

THE LARGER CUP FUNGI IN BRITAIN - part 1

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The species commonly referred to as ‘cup fungi’ represent a huge and diverse assemblage, cosmopolitan in distribution and to be found in almost all habitats. Many, perhaps the majority, are saprobes but cup fungi also include mycorrhizal species as well as parasites and pathogens, the latter attacking a wide range of herbaceous and woody plants, and including many species of economic importance. Some of the larger species, particularly truffles and morels, are also of importance as edible fungi.

The fruitbodies of cup fungi are known as apothecia and are basically cup- or disk-shaped structures, consisting of an outer structural layer (the receptacle) and an inner fertile component (hymenium) of intermixed spore-producing cells (asci) and sterile cells (paraphyses), though there are many which are greatly modified from the basic design. They include, for example, stalked or sessile, smooth or hairy, simple or compound structures which also exhibit a great range of colours and sizes. Many, especially the smaller species which can often be found in swarms on rotting stems or leaves, are extremely attractive fungi, well worth examination under a hand-lens or dissecting microscope. Also usually included as cup fungi, despite the shape of their fruitbodies but reflecting their true affinities, are species which develop below ground (hypogeous). These include the true truffles (*Tuber* spp.), and other truffle-like ascomycetes with globoid and solid or chambered fruitbodies in which the asci are indehiscent, i.e. they have lost the ability to forcibly discharge their ascospores.

The term ‘cup fungus’ is a convenient one, referring only to a general design and has little taxonomic value. Cup fungi belong to at least three different orders (Pezizales, Leotiales and Rhytismatales) and are classified fundamentally according to ascus structure. Most of the smaller species (some as tiny as 0.1 mm diam.) have asci which are known as ‘inoperculate’, i.e. with a thickened apex and an apical pore through which the spores are released. These belong mainly to the Leotiales, genera with small, simple, cup-

shaped apothecia, such as *Hymenoscyphus* and *Lachnum*, and a few such as *Geoglossum* and *Leotia*, with larger apothecia of modified form. These are the most numerous of the cup fungi with perhaps 1500 species known from the British Isles. In contrast, most of the larger cup fungi belong to the Pezizales, distinguished by the form of their asci which exhibit a quite different method of spore release. In these fungi the asci are ‘operculate’, releasing their spores through an apical ‘lid’ or operculum. In the majority of Pezizales the asci are thin-walled, cylindrical structures though in some groups they may be clavate to saccate in form, or have a thickened wall with a subapical operculum (‘suboperculate’), or dehisce via an apical split rather than a true operculum.

Even within the Pezizales there is still a great diversity of forms, from simple, cup-shaped apothecia which are characteristic, for example, of most species of *Aleuria* and *Peziza*, to more complex structures as exemplified by the morels (*Morchella* spp.) and saddle-fungi (*Helvella* spp.). They are less numerous than the Leotiales but nevertheless over 300 species of Pezizales occur in Britain. Although some of these are rarely seen and are not adequately known, there are many comparatively common species which can be readily found once their ecology, habitats and substrates are understood.

Although most of the larger cup fungi belong in Pezizales, this order also includes many species with tiny apothecia only a few millimetres across, as in some of the Pyronemataceae and in most of the Ascobolaceae and Thelebolaceae. In the case of the Ascodesmidaceae the fruitbodies are even smaller, minute structures which can scarcely be recognised as apothecia at all. In contrast, some Leotiales have comparatively large apothecia; in some species of *Sclerotinia*, for example, these may be well over 1 cm across. These groups can usually be readily distinguished under the microscope. Members of the Pezizales can be recognised by their asci but in addition their spores are generally characteristic. In most these are symmetrical in

form and ellipsoid to globose; they are never septate. Furthermore they commonly bear some form of surface ornamentation. In contrast, the spores of Leotiales are mostly asymmetric, usually narrowed to the base, frequently septate and very rarely ornamented.

In most cases identification of cup fungi requires microscopic examination, with emphasis on ascus and spore characters, as well as on any hairs or setae which may be present on the outer surface of the receptacle. In the Pezizales, the detailed structure of the receptacle itself is, in general, less useful than in the inoperculates, though it may provide important characters in some cases. Slide preparations in water are valuable for the examination of pigments and to determine the presence or absence of oil drops (guttules) in spores, but use of an iodine stain, usually Melzer's Reagent, is essential to examine amyloid reactions of the ascus wall. These are blueing reactions which, amongst the Pezizales, are characteristic of Pezizaceae. Melzer's Reagent as well as Cotton Blue or Aniline Blue can also be used for examination of spore surface ornamentation which sometimes needs to be observed under oil immersion for accurate determination of species. The last two stains may also be helpful for the examination of ascospore guttulation. They can also be used to observe nuclei in ascospores, although they are not specific stains for this purpose. Most Pezizales have spores with a single nucleus, but the spores of Helvellaceae have four, a helpful character for family recognition, particularly in the hypogeous species.

Although around 4000 species of cup fungi have been described, they remain little known;

undescribed species abound, and their ecology and life histories, physiology and chemistry are, for the most part, little known or understood. Their immense diversity provides a seemingly endless challenge. As a result, the identification of these fungi is frequently a difficult task but it is one that will amply reward serious study.

This series of articles is intended to provide an introduction to the Pezizales but will focus on the family Pezizaceae which includes the well-known and important genus *Peziza*, the largest in the family with over 50 species in Britain alone. The present article provides a key to families and subsequent articles will provide a key to the British genera of Pezizaceae and a description with keys to the species for each of these genera. There are, of course, many more species in Britain which may be regarded as larger cup fungi, notably the species of Helvellaceae and Morchellaceae, the few species of Sarcoscyphaceae and Sarcosomataceae and many of the Pyronemataceae. Identification keys to some of these have already been published, whilst others are now in preparation.

The following key is based on characters which are of practical use for identification though not necessarily of taxonomic value. It is designed for identification of the families of Pezizales as represented in the British Isles. Although it will apply also to most of northern Europe, it should be borne in mind that additional families occur elsewhere, viz. Carbomycetaceae, Eotereziaceae, Glaziellaceae and Karstenellaceae. It should be noted that Pyronemataceae here includes Otideaceae, a separate family for some authors.

Key to Families of Pezizales represented in Great Britain

1. Asci indehiscent (not forcibly discharging their spores); ascomata (fruitbodies) hypogeous or subhypogeous (in soil or litter); regular hymenium usually lacking; truffle-like fungi 2
1. Asci dehiscent through an operculum of various kinds; ascomata rarely hypogeous; regular hymenium present (most of the common larger cup fungi, morels etc) 7
2. Asci amyloid, cylindrical, arranged in a superficial hymenium **Pezizaceae** p.p. (*Sphaerozone*)
2. Asci non-amyloid, cylindrical or broadly ellipsoid to subglobose; hymenium if present not superficial 3
3. Ascospores 4-nucleate, ornamented; ascocarp solid or chambered; hymenium with paraphyses present **Helvellaceae** p.p. (*Choiromyces*, *Hydnotrya*)
3. Ascospores 1 (-2)-nucleate, ornamented or smooth; ascocarp solid, chambered or becoming hollow; hymenium present or not 4
4. Ascospores globose, ornamented; gleba solid; truffle-like fungi **Terfeziaceae**
4. Ascospores ellipsoid or if globose then smooth; gleba solid or chambered 5

5. Asci 1 - 6-spored, saccate, randomly embedded in glebal tissue; ascospores ornamented and pigmented **Tuberaceae**
5. Asci 8-spored, cylindric or cylindric-clavate, usually in a hymenium; if saccate then spores 8, smooth, paraphyses present; ascospores ornamented or not, hyaline or pigmented 6
6. Ascospores ellipsoid, smooth, hyaline; asci clavate to saccate, paraphyses present but regular hymenium lacking; ascocarps solid with small angular or sinuous chambers **Balsamiaceae**
6. Ascospores globose or, if ellipsoid, then ornamented, hyaline or pigmented; asci cylindric or cylindric-clavate; regular hymenium with paraphyses present or not; ascocarps chambered, or becoming hollow or with an apical opening **Pyronemataceae** p.p. (*Genea, Paurocotylis, Stephensia*)
7. Asci saccate, with large operculum; tissue between asci poorly developed; ascomata minute, subglobose, peridium lacking; ascospores pigmented, ornamented **Ascodesmidaceae**
7. Asci cylindric to clavate, rarely saccate, operculum, if present, normal; tissue between asci well developed; ascomata various in size, peridium present; ascospores various 8
8. Asci opening by a vertical apical split; fruit-body (apothecia) initially cleistothecial **Thelebolaceae**
8. Asci opening by an operculum; apothecia either never cleistothecial or remaining so 9
9. Asci thick-walled, operculum commonly subapical, 'suboperculate'. 10
9. Asci thin-walled, operculum usually apical 11
10. Apothecia bright coloured, orange-red carotenoid pigments usually present . . . **Sarcoscyphaceae**
10. Apothecia dull coloured, brown to blackish, carotenoids absent **Sarcosomataceae**
11. Ascospores thick-walled when young, without internal droplets (eguttulate), exospore at maturity becoming purple or purple brown, often ornamented with grooves or warts; asci often amyloid and often protruding from the hymenium at maturity **Ascobolaceae**
11. Ascospores thin-walled when young, guttulate or eguttulate, at maturity hyaline or brown, never purple; asci amyloid or not, sometimes protruding from the hymenium at maturity 12
12. Asci amyloid, not protruding from the hymenium at maturity **Pezizaceae** p.p.
12. Asci inamyloid, sometimes protruding from the hymenium at maturity 13
13. Ascospores with external polar 'crown' of guttules, internally eguttulate; apothecia large, stipitate, discoid or with thimble-like or ribbed fertile part; asci not protruding at maturity . **Morchellaceae**
13. Ascospores lacking external guttules, internally guttulate or not; apothecial form various; asci protruding at maturity or not 14
14. Apothecia discoid to convex or commonly brain-like to saddle-shaped, large, stipitate or attached by rhizoids; ascospores 1 - 2-guttulate; asci not protruding at maturity **Helvellaceae** p.p.
14. Apothecia various in form but not brain-like or saddle-shaped, stipitate or not, rhizoids lacking; ascospores guttulate or not; asci sometimes protruding at maturity **Pyronemataceae** p.p.



Two typical members of the larger cup fungi: on the left is *Peziza cerea*; on the right is *Helvella queletii* Photographs © Peter Roberts.