mushrooms have only recently been of any importance commercially, although florists and gardeners of English and French training have long been successful growers on a small scale. Nevertheless, during the past decade or so, the record of failures has been most conspicuous, and it is certain that, of the many who attempted this work, only a few, relatively, were uniformly successful.

4. A fairly moist atmosphere, avoiding the frequent and direct application of water to the beds.

5. A gradual renewal of the air, avoiding draughts.

In the following pages we will review these essential conditions and explain their relation to the growth and development of the mushroom.

TEMPERATURE

One of the all-important and controlling elements in mushroom culture is that of temperature—both the temperature of the atmosphere in the mushroom house and the temperature of the beds at spawning. In this article the temperature of the atmosphere alone will be considered, the other subject being treated under its appropriate head. The temperature of the mushroom house should be high enough to favor the growth of the spawn and sporophores, and yet be low enough to prevent the rapid development of their bacterial, insect and parasitic enemies. Experience has shown that the extreme range of temperature for profitable

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The conditions under which mushrooms may be successfully grown are limited, and intelligent attention is therefore essential. It must be said, moreover, that the majority of failures may be directly traced to erroneous ideas as to the cultural requisites, or to a reckless disregard of conditions. The essential conditions will be subsequently defined in detail, but it may be stated here that failures are usually due to one or more of the following causes: (1) Poor spawn; (2) very poor manure; (3) unfavorable temperature; and (4) heavy watering during the early stages of growth.

Under suitable conditions mushrooms may be grown with assurance of success. Ordinarily they are grown only where the conditions may be controlled, and success should therefore be invariable.

TEMPERATURE AND MOISTURE

Mushrooms may be grown in any place where the conditions of temperature and moisture are favorable. A shed, cellar, cave, or vacant space in a greenhouse may be utilized to advantage for this purpose. The most essential factor, perhaps, is that of temperature. The proper temperature ranges from 53° to 60° F., with the best from 55° to 58° F. It is unsafe to attempt to grow mushrooms on a commercial basis, according to our present knowledge of the subject, at a temperature much less than 50° or greater than 63° F. Any severe changes of temperature retard growth, or else act injuriously, and many changes of temperature would entirely destroy the profits of the mushroom crop. From this it is evident that in many places mushrooms may not be grown as a summer crop. With artificial heat they may be grown almost anywhere during the winter. Moreover, it is very probable that in this country open-air culture must be limited to a few sections, and restricted, commercially at least, to a single season.

It is very probable that the exact temperature which may be considered an optimum will vary somewhat in different sections of the country. It will be noted later in detail that the temperature factor acts not so directly upon the growth of the spawn or the production of mushrooms, as indirectly, to render some other conditions of the environment injurious. It is best to consider that in practice the optimum temperature for mushroom growing varies from 53° to 58° F.

growing is from 53° to 63° F., with the optimum at from 55° to 58° F. At the latter temperature the enemies of the mushroom are rather dormant or sluggish and will do correspondingly less damage. At lower temperatures the growth of the mushrooms will be arrested, but no harm will result. When the temperature rises again, and the necessary moisture is restored, a vigorous growth may be expected. At the higher temperatures irreparable damage will be inflicted, and a poor and unsalable crop will be the result. It is therefore essential that the temperature be constantly and closely watched. For maximum results, it would seem that a measure of control over the temperature is necessary. The dispositions to be made in that respect vary in different climates. It is a comparatively easy task to raise the temperature of the mushroom house to 55° or 58° when the outside temperature is below that mark. The judicious disposition of a few hot-water pipes will acomplish that result. This makes it possible to raise mushrooms in nearly all climates during the fall, winter and early spring. In the summer time, however, in climates where the atmosphere is usually above 60°, the problem becomes more complex, and involves artificial refrigeration. Those growers, however, who are fortunate enough to have at their disposal caves, cool cellars, abandoned mines or tunnels, where the temperature uniformly ranges below 60°, can grow mushrooms the year around, and especially in the summer months when the reduced supply has raised the market price. The question of moisture is also more easily solved in the summer, for the reasons outlined under the subject of "Moisture."

It was soon definitely ascertained that the conditions of pure culture growth are essentially different from those attending the growth of mushroom spawn in the bed. This was perhaps best indicated by comparing spawn grown in pots at 85° F. under impure conditions with similiar spawn grown at 50° F. At the former temperature, even though the conditions of moisture were properly maintained, there was little or no growth. Foreign fungi, molds, and bacteria, as well as insects, were, however, abundant. At the lower temperature there was little or no evident appearance of other fungi, molds or insects; yet the mushroom spawn grows slowly and continuously so long as other conditions are maintained. From numerous experiments of this nature, it is apparent that the temperature relation is one which is governed by the competition to which the mushroom spawn is subject in the bed. This is, of course, wholly in accord with the results obtained from the study of the relative growth made by mushroom spawn in fresh and composted manure.

The statement previously made, therefore, that the optimum temperature may vary slightly in different localities is true on account of the fact that the mites, insects, and other animal pests of mushroom growing may vary considerably in different localities, or under different conditions, even though there

Specimen of EDIBLE MUSHROOM VARIETIES

Grown from

"LAMBERT'S PURE CULTURE SPAWN"

Brown, (Bohemia)

MOISTURE

The mushroom, like most other fresh vegetables, contains a large proportion of water. It is therefore necessary that water in some form be supplied to it at the various stages of its growth. The bed, when properly prepared, contains enough moisture to supply the mycelium to the bearing period unless it has been robbed of its natural moisture by some of the agencies which we will consider.

It must be remembered that the ambient air constituting the atmosphere, normally contains a certain amount of water vapor increasing with its temperature. When the air at a given temperature contains all the moisture which it can hold, it is said to be saturated. Beyond that point, the air will not absorb any more moisture, and the excess over the saturation point will be released in the shape of a mist or rain. As has been stated, the capacity of the atmospheric air for moisture increases greatly with its temperature. It follows from that rule, that air saturated with moisture at 80 or 90 degrees F. will release, by condensation, a portion of this moisture as soon as the temperature is lowered. Conversely, air saturated with moisture at 30 or 40 degrees will, as soon as its temperature is raised, become hungry for moisture and take it from anything within its reach. This explains why the cold atmospheric air of the winter, with a normal moisture content for that temperature, as soon as it is introduced in a warm house, absorbs the moisture from the furniture and even from the throats of human beings living therein. Hence the necessity of supplying additional moisture to this warmed air, for the comfort of the inmates of the house. Again, it is observed in the summer that when the warm air strikes a colder surface, like a water pipe, a cave or a cold cellar, the saturation

may not be a great variation, perhaps, in the bacterial and fungus flora of the compost upon which the mushrooms are grown. Certain insects, for example, are more abundant in a moist climate, but if special precautions can be taken to eliminate all such pests, the growth problem is confined to the interrelation existing between the mushroom spawn and the microscopic flora of the compost. Mushrooms grown in the open will probably show greater variation with reference to the temperature factor than those grown in caves or cellars.

The direct effect of a temperature above the optimum upon the sporophores is manifest through the lengthening of the stipes and rapid expansion of the caps, ordinarily accompanied by toughness and decreased size. In other words, the lower-grade market product is produced at the higher temperature.

The moisture factor is also one of importance. It is undesirable that the place in which mushrooms are grown should be very damp, or dripping

point is lowered and the excess of moisture is condensed on the cooler surface, causing dripping.

Applying these principles to the mushroom house, it is clearly seen that the inside atmosphere must be kept near the saturation point in order to prevent the air from robbing the beds and growing mushrooms of their moisture. This is an easy matter in the summer, because the temperature of the outside air generally exceeds 60 degrees F., and when brought into contact with the cooler air of the mushroom house, the saturation point is quickly reached and easily preserved, and there is no loss of humidity. In the winter, however, conditions are reversed. The outside air is colder and has therefore a lower moisture content. When introduced into the warmer mushroom house, the saturation point is raised and the newly introduced air proceeds immediately to borrow moisture from the beds. The problem is therefore to supply this air with enough moisture to bring it near the saturation point and thus keep it from robbing the beds of their normal water content. This is done by different growers in various ways. The walls and alleys of the mushroom house may be liberally sprinkled. Some allow steam to escape in the mushroom house and thus provide it with the necessary heat and moisture at the same time. This process is, however, hard on boilers unless rain water is used. The beds are sprinkled as a last resort, with a fine spray, and then preferably after a picking. It must be remembered that while the mushroom requires a great deal of moisture, it is very sensitive to the direct application of water, and frequent sprinklings are liable to injure it. The mushroom breathes, so to say, and the too frequent application of water closes its pores and interferes with the breathing process.

A proper supply of moisture is considered one of the essential requisites of successful growing. The disregard of these rules is responsible for poor yields and many failures. A reliable hygrometer should at all times be hanging in the mushroom house, and the percentage of humidity should never be allowed to drop

with water. Nevertheless, a fairly moist condition of the atmosphere should be maintained throughout the growing and productive period. There should be a gradual, but slight, evaporation from the surface of the beds, and sufficient ventilation to insure this is believed to be essential. It is certain that in poorly ventilated caves mushrooms do not succeed. On the other hand, in a dry atmosphere, or exposed to drying winds, mushroom beds soon cease to bear, while such sporophores as are developing may have their caps cracked or torn.

below 70, for when the bed has once been robbed of its natural moisture it is well nigh impossible to properly restore it. Since a gradual renewal of the air in the mushroom house is necessary the moisture problem is ever present.

VENTILATION

Plants, generally, abstract carbonic acid gas (carbon dioxide) from the air and decompose the gas, fixing the carbon that it contains and setting the oxygen free. **Mushrooms,** on the contrary, seem to breathe like animals; they absorb and assimilate the oxygen of the air, throwing off the carbonic acid. This fundamental distinction should be well borne in mind, as it explains physiological phenomena which are often baffling to the mushroom grower. The quantity of oxygen consumed, and the corresponding amount of carbonic acid thrown off by the mushroom are enormous. A single mushroom has been shown to exhale 59 milligrams of carbonic acid in the short period of one and one-half hours. It is therefore observed in mushroom houses, where no provision has been made for a gradual renewal of the air, that the growth of the mushrooms is checked or sometimes arrested from the very start; they are said to "damp off", although this condition may also be induced by excessive watering or poorly prepared compost. Hence the importance of proper ventilation in the mushroom house.

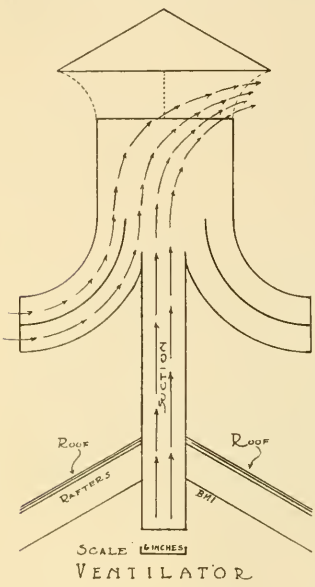
The object of ventilation is to remove the carbonic acid thrown off by the mushrooms and incidentally to supply the oxygen so necessary to their development. Carbonic acid gas is about one and one-half times as heavy as air, and is found at the bottom of the mushroom house, in depressions, etc. The exhaust pipes of the ventilation system must therefore extend nearly to the ground where they can gather the carbonic acid and expel it from the house just as water is pumped from the hold of a ship. The gas so removed will, of course, be automatically replaced by fresh air containing a new supply of oxygen.

Based on the above principles, the ventilating systems may vary according to the location and construction of the mushroom house. Where the floor of the house and the beds are above grade, it is possible to allow the carbonic acid gas to run off by gravity. But where the floor of the house is below grade, the heavier gas must be raised by suction or exhaust and discharged into the outside atmosphere. This applies especially to mines, caves, tunnels and cellars.

Specimen of EDIBLE MUSHROOM VARIETIES
Grown from
"LAMBERT'S PURE CULTURE SPAWN"

Cream

Ventilation by suction or exhaust is effected by various methods. In all cases a shaft or flue is essential. The lower air strata are made to ascend therein by means of a suitable apparatus utilizing the wind velocity, or by the direct action of an exhaust fan. Some growers assist the draught in the chimney by building occasionally a fire at its base. Various devices designed to raise the column of air in the flues may be found on the market. The accompanying sketch will illustrate the principle involved, and the device may be easily constructed by any tinsmith. The number and size of these devices, required for any particular building, depends, of course, upon it's size, construction and location. It is evident however, that in large underground mushroom plants, the positive action of an exhaust fan driven by power is almost a necessity.



VENTILATOR

While a gradual renewal of the air, through ventilation, is essential to the healthy development of the mushroom, direct draughts on the beds should be avoided. Draughts will rob the beds and atmosphere of the mushroom house of much needed moisture, affect the growth of the mushrooms and cause the caps to check and crack and to assume a darker color.

As will be explained in another chapter, ventilation is not without its influence on the temperature and moisture of the mushroom house. A thorough understanding of this relation and of the principles underlying it will often allow the intelligent grower to make use of his ventilating system in controlling or regulating essential conditions. He may, for instance, take advantage of cool nights to reduce the excessively high temperature in his mushroom house and close the ventilators when the outside temperature exceeds the optimum.

PREPARATION OF THE COMPOST

The cultivated mushroom is best grown on cured or composted horse manure. No practical substitute has been found for this

material. It is the best, and also the cheapest. Much depends, however, on the selection of the manure. The best manure is procured from stables where healthy, grain-fed and hard-working horses are kept. The manure should contain a fair proportion of straw, well trampled, and saturated with urine; the latter is an essential element which is often lost in well-drained barns. The material should be fresh; not over a week old.

Manure from barns where horses are kept for pleasure only is not so desirable because the animals do not receive so much grain, and the straw and droppings are removed before they are thoroughly impregnated with urine. Cow manure is unsuitable for the cultivation of mushrooms. Veterinary hospitals and barns where chemicals and disinfectants are freely used in the manure should be avoided. Manure which has been heaped against an outside wall and has been washed or leached in a rainstorm by the water from the roof, is of inferior quality.

As soon as the manure is assembled, it should be well mixed and the dry parts should be sprinkled. It is then made up into a pile 3 or 4 feet in height. While the length and width of the

PREPARATION OF THE COMPOST

It is not to be understood that there is one and only one method of preparing compost for mushroom growing. Nor is it always necessary that the compost shall be in one particular stage of fermentation or decay. In fact, every change of condition elsewhere may necessitate a similar change in the amount of fermentation which may be most desirable. At the outset it should be understood that it is not the "fermentation" that is absolutely essential. The "fermentation" is, of itself, a minor matter.

The rapid oxidation action of bacteria, and perhaps of independent ferments, upon manure causes a considerable rise of temperature. At the higher temperatures (which may be maintained as long as there are present rapidly oxidizable food products) bacterial action is vigorous, and is unquestionably injurious to mycelial development. Wholly aside from the rise of temperature accompanying their activities, bacteria are otherwise injurious. In fact, manure which is put to test in a small test tube shows little or no rise of temperature above that of the place in which it is incubated. Nevertheless, the mycelium of the mushroom will not grow under such conditions. Rapid bacterial action is therefore prejudicial. Under those conditions where bacterial action is not rapid, fresh manure might be used to advantage; in other words, if the beds are so constructed that the manure ferments very gradually, without either excessive bacterial action or rise of temperature, then spawning might be made in fresh manure.

The old belief that rotten manure does not have the necessary strength—that is, does not produce so vigorous a mushroom growth as that which has been less transformed by bacterial action—has been confirmed by practical experiments. This loss of effectiveness is probably due, in part, to a change in texture or to other physical changes. In well-rotted manure there is ample food material to support a very good growth of mycelium in pure cultures. This has been chemically proved by sterilizing such manure and growing mushroom spawn upon it in pure culture. Nevertheless, beds prepared with well-fermented manure and left for some time before spawning do not yield so well. It is believed that here the physical condition has much to do with the result.

piles are conventional, depending on circumstances and convenience of subsequent operations, the height is uniform and not less than three nor more than four feet. When too shallow, the pile will not heat enough; when too deep, it will heat too rapidly and dry out, and the progress of the fermentation will be arrested.

When thus made up, the manure is left to ferment and heat for about a week. The pile is then broken up, the manure is again shaken, thoroughly mixed, and sprinkled if too dry. In the new pile the outside is placed inside and the inside is placed outside, so as to give every part of the whole mass an equal chance to participate in the fermentation.

Under average conditions, three weeks and three successive turnings are required to complete the chemical and bacterial reactions in the manure and effect its transformation into compost suitable for the beds. These turnings are made at intervals of about one week, in the manner described for the first turning.

During these operations the material has undergone a radical change, both in texture and in appearance. The characteristic odor of manure is now entirely absent, and has given way to a rather sweet odor suggestive of the mushroom. The material has assumed a uniformly brownish color, velvety to the touch. It should be sufficiently moist to retain its shape when squeezed in the hand without allowing any liquid to ooze from it. Attention is invited to the technical studies on compost and ferments in Part 2 of this book.

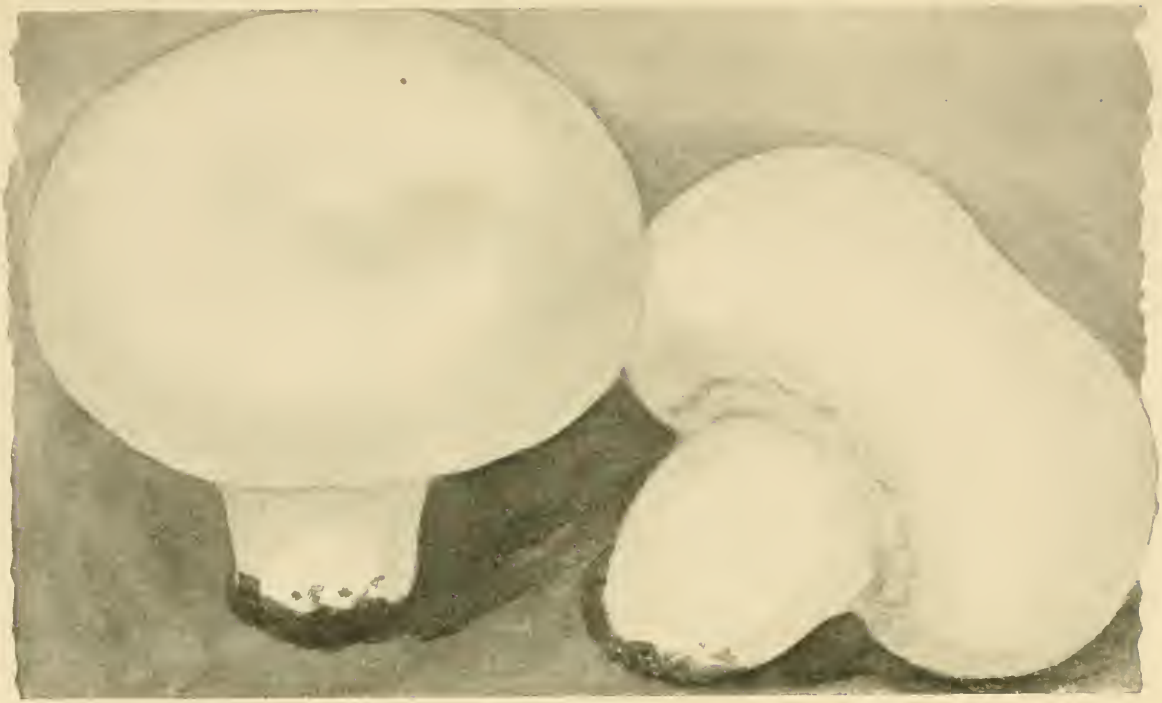
The latter does not by any means invalidate the following practice, which has commended itself to some very successful growers. The manure is piled in very large compost heaps, where it is kept moist and is turned only once or twice. It ferments very slowly. Then it is carted into the cave or mushroom house, long before it could be considered in proper condition to be spawned. The beds (usually flat when this is the procedure) are made immediately. These are fairly well moistened and compressed, then left to undergo a general fermentation, which may require a month. When the manure shows a tendency to fall to the temperature of the room it is spawned. Meanwhile, it will doubtless be found that a heavy crop of some small species of Coprinus will have appeared. The presence of this fungus is not injurious, but rather it may be taken as an indication that the conditions are favorable.

Ordinarily the manure is obtained as fresh as possible. It should include the straw used in bedding the animals, and the quantity of the straw will determine to some extent the value of the manure. The straw of cereals is far better than that of most of the grasses. The more resistant straws seem greatly to improve the texture of the compost for mushroom purposes. Commercially it is a mistake to attempt to get the manure free from straw. If fresh manure is not obtainable, that which has been trampled by the animals is ordinarily rich, well preserved, and desirable. It ferments best in large piles, and these may be of considerable extent, about 3 or 4 feet deep throughout. If not uniformly moist, the material should be sprinkled. At no time is a very heavy watering desirable. In from four days to a week or more the compost should

Specimen of EDIBLE MUSHROOM VARIETIES

Grown from

"LAMBERT'S PURE CULTURE SPAWN"



White, (Alaska)

Some growers, at the last turning, mix about one-fifth of loam with the manure. Such addition may have some advantages where suitable loam is found in abundance and where beds are made in tiers. It makes it easier to "beat in" a solid layer on the springy boards.

It is known that many insects and fungal diseases may be introduced into the mushroom house with the compost by the careless grower. It is advisable to scatter quick-lime over the ground where the manure is to be cured. This will dry out the soil and destroy eggs, larvæ and foreign spores.

When the compost is ready for the beds it is reduced to nearly one-half of its original volume.

A Simple Method for Beginners—The principles governing the composting of the manure, though familiar to the experienced grower, at first appear complex to the beginner and often discourage him at the start. For the benefit of amateurs who desire immediate results with least amount of trouble, we suggest the following method:

Mix in a barn or shed, where material will not freeze during the manipulation, 6 bushels fresh horse manure (free from long straws), with 2 bushels of good garden loam. Manure should be fresh, not dried, and loam should be moist. If material is fresh, no addition of water is necessary. Leave a few days, provided there is no danger of frost, which would freeze the material into cakes.

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be turned, or forked over, and a second turning will be required a week or ten days later. Water should be added only when necessary to maintain a moist (but not wet) condition. With this amount of moisture, and with the piles deep enough to become fairly compact as a result of their own weight, there will be little danger of any injurious fermentation. During the normal fermentation the temperature may rise higher than 150° F. In from fifteen to twenty-one days or more, depending upon the conditions, temperature will begin to fall, and the compost may be used in the construction of the beds. When used in the beds, it has ordinarily lost all objectionable odor, and the color of the straw has changed from yellow to brown.

It has been the experience of some of the most successful growers that the use of shavings for bedding material in the stables does not injure the value of the product for mushroom work. The presence of a large amount of sawdust, is, however, objectionable so far as the writer's experience goes. Compost containing much sawdust is necessarily very "short," and therefore the physical condition is not the most favorable for Agaricus campestris.

In another chapter attention is called to the fact that the value of the manure depends to a considerable extent upon the feed given the animals. It would not be wise to depend upon that obtained from stables in which hay and green foods are used to too great an extent. Moreover, it is not believed that compost made from the manure of cattle barns in mushroom growing is as desirable as stable manure.

Build a small box or partition in your cellar one yard square, twelve inches high. Bring in the material and spread one bushel at a time evenly in the box; tamp it firmly with a brick. Then bring in the next bushel, and so on.

Ascertain the temperature of the bed at frequent intervals, using a mushroom thermometer. When temperature of the bed has fallen to 75° F., plant the spawn, breaking the brick into 8 or 10 pieces, inserting a piece in the center of each square foot of bed, 2 inches below the surface. Cover, and tamp the holes. Then cover the bed with about 4 inches of clean straw, and, if convenient, with an old piece of carpet.

After 10 or 12 days, remove the straw and spread 1 to 1½ inches of fresh loam over the bed, tamp gently, and replace the straw and carpet. After about 40 days, mushrooms will commence to appear. The straw and carpet are then removed. The temperature of the cellar should not rise above 60° nor fall below 50° F.

The quantities above mentioned are based upon one square yard, for which one brick of "Lambert's Pure Culture Spawn" is required. For larger beds, increase the quantities proportionately.

It must not be assumed that this method is given as a perfect substitute for the usual and rational operations. It will not give maximum results, and is only suggested, not recommended, as a first experiment for beginners who have not studied and digested the principles outlined in this book.

INSTALLATION OF THE BEDS

Before the prepared compost is introduced into the mushroom house it is essential that the latter be free of noxious germs, insects or larvæ. It pays to fumigate and disinfect the house, shelves, etc., after each crop, for it is a difficult matter to combat

In some cities the municipal ordinances require that the manure shall be promptly removed from the feeding stables or that it shall be disinfected. In the latter case crude carbolic acid, or even corrosive sublimate, may be used to secure this end. Manure thus disinfected is, of course, undesirable for mushroom work. For the same reason the manure of veterinary hospitals is of questionable value.

For the most part manure may be composted in the open air. It may, however, be prepared with greater uniformity under cover. During midsummer protection may be desirable on account of drying out, while in the winter it is more important in case of excessive cold. If it is necessary to compost manure during the winter, moreover, the piles should be of considerable depth.

RIDGE BEDS IN CAVE OR TUNNEL—Spawned with "Lambert's Pure Culture Spawn"

the bacterial and insect enemies of the mushroom without injuring the growing spawn or the bearing crop. When it is considered that the spawn and the mushroom itself are of bacterial origin, and therefore readily killed by strong antiseptics, it will be realized that these remedies must be used before the compost or the spawn are present

A FLAT BED IN A BARN

Two types of beds are in general use, the flat bed and the ridge bed, as shown in the illustrations. Both have their advantages, and disadvantages. If the additional item of labor is not too great, the ridge bed is probably the best.

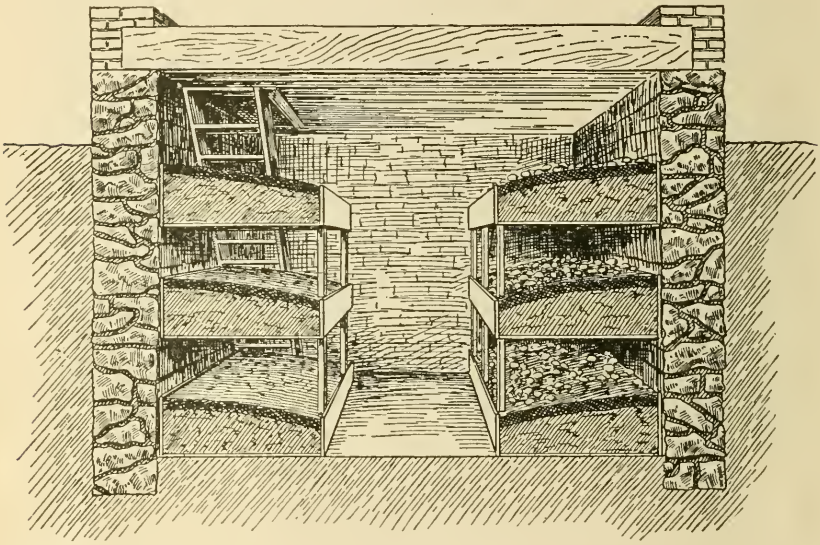
The cone-shaped ridge has a width of 18 to 22 inches at the base and an equal height. The smaller ridge is used in warm houses and the larger in cold houses. The ridge bed is more easily

INSTALLATION OF BEDS

Mushroom beds are of two general types, (1) the flat bed, frequently referred to as the English, and (2) the ridge bed, known as the French type. In making the former the entire floor space may be utilized as a bed, and the beds may be arranged in the form of tiers or shelves, as shown in the figure. In low cellars or caves, and, indeed, wherever the amount of floor space is not the most important consideration, it would be well to avoid the use of shelves; but where the amount of floor space is an important factor they may be adopted to advantage, although the additional labor involved in the growing of a crop under such conditions is an item to be considered. When the shelves are used one should be careful to whitewash these after each crop, in order to avoid the increased danger from insect depredations. In any case, flat beds should be made from eight to ten inches deep.

Ridge beds enable one to get a somewhat greater surface space in a given area, but they are also more expensive, so far as the labor of construction is

ventilated; it allows the carbonic acid gas, which is heavier than air, to drain off from its surface into the walkway, being replaced by fresh air containing a normal supply of oxygen. The dimensions above given should not be materially departed from. The ridges should be well packed and carefully combed. A pathway of about 15 inches is left between the ridges.

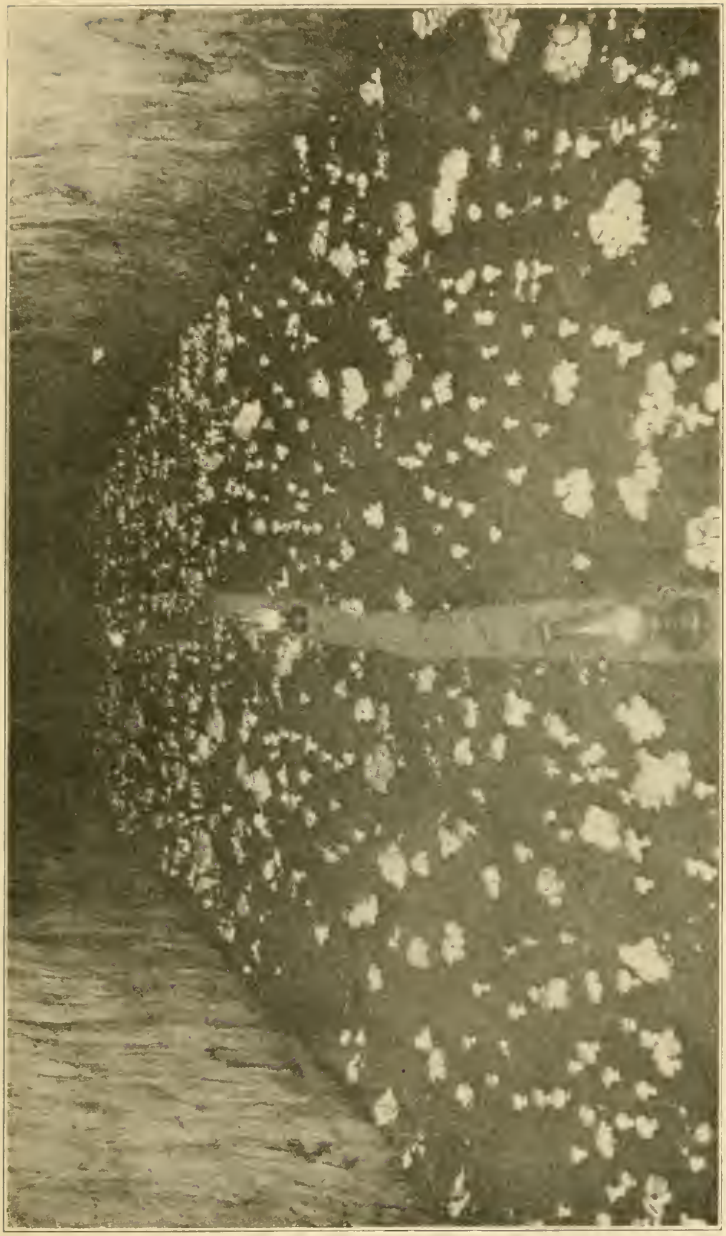


SHELF BEDS IN CELLAR

concerned. Nevertheless, under many circumstances they are obviously desirable. They should be about 2 feet wide at the base, tapering gradually to the apex, and not more than about 18 to 20 inches high when compressed and cased. The custom is to make two such beds in contact and then to leave a walk-way of 8 or 10 inches between the next two, and so on till the space is occupied. Next to the walls slanted beds may be prepared.

In any case, the manure is made up in the form of the bed desired, and should be firmed or compressed in order to prevent drying out and burning when the second fermentation takes place. At this time the manure should be neither wet nor dry, but merely moist. The only practical test of the proper moisture content of the manure which can be relied upon is when upon compression water cannot be readily squeezed out of it.

The prevalent opinion among amateurs that the bed should always be deep enough to maintain considerable heat is believed to be erroneous. Grown under more or less uniform conditions, mushrooms seem to require no bottom heat, and the bed should fall to the temperature of the room some time after spawning. Bottom heat, and hence large beds, are, however, desirable when sudden changes of weather would so reduce the temperature of the bed as to delay growth. Under similiar conditions, as well as in the dry air, mulching may be required.



FLAT BEDS IN CAVE OR TUNNEL—Spawned with "Lambert's Pure Culture Spawn."

The flat bed is probably more generally used in the United States because it is more easily constructed and involves less labor. Flat beds are made about ten inches deep. There is no advantage in making them deeper, and the foregoing remarks about the larger ridge bed may well be applied to the deeper flat bed. Mushroom beds do not require bottom heat.

In caves and tunnels, flat beds are ordinarily built on the ground. The floor may be of dirt, cement or boards, and should previously be disinfected with quick-lime. Provision should also be made against seepage. In cellars or mushroom houses, beds are often built in tiers; the same precautions should be taken to insure cleanliness.

To prevent the accumulation of carbonic acid gas on the flat beds, they should, if possible, be slightly inclined towards the alleyway in the center, so as to allow this gas to drain off as fast as it is exhaled by the mushrooms and be replaced by a new supply of oxygen.

In making the beds, either flat or ridge beds, the compost should again be mixed and divided so as to be of uniform composition. It is then well packed and tamped, preparatory to spawning. The critical stage of the operations has now arrived. The temperature of the beds may rise very materially, and again the rise may be insignificant. A reliable thermometer is now an absolute necessity, as the beds must be constantly watched until spawning.

SPAWNING

The best temperature of the beds for spawning has been found by repeated experiments to be about 70° F. It is dangerous to spawn at a higher temperature, and a proper start may not be secured if spawned at a lower temperature. Spawning should never be attempted when the temperature of the bed rises, as it is likely to rise beyond the danger point and kill the spawn. This

SPAWNING AND CASING THE BEDS

From what has been said concerning the temperature requirements it will be evident that spawn should not be inserted in the beds until the temperature has fallen low enough to insure successful competition on the part of the mycelium with other organisms. In many articles on mushroom growing it has been suggested that beds may be spawned when the temperature has fallen to about 90° F. From experience and observation, the writer can only conclude that such a temperature is frequently fatal, and it is believed that the temperature of the beds should be permitted to fall to 70° F. before being spawned. In fact the most successful results have been obtained at temperatures from 65° to 70° F. It was formerly believed that if the spawn were inserted at 90° F. this higher temperature incited the rather

is the fatal mistake which is often made by beginners who have otherwise carefully observed cultural directions and who are at a loss to account for their failure. The thermometer in the beds should be constantly watched, and as soon as the temperature of the beds has dropped to 70° the spawn should be planted immediately. If this opportunity is lost, a poor crop is sure to result. This emphasizes the necessity of having the spawn on hand before the critical time. It should therefore be ordered at the early stages of the operations, so as to make liberal allowance for delays in transit and for other unforeseen contingencies. It is safest to order the spawn before the preparation of the compost is undertaken. Under proper conditions of storage, brick spawn will keep for several months without deteriorating, and it can be shipped by freight, in quantities of fifty bricks or over, at lower rates. Special emphasis is laid on the foregoing considerations because there is a tendency on the part of the grower to delay ordering his spawn until he is nearly ready to use it, under the mistaken impression that it will be fresher when he receives it. The brick of spawn is broken in about eight pieces, which will spawn about eight square feet of beds. The practice of sawing the spawn is to be discouraged, as it tears and destroys a considerable portion of the mycelium.

Brick spawn alone is considered in this article, as it is not practicable for the average mushroom grower to handle or use loose spawn on account of its very perishable nature. It has been found advisable to dispose the spawn about to be planted on the bed a few days before time of spawning has arrived. The natural moisture of the bed will thus cause the mycelium of the spawn to gradually swell, and thus more readily run in the beds when planted. The spawn thus treated could not, however, be dried again for future use without material injury. Under no circumstances should the spawn be dipped in water before planting; such treatment is almost sure to result in permanent injury. This warning would seem superfluous to the experienced grower, except for the fact that we have actually seen the practice recommended in some publications.

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dormant mycelium to rapid and vigorous growth. It is clear, however, that the rapid development of the new mycelium from the pieces of spawn brick inserted is not so important a factor as suitable conditions for continued growth. If the temperature falls rapidly from 90° F. after spawning, however, no injury will result. Nevertheless, it is to be considered an unfortunate condition.

When the beds are in proper condition, they are spawned by inserting a piece of spawn about one inch below the surface. The hole is then filled, and tamped so as to insure intimate contact between the spawn and the compost. Care should now be taken that the beds do not lose any of their moisture. The walls and alleyways should be sprinkled to keep the atmosphere moist. The direct application of water on the beds at this stage is exceedingly dangerous; it is most likely to cause the delicate fibrous mycelium to rot and die. The beds should, however, contain a normal amount of moisture if the compost has been properly cured.

The mycelium of the spawn, whose life has been suspended, will now soon show signs of activity, and in a few days will radiate from the piece of spawn and slowly permeate the compost. Casing of the beds should not be undertaken until the growth of the spawn has taken a fair start and extends a few inches into the bed. About a week after planting a small quantity of material near the spawn may be removed in the hand and examined in a strong light. If the spawn is running, a grayish fuzz will be observed in the material, and, if sufficiently extended, the time for casing has arrived. This occurs ordinarily from one to two weeks after spawning. Casing should not, however, be delayed too long.

CASING THE BEDS

Casing consists in applying to the bed a layer of loam from 1 to 1½ inches deep. It is essential that this loam be free from ligneous or putrefying matter which might introduce into the bed injurious molds. The loam should be neither clay nor pure sand. Calcareous loam, or calcareous sand mixed with some good loam,

The bricks of spawn may be broken into from 10 to 12 pieces, from 1½ to 2 inches square. These pieces may be inserted about 1 inch beneath the surface of the manure. In flat beds they may be placed from 10 to 12 inches apart throughout the bed, and in ridge beds should be inserted on each side alternately, one near the top and the next near the bottom. It is well to insert the pieces vertically, as the mycelium does not then seem so readily to suffer damping off. After spawning the beds should again be firmed, and they are then ready to be cased or loamed, whenever this process may seem most desirable. At the time of spawning the beds should be in the best condition possible for the growth of the mycelium. Delay in growth at this time is one of the surest indications of a light yield. If the bed contains the proper amount of moisture, and if the walls and floors of the house or cellar are sprinkled occasionally, so as to maintain a moist condition of the atmosphere, it is possible to avoid wholly the use of water upon the beds immediately after spawning. In no case should a bed recently spawned be heavily watered.

is the best. The loam used for the casing should be fairly moist, and that condition should be preserved by keeping the atmosphere of the mushroom house saturated with moisture, or by a very light spraying on the casing. A casing which is in a muddy condition, or which is too dry, may be injurious to the growing mushrooms. The casing should not be applied until the spawn has been observed to run, but should not be delayed much thereafter. Under normal conditions this will occur from 1 to 2 weeks after spawning; this is under normal conditions.

When clay loam is applied to the beds in a muddy condition, it will completely shut off the air from the beds and will at the same time to some extent check the escape of the carbon dioxide which is continually generated in the interior of the beds. Moreover, such a muddy surface will later on dry and form cracks on the surface of the beds, thus breaking the mycelial threads, if any, that may have reached the surface to form small mushrooms, and damping off is almost sure to follow. If, before the casing is applied, the beds show moldy areas as if a plaster had been sprinkled in patches, it is evident that such beds are affected by the plaster mold (Monilia fimicola). Such patches should be sprinkled with powdered quick-lime when the surface is wet, or sprinkled with a one or two per cent solution of water and lysol if the surface is dry. This treatment is recommended when the infection is on the surface only where it has been brought from without. If the mold is found also in the interior of the bed (the result of poorly-composted manure) there is scarcely any remedy for it, and a maximum yield cannot be anticipated.

The surface may be sprinkled, if there is a tendency toward drying out. The same test for moisture content as has been outlined previously in these pages in the chapter on preparing the manure should be followed. The beds should become, gradually, somewhat drier, however, during the growth of the spawn.

The absolute water content for the bed at the time of spawning should be about 40 per cent, although this will vary considerably, according to the conditions, and especially with relation to the quantity of straw in the manure.

If the spawn grows rapidly at first and spreads throughout the bed, it will not be injured by a slight drying out, or by a temperature even as low as 32° F. On the other hand, a continuous high temperature for several days, or excessive watering, is sure to result in irreparable injury. In several instances where the experimental beds of the writer have been made during the late autumn and where a vigorous growth of spawn has been secured before the advent of the coldest weather, the beds have remained unproductive throughout the winter months, or so long as the temperature remained intermittently below 40° or 50° F. With the warmer weather, these beds have come into bearing several months later, and where the temperature has then remained favorable for some time a good yield has been obtained. In this case, moreover, the bed will bear much longer at a temperature of 60°

Several theories have been advanced to explain the function of the casing in the production of the mushroom. One thing is certain: without casing, little or no crop would be obtained. It is claimed that following a biological law peculiar to cryptogams, when the mycelium meets a changed medium which is no longer nutritious for it, it will become at once transformed into cylindrical stems and, upon contact with the air, will expand and form the button which later becomes the mushroom. Under this theory, the function of casing would be purely physical and the addition of fertilizers to the casing would seem to be superfluous.

As a matter of fact no absolute time can be laid down, for the appearance of the mushrooms is not only dependent upon the uniform temperature in the mushroom house, but also upon the quality of the compost, the care used in its preparation, the quality and condition of the spawn, the degree of moisture of the beds, and even the composition of the casing. Beds have been known to lay dormant for a number of months, and again have commenced to bear within six weeks after spawning. As long as there is spawn in the beds which is properly running and is not being re-absorbed, a crop may be looked for. If there is much delay in the appearance of mushrooms, the cause should be investigated and remedied. If the spawn has been killed by a material rise in the temperature of the beds after spawning, or by other causes, there is, of course, no remedy.

WATERING

Mushrooms, like other plants, require water; yet surface watering on the mushroom beds causes more or less injury. The mushroom requires oxygen to live; a sprinkling of water falling on a pin head mushroom completely covers it and consequently

F. or above, than if the temperature has been constantly in the neighborhood of 60° F. throughout the growing season of the spawn. As a rule, beds thus filled with spawn and then subjected for a time to cold conditions yield at the outset much larger mushrooms than beds exposed to a more constant temperature, even if this constant temperature may be optimum.

At any rate, the beds must be "cased" as soon as convenient after the spawn is inserted. As a rule, one should wait from one to two weeks in order to be sure that the spawn is growing. Casing consists in applying to the bed a layer of loam from 1 to 1½ inches deep. In France the casing soil consists of calcareous earth, sometimes mixed with loam. Ordinary loam of almost any quality will suffice. This should be secured in advance, and it is well to protect it from the weather, so that at a convenient time it may be worked over, and if necessary screened, in order to free it from large pebbles or trash. When the loam is applied, it should, on ridge beds, be carefully firmed. When cased, a bed should require watering for the most part merely to maintain a moist surface.

shuts off the air necessary to its existence. It practically drowns the mushroom, so to say. Likewise, on the beds, a film of water will seal them, especially when clay loam is used, and thus prevent the escape of the noxious gases generated in the interior of the beds as well as by the mushrooms and growing spawn. Water vapor used in saturating the atmosphere is the best means of supplying the needed moisture without causing any injury. The walls and alleyways of the mushroom house can be liberally sprinkled, but the sprinkling can should be used on the beds only as a last resort.

PICKING AND PREPARING FOR MARKET

The experienced mushroom grower can readily ascertain, by surface indications, when the mushrooms are about to appear on the beds. White, fuzzy patches, more or less regular or circular in form, may be seen around the places where the spawn has been planted. The casing will bulge and crack here and there, showing white globules. These growths may appear in the shape of white filaments, or may be composed of white vesicles running together. These manifestations should not, however, be confused with the efflorescent growth known as Monilia fimicola, the common "plaster mold," resembling in appearance an accumulation of white granulations suggesting plaster spots. Hence the popular name of the disease.

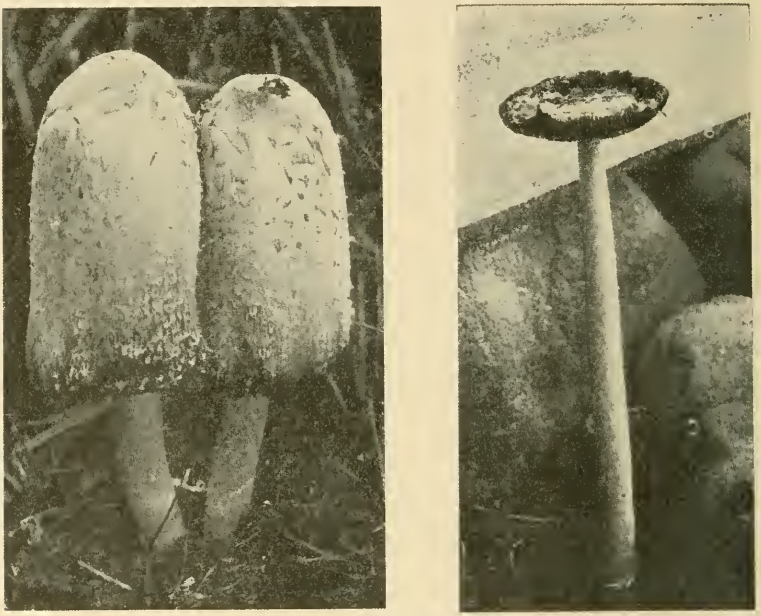
WATERING

As previously indicated, the spreading spawn should receive no water, or at least as little as possible. When, however, the mushrooms begin to appear, more water will be required, and a light sprinkling may be given once or twice each week, or as often as the conditions demand. Beds which come into bearing in proper condition should never be drenched. It has been found by experience that under the most favorable conditions a bed will require occasional sprinkling, since, owing to continual evaporation, there will be a gradual loss of water, at least after the mushrooms begin to appear. Sprinkling should be made after the mushrooms have been gathered, and the loam disturbed by the removal of the mushrooms should always receive a light sprinkling.

PICKING AND PREPARING FOR MARKET

When a bed is in full bearing the mushrooms should be gathered at least once in two days, and it is well to pick them every day, particularly if the temperature is up to 60° F. or more. Picking is itself an art, and the intelligent owner will soon find that the yield of a bed may be greatly lessened by lack of judgment in picking. To satisfy the general demands of our markets at the present time it is not recommended to take the buttons; yet, if there is a fancy trade for these, it should be met. Little or no gain of weight occurs in the mushroom, however, after the veil begins to break, so that mushrooms should not be left after this time. Flat tops are a third-grade article, but these, as well as all defective mushrooms, should be sedulously removed from the bed every day.

It is often found that some strange fungi appear on the beds in advance of the regular crop, the germs of which may have been introduced in the mushroom house with the compost. Chief among these intruders is the Coprinus, a species of which is herewith illustrated. Another species of the same genus is more squatty in appearance. They are short-lived, and the gills soon



COPRINUS COMATUS (SHAGGY MANE)
Before and after the gills have been dissolved

dissolve, forming a black, inky liquid; they are sometimes called "ink caps." The appearance of these fungi, which are edible, is considered by some a rather favorable omen.

The picking of the mushrooms should not be left to unintelligent or inexperienced hands. It is an easy matter to lose or waste half of the crop through careless picking. In harvesting the crop one should not be guided by the size of the mushrooms, but rather by their condition and stage of maturity. For example, a mushroom with a small cap and a long stem should not be allowed to

In picking, grasp the mushroom by the cap (a large one by both cap and stem), twisting it to remove it easily from the soil. Where the mushrooms come up in large united clusters, it will be best to cut them, in order not to disturb the mycelial connections of all. Some good growers practice "cutting" throughout, but the stubs must decay and are a source of danger. After all good mushrooms from a cluster have been taken, remove any fleshy spawn masses adhering and add fresh loam.

remain until the following day, for it will not gain in weight by remaining, but will have its cap entirely open the next day, becoming a third-grade article. On the other hand, a mushroom with a large deep cap and a short stout stem may remain a day or two longer without breaking its veil, and double or treble its weight in that short period. The best time to pick the mushroom is

A CLUSTER OF FIFTY MUSHROOMS ON ONE ROOT
Grown by Miller & Rogers from Lambert's P. C. Spawn
NOTE—This illustration is being copied and used by some persons without authority, in connection with other grades of spawn.

As they are picked, the mushrooms are put into shallow baskets and taken to a sorting and packing table. The stems are cut off and any adhering loam is brushed from the cap. It is true that mushrooms keep somewhat better if the stub is left attached and the loam removed by rubbing, but except in special cases this procedure is not to be recommended. It is not necessary to cut the stem off short, but the market demands that there shall be few long shanks.

For the best trade it is desirable to "sort" the mushrooms, placing only those of nearly the same size in the same packages. It is certainly not well to pack together "broilers" and buttons, if this can be avoided. Defective mushrooms should invariably be thrown out. Mushrooms should be treated as a first-grade product in every way, and therefore the package must be attractive. If the time involved in shipment is not to be very long, they may be put into 5-pound splintwood baskets, or they may be packed in 2-pound boxes arranged in crates, as prepared for fruit. Shipment may also be made in boxes of sizes demanded by the general or private trade. Baskets afford excellent ventilation, yet boxes are often to be preferred. If the latter are lined with a blue paraffin or oiled paper, a good color contrast will result and the package will be made much more attractive.

when the veil is about to separate from the stem; it has then acquired its maximum weight and will be graded as number one on the market.

FOUR POUNDS OF MUSHROOMS IN EACH BASKET
Grown by Mr. Swayne, from Lambert's Pure Culture Spawn

In picking, a gentle oscillation and twist is imparted to the mushroom. The cavity left in the surface of the bed should invariably be filled with fresh loam. Mushrooms should be handled carefully; they should not be thrown or dropped in the baskets. It must be remembered that every point of contact will show a dark spot in a few hours and mar their appearance for the market. Mushrooms deteriorate materially by frequent or careless handling.

In preparing the mushrooms for market, legitimate requirements, and even the caprices of the buyer, must be taken into con-

Under favorable circumstances, a bed may come into bearing within six weeks. It usually requires, however, a longer period, and eight weeks may more nearly represent the average conditions. If the conditions have been variable, and especially if at times a very low temperature has prevailed, bearing may be still further delayed. Again, the period of production or the profitable "life" of a successful bed may vary greatly, ranging from five weeks to as many months. As a rule, a bed which produces fine, heavy mushrooms will bear longer than one which yields plants of lighter weight. Many growers think that there is profit in a bed which yields one-half pound per square foot of surface area. One should not be satisfied with less than this, and if the best conditions prevail this yield is far below what should be obtained. Two pounds per square foot is an excellent yield and some of our growers report this amount.

sideration. The best market demands an attractive package containing from one to three pounds of clean, fresh mushrooms of uniform size and color, at the proper stage of maturity. Flat tops, unattractive packages, mixed sizes or colors will bring from

OVER TWO POUNDS PER SQUARE FOOT
Grown by Mr. Collins, from Lambert's Pure Culture Spawn

10 to 20 cents per pound less than the higher grade. Some markets are partial to large mushrooms, others to small or medium sizes, while still others have a preference for the pure white or the brown mushroom. These are matters of individual taste which the mushroom grower must study and cater to if maximum results are to be obtained. It is therefore advisable to sort the mushrooms before packing, so that uniformity may be secured in each package.

For shipping purposes, mushrooms are packed in baskets or in cartons or boxes, and crated. Grape or fruit baskets are used where they can be procured cheaply. The tendency is now to use special cartons, or paraffined boxes, of uniform size, which are attractive and inexpensive, and are easily crated. Second-hand fruit crates, lemon or orange crates may sometimes be obtained from grocers or fruit dealers at a trifling cost. Crates should be marked "Handle with care, this side up." Rough handling by carriers has resulted in bruised mushrooms and consequent loss in grade. Of course, mushrooms are never shipped by freight.

The total yield of a mushroom bed at one planting is dependent upon the careful observance of all cultural requisites. One pound to the square foot is a good average yield; two pounds are often obtained, and in many cases considerably more. The bearing per-

TEN-POUND SHIPPING CRATE

iod is from six weeks to three months, and its duration is largely influenced by the temperature and moisture content of the mushroom house. In colder beds the mushrooms grow slowly, are of better quality and are less subject to the attacks of their enemies, which are then more or less dormant. Some growers will prepare, spawn and case their beds in the usual way, and then allow them to cool off below the growing temperature, thus remaining dormant. At the proper time, they will restore the heat and moisture, and gather a vigorous crop in the early spring or at such other period when market prices are highest. The spawn must, however, have a few weeks' start before this treatment is applied.

The importance of securing maximum results cannot be overestimated. The cost of production is the same for a given area of beds, whether a good or a poor crop be harvested. While the raising of mushrooms pays the grower well with a fair crop, very large and quick profits are made in the big yields.

MARKET CONDITIONS

The best markets for the sale of fresh mushrooms are the local markets, and those markets in larger cities which can be reached within a day's ride by express for morning delivery. Fresh mushrooms are bought principally by hotels, cafes, restaurants and private consumers. They are also extensively handled by produce merchants and grocery stores. Direct sales to the consumer would seem to bring the best prices, but hotels, cafes and restaurants as well as grocery stores, desire to be assured of a steady supply. To produce merchants, mushrooms are generally consigned to be sold on a commission basis, usually ten per cent. The prices vary according to locality and the season of the year. There is always a strong demand for the No. 1 grade described in the preceding chapter; and the price for this grade seldom falls

MARKET CONDITIONS

The successful cultivation of mushrooms in America has not been so general as in most of the European countries. It is in France and England that the mushroom industry has been best developed. France is, properly speaking, the home of the present mushroom industry. Unusual interest has been shown in the United States in the growth of mushrooms within the past few years and it is to be hoped and expected that within the next ten years the industry will develop to the fullest limit of the market demands. The latter will, of course, be stimulated and developed by the increasing popular appreciation of this product. In some cities and towns there is already a good market demand for mushrooms, while in others they may be sold only directly to special customers. This should be borne in mind by prospective growers.

In the vicinity of Paris the mushroom industry has been remarkably developed during the past eight or ten years. The total product sold through the central market of Paris in 1898 was nearly 4,000,000 pounds; the quantity for 1900 is given approximately as 8,500,000 pounds, and for 1901 nearly 10,000,000 pounds.

These figures show most convincingly the present status of the mushroom industry in France. It may be safely assumed that more than one-third of this quantity is consumed in a fresh state in and about the city. The growth of the canning industry during this period has also been remarkable. In 1898 about 1,800,000 pounds were preserved, while in 1901 the canned product amounted to nearly 6,200,000 pounds. During 1901 the approximate monthly production of mushrooms ranged from 651,000 pounds to 985,000 pounds, from which it is evident that these caves yield heavily throughout the year. In some instances growers are able to get a crop every four or five months.

It is extremely difficult to estimate the quantity of mushrooms grown in the United States. It is certain, however, that the production has increased very greatly, and particularly within the last four or five years. In the vicinity of several of our larger cities there are today individual growers who produce more than the total commercial output in the neighborhood of those cities ten years ago.

There is now a very good open market for fresh mushrooms in a few of the larger cities, although many large growers continue to sell entirely by contract or by special orders to hotels and restaurants. With such an enormous comparative consumption of the canned product, there is every reason to believe that fresh mushrooms can be sold in much greater quantity as soon as this product becomes a certain factor in the market.

below 50 cents per pound, going as high as $1 and $1.50 per pound in certain localities. A drop in the market quotations will, as a rule, affect the lower grades only. Since the grades are in a large measure based upon the time and manner of picking and the care in packing, it is obvious that the grower, by his own care or neglect, can materially influence the market price of his crop as well as his margin of profit. In France and in England, the market for mushrooms is well developed and regulated. In the United States and Canada, the industry is still young and there is not much co-operation between growers in marketing their product. The demand for fresh mushrooms has been so strong that practically no effort has been made at canning any portion of the supply.

Since the fresh mushroom is a perishable article, and for that reason cannot be shipped to a very great distance, different sections of the country have their own market conditions. For instance, the growers on the Pacific coast have no competition to fear from the growers on the Atlantic coast, and vice versa. It must be admitted that the shipping methods of a large number of growers are still crude, their packages are unattractive and they fail to get the best price of the market.

It is comparatively easy to develop a local market for mushrooms in fairly populous and progressive cities. The proprietors of cafes and restaurants have frequent calls for fresh mushrooms. In the estimation of many patrons the place does nor rise to the rank of a first-class house until fresh mushrooms are found on the bill of fare. However, the hotel or cafe must be assured of a steady supply; and therein lies to some extent the secret of success and good prices in the local market. The grower who is in a position to supply mushrooms the year around has therefore the choice of customers in all markets and receives the best prices.

OLD BEDS.

The necessity of removing every vestige of the old beds from the mushroom house cannot be too strongly emphasized. To neglect or carelessness in this respect can be traced some of the diseases and insect pests which affect the mushroom crop. It will be remembered that one of the objects of raising mushrooms at a temperature below 60° F., is to mature and gather the crop before the mushroom enemies,which are rather sluggish at low temperatures have so far developed as to cause any damage. Should any part of these beds be left in the mushroom house after a crop, the

insect larvae and molds which have been partly developed would soon mature and spread to the new beds, attacking the growing spawn as well as the maturing crop.

The special elements of nutrition in the compost which are necessary for the growth of the mushroom, have practically been exhausted in the old beds. We have already seen that the mushroom is of bacterial origin and requires a favorable medium for its development. It may be compared in some respects to bacterial growths in the human body which, after running their course, leave the subject practically immune from the same diseases for want of proper food for the further development of the bacteria. Similarly when the mycelial growth of the mushroom has exhausted in the beds the special food required for its development, it has practically run its course and the bed has become, so to say, immune. However, a subject who has been immunized against one species of bacterial disease is not necessarily immune against another. Therefore the expended mushroom beds have lost none of their value for other purposes and make an excellent lawn dressing and fertilizer for flowers and garden products. In fact, this material is much in demand in large cities by florists and owners of gardens, who know its value, and is sold at prices averaging about $3 per load. This feature makes the growing of mushrooms especially attractive to market gardeners and florists, to whom the expended beds are exceedingly valuable; in fact the compost is preferable to fresh manure for their purposes. Florists utilize the waste space under the benches for the growing of mushrooms.

OPEN-AIR CULTURE

It is sometimes assumed by some people that because mushrooms, including the Agaricus campestris, are found outdoors, they can be grown in the open air under the same conditions. That is only partly true. There are seasons of the year in many climates where conditions happen to be favorable to the development of

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OLD BEDS

When a bed has ceased to bear, or is no longer profitable commercially, it should be taken down and every particle of the bedding and casing materials removed from the cave, cellar or house. The manure is still valuable for field and garden purposes, but is wholly useless and even dangerous for mushrooms, because it is not only exhausted with reference to mushroom growing but may also harbor the diseases or enemies of the mushroom. When the bed is removed the house should be thoroughly cleaned, and, if possible, sprayed or fumigated. If conditions remain constant, there is then no reason why another crop should not follow immediately.

mushrooms, and where these conditions temporarily exist mushrooms are found outdoors, sometimes in abundance. As soon, however, as these favorable conditions cease, the mushrooms disappear. If it were known how many million spores and how much spawn nature wastes under unfavorable conditions, in order to produce a limited number of mushrooms when favorable conditions occur, it soon would be found that the mushroom grower cannot do business on the same basis. He must be reasonably sure of a crop regardless of weather conditions and cannot afford to waste his labor and his material where the prospects are uncertain. It follows that open-air culture is restricted to those climates where weather conditions fairly correspond with the requirements of mushroom culture, that is a uniform temperature ranging between 52° and 60° F., a moist atmosphere and a reasonable protection from drenching rains.

However lawns and pastures have been successfully inoculated in various sections of the country, and it is surprising that park commissions do not more generally take advantage of the facili-

OPEN-AIR CULTURE

In some sections of England and France open-air culture of mushrooms in beds is practicable during the late autumn and winter months, in which case the productive period may extend into the spring. The difficulties, in the way of open-air culture are not merely those of maintaining a more or less uniform temperature, but also of maintaining practically constant conditions of moisture. For these reasons it is necessary to mulch the beds heavily with clean straw. In some instances a light mulch of straw is permitted to remain even during the period of production, for a rapid drying out of the surface would be hazardous or fatal. It is better, perhaps, to put the beds under some form of protection, such as an improvised cold frame.

In regions where the climatic changes are marked, open-air culture is probably not to be recommended during any season for commercial purpose. It is probable that there are some areas in the United States in which open-air culture might be practised with profit. It has seemed that certain sections of California might be favorable for this phase of the work. In the interest of experiments along this line the writer has made a special attempt to acquaint himself with the conditions in that section of the country. This has seemed particularly desirable, inasmuch as fresh mushrooms could not be shipped to the far West from sections in which they are at present grown in quantity. From the information obtained it is thought that successful open-air mushroom growing might be anticipated in those sections where the average temperature is between 48° and 55° F., provided there are relatively few days when the temperature falls as low as 32° F. At the same time, open-air culture cannot be recommended for those sections in which dry winds are prevalent. As a rule, during the wet or winter seasons the rainfall is so light that heavy mulching would probably suffice to prevent injury from excessive wetting. Nevertheless, it seems apparent that even in regions most favorable for open-air culture some inexpensive partial protection against the changes of temperature, due to direct sunlight, or against heavy rainfall, would be desirable.

ties at their disposal and inoculate with spawn certain portions of the public parks which happen to be well drained and shaded.

Lawns and pastures may be inoculated by breaking a brick of spawn in four pieces and inserting the same under the sod about two feet apart. Plant in the summer, and if the season is not wet mushrooms will appear in the fall. Avoid depressions where water would remain stagnant, as an excess of moisture destroys the spawn. Since weather conditions render open-air culture rather uncertain, the use of fresh high-grade spawn might be considered expensive. It is often possible, in such case, to obtain from dealers, at a much reduced price, spawn which has been kept in stock for some time and cannot therefore be sold as strictly fresh. The grower, thus incurring no expense in the preparation of beds, runs no chance beyond the small outlay for the spawn.

MUSHROOM SPAWN

The spawn proper, or "mycelium," is a delicate felt or thread-like growth of a greyish-white color which has been developed in a suitable medium from a spore or pure culture.

The advent of pure culture (or tissue and spore culture) spawn marks an epoch in the history of mushroom culture. The importance of its discovery was immediately realized by the Department of Agriculture, who in turn brought it to the attention of the American growers. Selection and improvement in the varieties of the cultivated mushroom are now possible. Where for-

MUSHROOM SPAWN

The mycelium of the cultivated mushroom has long been known commercially as "spawn." From early times it has been recognized that mushrooms may be grown from spawn, and it is quite certain that in all attempts to propagate mushrooms spawn has been used for the purpose.

A "Chance" Method—For practical purposes it is necessary to renew the spawn and to secure, if possible, spawn which has not previously weakened itself by the production of mushrooms—known as virgin spawn. Natural virgin spawn may be found wherever "in nature" it has been possible for the spores to germinate and to produce a mycelium.

Many attempts have been made by practical growers to develop spawn from spores, sowing the gill portions of mature mushrooms in specially constructed beds; but the results, so far as the writer is aware, have not been satisfactory. As a rule, therefore, growers have been compelled to rely wholly upon a virgin spawn which has been obtained by chance. It is said that in the vicinity of Paris some persons make a business of searching for this virgin spawn, which they sell to the growers at a high figure.

However adept persons may become in the identification of various varieties of spawn by odor, etc., this must be considered essentially a chance method.

A "Selective" Method—From what has been said it will be perceived that very little advancement could be made in the selection of desirable varieties of mushrooms, in varietal improvement and the like, so long as the chance method of securing spawn should prevail.

merly the grower was compelled to buy wild seed (English or French spawn), manufactured by the "chance" method, he is now in a position to buy pure culture spawn of the variety most suited to his markets and to the special conditions surrounding him.

Pure culture spawn bears to English and other wild spawn the relation that grafted or budded trees bear to fruit seed. The present method of manufacturing English and other wild spawn consists in gathering the mycelium wherever nature happens to have deposited it in its wild state, and "running" the same into bricks. No one, not even the manufacturer of this spawn, is able to tell what variety or varieties of mushrooms it will grow; in fact wild spawn contains a miscellaneous lot of varieties. Since a comparatively small number of those are susceptible of cultivation at all, it is not at all surprising that so many experienced growers using foreign spawn are continuously meeting with total or partial failures in spite of their most intelligent efforts.

Proceeding by selection and elimination, the pure culture method of manufacturing spawn admits of steady improvement in the varieties. Cultures are taken from choice specimens of desirable varieties known to be thoroughly acclimatized and selected with special reference to their hardiness, size, flavor, appearance, and prolificness.

Spawn, as the term is used commercially, includes the mycelium and its carrying medium, the brick. Since the mycelium is of a very delicate texture it must, for the purpose of transportation and storage, be protected from injury and deterioration. Several attempts have been made to raise the mycelium and ship it in loose material, but in most instances these experiments have resulted in failure. In such a medium the unprotected mycelium deteriorates and loses its vitality so rapidly that it will not stand transportation or storage. A fairly compact brick of close texture has given the most uniform and satisfactory results. These bricks when made and

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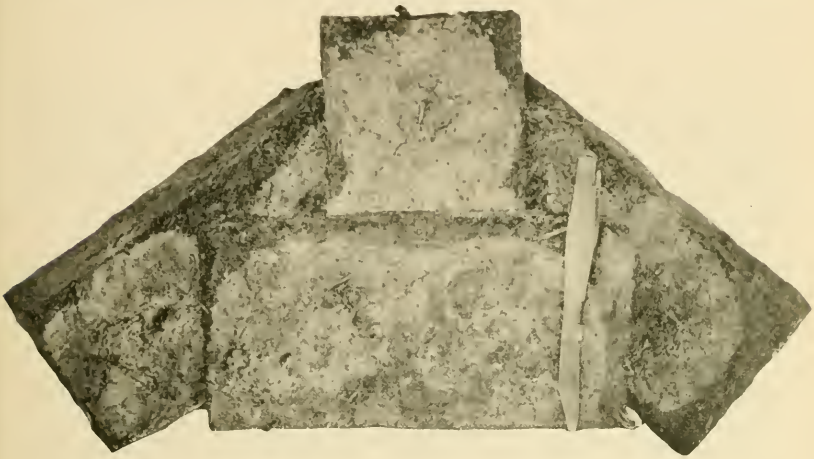
The successful germination studies with chemical stimulation mentioned in this paper were soon overshadowed by the discovery of the method of making tissue cultures. The use of the latter method has been the means of a sudden advancement in spawn-making in this country during the past few years, for many practical men have been quick to see the advantages which it offers.

The pure culture method of making virgin spawn is not one which will prove successful in the hands of wholly inexperienced persons, or of those who are unwilling to spend time and use the utmost care in the manipulation of the cultures and the culture material. The use of pure culture methods necessitates, to a considerable extent, a knowledge of the bacteria and molds which are everywhere present in the air and which are especially abundant wherever there are dusty or damp, moldy conditions.

partly dried are inoculated with the pure culture which soon permeates them thoroughly. This process is really a remarkable



PURE CULTURE BRICK SPAWN

demonstration of the dynamic force of growing organisms which, though apparently weak and delicate, will penetrate a comparatively hard and close-grained material. The mycelium in the brick spawn is not first grown in loose material and subsequently dried and pressed into bricks, as has been erroneously stated by some writers.

Thus protected, mushroom spawn (in brick form) will retain its vitality and remain unimpaired for several months or even over a year, if properly stored. The conditions of storage are similar to those required for seeds, bulbs, etc., they must be unfavorable

THE VITALITY OF MUSHROOM SPAWN

Many of the early experiments in mushroom growing undertaken by the writer were made in the hope of being able to ascertain the more frequent causes of failure and some of the chief difficulties encountered by American mushroom growers. The ordinary commercial (English) spawn used by amateurs, that is, such as is obtainable upon the market during the winter months, was purchased whenever possible. Samples of this spawn were placed under conditions which were supposed to be most favorable for growth. Nevertheless, in the majority of cases there was no indication of the development of a new mycelium from the bricks of spawn thus obtained.

Special importations of some of the commercial English and French spawns were made, and this was packed, shipped, and stored under conditions as favorable as may ordinarily obtain. This spawn was imported during the midwinter and stored until March or early April, when it was used in spawning some experimental beds. The conditions of the experiments were practically the same throughout, yet in not more than half the beds was there a favorable development of mushroom spawn.

to germination; in other words, a cool and dry place is required. When the bricks are well dried, frost will not injure them to any extent. But in a warm and damp atmosphere favorable for germination, spawn will get a start and will soon become unfit for planting.

A BED OF MUSHROOMS
Grown by Mr. Mathews, from "Lambert's Pure Culture Spawn" which had been stored by him for over a year

It is of great importance to the mushroom grower that his spawn be on hand when the time for planting has arrived. For, when the beds have reached the proper condition to be spawned, a delay of a few days is sure to be injurious, if not disastrous to the crop. The loss of temperature, and moisture, incident to this delay, cannot be retrieved, and a measly crop or perhaps a failure is the inevitable result. It is a mistake to suppose that the dealer is always prepared to fill a rush order for spawn, and especially pure

THE STORAGE OF SPAWN

It is possible to ruin good spawn by improper storage, even in a relatively short period of time. Spawn should be kept in a place that will be both cool and dry, but never hot and dry. This should be remembered by both seedsmen and growers, for many failures may, undoubtedly, be attributed to the improper storage to which the material has been subjected.

culture spawn. The demand for pure culture spawn, at present and for some time to come, will exceed the supply, and dealers can only obtain it from the manufacturers in limited quantities by placing their orders in advance and in excess of their needs. A careful grower will place his order with his dealer at least sixty days before his beds are expected to be ready for the spawn. If, as is often the case, the dealer has not in stock the kind of spawn or variety desired, he should be given time to order a fresh supply. Rush orders are filled with any stock on hand.

MUSHROOM ENEMIES

The principal enemies of the mushroom may be divided into two classes, insects and bacterial molds. They are treated in detail in the notes and in Part 2 (Technical Studies); we will therefore refer to them generally.

The insects causing injury to the mushroom crop are usually carried in the mushroom house in the form of larvæ, with the compost. This is corroborated by the fact that mushroom beds made from manure hauled and prepared in the winter months are remarkably free from insects. Recent discoveries tend to show that the insects are active agents in the spreading of parasitic diseases among mushrooms. Fumigations intended to destroy insects in houses containing beds in bearing are not very successful. In order to kill the insects the dose must be so strong that serious injury to the bearing beds results. The winged insects can be blown out of the mushroom house by occasionally causing a strong current of air to be blown through the house. We have seen this most successfully performed by means of a blower operated by a gasoline engine. An ingenious grower used a light in the evening with

MUSHROOM ENEMIES

Under suitable conditions and with the exercise of constant vigilance as to general cleanliness the mushroom bed will seldom fail as a result of diseases or insect depredations. Nevertheless, every precaution should be taken to avoid these difficulties. Some of the most common troubles reported in this country are as follows:

Fogging Off—During the pin head or button stage, and sometimes even later, the mushrooms which may be appearing in quantity, turn brown, cease to grow, and soon decay. This is supposed to be a physiological trouble; that is, one caused by a lack of essential conditions. Molds and bacteria may play a secondary part at least in producing this disease. It is most frequent in warm weather.

Black Spot—This disease manifests itself by the appearance of small discolored areas on the surface of the cap. It is said to be due to improper watering and to lack of proper ventilation.

Fungous Diseases—There are several fungous diseases of the mushroom, none of which, however, has been of serious importance in this country, and reference to them may, therefore, be omitted in this place.

fly paper tacked on the wall back of it. The winged insects would soon find the light and the paper and destroy themselves. It has not yet been proven that the sowbug or the centipede does any damage, and it has been observed that the latter destroys other vermin.

Foreign or parasitic molds or fungi, such as the PLEUROTUS and CLITOCYBE, are often introduced in the mushroom house with the casing. Others, such as the "plaster mold" may be brought in with the compost. In all cases preventive measures and strict cleanliness are the best remedies.

REMEDIES: The principal remedies and disinfectants used by mushroom growers are sulphate of copper, lime and sulphur.

SULPHATE OF COPPER in solution, one ounce or less to a gallon of water, may be used to advantage in spraying the manure at the last turning, or the beds before casing, so as to prevent the development of molds, insect larvæ, etc. In the proportion of one ounce to a quart of water it is used as a disinfectant in spraying the mushroom house before the beds are made up. QUICK-LIME is used, when pulverized, to sprinkle the ground where the manure is to be cured. It is also used in the alleyways between the beds to destroy larvæ and spores of foreign molds, and even on the beds

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MITES—There are one or two species of mites constantly to be found in compost heaps, which may be injurious in the mushroom bed. They are seldom troublesome at a temperature of less than 50° F., as they are then more or less sluggish; and, although they may be found upon the mushroom, they do little or no harm. At a higher temperature they are supposed to destroy the spawn to a certain extent and owing to their great numbers, they are at least objectionable upon the mushrooms.

WOOD LICE, OR "SOWBUGS."—These crustaceans, like the mites, are not of great importance where the conditions of temperature are favorable. The best methods of extermination are by trapping and poisoning them. This may be done by putting pieces of potato smeared with arsenic or Paris green, together with some dry rubbish, into tin cans or boxes placed on the side. Most of the sowbugs that enter these receptacles will be killed by eating the poison.

SNAILS—Snails and slugs are frequently pests in mushroom growing, but they may be readily trapped by the use of lettuce or cabbage leaves.

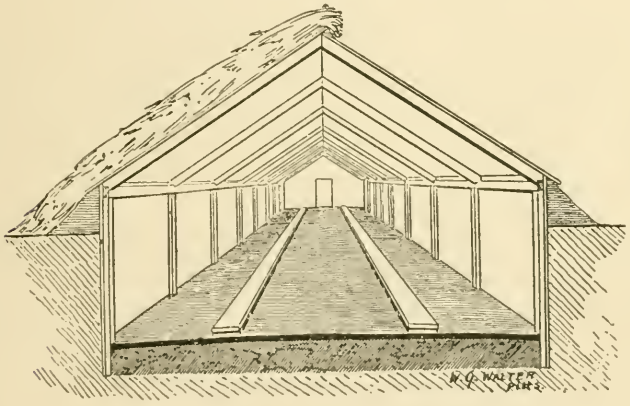
SPRINGTAILS—Springtails may become a source of great annoyance when mushrooms are grown in damp caves. As a rule, they can only establish themselves when carelessness has been shown in cleaning out old bedding material. When once established they multiply very rapidly, and the mushrooms are attacked by them in such numbers that within a day or two every appearance of fogging off is made manifest. These insects may be readily destroyed by fumigation with carbon bisulphide, but prevention is the wiser course.

LARVÆ OF FLIES—With good manure and under suitable conditions larvæ of mushroom flies are not usually injurious. Nevertheless, the larvæ of the little fly, Phora minuta, may be troublesome in warm weather. Fumigation, as previously suggested, may be of service in order that the life of a bed may be extended somewhat later into the warm season.

before casing, when they are found to contain an excess of moisture. Freshly slacked and mixed in water it is used extensively to whitewash and disinfect the mushroom house, shelves, etc. SULPHUR is probably the most effective fumigant used in the mushroom house. It is burned at the rate of 2 pounds per thousand cubic feet of space in a moist or steamed atmosphere. In a dry atmosphere the fumigant is not nearly so effective. The sulphurous gases penetrate all cracks and corners and destroy the spores, bacteria, and larvæ of parasites. It should be applied when the mushroom house is empty of beds and has been cleaned and swept out. It should never be used where beds are in bearing.

CONSTRUCTION OF MUSHROOM HOUSES

In a general way it may be stated that the mushroom house should be so constructed or equipped that a uniform temperature may be maintained therein and a gradual renewal of the air insured. The problems involved are, therefore, temperature and ventilation, and the method of their solution in the construction of the mushroom house will vary according to climate.

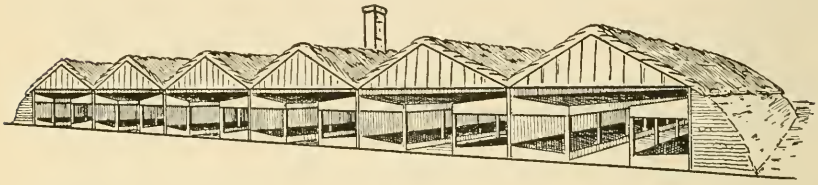


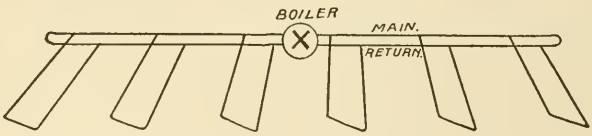
MUSHROOM HOUSE, PARTLY UNDERGROUND

The walls of the mushroom house, like the walls of the ice house, should be built of a material which is a poor conductor of heat, or should be so designed that the changes in the outside temperature will least affect the inside temperature. Double or hollow walls are preferable, as they are not so easily penetrated by heat or cold. The space between the inner and outer wall may be filled

with sawdust or other insulating material. The roof demands special attention, since it is most directly exposed to weather extremes and will materially affect the temperature of the house. The illustrations show an inexpensive treatment of the roof. A ceiling is advisable; it will form a closed air space between the roof and the beds.

A LARGE MUSHROOM PLANT





PERSPECTIVE OF HEATING PIPES.

Where the mushroom house is built partly or wholly underground an even temperature can more easily be maintained; but in all underground installations special provision must be made for disposing of the carbonic acid gas, as has been pointed out under the subject of VENTILATION.

CAVES, CELLARS AND HOUSES

Cellars, caves, and abandoned mines, or specially constructed houses are used for growing mushrooms, because in such places only can the conditions of temperature and moisture be best regulated. Cold is less injurious to mushroom beds than heat. The former renders the bed for a time unproductive, but the latter stimulates the spawn to too rapid growth, which is usually followed by the production of unsalable mushrooms, or by the eventual death of the spawn, supposedly by damping off.

Mushrooms may often be grown in a very simply constructed shed or unused barn which will provide against any sudden changes of the temperature, and when it is possible to employ artificial heat the season for mushroom production in such structures may be greatly extended. Cellars are very commonly used in producing mushrooms for family use. Natural or artificial caves are of the first importance, however, for commercial work, since the situation of these below the surface will best insure a temperature throughout almost the entire year more or less close to that which is desired. In selecting caves or cellars, one should guard against the possibility of flooding or of too much seepage water during a rainy season. Perhaps the least satisfactory situation among those mentioned is the greenhouse. Under ordinary circumstances it heats up too readily during the days of warm sunshine and, unless special precautions are taken, it is not to be generally recommended for amateurs.

Old sheds and barns are often utilized for growing mushrooms. In climates where the weather extremes take a wide range, it is advisable to insulate the walls and roof as explained.

Cellars, and especially the deep cellar, vegetable cellar or old cistern, make ideal places for raising mushrooms on a small scale. They can be used in the summer, where the temperature can be kept down below 60° F. In a warm spell, a chunk of ice left near the beds will often be sufficient to prevent an excessive rise in the temperature of the cellar. The amateur's first bed should preferably be made in the cellar where favorable conditions are more nearly realized than in any other building not specially constructed for that purpose. The experience thus acquired will be most valuable to him in future operations. Many city residences and suburban homes are now provided with a special corner in the basement for the mushroom bed from which the family table is regularly supplied.

Greenhouses can best be utilized in the winter. The waste space under the benches is well adapted for the cultivation of mushrooms. In the summer, however, the excessive heat in the greenhouse will not permit its use for that purpose.

Natural caves, abandoned mines and tunnels are admirably suited to the cultivation of the mushroom at all seasons, and are therefore of great commercial value. The temperature in these caves is fairly uniform and approximates the optimum. Provision must be made, however, for ventilation. The necessity of ample ventilation is not always sufficiently appreciated by growers and poor results due to this defect are often attributed to other causes.

Where the ventilating system of the mushroom house is ample and under easy control, it may often be used to regulate the temperature. For instance, should the temperature of the house exceed the optimum, advantage can be taken of cool nights to reduce

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Nevertheless, during the fall and winter it is possible to grow mushrooms under the benches or in any other unused space with but very little outlay of money or labor. Cold frames may also be used to good advantage during the autumn or spring. The natural caves of this country and abandoned coal mines in some sections should be further investigated with relation to their adaptability for the commercial production of mushrooms. A thorough study should also be made of open-air conditions.

In the construction of special mushroom houses any one of a variety of plans may be followed, and the selection of the style will depend, of course, upon its cheapness and efficiency in the particular locality.

From the reports of Dr. B. M. Duggar, Professor of Botany at the University of Columbia, and Collaborator of the Bureau of Plant Industry, U. S. Department of Agriculture.

it by opening the ventilators and then closing them as soon as the outside temperature again rises.

In the northern climates, and especially in houses built above the ground, it is generally necessary to provide some artificial means of raising the temperature in the winter months. Heat is supplied by several methods. In a large installation, steam or hot water pipes are to be preferred. When coal or oil stoves are used, provision must be made for the escape of the gases which are highly injurious to the growing spawn and mushrooms. A draught created for that purpose will incidentally ventilate the house.

HOW TO COOK MUSHROOMS

To the true epicure there are but four ways of cooking mushrooms—broiling, roasting, frying them in sweet butter and stewing them in cream.

In preparing fresh mushrooms for cooking, wash them as little as possible, as washing robs them of their delicate flavor. Always bear in mind that the more simply mushrooms are cooked the better they are. Like all delicate flavored foods, they are spoiled by the addition of strongly flavored condiments.

Broiled Mushrooms—Select fine, large, flat mushrooms, and be sure that they are fresh. If they are dusty, just dip them in cold salt water. Then lay them on cheese cloth and let them drain thoroughly. When they are dry, cut off the stem quite close to the comb, or, what is better, carefully break off the stem. Do not throw away the stems. Save them for stewing for soup or for mushroom sauce. Having cut or broken off the stems, take a sharp silver knife and skin the mushrooms, commencing at the edge and finishing at the top. Put them on a gridiron that has been well rubbed with sweet butter. Lay the mushrooms on the broiling iron with the combs upward. Put a small quantity of butter, a little salt and pepper in the center of each comb from where the stem has been removed, and let the mushroom remain over the fire until the butter melts. Then serve them on thin slices of buttered and well browned toast, which should be cut round or diamond shape.

Serve the mushrooms just as quickly as possible after they are broiled, as they must be eaten when hot. So nourishing are broiled mushrooms that with a light salad they form a sufficient luncheon for any one.

Fresh Mushrooms baked:—The following is Juliet Carson's recipe for baked mushrooms, and it is an excellent one:

Carefully cleanse the mushrooms as in the directions for broiling. Cut as many slices of bread as there are mushroom caps, trimming off the crust, and having each slice about two inches square. Lay the slices of bread in a baking pan and spread each slice with butter. Sprinkle each slice with a little salt and pepper. Next put on each slice of bread one or two mushrooms—just enough to cover the bread. Put the pan in a hot oven for five minutes. Then draw the pan to the front of the oven and season the mushrooms with salt and pepper and put a piece of butter as large as a hazel nut in each mushroom cap. Return the pan to the oven and finish baking the mushrooms, which are done as soon as tender. Serve them on the bread on a very hot platter.

Fried Mushrooms—Clean and prepare the mushrooms as for broiling. Put some sweet, unsalted butter in a frying pan—enough to swim the mushrooms in. Stand the frying pan on a quick fire, and when the butter is at boiling heat, carefully drop the mushrooms in and let them fry three minutes, and serve them on thin slices of buttered toast.

Serve a sauce of lemon juice, a little melted butter, salt and red pepper with fried mushrooms.

Stewed Mushrooms—Stewed mushrooms after the following recipe make one of the most delicious of breakfast dishes. It is not necessary to use large mushrooms for stewing—small button ones will do. Take the mushrooms left in the basket after having selected those for broiling, and also use the stems cut from the mushrooms prepared for broiling. After cleaning and skinning them put them in cold water with a little vinegar, and let them stand half an hour. If you have a quart of mushrooms, put a tablespoonful of nice fresh butter in a stew pan and stand it on the stove. When the butter begins to bubble drop the mushrooms in the pan, and after they have cooked a minute season them well with salt and black pepper. Now take hold of the handle of the stew pan and, while the mushrooms are gently and slowly cooking, shake the pan almost constantly to keep the butter from getting brown and the mushrooms from sticking. After they have cooked eight minutes pour in enough rich, sweet cream to cover the mushrooms to the depth of half an inch, and let them cook about eight or ten minutes longer. Serve them in a very hot vegetable dish.

Do not thicken the cream with flour or with anything. Just cook them in this simple way. You will find them perfect.

Mushroom Stew—Peel, cut up and wash. Stew in a little butter with red pepper, salt and a very little garlic. When soft add the milk and allow to stew some more. Set off the fire and beat a few eggs in the stew. Serve.

Mushroom Patties—Mushrooms are now often served at fashionable parties in the form of patties, very much on the style of oyster patties. Peel and cut in small pieces two pounds of nice fresh mushrooms. Add one-half cup of butter, pepper and salt, and one cup of rich, sweet cream. Stew for 12 minutes. When done sprinkle a small tablespoon of flour over them to thicken. This will fill about 20 patties.

Mushroom Sandwiches—Peel one pound of mushrooms and chop real fine. Stew for 10 minutes with butter, the size of an egg, and pepper and salt.

Toast about 20 thin slices of bread. Butter them and insert the hot stewed mushrooms. Trim the crust and cut diagonally in the shape of triangles. Serve real hot.

Deviled Mushrooms—Chop one quart of mushrooms, season with salt and pepper, and a little lemon juice; mix the yolk of two hard boiled eggs and two raw ones, stir in a pint of bread crumbs and a tablespoonful of butter. Fill baking shells with the mixture, cover with bread crumbs and bits of butter. Bake a nice brown.

Mushrooms and Tomatoes—Toast some slices of bread, cut them into round pieces two inches in diameter, and butter them, Peel some firm tomatoes, cut in thick slices, and lay them on the toast. On top of each place a peeled mushroom. Put them in a dish that can go on the table, pour a little clarified butter over them, put them in a hot oven for five or eight minutes, baste well and serve.

Brown Mushroom Sauce—Make a brown sauce, add to it one pint of fresh common mushrooms, simmer gently for fifteen minutes. Take from the fire and add wine if you use it. Some think a little mace or nutmeg an improvement, or a little Harvey sauce.

Cream Mushroom Sauce—Make a sauce, and add one cup of fresh common mushrooms chopped fine, cook in a double boiler for ten minutes. Stems chopped fine may be used for this sauce.

Mushroom Soup—Take a good quantity of the mushrooms, cut off the lower ends, and wash and peel, then put them in a stew

pan with butter, pepper and salt and a little stock, stir until tender, take off and chop in small pieces; prepare a good stock as for any soup, and add it to the mushrooms and the liquor they have been stewed in. Boil all together and serve. The stems only may be used for this soup with success.

Roasted Mushrooms—Cut the larger specimens into fine pieces and place them in a small dish, with salt, pepper and butter to taste; put in about two tablespoonfuls of water, then fill the dish with half-open specimens and buttons; cover tightly and place in oven (which must not be overheated,) for about ten or fifteen minutes. The juice of the larger mushrooms will keep.

Escalloped Mushrooms—Make a sauce of one tablespoonful of butter and one of flour, and two cupfuls of chicken broth or white stock; add to this the chopped stalks of a pint of mushrooms; reduce the same one-half, add a tablespoonful of chopped parsley, pepper and salt. Turn this sauce into a shallow baking dish, put in as many mushrooms as will fill the dish, placing them close together, gills up, put a piece of butter on each and sprinkle the tops with crumbs and place in an oven for ten minutes, or until tender and serve hot.

Curried Mushrooms—Stew a quart of button mushrooms for about twenty minutes in enough good stock to cover them well, add a tablespoonful of butter, thicken with a teaspoonful of curry powder and a tablespoonful of flour, boil slowly for ten minutes longer, and just before taking from the fire add half a cupful of cream; serve hot on a dish with slices of toast.

Mushrooms a la Bordelaise—Choose some big, firm, fresh mushrooms; peel, wash and drain them; make one or two slits on the top side of the mushrooms. Soak for an hour and a half in fine oil; pepper and salt. Broil them, turning when half cooked, so that each side may be equally broiled. Warm the oil in which the mushrooms have been soaked. Season with finely chopped onion and parsley. Dish the mushrooms and sprinkle with a few drops of vinegar or lemon juice, and pour the hot oil over them.

HOW TO PRESERVE MUSHROOMS

Dried Mushrooms—Take medium sized mushrooms, wash and peel them for immediate use. Place them for a few moments in boiling water to which has been added a little vinegar or lemon juice, to keep the mushrooms from turning black. It is claimed by some that distilled water is preferable. The use of salt must

be avoided on account of its hygrometric properties. The mushrooms being taken from the boiling water, are drained and then strung up on stout twine, bead like, in a shed or well ventilated room. Except in warm or dry climates, desiccation must be completed by placing the mushrooms in a moderately heated oven. In drying, the mushroom loses more or less of its flavor or aroma. Before using dried mushrooms they are first soaked in lukewarm water.

Mushroom Condiment—Proceed as above, but force the desiccation. The dried mushrooms are then reduced to powder on a fine rasp, and preserved in closed jars. The powder of several varieties mixed with 5 or 10 per cent of truffle powder prepared in the same manner. forms a condiment which is greatly esteemed by epicures.

Mushrooms in Oil—Peel and prepare the mushrooms as above, bleach in boiling water and drain. Place them in a jar and fill with olive oil or melted butter. When the jar is cool it is sealed and stored in a cool place. Though more expensive this process preserves the flavor and aroma of the mushroom.

Mushroom Ketchup—Take two pounds of fresh mushrooms, clean and peel them carefully. Cut in very thin slices and dispose in an earthen dish, each layer sprinkled with fine salt. On the top layer spread about four tablespoons of fresh walnut husks, finely chopped. Allow to macerate for four or five days in the cellar. When nearly melted pass through clean cloth. Reduce on slow fire to about half its volume; add its weight of calf's-foot jelly, season with pepper and laurel and reduce to consistency of jelly. Preserve in a cool place.

Preserved Mushrooms—Lambert's Process—Take fresh clean mushrooms, peel and place them in cold water containing ½ pound salt to the gallon, this is to prevent discoloring. Drain off the water and stew the mushrooms until they have reduced in bulk about 40 per cent. This only takes a few minutes. Put up in jars and cover the mushrooms with their own juice (for commercial purposes drain off the juice and fill with clear boiling water, this gives them a white appearance), screw on the cover loosely, boil for 30 minutes and immediately screw the cover tight. Stand the jars on their head for 24 hours to detect leakage, then boil again for one hour. This second boiling should be done exactly 24 hours after the first. The leaking jars should be processed over again. The glass jars should be protected from direct contact with the bottom of the boiler.

THE CANNING OF MUSHROOMS

From **"A Complete Course in Canning,"** republished from a series of articles in "The Trade" by an expert professor and chemist:

"Have the mushrooms as freshly gathered as possible and of even size. Wash, to free from dirt; peel. Blanch 3 to 4 minutes in bath of water, 12½ gallons; salt, 5 pounds; citric acid, 1 ounce; place in cans, hot-dip in brine (salt 2 pounds, water, 12½ gallons). Cap, tip and process at 240° F.; one-pound cans, 10 minutes; two-pound cans, 12 minutes."

From Bulletin No. 98, Oregon Agricultural college Experiment Station. **Preserving Wild Mushrooms:**

"Mushrooms may be canned as easily as fruit, and much easier than some vegetables. The buttons ranging in size from the smallest to those with the cup breaking from the stem are most desirable for canning, as they remain firm and white after being heated. When sufficient buttons are gathered they are cleaned by peeling, or by wiping with a cloth, removing any soiled spots or earth which may have adhered to them; the stems are cut off, leaving from one-half to one inch remaining attached to the cap; they may then be placed in a granite iron kettle and heated without water until shrinking ceases, after which they are placed in cans that have previously been cleaned and scalded, and the liquor poured over them, completely filling the can.

"If glass cans are used, after filling they are placed in any kind of vessel provided with a cover and containing a small amount of hot water. A sheet of asbestos, or a thin layer of excelsior is placed in the boiler to prevent the glass coming in contact with the bottom. The caps are placed loosely on the cans and with steamer cover in place, allow the water to simmer for half an hour. Upon removing the cover from the steamer, immediately screw the can covers down as tightly as possible, then place the cans away to cool, upside down, in order to detect any leak. If all are perfectly sealed, allow them to stand until the next day at the same time, when they are again heated in the same manner except that the time must be prolonged to one hour, because the contents of the cans are cold. Repeat this operation again the third day, which will complete the sterilization, and the mushrooms will be found to be as nearly like the fresh article as it is possible to have them. They keep well and do not deteriorate in consistency nor flavor. The cans must be kept sealed throughout the operation.

"When tin cans are used, they are handled in the same manner as the glass ones, with the exception of soldering the lid as soon as the can is filled, leaving the vent open until after heating the first time, when it is immediately closed with a drop of solder while can is hot, thus forming a partial vacuum that takes up the expansion caused by subsequent heatings.

"This method of sterilizing kills the vegetative germ-cell at its first heating, and the intermission between heatings induces the spores to germinate into cells, thus enabling a much lower temperature to be used than what would be required to kill the spores.

"If it is desirable to sterilize the mushrooms at one operation, the cans should be filled as already described, and, after sealing, heat them to a temperature of 240° F. for thirty minutes. This, however, requires a steam chest capable

of withstanding a pressure of over fifteen pounds to the square inch and the flavor and texture of the article being canned is materially impaired by this high temperature.

"When the older mushrooms are used for canning, they reduce very much in bulk, becoming mushy and turn black after being heated. They do not present such a tempting appearance, but the flavor is not impaired. A good use to make of older mushrooms is to dry them."

From Consular Reports, Volume 50, No. 186, March, 1896. "The Mushroom Industry in France."—**Preserving Mushrooms:**

"The most ancient method, and the one generally employed for preserving mushrooms for household purposes, is that of drying. Mushrooms of medium size are preferred, and the drying is accomplished either by natural or artificial heat. Carefully skin and clean them, just as if they were to be used at once, then plunge them in boiling water, into which the juice of a lemon has been squeezed or vinegar poured. Stir a few seconds and remove them. This is to prevent the mushrooms from turning black. Be very careful not to allow any salt or saline matter to come near the mushrooms.

"After taking the mushrooms from the boiling water, allow them to drain well on a wire screen; then string them like beads and stretch the string from wall to wall in a well ventilated room. Do not permit the mushrooms to touch each other. If the season or climate be too humid, place the strings of mushrooms in a gently heated oven. When thoroughly dry, put them in bags or boxes in a room perfectly devoid of moisture. It is true that mushrooms thus treated lose part of their aroma and flavor, but they keep indefinitely, and are an article of standard commercial value in France.

"Before cooking the dried mushrooms, they must be soaked in warm water or milk to restore them. The dried mushroom is extensively used as a condiment in France, and is highly appreciated. It is simply reduced to a fine powder and mixed with one-tenth to one-twentieth truffle powder.

"The process of conserving mushrooms in oil or melted butter, is, of course, more costly than drying, but the aroma and flavor are retained. Proceed to prepare the mushrooms exactly as above described, and let them drain well, but, of course, do not dry them. After sufficient draining, place them one by one in wide-mouthed bottles and pour over them melted butter or warm olive oil. Then cork and seal the bottles and put them in a cool place. There is great danger of fermentation, especially in the case of the melted butter, if the temperature of the storage room be too high.

"The preservation of mushrooms as here recited is resorted to mostly by households or dealers on a small scale. The large manufacturers invariably employ the 'Appert' process.

"**'Appert' Process**—The mushrooms are peeled and thrown in water made slightly acid with vinegar. They are then allowed to drain well, after which they are plunged in boiling butter until they are half-cooked or parboiled, then placed one by one in wide-mouthed bottles. Each bottle must contain three-fourths of its full capacity. The bottles are now well corked and the corks tightly and very securely held in place by strings. Then the bottles are placed in large caldrons of cold water, the bottoms of which have been covered with straw.

"The bottles are also wrapped in straw to prevent their breaking. The caldrons are then put on the fire and the water slowly brought up to the boiling point, which should continue ten minutes. The caldrons are then taken from the fire and the water allowed to cool gradually, after which the bottles are removed and sealed with wax.

"The small mushrooms, known as Paris mushrooms or 'Champignons de Paris,' are cultivated in the Bordeaux district to be sent to market or tinned. The mushrooms which are preserved are carefully washed, scraped, and then placed with a certain amount of water in tin cans, and the cans are boiled or steamed so that the mushrooms may be partially cooked. In some instances, where it is found necessary, the mushrooms are bleached by a weak solution of citric acid or lemon juice; this in no way improves the taste or flavor of the mushroom, but merely enhances its appearance. When this vegetable is used in the household the mushrooms may be taken out of the tin and cooked in any way desirable, or if the vegetable is merely used for the purpose of decorating the dish of meat, the mushrooms are sufficiently cooked to be eaten as they are.

"The center of the fresh mushroom industry is, of course, at Paris. Here mushrooms are gathered every morning, trimmed, washed, and sorted according to size and quality preparatory for the markets. Those that are preserved are sent to the factories for canning, where they are again washed in salt and water, selected and separated according to the quality, and then slightly cooked before being placed in tins. After the tins have been closed and soldered, they are then boiled again, in order that they may be more perfect in their preservation. Mushrooms are never washed in salt water unless for preserving purposes."

From **"Preserved Mushrooms,"** K. Weinhausen, Pure Products, Volume 6, No. 11, page 645:

"The young harvested mushrooms should be transported to the cooking room with as little delay as possible. The preliminary work varies according to the variety. The large mushrooms with open head are to be deprived of their stems, and the gills and upper skin of the head must be removed. It is best, however, to take the mushrooms when the head is still closed, as is the case when they are still young. When the above described operation is not necessary, the young mushrooms may be rapidly cleaned as follows: As much of the stem is cut away as is contaminated with dirt. The mushrooms are then immediately placed in salt water (1 handful of salt to 2 or 3 quarts of water); each mushroom is then individually inspected and any impurities removed. During this operation the mushrooms are removed as little as possible from the water in order to prevent a brownish discoloration by contact with the air. Instead of salt, a little citric acid may be dissolved in the water. The mushrooms are next washed in fresh salt water and then transferred to a suitable vessel for the blanching (it is better to use an earthenware or porcelain-lined vessel, if possible). The blanching is done with a little water over the fire.

"In consequence of their high albumen content, the mushrooms are liable to become indigestible when cooked too long. This fact is too little regarded in most recipes for preserving mushrooms, some of which direct that they

should be boiled for 25 or 30 minutes. Half of this time is sufficient to cause the mushrooms to shrink. This shrinkage is necessary before they are filled into the glasses or cans, since otherwise these receptacles would, after sterilization, be only half full.

"The process of blanching can be shortened considerably by the addition of ordinary cooking soda, the use of which quickly brings about the softening of the mushrooms in the blanching bottle, and they become much softer than where soda is not used at all. As much soda as will lie on the point of a knife will be sufficient for 2 pounds of mushrooms. After the blanching, the mass is turned out on a sieve, the broth is strained, seasoned with a little salt, and further heated on the stove while the mushrooms are being filled into the cans. After placing the mushrooms in the cans the filling is completed by the addition of the salted broth, the cans are closed and sterilized in the open water bath for 30 minutes, the sterilization being repeated after 24 hours to kill off any spores which may have germinated in the meantime."

PART II
TECHNICAL STUDIES

THE COMPOST[1]

1. SELECTION OF THE MANURE

What manure should we select? Experience has demonstrated that the use of horse manure has given the best results, or to be clearer, has given the greatest weight in mushrooms in proportion to the quantity of manure used. On the whole the real professional mushroom culture should be carried on by means of horse manure.

The best horse manure is obtained from the animals doing heavy work. It is, in fact, the manure that is most charged with urea, the base of ammonious fermentation. We will see in the following article why it is given the preference. We do not take any stock in the sayings of people who establish a difference between the manure from stallions, geldings and mares.*** The manure from buggy horses is of inferior quality because the straw is too often renewed in the stables. Such manure is too much loaded with straw, not sufficiently impregnated with urine, nor mixed with droppings. In districts where horses are fed without grain but with green fodder, pulps or leguminous foods, the manure is also of inferior quality.

We must reject manure mixed with garbage, green stuff, etc., for these render it less homogeneous and harder to work. What is worse, such filth is a source of complex fermentations which may develop parasitic diseases and destructive vermin against which we would have to struggle with great difficulty.***

It is said that rye straw manure is better than wheat straw manure. Manure must be of regular composition. It must also be of recent origin, to have retained to the highest degree all its fermentable qualities. If it has been for a long time exposed to the air, or to the sun; if it has been washed by rains, it has lost the largest part of its ammonious products. Thus it must be obtained in places having a sufficiently large number of horses to fill each load or car lot with manure not more than a week old at the most.

[1] S. REILLET, in "La Culture des Champignons Comestibles," pp. 6, 23, 53, 67, 79, 117.

New additions have been suggested as a remedy to poor manures; also ammonious or nitrous chemicals, liquid manure sprinklings, etc., but the difficulty is to dose the necessary quantities and to obtain by a chemical reaction the temperature necessary to the transformation of the cellulose of the straw—therefore, the result is less satisfactory. It is, nevertheless, an application worth trying when through lack of foresight or by accident we are caught with a lot of poor manure on our hands for which we have no other use.***

2. GOOD MANURE

We have said that the best material is manure from hard-working horses. It looks like wheat or rye straw which is the base of it, but it must be of a darker color, seeming golden yellow in sunlight. This appearance is due to the moistening of the straw by the urine of the horses. In it should be found the chunks of droppings, which should not predominate, but be present in a quantity just sufficient to give to the straw a pasty sheath at the time of the turning. In that way the moisture of the liquid manure is maintained around the straw and acts more rapidly and efficiently in disintegrating the fibre and transforming the cellulose into humus during the fermentation. Good manure should be free of foreign elements such as greens, garbage, stones and hard rubbish, etc.; these should be removed.

At the time of its reception the manure must be simply moist and not wet and oozing water; it must release a strong ammonious odor and must not contain already fermented black or dark brown parts, nor pale, dry or washed strawy parts. These conditions are difficult to realize in practice; but they exist in principle when the manure is of recent formation, and none should be accepted that is more than a week or ten days old.

To obtain good manure, the best plan is to personally gather it in the stables by wagon loads.*** We should be guided by the habitual care and the feed given to the horses by their owners.*** The quantity should be sufficient for a good fermentation, at least two to four cubic meters.*** In practice it is often difficult to be well supplied; and when, notwithstanding all the precautions taken, or because the imposed conditions cannot be realized, the manure that we have bought does not seem suitably composed, we must add to it by mixtures, cullings or additions.*** Thus, to manures too rich in droppings we add straw; to those with a surplus of straw we cull out the excess of straw that will be utilized for covers or for future operations; to manures too dry or too poor we add liquid manure; to those that are too wet, we add plaster or unslaked lime in lumps, which absorbs part of the water while raising the temperature.***

3. WHY IS IT NECESSARY TO PREPARE THE MANURE?

In nature, mushrooms are born, grow and fruit, that is to say, form caps, in pastures or woods in special places. These places

are those where vegetable remains have become transformed into humus through atmospheric agents and natural ferments. We know that the vegetable remains, grasses, leaves and small branches rot (this is the accepted term) under various influences. The agglutinous matters become dissolved, the cellulosic fibres become separated, the cellulose becomes alterated, and, at the end of a certain time there is formed a dark or brownish matter more or less pulverulent, called humus.

The humus is a complex matter as yet poorly defined; it is a mixture in which the agronomists agree to distinguish three principles:

1. The vasculose or transformed cellulose, insoluble even in alkaline liquids.

2. The brownish matter, soluble in alkaline liquids, whose principal element is the humic acid and which is a mixture of humates.

3. The various mineral salts, carbonates, nitrates, phosphates, sulphates, some soluble, others insoluble, which are retained with the humates by the vasculose operating as a sponge.

We easily conceive, that this material, the humus, is eminently proper to the fundamental phenomenon of the life of the vegetables, which consists in drawing up—"pumping"—the sap and the nutrient salts through the rootlets by means of the phenomenon of osmosis.

The higher fungi do not escape the common law of the vegetables; the humus is favorable to their development. Does this mean that all superior fungi require humus to fruit? Evidently not. It happens even that some mushrooms, living generally on humus, can fruit on a medium not containing the least trace of it when they are placed under certain conditions. To cite only one instance known to mushroom growers, it occurs sometimes that the mycelium of the cultivated mushroom leaves the beds, runs on the ground, climbs on the side walls of the caves, and fruits in cavities where there is not the least trace of humus, but this is an accidental occurrence; and yet we may say, that through some filaments at least, the mushroom is in relation with the humus of the manure.

If in nature the mushrooms in general live on humus, to cultivate the same we must seed them or transplant them in media containing humus as a base. It is natural to add: humus rich in nutritious assimilable substances, not only in nitrogenous organic products, but also in soluble mineral salts.

There lies the foundation of the culture. We must thus select and prepare a good humus.

Among the vegetable remains transformable into humus, the leaves and the straw are the most common and the most apt to modifications. We notice, by the way, that many species of

fungi grow also on decayed wood and on fruits in a state of decomposition. But the straw is the best substratum. More so than the leaves, the straw absorbs the liquids in great abundance; it is the most mineralized vegetable refuse; finally the texture of the cells of the straw and their lengthwise disposition facilitates the development of the mycelium which extends itself by lengthening and by ramifications. We must thus take straw and transform it into humus.

Again let us examine what takes place most frequently in nature concerning the straw of the grasses, the leaves and various herbs. They decay in heaps by a slow and incomplete labor. The ferments of putrifaction at first, together with the moisture, start their work in the interior, but they act slowly and require the aid of other organisms. The hatching of insect eggs, the work of the worms, the germination of the seeds, are many causes which induce a motion in the mass, let in the air and abandon it to other ferments, called aerobies whose action is much more intense. Molds, that is to say vegetable organisms, are born and propagated on the surface, then the superior fungi take their turn; their vegetation acts again on the mass of humus and the transformation goes on. We know very well that the "spent bed," meaning the manure after the mushrooms have been harvested, is a good deal more pulverulent, has taken a light brown tint and has completely lost the appearance that the manure had in the heap, or in the beds before the spawning. When the superior fungi have done their work, other vegetables improve from the humus; it is for that reason that spent mushroom beds are used in horticulture. We can thus see that a whole series of organisms govern the transformation of vegetable remains into humus, but only in proportion to the conditions they find adapted to their existence. They require first a suitable food, then moisture, the temperature, the propitious ventilation.

The part of the mushroom grower being to help the natural phenomena, to promote their evolution in as rapid a manner as possible and in any case more promptly and more surely than in nature, we see at once that, to raise the mushrooms, we must facilitate the transformation of the straw into humus by aiding and accelerating the vitality of the transforming organisms.

Instead of waiting until the phenomena occur, we must promote the immediate realization of the same, and, if the suitable conditions are fulfilled, the transformation becomes active and intense. If the straws have been sprinkled and mixed with animal dejections, if the heap is stirred to aerate it, if it is sprinkled with water to facilitate the contact and the dissolution of the products—in one word, if we feed the straw and if we prepare it—we obtain more rapidly and more surely the intended results. So then the manure, that is to say the straw plus the chemical elements that we find in the urine and excrements of the animals quite naturally sowed, moreover, with the organisms of fermentation gathered

from nearly everywhere, has become a composition very easily and rapidly transformable into a humus rich and suitable for the mushroom culture. But we must give to all elements present the means of becoming transformed; the air, the heat, the moisture, the stirring, the division to facilitate the contact, etc., and we must proceed to those operations at the proper time and for the desired period, in order that all things may take place rapidly and conveniently. All the organisms and chemical elements, in effecting their part give rise indeed to transformed products and the action must not become localized, but must spread through the whole mass. This makes sufficiently plain, we hope, the reason why manure has to be prepared.***

We want to say now, 1st, that we can take vegetable refuse other than straw to raise mushrooms; 2nd, that we can help the transformation into humus through other means than the addition of animal dejections; 3rd, that the preparation of the manure and other substrata for the mushroom culture can and must vary according to the initial composition, the physical state at the beginning, etc.***

The straw litter being the most commonly used, the manure from animals being very easily obtained, it is to them that we have quite naturally had recourse. Custom has all the more consecrated the use of it, because the work is relatively easy, and no recourse is necessary to artificial means or to foreign products.

This does not mean that through other processes, by using other compositions, we could not also arrive at good results.

4. PREPARATION

***The mushroom grower defines well prepared manure as "suitably moist and soft." It is sufficient to have only once-touched, well-prepared manure to readily appreciate that physical state.

The straw, which was formerly stiff and of a clear yellow tint, is now flexible and supple, the straws have taken the appearance of a sort of brown tow. There are no more whole droppings, these have become a kind of mud, or rather a coarse moist powder, which is spread through the whole mass. The manure has taken a reddish or clear brown tint, the color of brown earth, or of old flat tiles covering ancient farmhouses. The straws are more or less covered with a whitish efflorescence, grained, as if they had been sprinkled with fine white salt. This efflorescence is nevertheless quite different in appearance from the white molds and in particular from the disease called the plaster mold; it is localized on each straw, independently from the next straws. It is sufficient to have only once recognized this appearance and it will not be mistaken thereafter. The ammonious odor has completely disappeared; it is succeeded by a sweet odor, rather agreeable, recalling the mushroom scent. The whole has a sufficiently homogeneous appearance, that is, all the parts of the manure are nearly alike; we don't single out any more droppings, nor stiff and clear yellow

straws; all is supple, filamentous, pithy; all is of the same brown shade, neither too wet nor too dry, but only lukewarm and moist.

That is, as nearly as it can be described, the physical appearance which must be presented by the manure.

We do not always succeed, and, to make ourselves well understood, let us show the appearance of manure that is imperfectly prepared.

Three states are well known by the mushroom growers; the green manure, the greasy manure, the burned manure.

The **green manure** is that which has not been sufficiently worked. The straw is still rigid and the fibres poorly disintegrated; it contains yellowish straws, the ammonious odor has not totally disappeared and is manifest, if not throughout, at least in certain parts, when they are turned over. The manure is still heating to a temperature difficult to bear by the hand.

The ammonious odor is often associated with a slightly sour odor like that of heated wet hay. This happens with manure poor in urine and droppings, that has been worked too slowly, and has not heated enough. It is the indication of the development of noxious molds such as the vert-de-gris, the plaster mold, etc.

The **greasy manure** is that which has undergone a commencement of putrid fermentation. It is very easily detected. It is generally much too wet, oozes liquid when squeezed in the hand, and leaves a stickyish brownish mass that is well known in husbandry as "black butter." The straws have become decomposed, the tint of the manure has become much darker, turning to brownish black, the odor has become disagreeable, repulsive, like all odors of decay. It is the result of an excess of sprinkling, an insufficient airing of the heap, etc.

The **burned manure** is that which has heated too much in the heap; it is nearly always because it has been sprinkled neither sufficiently nor at the right time. The heat has reached a very high degree, going beyond 212° F., a very great evaporation has taken place. The dried-up straw has undergone a commencement of combustion and turns into coal. The manure falls into dust. Needless to say that such manure has lost most of its nourishing qualities for plants, and, while we can still utilize green manure or greasy manure, burned manure has no further utility.***

5. THE MAKING UP

The manure conveyed by wagon loads upon the selected location is unloaded in irregular heaps, and continues to ferment. Such fermentation, started in the special manure pits, etc., increases during the transportation and manipulations. We must thus immediately proceed to the making up of a rick. The site being chosen, on a spot well cleaned and disinfected with water

containing 2½ % of lysol, we spread the manure with the fork in slant layers so as to form a height of 5 feet, measured vertically. In the summer we endeavor to avoid violent heating of the manure, and to reduce the height of the ricks to the minimum. In the winter, on the contrary, and during the season when the ricks are most of the time exposed to rains and cold, there is an advantage in reducing the surface and to increase the height to 5 feet.

Each forkful must be stirred, shaken, whipped, to break the straws, divide the droppings, spread the locks of straw, untie the knots and the bands. The clever hand soon learns to handle the fork in a suitable manner to produce such result; there is in particular to acquire a special movement of the wrist which facilitates the spreading. We take out, if necessary, all foreign bodies, stones and sods, refuse, wood, hay locks, rags, etc. Each layer of manure of 9 to 18 inches in thickness, beaten with the fork, is moreover trampled on the top by a man who sprinkles a rainlike mist over the whole surface of the layer by means of a fine sprayer. It is generally the foreman who sprinkles and does the trampling, watching at the same time the hands who are making up the rick. These, two or more in number, are placed between the irregular heaps unloaded by the wagons and the rick which is in course of construction. They require only the necessary space for the handling of the fork, or four to five feet of width to reduce their movements to a minimum and avoid unnecessary labor. The hands placed on the side have the care of trimming the rick, by placing on the top of the pile prepared forksful, and settling the same with a stroke of the fork or a kick. It is very important for the ease of the subsequent work, to dispose the layers in a slanting manner and avoid working by horizontal layers placed over one another as still practiced by a number of mushroom growers.*** In a general way, it is at the beginning of the work that the manure has to be most sprinkled. Water is indeed indispensable to the start and to the development of the fermentations. It dissolves the gases that are formed (carbonic acid and ammonia), it helps the formation of carbonate of ammonia, dissolves it and soaks the straws with this alkaline solution, which acts in turn toward the decomposition of the cellulose.

We then leave the fermentation go on, the temperature of the pile rises in a very perceptible and gradual manner; we notice the pile smoking, that is to say, emit water vapor. If we plunge in the pile a sufficiently long thermometer, we find that at the base the temperature hardly exceeds 77° F.; as we go still higher up the temperature rises to 86° or 104°, we meet a layer where the temperature is very high, especially three or four days after the making up of the pile, we observe 140°, 176°, and even higher temperatures; in the upper parts, the temperature decreases very rapidly, so that the uppermost layer, of a thickness of 4 to 8 inches, is nearly even with the exterior temperature, or an average of 50° to 60° in the winter and 77° to 104° in the summer. If we concede to the rick a height of from 3 to 5 feet, it is by reason of the height

of the layers where the above-mentioned temperatures are observed. Indeed it is only at 20 or 30 inches from the ground that we begin to locate the real rise of temperature. On the other hand, as this rise does not take place in the uppermost layer which is 8 inches thick, and since the layer where the maximum temperature takes place should be at least from 10 to 12 inches in thickness, we can readily see that a height of from 3 to 5 feet is indispensable. It can be slight in the summer, because the sun, beating the pile, warms the mass. On the other hand, it is not necessary in the winter to increase such height beyond measure for two reasons: first, the manipulation would become more difficult; but above all things, it is essential that the air penetrate the mass easily in order that the fermentation may take place in a suitable manner. Hence the more we raise the height the more we reduce the aerated surface.

With those temperature phenomena, we observe transformation phenomena of the straw and also chemical actions. If we stir the manure, we notice that the straw has become irregularly altered in some places. In certain spots it has hardly changed; in others, it has turned slightly brownish, and has become soft, finally, in other spots, it has become quite brown and is covered with a whitish and grainy efflorescence.

At the time we stir, we scent a release of ammonious odor. These manifestations are the proof of two fermentations; one of these, the ammonious fermentation transforming the urea of the urine into ammonia, a part of which escapes in the air, the other part being retained as we will see immediately. The other fermentation is that of the materials of the straw (hydrates of carbon and soluble cellulose). Several aerobic ferments, that is to say requiring air to live, act under the circumstances such as the "bacillus amylobacter." These two fermentations are the more active as the aeration is improved. If the manure is not packed, being, however, sufficiently wet, these fermentations acquire considerable activity and the temperature rises. It is between 140° and 176° that their action seems to be the most efficient. It is to limit the temperature to that degree that we pack the manure by treading it; we also increase in this manner the contact of the elements in reaction. The addition of water has also resulted in facilitating the contact and to dissolve a part of the products of the chemical decompositions. At the same time, in the lower part of the heap, less aerated, the decomposition of the cellulose takes place through the formenic ferment with production of carbonic acid. This gas rises in the heaps, meeting the ammonious water and there carbonate of ammonia is produced. The carbonate of ammonia in solution, has itself a decomposing action on the straw and, filtering through the heap, facilitates the transformation in the lower part.

At the end of a certain time, through the more abundant formation of decomposition products, through the packing of the manure

suspending the introduction of air, also through the draining of the water, these fermentations become slower and it is then that it becomes necessary to stir the heap in order to encourage the fermentation of the parts that have not yet been transformed. While this "turning" contributes towards obtaining the homogenity of the manure, it permits the reintroduction of the air, the repartition of the decomposing products in the mass and, consequently, the continuation of the transformation.

It must be borne in mind that we must not either provoke a too rapid action on the straw, or we would go beyond the mark. We must not forget that the mushroom is itself an element proceeding to the transformation of vegetable refuse into humus and that, in order to be able to start and to develop itself, which is the aim of the culture, the manure must have attained a special degree of transformation, not more, not less; as it is absolutely necessary that there should not be too much urine in order to prevent the ammonious ferment to take the upper hand, or that the manure be not packed to excess in order to prevent the formenic ferment to take the upper hand.***

6. THE TURNING

We have examined what were the chief dispositions to take in undertaking the preparation of the manure intended for mushroom culture. After having made up a rick, we leave it work, ferment, by simply abandoning it to itself. We have, nevertheless, to add a few details concerning the accomplished operations.

We must take care while handling with the fork the manure that we arrange in a rick, to thoroughly mix the wet parts with the dryer parts; the clear droppings with the straw; the portions that have started to rot, like those coming from the bottom of the litters, or from the bottom of the cars in which the transportation has taken several days, or also from the base of the heaps, and from the bottom of the pits, where the producers place the manure coming from the barn—to mix the same, we say, with the scarcely transformed portions of the surface. We have to strive indeed to make up a mixture, a mass, as homogeneous as possible.

A second point to observe is, in the making up of the slant layers of the rick, while shaking and mixing the manure to prevent the droppings from falling in too great quantities at the base of the incline. Those escaping the fork have to be picked up with the wooden shovel, thrown back, and spread on the surface; the latter being oblique, easily retains the same, provided we are careful. While sprinkling we have to water more abundantly the sides and the dry parts. Even in certain cases we have to avoid sprinkling parts that seem rotten or too wet. In treading the rick to pack the manure, we have to compress the edges, to favor the fermentation. The edges have indeed always a sufficient contact with the exterior air, and, should we not pack the same, they would dry up

too fast under the influence of the wind. If, after the making up and completion of the rick, the manure should prove to be too dry, or too baked (that is to say that the parts where local exaggerated fermentation has taken place, at a high temperature, predominate), it is to our advantage to tread anew and to pack the surface in order that the moist vapor, product of the interior fermentation, should escape with less facility and better impregnate the interior. If the manure is black and very wet, it is to our advantage to avoid packing it too much to let the air penetrate it more easily, to develop the oxidation more rapidly and more powerfully, to cause the heat to raise and evaporate the excess of water.

The above observations perhaps better concern the care to be given at the time of the turning.

The turning operation consists in retaking the manure from the rick after it has been left to ferment from six to eight days and making it up into another heap or rick.

We attack the side by which we have terminated the former operation. We operate exactly in the same manner as for the making up of the rick the first time. In working properly, we come to turn the manure almost on its own space; that is to say, to tear down the first rick, to reconstruct it on its own space, at four to five feet near, just the space necessary to the men for the handling of the fork. It is very important to operate in this manner, since we avoid at the same time a loss of time and a waste of energy in the workmanship. In effecting the turning, we take all the precautions that we have explained concerning the shaking, the mixing of the manure, in order to keep on breaking the straw, to spread the droppings, and to make the whole homogeneous.

To that end, we have to watch so as to bring into the interior that which was on the edges, and to place on the other hand on the sides and on the surface the portions of the interior. At the turning, we have to sprinkle a good deal less than at the first operation of tearing down; most of the time, even if we operate in the winter and out doors, it is not necessary to sprinkle at each turning. It is impossible to give exact indications concerning the question of sprinkling during the working of the manure, as we can not foresee the quantity of rain that will fall on the rick. A measure of water quantities can be better made when we work on ricks under cover, or located in caves near the entrance; but everything still depends on the state of moisture of the manure that we receive to work, or of the condition of the rick that we are about to turn. It is thus a question of experience, and the safest guide is the impression that the manure gives, when we squeeze a certain quantity of it into the hand. Although after the first tearing down of the heap we may concede that a handful of manure, thus squeezed, oozes a little liquid manure it is better that this fact should not take place any more after the first turning, and should never occur after the second turning. This second turning is

accomplished from six to eight days after the first, operating always in the same manner. It is sometimes necessary to proceed to a third turning.

Finally, we have left the manure to ferment, and the chemical reactions to take place, during a period of from twenty to thirty days, a delay which can scarcely be reduced only in certain cases in the summer. In order to produce such fermentation and reactions in a suitable manner we have to stir the whole mass three or four times, sprinkle it when it seems too dry, and facilitate the drying by means of heating if it seems too wet.

We cannot conclude in a better way than in recalling what we have already said in defining the prepared manure. The aim to attain is: 1st, From a physical standpoint we must reach a suitable softness of the straw fibres, a complete mangling of the straws however without being cut too short. We must attain this special state of humus, of incompletely transformed cellulose, which does hardly contain any more gum, glucose, starch, in one word, sticky products. The manure is only a network of insoluble cellulose or vasculose, not dusty yet. Finally it is a matter in a physical state favorable to the support and propagation of the mycelial filaments.

2nd. From a chemical standpoint there must, in the midst of this substratum, exist chemical and physiological elements, in suitable composition and proportions to permit the life operations of the mycelium to take place. That is to say, that there must be a suitable degree of moisture, giving to the hand a sensation rather somewhat dry than too wet, well defined by the word moist, indicating at the same time a certain degree of heat that we will characterize by 59° to 77°; the mass must also contain the humates, assimilable nitrogenous principles, and the alkaline mineral salts, without which life, that is to say the absorption of the sap, the formation of the cells and the respiration of the mushroom could not exist.

Note—This should impress us with the principles governing the preparation of the manure. We take it for granted that the above article was written for the benefit of the mushroom growers of France, where conditions differ with ours in many details, some of which are of capital importance. We will mention the most important one, the retention of all the urine in the straw of the manure, which is made possible only in stables equipped with a waterproof floor. We do not give this detail much consideration in constructing a stable and as a consequence only a part of the urine is retained in the straw; such manure of course is of poorer quality. We usually make up for such loss by obtaining manure which does not contain so much straw. Such manure being of a shorter composition should not be trampled as much; should receive one more manipulation and requires a shorter interval between manipulations.

THE PART OF THE FERMENTS IN THE TRANSFORMATION OF THE MANURE[1]

The name of ferments is given to organic bodies enjoying the property of exercising a considerable chemical reaction, relatively, to their mass. A very small quantity is sufficient to transform an unlimited quantity, or nearly so, of certain bodies, such as manure.

We distinguish actually two kinds of ferments; one kind of these ferments follows well defined chemical principles, although their composition is not yet perfectly known; they are soluble in water, insoluble in alcohol. They are secretive products of vegetable or animal cells, but they are not organized bodies; they are generally called diastases. The others, named organized ferments, are represented by living organisms, that is to say, susceptible of growing in volume and of reproducing their kind. It is certain that these two kinds of ferments play their part in the transformation of the manure which brings it to a state of humus. But the part of the diastases, at least in the transformation of the manure, is very difficult to characterize, while the part of the organized ferments is exceedingly powerful and is recognized by characteristics perceptible to our senses.

Diastases—The diastases, which, according to Berthelot are very likely products of live cells, and which may be classed among the albuminoid matters, act in a large number of transformations of organic bodies, such as the transformation of sugar into alcohol and that of milk into casein. We note that action of various diastases in the digestive acts of men and animals, in the fermentation of juices attending the fabrication of wine, beer, etc. A good many of these diastases are the products of organized ferments such as yeasts and molds, which we compare scientifically to fungi or to algæ.

We say that the diastases certainly act in the transformation of the manure. In fact, to the decomposition of the urea, of the cellulose, of the starch, of the glucose, of the gums, etc., correspond diastases characterized as urase, cytase, amylase, etc.

The diastases act generally by fixation of the elements of the water on the bodies in reaction; some act by oxydation; in one instance they give immediately definitive products, in another instance they give rise to intermediate bodies. One of the characteristics of the reactions is the rapidity with which they produce themselves, and the small quantity of diastases necessary to act on a large quantity of matter. This explains why, without ever adding anything to the manure, there is always found the sufficient and necessary ferments to start the transformation of its own accord. The diastases, like the organized ferments of which we will speak later, are, without any doubt, carried by the dejections of the animals who have themselves gathered the germs in their food.

The German chemist Fischer has tried to explain that each diastase acts only on certain chemical bodies and in general on those with whom they have a constitutional analogy. The diastases act proportionately to the time and so much less as the distance is greater. It is certain that if the reactions become slower, then stop, it is caused by the accumulation of formed products on determined points of the mass. This explains why it is indispensable to stir the mass to re-establish the equilibrium and to permit the reaction to proceed.

Organized ferments—The organized ferments act, contrarily to the diastases, progressively and relatively slowly at the start. They provoke either direct products, or successive transformations, the term of which is often very hard to define, like in the putrefactions; it is precisely the case of the manure. From a chemical view, the fermentations are classed by Heninger according to the nature of the reaction:

1, Fermentation by hydration: the type is the fermentation of the urea

[1] Prof. P. C., in "La Culture des Champignons Comestibles," p. 83.

which, by fixing the water, becomes carbonate of ammonia under the influence of the micrococcus ureæ. 2, Fermentation by division, such as the lactic fermentation and the alcoholic fermentation, acting on the sugar. 3, Fermentation by reductions, such as the butyric fermentation. 4, Fermentation by oxydition, such as the acetic fermentation.

The fermentations by the diastases which are included in the classification of Berthelot do not make part of the above classification which comprises only the fermentations due to the organized ferments.

It is to Pasteur that we owe the first methods of study of the fermentations and most of the apparatuses necessary to that end. Those studies are exceedingly delicate and it is very difficult to draw neat conclusions from them; nevertheless, distinguished scientists have undertaken that arduous task and it is to them that we owe the nicest discoveries, of which it has been possible to draw applications in the industry, medicine and hygiene. In a general way, we may say that the physical or chemical agents have a great influence on the ferments. Heat produces very different effects. Some ferments resist to a temperature of 248° F., others, on the contrary, are killed at 122° or 140°. Ferments resist much better when they are dry than in a moist medium, in particular the spores of the spore-bearing species; for instance the bacilli resist to very high temperatures and often for a very long time. The most favorable temperatures to the development of ferments is found between 59° and 113° F. For what concerns the cold we may say that the ferments resist it much better than the heat; congelation sometimes suspends their development, but does not kill them.

Pressure is without action or nearly so. Light and electricity destroy the ferments, but these two agents exert that noxious effect rather on account of the bodies to which they give rise than by their own actions.

So then the ferments have great lasting power. They are able to remain a very long time while unutilized without dying or losing their power; it is the spore-bearing kind that lasts the longest, for instance the bacilli are much more resistant that the micrococci, these last mentioned being not spore-bearing.

Acidity is unfavorable to the preservation and to the development of ferments; many withstand well the alkalinity. This point is very important in the fermentation of manures. Acetic acid, for instance, is one of the most fatal and of the least tolerated; now there is acetic acid produced in the decomposition of the woods; the presence of ligneous matter in the manure is therefore unfavorable. Butyric acid is also fatal. Butyric acid is produced in manures which are poorly stirred. However, it has been observed that the ferments are susceptible of becoming acclimatized to the presence of acids, like also to that of antiseptics. This property has no utility in our case, it is rather interesting for laboratory preparations and some industrial operations. It must be noticed that certain bodies, the oxygen, for instance, act as a powerful antiseptic on certain fermentations and prevent their development. This is what occurs for the fermentations called anærobic fermentations.

In the preparation of the manure for the mushroom culture, the ærobic fermentations seem to play the greatest part; it is thus indispensable to well ærate the manure which condition is realized by stirring and turning it in one instance and by sprinkling it in another instance. The water in penetrating the heap dissolves a part of the bodies present, in particular the carbonic acid that is released; it thus calls for air in the interior.

We have said that the organized ferments were bodies growing in volume and reproducing their kind; meaning that they take up food. They do not all take up food in the same manner, and do not attack the same bodies; in general they need at the same time an organic element of one or several mineral elements.

On the manure we find several organic elements suitable to the ferments. The urea of the animal dejections, the cellulose of the straw litter; the starch, the sugar or glucose, etc. A certain ferment attacks each one of these bodies and a chemical reaction takes place.

Thus the micrococcus ureæ or ammoneous ferment, discovered and studied by Van Tieghem, as its name indicates, acts on the urea contained in the urine of the herbivorous animals and transforms it into carbonate of ammonia. The reaction is noted chemically.

$$\underset{\text{urea}}{CH_4\ N_2\ O} + 2H_2\ O = \underset{\text{carbonate of ammonia}}{CO_3\ N_2\ H_8}$$

The excess of ammonia is released and that is why the manure, in fermenting, diffuses the ammonia odor, that disappears only when the urea has been transformed.

That ferment is easily developed in an alkaline medium, like the urine of the herbivorous animals which contains carbonate of ammonia and of potash. It is to be noted that the carbonates so produced attack the straw and give an important reaction activated by the heat. It is to the alkaline carbonates that is due the dissolution of the nitrous matter, of the soluble cellulose, to leave only the insoluble vasculose.

Thus this last work, the attacking of the cellulose, is undertaken at the same time and favored by the formenic ferment; there is oxydation of the cellulose and release of carbonic acid and of formene or swamp gas; the chemical formula is

$$\underset{\text{cellulose}}{C_6\ H_{10}\ O_5} + H_2O = \underset{\text{formene}}{3CH_4} + \underset{\text{carbonic acid}}{3CO_2}$$

The operation takes place in an alkaline medium and the carbonic acid fixes the ammonia and the potash. This action is facilitated by the sprinkling and the temperature of the reaction. It is to be noted, however, that the formenic ferment does not necessarily require air.

It is a short, plump bacillus, which requires the oxygen of the air not for itself, but to revive its spores and for its multiplication. If it can transform the cellulose without æration, it requires æration and sprinkling to perpetuate its action and it is thus favored by the manipulations of the manure heap.

The transformation of the cellulose and the transformation of the urine constitute the two principal important phenomena which take place in the manure heap.

It is Messrs. Deherain and Magneux who have especially studied the formenic ferment. It is also to them that we owe the study of the butyric ferment which acts in the transformation of the manure by attacking the fatty matters.

Other ferments attack the sugar or glucose; the starch and the gums to give off hydrogen and carbonic acid. There is oxidation of those hydrates of carbon that are found in the straw and that do not exist any more in the finished manure.

That slow combustion takes its energy from the free oxygen, it raises the temperature of the heap and favors at the same time the reactions and the alkaline liquid introduced in the manure by the urine of the animals; that is what takes place in the upper part of the heap when the temperature attains and goes beyond 140°. Sheltered from the oxygen the combustion goes on by the activity of other ferments such as the formenic ferment, but in that case it is only an internal combustion, the combustible elements of which are taken from the cellulose and the temperature is lower. That is what takes place in the bottom of the heap.

There is also a ferment, which action is very important; it is an aerobic ferment, the micrococcus nitrificans. It is to Messrs. Schloesing and Muntz that we are especially indebted for the study of that ferment. Its function is the transformation of a part of the nitrogen of the organic matters into nitrates. There is fixation of the oxygen of the air to form nitric acid which forms a chemical combination with the ammonia, the soda and especially the potash found in the organic detritus; that is what is commonly called salpetration. This formation of nitrate of potash has been modified by artificial means, by adding lime to the organic matters present, we form nitrates of lime of a more fixed nature, that is to say, that they are not so easily dissolved as the nitrates of potash, but are nevertheless assimilable by plants for food. Every

one knows that the nitrates have the greatest influence on the development of plants.

It is thus probable that they have an influence on the development of mushrooms and it is doubtless for that reason that long ago the influence of saltpeter on walls, the addition of plaster to manure, etc., has been recognized by some mushroom growers to give good results.

In conclusion, it is well to call attention once more to the absolute necessity of bringing modifications to the medium in which fermentations or chemical reactions take place. We must never forget that these fermentations or chemical reactions give rise to residuary products, the presence of which is in opposition with the good continuation and with the development of the fermentations and principal reactions. It is only by stirring, sprinkling, ærating, heating or cooling the mass that we can come to transform it in a regular shape; to render it homogeneous. That is the chief end in working the manure for the production of the special state of humus favorable to the mushroom culture.

INSECTS INJURIOUS TO MUSHROOMS [1]

Cultivated mushrooms, especially during warm weather, are attacked by several species of insect pests which frequently destroy an entire crop, or so curtail the production as to make the industry unprofitable. Although this injury is at times serious, little interest has been taken by entomologists in the matter of its control, so that there is practically no available economic literature on the subject. This circular is of a preliminary nature, as the investigation of all insects injurious to mushrooms may not be completed for some time.

FIG. 1.—A mushroom fly, *Aphiochæta albidihalteris:* Male. Much enlarged. (Original.)

The insects 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 follow 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

(*Sciara multiseta* Felt et al.)

The injurious forms commonly known as "mushroom maggots" are small, whitish or yellowish-white maggots usually having black heads. They are the young of certain small flies or "gnats," two-

[1] By C. H. POPENOE, Entomological Assistant, U. S. Department of Agriculture.

winged and mostly black in color, of several species belonging to the families Mycetophilidæ and Phoridæ, and to the genera Sciara and Aphiochæta. Of these the species belonging to the genus Sciara are by far the most common and injurious of mushroom pests. They are minute in size, measuring about three thirty-seconds of an inch in length and about one-eighth inch in spread of wings. They are smoky or dusty black in color. The species attracting most attention as pests are Sciara multiseta Felt and Sciara agraria Felt. Both species are, like the other mushroom gnats, rapid and prolific breeders, especially during warm weather, 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 should always be made by a specialist.

Another common species, *Aphiochæta albidihalteris* Felt (fig. 1), superficially resembles the preceding, and has much the same habits, but as yet has not appeared to cause so much damage as have the species before mentioned.

The life history of one of the mushroom maggots is about as follows: The eggs, of which each female is capable of laying nearly 1,000, are generally 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 three days, but in colder weather this time may be 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 in a short time. On account of the perishable nature of their host they pass through their transformations quickly, the larvæ feeding for from 7 to 10 days, by which time the entire cap is destroyed. The larvæ then enter the ground, each spinning a slight silken cocoon just beneath the surface, and pupating. The pupa stage lasts from four to seven days, after which the insects emerge as adults, soon afterwards pairing and ovipositing 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 the presence of millions after the beginning of warm weather, thus effectually preventing the cultivation of mushrooms.

CONTROL

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 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 compost beds, so that it is well to disinfect or sterilize this substance by means of steam. This may be accomplished by placing the manure or soil in vats or boxes, through which steam pipes, perforated to allow the escape of the steam into the boxes, are conducted. (See fig. 2.) 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 bisulphid of carbon just previous to planting the mushrooms is also productive of good results in destroying maggots in the compost. The bisulphid 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. It is very inflammable and even 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.

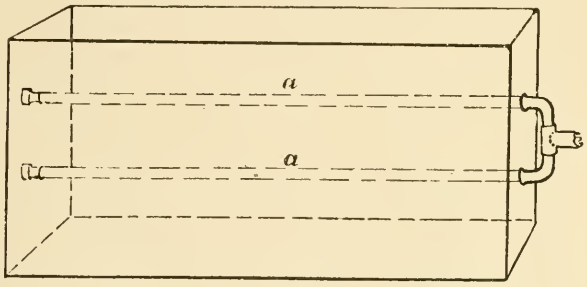

FIG. 2.—Steaming box, or sterilizer, for the treatment of compost. (Original.)

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 fumigants 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 pyrethrum or dusting the powder over the beds is also effective against the mushroom maggots if taken in time, but tobacco fumigation may be considered standard for this use.

THE MUSHROOM MITE

(*Tyroglyphus lintneri* Osb.)

The mushroom mite (*Tyroglyphus lintneri* Osb. 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 (*Tyroglyphus siro* L.) and resembles that species in appearance. It is, if anything,

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

more prolific than the cheese mite, becoming at times so abundant in mushroom beds as to cover the surface of the compost, and when present in such numbers is extremely destructive, feeding upon the mushrooms in all stages and penetrating the beds and destroying the mycelium. Indeed, in one case observed by Mr. August Busck, of this bureau, the mycelium was destroyed as fast as it grew from the spawn.

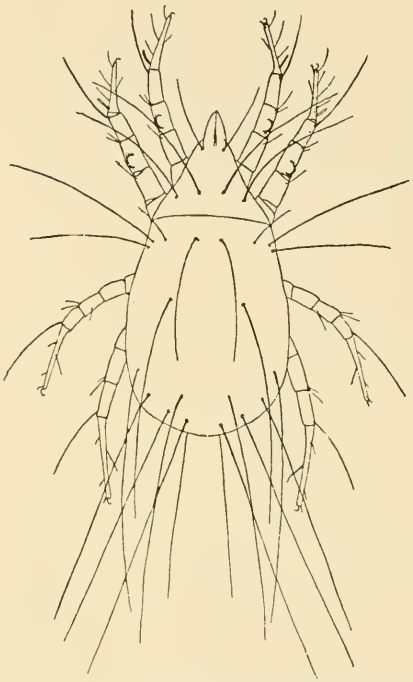

FIG. 3.—The mushroom mite (*Tyroglyphus lintneri*). Highly magnified. (From Banks.)

This species is undoubtedly the cause in many cases of the failure of the spawn to grow, 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 little suspected, 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 and rapidly break down the caps.

No direct observations bearing 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 of the mushroom, or on the young or developing caps. They hatch in a short time into the characteristic six-legged young, which rapidly mature to adults similar to the one in figure 3. The time from the deposition of the egg to the maturity of the mite, has not, to the writer's knowledge, been accurately worked out, but 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, according to Banks,[1] is peculiar to the family Tyroglyphidæ, to which this mite belongs, and is quite remarkable. The mite develops a hard, chitinous covering, has no mouthparts, 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 way mentioned above, the mite may obtain access to mushroom houses in infested compost or in spawn from infested houses. However, the greater part of the infestation 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 little affected by the fumigants suitable for the control of the other mushroom pests, while applications of sulphur, tobacco dust, and other suitable insecticides to the beds seem only to prove slightly inconvenient to the mite. It is one of the most stubborn pests with which we have to deal 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 unlimited time without death. The only measures, therefore, that may be considered are those of prevention.

When a house becomes infected, 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 it may be 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 distasteful to the mites. After complete disinfection has been accomplished the house should be screened, to

[1] Proc. U. S. Nat. Mush., vol. 28, p. 79, 1904.

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 only from uninfested houses. With these precautions it is unlikely that trouble will be experienced from the attacks of the mushroom mite. Close watch should be kept, however, for any signs of the presence of the mites in the beds, and the compost destroyed upon their first appearance, as it is impossible to secure good results with mushrooms when 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 by any artificial means, once the mushroom bed becomes infested, as the mites are buried so deeply in the compost that no insecticide will reach them.

FIG. 1.—A common injurious springtail. *Achoreutes armatum*. Much enlarged. (Original.)

A predaceous mite belonging to the Gamasidæ 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. The gamasid may be known by its longer legs and its manner or running swiftly over the compost or the mushrooms. The writer has seen cases where the gamasid has occurred in such abundance as greatly to outnumber its host. This predaceous enemy does not feed on the mushrooms after the destruction of the mites, but seeks other feeding grounds, or dies by starvation.

SPRINGTAILS

(*Achoreutes armatum* Nicolet et al.)

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, since the springing is performed by the aid of two short bristles situated on the anal segment of the abdomen. These insects (*Achoreutes armatum* see fig. 4) are present in almost all manure, where they feed on the decaying vegetation present, but on occasion they may become quite injurious in mushroom houses. A correspondent in St. Louis, Mo., reported that in one of his mushroom houses a bed 150 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 similiar to that of the adult. They are thus likely to be injurious in the same manner throughout their life history.

REMEDIES

The remedial measures applicable to the control of springtails are to a large extent preventive, as these insects are somewhat difficult to control when once established in a mushroom bed. They are quite resistant to tobacco powders, but applications of buhach or pyrethrum 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 Circular 37 of this bureau, 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.

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

SOWBUGS

(*Armadillidium spp. and Porcellio spp.*)

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 "wood lice," sowbugs and "pillbugs." Two species, the greenhouse pillbug (*Armadillidium vulgare* Latreille) and the dooryard sowbug (*Porcellio lævis* Koch) are illustrated in figures 5, 6, and 7.

Sowbugs live in damp, dark places, such as 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. 5.) 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.

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 similiar 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.

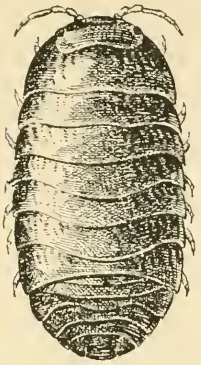

FIG. 5.—The greenhouse pillbug (*Armadillidium vulgare*) extended. Much enlarged. (Original.)

The destruction occasioned by sowbugs is due to their attacks on the caps or fruiting bodies of the 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.

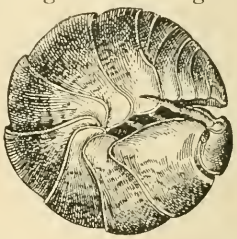

FIG. 6.—The greenhouse pillbug (*Armadillidium vulgare*) contracted. Much enlarged. (Original.)

Sowbugs are, more frequently than at first might be thought, 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 there throughout the growth of the spawn, but becoming injurious with the first growth of the mushrooms. The writer has seen sowbugs collected in manure piles to such an extent that numbers aggregating a pint or more in quantity might have been collected from a shovelful of material.

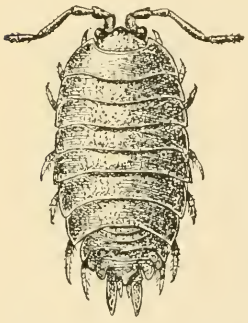

FIG. 7.—Dooryard sowbug (*Porcellio lævis*). Much enlarged. (Original.)

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 earthern 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. Treatment with sulphur dioxid is also effective, but this remedy should be applied after the mushroom crop has been harvested and the compost has been removed.

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

CRICKETS

Among other injurious forms which at times attack mushrooms, certain crickets are reported as eating into the caps of the mushrooms. On the Pacific coast a species known scientifically as Ceuthophilus pacificus Thom. has been reported as causing extensive injury to cultivated mushroom beds.

The remedies for crickets in their injurious occurrence are the same as those recommended for sowbugs in a previous section of this circular. Potatoes and carrots may be minced before applying the Paris green, in order to secure a somewhat thicker coat.

GENERAL SUMMARY

In the construction of mushroom houses care should be taken to make the building as tight as possible and with few outlets. If windows are necessary they should be small and should be screened with fine wire gauze, which forms an excellent prevention against the entrance of both maggots and mites, as previously mentioned. If possible, all compost should be steamed before being placed in the house and the temperature should be kept below 55° F., as all insects are more or less dormant at this temperature, and their otherwise rapid multiplication is thereby greatly checked, reducing infestation to a minimum. If these recommendations are carefully followed there should be little necessity for the radical measures of fumigation or destruction of the beds.

STAINS [1]

We know that most of the serious contagious diseases attacking the animals (tuberculosis, cholera, typhoid fever, etc.) are produced by bacteria, commonly called microbes.

Among the vegetables, on the contrary, the agents of the serious diseases are more frequently molds, that is to say very small filamentous fungi, feeding at the expense of the plant they attack; for instance: the wheat rust, the carbuncle and the decay of the cereals, the oidium and the mildew of the vine. The cultivated mushroom does not escape the common law; like the other vegetables, it is chiefly attacked by molds, of which we have already

[1] L. Matruchot, in "La Culture des Champignons Comestibles," pp. 371 and 402.

studied many (agents of the mold, of the plaster mold, of the vert-de-gris, etc.)

But if the vegetables are attacked by molds, oftener than the animals, they also have their microbian or bacterial diseases, the agent of which is a bacterium. Thus, certain tumors of the pines are due to an invasion of bacteria, attacking and deforming the ligneous tissues of these trees.

The cultivated mushroom has also its bacterial disease; it is called the *stain*.

Not having been known as it were at all times, as the mole has been (for the reason that it causes much smaller damage) the *stain* has been known by the mushroom growers for over thirty years; but it is at a relatively recent date that it has for the first time been made the object of a scientific study. It is M. Costantin who first has made that study and has demonstrated that it is a case of bacterial infection. To the documents that this study has furnished, we will add a few personal observations and some technical advice.

CHARACTER OF THE DISEASE

External character—The *stain* owes its name to a sufficiently characteristic peculiarity, noticed on the diseased mushroom while still on the mushroom bed; it exudes at the surface of the stem or of the cap driplets of a colorless or yellowish grey liquid which darkens in time. The driplets beading the surface of the mushroom are of various sizes; at first very small, each one of them grows and may attain the size of a pea. It is from these driplets or drops that the disease takes its name. These water driplets being due to an active perspiration of the mushroom, are no longer noticed on caps which have been picked for a certain length of time.

Under those conditions, to recognize the disease, we must resort to the other characteristics. They consist at first of stains very apparent externally, of a clear shade, greenish or even bright yellow at the beginning, then of a brown or even black color at the end. There is, moreover, a peculiar viscosity of the cap at the place of the stains. Finally the stained mushroom, when slightly squeezed between the fingers, oozes a drop of liquid. The shape of the stains produced by the disease is more or less variable. They are most frequently rounded or lobe shaped stains, spreading as far as to cover several square centimeters in surface; sometimes the spot developing unevenly in various directions takes arborized shapes.

In no case is there a deformation of the mushroom, as is seen so frequently in the mole; in a stained mushroom the tissue becomes hard, like swollen with water, but it continues to develop without becoming atrophied, and it is not rare to observe very pretty mushroom caps, largely developed and blossomed, that are stained in spots.

To sum up, the mushroom grower will easily detect the *"stain"*

in the mushroom on the beds through the exudations or "tears" that it produces; if this character passes unnoticed, the attention of the practitioner will be called by the peculiar spots presented by the diseased mushrooms and also by the infectious odor which is soon emitted.

Internal character—A cut made with the knife in the diseased region furnishes also very precise indications for the diagnosis of the disease. Under the green or brown stained epidermis, we distinguish a translucid zone of a water-green color, contrasting neatly with the heavy white color of the tissue of the healthy mushroom. The line separating the greenish zone of the white tissue is a sinuous irregular line; it can extend through the cap as far as to penetrate the whole thickness of it and reach the gills; in the stem it can reach a depth of two centimeters.

It seems that the production of the greenish and aqueous zone is the first symptom of the disease. While this zone increases in surface and in depth, the brown and black pigmentation appears; the darkened epidermis differentiates itself neatly from the subjacent tissue and separates from it.

The stem and cap can also be attacked; however, it is generally through the cap that the attack commences.

We had occasion to observe a case where the disease had penetrated the cap, the contagion spread on the stem through exudation driplets carried down by gravity; from the point of inoculation the evil has gradually reached the base of the stem. The specimen presenting these peculiarities was of a large size and had evidently taken many days to complete its evolution, which fact had permitted the disease to gradually reach the base of the mushroom.

The professional mushroom growers can discover the stain at the first symptoms. The slightly sticky cap has peculiar shades; a light yellowish tint, very small isolated dark spots are sufficient to detect the evil at its first appearance. Placed aside and preserved under bell glass at the ordinary temperature, those specimens, the tissue of which seems healthy and normal at first sight, soon begins to darken, and becomes covered with a thick glaireous coat, of a dirty grey, slightly yellowish, at the same time an intense putrefaction of the tissue takes place and a nauseous odor is emitted.

The stained mushrooms are not only unsalable on the market but a few of those inadvertently mixed with a lot of healthy mushrooms are sufficient to communicate to these a disagreeable odor and to make this sale doubtful. Therefore the care taken by the laborer in charge of the picking to avoid mixing stained mushrooms with the healthy crop is easily explained.

M. Costantin first detected that a bacterium was the agent of the disease. Having secured a few sticky and *stained* mushrooms at the time they came out of the mushroom cave, he placed them under glass bells in the laboratory; he observed the sticky part

grow and transform itself into a thick greyish glairy mass; that glairy mass is made out of bacteria. From the start of the evil, we can detect the presence of bacteria. If we examine under a magnifying glass a cap only beginning to show a few brown stains we notice at the place where those *stains* are located depressions, being sometimes in continuity with small pockets hollowed in the cap, the content of which is viscous and greyish. The bacteria live there also in large quantities.

Finally, even in the parts of the cap or of the stem not yet sticky or glairy but already attacked, we can put in evidence the presence of the bacteria by taking cultures of the same. The simplest process consists in breaking the mushroom at the place where the stain occurs, so as to expose the attacked tissue; then by means of a platinum wire previously sterilized to take a small part of the diseased tissue or simply a little liquid forced out of the wound by a slight pressure, and to spread the same on culture media suitable to the development of bacteria, such as gelatinous broths. If the region where the inoculation was taken contains bacteria, the correspondent culture will in a few days develop a distinct bacterial colony; in the contrary case the culture will remain sterile.

This method has made it possible to determine that the brown parts of the surface of the cap contain bacteria; in more deeply located regions of the same color, these bacteria become scarcer and may be absent. Finally the greenish translucid parts do not contain bacteria at the beginning. As to the white parts of the tissue of the stem or of the cap, they are always devoid of it.

We must conclude therefrom that this bacterial disease is of superficial origin; it spreads from the exterior to the interior, through the encroachment on the tissue of the bacteria coming from the outside

There is a curious fact. The bacteria developing in the body of the mushroom secrete liquids, diffusing gradually in the mass and render it translucid and greenish-like. But as the diffusion of the liquid takes place more rapidly than the penetration of the bacteria, the zone invaded by the micro-organisms is surrounded and seems preceded by a clear translucid zone.

The products preceded by the bacteria are diastases or digestive ferments transforming the opaque membranes of the tissue into a semi-transparent substance; at the same time they secrete a greenish fluorescent-like coloring matter fixing itself on the tissue, and giving it the so characteristic aspect that we have described.

The existence of the three successive zones, from the exterior toward the interior are thus explained; 1, the brownish or dark zone, generally sticky, where the bacteria swarm; 2, the slightly colored zone, not sticky, where the bacteria are less abundant; 3, the green translucid zone, not yet invaded by the bacteria, but which has already been reached by their secretions.

The agent of the *"stain"* is a short bacillus, shaped like a small stick rounded at both ends, of one-half of a thousandth of a millimeter wide and of one to two thousandths of a millimeter long.

This bacterium is very easily cultivated on all the usual media of the laboratories; it produces gelatinous colonies recalling the sticky masses observed on the diseased mushrooms; and on certain substrata (gelatinous broth, potatoes) it diffuses a greenish secretion of the same shade as that which characterizes the *"stain"* in nature.

We may ask to what is due the phenomenon of the formation of "drops" on the surface of the attacked parts of the stem or of the cap. M. Costantin supposes that the sticky gelatinous veil covering the cap more or less completely, must modify the perspiration of the mushroom, ordinarily so active; the water which continues to flow into the cap fills all the spaces and provokes a violent disturbance of the cells. When all the cavities are filled, liquid drops appear on the surface of the mushroom. It would be a phenomenon similiar to that produced in the evening for the green plants when the perspiration diminishes abruptly in consequence of the disappearance of the light.

There have been many remedies suggested against the *"stain"* for the cultivated mushroom. Butthe disease not seeming to present a considerable economic importance, compared for instance to that of the mole, no extended experiments have been attempted in practice.

There seems to be no doubt that the bacterial agent of the disease arises from the manure; when the latter is too green and poorly worked it contains swarms of bacteria, and there are great chances that those of the *"stain"* may attack the stem of the mushrooms.

In particular it is not a rare case to observe the *"stain"* in mushroom beds that the market gardeners build in the open air in the winter; the necessity arising to obtain a suitable temperature, to build the beds with incompletely fermented manure, is a propitious condition to the development of these bacteria. * * The best preventive measures consist in using only well fermented manure. * * When the disease has once broken out on a mushroom bed there is no remedy, since the cause of the evil resides in the manure under the surfacing. Nevertheless, it would be well to avoid the spreading of the disease to the bordering beds as the *"stain"* drops in falling on the surface earth constitute as many centers of infection. All the moist stains so formed on the earth surface of the beds should be treated with lime or lysol, and the stained mushrooms should be removed from the mushroom house.

It seems that the large varieties of the cultivated mushroom are more subject to the *"stain"* than the medium or small varieties. This is undoubtedly an appearance only, and is due to the fact that as a large mushroom takes a longer time to evolve, the disease has ample time to develop and to cause greater damage.

AMANITA [1]

The cap and stem are readily separated from each other, and the latter bears a ring. At the base of the stem is a cup or volva, which, with the ring, distinguishes this genus from Lepiota and Amanitopsis; that is, Amanita has both ring and volva, Lepiota only the ring, and Amanitopsis only the volva. The volva breaks into fragments and disappears in a few species of Amanita, and only the young plants can then be told with certainty from Lepiota. Amanita contains practically all the deadly poisonous species of the gill fungi. Although several species are edible, in particular, Cæsar's mushroom, the danger of mistaking a poisonous Amanita for an edible one is so great that every one should take the greatest pains to avoid eating any Amanita whatsoever, and especially mistaking it in the young button stage for a puffball, or in old age for a Lepiota.

The ancient name for some mushroom.

FIGURE 1. AMANITA PHALLOIDES

Deadly!

KEY TO THE SPECIES

1. Cap typically white, rarely yellowish to olive or brownish; volva with more or less of a free border ..... *A. phalloides*

[1] Prof. F. E. Clements in "Minnesota Plant Studies," Part 4, p. 6.

2. Cap white or buff-brown; volva merely of scales *A. solitaria*
3. Cap usually bright orange, red or yellow; volva sack-like or merely of scales.
   a. Volva large and sack-like, white; all other parts yellow or orange *A. cæsarea*
   b. Volva forming rings or scales on a bulb-like base; gills usually white or whitish
   (1) Whole plant dull red; flesh reddening when bruised *A. rubescens*
   (2) Stem white or yellowish; flesh not reddening
   (a) Cap 3-6 cm. wide; spores globose *A. frostiana*
   (b) Cap 8-15 cm. wide; spores elliptic *A. muscaria*

AMANITA PHALLOIDES, DEATH CUP, DEADLY AMANITA

Cap 4-10 cm. wide, usually white, more rarely olive, brown or yellow, slimy when moist, smooth or roughened with a few large or many small fragments of the volva; globose, then bell-shaped and finally expanded; Stem tall, stout, 7-13 cm. by 10-15mm., white, rarely dark, usually smooth, bulbous hollow above, ring superior, large drooping, white, volva usually large with a free border, but extremely variable; gills white and usually free, rarely slightly touching; spores globoid, 8-10u.

FIGURE 2. AMANITA VERNA

Deadly!

Common in forest and woodland from June to October; the deadliest of all the gill fungi, but easily avoided by the collector if he rejects all mushrooms with

both ring and volva. This species causes the majority of the deaths due to eating poisonous forms. Amanita verna is probably only a form of this species; it is equally deadly.

AMANITA SOLITARIA. SOLITARY AMANITA

Cap large, 7-15 cm. wide, white or greyish, rarely brownish, the surface often covered with flaky granules or distinct scales which are easily rubbed off, sticking to the hands, hemispheric to plane; stem tall, 8-20 cm. by 8-12 mm., white, solid, bulbous, with a root-like extension, more or less scaly like the cap, ring torn, more or less appressed, volva scaly, disappearing; gills free or touching, white; spores elliptic, 10x7u. The name refers to its habit of growing solitary, though this is not universal.

Common in woodland and grassland from July to October; said to be edible, but it is dangerous on account of its resemblance to poisonous Amanitas and every one should avoid all risk by leaving it entirely alone.

FIGURE 3. AMANITA SOLITARIA
Dangerous!

AMANITA CAESAREA. CAESAR'S MUSHROOM

Cap large, 7-20 cm. wide, reddish, orange or yellow, smooth but beautifully striate toward the margin, ovate to convex or expanded; stem 10-20 cm., tall, yellow or orange, somewhat scaly below the ring, hollow, scarcely enlarged below, ring yellow or orange, large, collar-like, hanging, volva white, large and sack-like; gills free, yellow; spores elliptic, 8-10u. The name probably refers to the large size and the beauty of this plant.

Rare in open woods; easily mistaken for the deadly fly mushroom and always to be avoided except by the expert.

AMANITA RUBESCENS. REDDENING AMANITA

Cap large, 8-12 cm. wide, dull reddish, becoming paler in age, the surface roughened with many cottony grayish scales, ovoid to convex, then expanded;

stem stout, 10-15 cm. tall, 20-25 mm. thick, dull reddish, reddening when touched or bruised, ring large, superior, white, volva showing only as a few fragments, readily disappearing from the upper part of the bulbous base of the stem; gills shining white, touching the stem with lines running down it; spores ellipsoid, 7-9u. The name refers to the characteristic reddening of the flesh.

Infrequent in forest and woodland from June to October; edible but always to be avoided except by the expert who knows the many variations of our species of Amanita.

AMANITA FROSTIANA. FROST'S AMANITA

Cap small, 3-6 cm. wide, bright yellow or orange, with wart-like scales or occasionally nearly smooth, margin striate, convex to plane; stem 5-8 cm. tall, white or yellow, bulbous, stuffed, ring delicate, often disappearing, volva a delicate margin on the bulbous base, or consisting of a few yellowish scales; gills white or yellowish; spores globose, 8-10u. Infrequent; poisonous.

AMANITA MUSCARIA. FLY CAP

Cap large, 10-15 cm. wide, bright red or orange, becoming yellow or even whitish in age, roughened with many thick white angular fragments of the volva, which often disappear in age, margin striate, globose to convex, more rarely expanded; stem stout, 8-15 cm. by 2-4 cm., white, scaly, bulbous, hollow, ring large, apical, torn, volva forming several concentric scaly rings on the bulb; gills free or touching, white or yellowish; spores elliptic, 8-10x6-8u. The name refers to the use of this fungus to kill flies.

Frequent in woodland, forest or clearing from June to frost; deadly poisonous.

The deadly poisonous mushrooms are all species of Amanita A. phalloides, A. verna and A. muscaria (figures 1, 2, 4). Each species contains a somewhat different poison, though they all act as powerful and fatal depressants upon the heart action. The chief antidotes are atropine and injections of salt solution. The effects of Amanita poisoning usually do not appear for 9 to 12 hours, and at this time remedial measures are too often unavailing. In consequence, every one who collects mushrooms for food should spare no pains to avoid getting Amanita into his basket. This means that he must learn to recognize Amanita under all conditions, and that as a further safeguard, he must learn the edible genera and species just as he would learn so many flowers or fruits. **Mushrooms with white gills, a ring about the stem and a volva at the base of the stem must always be avoided.** When it shows these three features, an Amanita can readily be distinguished from all other mushrooms. The greatest danger occurs in the button stage, or in old age when the volva or ring has more or less completely disappeared. Button Amanitas have been mistaken for puffballs, with fatal results, but this will never occur, if it is borne

in mind that even the button as usually found will show gills when cut open, a feature entirely lacking in the puffball. Perhaps the

FIGURE 4. AMANITA MUSCARIA
Deadly!

safest plan is to avoid all mushroom buttons, unless there is clear-cut evidence from their growth or the more mature plants alongside of them that they are not Amanitas. In other words, mushroom buttons should even less be taken on faith than the adult forms. As to the old forms, the best method is to become so familiar with the marks of Amanita, as shown in figures 1-3 that

they will be recognized under all conditions. While the deadly poisonous mushrooms are few in species and in individuals, no chances whatever should be taken with them. The opinion of one who does not know them definitely by their scientific names is worse than worthless; it is dangerous. The same statement applies to the various rules-of-thumb for detecting poisonous forms. These would all be laughable, if they did not often lead to fatal results. The change of color of the flesh, the floating or sinking in water, the discoloration of a silver spoon and other supposed tests are mere superstitions, unworthy of the slightest credence. Even the best cookbooks are often dangerously misleading.

POISONOUS AND EDIBLE MUSHROOMS

By Dr. W. G. FARLOW, Harvard University

The difference between the common edible mushroom and the fly agaric and deadly agaric, which the reader can easily remember, are as follows:

(1) The common mushroom has a pileus which is not covered with wart-like scales; gills which are brownish purple when mature; a nearly cylindrical stalk, which is not hollow, with a ring near the middle, and without a bulbous base sheathed by a membrane or by scales.

(2) The fly agaric has a pileus marked with prominent warts; gills always white; a stalk, with a large ring around the upper part, and hollow or cottony inside, but solid at the base, where it is bulbous and scaly.

(3) The deadly agaric has a pileus without distinct warts; gills are always white, and a hollow stalk, with a large ring, and a prominent bulb at the base, whose upper margin is membraneous or baglike.

(4) Other minor points of difference are the different places in which these species grow, and also the colors, which, although they vary in each case, are brilliant yellow or red in the fly agaric, white varying to olive in the deadly agaric, and white usually tinged with a little brown in the mushroom.

(5) A word should be said as to the size and proportions of pileus and stalk in these three species. In the mushroom the pileus averages from 3 to 4 inches in breadth, and the stalk is generally shorter than the breadth of the pileus and comparatively stout. The pileus remains convex for a long time, and does not become quite flat topped until old. The substance is firm and solid. In the fly agaric the pileus, at first oval and convex, soon becomes flat and attains a breadth of 6 to 8 inches and sometimes more. The stalk has a length equal to or slightly exceeding the breadth of the pileus, and is comparatively slenderer than in the common mushroom, but nevertheless, rather stout. The substance is less firm than in the common mushroom.

(6) The pileus of the deadly agaric is thinner than that of the common mushroom, and, from being rather bell-shaped when young, becomes gradually flat-topped with the center a little raised. In breadth it is intermediate between the two preceding species. The stalk usually is longer than the breadth of the pileus, and the habit is slenderer than in the two preceding species. All three species are pleasant to the taste, which shows that one cannot infer that a species is not poisonous because the taste is agreeable. The fly agaric has scarcely any odor. The other two species have certain odors of their own, but they cannot be described.

PART III
SPAWN AND SUPPLIES

PURE CULTURE SPAWN

Reliable mushroom spawn is hard to get. Cheap and inferior makes are a drug on the market. The intelligent mushroom grower is not looking for cheap spawn; he will have none but fresh and the very best—he is looking for results. The largest item of expense to the mushroom grower is in the preparation of the beds. This expense is the same whether he plants cheap spawn or a high-grade spawn. The loss sustained by a crop failure, however, is not compensated by the insignificant saving in the price of the spawn.

The pure culture method of making spawn was discovered in 1903, and the first pure culture spawn was placed on the market by the American Spawn Company, being now universally known as "Lambert's Pure Culture Spawn." The supply at first was very limited, the process of manufacture involving considerable labor and expert knowledge. The few growers who were then able to

EXTRACT from "The Truth about Mushrooms", a publication issued by this Bureau.

MUSHROOM SPAWN

Much of the mushroom spawn sold by the so-called spawn dealers, experts, "farms," and by seedsmen, is what is known as English, virgin or mill track spawn. It is wild spawn, as uncertain as any wild thing must be. You could no more be certain of a crop with such spawn than you could with any wild seed. The mushrooms from such spawn, when it does produce any mushrooms at all, are of all sizes and range in color from deep brown to lighter shades, when, as the experienced grower knows, the pure white or cream colored mushroom is the mushroom for which the demand exists and for which high prices are secured.

Wild English spawn is **cheap,** however—for the man who sells it. It is of so little actual value that it comes into this country classed as fertilizer, not as seed at all. It is so low in value that with the cost of the spawn, duty and freight all paid, it rarely costs the dealer or "farm" **over five cents a brick,** and then the dealers proceeds to sell it at 600 to 1,000 per cent profit. No wonder such spawn has made some people wonder whether after all there is anything in mushroom culture.

The other kind of spawn—the kind that the big, old growers, and the smaller successful growers as well, use—is known as **Pure Culture Spawn.**

Pure Culture Spawn as the name indicates, is the result of years of work on the part of the **United States Department of Agriculture** and certain **practical** mushroom growers, and is not wild spawn but spawn (mushroom seed)

procure it were more than surprised at their success. This spawn carried the highest award, a silver medal, at the Universal Exposition, St. Louis, 1904. It has been brought to our attention that many illustrations used in this book, and even the claim to the highest award at the Universal Exposition of St. Louis, 1904, have been copied for use in connection with other spawn or so-called "Pure Culture Spawn;" we therefore reproduce below, with the permission of the American Spawn Company, a fac-simile of the original and only diploma for mushroom spawn awarded at that Exposition.

Highest Award Universal Exposition, St. Louis, 1904

produced in this country from **cultivated** mushrooms of **known** varieties, white or cream colored, and of even, big size, for which the highest prices are obtainable always because the demand is for this kind of mushroom. The difference between the ordinary spawn and Pure Culture Spawn is the difference between wild and cultivated seeds—the difference between guesswork and certain results—the difference between failure and success.

It is to assure any one desiring to procure Pure Culture Spawn and truthful and complete information that the "Bureau of Mushroom Industry" has been established and located centrally in Chicago.

THE SELECTION OF SPAWN

Many dealers profess to sell "Selected Mushroom Spawn" that is selected by **themselves.** They will not, however, disclose their source of supply, and it is but natural to suppose that they will select the grade of spawn which yields them the largest margin of profit. It is human nature, and by some it is considered good business.

Since that time, important improvements have been brought to the manufacture of this spawn, and it is today unexcelled anywhere in the world. The large commercial growers have practically discarded all other forms or makes of spawn, since Lambert's Pure Culture Spawn, the only spawn raised from spore cultures, and true to color and variety, supplies them with that element of certainty which was so sadly lacking in the old-fashioned article. Genuine pure culture spawn absolutely eliminates all danger of raising poisonous mushrooms, and enables the grower to safely stamp his guarantee on every box of mushrooms delivered to his trade.

The Bureau of Mushroom Industry has investigated all makes of spawn as well as the makers. It has found that Lambert's Pure Culture Spawn, as a high grade article, is not equaled by

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It has now been well established, however, that the experienced mushroom grower is **not looking for cheap spawn**; he will have **none but fresh** and the very best—he is looking for results. The commercial grower cannot afford to experiment with wild spawn which has been **shipped across the ocean** and killed in the close and hot hold of a slow freighter. For similiar reasons, loose or flake spawn has resulted, in most instances, in absolute failure. The loose texture of this spawn allows the "mycelium" to deteriorate and lose its vitality so rapidly that it will not stand transportation or storage. The **brick** is now considered the safest carrying medium for the delicate growth known as the "mycelium" of the spawn.

After careful investigation and tests of the various makes of spawn on the market, the Bureau has found that the old adage is still true, "**the best is the cheapest.**" Cheap spawn is worthless.

The Bureau of Mushroom Industry has, therefore, also made a selection of spawn for its patrons, but it is willing to take them into its confidence. It has found but one grade of spawn which fully comes up to the high standard of its requirements. It is "Lambert's Pure Culture Spawn," made by the American Spawn Company. While this high-grade spawn is the **dearest** in the market, it is by far the **best** and therefore the **cheapest,** when measured by results.

The makers of "Lambert's Pure Culture Spawn" were the first to put in practice the important discovery of the pure culture method and, in collaboration with experts of the United States Department of Agriculture, have steadily improved these methods, until now their spawn stands alone in its class, unexcelled by any spawn in the world. They have recently introduced "spores" in their pure cultures, and the result has been such added vigor to the growth that mushrooms will appear on the beds and a total yield may be obtained in a much shorter time.

The American Spawn Company does not retail its product. It is only obtained in limited quantities by a few leading seedsmen and dealers for the use of large commercial growers who are under contract to furnish mushrooms at stated times and in certain quantities. These experienced men are thus eliminating all elements of uncertainty from their business, and enjoy a large and steady income, increasing every year.

Notwithstanding the pressing demand for this spawn, the Bureau of Mushroom Industry has succeeded in arranging with the makers for a limited supply and has received assurances of an increased and continuous supply in the near future.

We are, therefore, in a position to now supply our customers with this spawn in limited quantities, and in order to build a foundation for future and permanent relations with our patrons, we are for the present practically eliminating our margin of profit, and will sell "Lambert's Pure Culture Spawn" at prices quoted by many dealers for the inferior or worthless article.

any other spawn on the market, and that the standing of the makers, the American Spawn Company of St. Paul, Minn., in the business world is of the highest. The makers of this spawn do not retail it, and the demand for it still exceeds the supply notwithstanding the yearly increase in the output. This Bureau has succeeded in arranging for its supply, which is offered at prices little in excess of the prices quoted for the low-grade article. Prices are F. O. B. Chicago, when cash accompanies the order:

7 bricks, sufficient for 50 sq. ft.	$ 2.00
14 bricks, sufficient for 100 sq. ft.	3.75
28 bricks, sufficient for 200 sq. ft.	6.00
42 bricks, sufficient for 300 sq. ft.	8.00
80 bricks (½ case) by freight, at 15 cents	12.00
160 bricks (full case) or more in case lots, at 14c	22.40

Estimate one brick for about 8 square feet of beds.

This book, "The Cultivated Mushroom," is furnished free with the **first order only** for 7 or more bricks of spawn.

Each brick of "Lambert's Pure Culture Spawn" measures 9 inches in length, 5¼ inches in width and is about 1½ inches thick. The weight may vary from 1 to 1¼ pounds per brick.

Express Charges—Mushroom spawn is rated as seed, and is therefore carried by express companies at lowest rates. Express companies always meet postal rates. The parcel post law will therefore insure the very lowest rates obtainable. We watch express charges very carefully, and always secure the lowest.

Remittances—Always remit by postoffice or express money order, or by registered mail. To personal checks or bank drafts, add 15 cents for exchange or cost of collecting it.

Canada—There is no duty on spawn shipped into Canada.

Address all orders to

Bureau of Mushroom Industry

1342 N. Clark St., Chicago, U. S. A.

TRADEMARK.

The phenomenal success of Lambert's spore cultures has brought into the market many cheap grades sold as "Pure Culture Spawn." They are even stamped with a close imitation of the trademark which appears on every brick of "Lambert's Pure Culture Spawn." The genuine article is stamped with the letters P C enclosed in a **diamond—not** a circle, heart or square.

Realizing that the discovery of Pure Culture Spawn will soon result in the abandonment of English and other forms of wild spawn, some importers of the old-fashioned wild spawn have attempted to meet the situation by offering such spawn, at a reduced price, under the name of "English Pure Culture" spawn. They are unable, however, to name the specific variety of mushrooms which this so-called "English Pure Culture" spawn will produce. Since that is the fundamental distinction between pure culture spawn and wild spawn, the deception is easily exposed.

The B. M. I. Improved Mushroom Thermometer

Size, 14 Inches (Including Handle)

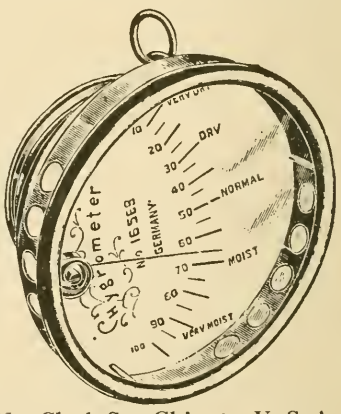
For strength and durability, this thermometer is unexcelled. It has galvanized frame, black scale, wood handle and mercury bath. It is easily taken apart for cleaning purposes. It is specially designed to stand the wear and rough handling incident to hot-bed or mushroom growing.

Price Postpaid, $1.50

The B. M. I. Improved HYGROMETER

2-inch dial; improved scale denoting humidity of the air without reference to any tables, nickel-plated case. Indispensable to the mushroom grower.

Price Postpaid, $1.25

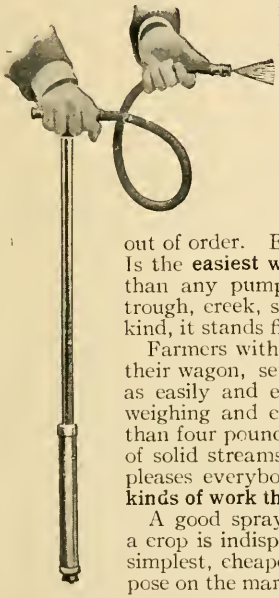


Address orders with remittance to Bureau of Mushroom Industry, 1342 No. Clark St., Chicago, U. S. A.

New Ideas In Spray Pumps

The "Kant-Klog" Sprayer

JUNIOR No. 5

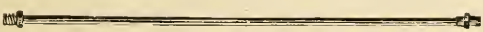


We do away entirely with the objectionable foot-rest, clamps, leather suction, packing, etc. This pump requires **no fastening of any kind,** holds itself down and works anywhere and everywhere. All the operator need do is to press the plunger down. **It rises of itself,** the upward stroke being made by a brass spring forcing the cylinders apart.

The **all brass** suction working within a **brass cylinder** with all **Brass Valves,** does away entirely with all leather, rubber, or other packing. It is practically impossible for any part to get out of order. Everything except handle and hose is **Solid Brass.** Is the **easiest working** and will do more different kinds of work than any pump ever made. Will pump from a pail, barrel, trough, creek, spring, boat or sink. Without fastenings of any kind, it stands firmly wherever placed.

Farmers with an ordinary amount of spraying put a barrel on their wagon, set this pump in the bunghole and spray their trees as easily and effectively as their neighbor who uses an outfit weighing and costing five times as much. This weighs less than four pounds. Makes two sizes of continuous spray and two of solid streams, has automatic mixer to keep solutions stirred, pleases everybody, lasts a lifetime, and **will do more different kinds of work than any pump ever made.**

A good sprayer for whitewashing the mushroom house after a crop is indispensable to the mushroom grower, and this is the simplest, cheapest, and yet most effective device for that purpose on the market.



BRASS EXTENSION PIPE

Brass Pipe, 3 feet long, with quarter inch standard cut threads, needed ing the nozzle in tree spraying, whitewashing, etc. Several can be ther when desired. Price of pump, complete as shown in cut, ension pipe, by parcel post, prepaid..... **$4.50**

Address orders with remittance to

Bureau of Mushroom Industry

1342 No. Clark St., CHICAGO, U. S. A.

MUSHROOM BOXES (CARTONS)

The time has passed when the mushroom grower could ship his mushrooms in any old package, cover it with a newspaper, tie it up with a string, and let it go at that. The public is now more exacting and discriminating. An attractive package will sell readily at a good price, while the unattractive basket will go begging and must be sold at a sacrifice.

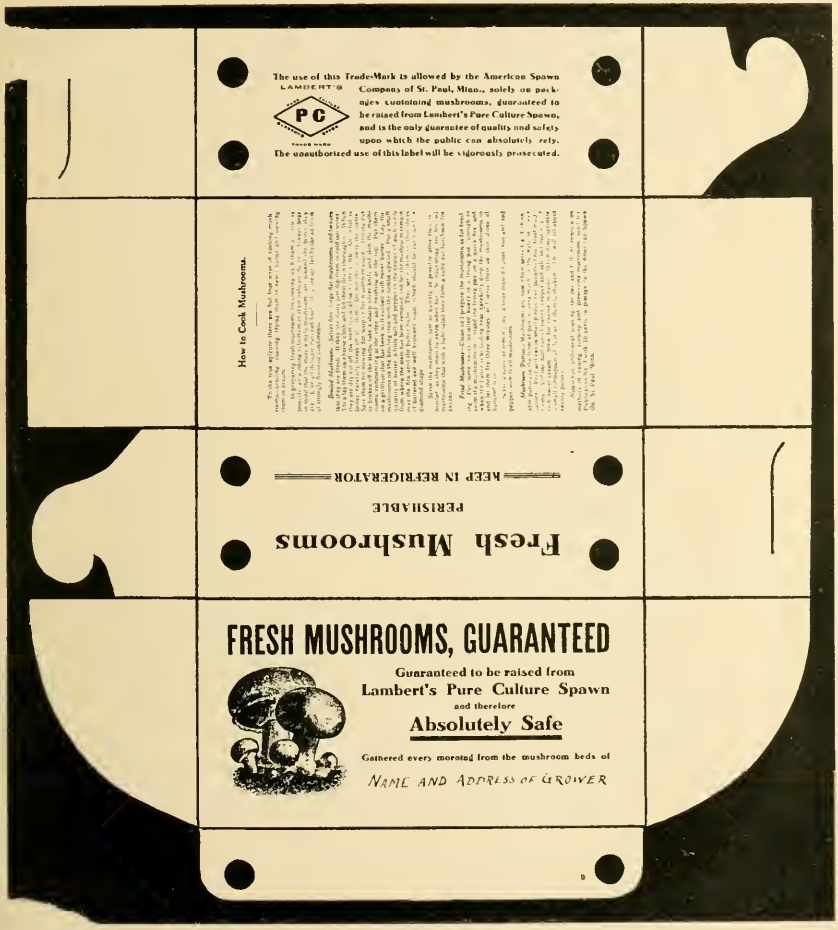
The fresh mushroom is a very perishable article and will not stand rehandling or repacking without injury and serious loss in grade. If shipped in bulk it becomes a third-grade article when repacked. The demand has therefore gradually become imperative for a package which will safely carry the fresh mushroom from grower to consumer. The following requirements of the trade must be met in any package.

1. **A standard size,** made of one piece, small enough to avoid generally the necessity of repacking by commission men and grocers. The one-pound box seems to be most universally in demand by grocers and private consumers. For hotels and large consumers, the three-pound box is preferred. The one-pound box is

LAMBERT'S VENTILATED MUSHROOM BOX
Paraffined 1-lb. size, oblong, 7¾x4x3 inches.

made in two styles; the oblong shape, which is very attractive, for small and medium size mushrooms, and the square shape for large mushrooms. The three-pound box is made in the oblong shape only for all sizes of mushrooms.

It is not advisable for mushroom growers to encourage the use of one-half pound or other boxes of odd sizes, as they are not in great demand, must be specially made and are therefore more expensive.



ushroom box, knocked down for shipment. Weight, 105 lbs. per 1000 boxes.

2. **Ventilation** is deemed essential to prevent rapid decaying which occurs in tight boxes.

3. **The natural moisture** of the mushroom, which gives it a fresh appearance, must be preserved. This moisture is rapidly absorbed by the porous material of the ordinary carton, leaving the mushroom in a withered condition. This objection has been overcome by paraffining the inside of the box.

4. **Cooking recipes,** either printed on each box or furnished in loose form, are very welcome by the housewife. It is surprising how many people refrain from buying mushrooms because they do not know how to cook them.

5. **Guaranty as to safety.** Fear of eating poisonous mushrooms is by far the **greatest handicap** now resting on the mushroom trade, and the press reports recording, almost daily, the death of some person after eating poisonous mushrooms contribute to this fear. Hundreds of thousands of people, who are now afraid of mushrooms, would buy them under a reliable guarantee as to their safety. Before the discovery of Pure Culture Spawn no grower was in a position to give this guarantee. He could not even guess at the variety or color of his mushrooms before they appeared on his beds, and then they were far from being uniform in variety or color. The grower of mushrooms from genuine Pure Culture Spawn has therefore an assest of inestimable value and a lead over his competitors who are still using English and other forms of wild spawn, of which he should take full and immediate advantage. He can now boldly and safely guarantee his product and give good reasons. The public will invariably buy the **guaranteed mushrooms** as against the article which cannot be guaranteed and will soon compel the grocers to procure it.

6. **Price.** The average grower cannot afford to buy an improved mushroom box in sufficiently large quantities to obtain a low price. A glance at the prices quoted below will show that we have successfully solved this problem. To that end we have had the dies and plates made (leaving name and address blank), paraffined the stock, and have the boxes manufactured and printed in very large quantities, necessitating only the additional printing of the name and address of the grower. We are thus in a position to give small and large growers, proportionately, the benefit of prices on very large quantities.

Net prices of Lambert's Ventilated Mushroom Boxes, paraffined, with printed cooking recipes, printed guarantee as to safety, and grower's name and address (prices F. O. B. St. Paul):

Quantity	1-lb. Oblong.	1-lb. Square.	3-lb. Oblong.
300 or less	$3.50	$3.50	$7.00
500	4.25	4.25	10.00
1000	6.75	6.75	15.00
2000	12.50	12.50	29.00
5000	30.00	30.00	71.00
10000	55.00	55.00	140.00

Address orders to Bureau of Mushroom Industry,
1342 No. Clark St., Chicago, U. S. A.

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