

A FLORISTIC STUDY
OF THE BASIDIOMYCETES OF
THE SANDIA MOUNTAINS, NEW MEXICO

By
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Since 1904, when G. G. Hedgecock collected fungus specimens in New Mexico, little has been written about the floristics of the Basidiomycetes of the Sandia Mountains. The present study began in 1958 with a survey of the history of mycological investigation in New Mexico. A sampling of the Basidiomycetes of the Sandia Mountains, New Mexico, was made. The fungi were identified, preserved, and stored in the University Herbarium. The fungi were related to the plant association in which they were found. Charts were constructed correlating time of collection with climatological conditions prevailing for the preceding ten days.

Field notes were taken in code and transcribed on the tape of a portable recorder. Keying was aided by an adaptation of punchcard and polygonal graph techniques. A micro-increment borer was constructed which was used in sampling pileus context for microscopic and chemical tests. Paintings and photographs were made of most of the specimens collected.

With the exception of the forest pathological species listed by the United States Forest Service, this thesis now represents the only record of the Basidiomycetes of the Sandia Mountains, New Mexico.

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INTRODUCTION

Statement of Purpose of the Study

With the decline of the naturalistic approach to the study of biology it has become customary for an investigator to confine his attention to smaller and more specific scientific "compartments." Such a compartment is mycology--but these days it cannot really be said that the subdivision is a small one--reaching as it does into the very basis of biological life cycles.

The basidiomycete flora of the Sandia Mountains has never really been investigated before. At best this survey can serve only as a rather spotty general sketch of fungi in the area. But at least it is a beginning, and one which is not slanted just at the pathological aspects. It is my hope that such information as has been uncovered will help in future ecological and taxonomic investigations of the fungi of these mountains.

Area Covered

The area studied extends in a belt from Sandia Park ($35^{\circ}10'N--106^{\circ}22'30"W$) to the Crest ($35^{\circ}12'30"N--106^{\circ}26'W$) and reaching in general about one-fourth mile to either side of the Crest road. The road itself proceeds in a north-westerly direction from Sandia Park until Capulin Picnic

Grounds is reached. It then leads southwest to the Crest.
During the ascent the altitude changes from 7200 ft. to
10,678 ft.

REVIEW OF LITERATURE

Much of the mycological investigation in the state of New Mexico has been done by the United States Forest Service in the attempt to control forest fungal diseases. Cockerell collected in the state in 1904, and published his list in the *Journal of Mycology*. The list was later incorporated in W. A. Archer's thesis (1920). Standley (1916) described many species in his *Fungi of New Mexico*. By far the most scholarly and complete record of agarics (and other fungi) was completed by Archer. Archer's thesis has been micro-filmed by the University of New Mexico Library, and is available for study. Since Archer's list is only a part of his bachelor's thesis, perusal of the thesis yields other valuable information not readily available elsewhere. For example, he refers to another early collector:

. . . Hedgcock, a collector of forest pathological specimens, has furnished duplicate cards from his files of all forest collections in the Forest Pathology Herbarium at Washington. . . .

He also mentions letters 56, 58, 62, 63, 65, and 66 of G. C. Lloyd, published in Cincinnati, Ohio. It is my understanding that Lloyd was an amateur mycologist of considerable talent, whose hobby was identification. Long (1941, 1942, 1945a, 1945b, 1947, 1948) discovered and described several new genera and species of gasteromycetes and agarics from

New Mexico.

Many techniques for identifying mushrooms have been developed. Krieger (1920), Thomas (1928), and others formulated rigorous methods of identification which made use of spore color, growth habit, and the appearance of the specimen. Podzimek (1927) suggested using taste and fragrance as bases for identification, while Gilbert (1934) was in favor of using odor alone. Classification of the Tremellales by basidium characteristics was described by Martin (1945). Fergus (1960) has prepared a key very useful in identifying the wood-destroying fungi. At about the same time, chemists were experimenting with characteristic color reactions. Kühner (1934) described characteristic color reactions for closely related species when the pileus tissue was treated with cresyl blue. Bringing together the sight identification of the old investigators, the technique of the microbiologists, and the color reactions discovered by the chemists, Smith (1949) created a system of identification which, though complicated, is surely the best answer for the modern mycologist.

Drying is the traditional method for the preservation of fungi. But the unnatural appearance of the dried specimen led Ewart (1933) and Hutchinson (1950) to experiment with plastic impregnation and embedment as a technique. As an adjunct to the botanical key, many mycologists make drawings, photographs, and paintings of both fruiting bodies and

spores. Krieger (1926) described the sketching of fleshy fungi with the aid of the camera lucida. A method of photographing living mycelium was developed by Sherbakoff (1927). Honey and Fisher (1928) outlined dark field photomicrography in the study of hyaline fungal structures. Graham (1927) found that mushrooms may be classified into communities which are related to a corresponding association of higher plants. The use of the particular mushroom community as an indicator of the kind of succession was summarized. Spore dispersal by the larvae of diptera has been discussed by Chastukhin (1932), and the role of the Phthiracarid mite in the reduction of spruce litter already partially decomposed by fungi has been described by Jacot (1936). Smotlacha (1942) stated that most hyaenomyces live in symbiosis with forest trees. Many live with only one or a few genera of trees.

DESCRIPTION OF AREA

Geology

The Sandia Mountains are located in central New Mexico and occupy the northeast corner of Bernalillo County and the southeast corner of Sandoval County. The mountains have been characterized by the New Mexico Geological Society (1961) as "an eastward tilted north-south uplift about 20 miles long. Several subsidiary high-angle faults modify the back slope."

In the vicinity of Doc Long's Recreation Area are outcroppings of Pennsylvanian Magdalena and Precambrian Sandia granite. Gray crystalline fossiliferous limestone is also noted there. Barro Canyon, north of Doc Longs, lies along a fault which shows a Precambrian substrate. The most xeric high-altitude portion of the mountain, Tejano Canyon, shows bedrock of limestone, mudstone, and granite. At Tree Spring (8400 ft) the geology is characterized by Pennsylvanian Madera limestone ledges with an admixture of some shale and sandstone. The rest of the ascent to Sandia Crest is on a dip slope with a substrate of lower Madera limestone.

Soils

Formation of soils in the Sandia Mountains is, of course, influenced by the vegetational cover prevailing at the place involved. Beginning at the pinon-juniper level

(7000 ft) the soil is found to be loose, not well stratified, occasionally sandy, and varying in pH from about 4.0 to 5.0 in the A-horizon. At about 7500 ft can be found sclerophyllic chaparral consisting largely of Quercus gambelii, Quercus grisea, Cercocarpus montanus, and certain understory grasses. The soil here is generally rocky, quite undeveloped, and has a pH in the vicinity of 5.5. On the west face of the mountain the sclerophyll occupies a rather even-width belt, but on the east face the sclerophyll is spotty and interdigitated with areas of pinon-juniper and western yellow pine-Douglas fir. In one instance there is to be found a juxtaposition of Sonoran Desert types with a white fir stand. The xeric SW-facing slope of Tejano Canyon supports the former.

Proceeding up the mountain one eventually encounters Abies concolor--either in rather pure stands or in ecotone with Pinus ponderosa in the lower elevations and alpine fir-Engelmann spruce in the higher. In these ecotones and stands the soil grades toward the podzolic.

Extending in an almost unbroken belt from 9,500 to 10,500 ft is found an alpine fir-Engelmann spruce forest. The soil here is typically podzol and rather thin (6-8 in). Extending through this belt, and usually following canyons are many fire subclimax tongues composed of stands of Populus tremuloides. In these stands, as might be expected, the A-horizon is dark, organic, shot through with

grass roots, layered near the surface with aspen leaves, and rather high in pH (5.6-6.0). In certain parts of the Populus tongues, islands of Quercus gambelii bush are noticed--and usually in these places the A-horizon is thin.

At Sandia Crest (10,800 ft) conditions approach those of Alpine Tundra. Wind training, gnarling, and layering of trees is noted. Pinus flexilis, Pinus aristata, and Populus tremuloides are to be found among the woody plants of this area. Since the winds are prevailing westerlies, soils at the rim are blown away toward the east as fast as they are formed. This is to say that soils at the rim are virtually nil. Snow and ice may be found on the rocky backbone of the crest during many months of the year. When the thaws come, the expected nivation occurs, gradually cracking and pulverizing the rock surface. As particles are loosened, wind erosion and saltation remove and transport them. Such ground cover as exists is typified by grasses, lichens, mosses, and dwarf forms of Castilleja and Androsace. These plants are either in the rock cracks or are adhered to the faces. If one could imagine the crest area as being much like a knife blade with the honed edge pointing toward the sky and the blade proper oriented approximately north-south, he would have a fair idea of what the crest is like. On the west side (windward) of the edge exists little growth of any but the hardiest plants. On the east side (leeward) is an area of rather luxuriant growth including Abies lasiocarpa

var. arizonica, Picea engelmanni, and some Populus tremu-
loides. Robinia neomexicana often forms a suffruticose
layer. There is an extensive understory consisting of such
plants as Erysimum, Potentilla, Galium, Allium, and in the
wet areas, Iris. On the east side the precipitation is
greater, the evaporation is less, and the winds do not buf-
fet. As a result mosses and hanging lichens (Ussnea) do
very well there. In addition, moisture seems to be suf-
ficient for the activities of fungi.

Macroclimate

Most rainfall in the Sandia Mountains occurs during
the summer months when maritime tropical air moves into New
Mexico from the Gulf of Mexico. During May through October
it is not unusual for the east slope of the mountain to re-
ceive 10 in of rain (Fig. 1). The west-facing slope gen-
erally gets much less precipitation, possibly because storm
paths seem to run along the east slope. This would tend to
create a rain shadow along most of the west face.

Diurnal range of temperatures during the mushroom-
growing season can vary from 35 F in May to 10 F in August.
Fig. 2 shows mean monthly temperatures for May through
October during 1957.

Fig. 1.- Average rainfall in inchesSandia MountainsMay through October, 1955-1961

Year

1955 1956 1957 1958 1959 1960 1961

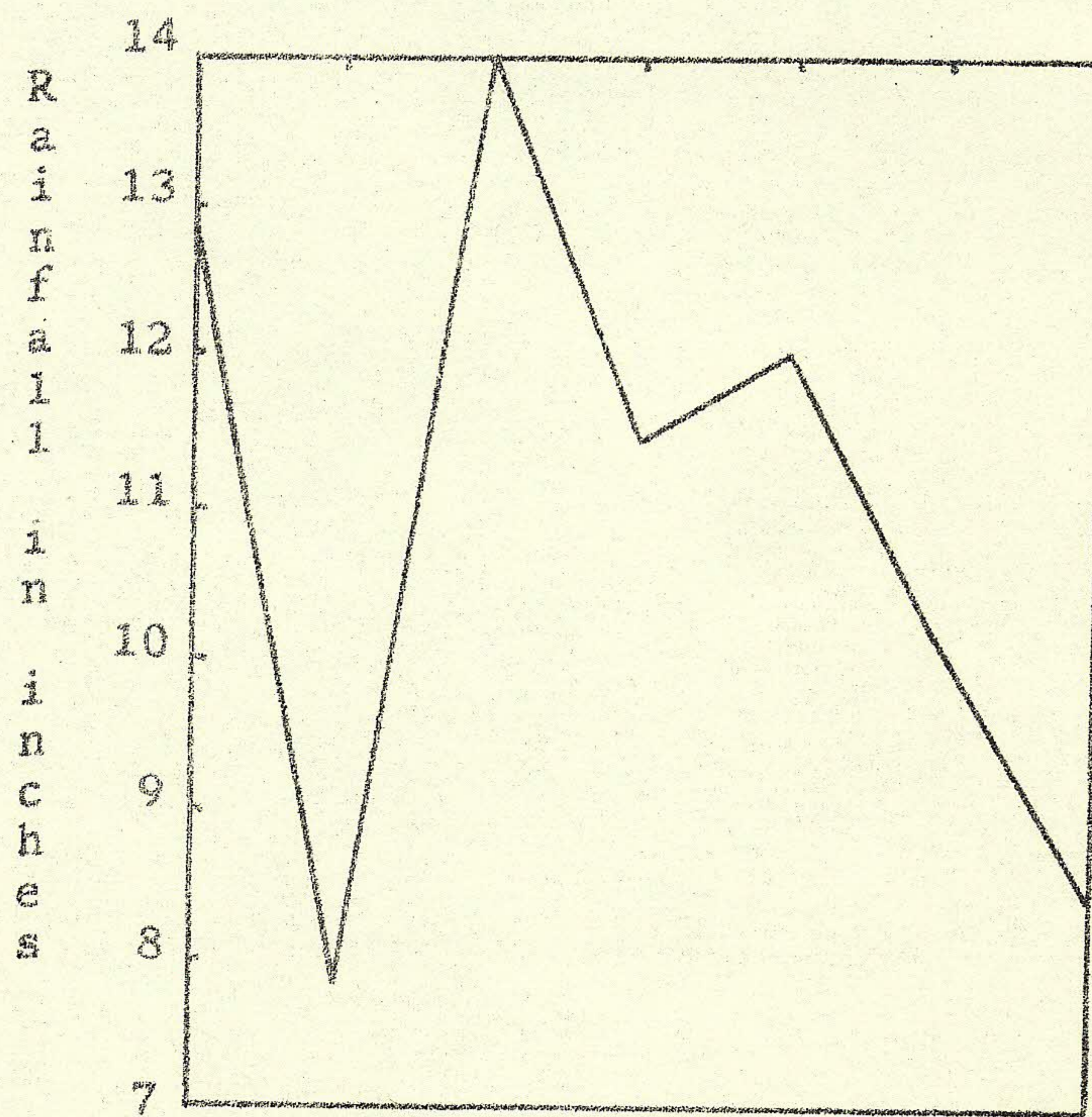
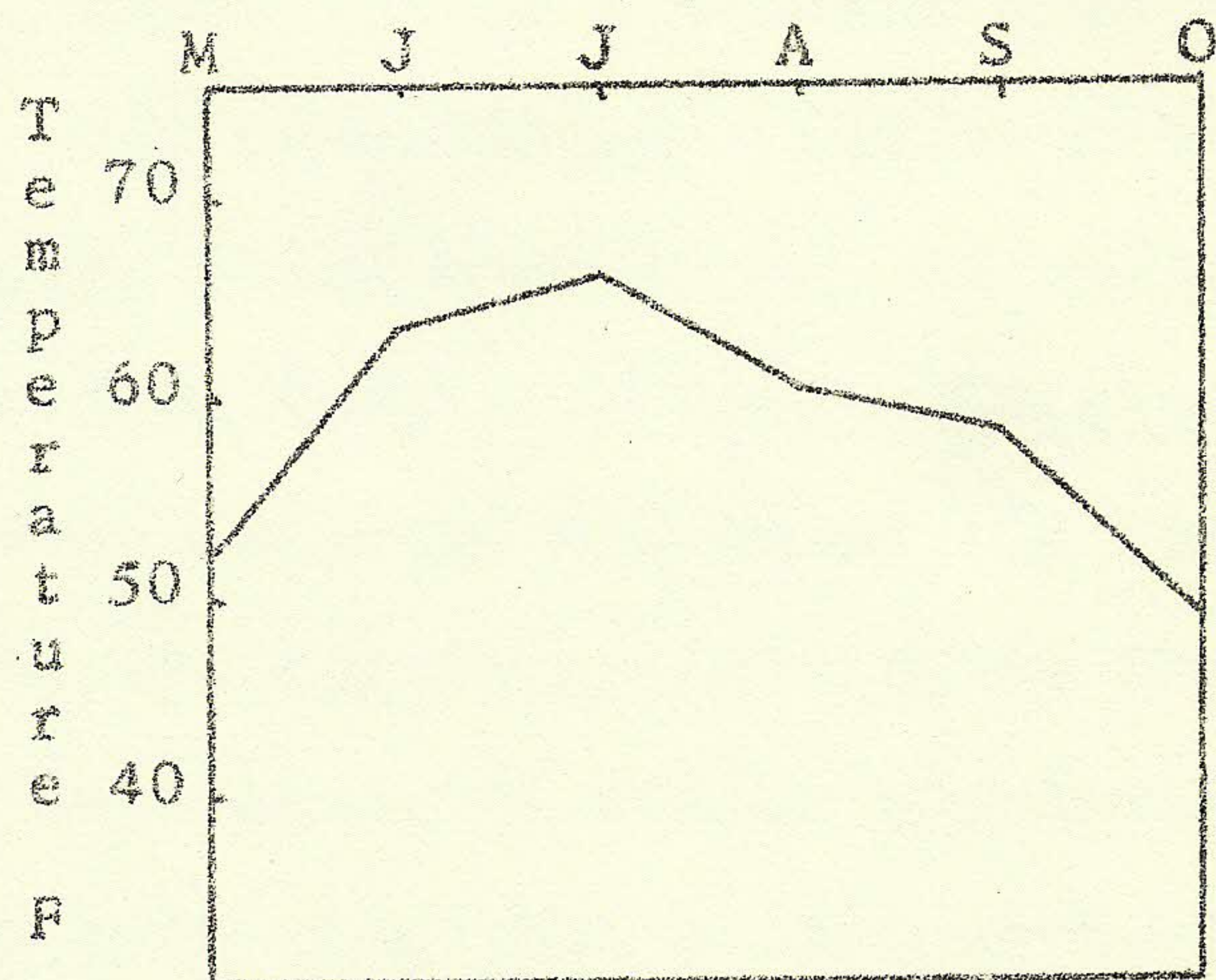


Fig. 2.- Mean monthly temperaturesSandia ParkMay through October, 1957

Month



MATERIALS AND METHODS

Collecting

Many mushrooms display a definite and successful protective coloration. Although this fact complicates matters for the collector, it probably has much to do with the survival of the mushroom. It should be added immediately, though, that many other mushrooms are blatantly conspicuous--especially those depending on insects for their spore dispersal. At any rate, the fact remains that certain fungi are remarkably well camouflaged. Litter-dwelling forms, such as Marasmius, often display colors which are almost indistinguishable from substrata hues. Geaster growing under oak resembles both in shape and color the acorns lying on the ground. Any mycologist collecting in the field has had, I am sure, the experience of seeing previously unnoticed specimens "jump into view" all of a sudden--come into focus as it were--with an abruptness which makes him wonder how many specimens he has passed up on the way. A realization of this fact has encouraged me to emphasize thoroughness and care rather than speed while collecting.

Recently, because I found that my stock of collecting equipment was mounting, I designed a carrying case for it. The case is of very light-weight plywood and veneer and is

fitted to provide niches for photographic and recording equipment as well as for those chemicals which I use in the field. I photograph with a pre-focused 35mm camera set by frosted glass to take a picture at 162mm. The only film I use is Daylight Kodachrome 135.

If enough individuals of the same species are available I turn one specimen up so that the gills or pileus underside of one mushroom and the side view of another can be photographed simultaneously. Then I adjust the camera, which is mounted on a reversible tripod, so that it will take the picture in the pre-arranged plane. For measuring subject-to-lens distance I use a wooden rod cut to 162mm. Usually there is not enough sunlight for successful color photography, so I take all pictures with the light of a flashbulb (M-25 medium peak blue). Such close work demands the use of a Wratten neutral filter so as not to "burn out" the subject. Depth of focus is increased by photographing at f22. Tiny specimens, such as Marasmius, are photographed in the laboratory through a Bausch and Lomb 20X dissecting microscope.

Field description normally follows the photography. The mushroom is described in words and numbers spoken into the microphone of a transistorized portable tape recorder which is installed in the field case. I follow a semicoded check list designed to take into account each aspect of the mushroom, starting with location and growth habit and ending

with a note on the substrata. For example, the code number sequences 3 - 1 - 5 - 8 - 9 - used to describe the cap of Pholiota squarrosa adiposa might be decoded later as follows: pileus (3) tough (1) scaly (5) hygrophanous (8) and has fragments of the veil attached (9). The approximate color of cap and stipe is recorded in words, as are any other peculiarities of the specimen not coded in the check list. The collections are removed carefully from the substrata and placed in numbered waxed-paper bags. Bagged collections are carried in a plastic pillow cover. Spore prints and microscopic examinations are made in the laboratory.

Identification

The synonymy existing in mycological nomenclature is presently being eliminated by the Committee on Fungi of the International Botanical Congress. Common names, still used by many, often have interesting histories. Thus, Armillaria mellea (Fr.) Quelet was the "honey mushroom" of the early American settlers, and Psilocybe candidipes Singer and Smith was one of the venerable hallucinatory Teonanacatis of the ancient Aztecs. One can imagine times in the history of mankind when survival of the tribe might well have depended upon accurate identification of such potential foodstuffs as mushrooms. One can also recreate in the imagination a series of events which might have led up to some of the modern identification techniques. After the medicine men

of the tribe had lost their influence and civilized society had gained its ascendancy, there were others who "knew about mushrooms." Maybe the old, gray-headed crone who lived near the outskirts of town could tell about them. She probably even had names for some of her favorites. Later, when specialists such as scientists developed, identification depended more and more upon their knowledge and experience. Sight identification forced the expert to memorize the appearance of a very great number of species, and this fact led to its eventual downfall as a technique.

Using the systematic and scientific approach outlined in Smith's Mushrooms in Their Natural Habitats (1949), I attempt at least a tentative identification of the mushrooms as soon after collection as possible. Spore prints are taken both on paper and on a clean microscope slide. White spore deposits are treated with amyloid indicator (chloral hydrate-iodine), and the color produced is noted. Microscopic examination of the spores reveals their morphology. Spore shape is often a valuable indicator of genus. Next, the pileus is broken or cored, the flesh is treated with 2.5% KOH solution, and any color change is noted. When, because of the rarity or lack of abundance of a specimen I do not wish to destroy it, I use an adaptation of the increment-boring technique to remove a portion of the pileus for treatment with KOH. The boring instrument is a hypodermic syringe, the needle of which has an inside diameter of about

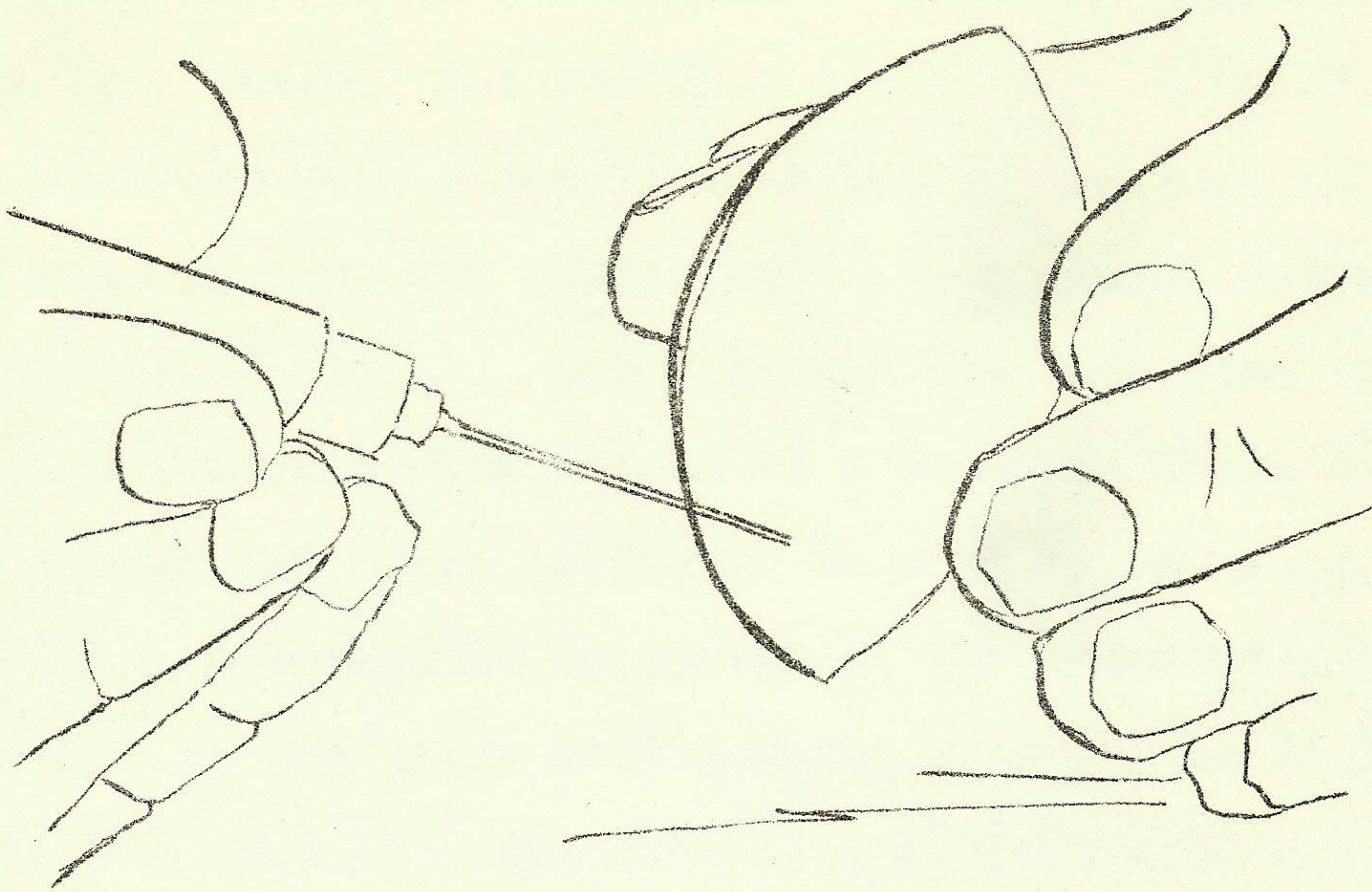


FIG. 3. Removal of core from pileus

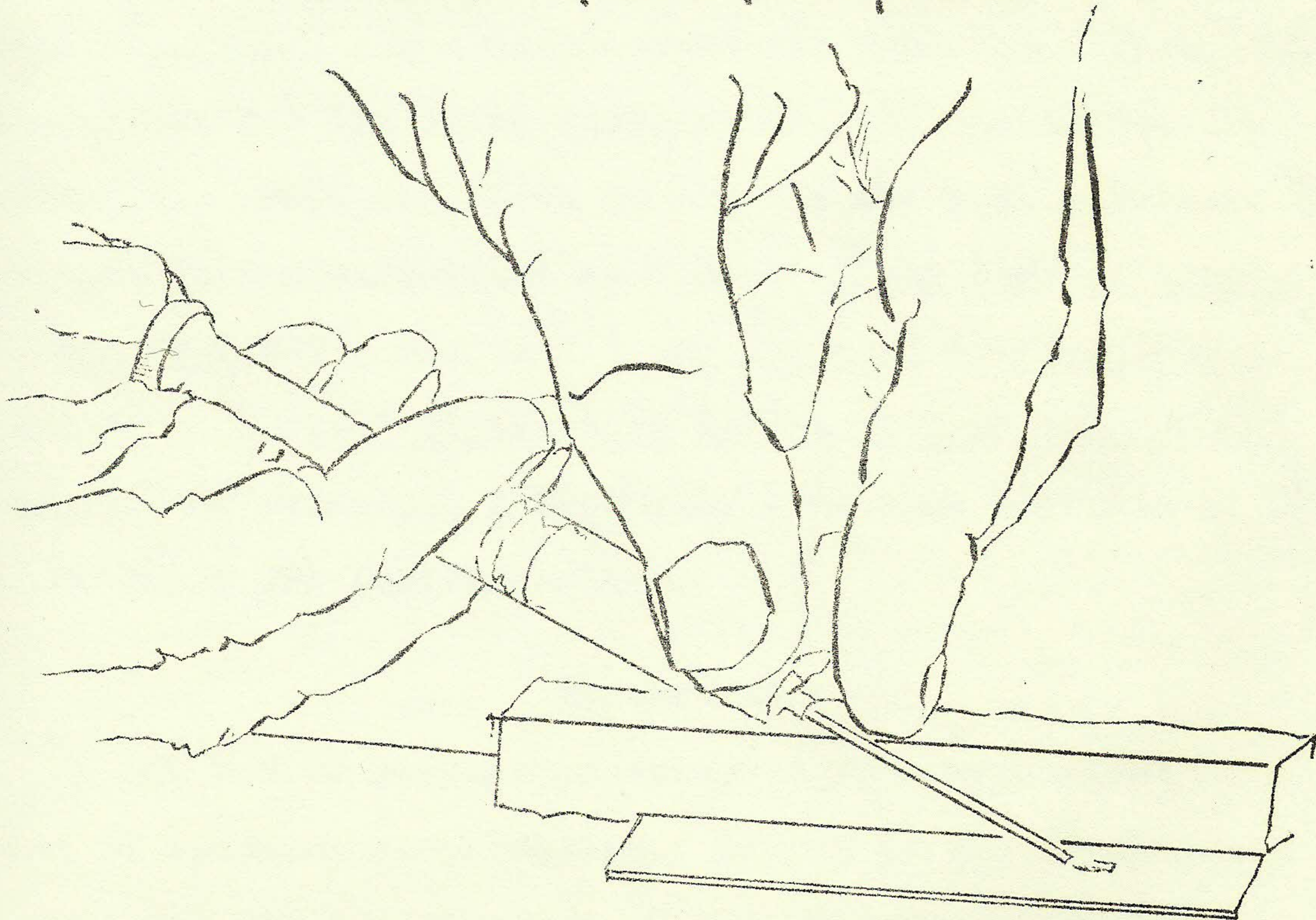


FIG. 4. Transfer of core to slide

1.5mm, and which has been modified by removing the point and grinding the end of the needle so that it resembles the tip of a cork borer. The modified needle may be inserted into the mushroom with a slight twisting or twirling motion, and the core removed and placed on a clean microscope slide. (See Figs. 3 and 4). Extrusion of the core from the borer is facilitated by the action of a wire rod which fits inside the needle and which is pushed forward by the plunger of the syringe. Microscopic fragments of the hymenium are removed by scraping the gills with a razor blade. The fragments are then mounted on a slide in water, covered with a cover slip, and examined to determine the presence of pleurocystidia, cheilocystidia, and other microscopic features. Then, following the key and using field notes, the identification is attempted. When specimens do not fit the key, reference is made to such publications as Thomas' Field Book of Common Mushrooms (1948), McIlvane's One Thousand American Fungi (1912), or Fergus' Illustrated Genera of Wood Decay Fungi (1960). On occasion, I have sent specimens directly to Dr. A. H. Smith for identification.

Preservation

A subject of particular interest to a mycologist is that of specimen preservation. Drying is the traditional method for the preservation of all mushrooms except the

Phalli and Coprini. Material so preserved can be revived in 2% KOH and studied, even microscopically. The succulent mass of hyphae comprising the pileus and stipe is, however, an almost perfect rearing medium for the larvae of flies and beetles. Moennich (1939) found seven families of beetles, represented by 38 species in fungi. Chastukhin (1932) discovered that Coprinus spores are actually dispersed by larvae and adults of Drosophila. Many fresh specimens which look perfectly sound in the field may by the next day be reduced to a soggy mass, writhing with maggots. Practically the only hope of saving a badly infested specimen is to heat it in an oven at 80 C for 10 minutes. Then the mushroom may be placed on a drying rack (0.25 in. galvanized wire mesh) and dried for several days in the open air. Before placing any specimen in the fungus herbarium it is advisable to fumigate it with a commercial fumigant, such as Dowfume 72.

The handling of dried specimens is hazardous, at best. When a dried mushroom is dropped it may be cracked and ruined. I have tried to find a satisfactory method of preservation which would allow handling. Hutchinson (1950) suggests embedding in methyl methacrylate. This method would apparently necessitate desiccation of the specimen. Ewart (1933) gave directions for producing a preserved specimen which holds its original shape and color. Since Ewart's method involves the polymerization of a phenolic resin within the cells

themselves, the two techniques theoretically could be combined to yield an embedded example in perfect condition. Another possibility involves the gradual removal of water from the specimen by passing it through an alcohol series. The dried specimen would then be ready for embedment.

Storage

Each mushroom or clump is tagged with a 1.5 cm x 10 cm heavy paper strip upon which is printed the pertinent details of collection and the accession number. The tagged collection is then stored in a covered cardboard box, which is also marked on the front with the specific epithet, order, and class. Box storage is at present to be in wooden cabinets located in the University Herbarium.

Mushrooms were grouped for construction of the key by making use of a polygonal graph for each specimen. The polygon blank was printed on a card with a hole punched at a predetermined spot near the center. Information regarding spore color, substrata, and date of collection was plotted at the appropriate positions, and the cards were then cut along the graph line. The cut cards were then stacked by impaling them through the hole on an upright iron nail protruding from a flat board. It was then a simple matter to compare cards and to separate them into piles corresponding to similar characteristics.

ECOLOGICAL NOTES

Fungal spores, being air transported, can be found in every conceivable place. Leaf surfaces, all soils, and even the skin and fur of animals are literally covered with spores. The oceans, lakes, and rivers of the world doubtless receive a tremendous share of the spore material produced. Hirst (1953) using a power operated suction trap collected aerial solids on the sticky surface of a slowly moving slide, and recorded the kinds of spores caught at different times of day. He found that basidiospores had a more or less unvarying diurnal distribution--showing up even when weather conditions were limiting the presence of other kinds of spores.

The moving air of the prevailing westerlies is loaded with spores, and one can visualize a considerable world-wide temperate belt distribution of species by means of spore dispersal. As air moves over a crested upthrust such as is found in the Sandia Mountains, slow-moving pockets are formed in the air mass on the lee side which allow for the deposition of suspended particles. Spores deposited from suspension on a suitable substrata will produce hyphae.

Considering the amount of air which has moved from place to place since the fungi evolved, it seems hard to explain the fact that there is not a complete fungal flora

in every suitable place in the world. That there is not is a matter of fact. Why there is not requires some explanation.

Factors Limiting Complete Fungal Flora

Lack Of Suitable Substrata. Fungi can be classified roughly according to the kind of material on which they flourish--or to put it another way--on the basis of the substrata most successfully reduced by them. Fungi growing on wood are therefore called lignicolous fungi (L. Lignum = wood). Coprophilous fungi live on fecal material, and pyrenophilous fungi can be found usually only where there has been a fire in forest or field. This specificity of fungi to substrata goes even further. Among lignicolous fungi--for example in the genus Fomes--we find Fomes betula growing only on birch, and other species of Fomes being just as preferential in their food source. In addition, we find Panaeolus semiovatus to be specific for horse feces and Coprinus atramentarius to be found on bovine droppings. It can be seen, then, that the natural distribution of substrata materials is often very limiting to hyphal propagation, even assuming a very heavy spore distribution over a given area.

Change In Prevailing Climate or Microclimate. If spores of a hydrophyllic coprophilous mushroom should happen to land on an acceptable material and if moisture and temperature are optimal, a tangled mass of hyphae can be expected to develop in and on the substrata. But later on,

the climate could change so that moisture was no longer available, and the hyphae would die. Or perhaps the tree limb shading the substrate would break off, exposing the substrata to sunlight and eventual desiccation. Gottlieb (1928) found that temperatures lethal to the mycelium of some fungi were reached on warm summer days.

Chance Distribution Of + And - Strains. The Factor Of Sexual Compatibility. One could imagine a situation involving a "+" type hyphal tangle growing in one place in the Sandia Mountains and next to it the "-" type of the same species. For successful nuclear fusion and subsequent development of fruiting bodies, plasmogamy must first occur between hyphae of the two strains. In addition, the cells of both hyphal masses must carry the genotype for sexual compatibility.

Alexopoulos (1932) states that in about 90% of all investigated species plasmogamy can take place only between hyphae originating from different basidiospores which carry opposite factors for compatibility. Knowing this, it is, I think, permissible to hypothesize that at the present time in the Sandia Mountains there are flourishing the hyphal tangles of exotic mushrooms. Since the sexually compatible counterparts never developed, for reasons of non-arrival of the spores or destruction of the hyphal mass, we have no opportunity to notice the fruiting bodies which would have developed had all conditions been met. The vegetative mycelia

are there, nevertheless, even though we lack the means of identifying them. slope, or character of the surface.

The hypothesis can be carried a step further. It is known that a hyphal mass can live asexually for hundreds of years, provided that environmental conditions remain good. I submit that hyphae of otherwise extinct mushrooms probably do exist in the Sandia Mountains, but that the species cannot be identified because fruiting bodies cannot be produced. In addition, it can be postulated that mycelia of exotic and unknown species are in the area, successfully producing fruiting bodies, and remain only to be discovered and identified.

Fungi and Plant Associations

Graham (1927) states that mushrooms may be classified into communities which are related to a corresponding association of higher plants. Table 1 lists Sandia Mountain mushrooms as inhabitants of climax associations and also gives information about the meteorological conditions prevailing during approximately ten days before the specimens were collected. Perusal of climatological data of the United States Weather Bureau (1955-1961) provided the necessary information. High and low temperatures for most collecting dates were recorded by the Bureau both at Sandia Crest and at Sandia Park. Interpolation provided the approximate temperatures existing at the collecting sites. Rainfall at the sites was approximated by averaging recorded precipitation

at both Crest and Park. No adjustment was made for influence of cover, slope, or character of the surface.

TABLE 1. Fungi of Sandia Mountains
arranged as to association and climate

Fungus	Associa- tion	Temp. trend 10 days preceding collection			Other data 10 days preceding collection			Date
		Ris- ing	Fall- ing	No	Temp. High	Low	Ppt. in.	
<u>Auricularia</u> <u>auricularis</u> (S.F. Gray)	<u>Abies</u> <u>concolor</u>							1958
<u>Coprinus</u> <u>comatus</u> (Fr.)	pure stand			*	80	51	1.3	8/28/58
<u>Hygrophorus</u> <u>conicus</u> (Fr.)								9/12/59
<u>Lepiota</u> <u>clypeolaria</u>			*		65	42	1.5	9/28/58
<u>Marasmius</u> sp.								8/21/55
<u>Pholiota</u> <u>squarrosa</u> <u>adiposa</u> Lange				*	78	50	1.5	8/26/55
<u>Russula</u> <u>emetica</u>								9/12/59
<u>Tricholoma</u> <u>flavovirens</u>				*	70	50	0.48	9/13/58
<u>Xeromphalina</u> <u>campanella</u>				*	79	53	1.75	8/21/55

TABLE 1. Fungi of Sandia Mountains
arranged as to association and climate

Fungus	Associa- tion	Temp. trend 10 days preceding collection			Other data 10 days preceding collection			Date
		Ris- ing	Fall- ing	No	Temp. High, Low	Ppt. in.		
<u>Boletus</u> sp.	<u>Abies</u>		*		62	44	0.55	9/18/61
<u>Cortinarius</u> <u>calyptratus</u>	with			*	64	45	0.50	9/18/61
<u>Cortinarius</u> <u>violaceus</u>	islands	*			61	41	0.20	9/26/61
<u>Gymnopilus</u> <u>spectabilis</u>	of			*	64	45	0.50	9/18/61
<u>Leucopax-</u> <u>illus</u> <u>septentrion-</u> <u>alis</u>	<u>Quercus</u> and tongues of	*			61	41	0.20	9/26/61
<u>Marasmius</u> sp.	<u>Populus</u>							10/10/61
<u>Pholiota</u> <u>squarrosa</u>			*		62	44	0.50	9/18/61
<u>Pholiota</u> <u>squarrosa</u> <u>adiposa</u>				*	62	43	0.20	9/26/61
<u>Pleurotus</u> <u>sapidus</u>								10/8/61
<u>Sparassis?</u>				*	62	43	0.20	9/26/61

TABLE 1. Fungi of Sandia Mountains
arranged as to association and climate

Fungus	Associa- tion	Temp trend 10 days preceding collection			Other data 10 days preceding collection		Date
		Ris-	Fall-	No	Temp. High, Low	Ppt. in.	
<u>Russula</u> <u>emetica</u>	Alpine			*	57	41	9/18/61
<u>Lycoperdon</u> <u>pyriforme</u>	Fir Engelmann			*	57	41	9/18/61
<u>Marasmius</u>	Spruce						9/18/61

A SHORT GENERIC AND FAMILY KEY TO THE BASIDIOMYCETES
OF THE SANDIA MOUNTAINS, NEW MEXICO

- | | | |
|----|--|----|
| 1. | Hymenium disposed on gills | 2 |
| 1. | Hymenium otherwise disposed | 24 |
| 2. | Fruiting body growing on deadwood | 3 |
| 2. | Fruiting body growing on other substrata | 8 |
| 3. | Spore color ochre | 4 |
| 3. | Spore color otherwise | 5 |
| 4. | Stipe present; pileus convex <u>Pholiota</u> p. 33 | |
| 4. | Stipe absent; pileus renate <u>Crepidotus</u> p. 33 | |
| 5. | Spore color rust brown; pileus yellow; scales
tiny <u>Gynnopilus</u> p. 33 | |
| 5. | Spore color otherwise; pileus white to brown;
scales absent | 6 |
| 6. | Spore color white | 7 |
| 6. | Spore color violet <u>Pleurotus</u> p. 34 | |
| 7. | Fruiting body tiny; less than 1 cm in diameter;
rhizomorpha absent <u>Marasmius</u> p. 34 | |
| 7. | Fruiting body large; always more than 1 cm in
diameter; rhizomorpha present <u>Armillaria</u> p. 34 | |
| 8. | Fruiting body on ungulate feces | 9 |
| 8. | Fruiting body on other substrata | 10 |
| 9. | Spores black; pileus ovate and not auto-
digestive. <u>Panaeolus</u> p. 35 | |
| 9. | Spores brownish-black; pileus long-ovate and
autodigestive <u>Coprinus</u> p. 35 | |

10. Fruiting body on grass 11
10. Fruiting body on other substrata 12
11. Spores white; stipe velvety and radicate . . .
Collybia p. 35
11. Spores purplish-brown; stipe not as above . . .
Psilocybe p. 36
12. Fruiting body on needles and other leaves;
pileus less than 1 cm in diameter
Marasmius p. 36
12. Fruiting body on other substrata; pileus more
than 1 cm in diameter 13
13. Fruiting body on duff of Abies concolor 14
13. Fruiting body on other substrata 15
14. Pileus tan; spores white; taste astringent;
veil absent Leucopaxillus p. 37
14. Pileus umber; spores rusty; taste bland;
veil present and cobwebby . Cortinarius p. 37
15. Fruiting body on duff of Pseudotsuga
taxifolia; pileus cherry red . . Russula p. 37
15. Fruiting body on other substrata; pileus
usually not red 16
16. Fruiting body on duff of Quercus gambelli 17
16. Fruiting body on other substrata 20
17. Spores rusty; pileus deep violet; veil
cobwebby Cortinarius p. 38
17. Spores white; pileus not violet; veil not
cobwebby 18
18. Pileus cherry red and conic . Hygrophorus p. 37
18. Pileus yellow or olive; never conic 19
19. Pileus yellow; tip of umbo covered with
red scales Lepiota p. 38

19. Pileus olive; tip of umbo not covered with red scales Mycena p. 38
20. Fruiting body on duff of Populus tremuloides; both annulus and volva present . Amanita p. 39
20. Fruiting body on other substrata; volva absent; annulus absent or present 21
21. Fruiting body on duff of Alpine Fir; stipe white Russula p. 37
21. Fruiting body on duff of Pinus ponderosa; stipe some other color 22
22. Pileus infundibuliform; gills decurrent Clitocybe p. 39
22. Pileus not as above; gills not or only partially decurrent 23
23. Pileus and gills orange Xeromphalina p. 39
23. Pileus and gills yellow Tricholoma p. 40
24. Fruiting bodies ear-like, gelatinous or cartilaginous Auricularia p. 40
24. Fruiting bodies not as above 25
25. Hymenium disposed in tubes 26
25. Hymenium otherwise disposed 27
26. Tubes separable from fleshy pileus context Boletaceae p. 40
26. Tubes inseparable from woody pileus context Polyporaceae p. 41
27. Spores borne on surface of antler-like branches Clavariaceae p. 41
27. Spores enclosed in stomach-like sac Series Gasteromycetes p. 41

DESCRIPTIONS AND ILLUSTRATIONS

Pholiota squarrosa (Fr.) Quelet, Champ. Jura and Vosges
p. 126. 1872. The Scaly Pholiota.

Base of Pinus ponderosa, 8,000 ft; base of Populus tremuloides, 9,000 ft. Pileus tan, convex, covered with numerous shaggy yellow scales; lamellae crowded, adnexed, and dark yellow-green; spore deposit dark rust-brown; stipe central to slightly eccentric, often cespitose from a single base; annulus present. Fig. 5.

Pholiota squarrosa-adiposa Lange, Flora Agaricina Danica
5:101. 1940.

On deadwood and stumps of Pinus ponderosa, 7,000-9,000 ft. Pileus red-orange, convex, covered with brown triangular scales, and sticky when wet; lamellae arranged in several layers, clay gray; spore deposit cinnamon brown; stipe central to slightly eccentric, often cespitose from a single base; scaly; annulus present. Fig. 6.

Crepidotus (Fr.) Quelet sp.

On conifer slash, 7,000-9,000 ft. Pileus burnt sienna, tomentose, and renate; lamellae with sawtooth edge; warm white; spore deposit ochre; stipe lacking; annulus none.
Fig. 7.

Gymnopilus spectabilis (Fr.) comb. nov.

Agaricus spectabilis Fries, Blench. Fung. p. 28. 1828.

On deadwood and stumps of conifers. Pileus orange-yellow, convex; scales minute, brown; lamellae crowded, cadmium yellow; deep, spore deposit rust-brown; stipe central, cespitose from a single base; annulus present. Fig. 8.

Marasmius Fries sp.

On leaf litter of Populus tremuloides, 9,000-10,500 ft. Pileus tan, convex, and smooth; lamellae distant, adnate, and white, 4-5 mm in diameter; spore deposit white; stipe long (2-3 cm) in relationship to pileus, and more fleshy than hair-like; annulus not present.

Entire dried plant revives when moistened. Fig. 9.

Armillaria mellea (Fr.) Quelet, Champ. Jura et Vosges p. 75.

1872. The Honey Agaric.

Clustered on living Abies concolor. Pileus honey-colored, broad (up to 15 cm), and irregular in outline; lamellae crowded, broad, adnate, and tan; spore deposit white; stipe central, stuffed; annulus present.

Rhizomorphs can be found under bark of parasitized tree. Fig. 10.

Pleurotus sapidus (Schulzer apud Kalchbrenner) Saccardo,

Syll. Fung. 5:348. 1897.

On aspen log, mouth of Habudo cave, 8,000 ft. Pileus white; funnelliform, surface smooth and leathery; lamellae close, decurrent, and white; spore deposit lilac; stipe heavy and hollow, cespitose from a single base; annulus not

present. Fig. 11.

Panaeolus semiovatus (Fr.) Lundell, Fungi Exsiccati Suecici, fasc. 11-12, No. 537. 1938.

On horse feces; 7,000 ft to 9,000 ft. Pileus dun colored, campanulate, thin, and glistening when damp. Lamellae close, broad, and spotted white and black; spore deposit black; stipe long, twisted, weak, and hollow; annulus present. Fig. 12.

Coprinus atramentarius Fries, Epicr. Syst. Myc. p. 243. 1838.

On horse feces; ubiquitous. Pileus oblong with flat apex, gray, and streaked with brownish lines; lamellae crowded and pink at first, becoming blackish as spores develop and deliquescence proceeds; spore deposit black; stipe central and hollow; annulus not observed. Fig. 13.

Coprinus comatus (Fr.) S.F. Gray, Nat Arr. Brit. Pl. 1:633.

1821. The Shaggy Mane.

Coprophilous; ubiquitous. Pileus white, oblong, and covered with shingle-like scales which curl up toward apex; lamellae crowded, pink when young, and becoming blackish as spores develop and deliquescence proceeds; spore deposit black; stipe central, stuffed, longer than length of pileus, and possessing a ring of annulus material. Fig. 14.

Collybia radicata (Fr.) Quelet, Champ. Jura et Vosges, p. 92.

1872. The Rooting Collybia.

In grassy areas, 8,000 ft. Pileus umber, convex to flattened, and broad; lamellae adnexed; close; whitish; spore

deposit white; stipe radicate and velvety; annulus not present. Fig. 15.

Psilocybe sp.

In grassy areas, 8,000-9,000 ft. Pileus pale yellow, hemispherical, and viscid when wet, remnants of floccose veil adhering to edge; lamellae close, wide, and dark violet with white outer edge; spore deposit deep violet; stipe central, stuffed; annulus not present. Fig. 16.

Marasmius Fries sp.

On needles of Abies concolor. Pileus warm white, small (1 cm in diameter), membranous, and ragged; lamellae distant, adnate, and white; spore deposit white; stipe central, same color as pileus, leathery; annulus not present.

Entire mycelium in and on one needle.

Marasmius Fries sp.

On needles of Pinus ponderosa. Pileus burnt sienna, small (1-2 mm in diameter), and campanulate; lamellae distant, adnate, and white; spore deposit white; stipe central, long (3-4 cm) in relationship to size of pileus, dark brown or black; surface shiny, resembling hair; annulus not present.

Entire mycelium in and on one needle. Fig. 17.

Marasmius Fries sp.

On litter of Alpine Fir, 10,000 ft. Pileus white, small (1 cm in diameter), and campanulate; lamellae distant; spore deposit white; stipe central, white, and glabrous; annulus not present.

Leucopaxillus septentrionalis Singer and Smith, Mycologia

39:726. 1947.

On duff of conifers, 7,000-9,000 ft. Pileus tan, broad (12 cm), convex to slightly concave in fully expanded specimens, surface resembling chamois skin in both texture and color, margin wavy to incurved; lamellae close, decurrent, broad, and white; spore deposit white, strong amyloid reaction; stipe central, heavy; annulus not present.

Taste of flesh immediately and persistently bitter.

Fig. 18.

Cortinarius cinnamomeus (Fr.) S.F. Gray, Nat. Arr. Brit.

Pl. 1:630. 1821. The Cinnamon Colored Cortinarius.

On litter and duff of Abies concolor, 8,000 ft. Pileus pale amber, conic at first, and becoming flattened with age; lamellae crowded, ochre; stipe central; veil of cobwebby strands covered with cinnamon colored spores. Fig. 19.

Russula enetica Kauffman, Agar. Mich. p. 152. 1918.

On duff of Pseudotsuga taxifolia, 7,500 ft. In groups on duff of Alpine Fir, 10,000 ft. Pileus cherry red (except for specimens taken at 10,000 ft which had white margins), broadly convex, about 5 cm in diameter, flesh thin; lamellae crowded, adnate, thin, and white, spore deposit white; stipe central, solid, thick, and white; annulus not seen. Fig. 20.

Hygrophorus conicus Fries, Epicr. Syst. Myc. p. 331. 1838.

The Conic Hygrophorus.

On litter and duff of Quercus gambelii, 7,300 ft. Pileus

cherry red, satiny, and conic, color changes to black with age; lamellae close, adnexed, yellow to orange, consistency described as waxy by Smith (1949); spore deposit white; stipe central, slender, hollow, and twisted; annulus not noted. Fig. 21.

Mycena sp.

On litter of Quercus gambelii, 7,000 ft. Pileus olive, convex; lamellae adnate, white; spore deposit white; stipe central; annulus not present.

Lepiota clypeolaria (Fr.) Quelet, Champ. Jura et Vosges p. 72. 1872. The Shield Lepiota.

On litter and duff of Quercus gambelii, 7,500 ft. Pileus yellowish except for a patch of red scales at tip of umbo, membranous; lamellae rather crowded, light tan; spore deposit white; stipe central; annulus present. Fig. 22.

Cortinarius calyptratus Smith, Contr. Univ. Mich. Herb.

No. 2, p. 14. 1939.

In fairy rings at base of Quercus gambelii, 8,000-10,000 ft. Pileus violet, broad, flat, and viscid; lamellae broad and crowded, rust brown; spore deposit rust brown; stipe central, heavy, and bulbous at the base; veil of hundreds of hyphae arranged like the shroud lines of a parachute and stretching from edge of pileus to near base of stipe.

All flesh stains magenta in 10% KOH. Fig. 23.

Cortinarius violaceus? (Fr.) S.F. Gray, Nat. Arr. Brit.

Fl. 1:628. 1821.

On litter and duff Quercus gambelii, 8,000 ft. Pileus brilliant violet, broad, and having cobwebby veil attached; lamellae broad and crowded, rust brown; spore deposit rust brown; stipe central, bulb not present.

All flesh stains red in 10% KOH.

Amanita verna (Fr.) Quelet, Champ. Jura et Vosges p. 230.

1872. The Destroying Angel.

On duff of Quercus gambelii and Populus tremuloides, 7,000-9,000 ft. Pileus snow-white, convex, and has fragments of veil attached at edge; lamellae crowded, adnexed, and white, spore deposit white; stipe narrow, stuffed, and ending in a bulbous base surrounded by a volva; annulus present.

Clitocybe infundibuliformis

On duff of Pinus ponderosa, 7,000 ft. Pileus light reddish tan, coriaceous, smooth, and infundibuliform; lamellae decurrent, crowded, and sharp edged; spore deposit white; stipe thick, stuffed, and erupting from a mass of cottony hyphae interwoven with the substrata; annulus not present. Fig. 24.

Xeromphalina campanella (Fr.) Kuhner and Maire, Bull. Soc.

Myc. Fr. 50:18. 1934.

On litter of Pinus ponderosa, 7,200 ft. Pileus orange, 0.5-1 cm in diameter, and umbilicate; lamellae decurrent, distant, and orange; spore deposit white; stipe central, smooth, polished, dark sienna-colored, and covered at base with a tomentose mat of bright orange hairs; annulus not present. Fig. 25.

Tricholoma flavovirens (Fr.) Lundell, Fungi Exsiccati

Suecici, fasc. 23, No. 1102. 1942.

On duff of Pinus ponderosa, 7,200 ft. Pileus lemon yellow, convex, and sticky when wet; lamellae yellow, close, broad, and adnexed; spore deposit white; stipe central, heavy, and yellow, annulus not present. Fig. 26.

Auricularia auricularis (S. F. Gray) Martin, Am. Midl. Nat.

30:1. 1943. The Ear Mushroom.

On conifer slash. Pileus olive-brown, gelatinous or cartilaginous, and ear-like; spores hyaline; stipe absent.

Boletus felleus (Bull. ex Fr.) Karst.

The Bitter Boletus.

Under conifers, below 10,000 ft. Pileus very light tan, thick, and smooth; tube context white; spore deposit white; stipe central, and covered with a network of hyphae resembling the vein structure of a fly wing.

Taste very bitter.

Xeroconus chrysenteron (Bull. ex Merat)

The Red-Cracked Boletus.

On litter and duff of conifers. Pileus raw sienna, cracked, and revealing lines of yellow-green flesh beneath; tube context pale lemon-yellow; spore deposit ochre; stipe is streaked with vermillion; annulus not present. Fig. 27.

Polyporus sp.

On conifer slash. Pileus leathery; hymenium arranged on inner surface of tubes; spore deposit not taken; stipe

present; annulus not present. Fig. 29.

Clavaria purpurea Pries, Syst. Myc. 1:480. 1821.

The Coral Mushroom.

On conifer litter and duff, below 9,000 feet. Hymenophores dichotomously branched, light umber with a violet tint; spore deposit ochrei; stipe hollow, tinged with green streaks, and giving rise to the branches. Fig. 29.

Calvatia gigantea (Pers.) Lloyd, Mycological Writings,

Note No. 269. Vol. 1:166. 1904. The Giant Puffball.

Under Pseudotsuga taxifolia. Peridium wall eventually splitting into patches and plates; spore mass dark olive drab. Fig. 30.

Cyathus striatus Lloyd

The Birdnest Fungus.

On slash of both coniferous and deciduous trees.

Spores contained in egg-shaped peridioles borne in a cup-like striated peridium; peridioles attached to peridium by a sticky funiculus. Fig. 31.

Geaster sp.

The Earth Star.

On duff of Quercus gambellii, 7,000 ft. Peridium contained within an outer shell which eventually splits longitudinally and curls down from the top; spore mass olive drab, often dispersed through an orifice at top of peridium. Fig. 32.

Lycoperdon perlatum Persoon, Syn. Meth. Fung. p. 145. 1801.

The Gem-Studded Puffball.

On slash. Fruiting body spherical, 2-3 cm in diameter; peridium white and covered with short projections; spores olive brown.

Lycoperdon pyriforme Persoon, Syn. Meth. Fung. p. 148. 1801.

The Pear-Shaped Lycoperdon.

On deadwood. Fruiting body pear-shaped, 3.0-3.5 cm in diameter; peridium white at first, becoming light amber at maturity; spores olive brown. Fig. 33.

Scleroderma sp.

On litter and duff of Populus tremuloides and Pseudotsuga taxifolia; fruiting body roughly spherical; peridium sclerotic; spores orange.

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FIG. 5. *Pholiota squarrosa**

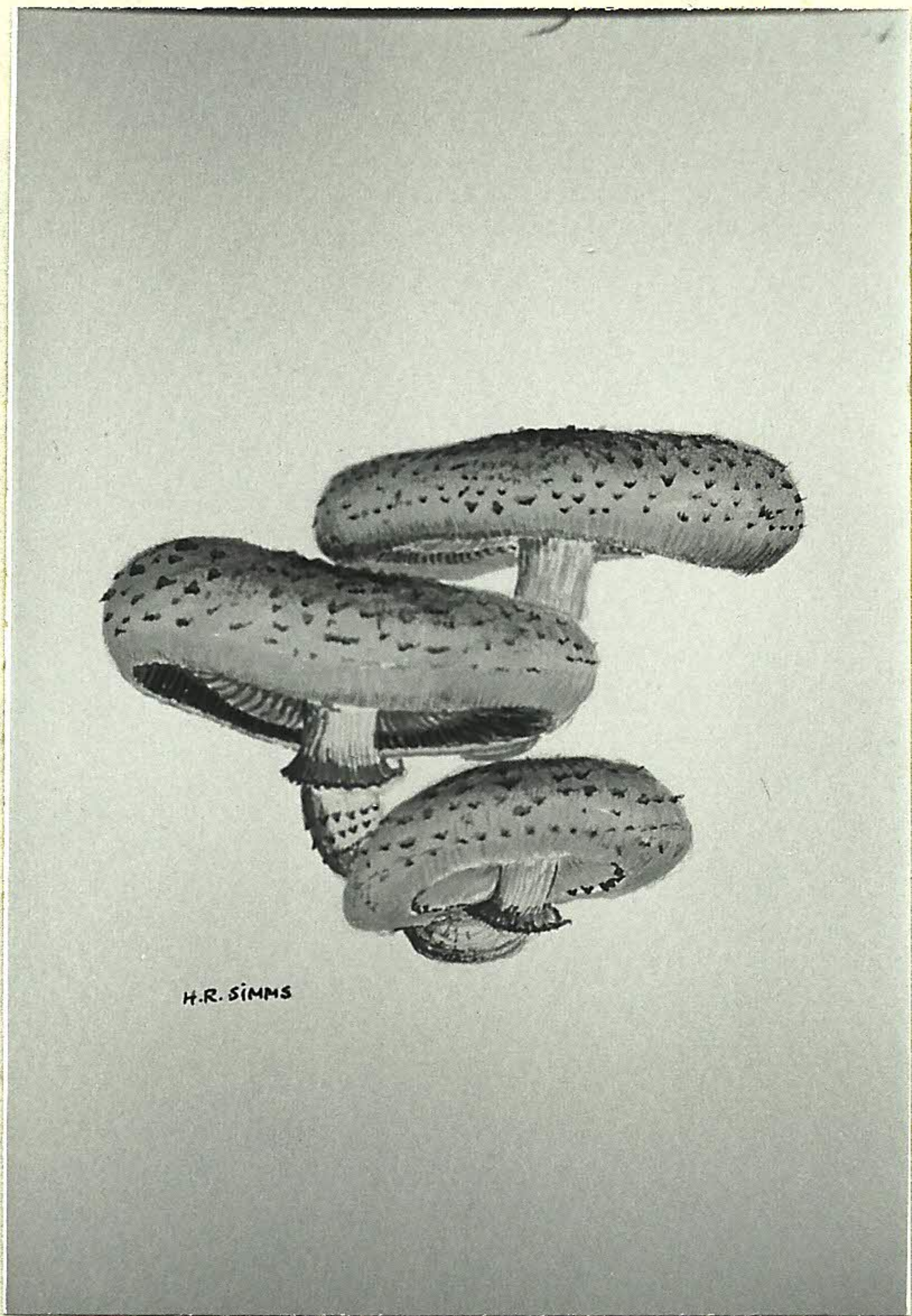


FIG. 6. *Pholiota squarrosa-adiposa*.



FIG. 7. *Crepidotus* sp.



FIG. 8. *Gymnopilus spectabilis*.



FIG. 9. *Marasmius* sp.



FIG. 10. *Armillaria mellea*.



FIG. 11. Pleurotus sapidus.

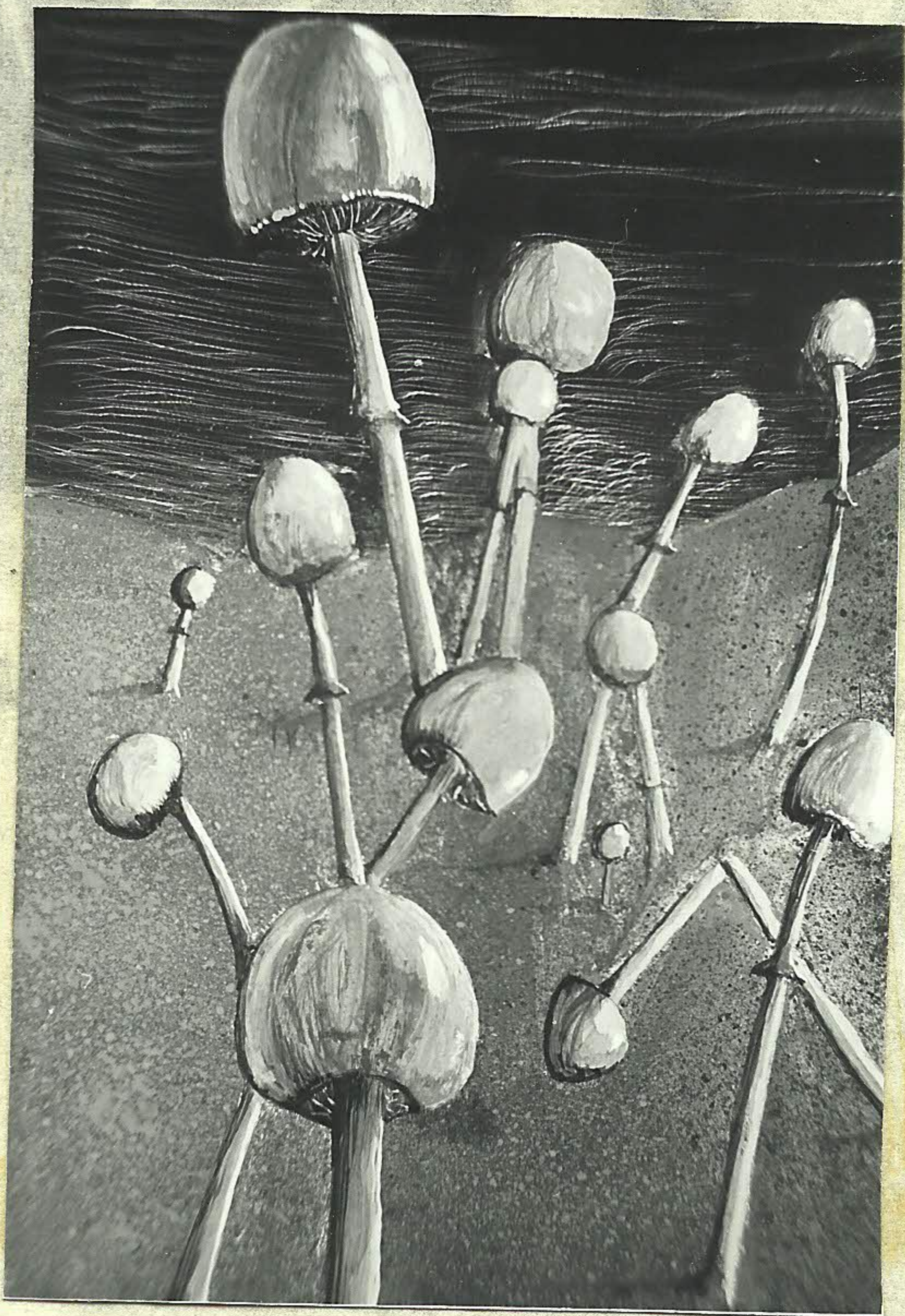


FIG. 12. Panaeolus semiovatus.



FIG. 13. Coprinus atramentarius. FIG. 14. Coprinus comatus.

FIG. 15. Helicoglyphis sp.



FIG. 15. Collybia radicata.



FIG.

FIG. 16. Psilocybe sp.

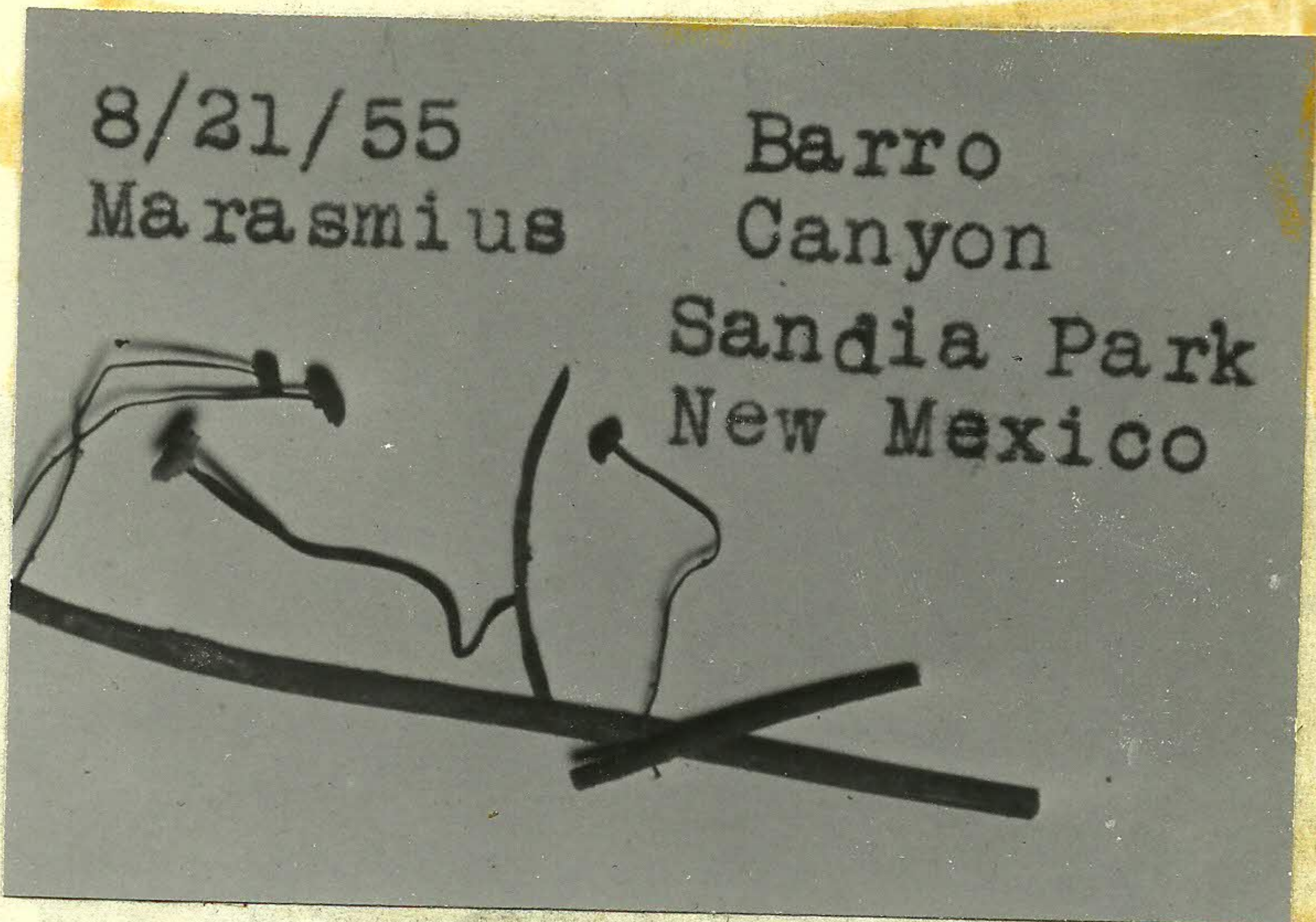


FIG. 17. Marasmius sp.

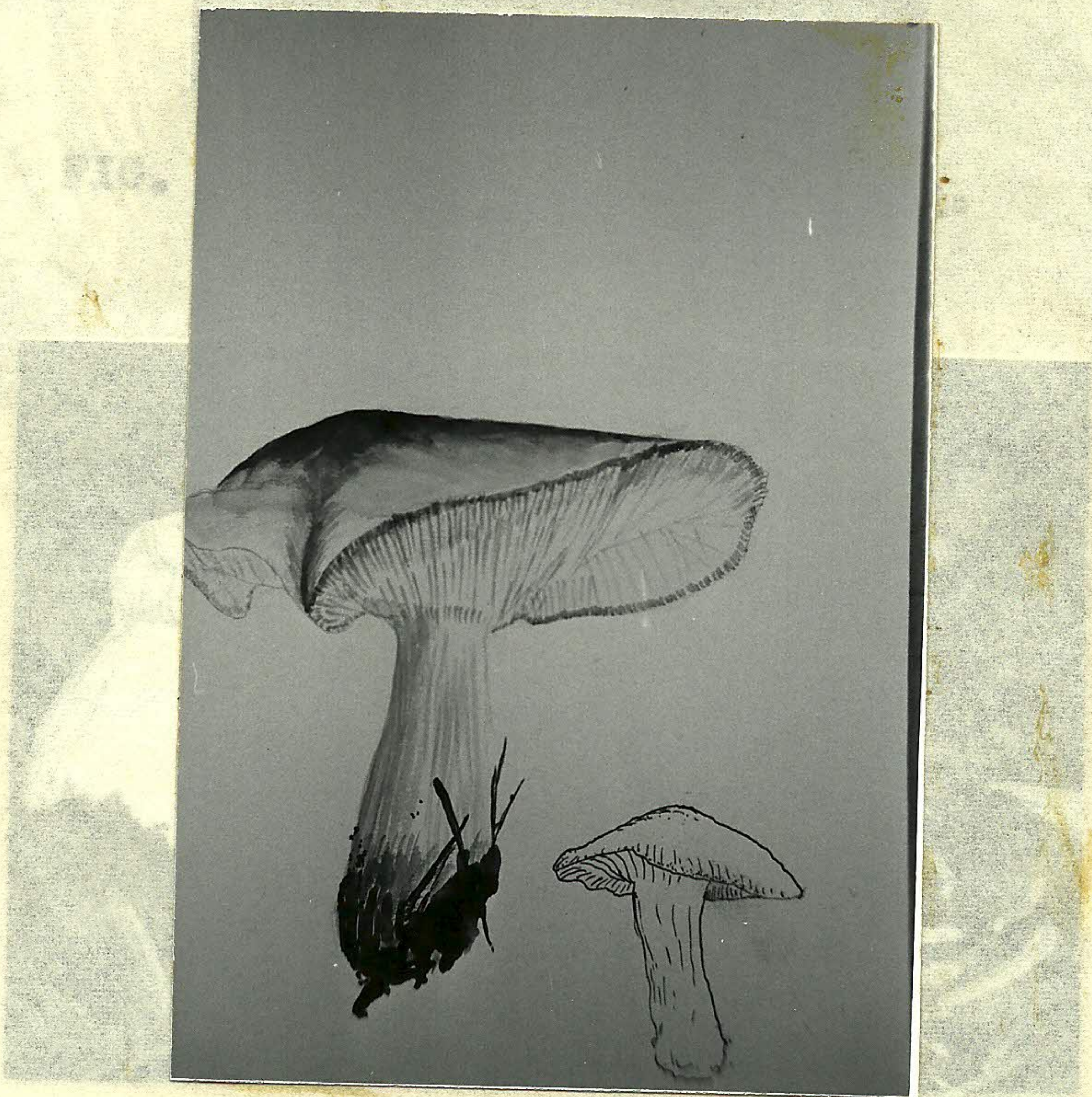


FIG. 20. Leucopaxillus septentrionalis.

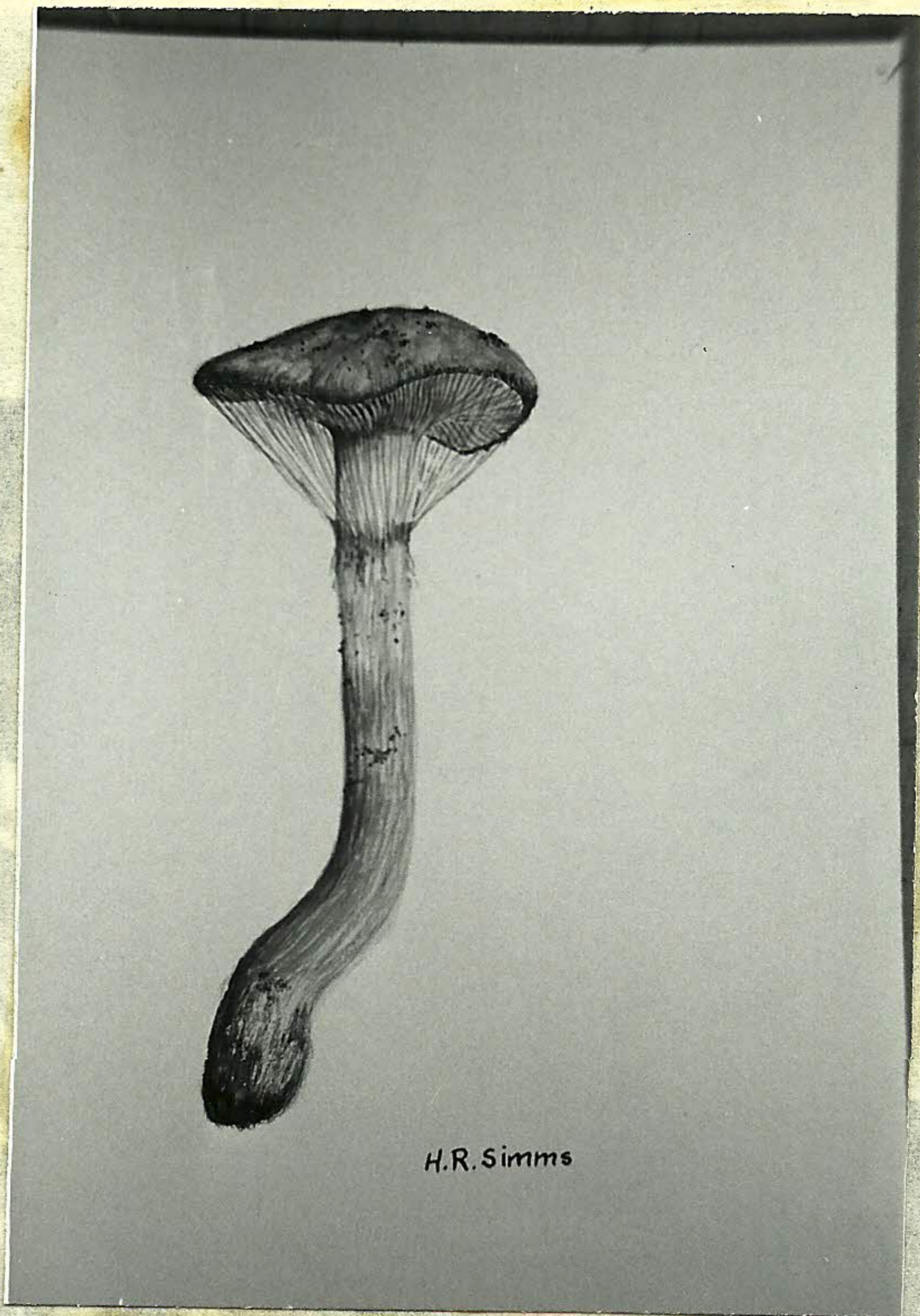


FIG. 19. Cortinarius cinnamomeus.



FIG. 20. Russula emetica.

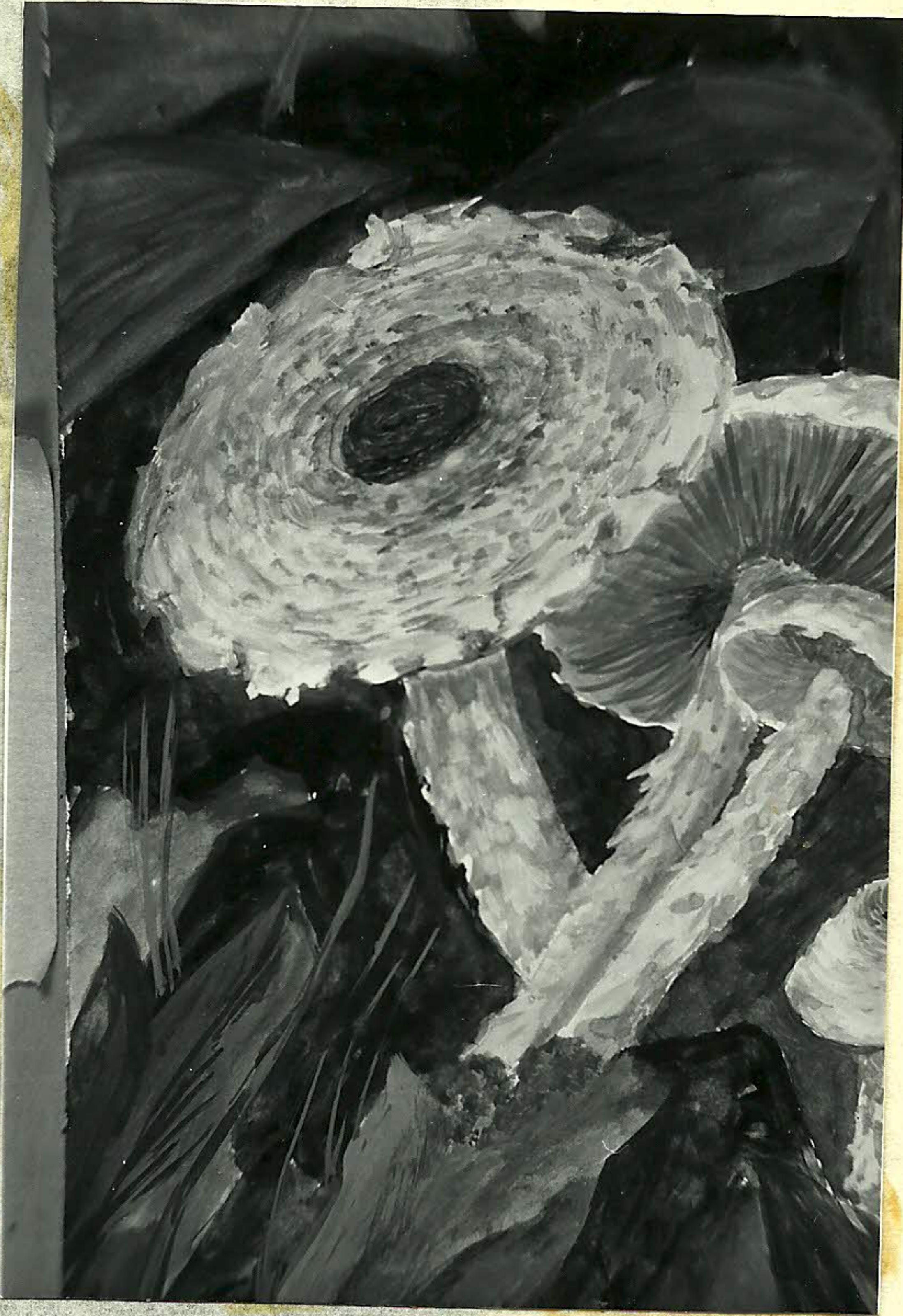


FIG. 21. Hyporhynchus conicus.

FIG. 22. Lepiota clypeolaria.

FIG. 23. Clathrus lobatus.



FIG. 23

FIG. 23. Cortinarius calyptratus.



FIG. 24. Clitocybe infundibuliformis.



FIG. 25. Xeromphalina campanella.



FIG. 26. Tricholoma flavovirens.



FIG. 27. Xerocomus chrysenteron.

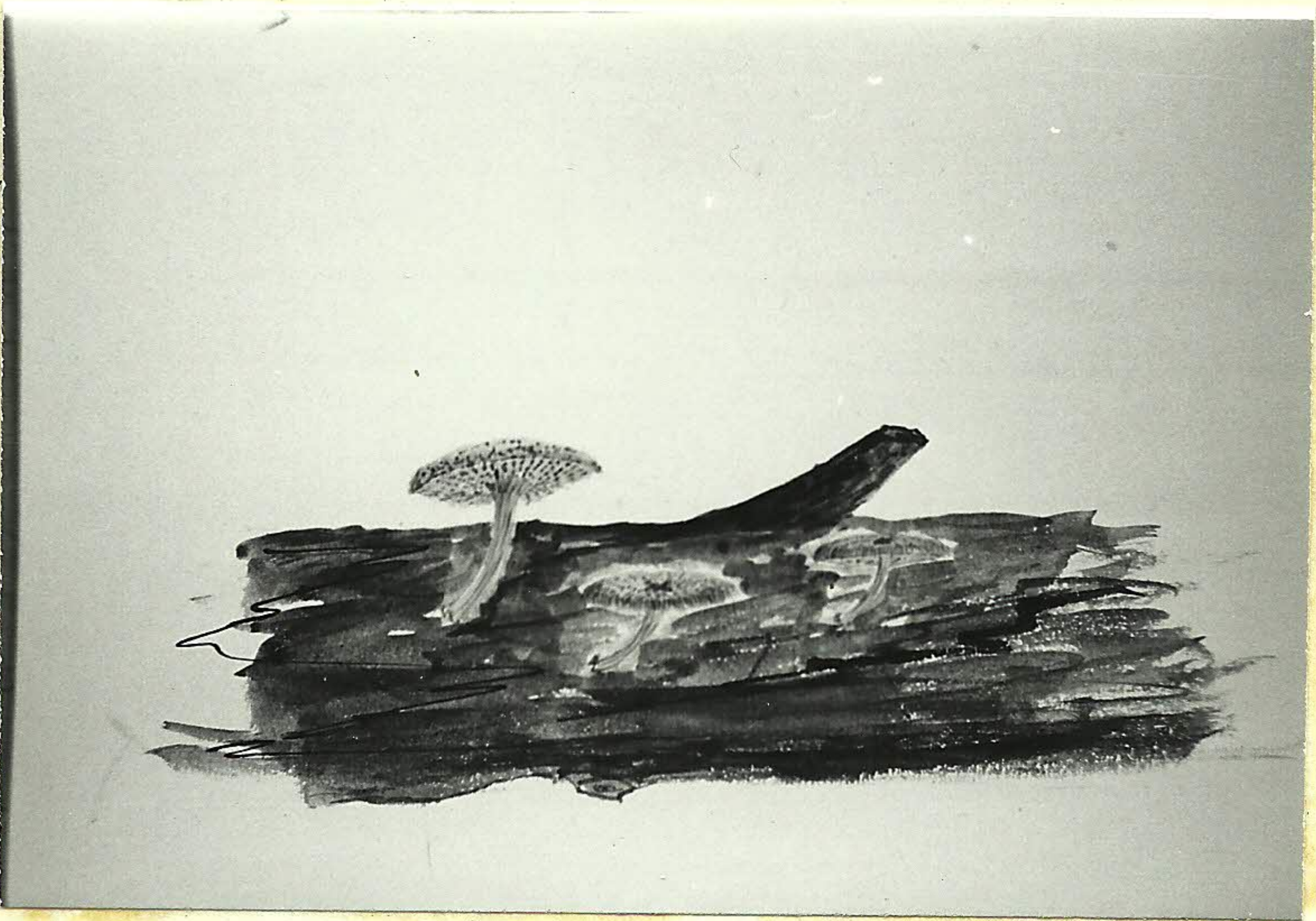


FIG. 28. Polyporus sp.

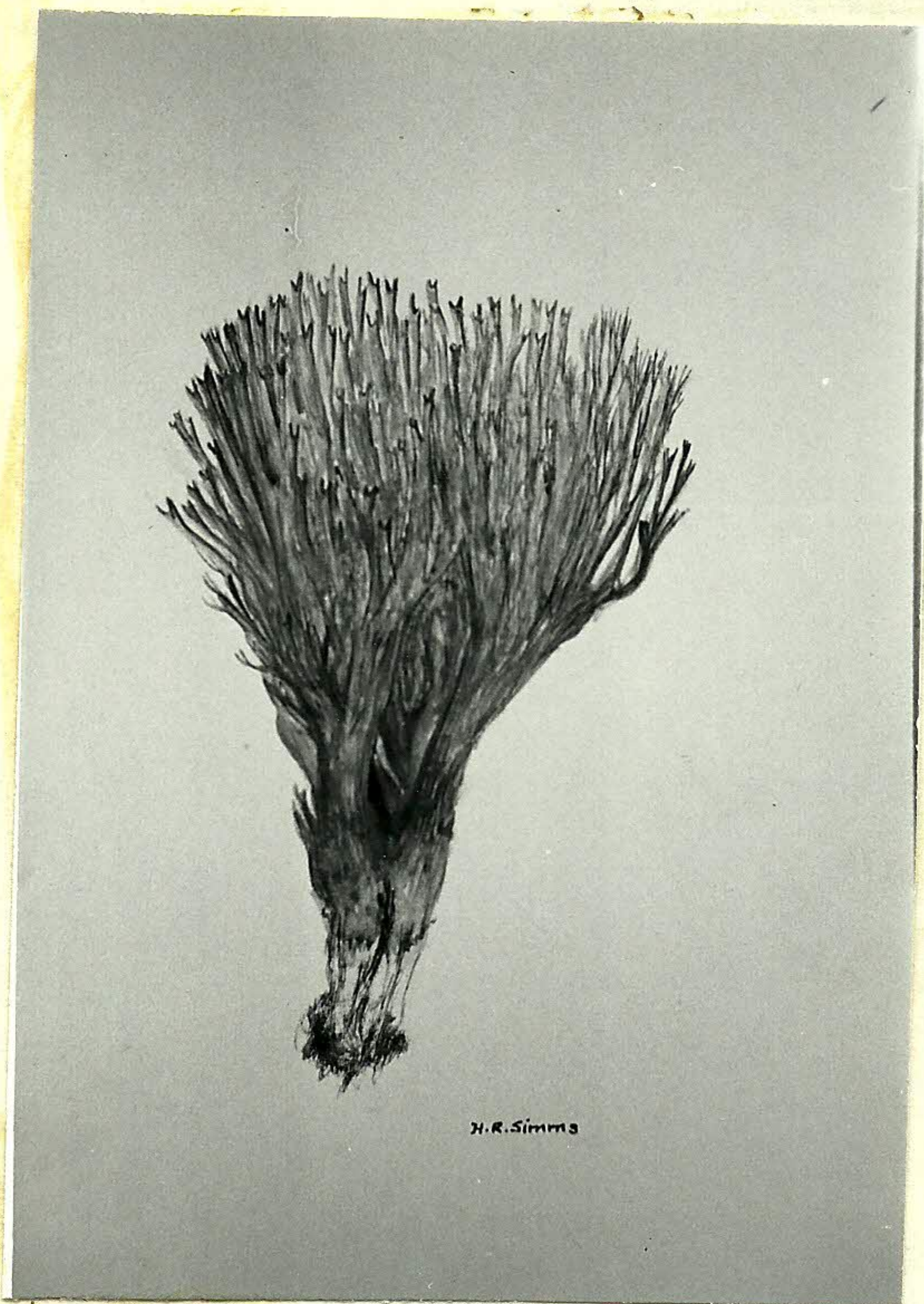


FIG. 29. Clavaria purpurea.

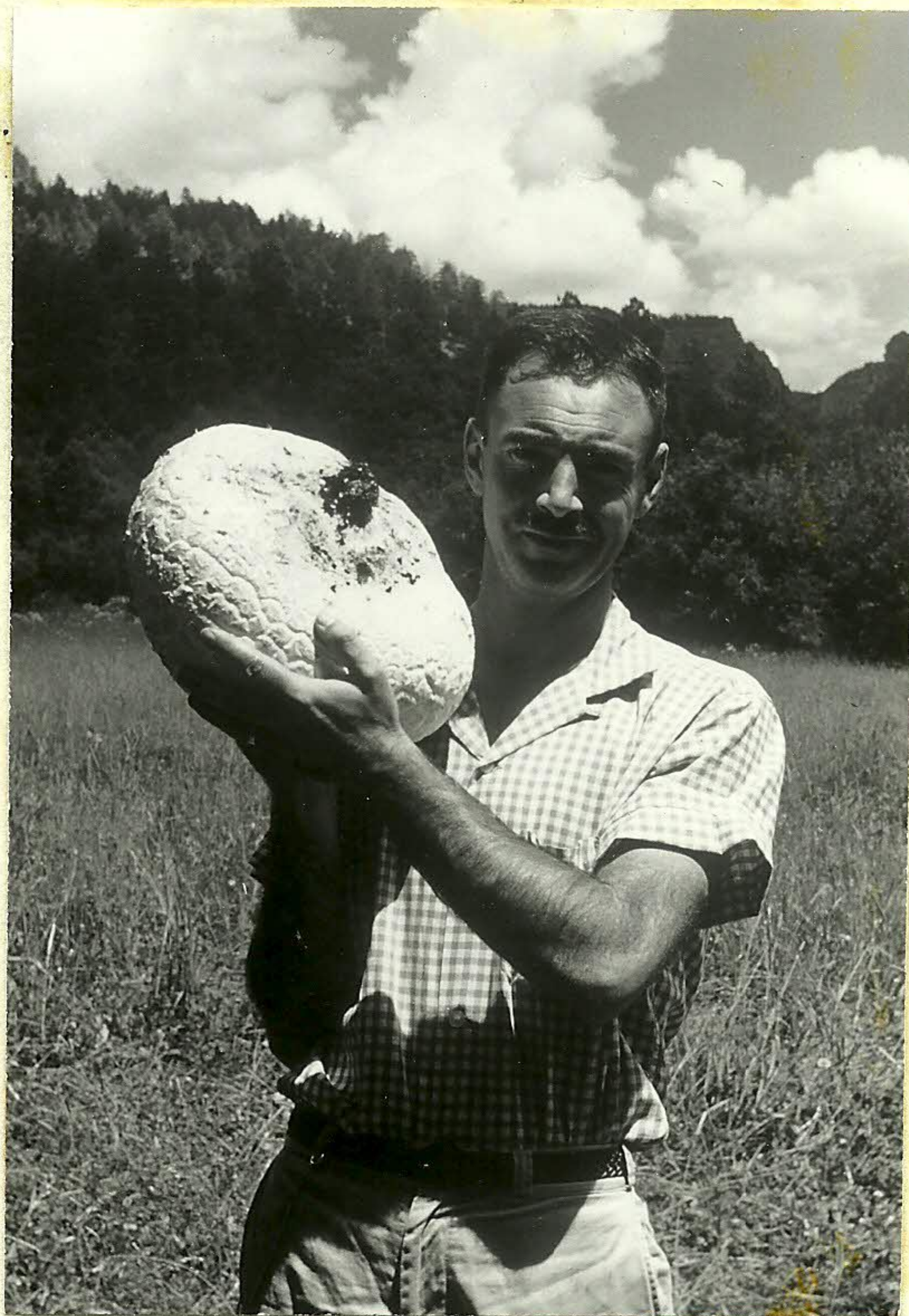


FIG. 30. Calvatia gigantea.

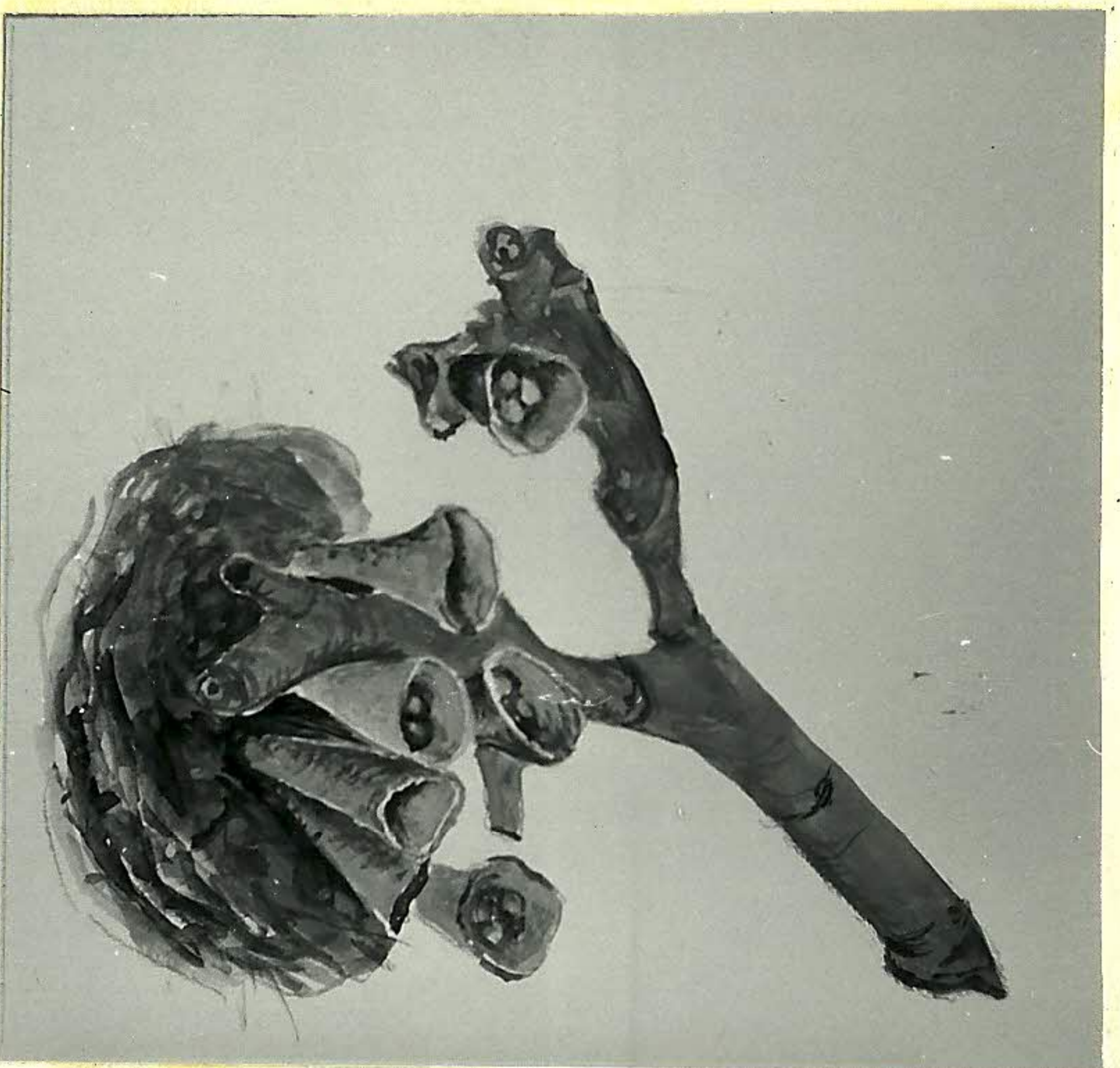


FIG. 31. *Cyathea striatula*.



FIG. 32. *Qanater* sp.



FIG. 33. Lycoperdon pyriforme.