Hallucinogenic Mushrooms

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Abstract
Methods of examining dried fragments of hallucinogenic fungi are given; a key to the preliminary identification of suspected hallucinogenic mushrooms is offered to assist those working in this field. The key depends principally on simple microscopy.

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Introduction

The hallucinogenic mushrooms belong to the Basidiomycotina, a group of larger fungi which also include the cultivated and field mushrooms (*Agaricus* spp.), and the death cap (*Amanita phalloides*), which is responsible, after eating, for many fatalities in Europe. In addition the Basidiomycotina covers the wood-rotting polypores important in forestry management, the fairy-clubs, and the hedgehog fungi and their relatives. All the fungi, be they moulds, mildews or mushrooms and toadstools, constitute a group of organisms considered by some to be lower plants (*Thallophyta*) lacking chlorophyll and deriving their food from the breakdown of complex organic substrates. Along with the bacteria the fungi play an important role in the ecosystem, releasing simple compounds from the organic fraction for eventual use by other animals and plants. During this breakdown secondary metabolites or by-products are produced, and these either may be released into the soil or medium, or may be stored within the fungus structure (thallus). Some of the compounds produced are toxic, even causing death if taken in any quantity, and some have hallucinogenic properties.

The hallucinogenic mushrooms contain sufficient quantities of psychomimetic agents for them over many centuries to have been used by man for extra-perceptual effects; some species have even been used in religious ceremonies. Far more recently hallucinogenic fungi have been used as a source of drugs and much discussion has raged over the question as to whether a criminal offence has taken place when wild hallucinogenic mushrooms have been collected and eaten. Using similar cultural techniques to those employed for the cultivation of the commercial mushroom it is now possible to grow hallucinogenic mushrooms in the home; this is a somewhat worrying extension of the overall problem.

The subject of "magic" mushrooms has featured in several, often sensational, British press accounts over the last four years and court cases implicating the possession of hallucinogenic mushrooms have often been high-lighted. With the general widespread increase in the use in Britain of these fungi, often called recreational drugs in North American literature [1], it was obvious that the time was ripe for some kind of guide to be produced. In the September-October period of 1981 well over fifty cases involving hallucinogenic mushrooms were drawn to the attention of the hospital authorities in Edinburgh and to a lesser extent to the police, at least four of them dealing with groups of participants and not simply individuals. Even more alarmingly, most of these were within the 13- to 20-year-old age bracket.

The hallucinogenic mushrooms so far recognised all belong, except for one,

to a single group within the Basidiomycotina called the agarics (Agaricales). The term agaric is the general name applied to those fungi which basically possess an umbrella-shape, consisting of a cap (or pileus) on a centrally placed stem (or stipe), and radiating plate-like structures, called gills (or lamellae) on the underside of that cap (Figure 1, A–C); "agaric" is therefore a term which covers those fungi commonly called mushrooms and toadstools. The gills bear on their surfaces the tissue which produces the basidia, those reproductive cells on which the spores develop (Figure 2, H); the fungus is spread from place to place by the spores (Figure 2, E–G).

The term agaric is necessary because the two common words "mushroom" and "toadstool" are very vague and really do not reflect their toxic or edible characters. Some fungi, which would be undoubtedly considered by many to be toadstools, are far from poisonous, and indeed are sought after in some countries as delicacies. There are also members of the genus containing the cultivated and field mushrooms which are distinctly poisonous although not fatal. Particularly dangerous agarics are those responsible for cytolytic poisoning, because liver and kidney damage, obscured by early gastroenteric symptoms, might not become apparent for several days. Only small quantities of these fungi need to be ingested to cause acute, if not fatal, poisoning. Some poisonous agarics contain thermolabile toxins, e.g. haemolytic compounds, which probably accounts for some fungi only being poisonous when eaten raw; hallucinogenic fungi are usually eaten raw.

A further group of agarics are merely gastroenteric irritants and these cause poisonings, the degree of which, as with the fungi which will induce allergic reactions, varies from person to person. Psychotropic poisoning, as the name implies, affects the central nervous system and within one to four hours after ingestion. There is little evidence that hallucinogenic mushrooms by themselves have caused death, although the resulting hallucinations may have brought about a state of mind which led to such events. Delirium may be associated with psychotropic poisoning but hospitalisation for more than 24 hours, and often less, is rarely required. Extreme symptoms have only occasionally been seen and then in patients who have taken large quantities of psychomimetic mushrooms in genuine misunderstanding for edible fungi. Finally it should be noted that fleshy fungi quickly decay and gastroenteritis and associated symtoms may result after eating species which are normally edible or hallucinogenic, but which have become diseased or parasitised, or simply are overmature. This could well happen when mushrooms are collected in polythene bags and are allowed to remain in confined spaces for relatively long periods before consumption.

Agarics traditionally have been identified after a careful recording of only field characters such as colour and texture, a method, however, which relies heavily not only on the availability of fresh material but also the presence of the entire fruit-body. In addition, many of the characters used are very subjective; colour for instance is difficult to define, and what is more important, it is difficult to convey from one worker to another what is really meant by a particular colour-name without resorting to an often expensive and sometimes inaccessible colour-chart. With the introduction of the use of the microscope in agaricology in the early twentieth century more characters were made available; microscopic structures, such as spores and sterile cells called cystidia, (Figure 2, I) were often found to be characteristic for a single species or group of species. Over the subsequent period these cells have been used in the basic classifying of agarics, and their variability or constancy has been determined.

The formulation of an International Code of Nomenclature by botanists has gone a long way to stablilise the names given to plants and its adoption has resulted in the necessity to develop techniques for critically analysing herbarium material. This examination of dried material has become a routine part of not only the flowering plant botanists' work but also that of the agari-

cologist. Although an emphasis on the fresh condition is still slavishly adhered to by some, the introduction of the use of the microscope in both the identification of fresh collections and the examination of dried material is a necessity. It is now possible in a large number of cases to be confident of an identification even to species level using dried material alone.

For example, *Amanita muscaria* and *A. pantherina* when found in the possession of miscreants are usually as fairly small dried fragments of the cap; such fragments are curled and contorted, and resemble dried, but more strongly coloured, walnuts. *Psilocybe* is usually, however, intercepted as whole fruit-bodies but recently material has been confiscated which had been ground to a coarse powder. This preparation may have been taken as snuff but probably the reason for powdering was to try and avoid detection.

It is now possible to make accurate determinations of agarics from dried material because the modern classification is based more on the structure of tissues, and differentation of the end-cells of the hyphae than on the gross morphology. Techniques are therefore described herein which will allow fragments as well as whole fruit-bodies to be examined and the species involved determined.

Techniques in identification

The accurate determination of a fragment of agaric needs no expensive equipment except the possession of a student microscope equipped with an eye-piece graticule, and also preferably fitted with an oil-immersion objective. A supply of slides and coverslips and razor blades is needed along with a dissecting needle, a fine camel hair paint-brush, and a pencil with an eraser attached to the end. Two reagents used are a 10% aqueous solution of ammonium hydroxide (clear household ammonia will do) and a solution of 1·5g iodine in 100ml of an aqueous mixture containing 5g of potassium iodide and 100g of chloral hydrate (Lugol's iodine, or similar reagents containing iodine if available will do if the above mixture, known as Melzer's reagent, is not prepared). The razor blades can be replaced by a "cut throat razor" if so desired but single-edged blades are ideal provided a new, clean edge is always used. The blades are employed to cut sections of the agaric under study, the needle and/or brush for transferring sections from one slide to another and the eraser for gently squashing the sections so formed.

The 10% ammoniacal solution acts as a mild clearing agent and has a contrasting refractive index. It also acts as a swelling agent and allows the tissues to return to the state they were in when the agaric was fresh. The Melzer's reagent when placed on tissue or spores may turn them blue or bluish-black, purple-brown, or golden to yellowish; the colour change is characteristic for the fungus under study.

The characters used in the key below are the spores, the cystidia (sterile cells in the sterile and fertile portions of the fruit-body), the basic structure of the outer layer of the cap and basic structure of the tissue between the faces of the gills; when available gross-characters of the dried fruit-body are useful. The colour and size of the spores are essential for a definitive determination and their reaction, if colourless, with the solution containing iodine detailed above; the same solution can be used for treating the tissues of the fruit-body.

Three mounts are required to identify a hallucinogenic agaric: that of a complete or partial gill, that of a "scalp" of the cap and that of a section longitudinally cut through the gill: see Figure 1.

Cut the gill (G) from the fruit-body (F) and mount face-down directly in the 10% ammoniacal solution; allow to stand for a minute or so in order for the tissues to expand before covering with a glass cover-slip. On gently tapping the cover-slip with the rubber-tipped pencil the cells will begin to separate from each other (H–I). DO NOT crush the mount.

A "scalp" is a thin sliver (D & E) from the cap of the fruit-body (B & C);

this should be placed in a drop of the 10% ammonia on a slide. Proceed as before but do not tap with the pencil as the section will be thin enough around the edge to determine the necessary information. Care must be taken not to reverse the section when transferring the "scalp" to the mountant, either by turning the needle, or by allowing the surface tension of the liquid to pull the section upside down.

The "scalp" need only be at most as big as a pin-head in diameter although the gill fragment can be anything from 1 to 3mm in size making sure that the natural edge to the gill is always included. If the edge cannot be easily seen, or has been damaged in any way, examination of the entire sample under the dissecting microscope, either in the dry condition or immersed in 10% ammonia, will reveal an intact gill. The edge will usually be revealed as a white line in the dried material, or as a pale line in the reconstituted material.

The gill-section should be cut vertically down from the outermost layer of the cap through the reproductive tissue below, as shown in Figure 1, F to J. This will ensure that the gills remain attached to the cap-flesh so easing examination (K). A reasonably thin section should be aimed at; 0·1mm thick sections of dried material give admirable sections when wet-mounted. Mount the section first in water and leave for a minute or so for swelling to take place, then mount in Melzer's reagent and cover with a glass-slip. Press lightly on the cover-slip with the rubber-ended pencil whilst, in addition, slightly rotating the eraser; this will separate the tissues (L).

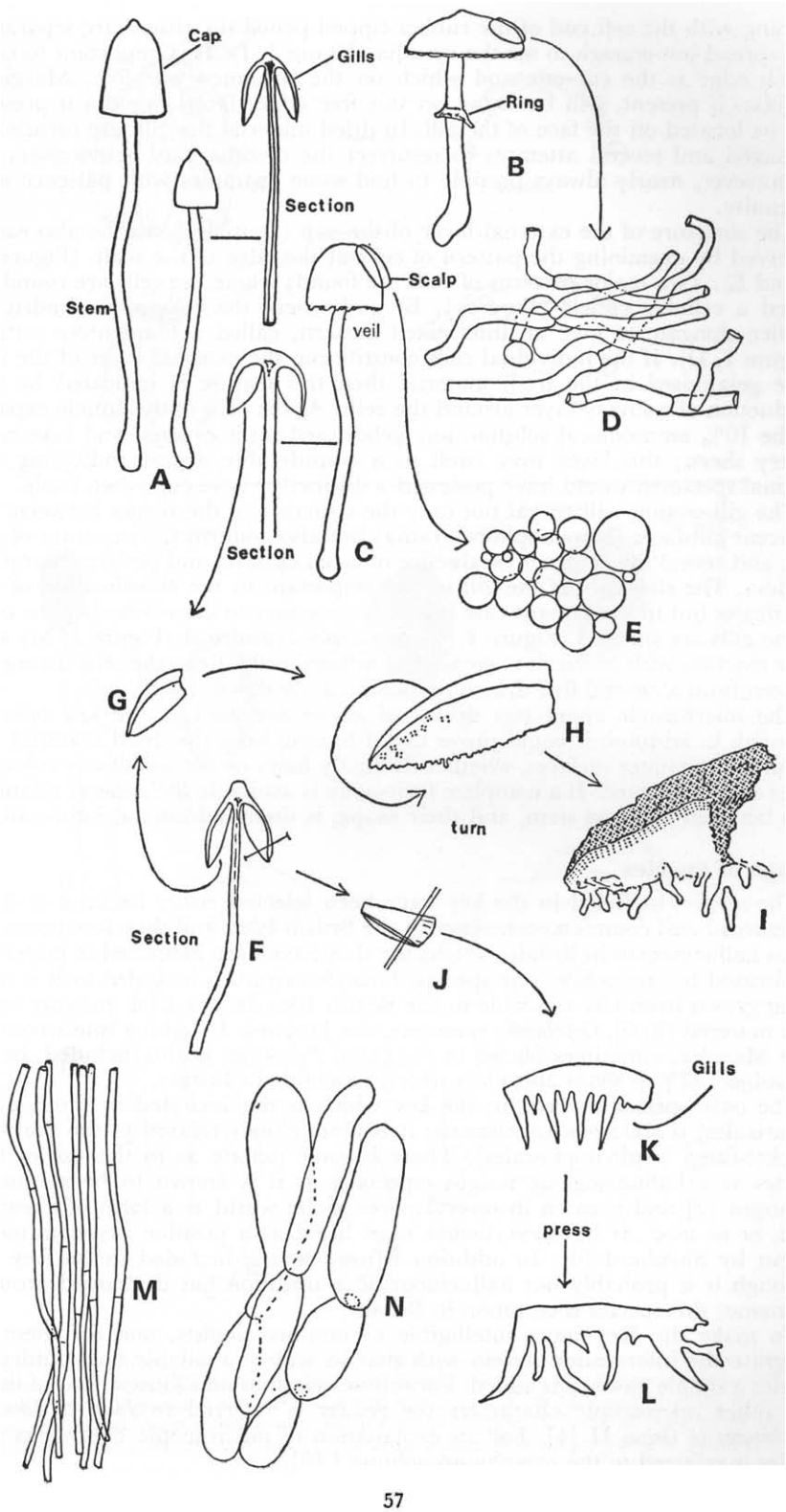
The techniques for sectioning both dried and fresh agarics are not covered in texts on general mycology but they have been dealt with at length in other publications and can be followed by those wishing to do so [2–4].

Characters of identification

In the mount of the gill-fragment the colour and size of the spores may be determined as they will be found floating in the liquid mountant. In fact spores free of tissue can be obtained very easily from the sample simply by washing the gills in the 10% ammonia. This can be achieved by lifting up one edge of the cover-slip with the dissecting needle and jerking it up and down. The spore-dimensions are expressed as the ranges of length of the spore (from apex to base, Figure 2, G) and width of the spore in face-view and in side-view (Figure 2, F and G); often spores are slightly compressed in one view. The base has a small appendage called the apiculus or hilar appendix (Figure 2, F) and this is the remnant of its attachment to the basidium. At the opposite end of the spore there may be what appears to be a hole (Figure 2, E); this is called the germ-pore, and its presence or absence is necessary in identification. The germ-pore in some agarics is sometimes difficult to see but if present it is obvious in the hallucinogenic agarics. The colour of the spores and their general shape are important characters. If the spores are colourless it is essential to know their reaction with iodine; if they become blue, bluish-grey or blue-black in Melzer's reagent they are amyloid, and if unchanged or only become slightly yellowish they are termed inamyloid or non-amyloid. The last reaction is easy to see but in the former, if the microscope light is too high the blueness when present may be "burnt out"; use the diaphragm of the microscope condenser to ensure the reaction is not masked.

The sterile cells or cystidia most characteristic for the species are to be found on the gill (Figure 2, I); their dimension, and shape are diagnostic (Figures 3 and 4). The cystidia when present in the hallucinogenic agarics are easily observed although in other fungi they may be concealed. By slightly

Figure 1. (Facing) Sketches and sections of fruit-bodies of agarics: A. *Psilocybe semilanceata*; B. *P. cubensis*; C. *Panaeolus sphinctrinus*; D. Filamentous "cuticle"; E. Cellular "cuticle"; F. Section of *P. semilanceata* showing detached gill G; H. Gill G magnified; I. H after squashing to release marginal cystidia; J. Wedge of tissue from F; Cut as shown to give K; L. Rotated section to separate gills; M. Filamentous cells in gill-trama; N. Swollen cells in gill-trama.


Cap
Gills
Section
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A
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N
Gills
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press
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tapping with the soft end of the rubber-tipped pencil the tissues are separated and spread out enough to see the cystidia (Figure 1, I). It is important to note which edge is the cut one and which on the specimen was free. Marginal cystidia, if present, will be found on this free edge; facial cystidia if present can be located on the face of the gill. In dried material the gills are invariably damaged and several attempts to resurrect the cystidia may be necessary. It is, however, nearly always possible to find some examples with patience and ingenuity.

The structure of the external layer of the cap ("cuticle") can be also easily observed by examining the pattern of cells at the edge of the scalp (Figure 1, D and E). Two major patterns of cells are found; where the cells are rounded, called a cellular cuticle (Figure 1, E) and where the cells are cylindric to swollen-elongate to give an intermixed pattern, called a filamentous cuticle (Figure 1, D). If the individual cells constituting the external layer of the cap were gelatinised in the fresh material then this feature is indicated by the production of a silvery layer around the cells. As the cells of the cuticle expand in the 10% ammoniacal solution any gelatinised surfaces swell and take on a silvery sheen; this layer may swell to a considerable degree indicating the original specimen would have possessed a distinctly viscid cap when fresh.

The gill-section will reveal not only the structure of the tissues between the adjacent gill-faces (hymenophoral trama) but also confirm the structure of the cap, and reveal the presence or absence of facial cystidia and perhaps marginal cystidia. The structure of the gill is very important in the classification of the Agaricales but in the present case it is only necessary to know whether the cells of the gills are inflated (Figure 1, N) or simply cylindrical (Figure 1, M) and their reaction with Melzer's reagent. The inflated cells often take on a divergent pattern from a central line drawn perpendicularly down the gill.

The microscopic characters described above are used in the key offered, although in addition it could prove useful to note from the dried material the texture of the outer surfaces, whether distinctly hairy or not and if any colouration can be observed. If a complete fruit-body is available the general relationship between cap and stem, and their shape, is useful additional information.

Range of species

The species included in the key have been selected either because of their widespread and common occurrence in the British Isles, and therefore potential use as hallucinogens in Britain, or because they have been identified in materials confiscated by the police; one species, *Psilocybe cubensis* is included as it is now being grown from kits available in the British Isles designed for growing one's own material [5, 6]. *Copelandia cyanescens*, the Japanese Laughing mushroom or Blue Meanies, sometimes placed in the genus *Panaeolus*, is also included, being the subject of pop songs and films widely available in Britain.

The only species covered in the key which is not included in the agarics (Agaricales) is *Schizophyllum commune*; it is more closely related to the pore- or bracket-fungi (Aphyllophorales). There is some debate as to the use of this species as a hallucinogenic fungus especially as it is known to be a human pathogen [7] and is eaten in several parts of the world as a form of chewing gum, or as food. It has nevertheless been listed as a possible psychomimetic fungus by Shepherd [8]. In addition *Mycena pura* is included in the key for although it is probably not hallucinogenic a tradition has developed around the name; this species is common in Britain.

To make the Key more intelligible to non-mycologists, and for them to integrate the information herein with that in widely available field-guides to agarics a simple glossary is added. For full descriptions and illustrations of these and other microscopic characters the reader is referred to *How to Identify Mushrooms to Genus* II [4]. For an explanation of macroscopic characters the reader is referred to the companion volume I [9].

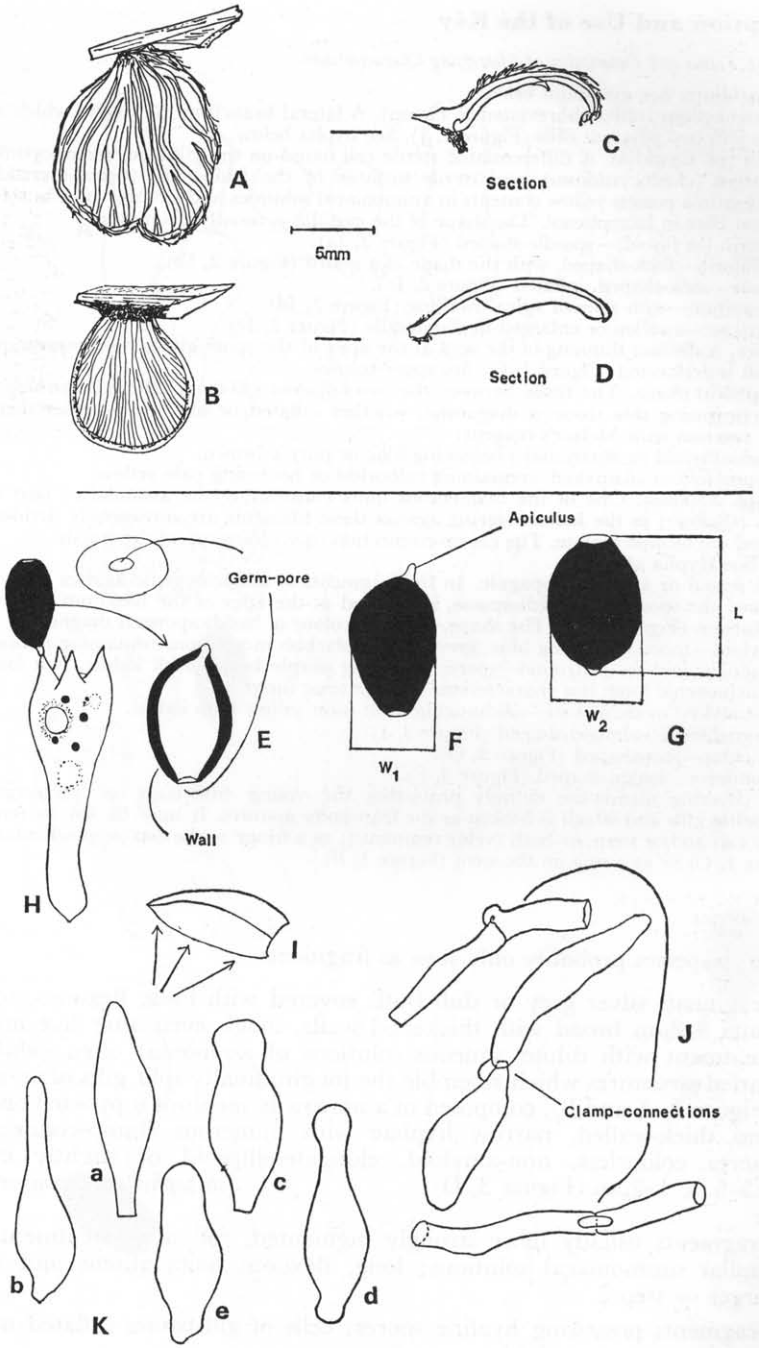

Figure 2. Sketch and section of fruit-body of *Schizophyllum commune* showing split-gills (A & C), compared with agaric *Crepidotus variabilis* showing true gills (B & D); E. Spore of *Psilocybe cubensis* showing thick, pigmented wall, apiculus and germ-pore; F. & G. Spore showing dimensions measured; H. Basidium showing asymmetrically placed spore; I. Location of marginal cystidia; J. Clamp-connections; K. Cystidia (a. fusiform, b. lageniform, c. saccate, d. subcapitate and e. ventricose).

Description and Use of the Key

Glossary of Terms and Description of Identifying Characteristics

Chrysocystidium. See cystidium below.

Clamp-connections (often abbreviated to clamp). A lateral branch to the hypha which arches over to join two adjacent cells (Figure 2, J). See hypha below.

Cystidium (pl. Cystidia). A differentiated sterile cell found on the gill-face (pleurocystidium), gill-margin (cheilocystidium), and sterile surfaces of the fruit-body (dermatocystidium). Chrysocystidia possess yellow contents in ammoniacal solutions and strongly blue in solutions of cotton blue in lactophenol. The shape of the cystidia is usually diagnostic:
fusiform (or fusoid)—spindle-shaped (Figure 2, Ia).
lageniform—flask-shaped, with the shape of a gourd (Figure 2, Ib).
saccate—sack-shaped, inflated (Figure 2, Ic).
subcapitate—with a small apical swelling (Figure 2, Id).
ventricose—swollen or enlarged in the middle (Figure 2, Ie).

Germ-pore. A distinct thinning of the wall at the apex of the spore giving the impression that the wall is perforated (Figure 2, E). See spore below.

Hymenophoral trama. The tissue between the two adjacent gill-faces. The relative size of the cells constituting this tissue is diagnostic, whether inflated or not and whether there is a colour reaction with Melzer's reagent:
pseudoamyloid or dextrinoid—becoming lilac or purple-brown.
non-amyloid or inamyloid—remaining colourless or becoming pale yellow.

Hypha (pl. hyphae). One of the filamentous units constituting the assimilative part of the fungus (thallus); in the hallucinogenic agarics these filaments are transversely divided into cells and are termed septate. The clamp-connection (q.v.) joins two of these cells.

Septate. See Hypha above.

Spore. A sexual or asexual propagule. In the fragments of hallucinogenic agarics likely to be examined the spores are basidiospores, ie. formed at the apex of the basidium after sexual reproduction (Figure 2, H). The shape, size and colour of basidiospores is diagnostic:
Amyloid—spores becoming blue, grey-blue or blackish in solutions containing iodine.
pseudoamyloid or dextrinoid—spores becoming purple brown with iodine. Not found in hallucinogenic fungi but characteristic of some toxic fungi.
non-amyloid or inamyloid—unchanging or at most yellow with iodine.
amygdaliform—almond-shaped (Figure 3, I).
lenticular—lens-shaped (Figure 3, O).
limoniform—lemon-shaped (Figure 3, F).

Veil. A covering membrane entirely protecting the young fruit-body or protecting the developing gills and which is broken as the fruit-body matures. It may be left as remnants on the cap and/or stem, or both (velar remnants), as a fringe to the cap (appendiculate veil) (Figure 1, C) or as a ring on the stem (Figure 1, B).

Key to Species

* Large species probably only seen as fragments.

(1) Fragments silver grey or dull buff, covered with long, flexuous, septate hairs 3–8μm broad with thickened walls, tough even after five minutes treatment with dilute aqueous solutions of ammonia; often exhibiting curled structures which resemble the longitudinally split gills of an agaric (Figure 2, A and B), composed of a narrow hymenium supported on thin- and thick-walled, narrow hyphae with numerous clamp-connections; spores colourless, non-amyloid, elongate-ellipsoid or slightly curved 3·5–5 × 1–2μm (Figure 3, D). *Schizophyllum commune* Fries

or

Fragments usually more strongly pigmented, soft after treatment with similar ammoniacal solutions; long, flexuous hairs absent and spores larger → step 2.

(2) Fragments possessing hyaline spores; cells of gill-tissues inflated or not, pseudo- or non-amyloid → step 3.

or

Fragments possessing distinctly pigmented spores in some shade of brown or black; cells of gill-tissues non-inflated, non-amyloid → step 5.

(3) Spores blueing in Melzer's reagent (amyloid), subcylindric to narrowly ellipsoid, 6–9 (–10) × 3–3·5μm; fragments of gill at their margin possessing saccate or ventricose cells with elongate neck and obtuse apex;

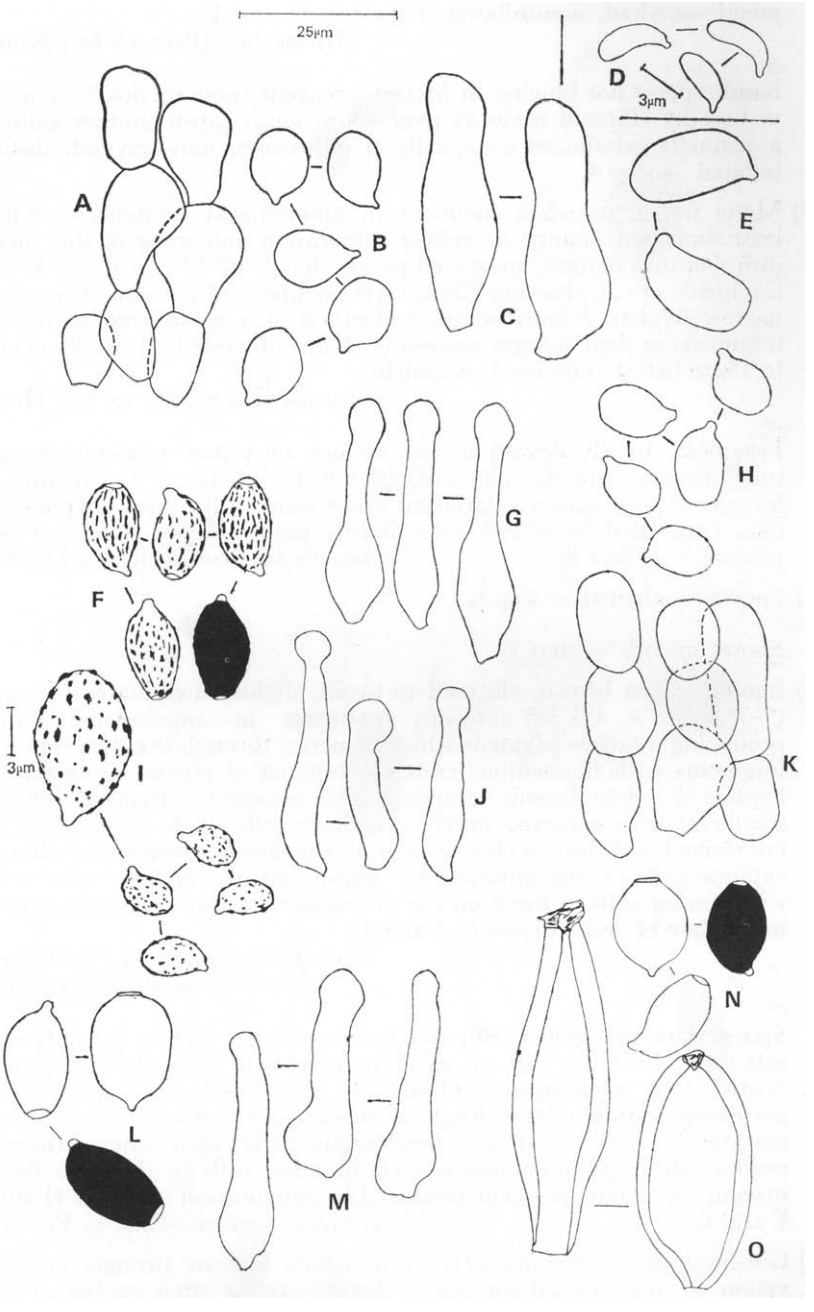

Figure 3. A; C; G; J; K; M; O, Marginal cystidia; B; D; E; F; H; I; L; N, Spores. A & B. *Amanita muscaria*; C & E. *Mycena pura*; D. *Schizophyllum commune*; F & G. *Panaeolina foenisecii*. H & K. *Amanita pantherina*; I & J. *Gymnopilus junonius*; L & M. *Panaeolus sphinctrinus*; N & O. *Copelandia cyanescens*. Magnification as indicated or where greater the appropriate increase is given.

cap-fragments showing no outer gelatinized zone; cells of gill-tissues pseudo-amyloid, non-inflated (Figure 3, C and E).

Mycena pura (Pers. ex Fr.) Kummer

or

Basidiospores not blueing in Melzer's reagent (non-amyloid), subglobose to broadly ellipsoid majority over 10μm long; cap-fragments exhibiting a distinctly gelatinized zone, cells of gill-tissues, non-amyloid, distinctly inflated → step 4.

(4) Many fragments when mounted in ammoniacal solutions showing at least some red, orange or yellow colouration and some of this pigment diffusing into mount; spores ellipsoid, (8·5–) 10–12 × (6–) 7·5–10μm; fragments of cap showing distinct yellow line under a zone composed of narrow hyphae 2–5μm broad, embedded in a gelatinized matrix; gill-fragments at their margin possessing chains of irregularly swollen cells up to 15μm broad (Figures 3, A and B).

Amanita muscaria (L. ex Fr.) Hooker*

or

Fragments totally devoid of red, orange or yellow colouration; spores subglobose to broadly ellipsoid, (8–) 9–11·5 (–12) × 6·5–8·5μm; cap-fragments possessing a gelatinized outer zone with narrow hyphae up to 6μm embedded in it and only slightly pigmented in shades of brown (Figure 3, H and K). *Amanita pantherina* (DC. ex Fr.) Secr.*

(5) Spores roughened → step 6.

or

Spores smooth → step 7.

(6) Spores golden brown, ellipsoid to ovoid, slightly inequilateral in profile (7–) 8–10 × 4·5–5·5 (–6)μm; fragments in ammoniacal solutions producing a yellow pigment which disperses through the mountant; cap-fragments with filamentous cuticle composed of repent, non-gelatinized hyphae 4·5–9μm broad, terminating in brownish encrusted cells; gill-fragments with scattered sterile, ventricose cells 20–30 × 6–7·5μm often intermixed with brown clavate cells on the face and ventricose often subcapitate cells on the gill-margin; stem-fragments on their outer surface with similar cells to those on the gill-margin; clamp-connections present on hyphae of flesh (Figure 3, I and J).

Gymnopilus junonius (Fr.) P.D. Orton*
(= *G. spectabilis* (Fr.) Singer)

or

Spores dark red-brown, ellipsoid to limoniform, slightly inequilateral in side view, 13–17 × 7–9μm; cap-fragments with non-gelatinized cellular "cuticle" of sphaeropedunculate units 20–50μm broad; gill-fragments possessing variable lageniform to subcapitate sterile cells at the gill-margin, 35–55 × 7.5–10μm; stem-fragments on their outer surface with similar, although often shorter and broader, cells to those on the gill-margin; no yellow pigment produced in ammoniacal solutions (Figure 3, F and G). *Panaeolina foenisecii* (Pers. ex Fr.) Maire

(7) Gill-fragments possessing sterile cells which become strongly pigmented yellow in ammoniacal solutions (chrysocystidia) often on both gill-face and margin but usually best seen on the former after washing the gill (Figure 4, A and G) *Stropharia* spp.

or

Gill-fragments lacking evidence of chrysocystidia → step 8.

(8) Spores limoniform with broad germ-pore visible at one end (apex) (Figure 2, E) in both face- and side-views; cap-fragments with non-gelatinized "cellular" cuticle. Gill-fragments dark black or grey-black in

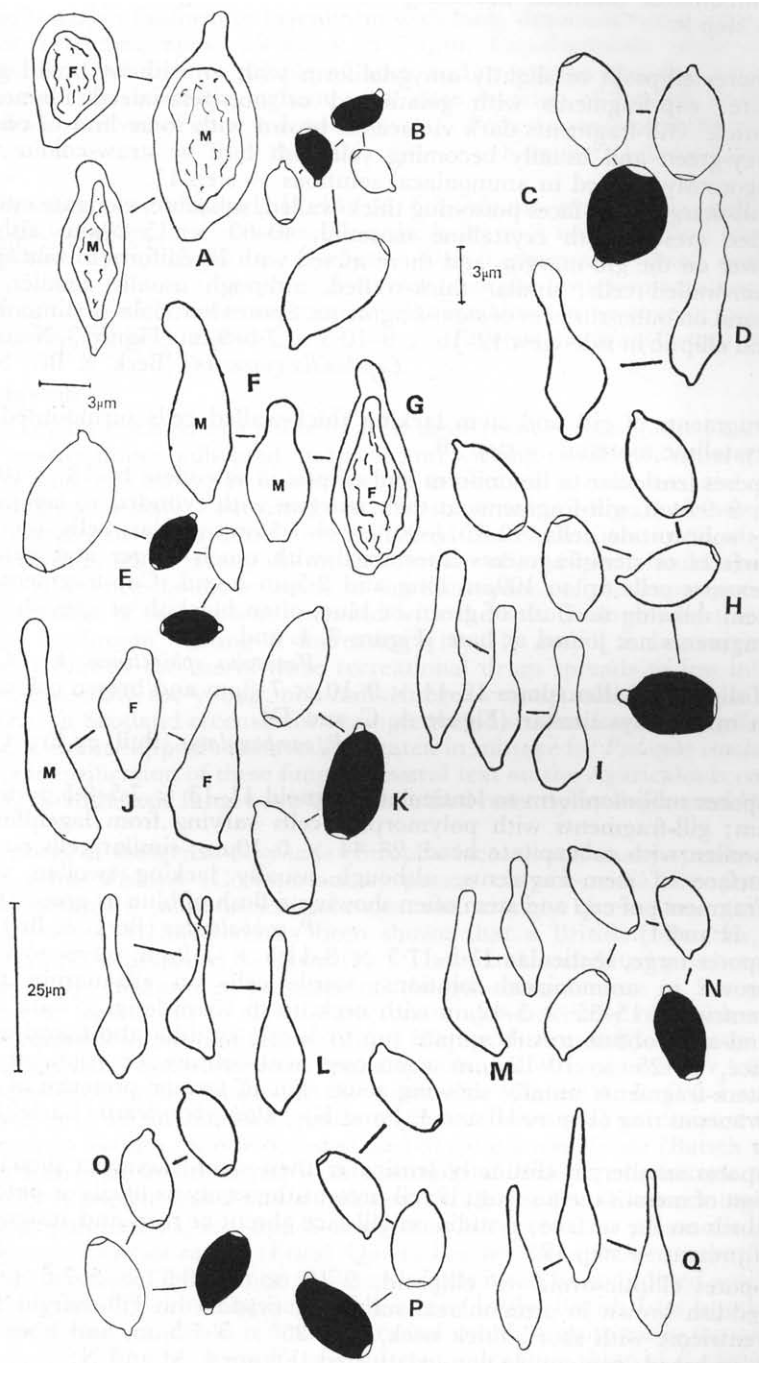

Figure 4. A; D; F; G; I; J; L; M & Q, Cystidia are marginal (M) unless otherwise stated (facial F): B; C; E; H; K; N; O; P, Spores. A & B. *Stropharia cyanea*; C & D. *Panaeolus campanulatus*; E, F & G. *Stropharia aeruginosa*; H & I. *Panaeolus subbalteatus*; J & K. *Psilocybe cubensis*; L & O. *P. semilanceata*; M & N. *P. cyanescens*; P & Q. *P. fimetaria*.

ammoniacal solutions becoming whitish when vigorously washed → step 9.

or

Spores ellipsoid or slightly amygdaliform with or without broad germ-pore; cap-fragments with gelatinized or non-gelatinized filamentous cuticle. Gill-fragments dark violaceous brown with some hint of olive or grey-green and usually becoming yellowish buff or straw-colour when vigorously washed in ammoniacal solutions → step 11.

(9) Gill-margin and -faces possessing thick-walled, subacute, elongate cystidia, often crested with crystalline material, 40–60 × 15–20μm, although fewer on the gill-margin, and there mixed with lageniform to subcapitate thin-walled cells; similar thick-walled, although usually smaller, cells found on outer surfaces of stem-fragments. Spores lenticular to limoniform, and elliptic in side-view 12–16 × 9–10·5 × 7·5–9μm (Figure 3, N and O).

Copelandia cyanescens (Berk. & Br.) Singer

or

Fragments of gill and stem lacking thick-walled cells surmounted with crystalline material → step 10.

(10) Spores lenticular to limoniform and elliptic in side-view 14–18 × 10–11·5 × 9–9·5μm; gill-fragments at their margins with cylindric to lageniform, ± subcapitate cells, 40–75 (–90) × 4–7·5μm; similar cells on outer surfaces of stem-fragments intermixed with much longer and narrower flexuous cells up to 100μm long and 2·5μm broad. Cap-fragments and stem showing no flush of green or blue, often blackish or greyish; stem-fragments not joined at base (Figure 3, L and M).

Panaeolus sphinctrinus (Fr.) Quélet

If slightly smaller spores 12–14 × 9–10 × 7–8μm and brown colours but in other ways similar (Figure 4, C and D).

P. campanulatus (Bull. ex Fr.) Quélet

or

Spores sublimoniform to lenticulate-ellipsoid 11–13 × 7·5–8·5 × 6·5–7·5 μm; gill-fragments with polymorphic cells varying from lageniform to swollen with subcapitate head, 28–44 × 5–10μm; similar cells on outer surface of stem-fragments, although usually lacking swollen venter. Fragments of cap and stem often showing a flush of blue or green (Figure 4, H and I). *P. subbalteatus* (Berk. & Br.) Sacc.

(11) Spores large, lenticular 11·5–17·5 × 8–11·5 × 7–9μm, olive- to yellow-brown in ammoniacal solutions; sterile cells on gill-margin fusoid-ventricose, 15–35 × 5–12μm with neck up to 15μm long × 5μm broad, and apex obtuse to subcapitate (up to 5μm); cystidia also found on gill-face, 15–25 × 10–12·5μm ventricose with obtuse or rounded apex. Stem-fragments usually showing some sign of former presence of membraneous ring (Figure 1B and 4, J and K). *Psilocybe cubensis* (Earle) Singer

or

Spores smaller, if distinctly lenticular then stem-fragments showing no sign of membraneous ring; if veil present then only as fibrils or patches of fibrils on the surface; cystidia on gill-face absent or rare and insignificant if present → step 12.

(12) Spores elliptic-ovoid to ellipsoid, 9–12 × 5·5–8·5 × 5–7·5 (–8)μm, reddish brown in ammoniacal solutions; cystidia on gill-margin fusoid-ventricose with short, thick neck, 12·5–25 × 5–7·5μm, and apex up to 4μm broad; cap-cuticle non-gelatinized (Figure 4, M and N).

Psilocybe cyanescens Wakefield

or

Spores ellipsoid, narrower and usually longer, purplish brown to fuscous brown in ammoniacal solutions; cap-cuticle slightly gelatinized → step 13.

(13) Basidiospores ellipsoid to elliptic-ovoid, 12–14 × 7–8·5μm; cystidia on gill-margin fusiform to lageniform with long, drawn-out neck with obtuse or branched apex, 25–35 × 5–7·5μm. Cap-fragments often showing evidence of distinct pimple at apex and/or margin clasping stem-apex: stem silky striate throughout with loose covering of hyphae from well-developed veil (Figure 4, L and O). *Psilocybe semilanceata* (Fr. ex Secr.) Kummer (Liberty Cap)

or

Basidiospores ellipsoid 11–14 × 6·5–7·5μm; cystidia on gill-margin pointed lageniform or resembling the hairs on a nettle (*Urtica*) except for obtuse apex, 15–30 × 4–7·5μm. Cap-fragments in dried and fresh material convex to expanded convex, margin not clasping stem; stem-fragments with some evidence of velar remains as ring-zone or patches of fibrils (Figure 4, P and Q). *Psilocybe fimetaria* (Orton) Watling

Discussion

The key is presented as a guide to assist those recovering suspected hallucinogenic agarics from confiscated materials and wishing to identify dried material quickly and efficiently; it is not meant to replace a complete and critical analysis by a specialist, but simply to offer some assistance to those attempting a preliminary investigation. It is emphasised that with such a difficult group as the agarics, when in any doubt the opinion of an expert should always be sought. Reference should be made to the illustrations of the important microscopic features of each species included with the key. Undoubtedly the cult of "magic mushroom" eating is increasing [10, 11] and it is becoming more apparent that as the use of these recreational drugs spreads to less informed people, especially the young, non-hallucinogenic and possibly toxic taxa will be eaten. In Scotland recently for example the poisonous *Inocybe geophylla* (Sow. ex Fr.) Kummer appears to have been eaten in mistake for *Psilocybe semilanceata*. For the identification of these fungi a general text on the Agaricales is required [12–14]. British toxic fungi have been described recently by Pegler and Watling [15].

Members of the genus *Stropharia* (Strophariaceae) and many species placed in the genus *Pholiota* (Cortinariaceae) possess chrysocystidia, i.e. possessing yellow contents in ammoniacal solutions and strongly blueing in cotton blue in lactophenol. It has recently been shown that a British collection of the common and widespread *S. cyanea* (Fr.) Tuomikoski exhibited psychomimetic activity [16]; this species possesses on the gill-margin more or less pointed fusiform or lageniform to clavate-mucronate cystidia many of which contain yellow contents in ammoniacal solutions (Figure 4, A and B). *S. cyanea* in this way differs from the widespread similarly coloured *S. aeruginosa* (Fr.) Quélet, the latter lacking the marginal chrysocystidia (Figure 4, E–G). Immature fruit-bodies of an unidentified species of *Pholiota* have been confiscated from a miscreant in Britain on one occasion and *Stropharia semiglobata* (Batsch ex Fr.) Quélet has been found mixed with a sample of *Psilocybe semilanceata* of wild origin. It is known that *Pholiota squarrosa* (Müll. ex. Fr.) Kummer can cause blushing, palpitations, etc. and *S. semiglobata* is reported as poisonous [17].

Although *Psilocybe callosa* (Fries) Quélet has not been shown to be psychomimetic, because of its closeness to *P. semilanceata* it can be considered potentially hallucinogenic. The distribution of this species in the British Isles is unknown, although there is no doubt it does occur, and could be quite easily mistaken for *P. semilanceata*. The spores of *P. callosa* are broader than those of *P. semilanceata* (10–12 × 6–8μm) and the cap becomes umbonate-convex to gibbous, unlike *P. semilanceata* which has the characteristic "liberty helmet" shape.

In North America collections of *Conocybe cyanopus* (Atk.) Kühn. have been shown to contain psilocybin [18]. This fungus, characterised by smooth, golden brown, thick-walled spores with an apical germ-pore has only been

found once in the British Isles. The base of the stem stains bluish green.

As indicated earlier the key covers those hallucinogenic mushrooms of which the author has had personal experience and which, except for one, occur in the British Isles. *Psilocybe cubensis* is not native to Britain but has been intercepted by police in the recent past. The key therefore does not take into consideration species which have been used in North America, ie. *Psilocybe stuntzii* Guzmán & Ott which could conceivably become a problem in the future with the set-up of any illicit trade between countries. The key is also rather conservative in that lack of knowledge inhibits our ability to decide which species of agaric in our native flora are potentially hallucinogenic. Thus elsewhere in the world species of the genus *Boletus*, of which there are sixty-six species in Britain, and of the genus *Russula*, of which there are seventy-five species in Britain, are known to induce a psychotropic condition.

The field is therefore very much open to investigation but our ignorance casts a cloud on those genuine people who are amateur mycologists and enjoy picking fungi. They do not know whether a particular agaric they are picking is potentially hallucinogenic, and therefore once picked whether they are possessing a scheduled drug and committing a criminal offence. A subcommittee of the British Mycological Society was set-up some time ago to look into such situations; although disbanded because of the then views of the courts, with recent changes it may be necessary to convene it again.

The species appearing in the above key have now been included in a completely interactive on-line identification programme for poisonous and hallucinogenic mushrooms of interest for forensic science prepared by my associate Pierre A. J.-L. Margot [19].

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