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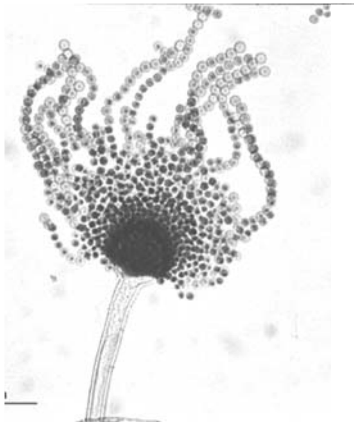

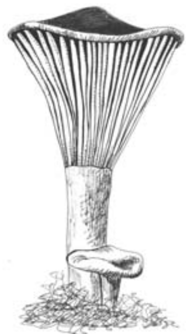

INTRODUCTION

Fungi and fungal diseases

Interest in fungi is mushrooming. Increasingly explored by mycologists, medical scientists, gourmets, folklorists, thrill-seeking adventurers, and mind-expansionists alike, this often-overlooked group of organisms provides us with food, drink, valuable medicines, industrial chemicals, recreational drugs, and unsurpassed marvels of nature. Some even take care of our radioactive waste. The role of fungi in evolutionary processes is now better understood and their value as recyclers and symbionts better appreciated.

Symbiotically associated with plant roots, fungi distribute essential nutrients, thereby transforming inhospitable environments into hospitable ones and enabling plants to settle and grow. Their role in the evolution of Mother Earth is now believed to have been the guidance of water-inhabiting algae onto dry land.

By entering into a coalition with algal partners and allowing them to be dominant these consortiums evolved into land plants. It is certainly no coincidence that 95% of today's land plants have symbiotic fungi in their roots. [Most of the 5% of plants that lack persistent fungal symbionts have returned to the water or never left it; they are aquatic plants.]

However, in their role as recycling transformers fungi are not always to our advantage or convenience. We are not pleased with the increasing incidence of medical mycoses and of fungal diseases of livestock and crops. Although regarded as the villains of the piece, fungi merely play their part. Being essentially saprophytes [saprobes] - recycling dead or decaying material -, fungi, then termed "opportunists," produce systemic and subcutaneous mycoses. During the last 50 years or so saprobes "suddenly have become parasitic and pathogenic," which is probably due to the rapid development of antibacterial, antineoplastic and immunosuppressive drugs.

"A dramatic change in the epidemiology of infectious diseases has taken place with the advent of new chemotherapeutic agents, new immunosuppressive agents, organ transplantation, parenteral alimentation, broadspectrum antibiotics, and advanced surgical techniques. In this new scenario, fungal infections have emerged as a critical issue in the compromised host." [www.doctorfungus.org]

In unhealthy functioning ecosystems fungus-plant interactions result in disease. Disruption of human immune systems has similar damaging consequences. The maintenance of agricultural monocultures with large-scale use of fertilizers and pesticides as well as the breeding of new crop varieties by genetic manipulation has resulted in significantly decreased resistance of crops to fungal infestation, which, in turn, causes a steep rise in both mycotoxin levels and spore production. A major cause of hypersensitivity [allergic] reactions, both out and indoors the air is filled with spores and other fungal elements. In addition, eczema, chronic digestive problems, acute diarrhoea, and irritable bowel syndrome have all been associated with the ingestion of the products of mould fungi.

In nature much of the effort of fungi goes into undoing the human disruptions of ecosystems. For undoing the disruptions of human immune systems likewise fungi can be employed, to which the ancient history of the use of medicinal fungi as immunostimulants in the Far East bears adequate witness.

Fungal remedies

The various repertories and homeopathic encyclopaedias list 72 names of fungal remedies [fungal compounds included]. Of these, 32 fungi are represented in the abbreviation lists by nothing more than a name, i.e. there are no symptoms, whilst of the remaining 40 fungi 27 have less than twenty symptoms. It leaves us with 13 fungi we might possibly come across when repertorizing. Yet, even that number does not reflect the actual situation. Our understanding of the entire kingdom is based in essence on a total of *three* fungi: Agaricus, Bovista, and Claviceps [Secale], with a few more having a place in the background: Psilocybe, Ustilago, Sticta, Polyporus officinalis, Candida albicans, and the fungal compounds Alcoholus and Penicillinum. This well-known trio supplies the rudiments, the basics, the ABC of the homeopathic perception of the kingdom. One may safely assume that such a foundation is too narrow.

To broaden the horizons - admittedly, my own in the first place - I have spent some years studying the biology of fungi and collecting evidence from the dusty corners of homeopathy. All gathered material I have put together to come to a working hypothesis designed to enable pattern recognition. Emphasis is placed on the biological features of the individual fungus, based on the conviction that similarity is a matter of analogy between the nature of the substance and the nature of the person. Defining homeopathy as a process of cause and effect ["What can cause can cure"] seems to me too limited and too limiting.

Keys

The process of researching and dusting has resulted in *keys* for the individual fungi. The keys are combinations of mycological and toxicological data, medicinal use, culinary delights, fungal lore, thematic concepts, peculiar properties, and homeopathic symptoms [where available]. The keys are meant as *potential* indications; they cannot be conclusive since clinical verification is lacking for most of the 109 fungi and fungal compounds included in *Spectrum*. As already stated 32 have an abbreviation only; 27 have twenty or less symptoms, and 37 are new.

Dealing with the *Kingdom Fungi, Volume 2* of *Spectrum* presents an orientation in this fascinating but arcane kingdom. It includes drug pictures, rudimentary or more complete, with a range of analogous information [signatures] as its points of departure.

The kingdom Monera [including the kingdom-less viruses] has been discussed in *Volume 1*; the remaining kingdoms - protists, plants, animals, elements - will be presented in subsequent volumes of *Spectrum*.

Enigmatic species

Some fungi, as presented in remedy abbreviation lists or actually existing as homeopathic remedies, have remained obscure regarding their taxonomy or their potential health benefits. These include:

- *Cladosporium lugdunense* [abbr.: *Clados-l.*]. Obviously an organism of French origin [lugdunense means 'from Lyon'], yet non-existent under this name within Cladosporium, a genus of ubiquitous moulds. Cladosporium spp. grow on deteriorating plant materials - some even thrive on vegetables stored in refrigerators - and discharge such huge numbers of spores that they are among the commonest causes of fungal allergies.
- *Monilia coerula* [abbr.: *Moni-c.*]. The genus Monilia originally comprised a group of organisms that are now placed in the separate genus *Candida.* Equally stubborn as erroneous, homeopathy persists in holding on

to the old classification. Since there are no references to a fungus named *Monilia coerula*, it might reflect the old situation and really be a Candida species. In that case the only candidate is Candida krusei var. coeruleum [now shortened to Candida krusei]. [*See* Candida albicans]. On the other hand, if the specific name 'coerula' is conclusive, there are several other candidates, such as the moulds Absidia coerulea and Fusarium coeruleum.

• *Hydnum repandum* [abbr.: *Hydn-r.*]. With Hydnum the problem is not so much its taxonomy, but more the absence of any reported adverse or beneficial effects. An esteemed edible mushroom, it appears to be totally harmless, despite a slight occasional gastrointestinal upset when eaten raw. Its signature is interesting, though. It belongs to a group of fungi that have *teeth* , rather than gills or pores,[actually brittle but soft needle-shaped spines], to which its alternate name *Dentinum* repandum refers, and, with some imagination, it resembles a hedgehog [Hedgehog Mushroom]. Hydnum repandum has no history of medicinal use, as far as I could ascertain.

• *Lactarius deliciosus* [abbr.: *Lacta-d.*]. A delectable edible loved by the ancient Greeks, the Russians still go bananas over Milk Caps. Russia has been called the Milk Cap Mecca. Belonging to the family Russulaceae, Milk Caps share with Russulas certain brittleness and a distinct display of colours. As the name indicates, the discharge of a milky latex when broken or cut distinguishes them from the 'dry' Russulas. Lactarius deliciosus causes gastrointestinal disturbances when eaten raw. The sesquiterpenes contained in Milk Caps are mostly destroyed on cooking. Sesquiterpenes are responsible for the bitterness or pungency of some Milk Caps and increase digestive secretions. Although Lactarius deliciosus is mild tasting, suggesting low levels of sesquiterpenes, the invigorating and appetite-inducing effects of these compounds, might explain why both this species and L. piperatus [Peppery Milk Cap] in the mid-19th century had such a reputation in the treatment of pulmonary tuberculosis. It has also been claimed that this use is supported because of the strong antibacterial activity present in some Lactarius species. Unfortunately, these testimonials in the older literature didn't catch lasting attention, so that the therapeutic value of Lactarius spp. is now replaced by culinary praise.

Believing is seeing

The doubting Thomas wanted to see first and then believe, as do some homeopathic practitioners. Such a concept is like the snake that bites its own tail: a vicious circle.
That it is all about perspective is illustrated by Andrew Weil's story "Believing is Seeing." Replace the words 'mushroom' or 'morel' in the story by the word 'remedy,' and see what you see …

Mushroom hunting can teach us a lot about the larger world. A common experience of mushroom hunters is not being able to see a particular mushroom when they first try to collect it. It's not a question of visual acuity, but of pattern recognition. One woman wanted to find morels. She'd been told they grew in her area, but nobody would show her exactly *where*, and she had never seen one in the flesh. So finally she went out by herself to the woods and spent an entire morning looking, without finding a single morel. In frustration she got down on her hands and knees and began sifting through last year's leaves. Just as she was about to give up, she saw one morel a few inches away, and picked it. Clutching it triumphantly, she looked up and saw *hundreds* of them scattered through the woods in all directions.

A useful lesson can be drawn from this: that our brain acts as a filter, screening out what it doesn't consider significant. A certain "key" has to be in place before our brain can say "Aha!" and recognize something. And of course, what we recognize has real consequences. In this case, the person who can see the morels gets to put them in the basket and take them home to eat. The larger principle is that what we experience is determined by what we are able to perceive. It leads me to believe that we should be willing to accept other people's experiences - for instance, telepathy or pre-recognition - or at least *consider* that they have validity, even though we do not share them. Otherwise we could live in a forest full of morels and never see them.
[Cited in David Arora, *All That the Rain Promises and More* …]

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Frans Vermeulen, Molkom, Sweden, 24 April, 2006.

CLASSIFICATION KINGDOM FUNGI

[A true “nomenclatural nightmare”, the taxonomy of fungi is subject to ongoing debate, “riddled with contradictions”, and unresolved disputes. Of the 200,000 species of fungi estimated to exist, about 70,000 have been described, the lion’s share of which consists of microscopic fungi such as yeasts and moulds. For the nomenclature and the author citations, standardised to follow Brummit & Powell (1992), I am indebted to Dr Vilma Bharatan, Department of Botany, Natural History Museum London. Synonyms indicate old names, now mostly obsolete, or names currently used in mycological literature but without official nomenclatural status.
The classification given below is mainly based on Bryce Kendrick’s authoritative *The Fifth Kingdom*.]

Fungal nomenclature in homeopathy

Elias Fries [1794-1878] based his classification system on macro morphological features of fungi, placing every gilled fungus into the genus Agaricus and every pored fungus into Boletus. Later he subdivided the latter group and placed the fleshy species into Boletus and the corky or woody ones into Polyporus. The Friesian system of classification prevailed for over a hundred years but is now replaced by systems that distinguish genera and species on the basis of microscopic characteristics. The names used in homeopathy follow the Friesian system: all gilled mushrooms are called Agaricus, all pored species are either Boletus or Polyporus.

PHYLUM EUMYCOTA [“True Fungi”]
The higher or true fungi constitute a single phylum, the Eumycota, which includes two subphyla, Ascomycota and Basidiomycota. In some classification systems the Deuteromycota [Imperfect Fungi] are included as a separate subphylum of the Eumycota, as are the Mastigomycota and the Zygomycota. The Mastigomycota, consisting predominantly of aquatic fungi or fungi that flourish under particularly damp conditions, is divided into three classes:

Chrytridiomycetes, Hyphochytridiomycetes and Oomycetes. In other systems the three classes of the Mastigomycota as well as the Zygomycota are treated as four separate phyla of the lower fungi. The latter system is adapted below.

SUBPHYLUM BASIDIOMYCOTA [Club Fungi]
Contains approximately 25,000 known species, mostly terrestrial and *extensive in growth.* Most of the large, conspicuous fungi encountered in woods and fields, such as mushrooms, puffballs, stinkhorns, and bracket fungi belong to the basidiomycota. In addition the subphylum includes numerous inconspicuous forms, many of which are plant parasites. The spores, usually four, are borne on the outside of a club like cell [basidium], usually in a fruiting body. Basidiospores develop externally and, when mature, are often shot from the basidium, usually with a force sufficient to carry them free of the spore-producing tissue.
The subphylum comprises three classes: Holobasidiomycetes, Phragmobasidiomycetes, and Teliomycetes. The class Holobasidiomycetes is subdivided in two highly interrelated series, called Gasteromycetae and Hymenomycetae.

- CLASS: **Holobasidiomycetes**

- SERIES **Gasteromycetae** [Gasteromycetes]

- ORDER: Lycoperdales [Puffballs and Earth Stars]
  - FAMILY: Lycoperdaceae
    - GENUS: Bovista
      - SPECIES: *Bovista nigrescens*
    - GENUS: Calvatia
      - SPECIES: *Calvatia bovista*
        Calvatia gigantea
        [syn Langermannia gigantea]
    - GENUS: Lycoperdon

- ORDER: Phallales [Stinkhorns]
  - FAMILY: Phallaceae

- GENUS: Phallus
  - SPECIES: *Phallus impudicus*
- ORDER: Sclerodermatales
  - FAMILY: Sclerodermaceae
    - GENUS: Scleroderma
      - SPECIES: *Scleroderma citrinus*

- SERIES **Hymenomycetae** [Hymenomycetes]

- ORDER: Agaricales
  - FAMILY: Agaricaceae
    - GENUS: Agaricus
      - SPECIES: *Agaricus bisporus*
        Agaricus blazei
        Agaricus campestris

  - FAMILY: Amanitaceae
    - GENUS: Amanita
      - SPECIES: *Amanita citrina* [hom.: Agaricus citrinus]
        Amanita muscaria [hom.: Agaricus muscarius]
        Amanita pantherina [hom.: Agar pantherinus]
        Amanita phalloides [hom.: Agaricus phalloides]
        Amanita rubescens [hom.: Agaricus rubescens]
        Amanita verna [hom.: Agaricus vernus]

  - FAMILY: Coprinaceae
    - GENUS: Coprinus
      - SPECIES: *Coprinus atramentarius*
    - GENUS: Panaeolus
      - SPECIES: *P. campanulatus* [hom.: Agar. campanulatus]

  - FAMILY: Cortinariaceae
    - GENUS: Cortinarius
      - SPECIES: *Cortinarius orellanus*
    - GENUS: Gymnopilus
      - SPECIES: *Gymnopilus spectabilis*

- FAMILY: Lepiotaceae
    - GENUS: Lepiota
        - SPECIES: *Chlorophyllum molybdites*
          Macrolepiota procera [hom.: Agaricus procerus]

- FAMILY: Paxillaceae
    - GENUS: Paxillus
        - SPECIES: *Paxillus involutus*

- FAMILY: Russulaceae
    - GENUS: Lactarius
        - SPECIES: *Lactarius deliciosus*
    - GENUS: Russula
        - SPECIES: *Russula emetica* [hom.: Agaricus emeticus]
          Russula foetens

- FAMILY: Strophariaceae
    - GENUS: Psilocybe
        - SPECIES: *Psilocybe caerulescens*
          Psilocybe semilanceata
    - GENUS: Stropharia
        - SPECIES: *Stroph. semiglobata* [hom.: Agar. semiglobatus]
          Stroph. stercoraria [hom.: Agar. stercorarius]

- FAMILY: Tricholomataceae
    - GENUS: Armillaria
        - SPECIES: *Armillaria mellea*
    - GENUS: Lentinula
        - SPECIES: *Lentinula edodes* [Shiitake]
    - GENUS: Omphalotus
        - SPECIES: *Omphalotus illudens*
    - GENUS: Pleurotus
        - SPECIES: *Pleurotus ostreatus* [Oyster mushroom]

ORDER: Aphyllophorales
- FAMILY: Ganodermataceae

        - GENUS: Ganoderma
            - SPECIES: *Ganoderma lucidum* [Reishi]

    - FAMILY: Polyporaceae [Conks]
        - GENUS: Fomitopsis
            - SPECIES: *F. officinalis* [hom. Polyporus officinalis]
              [syn. Laricifomes officinalis; hom.: Boletus laricis]
              Fomitopsis pinicola [hom. Polyporus pinicola]
        - GENUS: Grifola
            - SPECIES: *Grifola frondosa*
        - GENUS: Inonotus
            - SPECIES: *Inonotus obliquus* [syn. Polyporus obliquus]
        - GENUS: Piptoporus
            - SPECIES: *Piptoporus betulinus*
        - GENUS: Pycnoporus
            - SPECIES: *Pycnoporus sanguineus*
        - GENUS: Trametes
            - SPECIES: *Trametes versicolor*
              Trametes suaveolens [hom.: Boletus suaveolens]

- ORDER: Boletales
    - FAMILY: Boletaceae
        - GENUS: Boletus
            - SPECIES: *Boletus edulis*
              Boletus luridus
              Boletus satanas

- ORDER: Cantharellales
        - FAMILY: Cantharellaceae [Chanterelles]
            - GENUS: Cantharellus
                - SPECIES: *Cantharellus cibarius*

- ORDER: Hymenochaetales
    - FAMILY: Hymenochaetaceae
        - GENUS: Phellinus
            - SPECIES: *Phellinus nigricans*

- CLASS: **Phragmobasidiomycetes**

- ORDER: Auricularіales
    - FAMILY: Auriculariaceae
        - GENUS: Auricularia
            - SPECIES: *Auricularia polytricha*

- ORDER: Tremellales [Jelly Fungi]
    - FAMILY: Filobasidiaceae
        - GENUS: Filobasidiella
            - SPECIES: *Cryptococcus neoformans*
              [anamorph of Filobasidiella neoformans]
        - GENUS: Pityrosporum [syn. Malassezia]
            - SPECIES: *Pityrosporum orbiculare*

    - FAMILY: Tremellaceae
        - GENUS: Tremella
            - SPECIES: *Tremella fuciformis*

- CLASS: **Teliomycetes**

- ORDER: Ustilaginales [Smut Fungi]
    - FAMILY: Sporidiobolaceae
        - GENUS: Sporobolomyces
            - SPECIES: *Sporobolomyces roseus*
              Sporobolomyces salmonicolor

    - FAMILY: Ustilaginaceae
        - GENUS: Ustilago
            - SPECIES: *Ustilago maydis* [Corn Smut]

SUBPHYLUM ASCOMYCOTA [Sac Fungi].

Contains more than 30,000 known species, mostly terrestrial and saprophytic, occurring on plant and animal remains, on dung, or in soil. *Extensive in growth.* Some species are parasitic on plants. Spores, usually eight, are borne inside a bladder like sac [ascus], which is the characteristic sexual reproductive structure of the ascomycetes. There is no universally accepted classification of the Ascomycota. Here is adopted the subdivision into the classes Ascomycetes and Saccharomycetes. The class Ascomycetes is divided into four series, depending on the structure of the asci, as reviewed by Kendrick.

1. Unitunicate-Operculate Asci have a single wall with a built-in lid or operculum at the tip. At maturity the lid pops open to eject the spores.
2. Unitunicate-Inoperculate Asci lack an operculum but have instead an elastic ring mechanism, letting the spores shoot through at maturity.
3. Prototunicate Asci have no active spore-shooting mechanism; the spores are released when the walls of the asci dissolve, decay or rupture.
4. Bitunicate Asci have a double wall. At maturity the thin outer wall splits, and the thick inner wall absorbs water and expands upward, carrying the ascospores with it.

- CLASS: **Ascomycetes.**

- SERIES *Unitunicatae-Operculatae*.

- ORDER: Pezizales.
  - FAMILY: Discinaceae [Helvellaceae].
    - GENUS: Gyromitra [False Morels].
      - SPECIES: *Gyromitra esculenta* [Brain Mushroom].

  - FAMILY: Morchellaceae.
    - GENUS: Morchella [Morels].
      - SPECIES: *Morchella esculenta* [Yellow Morel].

  - FAMILY: Tuberaceae [Truffles].
    - GENUS: Tuber.
      - SPECIES: *Tuber aestivum* [Summer truffle].

Tuber magnatum [White truffle of Piedmont].
Tuber melanosporum [Black truffle of Périgord].

- SERIES *Unitunicatae-Inoperculatae*.

- ORDER: Clavicipitales.
  - FAMILY: Clavicipitaceae.
    - GENUS: Claviceps.
      - SPECIES: *Claviceps purpurea* [hom.: Secale cornutum].
    - GENUS: Cordyceps.
      - SPECIES: *Cordyceps militaris.*
        Cordyceps sinensis.
        Cordyceps subsessilis
        [teleomorph of Tolypocladium inflatum, producer of Cyclosporin].
    - GENUS: Epichloë
      - SPECIES: *Neotyphodium lolii* [endophyte of the grass Lolium temulentum]

- ORDER: Hypocreales.
  - FAMILY: Hypocreaceae.
    - GENUS: Fusarium.
      - SPECIES: *Fusarium graminearum.*
        Fusarium oxysporum.
        Fusarium sporotrichioides.

  - FAMILY: Nectriaceae.
    - GENUS: Nectria.
      - SPECIES: *Nectria ditissima.*

- ORDER: Leotiales.
  - FAMILY: Sclerotiniaceae.
    - GENUS: Botrytis.
      - SPECIES: *Botrytis cinerea.*

- ORDER: Microascales.
  - FAMILY: Microascaceae.

- GENUS: Pseudallescheria.
  - SPECIES: *Pseudallescheria boydii.*
    [hom.: Acladium castellani]
- ORDER: Sordariales.
  - FAMILY: Lasiosphaeriaceae.
    - GENUS: Arthrinium.
      - SPECIES: *Arthrinium arundinis.*

- SERIES *Prototunicatae*.

- ORDER: Eurotiales [green and blue moulds].
  - FAMILY: Trichocomaceae.
    - GENUS: Aspergillus.
      - SPECIES: *Aspergillus bronchialis.*
        A. candidus [hom.: Sterigmatocystis candidum]
        Aspergillus flavus.
        Aspergillus fumigatus.
        Aspergillus niger.
    - GENUS: Penicillium.
      - SPECIES: *Penicillium camemberti.*
        Penicillium cyclopium.
        Penicillium expansum.
        Penicillium [*aurantio*]*griseum.*
        Penicillium griseofulvum.
        Penicillium notatum.
        Penicillium piceum.
        Penicillium roqueforti.

- ORDER: Onygenales.
  - FAMILY: Arthrodermataceae.
    - GENUS: Trichophyton.
      - SPECIES: *Trichophyton mentagrophytes*
        [hom.: T. depressum].
        Trichophyton persearum [hom.: T. persicolor].
        Trichophyton rubrum.
        Trichophyton tonsurans.

- FAMILY: Onygenaceae.
  - GENUS: Blastomyces.
    - SPECIES: *Blastomyces dermatitidis*.
  - GENUS: Coccidioides.
    - SPECIES: *Coccidioides immitis.*
  - GENUS: Geomyces.
    - SPECIES: *Geomyces pannorum*
      [hom.: Aleurisma lugdunense]
  - GENUS: Histoplasma.
    - SPECIES: *Histoplasma capsulatum*.
  - GENUS: Paracoccidoides.
    - SPECIES: *Paracoccidoides brasiliensis.*

- ORDER: Ophiostomatales.
  - FAMILY: Ophiostomataceae.
    - GENUS: Sporothrix.
      - SPECIES: *Sporothrix schenckii*.

- SERIES *Bitunicatae*.

- ORDER: Dothideales.
  - FAMILY: Dematiaceae.
    - GENUS: Stachybotrys.
      - SPECIES: *Stachybotrys chartarum*.

  - FAMILY: Dothioraceae.
    - GENUS: Aureobasidium.
      - SPECIES: *Aureobasidium pullulans.*
    - GENUS: Hortaea.
      - SPECIES: *Hortaea werneckii.*
        [hom.: Cladosporium metanigrum]

  - FAMILY: Pleosporaceae.
    - GENUS: Alternaria.
      - SPECIES: *Alternaria alternata.*

- CLASS: **Saccharomycetes.**

- ORDER: Endomycetales [Saccharomycetales].

  - FAMILY: Ascoideaceae.
    - GENUS: Candida.
      - SPECIES: *Candida albicans* [hom.: Monilia albicans].
        Candida kefyr.
        [anamorph of Kluyveromyces marxianus]
        Candida parapsilosis.

  - FAMILY: Saccharomycedaceae.
    - GENUS: Kloeckera.
      - SPECIES: *Kloeckera apiculata*
        [hom.: Saccharomyces apiculata]

  - FAMILY: Saccharomycetaceae [Yeasts].
    - GENUS: Kluyveromyces.
      - SPECIES: *Kluyveromyces lactis.*
        Kluyveromyces marxianus.
        [teleomorph of Candida kefyr]
    - GENUS: Saccharomyces.
      - SPECIES: *S. carlsbergensis* [hom.: Cerevisia lager].
        S. cerevisiae [hom.: Torula cerevisiae].

SUBPHYLUM DEUTEROMYCOTA [Imperfect Fungi]
Imperfect fungi - fungi lacking sexual stages or having lost the ability to reproduce sexually - were traditionally grouped together in the artificial taxon Deuteromycota. For example, asexual Ascomycota, such as Penicillium, Aspergillus or Candida species, used to be classified separately in the Deuteromycota, but have now been integrated into the Ascomycota. Fungal species whose status is yet to be determined and hence have not yet been placed in the existing divisions are grouped together in the “orphanage”, also called “holding group” known as the Imperfect Fungi. Deuteromycetes are mostly terrestrial and *extensive in growth.*

SUBPHYLUM LICHENES [Lichens]
Lichens are symbiotic associations, mostly of Ascomycota [subclass Discomycetes] with either Cyanobacteria [blue-green algae] or Chlorophyta [green algae]. Occasionally the fungal partner is a basidiomycete or a deuteromycete [imperfect fungus]. They are classified according to the nature of the fungus. Although by some mycologists not recognized as a formal taxonomic group, also because the affinities of many lichens are still unknown, the [sub]phylum Lichenes is maintained for convenience.

Lichens

- CLASS: **Ascolichenes.**

- ORDER: Lecanorales [contains the majority of lichens].

  - FAMILY: Cladoniaceae.
    - GENUS: Cladonia.
      - SPECIES: *Cladonia pyxidata*.
        Cladonia rangiferina

  - FAMILY: Parmeliaceae.
    - GENUS: Cetraria.
      - SPECIES: *Cetraria islandica*.
        - GENUS: Usnea.
      - SPECIES: *Usnea barbata*.

- ORDER: Peltigerales

  - FAMILY: Lobariaceae.
    - GENUS: Lobaria.
      - SPECIES: *Lobaria pulmonaria* [hom.: Sticta].

- CLASS: **Basidiolochenes.**
- CLASS: **Lichenes Imperfecti.**

PHYLUM ZYGOMYCOTA

[Characterized by the formation of sexual, thick-walled zygospores and asexual, nonswimming sporangiospores. Most members of the class Trichomycetes are parasites or commensals inside the guts of living arthropods. The Zygomycetes form a diverse group, some of them being common and fast growing, primary colonizers of carbon-containing substrates. Black bread mould, Rhizopus nigricans, is a well-known representative of the Zygomycetes in the order Mucorales.

The order Entomophthorales contains species pathogenic for humans, causing zygomycosis, as well as species that parasitize and kill various insects. The species *Entomophthora muscae* infects the common housefly. Its mycelium grows within the host's body, so that infected flies are often found attached to windows in late summer or fall, their body surrounded by a halo of whitish spores.]

- CLASS: **Trichomycetes.**

- CLASS: **Zygomycetes.**

- ORDER: Entomophthorales.

    - FAMILY: Entomophthoraceae.
        - GENUS: Entomophthora.
            - SPECIES: *Entomophthora muscae.*

- ORDER: Mucorales.

    - FAMILY: Mucoraceae.
        - GENUS: Mucor.
            - SPECIES: *Mucor mucedo*.
        - GENUS: Rhizopus.
            - SPECIES: *Rhizopus nigricans* [= *Rhizopus stolonifer*].

PHYLUM CHYTRIDIOMYCOTA

[Predominantly saprobic aquatic fungi, although many exist as parasites of other fungi, algae, aquatic animals, or terrestrial plants. Some saprobic species degrade resistant substances, such as chitin and keratin. The phylum has four orders: Blastocladiales, Chytridiales, Harpochytridiales, and Monoblepharidales. There are no representatives of these groups in homeopathy.]

FUNGAL TAXONOMY

Fossil fungi date from 450 million to 500 million years ago. Their ancestry is not well understood. The two main classes - ascomycotes and basidiomycotes - are closely related to each other and probably descended from a common ancestor.

Fungi have been traditionally classified in the plant kingdom. Herbalists and botanists stuck closely to classical authority in the explanations given about the origin of these "bastard plants," taking no notice of suggestions that fungi are not plants. As early as 1583 the Italian botanist Andreas Caesalpini [1519-1603] concluded that fungi are "a sort of intermediate existence between plant and inanimate nature" and "in this respect resemble zoophytes, which are intermediate between plants and animals."

The question temporarily occupied the mind of Linnaeus [1707-1778], father of modern taxonomy, who thought fungi might form a new natural kingdom between those of plants and animals. But Linnaeus wasn't particularly interested in working out the details. He actually disliked fungi, which, in his opinion, "have no soul." The systematist in him, however, produced a competent treatment of fungi in *Flora Suecica* [Flora of Sweden] and found it "a scandal of art" that "the order of Fungi is still Chaos."

Personal distaste conflicting with professional vocation might have been the reason why Linnaeus supported the odd conceptions of the German Otto von Münchhausen [1716-1774], chancellor of Göttingen University, whose notions were in no way less extravagant than the adventures of his fictional heroic namesake Baron von Münchhausen.

Otto claimed that spores of Ustilago [smut fungus], if placed in water, develop into insect eggs. Spores of toadstools furthermore proved to be the eggs of small animals and fungal fruiting bodies were not plants but dwellings and edifices of innumerable minute creatures. In the twelfth edition of his *Systema Naturae* Linnaeus, consequently, added the new genus *Chaos* to the

subkingdom Vermes [Worms], which included *Chaos Fungorum* and *Chaos Ustilago*. In the early 19th century the Swede Elias Fries [1794-1878] and the South African Hendrick Persoon [1755-1837] brought order in Chaos, the shapeless and unformed world of fungal taxonomy.
Their pioneering work still stands as the foundations for all that has followed in the field of mycology. Thousands of species described by Fries or Persoon still have the name they gave them, denoted by Fr. or Pers., respectively.

BIOLOGY OF FUNGI

Fungi are more distinct from vascular plants than they are from animals. Considering that *chitin* is the main component of both fungal cell walls and the exoskeletons of insects, arachnids [spiders, scorpions, mites, etc.] and crustaceans, fungi are clearly more closely related to animals than to plants. Yet, the fact that they differ from animals *and* plants in their characteristics, such as life cycle, mode of nutrition, pattern of development, etc., has been a strong argument for a classification on their own right.

Differences with plants

I. The archetypical body of the flowering plant consists of root, stem, leaves and flowers. The bodies of fungi are variously shaped; roots, leaves and flowers are lacking.
II. Plants reproduce by seeds; fungi by spores.
III. Chlorophyll is present in plants and absent in fungi.
IV. Plants are autotrophic [self-feeding]: they obtain the starchy and other organic foods on which they live by building them up from atmospheric carbon dioxide and the mineral salts of the soil. Fungi are heterotrophic: they depend on green plants for carbon and absorb nutrients already elaborated by other organisms, either directly or indirectly. “This somewhat immoral habit, of living on the energies of their neighbours, renders it unnecessary for them to perform many of the duties of the flowering plants, and this has caused their evolution to develop on simpler lines.” [Rolfe & Rolfe]
V. Light is essential for the development of plants. Light is not essential for fungi during the vegetative stage, but in many fungi it plays an important

role during the reproductive stage [production of fruiting bodies and/or spore dispersal].
VI. Plants have two genders; their reproductive organs are male or female. Fungi are more or less genderless, having countless mating types instead.
VII. Plants build up true, specialized tissues, unlike fungi, which have no true tissues.
VIII. Plants are limited in comparison to fungi. "There are hundreds of species of fungi which are ubiquitous throughout the world, at any rate where climatic conditions are suitable, whereas very much more limited habitats are found in the case of many flowering plants which climatically are equally favoured." [Rolfe]
IX. Plants need one or two seasons to produce seeds; fungi proceed much more rapidly, producing a fruiting body within hours or days.
X. Fungi grow more rapidly in proportion to their body weight than do green plants, and consequently expend relatively more energy in converting their food into an assimilable form. With moulds an increase in body weight amounting to a thousandfold within a 10-day period, such as occurs in Aspergillus niger, is not uncommon. [Wolf & Wolf]

Expansion and penetration

Fungi develop directly from spores. Spores germinate into thread-like cells known as *hyphae,* rapidly growing slender tubes divided into cells by incomplete cross walls [septa]. In most hyphae, organelles [including nuclei and mitochondria] can more or less freely move around because the septa seldom separate the cells completely. The hyphae of some fungi even have no septa at all. The majority of fungi are composed of hyphae, in contrast to yeasts, which are single-celled. The hyphae form webs or mats known as *mycelium*, which is the feeding, growing form of most fungi. Yeasts do not form mycelia but remain as single cells.
Often the mycelium is *invisible*: it is buried within the substrate out of which the mushrooms spring. The mycelium is beautifully fitted to its ecological role: it has a great surface area and grows at the tips of the hyphae. Each hypha is a transparent tube, branching and rebranching. "In each tube is a rushing torrent of the living contents, the protoplasm, pressing towards the ever expanding tip," as Brodie puts it. The elements of *penetration* and *extension* are keynotes of fungi. The total hyphal growth of a mycelium [not

the growth of an individual hypha] may exceed 1 km per day! The hyphae have various functions: growth and extension, absorption of nutrients, and anchoring the fungus to its substrate. When sexual spores are produced the mycelium interweaves and mats together its hyphae into elaborate fruiting bodies such as mushrooms. Fruiting bodies spring up from a subterranean web of proliferating threads, the mycelium, that is the *real fungus*, for there are many fungi that do not make their presence known through a fruiting body.

Perhaps the most notorious example of *expansion* is the Honey Mushroom [Armillaria spp.]. Its mycelium spreads by stringy blackish brown strands, which may extend up the host's trunk or infect neighbouring trees by traversing great distances through the soil. Armillaria is claimed to be the biggest of all living organisms. In Michigan, U.S.A., mycelial threads over an area of 128 hectare were found to belong to a single individual, which was an estimated 1,500 years old. And this is a small one!

A single colony of Armillaria ostoyae growing in the forests of the western state of Washington has been found to cover 600 hectares and to have biomass exceeding that of a blue whale. Every Honey Mushroom meets his match one day, for a few years ago Armillaria-strands were discovered to occupy 890 hectares of the Malheur National Forest in eastern Oregon. DNA analysis demonstrated that 60 of the 100 samples taken were genetically identical. Weighing about 150 metric tons and being at least 2,400 years old, this fungus is among the largest, heaviest and oldest living organisms known on our planet.

“The fifth kingdom, that's what fungi are,” concludes David Moore. “More like a fifth column if you ask me; they're all around us, but nobody knows about them.”

Reproduction

Most fungi reproduce by the spreading of asexual spores [directly formed spores, without any sort of sexual fusion] by wind, water or animals. Unicellular fungi [yeasts] reproduce by cell division. Another form of asexual reproduction is simple breakage of the mycelium. From time to time, most fungi form a sexual stage, including reproductive structures.

Sexual reproduction in many fungi features an interesting twist. There is

> no distinction between female and male structures, or between female and male organisms. Rather, there is a genetically determined distinction between two or more *mating types*. Individuals of the same mating type cannot mate with one another, but they can mate with individuals of another mating type. This distinction prevents self-fertilization. Individuals of different mating types differ genetically from one another but are often visually and behaviourally indistinguishable.
> [Purves et al. 1998]

The actual number of genders or mating types in certain species is very large, which makes the number of possible pairwise combinations astounding. The species Schizophyllum commune, Split-Gill, widely used in genetic studies, was found to have some 21,000 kinds of pairings! Each mating type of many of the higher fungi is determined by *two* sets of genes, in contrast to humans, animals and higher plants, in which each gender is defined by a single set of either male or female genes.
In addition, fungal genes can have hundreds of individual variations. In most kinds of plants and animals the mingling of heritable materials derived from both parents takes place soon after two sex cells unite. In mushrooms this happens only after an extensive courtship.

> In the fungi, the fusing of the two nuclei happens *long after mating.* When two sexually compatible filaments mate, the nuclei remain separated [haploid]. They remain so as the filaments grow, up to the moment when a fully mature mushroom forms its spores. Thus, for most of its life, each filament contains two separate kinds of nuclei.
> Why do the cells wait until the last possible minute to combine their nuclei? At first glance, combining nuclei early or late would seem to make little difference: in each case, two sets of chromosomes are carried by the same cell. If the nuclei fuse, however, they form an irreversible union that seals the fate of their [now diploid] genetic material. The dikaryon [cell with two nuclei], on the other hand, by keeping the two nuclei apart, provides another shot at genetic diversity. In the words of a Boston mycologist, Richard Batchelor, the two nuclei live as roommates, capable of further dalliances.
> A dikaryotic filament can still fuse with another filament, leading to a new combination of nuclei and to a different arrangement of genes. It seems that fungi wish to leave themselves open to new genetic opportunities

> until the last minute. If we applied the terms of human behaviour to mushrooms, we would conclude that the fungi "commitment" is highly tentative.
> [Schaechter 1997]

Fungi seem often highly opportunistic, keeping their options open to the last minute. [See also Flexibility.]

Spores

Fungal spores are microscopically small. They consist of only a single cell and carry only a minute food reserve to sustain the young individual that will emerge from them. Unlike plants, who need to attract pollinators for fertilization, fungi produce spores that are fertile in themselves. The function of fungal fruiting bodies is solely one of dispersal.

> Fungi cannot walk or run, but some can swim, most can soar, a few can jump, and some must be carried. … One of the main reasons for the success of the fungi is their ability to produce and disperse vast numbers of tiny, but often highly characteristic and specialized, spores. By sheer fecundity, the fungi make sure that, whenever and wherever a new food substrate becomes available, they will be on hand to exploit it. Most fungi are cosmopolitan - you could find them almost anywhere in the world. The air we breathe sometimes contains more than 10,000 spores per cubic metre. … Of course, even these huge numbers become greatly attenuated when the spores are dispersed in the vastness of the atmosphere, but the total spore load of the outside air is always significant, and can on occasion be a real threat to health. [Kendrick 2000]

Metabolism

Unlike green plants and algae, fungi are unable to synthesize their energy requirement from sunlight. Quite the reverse, they generally avoid direct sunlight. Fungi cannot assimilate carbon dioxide. Due to the lack of chlorophyll fungi have adopted another, more animal-like strategy: they obtain their nourishment and energy from organic compounds already produced by other organisms [animals and plants].

Fungi prefer carbohydrates and nitrogen as their main sources. Like animals, they store energy in glycogen rather than in starch, which is the usual storage compound in plants. They can readily absorb and metabolize a variety of soluble carbohydrates, such as glucose, xylose, sucrose, and fructose, but are also characteristically well equipped to process such insoluble carbohydrates as starches, cellulose, hemicellulose and lignin. To be able to do so, food must be taken in dissolved form [in water], which is being prepared by enzymes. [The carbon source must be an *energy-rich* substance previously synthesized by another organism.] In this fungi are similar to insects and spiders. Decomposition products of proteins can be used by most fungi as nitrogen sources. A number of fungi need additional nitrogen and thus grow on dung or parasitize on arthropods. To obtain nitrogen some have even developed ingenious mechanism for trapping microorganisms, such are amoebas, roundworms and rotifers.

A range of elements is required for normal growth. These include macronutrients such as potassium, phosphorus, magnesium, sulphur, and calcium, and micronutrients like iron, copper, manganese, zinc, and molybdenum. Oxygen and hydrogen are absolute requirements; they are supplied in the form of water or are obtained from carbohydrates. Fungi can do without boron, chlorine, fluorine, iodine and silicon, in contrast to plants, for which these elements are essential or physiologically promotive.

> The metabolism of fungi can be likened to that of animals, as it is destructive. The end is the total mineralization of the organic substances. In this the various kinds are able to work together in teams, one variety continuing the destructive process where the other leaves off. Only when understood as a unit can these complicated chain systems show their true functions which, taken all together, constitute the metabolism of the fungi.
>
> The green, assimilating plant raises dead, mineral substances into the realm of life, building up first carbohydrates, then proteins, fats, etc. The digestive activity of the fungi runs in exactly the opposite direction; it leads substances back - step-by-step - into the mineral state.
>
> From its darkness the Earth flowers and fruits through its fungi. The processes that normally terminate vegetative plant growth in the light, i.e. flowering and fruiting, have here sunk down into the soil and become independent. The process takes place at a different level. These fungi sometimes look like shapes born of a nightmare or coming from an underworld. Some seem harmless enough, others have frighteningly glaring colours. There is any amount of variety. Enticement and destruction seem

> to be embodied in them side by side, and they exert a strange fascination. Fungi can do nothing but grow and digest. They can make neither leaves nor stalks nor roots "because the sun does not bother with them."
> Many things point towards the fact that in fungi only earthly influences work, but not the cosmic light forces. Instead of the ethereal scent of a flower we can smell anything from spicy meat to a repulsive stench. Instead of bees and butterflies, we see flies, beetles and slugs feeding on the slimy substances of fungi and the decomposing by-products.
> [Grohmann 1974]

Light

Direct sunlight may be avoided and the sun may not bother with them, yet light is a necessary requirement for many fungi to form fruiting bodies or spores. The actual amount of light needed can be very small. In many cases a brief period of illumination during the early stages of development is all that is necessary; once started, the differentiation of the pileus can be completed in the dark. If the total illumination, however, is too small, growth may be retarded, but with larger amounts death may ensue. Not all species of fungi are equally sensitive to sunlight.
Phototropic fungi respond to the stimulus of light, e.g. by aiming their explosive sporangial mechanism at the light. The presence of light holds the promise of space, maximizing the chance that spores can be projected as far as possible from their launch pads.

> Some fungi in culture display daily rhythms of growth, pigment production, or sporulation, which seem to be responses to the alternation of light and darkness. … Since fungi grow in so many different habitats, and have such varied ecological requirements, it isn't surprising that we can't generalize on the link between light and sporulation. Light may inhibit, it may stimulate, or it may have opposite effects at different points of development. The effects of light have been investigated from two angles: which wavelengths are active [the action spectrum], and how much light is needed [the dosage response]. … Most phototropic fungi respond best to blue light. Some ascomycetes and conidial fungi respond to UV, but not to visible light.
> [Kendrick 2000]

Growing conditions

Fungi generally require an *acidic* environment [below pH of 7], while bacteria generally grow in basic environments [at or above pH of 7]. Fungi are very susceptible to drying. If weather conditions are favourable, fruiting bodies of fungi can spring from the soil overnight; but as fast as they come they disappear and dissolve again. No firm frame supports them, no hard shell protects them, and there is no kernel or pip within them.
Some fungi, on the other hand, can tolerate extreme dryness.

> Some conidial fungi [fungi that form their spores from a hyphal tip] and yeasts are the most xerotolerant [xero=dry] organisms known, able to grow at water activities [a_w] as low as 0.70. If we consider that most animals grow only above a_w 0.99, most green plants wilt irreversibly at a_w 0.97, and most bacteria will grow only at a_w 0.95 or higher, this must be recognized as a truly remarkable talent.
> [Kendrick 2000]

Lichens deal in another way with low water levels. They stop their activities and become dormant during long periods of drought, like hibernating animals.

Rapidity

The fruiting bodies of fungi develop with incredible speed. The embryo of higher fungi starts out as a small but compact latticework of filaments that can barely be seen with the naked eye. Yet the shapes of both the cap and stem are there from the very beginning.
Some fungi don't bother with division of cells or building up specialized tissues, but instead pump fluids into the cells to increase their size in one dimension by 10, 20, or 50 times. Others follow the strategy of just making more cells to increase the volume of the tissue. This explains why the development of fruiting bodies seems so abrupt.

Fungal frigidity

Mushrooms are usually regarded as "cold". At the end of the 19th century the German mycologist Richard Falck examined whether this is a subjective matter or an objective fact. He found that some mushrooms could be up to 9° C warmer than the surrounding air. Botanist Nicholas P. Money revisited the heating phenomenon one century later and came to the opposite conclusion.

> Mushroom temperatures were taken by inserting thin wire thermocouples between gills and spines, or up inside the tubes of boletes and other fruiting bodies with pores beneath their caps. A group of students became deeply involved in the work, and measured temperatures from the hymenial surfaces of eighteen types of mushroom in the beech-maple woodland surrounding my university campus in Ohio. Contrary to the earlier work, we found that the mushrooms were colder than the air. I couldn't accept this result for the first few days and kept looking for errors in our method. But the thermocouples were very accurate, and we confirmed that mushrooms cooled during periods of spore release. Cooling was most extreme on warm days, when gills chilled as much as 5° C, but it continued even on cold mornings in November. We then studied mushrooms grown in the laboratory and found that cooling was stimulated by the passage of air around the fruiting body. This suggested an evaporative mechanism of cooling - the origin of chill we experience after swimming.
> The warming measured by Falck was probably due to the decomposition of mushrooms that he had plucked from the woods and brought into the laboratory. I'd never noticed how cold mushrooms felt before our experiments. Now I can't walk by a fruiting body without touching its cap. Mushrooms often feel very cold. … Our experiments exposed the forest floor as a thermal mosaic, with mushrooms as its coldest inhabitants. …
> The loss of the water-dependent mechanism of spore propulsion enables gasteromycete fungi to colonize much drier habitats than other basidiomycetes, and many of them are found on sandy soils and even in deserts. For these fungi, water conservation makes more sense than evaporative cooling, and not surprisingly, the temperature of phallic mushrooms, puffballs, and earth-stars is the same as the air that surrounds them.
> [Money 2002]

Constant activity to maintain intimate relationship with environment

Fungi are essential for life on earth. They release, into soil or atmosphere, carbon, oxygen, nitrogen, and phosphorus, elements that otherwise would be forever locked up in undecomposed organic matter. In feeding on dead or decaying matter, fungi reduce complex organic compounds to simpler building blocks. Thereby, plants and eventually animals can re-use them. Thus, fungi are life-destroyers as well as life-givers. Existing life must die if new life is to flourish. Fungi bring life to forest floor and meadow both by their ability to draw nutrients to the living and by their capacity *to transform the dead*. Fungi are nature's recyclers, the soil's replenishers.

> With their rapid growth and filamentous form, fungi have a relationship to their environment that is very different from any other group of organisms. The surface-to-volume ratio of fungi is very high, which means that they are in as *intimate* a *contact* with the environment as are, for example, the bacteria. With a few exceptions, no part of a fungus is more than a few micrometers from its external environment, being separated from it only by a thin cell wall and the plasma membrane.
> With its extensive mycelium, a fungus can have a profound effect on certain aspects of the surroundings, for example, in binding soil particles together. The maintenance of this intimate relationship between fungus and environment requires that all parts of the fungus are metabolically active; the sorts of quiescent layers of tissue, such as wood, that are found in plants are absent in fungi. The enzymes and other substances that are secreted by fungi have an immediate effect on their surroundings and are of great importance for the maintenance of the fungus itself.
> [Raven et al. 1986]

Relationship to immediate environment - settling down

Fungi can be divided into three categories based on their relationship to their substrate [immediate environment]. Saprophytic fungi or *saprobes* live on dead or decaying matter; parasitic fungi or *parasites* absorb nutrients from living organisms; and *mycorrhizal* fungi or *mutualists* live in mutual beneficial symbiosis with other organisms.

Most serious fungus pests, such as wheat rust, ergot, blights, Dutch elm disease, fall into the category of parasites, but relatively few mushrooms [fungi with a fruiting body] are parasitic. Saprophytic fungi subsist on dead or decaying matter [wood, humus, soil, grass, dung, and other debris]. Mutualists form a mutually beneficial relationship with the rootlets of plants, shrubs or trees called mycorrhiza [from *myco,* fungus, and *rhiza,* root].

> Many plants, including almost all tree species, depend on a mutually beneficial symbiotic association with fungi for an adequate supply of water and mineral elements. Unassisted, the root hairs of such plants do not absorb enough of these materials to sustain maximum growth. However, the roots become infected with fungi, forming the association called a mycorrhiza.
> In ectomycorrhizae, the fungus wraps around the root; in endomycorrhizae, the infection is internal to the root, with no hyphae visible on the root surface. Infected roots characteristically branch extensively and become swollen and club-shaped. The hyphae of the fungi attached to the root increase the surface area for the absorption of water and minerals, and the mass of the mycorrhiza, like a sponge, holds water efficiently in the neighbourhood of the root.
> Most families of flowering plants contain some species that form mycorrhizae, as do liverworts, ferns, club mosses, and gymnosperms. Certain plants that live in nitrogen-poor habitats, such as cranberry bushes and orchids, invariably have mycorrhizae. Orchid seeds will not germinate in nature unless they are already infected by the fungus that will form their mycorrhizae. Plants that lack chlorophyll always have mycorrhizae, which are often shared with the roots of green, photosynthetic plants.
> The symbiotic fungus-plant association of a mycorrhiza is *important to both partners*. The fungus obtains important organic compounds, such as sugars and amino acids, from the plant. In return, the fungus greatly increases the absorption of water and minerals [especially phosphorus] by the plant. The fungus also provides certain growth hormones, and it protects the plant against attacks by microorganisms.
> Plants that have active mycrorrhizae typically are a deeper green and may resist drought and temperature extremes better than plants of the same species that have little mycorrhizal development. The partnership between plant and fungus results in a plant better adapted for life on land.
> [Purves et al. 1998]

Mycorrhizal fungi are host-specific. They cannot grow without their host[s] and their host[s] cannot grow without them. Plants deprived of their fungi grow slowly; many die. Trees deprived of their mycorrhizal partners do not compete successfully with those that have their normal complement. Such fungi have proved invaluable in reforestation projects. Attempts to introduce some plant species to new areas failed until a bit of soil from the native area [containing the fungus necessary to establish mycorrhizae] was provided. They literally help other organisms to settle down, to take root. Providing added resistance to certain diseases, mycorrhizal fungi have *immunostimulant* activities. In addition, many fungi produce substances - auxin, cytokinin, ethylene, gibberellic acid - that act as *plant growth* regulators.

STRENGTH and SURVIVAL

• Chitin is far more resistant to microbial degradation than is the cellulose found in plant cell walls. Its durability allows certain fungi to break through asphalt in tennis courts and to uproot paving stones.

> Mushrooms may be soft, but they have been known to lift stone slabs and force their way through tarmac. Back in the 1860s, a famous mycologist called M.C. Cooke wrote *A Plain and Easy Account of British Fungi* in which he told of “a large kitchen hearthstone which was forced up from its bed by an under-growing fungus and had to be relaid two or three times, until at last it reposed in peace, the old bed having been removed to a depth of six inches and a new foundation laid.” Not only 19th-century building standards are prone to fungal attack. …
> Reginald Buller, a Canadian researcher, did some experiments in the 1920s in which he put weights on the top of developing mushrooms to see how much pressure they could exert. He worked out that a single mushroom could apply a pressure of at least two-thirds of an atmosphere, which is about 10 pounds per square inch. It’s all a matter of hydraulics. The mushrooms can fill themselves with water and force their way through cracks and crevices.
> They are not doing it because of some perverse intention to break up pavement, but because in nature they need to push through soil and plant litter in order to bring their fruit bodies to a position from which they can release their spores to the winds. Evolution has equipped them with the tools that ensure that they will persist for generations.
> [Moore 2001]

• Strength is the quality that enables fungi to accomplish their remarkable exploits. It is also the quality that fungi transfer to either trees in reforestation projects, to lichens for surviving the most inhospitable environments, or to

Vikings, Siberian shamans [*see* Agaricus], Chinese athletes [*see* Cordyceps] or people with weakened immune systems [*see* Ganoderma].
Moulds are known for their resilience. In an experiment conducted in 1935, spores of seven moulds were loosely sealed into small quartz tubes fastened to the outside of the gondola of the Explorer II.
On the Explorer's return from an ascent to 72,395 feet, five of the moulds had their vitality unimpaired, though subjected for many hours to drying, extreme cold, strong light rays, ozone and low air pressure.

• Herbs or fungi that help the body adapt during times of stress are called *adaptogens* or *tonics.* Tonic properties of herbs [and fungi] are usually associated with a *bitter* taste. Tonics make the body more resilient and strengthen the body's natural defences.
Clinical results with Polyporus officinalis [= Fomitopsis officinalis] in cases of "obstinate intermittent fevers" and "those agues which have been aggravated by abuse of quinine" brought Burt [cited by Hale] to a similar conclusion: "The cases that the Polyporus will give us the best satisfaction in are those of long standing, that have been thoroughly saturated with Quinine and all kinds of remedies; where there is more or less disorder of the liver and abdominal viscera, with anaemia; sallow, jaundiced appearance of the skin; the bowels loose or torpid; but does better if the bowels are costive."

• Fungi affect the immune system. Some act as immunostimulants, whereas certain fungal secondary metabolites, such as *cyclosporin*, are used to depress the immune system in order to "give transplanted organs a better chance of being accepted by the body." Considering the strong fungal affinity for the immune system, it will not come as a surprise that fungal diseases [mycoses], e.g. candidiasis, occur predominantly in immunocompromised patients, just like fungal pests [parasites] flourish in immunocompromised ecosystems, that is on crops grown on soils weakened by monocultural demands and excessive employment of pesticides.
Strength requires energy. Fungi are such excessively energetic organisms because they live on *energy-rich* substances [saccharides] previously synthesized by other organisms. Fungi need to be excessively energetic because they

> … live in a hostile environment amongst decay on the harshest layer of the ecosystem. There, they encounter disease-causing pathogens far more frequently than other life forms. To survive, they must have proactive, healthy immune systems. Some scientists believe that the antipathogenic properties in mushrooms are precisely what make mushrooms valuable to the human immune system.
> [Halpern & Miller 2002]

• The Kuma tribe of New Guinea employ several mushrooms to evoke a state of excitement known as "mushroom madness." The men get "very excited and combative, to the point of threateningly brandishing their weapons and even lightly wounding others."
The women use other "weapons": they become "flirtatious and provocative, boasting of sexual exploits with members of their husbands' clans." Limitless in energy, both men and women are affected. [*see* Boletus]

• The Okanagan-Colville Indians of British Columbia and Washington were known to bathe their babies in a broth of mushrooms with the idea that like mushrooms, which are so strong they move rocks as they grow out of the soil, babies subjected to the broth would grow up strong enough to move men [Hobbs 1995].

FLEXIBILITY

Strength and constant activity to maintain an intimate relationship with the environment have made fungi in terms of evolution into a very successful group of organisms. Adaptability and flexibility have strongly contributed to this success. Through time fungi have kept their options open by avoiding irreversible specialization.

> A key feature during the embryology of even lower animals is the movement of cells and cell populations, so cell migration [and everything that controls it] plays a central role in animal development. Being encased in walls, plants cells have little scope for movement, and their changes in shape and form are achieved by regulating the orientation and position of the wall that forms when a plant divides. Fungi are also encased in walls, but their basic structural unit is a tubular, thread-like cell called a hypha.

The hypha has two peculiarities that result in fungal development being totally different from that in plants: it grows only at its tip and new walls form only at right angles to the growth axis of the hypha. …

Highly flexible developmental processes allow fungi to adapt to a wider range of conditions. The criterion for successful adaptation is successful production of spores, and even the most monstrously abnormal mushroom can do that. This is not true for animals and plants, where even mild abnormalities can reduce their ability to reproduce quite drastically. Fungi differ from animals and plants, therefore, by having much less selection pressure against developmental abnormality.

Development of a structure like a mushroom fruit body, flowering plant, or furry little animal involves individual cells undergoing different sorts of specialization to carry out different functions in the final structure. Generally speaking, this sort of cell differentiation involves successive steps that steadily reduce the options the cell can follow. Eventually, the cell has only one option: it is fully specialized for a particular function.

Early in this differentiation pathway, the cell retains the ability to revert back to the unspecialized 'embryonic' state, but as it progresses through its differentiation pathway, it becomes committed to that pathway and can turn back no more, which is another respect in which fungi differ from animals and plants. The only committed cells we've been able to find in mushrooms are those that make spores. All other cells, no matter how differentiated they become to particular functions, are able to revert to the simple original state if they are removed from the fruit body and put onto some nutritive artificial medium.

This is another evolutionary adaptation that permits flexibility. It allows the fungus to start over again if conditions really turn so nasty that continued development of the fruit body is not feasible. But this feeble grasp on their specialization also tells us something else unexpected about fungal developmental biology.

Because undisturbed cells in the fruit body do not revert to hyphal growth, their differentiated state is somehow continually reinforced while they are inside the fruit body. Rather than rigidly following a described sequence of steps, developmental pathways in fungi allow application of rules that allow great variability in expression. A sort of fuzzy logic in which decisions between possible pathways are made with a degree of uncertainty, being based on balancing probabilities rather than all-or-none switches.

Fungal cell differentiation is no less sophisticated or complex than is found

> in animals and plant, but it is very different. Fungi can vary the timing, extent, and mode of differentiation in response to external signals. They can swap growth forms and procreative phases of their life cycle. It all contributes to making them supremely able to adapt to challenging conditions.
> [Moore 2001]

In resilient communities such as forests, capable of changing through time in response to changing conditions, fungi are the instruments of much of this dynamism. When environmental change is too extreme or too rapid, not in the last place from disruptions to the forest environment by human activity, the fungal response can damage, even destroy the forest. Ultimately bringing the fungus and tree populations back to a balanced condition in disrupted communities, disease epidemics do not occur in communities where fungi and their host trees have adapted to each other and their environment.

KEYNOTE: ***Supreme ability to adapt to challenging conditions and to restore balance.***

COLONIZERS

Lichens manage to survive in the most extreme environments, often on bare rock. They grow in the driest deserts and the coldest, windiest mountaintops throughout the world, places that are inaccessible to other organisms. Such organisms are termed *colonizers* or *pioneers*; they represent the first step in developing a biotic environment where there was only an abiotic one. Lichens still fulfil this role, while:

> Without the plant-fungus partnership, the very colonization of the land by higher plants and animals, 450 to 500 million years ago, probably could not have been accomplished. The barren, rain-lashed soil of that time was not hospitable to organisms more complex than bacteria, simple algae, and mosses. The earliest vascular plants were leafless, seedless forms that superficially resembled modern-day horsetails and quillworts. By allying themselves with fungi, they took hold of the land.
> [Wilson 1992]

Colonizing and exploring is what fungi do for their business. Hyphal growth allows the fungus to colonize a food source as well as to grow from one food source to another. Depending on the substrate and the nature of the fungus - mycorrhizal or parasitic - these characteristics are either a blessing or a curse. As the natural equivalent of “networking” and “connecting people” [the slogan of a telephone manufacturer], mycorrhizal fungi are so abundantly present in lush lowland forest soil that they connect the trees together, so that trees and their seedlings can exchange food and messages. On the other hand, the fungal urge to explore grows *invasive* and *rampant* when the substrate involves structures that are designed to last, e.g. houses. Some fungi can degrade almost everything we make, with the Serpula lacrymans, the dry rot fungus, as a nightmarish example.

> Groups of hyphae [of Serpula] join together along their lengths to form strands. Some of these can reach a thickness of 5 millimetres or more. The strands are invasive, and the cells of which they are made cooperate to grow away from the food source that is already infected to find other food sources. … In a real sense, the strands are explorers, and if wood is reached in a strand’s wandering, it is immediately attacked and eventually destroyed.
> The strands are what make Serpula so dangerous. Strands can penetrate through the pores in bricks, cement, and stones, under tiles and other flooring, over plaster and other ceilings, and across anything that provides mechanical support. In the laboratory, strands have been grown across a full meter of totally dry plasterboard, and they can do this as long as the originally infected wood continues to provide nutrition to the explorer.
> [Moore 2001]

Fungi ensure survival by producing astronomical numbers of spores. More by hit than by wit, at least a few will land in a place suitable to germinate. To avoid having to embark on a random search for a new substrate, however, some fungi have equipped their spores with special talents to find a host by actively tracing it.
Resistant to desiccation and designed to survive long trips, fungal spores cover distances far in excess of the distances covered by the larger and less portable seeds of the flowering plants.

> Survival of the fittest requires that a species not only out-eat and out-fight its neighbours, but also maintains the ability to spread into new territories. The farther a species travels, the more likely it is to find new sites for growth and development. Nature is not just "red in tooth and claw" - it is filled with wanderlust as well. The mushrooms are a fine example of this strategy.
> [Schaechter 1997]

Wanderlust! Can the tuberculinic nature of fungi be better expressed? [McIlvaine looks upon the species Lentinus lepideus as "a sort of commercial traveller" because it is "common wherever railroads are."]

FOOD and ALCOHOL

Lower fungi - yeasts and moulds - and their secondary metabolites or enzymes become increasingly important in food processing and the production of pharmaceuticals. The manufacture of bread, beer and wine depends on the activities of the yeast-genus *Saccharomyces*.
Soft-ripened cheeses and blue cheeses are produced by fungi. The former kinds include Camembert and Brie, both ripened by the moulds *Penicillium camembertii* or *Penicillium caseiolum*, which form a dense white mycelial mat on the surface of the cheese and whose milk–protein-digesting enzymes give the cheese its soft consistency. Blue cheeses - Roquefort, Stilton, Gorgonzola, Danish Blue, Blue Cheshire, Blue Castello - are ripened by *Penicillium roquefortii*, which grows as blue-green veins throughout the cheese, producing its unique pungent flavour and its penetrating odour. Yeasts that grow on the surface of Limburger cheese [Constantine Hering's favourite cheese] provide aroma.
Where for the production of hard cheeses animal enzymes [called rennet], traditionally extracted from the stomach membranes of unweaned ruminants, were used to curdle the proteins in milk, the rapid expansion of the modern cheese-making industry necessitated the development of alternative sources of rennet. And what could better meet such rapid expansion than typically expansive organisms like fungi? Moulds like *Mucor* and *Aspergillus* supply milk protein coagulants to the extent that around 80 percent of cheese making now uses them.
Acidity regulators such as citric acid and fumaric acid, widely used in foods

and soft drinks, are produced on an industrial scale by the moulds *Aspergillus niger* and *Rhizopus nigricans*, respectively. Aspergillus niger is also the active ingredient of "Beano", a product designed to metabolize the galactose in beans or brassicas and so prevent flatulence when eating such foods.

A mould now being produced commercially as a meat substitute is *Fusarium graminearum,* marketed under the name "Quorn", which contains a large amount of protein compared to other fungi - about 12 percent.

In the conversion of cabbage, green olives, and cucumbers into sauerkraut, cured olives, and pickles, the microbial actions of lactic acid bacteria are followed by fermentation by the yeasts *Saccharomyces* and *Torulopsis*.

Fungus-fermented soy foods and condiments - soy sauce, miso, tempeh, ketjap, and hamanatto - form an essential part of the diet in Asian countries. The Japanese begin their day with a fortifying bowl of miso soup and use this rich, salty condiment to flavour a variety of foods in other meals throughout the day.

To make miso, soybeans and grains such as rice or barley, are combined with salt, a mould culture [*Aspergillus oryzae*] and a yeast [*Saccharomyces rouxii*] and then aged in cedar vats for one to three years. Aspergillus oryzae is also involved in the manufacture of hamanatto, soy sauce and its Indonesian variety ketjap, while another mould, *Rhizopus oligosporus*, is employed for the production of tempeh, a kind of soybean cheese.

ALCOHOL and URINE

Fungi and alcohol are closely related. Lower fungi such as yeasts produce alcohol - alcohol and carbon dioxide are by-products of the respiration of yeast - just like quite a number of fungi evoke a state of inebriation [drunkenness, intoxication]. The active components of the fly agaric are excreted unchanged with the urine, so that it has been common practice, at least in Siberia, to drink one's urine after ingesting the mushroom or the urine of another person who had taken the mushroom. The same occurs after ingestion of psilocybian mushrooms, but to a lesser extent; 25% of psilocine is excreted in the urine.

The Soma of the Rig Veda, suggested by Gordon Wasson to have been the fly agaric, in the form of a potion - urine - was offered as a drink, which would make the imbiber immortal. Rather than with immortality urine is now associated with drunkenness or foolishness. Getting pissed refers to getting extremely drunk and a person who is behaving in a foolish or time-wasting way is said to 'piss about', while a 'piss artist' is someone who drinks heavily or a foolish show-off.

PHARMACEUTICALS

Many fungi cause diseases in humans, animals and plants. But just as many fungi yield products useful to humans. Moulds like *Rhizopus nigricans* and *Curvularia lunata* bring about chemical transformations of compounds, especially steroids such as cortisone, hydrocortisone and prednisone, in a reliable and reproducible way. The mould *Aspergillus terreus* produces a substance called lovastatin that acts as a cholesterol-lowering agent by interfering with enzymes that make cholesterol in mammals. Fungi also produce antitumour agents and immunoregulators. Ergot alkaloids, derived from the parasitic fungus *Claviceps purpurea*, have a variety of applications: migraine headaches, high blood pressure, Parkinson's disease, endocrine disorders, and prevention of postpartum haemorrhage.

The best-known fungal secondary metabolite, no doubt, is penicillin. The first penicillin was extracted from *Penicillium notatum* in the 1940s, after Sir Alexander Fleming had isolated the mould in 1927. It was found that *Penicillium chrysogenum* produced much more penicillin than P. notatum. Even higher-yielding strains were soon selected, resulting in the commercial production of penicillin G, penicillin V and [semisynthetic] beta-lactam antibiotics. In the 1960s, a new kind of beta-lactam antibiotic was isolated from the marine mould *Cephalosporium* and named cephalosporin. During the 1950s the antifungal narrow-spectrum antibiotic griseofulvin, derived from *Penicillium griseofulvum*, came into use to combat dermatophyte infections of skin or nails [tineas]. Treatment needs to be very prolonged and side effects include gastrointestinal disturbances, headache, photosensitivity and allergic reactions [rashes, fever].

NUTRITIONAL VALUE

The nutrient composition of edible mushrooms, wild or commercially cultivated, varies somewhat according to species. Benjamin summarizes the

nutritive value as:
- For overall nutrition, mushrooms fall between the best vegetables and animal protein sources.
- Mushrooms consist largely of water [85-95%].
- The protein content of mushrooms is 15-40% of dry weight.
- All essential amino acids are present in mushrooms.
- Fat-soluble vitamins [A, D, E, K] are present in small quantities.
- Water-soluble vitamins [B-group except B12, biotin; vitamin C] are well represented.
- All the important minerals are present, except iron, which occurs in negligible amounts, except in yeast and some higher fungi. Sodium, potassium, and phosphorus are particularly abundant.
- Carbohydrates are major components, averaging 40-60% of the dry weight.

Hering found that certain tissues need certain condiments. “There remains muscular weakness from all sickness. In such cases a diet of mushrooms will be beneficial. They contain potash and phosphoric acid in a high percentage, which restore muscular tissue. For travellers on foot, rowers, and mountain climbers, they prove a restorative of wasted muscular tissue.”

FUNGOPHOBIA

In the western world, mushrooms and toadstools are inevitably dragged in for describing fear, loathing, total revulsion, and imminent death. Linnaeus saw fungi as “thieving and voracious beggars which seize upon the odds and ends which plants leave behind them when Flora is leading them into their winter quarters.”

“Like snakes, slugs, worms, and spiders, they are regarded as unearthly und unworthy, despicable and inexplicable - the vermin of the vegetable world,” observes David Arora. Mushrooms were closely allied with toads and witches, both regarded as inherently dangerous and evil. It was a common belief in Brittany that the foul materials of the ground engendered both toads and fungi.

Irrational fear of fungi - fungophobia - seems to be particularly common amongst the British. William Delisle Hay, an astute Englishman, expressed it this way in *British Fungi* [1887]:

> Among this vast family of plants, belonging to one class, yet diverse from one another, comprising more than a thousand distinct species indigenous to the islands, there is but one kind that the Englishman condescend to regard with favour. The rest are lumped together in one sweeping condemnation. They are looked upon as vegetable vermin, only made to be destroyed. No English eye can see their beauties, their office is unknown, their varieties not regarded. They are hardly allowed a place among nature's lawful children, but are considered something abnormal, worthless, and inexplicable.
>
> By precept and example children are taught from earliest infancy to despise, loathe, and avoid all kinds of 'toadstools.' The individual who desires to engage in the study of them must boldly face a good deal of scorn. He is laughed at for his strange taste among the better classes, and is actually regarded as a sort of idiot among the lower orders. No fad or hobby is esteemed so contemptible as that of 'fungus-hunter,' or 'toadstool-eater.'
>
> This popular sentiment, which we may coin the word 'fungophobia' to express, is very curious. If it were human - that is, universal - one would be inclined to set it down as an instinct, and to revere it accordingly. But it is not human - it is merely British. It is so deep and intense a prejudice that it amounts to a national superstition. …
>
> It is a striking instance of the confused popular notions of fungi in England that hardly any species have or ever had colloquial English names. They are all 'toadstools,' and therefore are thought unworthy of baptism. Can anything more fully demonstrate the existence of that deep-rooted prejudice called here 'fungophobia'? …
>
> [cited by Benjamin, 1995]

Fungi hold a special place of fear in the hearts of the British and to others who trace their descent from the subjects of Richard the Lionheart. These lowly members of the Fungi kingdom were, and still are, in English-speaking countries largely overlooked for any utilitarian purpose. Herbalist John Gerard [1545-1612] expressed the general opinion about "mushrumes or toadstooles" in his major work, the *Herball or General Historie of Plantes* [1597], by stating that:

> They that be not deadly have a gross slimy moisture that is disobedient to nature and digestion and be perilous and dreadful to eat and therefore it

is good to eschew them.

To criticise people who "hunger after the earth's excrescences called mushrooms" Gerard wrote:

> Galen affirms, that they are all very cold and moist and therefore do approach unto a venomous and murdering faculty, and engender a clammy, pituitous [slimy], and cold nutriment if they be eaten. To conclude, few of them are good to be eaten, and most of them do suffocate and strangle the eater. Therefore I give my advice unto those that love such strange and new fangled [foppish] meats, to beware of licking honey among thorns, lest the sweetness of the one do not countervail the sharpness and pricking of the other.

More than 400 years later fungophobia still can go disguised as dietary advice. Robert Young, for instance, issues the warning to "avoid mushrooms of all kinds, truffles, etc." because "these foods are all acid-forming and contain mycotoxins." The unsubstantiated allegation continues with: "Contrary to popular belief, there is no such thing as a good fungus.

The edible ones are just less poisonous than the ones that kill you immediately!" Eager to prove his point that all fungi cause disease, Young throws in some more absurdities for good measure: "Mushrooms contain varying amounts of *amanitin*, the mycotoxin in all mushrooms. Eaten in small amounts it will kill you slowly. In larger amounts it will kill you almost instantly." With such defective judgement to distinguish the true from the false Young indeed exemplifies the whole idea of fungi.

Fungophobal prose and poetry

Numerous examples of prose and poetry directed against mushrooms are readily found in English literature. The English poet Percy Bysshe Shelley [1792-1822] described in *The Sensitive Plant* [1820] the final dissolution of a beautiful garden due to it being neglected after the death of its lady guardian, using mushrooms images as a metaphor of total disintegration and decay:

> Plants to whose names the verses feel loath
> Filled the place with a monstrous undergrowth,
> Prickly and pulpous and blistering and blue,

And agarics and fungi and mildew and mould
Started like mist from the wet ground cold,
Pale fleshy as if the decaying dead
With a spirit of growth had been animated.

Their moss rotted off them, flake by flake,
Till the thick stalk stuck like a murderer's stake,
Where rags of loose flesh yet tremble on high,
Infecting the winds that wander by.

The images of dreadful dreariness, death, decay and dissolution aroused by mushrooms highlight the gloomy-ghostly atmosphere in a passage from *Sir Nigel* [1906], a novel by the British physician and creator of Sherlock Holmes, Sir Arthur Conan Doyle [1859-1930].

> The rain had ceased at last, and a sickly autumn sun shone upon a land that was soaked and sodden with water. Wet and rotten leaves reeked and festered under the foul haze which rose from the woods. The fields were spotted with monstrous fungi of a size and colour never matched before - scarlet and mauve and liver and black. It was as though the sick earth had burst forth into foul pustules; mildew and lichen mottled the walls, and with that filthy crop, Death sprang also from the water-soaked earth.

For D.H. Lawrence [1885-1930], English novelist, poet and essayist, fungi were suitable metaphorical tools to belittle the British bourgeoisie in *How Beastly the Bourgeois Is* [1923].

How beastly the bourgeois is
especially the male of the species –

Nicely groomed, like a mushroom
standing there so sleek and erect and eyeable –
and like a fungus, living on the remains of bygone life,
sucking his life out of the dead leaves of greater life than his own.

And even so, he's stale, he's been here too long,
touch him, and you'll find he's all gone inside
Just like an old mushroom, all wormy inside, and hollow

under a smooth skin and an upright appearance.
Full of seething, wormy, hollow feelings
rather nasty –
How beastly the bourgeois is!

Standing in their thousands, these appearances, in damp England
what a pity they can't all be kicked over
like sickening toadstools, and left to melt back, swiftly
into the soil of England.

And American poet Emily Dickinson [1830-1886]:

Had nature any outcast face
Could she a son condemn
Had nature an Iscariot
That mushroom - it is him.

Embodiment of bad properties

Animals and plants are commonly used in expressions denoting positive human qualities. Fungi, on the other hand, express implicitly unwanted or undesirable things. The ancient Greeks, for example, referred to their compatriots as being like mushrooms, having noted the similarity between "sphongos" [from which the Latin word 'fungus' is derived] and certain doltish, softheaded people.

> When an animal achieves disembodied immortality by becoming a verb, human speakers usually honour its behaviour: we hawk our wares, gull or buffalo our naïve competitors, hounds our adversaries, and clam up in the face of adversity; we have also been known to man the barricades and kid around with our companions. But plants and other rooted creatures do not feature so great a range of overt action, and our botanically based verbs therefore tout growth and appearances as sources of metaphor.
> Consider the two most prominent examples, citing comparable phenomena but with such different meanings - for one usually expresses our joy and the other our fear. Art and prosperity 'flower'; taxes and urban violence 'mushroom.' The burden of difference reflects an obvious in our culture and legends. We love the bright colours of the 'higher' plants, either radiant in the sunlight or jewel-like in the quiet darkness of the forest. We loathe the

> spongy, fruiting bodies of 'lowly' fungi, growing in dank dampness, sprouting in cancerous formlessness from rotting logs. [Even a colourful mushroom usually strikes us as sinister rather than lovely.] I well remember a common schoolyard taunt, often cruelly directed at unloved classmates. "There's a fungus among us" – a cry that always inspired the ritual retort: "Kill it before it multiplies."
> [Stephen Jay Gould - "A Humongous Fungus Among Us," *Natural History,* July: 10-17, 1992; cited by Benjamin.]

The grotesque and bizarre shapes of fungi, their abundant diversity in form and size, their staggering play of hues, tints and shades, their ephemeral existence, their sudden overnight appearance and extraordinarily rapid growth, their tendency to manifest themselves in the most unusual places, gave rise to associating them with the unearthly world of fairies, elves and witches. Common names for mushrooms still reflect this, e.g. Witch's Butter [Tremella spp.], Witch's Hat [Hygrocybe conica], Elfin Cups, Elfin Saddle or Elfin Saucer [Helvella spp.], Eyelash Pixie Cup [Scutellinia scutellata], Hairy Fairy Cup [Humaria hemispherica], Fairy Bonnet [Coprinus disseminatus], Fairy Club or Fairy Fingers [Clavaria spp.], Fairy Fan [Spathularia flavida], Fairy Hair [Macrotyphula juncea], Fairy Stool [Coltricia cinnamomea], and Fairy Tub [Peziza sylvestris].

Names can be descriptive. Latin binomials applied to the fungi denote birds' nests, navels, eyes, ears, tongues, phalli, fingers, feet, hair, manes, etc. Among the peculiar shapes of fungi are many that resemble certain animals or parts of animals. The Fungi kingdom represents a complete zoo, including bulls, chickens, crocodiles, deer, dogs, donkeys, elephants, goats, hedgehogs, horses, lions, lizards, lobsters, magpies, octopuses, oxen, oysters, pigs, rabbits, sheep, shrimps, and turkeys.

FUNGAL LORE

Fungi tend to spread their mycelium equally in all directions. This predilection for circular growth is demonstrated by the round mouldy patches on fruits and bread, the ringworm on bare skin and the fairy rings in meadow or forest. Fungi expand in ever-increasing circles, often with concentric zones. The formation of a fairy ring has been aptly compared with the regular spreading of

fire when, on a still day, a lighted match is dropped in dry grass. A fairy ring is usually bordered by vegetation of a more vigorous growth [probably due to growth-stimulating plant hormones produced by the fungus], while that within the area of the ring is often quite rank and stunted. A similar pattern can be detected in "herpes circinatus": the vesicles of ringworm appear in the form of a circle, the centre of which is fading, while on the periphery the vesicles are spreading. "Sometimes, however," states Raue, "there is one larger vesicle, which not infrequently is filled with a bloody fluid, right in the centre of the ring, and around the ring appears still another larger ring."
It is a mystery why mushrooms [or vesicles] are seldom seen inside the ring. "At first glance, this may seen obvious," observes Schaechter, "the center areas have either run out of food or have accumulated substances that inhibit the fruiting of mushrooms from the fungal growth in the soil. But some fairy rings are hundreds of years old [and cover many acres of land, as, for example, in the pastures by England's Stonehenge], which begs the question of why, after so much time, the original state of fecundity has not been re-established inside the circle.

At any rate, the timeless captivation of fairy rings has resulted in a hotchpotch of conjectures, beliefs and superstitions.

> That in England was that the circular growths marked the paths of dancing fairies … and that they brought good luck to the houses built in fields in which they occurred. French peasants could not be induced to enter the rings because enormous toads with bulging eyes abounded there … In Germany the bare portion of the ring marked the place where a glowing dragon had rested after his nocturnal wanderings. A very prevalent belief was that such rings marked the presence of treasures which could not be obtained without the aid of the fairies or witches. The earliest scientific explanations were almost as fantastic - thunder, lightning, whirlwinds, ants, moles, haystacks, animal urine and such being considered the causal agents.
> [Ramsbottom 1923]

Welsh folktales describe the fate of mortals who enter the ring. He finds within the ring a group of spirits [fairies] and is forced to dance with them. When released and allowed to return home, he finds strange people living there. The disoriented traveller is offered bread. Upon eating it, the passage of time that he has been away manifests itself in his body and he crumbles to dust. The land of the spirits operates on a different time scale than our world. A moment of fairy time represents an eon of mortal time.

FUNGOPHILIA

Dealing with fungi is for the British a hard nut to crack, whilst the Russians are absolutely nuts about them. Mushrooming is a commonplace tradition in Russia, as well as in other Slavic cultures, and a joyful and pleasurable experience. The forest hunt, or "silent hunt", provides relaxation and joy for the whole family. No corner of the forest is left unexplored. Boletes, milk caps [Lactarius spp.] and some other species are of special value. They have to be cut, not pulled out of the ground, so that the mycelium remains and others will grow in their place. The real work begins at home, where hours are spent on sorting, washing and drying the precious harvest. They can be dried and used for hot soups in the cold winter. In the villages whole mushrooms are put on threads and hung up to dry in the sun.

They can also be marinated or salted to eat with trimming [usually potatoes]. Much appreciated in combination with vodka, mushrooms can be ordered in all restaurants that serve Russian cuisine. Unfortunately, many cases of mushroom poisoning occur. Even good mushrooms become inedible because of the bad ecology. In the region of Chernobyl strange mushrooms, mutants, have appeared, which, allegedly, are very harmful.

Mushrooms play an important role in Russian folk medicine. For centuries people have made tinctures - crumbled fly agaric [Amanita muscaria] steeped in vodka for two weeks - to alleviate joint pains [external use].

Featuring as permanent characters in Russian fairy-tales, edible mushrooms are usually very attractive, kind forest creatures, whilst poisonous mushrooms, such as toadstools and fly agarics, are obligatory attributes of such evil, dark forest-forces as witches and goblins.

MUSHROOMS of IMMORTALITY

Further to the east, the Chinese and Japanese have ancient traditions of eating wild fungi and cultivated species, both for culinary and medicinal purposes. China has the longest tradition, going back some 5000 years. It is impossible to imagine life today in China and Japan without fungi. In contrast to other cultures, where the mushroom stands for anything short-lived - "a one day mushroom" - mushrooms, in particular woody [bracket] fungi, are symbols of longevity in China.
These magical mushrooms, called *chih*, last a very long time when they are dried and therefore were considered to be "herbs of deathlessness." Should they be eaten, one would immediately attain long life and immortality. A mushroom was one of the attributes of the god of longevity. The Immortals ate them, together with cinnamon, gold and jade. Mushrooms gave the Immortals "bodily lightness." There were supposed to be 120 kinds of mushroom chih, which ranged in potency, producing a short longevity of 100 years, up to the potent forms that ensured a life of over 1,000 years.

SACRED MUSHROOMS

The use of mushrooms in Mexico for the purpose of divination and healing has deep roots in centuries of native tradition. Archaeological artefacts called "mushroom stones", excavated from highland Mayan sites in Guatemala and dating from about 500 BC, reveal the existence of a sophisticated mushroom cult at such an early date. Sacred mushrooms were called *teonanacatl* by the Aztecs, which, according to Schaechter, "means 'dangerous mushroom' but which has been grandly translated as 'flesh of the gods'."

> The Spanish conquerors of Mexico were much disturbed by an important religious cult based on the sacramental consumption of sacred mushrooms. The Indians communed with the spirit world through the mushroom-induced hallucinations. Divination, prophecy, and curing rites likewise depended on the narcotic effects of these fungi. As with other Mexican religions that utilized inebriating plants, European persecution drove the mushroom cult into hiding in the hinterlands. Most of the early chroniclers were clerics who emphasized the need for stamping out such a loathsome custom as the sacramental eating of toxic mushrooms.

> As mycophobes, their religious fanaticism was easily directed towards a despised form of plant life which, through its vision-inducing powers, held the Indian in awe. There was little that Christianity could offer comparable in the Indian mind to the supernatural power of the mushrooms. …
> One of the first European references to teonanacatl mentioned mushrooms "which are harmful and intoxicate like wine" so that those who partake of them "see visions, feel a faintness of heart and are provoked to lust." The natives were reported to eat the mushrooms with honey and "when they begin to be excited by them start dancing, singing, weeping. Some … see themselves dying in a vision; others see themselves being eaten by a wild beast, others imagine that they were capturing prisoners of war, that they are rich, that they possess many slaves, that they have committed adultery and were having their heads crushed for the offence." …
> Despite the great age of the mushroom cult and the numerous detailed and forceful Spanish reports of this curious use of the fungi, our knowledge of their identification, utilization, and chemistry is all recent.
> [Schultes & Hofmann 1980]

"As pilgrims seeking the Grail," R. Gordon Wasson and his wife did much to unravel the mysteries surrounding the sacred mushrooms. Their publications on the subject had an unwanted side effect: legions of adventurers, spiritual seekers and sensationalists popped up like mushrooms. "Following my article in *Life*," wrote Wasson, "a mob of thrill-mongers seeking the 'magic mushroom' descended on Huautla de Jiménez - hippies, self-styled psychiatrists, oddballs, even tour leaders with their docile flocks, many accompanied by their molls. … Countless thousands elsewhere have taken the mushrooms [or the synthetic pills containing their active agent] and the chatter of some fills the nether reaches of one segment of our 'free press.' I deplore this activity of the riffraff of our population but what else could we have done?"
The search for mind-travel-inducing "Liberty caps" had begun.

INDIA

R. Gordon Wasson championed the notion that hallucinogenic mushrooms were prime factors in the early development of human consciousness. He and his collaborators claimed that the Greek Eleusinian rites were inspired by the drinking of a Claviceps-containing potion; that Mexican religions were based on the use of sacred mushrooms and that soma, a plant whose juice was used by Vedic Indians in preparing an exhilarating ritual beverage, was actually Amanita muscaria. Although Wasson's research is exhaustive and authoritative, other researchers come up with proof to the contrary.

> If Wasson is right, we are dealing with a mushroom that was highly regarded, consumed by Brahmins, and even deified in ancient India. On the other hand, many peoples around the world associate mushrooms with decayed matter and regard them as little different from carrion and other "rotting, decaying, or dying" substances that disgust people and make them seek to keep these substances from entering their bodies. Such views have also been common in India, where Hindus are virtually concerned with pollution brought on by dead and decaying things.
> Thus, mushrooms were among the forbidden foods of the Dharma-sutras [composed from about 500 BC to AD 600], which group mushrooms with alliums as deriving from impure substances. They liken mushrooms to such disgusting or unlawful foods as excrement of a pig, flesh of humans or carnivorous animals, food touched by crows or dogs, or the leavings of Sudras. They are improper for a twice-born man to eat, and if he does so, penance is required and he may even become an outcast. If a person wishes to remain pure when he has eaten banned food unintentionally, he should vomit it up or quickly undergo purification.
> Though mushrooms are widely eaten in present-day India, their association with decay remains a concern to persons aspiring to ritual purity. People of one North Indian village have a somewhat different perspective on mushrooms and pollution. They call mushrooms by a word meaning that they grow in places where dogs urinate. Since Brahmins look on dogs as unclean, this contributes to the impurity of mushrooms. Another suggestion is that Brahmins may reject mushrooms because of their odour or because they are cooked like meat and have a flavour like meat.
> [Simoons 1998]

Bold
Curious
Danger-seeking
Uninhibited by conventional wisdom

CROSSING BRIDGES

Mankind has always had a love-hate relationship with fungi.
A striking example of a fungophobe turning fungophilic is R. Gordon Wasson. The son of an Episcopalian minister, Wasson made a successful career as an investment banker. In 1926, he married a Russian paediatrician,

Valentina Pavlovna, who brought him into contact with mushrooms. It triggered a lifelong search for references and practices involving mushrooms and of cultures manifesting either a great loathing of mushrooms or else a proclivity to treasure them. The Wassons initiated ethno mycology and are leading authorities on the subject of sacred mushrooms.

> Those who do not know the story will be interested in learning how it came about that my late wife, a paediatrician, and I, a banker, took up the study of mushrooms. She was a Great Russian and, like all of her countrymen, learned at her mother's knee a solid body of empirical knowledge about the common species and a love for them that is astonishing to us Americans. Like us, the Russians are fond of nature. But their love for mushrooms is of a different order, a visceral urge, a passion that passes understanding.
>
> The worthless kinds, the poisonous mushrooms - in a way, the Russians are fond even of them. They call these "worthless ones" *paganki*, the "little pagans," and my wife would make of them colorful centrepieces for the dining-room table, against a background of moss and stones and wood picked up in the forest. On the other hand, I, of Anglo-Saxon origin, had known nothing of mushrooms. By inheritance, I ignored them all; I rejected those repugnant fungal growths, manifestations of parasitism and decay. Before my marriage, I had not once fixed my gaze on a mushrooms, not once looked at a mushroom with a discriminating eye. Indeed, each of us, she and I, regarded the other as abnormal, or rather subnormal, in our contrasting responses to mushrooms.
>
> A little thing, some will say, this difference in emotional attitude toward wild mushrooms. Yet my wife and I did not think so, and we devoted a part of our leisure hours for more than thirty years to dissecting it, defining it, and tracing it to its origin. … Many have observed the difference in attitude toward mushrooms of the European peoples.
>
> Some mycologists in the English-speaking world have inveighed against this universal prejudice of our race, hoping thereby to weaken its grip. What a vain hope! One does not treat a constitutional disorder by applying a band-aid. We ourselves have had no desire to change the Anglo Saxon's attitude toward mushrooms. We view this anthropological quirk with amused detachment, confident that it will long remain unchanged, for future students to examine at their leisure. …
>
> Mushrooms are widely linked with the fly, the toad, the cock, and the

> thunderbolt; and so we studied these to see what associations they conveyed to our remote forebears. … Since we began to publish, in 1955, people from all walks of life have come to us in increasing numbers to contribute information, and often the contributions of even the lowliest informants have been of the highest value, filling lacunae in our argument. We were amateurs, unencumbered by academic inhibitions, and therefore we felt free to range far and wide, disregarding the frontiers that ordinarily segregate the learned disciplines. What we produced was a pioneering work.
> [Wasson 1968]

Whether the deep contact with fungi brought up a fungus-mentality in Wasson, or whether such a mentality resulted in his life-long mushroom quest, is a matter of the hen or the egg. It just proves that the internal corresponds with the external and vice versa.

The fact is that Wasson put some typical aspects of the fungus-mentality aptly into words. Slightly remodelled, we get this: *Unencumbered by inhibitions, we felt free to range far and wide, disregarding the frontiers.* Could fungi speak for themselves, the odds are that they would say the same.

MEDIATORS

Fungi are mediators, effecting a reconciliation of whatever binary opposition they are involved in. As hermaphroditic, they mediate male versus female; as cultivatable organisms, they mediate wilderness versus civilization; as edible poisons, they mediate life versus death.

A widespread belief has it that mushrooms appear where lightning strikes the earth. The thunderbolt of Zeus or Donar is itself a mediation between the celestial realm and earth.

DANGERS of FUNGI

The early classical authors had little system for identifying and classifying plants and animals. The Roman scientist Pliny the Elder [23-79], author of the *Natural History*, tended to lump together animals and plants in order of size. One of the mysteries with which ancient man had to contend was the

mysterious appearance of fungi that emerged in a matter of hours from nothing more than bare wood, rotting leaves, or a pile of dung.
Such manifestations of nature were difficult to explain, the more since fungi have neither roots nor seeds. For Pliny fungi, particularly truffles [Tuber spp.], were "imperfections of the earth." Two centuries earlier, Nicander [ca. 150-200 BC] had written that the hot central core of the earth generated mushrooms on the surface by rarefying the muds, resulting in excrescences that Nicander regarded as "evil ferments".

An early "classification system" was the division of fungi into edible or poisonous. According to William Emboden, "every Roman and Greek commentator spoke of the danger of fungi, but many of their compatriots ignored their warnings and experimented with this delicacy. A mushroom collector might be appointed to a wealthy family, and his life depended on his ability to procure a variety of edible fungi for the household." Pliny over-simplified matters by stating that all fungi of a livid hue were poisonous and that the best of the edible ones were those that turned red.
That this "system" inevitably led to misidentification is shown by the numerous recorded cases of people who were "strangled" [respiratory failure or asphyxia] by eating mushrooms. Mushroom tasters were just as little a safety warranty, to the detriment of Claudius Caesar [Tiberius Claudius the Emperor], whose untimely demise was reportedly due to a fungal repast prepared for him by his [fourth] wife Agrippina and his stepson Nero. The dish of Claudius's beloved Caesar's mushrooms [Amanita caesarea], liberally laced with Amanita phalloides [Death Cap], had been passed by Claudius's trusted taster, the eunuch Halotus, because the first symptoms of the Death Cap poisoning take eight to 24 hours to develop.
The Death Cap paved the way for Claudius to become a god, for it was reported that he ascended into heaven upon his death. Nero, the co-conspirator, is known to have remarked when hearing mushrooms at a banquet being described as *the food of the gods,* "Oh, yes indeed, it was fungi that made my father a god!" - a term, curiously enough, that was independently used by Central American Indians at that same time.

In the 16th century it became commonplace to refer to edible fungi as "mushrooms" and to poisonous species as "toadstools", a distinction which, however, has no scientific basis. How such a distinction came about is told by a tradition current in Poland and adjoining regions.

> When Christ and Peter were passing through a forest after a long journey without food, Peter, who had a loaf in his sack but did not take it out for fear of offending his Master, slipped a piece in his mouth. Christ, who was in front, spoke to him at that moment and Peter spat out so that he could answer. This occurred several times until the loaf was finished. Wherever Peter spat out, edible fungi appeared.
> The devil who was walking behind saw this and decided to go one better by producing brighter and more highly coloured mushrooms. He spat mouthfuls of bread all over the countryside. The wonderfully coloured mushrooms as well as those which looked very much like St. Peter's mushrooms, were, however, all poisonous.
> [Ramsbottom 1953]

Various common names of fungi still testify to this belief: Deadly Cortinarius [Cortinarius gentilis], Deadly Galerina [Galerina autumnalis], Deadly Parasol [Lepiota josserandii], Dead Man's Fingers [Xylaria polymorpha], Dead Man's Foot [Pisolithus tinctorius], Dead Man's Hand [Scleroderma geaster], Death Angel or Destroying Angel [Amanita ocreata], Death Cap [Amanita phalloides], Devil's Dipstick [Mutinus elegans], Devil's Eggs [Phallus spp.], Devil's Stinkhorn [Phallus rubicundus], Devil's Urn [Urnula craterium], and Satan's Bolete [Boletus satanas].

It was soon found that the colour of mushrooms is far from a reliable telltale sign of danger. Colour is one of the most deceptive and variable features of fungi. The ancients recognized that colour should be used in conjunction with other characteristics, such as the habitat of the fungus. They had noticed that mushrooms growing in association with certain trees were more likely to be edible than those that had other trees as their partner.

> The main problem is one of identification. There is no simple rule or test that will tell whether a mushroom is edible or deadly poisonous. Many people are blissfully unaware of this, and rely on tests, which are irrelevant and fallacious. They are playing Russian roulette. … Every year, many people take unnecessary chances by eating unfamiliar mushrooms, or confuse poisonous species with edible ones, and every year some unfortunates are fatally poisoned.
> [Kendrick 2000]

ANTIDOTES

Methods have been developed to detect and/or neutralise possible toxins in mushrooms. Purported means of identifying poisonous and non-poisonous types have become part of folklore and widely accepted as fact. A traditional method is to stick a silver spoon into the cooking mushrooms. If the spoon turns black, the mushrooms should be discarded; if not, they can be eaten safely. [Sulphuric compounds may be detected this way since silver turns black when exposed to hydrogen sulphide.] This belief is best forgotten: some deadly fungi will leave the silverware sparkling.

Pliny, like others, recommended cooking mushrooms with pear branches or combining them with meat. A wild pear after the meal would "kill or dull the malice that they may have" if all else failed. Nicander produced a whole range of possible antidotes, including cabbage, rue [Ruta], pyrethrum, soda, cress, mustard, chicken dung, ashes of clematis steeped in vinegar, and "the efflorescence which has accumulated on old corroded copper" [copper carbonate; copper is a general ingredient of fungicides!].
He thought it best to take all these as a mixture and then "putting your right finger in your throat to make you sick, vomit forth the baneful pest." Vinegar and/or salt as neutralising agents are still applied in eastern Europe, where bitter or peppery varieties of mushrooms are prepared by marinating or pickling them in salt, with or without vinegar.

> The idea of removing the poisons by extracting the mushrooms in vinegar or water reached its peak in France in the 19th century. Frédéric Gérard, an assistant at the Jardin des Plantes, Paris, sent a memoir to the Conseil de Salubrité of Paris in 1851, asserting that he had eaten all kinds of poisonous fungi without any health problems. This claim may have been inspired by Jean Jacques Paulet, who in *Traité des champignons* [1790-1793] claimed that poisonous fungi became innocuous to animals after being cut into pieces and steeped in water containing salt, vinegar, or alcohol.
> In the presence of the commission, Gérard prepared and ate 500 g of *Amanita muscaria* one day and at least 70 g of *Amanita phalloides* on another, showing no ill effects at all. All he had done was to cut up portions of the mushrooms, soak them in vinegared water for a few hours, wash

> them, and then boil them for half an hour. [This is no report on how they tasted after this maltreatment.] Suspicion still lurks that he eventually succumbed to mushroom poisoning as a result of his experimental ardour. The French have a penchant for such public displays of bravado.
> [Benjamin 1995]

Symptoms such as "Delusion he is a great person" and "Egotism, reciting his exploits," both recorded for Agaricus, nicely illustrate Gérard's "public display of bravado."

Interestingly, the materia medica of both Agaricus [= Amanita muscaria] and Agaricus emeticus [= Russula emetica] contains some references to vinegar. Hering mentions for Agaricus "Smell of vinegar unbearable" and "Vinegar [and Eau de Cologne] induce fainting," while Allen has the opposite: "The patient did not arouse from this state of stupor, except when teased into drinking a mixture of vinegar and water."

Under Agaricus emeticus we find in Allen: "Violent vomiting, with anxious sensation, as if the stomach hung on threads, which would be momentarily torn into, with ice-cold sweat of face, and constantly renewed faintness, even from moving the head on listening to reading; increased by smelling cordials, especially by *vinegar*, which is unbearable. It seems that the symptom "smell of vinegar unbearable" ended up with the wrong Agaricus.

But ultimately and "despite popular belief to the contrary," Ramsbottom is right in arguing that "there is only one practical way of distinguishing between edible and poisonous toadstools. This experimental method is sure, but the result may not profit a man."

NOTHING VENTURED, NOTHING GAINED

People can conveniently be divided into two groups: those who love to venture on eating wild mushrooms and those who not even want to consider it. There doesn't seem to be any middle ground: one is either a "picker" or a "kicker", as David Arora puts it aptly. Although mushrooming is still regarded [in North America] as a bold and unusual avocation, its practitioners are no longer placed in the category reserved for amateur parachutists or daredevil bungee jumpers.

Eating wild mushrooms is like "playing with fire", according to Harvard microbiologist and devoted mushroomer, Elio Schaechter. He compares it with the Japanese custom of eating fugu, the highly poisonous puffer fish, and considers an old Japanese saying to apply to mushroomers as well: "Those who eat fugu are stupid but those who don't eat fugu are even more stupid." Nothing ventured, nothing gained.

> Surely some of the fascination of eating wild mushrooms is that it is like playing with fire. There is a measure of danger, one that even the most experienced mycologists acknowledge, if not always aloud. I believe that my own fears are usually under control, and I don't fret visibly when eating a reputable species that I have eaten before. My "warning signal" flares when I am confronted with a species new to my palate, however. I imagine all that could happen, but more often than not I end up eating a small amount. Perhaps it is the thrill of the unknown. …
>
> People often need to joke about the dangers they face. Little wonder that several mushroom clubs call their yearly celebration "The Survivors' Banquet," or that certain walks are called "The Optimists' Foray." Ditties and mild jokes are often exchanged, especially between experienced mushroomers and beginners.
>
> Most of the humour may not seem particularly funny out of context, but it does reveal something of how people confront danger. Consider the novice's question: "Can you eat this kind?" Answers the experienced mushroomer: "Yes, of course. You can eat any mushroom once." Or the ditty: "There are old mushroom hunters and bold mushroom hunters, but there are no old, bold mushroom hunters."
>
> [Schaechter 1997]

Despite the obvious hazard, dedicated "pickers" seem unable to resist wild mushrooms. Continuing to try new found species, one avid mushroom hunter commented: "I think twice before I eat a wild mushroom - and then I eat it."

LIKE A CHILD

It takes "a certain boldness and curiosity to seek out mushrooms, and creativity to put them to good use," an attitude quite the opposite of the fungo-phobic belief that "mushrooms are actively hostile at worst and worthless at best." [Hence, perhaps, the lingering distrust of western medicine towards medicinal mushrooms and the inability to perceive them as potentially powerful, despite fungus-derived wonder drugs such as penicillin and cyclosporin, the undiscriminating prescribing of which, unfortunately, has brought up the invasive side of fungi.]

The fungus characteristics of curiosity, energy and resourcefulness are natural characteristics of children. Is it coincidence that certain mushrooms in the Orient are associated with eternal youth?

If unbalanced, these characteristics may result in borderless and uncontrollable behaviour with the impish oddities typical for this group of remedies. Such behaviour is more based on lack of judgement than on intentional mischief. Lack of discernment is what brings mushroom hunters into trouble for it requires keen judgement to distinguish the true from the false, the edibles from the poisonous look-alikes. Judgement of reality may likewise be impaired in the fungus remedies.

The other extreme in people needing a fungus remedy is that judgement, energy and ingenuity are challenged or compromised. This, in turn, invites others to invade their space and privacy, or even to parasitize on them. Opportunists, either germs or humans, are always happy to fill the gaps. The immunostimulating properties of fungi, understood so well by eastern cultures, apply equally to the psychological level of self-defence and putting up one's borders.

The child, symbolizing innocence, spontaneity and lack of aggression, is self-contained and without forethought or afterthought, according to the Chinese. The main threat of the "child" is fragmentation. Twentyman[1] sees a parallel between the realm of fungi and "the system which in the human organisation carries pre-eminently the forces of death - the brain and nervous system."

> The nerve fibres run as threads throughout the organism. The brain and nerves live fundamentally as parasites upon the organism. Only in the embryo do the nerve cells multiply; probably after birth or early childhood they lose the possibility of reproduction. The fungi of course retain this capacity and the hyphae are composed of long chains of cells, unlike the nerve fibres arising from a single cell.
>
> In the embryonic stage of life, and even to a great extent in babyhood, we are almost all head with a small appendage of trunk and limbs. Gradually we grow down from this head, as a plant grows up from the root. It has

often been noted that plant and man stand in inverted relationship to each other. A man would have to be turned upside down and planted with his head in the earth, trunk, limbs and genitals pointing upwards, for the correspondences between man and plant to become clear.

So if there were a possible relationship to be discovered between brain and nerves and the realm of the fungi, it would point again to the earth as the home of these strange forms of life. In the embryo and baby, the head is still concerned with growth, and consciousness is obviously not yet imprisoned within the witch's cottage of our head. But as the death processes gradually take over in our brains, we wake up in our heads. Historically it was only in Greek times that thinking began to be experienced as related to the brain.

Can we get any further by looking at the drug pictures and medical experiences in relation to fungi? The very nature of fungus activity leading to fragmentation and disintegration, even to atomization, is echoed in the intellectual activity based on the brain. This too in its one-sided analytical and abstracting activity leads to information of ever increasing complexity and chaos, the information explosion.

… The brain and nervous system normally function in adult life in an inhibitory manner. The expression "to keep a cool head" is highly indicative. Bergson at the beginning of this century showed that our senses screen for us, as it were, the multitudinous incoming impressions, so that we become conscious only of a tiny selection, those needed for our action. It would seem then that the fungus represents the brain and nervous system at an earlier, more embryonic stage of development, before it has been overwhelmed by the death or dying processes characteristic of the adult stages. Sense impressions in our drug picture [of Agaricus] are therefore described as more vivid, more full of life, beauty and springtime. When we look back even as far as the Greek civilization we are enchanted by the freshness of their thoughts, which are still full of life and perception. They have not yet been killed off into the abstractions of modern thought life. So under the influence of Agaricus the Lapps and Siberian Shamans find it easier to re-enter states of consciousness of a dreamlike clairvoyance. They become mediums for inspiration by other influences. Wordsworth's *Ode to Immortality* represents a similar idea in respect to childhood.

We may further question whether the movements of uncoordinated character also reflect in some degree the uncoordinated movements of the baby before it has learnt to still the unnecessary, useless movements

and permit only the useful ones to occur.
In agreement with such an interpretation of the *Agaricus* picture would be the use of this remedy in mental retardation where there is a failure of the child to wake up in its mental functions and persistence in a consciousness of babyhood.

1 L.R. Twentyman - The Fungi. The British Homeopathic Journal, Vol. 74. No. 1. January 1985, p.16-25.

MYCOTOXINS

The classification of mushroom poisoning, designated by the term *mycetismus*, most widely adopted in the beginning of the 20th century was that of Huseman, who recognized three types: mycetismus [gastro]intestinalis, mycetismus choleriformis and mycetismus cerebralis.
In 1923, Ford modified and extended this classification with two more types: mycetismus nervosus and mycetismus sanguinareus. Rather than on organ affinities modern systems focus on the types of toxins [mycotoxins], which are divided into eight groups. The following is a blend of old and new.

• *Mycetismus gastrointestinalis - Gastrointestinal irritants.*
Rapid onset of mainly gastrointestinal symptoms [nausea, vomiting, diarrhoea], which vary greatly in severity but terminate rapidly and usually spontaneously. Health restored in a couple of days; fatalities very rare.
Typical representatives: Russula emetica [Agaricus emeticus in homeopathy]; Boletus luridus and Boletus satanas [blueing Boletus spp.]; Amanita brunnescens; Lactarius spp.

• *Mycetismus choleriformis - Amatoxins and Phallotoxins.*
Delayed onset, 6 to 24 hours after ingestion, most commonly about 12 hours. Gastrointestinal disturbances prominent at first: violent abdominal cramps, vomiting and purging, lasting 1-2 days and followed by an asymptomatic interlude. During the latency period [6-24 hours] and the brief, misleading remission of symptoms the toxins attack and destroy the cells of liver, kidney and intestine. Loss of strength and weight is rapid, accompanied by pain, nephritis, anuria, delirium and coma. Death, in two to five days,

occurs in nearly 50 per cent of cases.
Typical representatives: Amanita spp. [A. phalloides, A. verna, A. virosa, A. ocreata]; Galerina spp. [G. autumnalis, G. marginata, G. venenata]; Lepiota spp. [L. castanea, L. helveola, L. josserandii]; Conocybe filaris.

• *Mycetismus nervosus - Muscarine.*
Violent gastrointestinal onset, 30 minutes - 2 hours after ingestion, accompanied by "PSL-syndrome" [stimulation of exocrine glands, resulting in profuse perspiration, salivation and lachrymation], contracted pupils, blurred vision, convulsive movements of muscles, slow heartbeat, decreased blood pressure, difficulty in breathing, mental confusion, delirium, hallucinations. Recovery normally within 24 hours, but in severe cases, death may result from respiratory failure or in patients with existing cardiovascular disease. The specific antidote is atropine.
Typical representatives: Clitocybe spp. [C. cerussata, C. dealbata, C. rivulosa, C. sudorifica], Inocybe spp. [I. geophylla, I. patouillardi, I. pudica], certain red-spored species of Boletus, and probably Omphalotus illudens.
Muscarine is present in Amanita muscaria but presumably in too insignificant amounts to produce effects.

• *Mycetismus sanguinareus - Gyromitrin.*
Gastrointestinal symptoms appear 2-12 hours after ingestion: bloated feeling, nausea, vomiting, abdominal cramps, and diarrhoea. Jaundice and anaemia develop later. Haemolytic toxin; urine may contain haemoglobin. Levels of bilirubin and liver enzymes rise, blood sugar level falls. Symptoms include headache, faintness, loss of muscular control, and fever. Coma and death may ensue after 2-7 days.
Typical representatives: Gyromitra spp. [G. esculenta, G. brunnea, G. caroliniana, G. fastigiata, G. infula]; possibly Helvella spp. [H. eleastica, H. lacunosa] and Paxina spp.

• *Mycetismus cerebralis - Ibotenic acid/ Muscimol*
Symptoms normally appear 30 minutes to 2 hours after ingestion, consisting of nausea and vomiting [depending on number of mushrooms used], dizziness, dilatation of pupils, visual distortions, muscle spasms, loss of muscular coordination, followed by "peculiar cerebral symptoms" [exhilaration,

laughing, loquacity, altered perceptions, feeling of greater strength, etc.], or deep sleep full of fantastic dreams. Drowsiness is a common phenomenon. Convulsions may occur.
Typical representatives: Amanita spp. [A. muscaria, A. gemmata, A. pantherina].
Panaeolus campanulatus is thought to contain both chemicals.

• *Orellanine syndrome.*
Extremely delayed onset of symptoms - up to three weeks. Nephrotoxic; death in severe cases, from kidney failure.
Typical representatives: Cortinarius spp. [C. orellanus, C. gentilis, C. rainierensis].

• *Coprine syndrome.*
Symptoms occur at any time for up to 5 days after consumption of Coprinus atramentarius when an alcoholic beverage is taken. The alcohol reacts with a compound [coprine] contained in the mushroom, mimicking the effects of anti-alcohol prescription drugs such as Antabuse. Symptoms appear 30-60 minutes after the alcohol intake: reddening of ears and nose, hot flushes of face and neck, metallic taste in the mouth, palpitations, tingling sensations, throbbing headache, nausea and vomiting.
Symptoms persist as long as there is alcohol in the system, usually 2-4 hours.
Typical representatives: Coprinus atramentarius and Clitocybe clavipes.

• *Hallucinogenic syndrome* [psilocybin - psilocin].
Symptoms similar to those of LSD, arising shortly after ingestion and remaining for several hours. Psilocybin, a compound containing phosphate, is converted by the human body [by removing the phosphate] into the psychotropically 10 times more active psilocin. These mushrooms are known as “magic mushrooms” and belong to four agaric genera [agaric = having stem, cap and gills].
Typical representatives: Psilocybe spp. [P. baeocystis, P. caerulescens, P. cubensis, P. cyanescens, P. mexicana, P. semilanceata, P. silvatica, etc.]; Panaeolus spp. [P. cyanescens; P. foenisecii, P. subbalteatus]; Conocybe cyanopus; Gymnopilus spectabilis.

FUNGAL INFECTIONS

Fungal infections [mycoses] can be divided into three categories, which Kendrick describes as follows:

• *Cutaneous infections*, which involve the outer layer of the skin and cause an allergic or inflammatory response.
• *Subcutaneous infections*, usually involving fungi of low inherent virulence which have been introduced to the tissues through a wound of some kind, and which remain localized or spread only by direct mycelial growth.
• *Systemic infections*, which are caused either by true pathogenic fungi which can establish themselves in normal hosts, or by opportunistic saprobic fungi which could not infect a healthy host, but can attack individuals whose immune system is not working. Both kinds of fungi sometimes become widely disseminated through the body of the host.

The first category consists of mycoses caused by about 40 species of specialized keratinolytic fungi [fungi that have the capacity to utilize the highly insoluble keratin]. Known as *dermatophytes* these fungi are placed in three genera: Epidermophyton, Microsporum, and Trichophyton. They cause what is commonly known as *tinea* or *ringworm*.

The second category includes *chromoblastomycosis* [verrucous dermatitis, occurring in barefoot tropical peoples, producing stalked, dull red or greyish warty growths on feet or legs], *entomophthoromycosis* [formation of steadily growing subcutaneous tumour which may involve a whole limb, the chest or shoulder], *maduramycosis* [disease of the feet, occurring in barefoot tropical peoples and characterized by chronicity, tumefaction, and multiple sinus formation] and *sporotrichosis* [nodular, ulcerous lesions of hand and arm, caused by the cosmopolitan plant saprophyte Sporothrix schenckii found on rosebushes, barberry bushes, sphagnum moss, and other mulches].

The third category involves systemic mycoses caused by specialized pathogenic fungi - histoplasmosis [Darling's disease], coccidioidomycosis [Valley Fever], paracoccidioidomycosis [South American blastomycosis], blastomycosis [Gilchrist's Disease]- or by opportunistic saprobes which all rely on some breakdown in the mechanisms of resistance - candidiasis, zygomycosis, cryptococcosis, aspergillosis, phaeohyphomycosis.

General Diagnostic Principles

I. – Many of the causative fungi are opportunists and are not usually pathogenic unless they enter a compromised host. Opportunistic fungal infections are particularly likely to occur and should be anticipated in patients after ionizing [x-] radiation and during therapy with corticosteroids, immunosuppressants, or antimetabolites; such infections also tend to occur in patients with AIDS, azotemia, diabetes mellitus, bronchiectasis, emphysema, TB, Hodgkin's disease or other lymphoma, leukemia, or burns.

II. – The major characteristic of virtually every systemic mycosis is its chronic course. Septicaemia or acute pneumonia is rare. Lung lesions develop slowly. Months or years may elapse before medical attention is sought or a diagnosis is made.

III. – Symptoms are rarely intense, but fever, chills, night sweats, anorexia, weight loss, malaise, and depression all may be present.

V. – When a fungus disseminates from a primary focus in the lung, the manifestations may be characteristic. For example, cryptococcosis usually appears as meningitis, progressive disseminated histoplasmosis as hepatic disease, and blastomycosis as a skin lesion.

[The Merck Manual, 16th edition]

ALLERGENIC FUNGI

Allergic pulmonary disorders caused by hypersensitivity to fungi include hypersensitivity pneumonitis and allergic bronchopulmonary aspergillosis. These diseases arise from a combination of constitutional factors and environmental exposure, in this case to fungal spores.

Spores as allergens

The prime suspect of respiratory allergies provoked by airborne particles were originally the pollen grains of plants, causing what is widely and inaccurately known as 'hay fever'. But people tended to forget that allergenic pollen is actually only a summer problem, while many respiratory allergies persist in fall and winter. So scientists had to look elsewhere for other less

> seasonal causative agents, and found them in the form of fungal spores. … Many common fungi are now known to be allergenic, and more allergens are being recognized as time goes on. … Very high concentrations of spores can be encountered during epidemics of fungal plant diseases such as wheat rust, and the spore concentrations to which farm workers handling mouldy hay are exposed can eventually cause a serious and sometimes fatal allergic disease called 'Farmer's lung'.
> Here, repeated exposure to high concentrations of spores from a number of different allergenic fungi [often species of *Penicillium* and *Aspergillus*] can lead to sensitization, and produce acute or chronic symptoms. … Similar complaints have been seen in some office workers when hidden air-conditioning systems have supported massive growth of similar moulds. Bronchial asthma is also frequently provoked by airborne fungal spores, usually belonging to the mould genera *Alternaria, Aspergillus, Drechslera* ['*Helminthosporium*'] and *Penicillium.* These spores reach their highest numbers in fall, with another lower peak in spring.
> [Kendrick 2000]

Gray gives the percentages of *skin reactions* to various fungi in 261 fungus-sensitive patients. Alternaria tops the list, with skin reactions in 91% of the 261 patients, followed by Drechslera [60%], yeast [56%], smut [54%], ergot [52%], Aspergillus [34%], Penicillium [30%], Trichophyton [29%], Mucor [28%], mushroom [25%], Fusarium [25%], Rhizopus [24%], and puffball [6%].

Hypersensitivity pneumonitis

[from: The Merck Manual, 16th edition]

Disease	*Antigen*	*Source of particles*
Farmer's lung	Micropolyspora faeni or Thermoactinomyces vulgaris	Mouldy hay
Air-conditioner	M. faeni, T. vulgaris, etc.	Humidifiers, air conditioners [or humidifier] lung
Bagassosis	T. vulgaris or M. faeni	Bagasse [sugar cane waste]
Mushroom worker's lung	M. faeni or T. vulgaris	Mushroom post spawning compost
Suberosis [cork worker's lung]	Mouldy cork dust	Mouldy cork
Malt worker's lung	Aspergillus fumigatus or clavatus	Mouldy barley, malt
Sequoiosis	Pullularia pullulans or Graphium spp.	Mouldy sawdust from Redwoods
Cheesewasher's lung	Penicillium spp.	Mouldy cheese

Clinical features

[from: The Merck Manual]

In *acute disease,* episodes of fever, chills, cough, and dyspnoea occur in a previously sensitized person, typically appearing 4 to 8 hours after re-exposure to the antigen. Anorexia, nausea, and vomiting may also be present. Fine-to-medium inspiratory rales may be heard on auscultation. Wheezing is unusual. With avoidance of the antigen, symptoms usually improve within hours, though complete recovery may take weeks and pulmonary fibrosis may follow repeated episodes. A *sub acute* form may begin insidiously with cough and dyspnoea over a period of days to weeks, with progression requiring urgent hospitalization. In the *chronic* form, progressive exertional dyspnoea, productive cough, fatigue, and weight loss may occur over months to years. The disease may progress to respiratory failure.

TUBERCULOSIS

The symptoms of fungal diseases, pulmonary or otherwise, bear a close resemblance to those of tuberculosis: fever, chills, night sweats, anorexia, weight loss, malaise. Some mycoses run a similar course to tuberculosis, with dissemination to the same organs. In aspergilloma, for example, the fungus [Aspergillus fumigatus] forms a mycelial ball in a lung cavity produced by an earlier attack of tuberculosis. And with sporotrichosis the infection spreads through the lymphatic system and eventually may become systemic, affecting first the joints, then the bones, and finally the internal organs, through the bloodstream. Interestingly, the bacterium responsible for TB is a *mycobacterium,* literally "fungus-bacterium," due to its mycelium-like growth.
Furthermore, antibodies directed against Mycobacterium bovis [Bacillus Calmette-Guerin, BCG] are highly sensitive in detecting bacteria, mycobacteria and microfungi, whereas spirochetes, viruses and protozoa show no reaction.

> Froio and Bailey write of a case of pulmonary cryptococcosis, which was diagnosed as tuberculosis and lung tumour; Smith reported that cases of coccidioidomycosis have been incorrectly diagnosed as pneumonia, influenza, tuberculosis, measles, smallpox and occasionally even poliomyelitis, typhoid fever, and syphilis. Brasher and Furcolow [1955] state that there are probably a great many cases of histioplasmosis "masquerading" as, or combined with, tuberculosis in various tuberculosis sanatoria. Schneider [1930] suggested that in all likelihood some cases of aspergillosis are undetected as such, since clinical symptoms and X-ray findings are identical with those of chronic pulmonary tuberculosis. He further points out that tuberculin tests are of no diagnostic value, since aspergillosis gives the same local reaction as tuberculosis.
> [Gray 1959]

"The most important use of White Agaric [= Fomitopsis officinalis;

Polyporus officinalis in homeopathy] is in the treatment of sweats in wasting conditions such as phthisis," writes Mrs. Grieve. "Its value in checking these profuse sweats has been confirmed by clinical experience." Agaricus muscarius [Amanita muscaria] is of use in "incipient phthisis," according to Boericke, because the remedy "is related to the tubercular diathesis."
The fungal infection *pityriasis versicolor* is "based on a tuberculous diathesis," according to Lilienthal in 'Homeopathic Therapeutics'.
Some Lactarius [Milk Cap] species have been used for treating tuberculosis, a use that is supported because of the strong antibacterial activity present in these mushrooms.

> Porcher [1854] commented on several mushrooms for treating tuberculosis. He reported that a French doctor, Dufresnoi, in the early 1800s, cured over 30 cases of tuberculosis using an electuary [a sweet herbal formula] that contained the fungus *Lactarius deliciosus*, conserve of roses, spermaceti, washed sulphur, and syrup of yarrow with a dose the size of a grape during the day. Another French doctor recommended the powder of the mushroom be simply mixed with honey and given in small doses. …
> One of the most widely used of medicinal fungi for tuberculosis was *Coriolellus suaveolens* [= *Trametes suaveolens*]*, a polypore with an anise-scented fruiting body. It was highly recommended by a number of French and German doctors of the time as a cure for this ailment; several cases were reported in Porcher that had been given up as incurable and then completely recovered. Two drams of the powder were given morning and evening to affect a cure.
> [Hobbs 1995]
>
> * In homeopathy as Boletus suaveolens.

The therapeutic connection of fungi with lung disease is probably strongest in the lichens, known as the "lungs of the earth." [*see* under Lichens]
Evidently, the central themes and issues of fungal remedies will show a likeness with the characteristics of the tubercular miasm!

COMMON SYMPTOMS OF THREE FUNGAL REMEDIES

A = Agaricus. B = Bovista. C = Claviceps [Secale].

Mind

Ailments from sexual excesses.	A B C
Alcoholism.	A B C
Anxiety - about his own health.	A B
Audacity.	A B
Awkward - drops things.	A B
Cheerful.	A B
Company - aversion to	A B C
Company - desire for	A B
Confusion of mind - on waking [in morning]	A B
Delusions - distances are enlarged.	A B
Delusions - objects are enlarged.	A B
Delusions - sees ghosts.	A B C
Fear - of impending disease.	A B
Fear - of insanity.	A B
Fight, wants to.	A B C
Heedless.	A B
Indifference to everything.	A B C
Irritability - in morning on waking.	A B
Irritability - after coition.	A B
Mistakes - in speaking.	A B C
Speech - by jerks.	A B
Speech - slow.	A B C

Vertigo

With tendency to fall - forward.	A B C
With tendency to fall - backward.	A B
During headache.	A B C
Objects seem to turn in a circle.	A B
Sudden.	A B C

Head

Congestion.	A B C

Enlarged sensation.	A B C
Pain - pressing - Occiput.	A B C

Eye

Staring.	A B C
Lachrymation - during headache.	A B

Nose

Constant inclination to blow the nose.	A B
Epistaxis - morning.	A B C
Obstruction - at night.	A B C
Sneezing - morning.	A B

Mouth

Dryness or Salivation.	A B C
Speech stammering.	A B C

Abdomen

Pain - pressure >.	A B C

Female

Pain, bearing down, Uterus - during menses.	A B C
Pain, labour-like - during menses.	A B C

Chest - heart

Anxiety in region of heart.	A B C
Oppression of chest.	A B C
Pain, pressing, in heart.	A B C
Palpitation - during menses.	A B
Palpitation - from motion.	A B

Extremities

Cramps - calf of leg.	A B C
Numbness - lower limbs - legs.	A B C
Pain - joints - gouty.	A B C
Stiffness - fingers.	A B C

Weakness - upper limbs.	A B C

Generals

Appetite increased/ ravenous	A B C
Appetite wanting.	A B C
Desire for cold drinks.	A B C
Coldness - cold sensation in stomach and abdomen.	A B C
Coldness - hands and feet.	A B C
Coldness - skin.	A B C
Coldness - general chilliness.	A B C
Cold <. Winter <.	A B C
Dryness of usually moist internal parts.	A B C
After coition <.	A B
Dry food <.	A B
Injuries - dislocation - sprains.	A B
Pain burning [nose; mouth; throat; rectum; urethra; chest; limbs; skin].	A B C
Sensation of strength.	A B
Weakness - during menses.	A B C
Weakness - from perspiration.	A B C
Weather - cold, wet <.	A B C
Weather - dry >.	A B

INCENTIVES

What fuels the fascination for fungi? What is so powerfully persuasive about them as to initiate the intrepidity of the true mushroomer? May we expect a similar attitude and philosophy in people needing a fungus-derived remedy? Here are some suggestions.

• It requires the right mentality, which David Arora describes as “a willingness to plunge into the woods, to uncover their secrets, to learn their characteristics, to penetrate their haunts.”

• Accordingly, one need “possess sufficient curiosity so that one wishes to understand more than is afforded by cursory inspection,” adds Harold J. Brodie.

• “Surely some of the fascination of eating wild mushrooms is that it is like playing with fire. There is a measure of danger, one that even the most experienced mycologists acknowledge, if not always aloud,” says Elio Schaechter.

• One must be willing to prepare the way, to be among the first to occupy bared ground. Or as Gordon Wasson put it: “We were amateurs, unencumbered by academic inhibitions, and therefore we felt free to range far and wide, disregarding the frontiers that ordinarily segregate the learned disciplines. What we produced was a pioneering work.”

• An attitude of taking nothing for granted is conveyed by Charles McIlvaine: “I have determined so many of the reputed poisonous species to be edible, that unless positively authenticated, I do not accept repute as truth, but carefully test suspicious species upon myself. When sure there is no danger, I as carefully have them tested by my numerous under-tasters - male and female.”

SIGNATURES/ THEMES OF FUNGI

[These are general outlines; accents may differ within groups and signatures / themes may overlap. Puffballs (e.g. Bovista) as well as polypores fall into separate groups but both are used as styptics, thus indicating an affinity with haemorrhages. Only a few macroscopic fleshy fungi have a predilection for liver and kidneys, causing failure of these organs, notably Amanita phalloides, Gyromitra, Paxillus, and Cortinarius, and hence display a syphilitic element. Cryptococcus is placed in the dimophic fungi group due to the symptoms it causes, not because of its nature.]

Macroscopic fleshy fungi

[Agaricus; Amanita; Boletus; Bovista; Cantharellus; Chlorophyllum; Coprinus; Cortinarius; Gymnopilus; Gyromitra; Morchella; Paxillus; Psilocybe; Russula; Scleroderma; Stropharia]

- Affinities: CNS. Psyche. Gastrointestinal tract. Liver. Kidneys.
- *Disposition: Tuberculinic.*
- Expansion. Extension. Invasion. Penetration.
- Exploration. Colonization.
- Pioneering. Ability to adapt to challenging conditions.
- Beyond limits. Limitless. Rampant.
- Beyond control. Uncontrollable. Lack/ loss of control.
- Space. Distorted sense of space.
- Opportunistic. Commitment tentative.
- Flexibility. Avoiding irreversible specialization.
- Constant activity to maintain intimate relationship with environment.
- Nothing ventured, nothing gained.
- Invisible.
- Symbiotic or saprophytic [recycling, transformation].
- Help others to settle down.
- Exploitation.
- Carbohydrates. Energy. Alcohol.
- Strength.
- Light - photophobic or phototropic.
- Blue light stimulates. Red light inhibits.
- Moisture/ dampness. Susceptible to drying. Dehydration.
- Rapidity.

- Frigidity.
- Acidity. Vinegar.
- Death. Decay. Dissolution. Disintegration.
- Grotesque. Bizarre. Variable.

Moulds

[Alternaria; Aspergillus; Aureobasidium; Botrytis; Microsporum; Mucor; Penicillium; Rhizopus; Trichophyton]

- Affinities: Respiratory organs. Sinuses. Mucous membranes. Skin.
- *Disposition: Psoric.*
- Isolation. Seclusion/ exclusion. Banishment.
- Expansion. Extension. Invasion. Penetration.
- Hypersensitivity.
- Autumn allergies. Indoor allergies.
- Food allergies.
- Dust.
- Cats and dogs.
- Birds.
- Moisture/ dampness. Susceptible to drying. Dehydration.
- Antibiotics.

Parasitic - endophytic fungi

[Claviceps (Secale); Cordyceps; Fusarium; Neotyphodium (Lolium tem.); Stachybotrys; Ustilago]

- Affinities: CNS. Psyche. Cardiovascular. Hormonal system.
- *Disposition: Sycotic.*
- Dependency.
- Home-bound. Inseparable.
- Expansion. Extension. Invasion. Penetration.
- Endurance.
- Production. Procreation.
- Haemorrhages.
- Hormonal disorders.
- Hyperplasia. Hypertrophy.

- Tremors; shakes & staggers.
- Coolness >; heat <.

Wood-inhabiting fungi

[Armillaria; Auricularia; Ganoderma; Grifola; Inonotus; Lentinula; Nectria; Omphalotus; Piptoporus; Pleurotus; Polyporus; Pycnoporus; Trametes]

- Affinities: Cardiovascular. Gastrointestinal tract. Skin. Immune system.
- *Disposition: Sycotic-syphilitic [cancer-miasm].*
- Abundant; profuse; opulent.
- Inflexible when dry; flexible when moist.
- Tough; unyielding.
- Ferocious; troublesome.
- Hard; rigorous.
- Strangling or strengthening.
- Stimulant. Adaptogen.
- Expansion. Extension. Invasion. Penetration.
- Death. Decay. Dissolution. Disintegration.
- Immortality.
- Luminescence.
- Volume [weight] loss.

Yeasts

[Candida; Kloeckera; Kluyveromyces; Pityrosporum; Saccharomyces; Sporobolomyces]

- Affinities: Assimilation/ metabolism. Mucous membranes. Skin.
- *Disposition: Sycotic.*
- Effervescence.
- Bubbling, belching and burping.
- Expansion. Extension. Invasion. Penetration.
- Wild or domesticated.
- Social alienation.
- Spaciness.
- Mood swings.
- Anger and aggression; explosive or suppressed.

- Carbohydrates. Energy. Alcohol.
- Allergies.

Dimorphic fungi

[Blastomyces; Cryptococcus; Coccidioides; Histoplasma; Hortaea; Paracoccidioides; Sporothrix; Tremella]

- Affinities: Lungs. Skin and subcutaneous tissue. Immune system. CNS. Musculoskeletal system. Glands.
- *Disposition: Syphilitic.*
- Dissemination. Metastasis.
- Expansion. Extension. Invasion. Penetration.
- Death. Decay. Dissolution. Disintegration.
- Moisture.
- Conversion. Transformation.
- AIDS.