MYCOTICON textbook

Identification and sustainable exploitation of wild edible mushrooms in rural areas

Editors:
Denchev, C. M.
Venturella, G.
Zervakis, G.

(MYCOTa Intereuropean COoperation Network)

TEI Thessaly, 2013
EUROPEAN UNION

LEONARDO DA VINCI – TRANSFER OF INNOVATION

"MYCOTICON" (MYCOTa Intereuropean COoperation Network)

“Identification and sustainable exploitation of wild edible mushrooms in rural areas”

Grant Agreement no: 2011-1-GR1-LEO05-06802

Copyright © MYCOTICON project 2013, All rights reserved.

MYCOTICON Project website: http://mycoticon.teilar.gr


Beneficiary organization: Technological Educational Institute of Thessaly

MYCOTICON Project Manager: Prof. Panos Fitsilis

TEI Thessaly

41110 Larissa,

Greece

fitsilis@teilar.gr
MYCOTICON (MYCOTa Intereuropean COoperation Network)

“Identification and sustainable exploitation of wild edible mushrooms in rural areas”

MYCOTICON Project team / List of Contributors

| Technological Educational Institute of Larissa (Beneficiary organization) | • Prof. Panos FITSILIS (MYCOTICON Project Manager)  
• Prof. Ioannis KOKKORAS  
• Associate Prof. Vassilis GEROGIANNIS  
• Assistant Prof. Leonidas ANTHOPOULOS  
• Thomas POULIOS  
• Dimitris NATSIOPoulos  
• Dr. Konstantinos KOKKINOS |
| --- | --- |
| AGRICULTURAL UNIVERSITY OF ATHENS | • Assistant Prof. George I. ZERVAKIS (coordinator)  
• Dr. Elias POLEMIS |
| UNIVERSITY DEGLI STUDI DI PALERMO | • Associate Prof. Julia GEORGI (coordinator)  
• Prof. Fotios GRAVANIS  
• Dr. Apostolos KAPSALIS  
• Vassilia IOANNOU |
| Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences | • Prof. Cvetomir M. DENCHEV (coordinator)  
• Teodor T. DENCHEV  
• Boris ASSYOV |
| C.V.T. Aigeas | • Stergios PAPAETTHIMIOU (coordinator)  
• Christos PAPATHANASIou  
• Anna GARAVEI  
• Athanasios AGRAFIOuIS  
• Apostolos KAPSALIS |
**TABLE OF CONTENTS**

Chapter 1 - “INTRODUCTION TO MUSHROOMS”  
by C.M. Denchev, T.T. Denchev and B. Assyov  
(with contributions by F. Gravanis, E. Polemis and G.I. Zervakis)  

Chapter 2 - “CHOICE WILD EDIBLE MUSHROOMS”  
by E. Polemis and G. I. Zervakis  
(with contributions by G. Venturella, and C.M. Denchev and B. Assyov as regards species occurring in Italy and Bulgaria respectively)  

Chapter 3 - “POISONOUS MUSHROOMS”  
by E. Polemis and G. I. Zervakis  
(with contributions by G. Venturella, and C.M. Denchev and B. Assyov as regards species occurring in Italy and Bulgaria respectively)  

Chapter 4 - “COLLECTION, PROCESSING, PRESERVATION AND TRADING OF WILD EDIBLE MUSHROOMS”  
by G. Venturella and M. L. Gargano  

Chapter 5 - “CULTIVATION OF SELECTED EDIBLE MUSHROOMS”  
by G. I. Zervakis, E. Polemis and G. Venturella  

Chapter 6 - “NUTRITIONAL VALUE AND HEALTH PROMOTING EFFECTS OF WILD EDIBLE MUSHROOMS”  
by G. Venturella and M. L. Gargano  

Chapter 7 “USE OF WILD EDIBLE MUSHROOMS IN THE SERVICES SECTOR”  
by J. Georgi, C.M. Denchev, B. Assyov and G. Venturella  

Chapter 8 - “AN OVERVIEW OF EXISTING LEGISLATION ON COLLECTION, TRADING AND CONSERVATION OF WILD EDIBLE MUSHROOMS”  
by G. Venturella, M.L. Gargano and G. I. Zervakis
Identification and sustainable exploitation of wild edible mushrooms in rural areas
EUROPEAN UNION

LEONARDO DA VINCI – TRANSFER OF INNOVATION

"MYCOTICON" (MYCOTa Intereuropea COoperation Network)

“Identification and sustainable exploitation of wild edible mushrooms
in rural areas”

Grant Agreement no: 2011-1-GR1-LEO05-06802

Chapter 1

“INTRODUCTION TO MUSHROOMS”

by

C.M. Denchev, T.T. Denchev and B. Assyov

Institute of Biodiversity and Ecosystem Research
Bulgarian Academy of Sciences, Sofia, Bulgaria

(with contributions by F. Gravanis, E. Polemis and G.I. Zervakis)

October 2012
1.1. What are fungi? (Cvetomir M. Denchev & Teodor T. Denchev)

For a very long time in the human history, people perceived and classified the living organisms mostly on the basis of two criteria: external similarity by clear and easy to group characters, and economic importance. The organisms have been divided into two major groups, plants and animals. Later the scientists started using the term Kingdom for those two groupings.

In his Systema Naturae (first published in 1735), Carolus Linnaeus divided the living organisms into two kingdoms: Animalia, for animals, and Vegetabilia, for plants. His classification was quite reasonable at that period of time since plants and animals could be very clearly distinguished: the plants as stationary organisms, fixed to the soil, with self-sufficient nutrition, and the animals as capable of movement, and feeding on plants and other animals.

The easy dichotomic scheme ‘plants–animals’ by its logic and simplicity seemed unshakable until the middle of the 19th century. However, a number of
species were hard to place between plants and animals, or were placed in different kingdoms by different authors (e.g., the mobile algae of *Euglena*).

Fungi, if considered at all, were referred to the Kingdom Plant, due to their immobility, the types of reproduction and the similarity in their habit. Today we know with certainty that fungi are neither plants nor animals. But if not attributable to the above two kingdoms, then what are they and what characters may we use to distinguish them steadily from both plants and animals? And do all organisms, which for over 250 years were studied by mycologists, may be called *fungi* in the current strict sense of this term?

**Fig. 1.** Whittaker’s five kingdom tree — a system of five kingdoms based on three levels of organization: prokaryotic (Kingdom *Monera*), eukaryotic unicellular (Kingdom *Protista*), and eukaryotic multicellular and multinucleate (Kingdoms *Plantae*, *Fungi*, and *Animalia*). Kingdoms *Plantae*, *Fungi*, and *Animalia* are distinguished mainly by differences in nutrition (after Whittaker 1969).
Fungi are the most variable group of organisms, which demonstrate a great variety of morphology and life cycles. For some morphologically simple organisms, studied by mycologists, which cannot be placed either among plants or among animals, a third kingdom was proposed, *Protoctista* (Hogg 1861). The slime moulds were placed in this kingdom, as well as the fungus-like organisms with motile spores in their life cycle (zoosporic fungi). It was gradually realized that there is need of more detailed system for classifying organisms within kingdoms. There have been long debates for their number and the criteria for their separation. This led to several different schemes with different number of kingdoms. The conclusion was drawn that fungi belong to a separate kingdom, but it was not easy to define the characters that distinguish them from the other kingdoms. This became possible with the use of ultrastructural and biochemical characters, and especially with the acceptance of molecular methods in scientific research.

*Fig. 2.* A five kingdoms scheme for living organisms (after Margulis 1981).
In the system of Whittaker (1969) (Fig. 1), later developed with suggestions by Whittaker & Margulis (1978), Margulis (1981), and Margulis & Schwartz (1982) (Fig. 2), there are five kingdoms, one of which is set up for the prokaryotes (organisms with chromonematous organization, lacking nuclei in their cells) – Monera. The eukaryotes (organisms with chromosomal organization and nuclei) are separated into four kingdoms, as follows: Protista, Plantae, Fungi and Animalia. Whittaker & Margulis (op. c.) emphasize that in the ecological chain of the natural relationships, the living organisms are either producers, or consumers, or decomposers. These modes of nutrition approximately correspond to the lifestyles of the members of the three kingdoms of eukaryotes. The plants are producers, the animals – consumers, and the fungi are decomposers. The producers in general might be photoautotrophs or chemoautotrophs and obtain their food from inorganic compounds due to photosynthesis or by direct oxidation of reduced inorganic components. The last mode of nutrition (chemoautotrophy) is employed only by prokaryotes; consequently, the autotrophy of the eukaryotes is always photoautotrophy (some of the terms used here are briefly explained in the following pages). Both consumers and decomposers are heterotrophs, i.e. organisms those cannot synthesize their own food and need readily available organic compounds, but these two groups of organisms obtain them in different manners. All consumers swallow the food inside their bodies, where it is digested. The decomposers do not swallow the food, but exude digesting enzymes in the surrounding environment for breaking down food into simpler compounds, and then absorb them. Using this scheme, the macroscopic eukaryotes can be successfully distinguished into three kingdoms: Plants, Fungi, and Animals. Unfortunately, there is one rather heterogeneous group that remains, which cannot be assigned to this scheme. This rather diverse group includes single-celled or multicellular organisms which in the dichotomic scheme ‘plants–animals’ had been treated as either plants or animals. Here, for example, fall the protozoans, slime moulds (Myxomycota), different phyla of algae, as well as ‘fungi’ with motile spores in their life cycle (the so called fungus-like organisms) – Hyphochytriomycota, Oomycota, and Chytridiomycota. Those taxonomic groups
were placed in the Kingdom Protosticta while the fungal species without plasmodia and/or zoospores in their life cycle (members of Zygomyctota, Ascomycota, and Basidiomycota) were placed in the Kingdom Fungi.

Apart of its great historical value, this system was not free of disadvantages, and it was not until the eighties (20th century) when it became clear that opposition between protoctists and the rest of the eukaryotes does not lead to natural systems of classification for the major phyla of organisms. This stimulated elaboration of new taxonomic schemes, and a number of new systems were published, in some of which the number of kingdoms was higher – seven, eight, or even more (see Cavalier-Smith 1981).

Initially, from the greater group with fungus-like organisms, slime moulds were excluded (Fig. 3), and transferred to Kingdom Protozoa, based on the mode of nutrition and the presence of a free-living plasmodium (Cavalier-Smith 1981). Currently, this place of the slime moulds is kept.

Fig. 3. Slime mould (Lycogala epidendrum) (Bulgaria, Mt. Vitosha; photo: C.M. Denchev).
In the modern systems, the fungus-like organisms are placed in the Kingdom *Chromista*, where some of the classes of algae also belong. From the groups of organisms, initially defined as fungus-like organisms, the oomycetes (*Oomycota*) and hyphochytrids (*Hyphochytriomycota*) were included in Kingdom *Chromista* (they contain cellulose in their cell walls). The chytridiomycetes (possessing zoospores and cell walls in which chitin has replaced cellulose as the major structural component) and the ‘true fungi’ (zygomycetes, ascomycetes, and basidiomycetes) were placed in the Kingdom *Fungi*.

The groups of organisms, traditionally studied by mycologists, are nowadays classified as follows:

**Kingdom Protozoa**
- slime moulds (Fig. 3)
- etc.

**Kingdom Chromista**
- Phylum *Oomycota*
- Phylum *Hyphochytriomycota*
- etc.

**Kingdom Fungi**
- Phylum *Chytridiomycota*
- Phylum *Zygomycota*
- Phylum *Ascomycota*
- Phylum *Basidiomycota*
- etc.

Recent molecular data strongly suggest that Kingdom *Fungi* are more closely related to animals than to plants. Furthermore, such type of information evidenced the phylogenetic uniqueness of *Fungi*, but their inclusion here is beyond the scope of this textbook.
Like animals, fungi are dependent on their organic substrates (living or dead). On the basis of the mode of nutrition, the crown taxa of eukaryotes can be divided as follows (Whittaker & Margulis 1978; Margulis 1981; Moore 1996, 1997):

- **plants** are autotrophic organisms which photosynthesise (a process in which solar energy is absorbed by green chlorophyll, and used to form organic nutrient substances from atmospheric carbon dioxide and water) and have self-sufficient nutrition;

- **animals** are heterotrophs (non-photosynthetic organisms, and therefore incapable of producing organic compounds from inorganic nutrients) which have phagotrophic nutrition (with swallowing insoluble nutritive compounds and metabolizing them within their body);

- **fungi** are heterotrophs which have absorptive nutrition – they secrete enzymes externally (from their hyphae into the surrounding environment), where organic substrates are broken down, and then nutrient compounds are absorbed in a soluble form.

### 1.2. Classification, taxonomy, and nomenclature

For being easily recognizable, fungi (as all living organisms) are given names and are classified into systems. In biology, *classification* is a process of arrangement of organisms into groups that share similar characteristics. Each such group we term as a *taxon*. The term *classification* is used also for the result of this process, i.e. for the resulting system of taxa. For this reason, we speak for both *classifying fungi* and *classification of fungi*. *Taxonomy* is the science that deals with the principles and practice of classification.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Ending</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingdom</td>
<td></td>
<td><em>Fungi</em></td>
</tr>
</tbody>
</table>
The taxa are grouped interrelated and ascending in a hierarchical system, called *taxonomic hierarchy*. Ideally, the system is natural and reflects the relationships between the taxa. Each of the levels of this taxonomic hierarchy is called *taxonomic rank*. The principal ranks of taxa in descending sequence are *kingdom*, *phylum*, *class*, *order*, *family*, *genus*, and *species*. Each group of basically identical individuals is called *species*. Each species belongs to a genus, each genus to a family, etc. through order, class, phylum, and kingdom (Table 1). In this way, the genus *Boletus* includes species like *Boletus edulis* and *Boletus satanas*; the genera *Boletus* and *Leccinum* are members of the family *Boletaceae*, while *Suillus* is a member of the *Suillaceae*; both families are members of the order *Boletales*, etc.

The species has a central place in taxonomy as it forms the basic unit of biological classification. Species are the smallest groups that are consistently and persistently distinct, and distinguishable by ordinary means (Cronquist 1978).

*Nomenclature* refers to the naming of organisms. Naming the fungi is governed by the *International Code of Nomenclature for algae, fungi, and plants* (ICN). The name of a genus is a noun in singular, or a word treated as a noun. Each name of a species is a combination consisting of the name of the genus followed by a single specific epithet, thus being binomial. Usually, the specific name is descriptive, i.e., a word which is connected with any diagnostic character of the fungal species (e.g., *melanosporus* means black-spored) or refers to the name of its substratum, but it is not obligatory and any word may be used as an epithet. When several species of

<table>
<thead>
<tr>
<th>Rank</th>
<th>Ending</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum</td>
<td>-mycota</td>
<td>Basidiomycota</td>
</tr>
<tr>
<td>Class</td>
<td>-mycetes</td>
<td>Agaricomycetes</td>
</tr>
<tr>
<td>Order</td>
<td>-ales</td>
<td>Cantharellales</td>
</tr>
<tr>
<td>Family</td>
<td>-aceae</td>
<td>Cantharellaceae</td>
</tr>
<tr>
<td>Genus</td>
<td></td>
<td>Cantharellus</td>
</tr>
<tr>
<td>Species</td>
<td></td>
<td>Cantharellus cibarius</td>
</tr>
</tbody>
</table>
a certain genus are difficult to distinguish in the field, they might be termed with their generic name, followed by the abbreviation ‘spp.’ or ‘sp. pl.’.

Currently, taxonomists can use DNA sequence data to classify samples, enabling specimens to be identified easily and accurately. The taxonomic studies are crucial for understanding the biodiversity of the Earth.

The fungal species (which were selected on the basis of their commoness in the countries participating in the "MYCOTICON" project and their value as edible mushrooms) presented in this manual may be grouped in the following way:

Kingdom *Fungi*

Phylum *Ascomycota* (ascomycetes)

Class *Pezizomycetes*

Order *Pezizales*

Family *Discinaceae*

*Gyromitra esculenta*

*G. gigas*

*G. infula*

Family *Morchellaceae*

*Morchella elata*

*M. esculenta*

Family *Tuberaceae*

*Tuber aestivum*

*T. borchii*

*T. brumale*

*T. magnatum*

*T. melanosporum*
Phylum *Basidiomycota* (basidiomycetes)

Class *Agaricomycetes*

Order *Agaricales*

Family *Agaricaceae*

*Agaricus campestris*
*A. urinascens*
*A. xanthodermus*
*Calvatia gigantea*
*Macrolepiota procera*

Family *Amanitaceae*

*Amanita caesarea*
*A. muscaria*
*A. pantherina*
*A. phalloides*
*A. verna*
*A. virosa*

Family *Entolomataceae*

*Entoloma sinuatum*

Family *Lyophyllaceae*

*Calocybe gambosa*

Family *Marasmiaceae*

*Marasmius oreades*
*Omphalotus olearius*
Family *Pleurotaceae*

*Pleurotus eryngii*

*P. nebrodensis*

*P. ostreatus*

*P. pulmonarius*

Family *Strophariaceae*

*Agrocybe cylindracea*

Family *Tricholomataceae*

*Infundibulicybe geotropa*

*Tricholoma portentosum*

*T. terreum*

Order *Boletales*

Family *Boletaceae*

*Boletus aereus*

*B. edulis*

*B. legaliae*

*B. luridus*

*B. pinophilus*

*B. reticulatus*

*B. rhodopurpureus*

*B. rhodoxanthus*

*B. satanas*

*Leccinum scabrum*

Family *Sclerodermataceae*

*Scleroderma cepa*

*S. citrinum*
Chapter 1: Introduction to Mushrooms

S. meridionale
S. polyrhizum
S. verrucosum

Order Cantharellales
Family Cantharellaceae
Cantharellus cibarius
C. cinereus
Craterellus cornucopioides
C. tubaeformis

Family Hydnaceae
Hydnum repandum
H. rufescens

Order Russulales
Family Russulaceae
Lactarius deliciosus
L. salmonicolor
L. sanguifluus
L. semisanguifluus
Russula cyanoxantha
R. virescens

1.3. Morphology

What collectors of wild mushrooms find in nature (on soil, stumps, rotting wood or other organic substrates) are merely basidiomata (sing. basidioma) of fungal species (previously called fruiting bodies or sporocarps). Their function is to form the spores and to aid their liberation. In fact, the main body of these fungi is situated below
ground, in wood or in another, specific for the species substrate, and consists of a network of branched **hyphae** (thread-like structures), which form the fungal **mycelium**. The mushroom basidiomata and other structures (e.g. sclerotia) are composed of organized hyphae compacted into pseudotissues.

![Figs. 4 & 5. Asci with ascospores of Peziza sp. (left) and Tuber borchii (photos: E. Polemis).](image)

The hypha starts its development from a spore. At certain temperature and humidity conditions, it increases its volume, the spore wall tears and from the inside emerges the hyphal tip. This is the beginning of the mycelium formation. Initially the hyphal growth is supported by the nutrients existing in the spore. For its further development however, the fungus needs external sources of nutrients. Ascomycetes and basidiomycetes are characterized by regularly septate hyphae. Hyphae grow at their apical part and only by length, the mycelium growth thus being practically not restricted and may continue for many years if the suitable substrate resources are available. At a certain stage of development and under favorable environmental conditions the mycelium may produce **basidiomata** (in basidiomycetes) and **ascomata** (in ascomycetes). In most cases they appear above the ground (or onto other substrates), but there are several species (both ascomycetes and basidiomycetes) which form ascomata and basidiomata under the ground.
The particular part on ascomata or basidiomata where the cells for sexual reproduction are formed (fertile part) is called **hymenium** and the whole surface that surrounds them **hymenial layer**. In the case of ascomycetes, the sexual spores are called **ascospores** and they are developed within specialized reproductive structures (sac-like cells) called **asci** (Figs. 4 & 5), while in the case of basidiomycetes the sexual spores are called **basidiospores** and they are developed on top of specialized reproductive structures (club-shaped cells) called **basidia** (Figs. 6 & 7), which bear sterigmata. Examples for the life cycles of wild edible mushrooms will be provided in the next section.

![Figs. 6 & 7. Basidia with basidiospores on top of sterigmata (Image: E. Polemis).](image)

The morphology of the ascomata and basidiomata is characterized by a great diversity, and correct descriptions are important for the identification of both ascomycetes and basidiomycetes. The different groups of fungi appear on different substrates and have different strategies for spore dispersal: the ascomata and basidiomata may appear above or below the ground; those which are formed above
the ground develop different types of associations with the substrate, from which they obtain nutrients. Others form symbiotic relationship mostly with woody and rarely with grassy plants. This kind of symbiotic relationship is known as *mycorrhiza*.

The diversity of ascomata and basidiomata is enormous, e.g. there are species which basidiomata are relatively simple and are spread over the substrate (wood or soil). For the purposes of this textbook, we will limit our overview of the morphological characters in fungi mainly to those, related to the included species of WEM. Ascomata and basidiomata were evolved for sheltering the hymenial layer from unfavorable environmental conditions and towards providing better spore dispersal.

![Diagram of a gilled mushroom](image)

**Fig. 8.** Basidioma of a gilled mushroom (*Amanita caesarea*); note the veil patches (remnants of the universal veil), the stipe ring (a remnant of the partial veil), and the sac-shaped volva (a remnant of the universal veil) (Drawing: T.T. Denchev).

In most basidiomata, there are well-shaped *pileus* (also called *cap*) and *stipe* (also called *stem*), and the hymenial layer is raised above the substrate (Fig. 8). In other cases the differentiation aims towards better protection and the hymenium remains
enclosed in the basidioma until it is fully mature (this is the case with the so called gasteromycetes or gasteroid fungi, e.g., *Calvatia gigantea*).

The **basidioma development** could be of the:

- **gymnocarpic** type – the hymenial layer is exposed from its formation until maturity;
- **hemiangiocarpic** type – the hymenial layer is initially protected by different means but becomes exposed before its maturity;
- **pseudoangiocarpic** type – the hymenial layer is initially exposed but it is later protected by the downward and inward curling of the pileus margin;
- **angiocarpic** type – the hymenial layer is enclosed until maturity, after which the basidioma opens through an opening or by destruction of the entire structure.

**Fig. 9.** Stages of basidioma development of *Phallus impudicus*: left – young basidiomata, in the middle – mature, right – overripe) (Bulgaria, the Rhodopes; photo: C.M. Denchev).
Different stages of basidioma development are indicatively illustrated on Fig. 9 (the case of *Phallus impudicus*: left – young basidiomata, in the middle – mature, right – overripe).

The following main **types of shape** can be recognized among the basidiomycetes and discomycetes (i.e., a former taxonomic class of ascomycete fungi which includes all of the cup, sponge, brain, and some club-like fungi) (Fig. 10):

- **pileus and stipe** (e.g., *Agaricus* – Fig. 11, *Boletus*);
- **bracket or fan shape** (e.g., *Fomes, Trametes*);
- **resupinate or lobed** (e.g., *Serpula, Tremella*);
- **trumpet-like** (e.g., *Craterellus cornucopioides*);
- **pear shape or ball**;
- **star shape**;
- **phallic shape**;
- **cup, disk or nestlike**;
- **club shape**;
- **coral or sponglike**.

**Fig. 10.** Different shapes of basidiomata and discomycte apothecia (Drawing: T.T. Denchev).
• **pear shape** or **ball** (e.g., *Lycoperdon* – Fig. 12, *Calvatia, Scleroderma*);

• **star shape** (e.g., *Geastrum*);

• **phallic shape** (e.g., *Phallus* – Fig. 9, *Mutinus*);

• **cup, disc or nestlike** (e.g., discomycete apothecia, *Cyathus* – Fig. 13, *Crucibulum*);

• **club shape** (e.g., *Clavariadelphus, Macrotyphula, Typhula*);

• **coral or sponge-like** (e.g., *Ramaria* – Fig. 14, *Hericium, Sparassis* – Fig. 15).
Figs. 11 to 15. *Agaricus silvicola*, *Lycoperdon echinatum*, *Cyathus striatus*, *Ramaria* sp., *Sparassis crispa* (Bulgaria, the Rhodopes; photos: C.M. Denchev; from top left to bottom).

For the fungi that produce basidiomata with pileus and stipe, the variability of the shapes, colours, sizes, structures, and the macrochemical reactions of the pileus, stipe and flesh/context to specific reagents, as well as the presence or absence of a veil, are important taxonomic characters.

The **pileus** (Fig. 8) ensures the connection of the hymenial layer and its protection. Its diameter may largely vary in different species, 0.5–20 (–60) cm in diameter.

![Types of pileus to stipe attachment](image)

*central*  *excentric*  *lateral*  *stipeless*

**Fig. 16.** Types of pileus to stipe attachment.

Depending on its position, the pileus may be connected to a stipe (with **central**, **excentric** or **lateral** attachment) or directly to the substrate (**stipeless** attachment) (Fig. 16).
The upper surface of the pileus may be shiny or mat; dry, wet or sticky; glabrous, scaly (appressed or uplifted), velvety or finely powdered. Sometimes the entire surface may be veined, wrinkled, rugged or uneven.

Figs. 17 & 18. *Suillus luteus* and *Clitocybe gibba* (Bulgaria, the Rhodopes; photo: C.M. Denchev).

The pileus cuticle may peel off easily (the case of *Suillus*, Fig. 17) or with difficulty or may not be peeled off at all.

According to its shape the pileus may be convex (domed upward, cushion-shaped), hemispherical, spherical, ovoid, conical, cylindric, flat, campanulate (bell-shaped), umbonate (with a central bump), papilatate (if the central bump is very small and pimple-like), depressed (with a depression – Fig. 18), umbilicate (with a depression with a small bump or pimple in the centre), funnel shaped (with a very deep depression), uplifted, etc. (Fig. 19).
The pileal margin may be entire, irregular or split (Fig. 16); with or without radial streaks (Fig. 8); thin or thick; curved outwards, straight (acute, obtuse, rounded) or inrolled (Fig. 21); in the beginning it is often inrolled and later becomes flat. The hymenophore usually reaches the pileal margin, but it is also possible that it does not reach it (such margin is called "sterile").

The hymenophore may be composed of gills (e.g., in Agaricus – Fig. 11; Amanita – Fig. 8), tubes (e.g., in Boletus, Suillus – Fig. 17), spines (e.g., in Sarcodon – Fig. 22, Hydnum), ridges or may have other forms.

The gills attachment to the stipe (Figs. 23 to 26) may be (i) free (not reaching the stipe; a circular gap is visible around the top of the stipe where the pileal underpart can be seen), distant (when the distance between the gills and stipe is large), or remote (when the distance is even larger); (ii) fused – adnexed (narrowly attached to the stipe), adnate (broadly attached), notched (appearing as if a notch was removed from the lower part of the gill where it attaches to the stipe), or triangular; (iii) decurrent (running down the stipe top – Fig. 24) or falcate-decurrent.
(decurrent gills which arch upwards and outwards towards the pileal margin – Fig. 25).

Figs. 20 & 21. Various types of pileus margins.

Figs. 22 & 23. *Sarcodon imbricatus* and *Marasmius oreades* (Bulgaria, the Rhodopes and near Sofia respectively; photo: C.M. Denchev).

In species with gilled hymenophore, the gill edges may be **entire** (smooth and even – Fig. 27), **dentate** (having toothlike pointed projections), **serrate** (having sharp teeth like a saw – Fig. 27), **crenate** (coarsely jagged) or **ciliate** (fringed).
Chapter 1: Introduction to Mushrooms

Figs. 24 & 25. *Cantharellus cibarius* and *Pleurotus ostreatus* (Bulgaria, the Rhodopes; photo: C.M. Denchev).

The flesh of the pileus may be composed of usually two types of *pseudotissues*, — with generative and skeletal or binding hyphae. The main pseudotissue is composed of thin-walled generative hyphae, and skeletal (and sometimes also binding) pseudotissue composed of thick-walled hyphae. Apart of those, the basidiomata of some species may have lactiferous hyphae (e.g., the pileus of the genus *Lactarius* has hyphae which contain a white or coloured milky latex). The colour of the flesh varies,
but most often it is white. The colour of the flesh in many species may change when exposed to air (the so called auto-oxidation); this is an important character for identification. The flesh texture may be soft, leathery, gelatinous, corky, woody, etc.

Fig. 27. Shape of gill edges.

The stipe (Fig. 8) is in most of the cases the non-reproductive part of the basidioma and it supports the pileus, being differently rigid in various species. The pileus is connected centrally or eccentrically (Fig. 25) to the stipe (Fig. 16). In species which the pileus is directly attached to the substrate, the stipe is lacking. The stipe is composed by vertically arranged and tightly packed and interconnected hyphae. It raises the hymenophore above the soil (or other substrate, specific for a particular fungus), thus facilitating the better liberation and dispersal of the spores.

Figs. 28 & 29. Rooting stipe of *Xerula radicata* (Bulgaria, the Rhodopes; photo: C.M. Denchev), and various types of stipe-root shapes.
By its shape the stipe may be spherical, egg-shaped, paddle-shaped, inversed paddle-shaped, cylindrical, spindle-shaped, tapering towards the base, rooting (Fig. 28), etc. (Fig. 29). In species with heavier pilei, the stability is ensured by the top to base gradual widening of the stipe or by its bulbous swelling at the base part (Fig. 28).

![Fig. 30. Sections through different types of stipes.](image)

The stipe may be straight or curved, and solid, hollow or cavernose (chambered – with separate cavities), and in cross section – circular, flattened or grooved (Fig. 30). By its texture, surface or viscosity, the stipe could be: fragile or leathery; soft, tough or woody; with smooth, scaly, warty, fibrillose or furrowed surface; dry, sticky or viscid. Depending on the presence of remnants of universal or partial veil, the stipe may or may not bear the so called ring – remnant of partial veil (Figs. 8, 17, 31); and may be with or without volva (or bag – Figs. 8, 32), collar or rims of warts (Figs. 31 & 32).
For the pileus, as well as for the stipe, it is important to evaluate the colours properly, for which the use of standard colour charts is recommended.

In basidiomycetes the following major basidiomata types are distinguished:

- **Open** (without a veil) or **semi-open** (with a veil) basidiomata, consisting of pileus and stipe or of a pileus only. The **veil** may be universal or partial. The **universal veil** (velum universale) is a membranous or leathery bag, which completely encloses the young basidioma. During growth, the universal veil cracks and tears, leaving remnants in the stipe base. These remnants may be in the form of a bag-like volva, collar or rims of warts or scales (Figs. 8, 31, 32). Other remains of the veil may appear on the pileus in the form of powdery grains, scales or warts of different shape, size and placement (Fig. 8). The **partial veil** (velum partiale) is membranous, thread-like or cobweb, which in young stage connects the pileus margin with the upper part of the stipe, covering the spore-bearing surface, situated on the lower surface of the pileus. With the mushroom growth, the partial veil tears and part of it remains as a lasting or disappearing ring, usually placed on the upper part of the stipe (Figs. 8, 17, 31). Sometimes on the pileus the presence of scaly or thread-like remnants of the partial veil could be observed.

Depending on the **presence or absence of veil**, fungi of this group may be:

- species with universal and partial veil;
- species with a universal veil only;
o species with a partial veil only;
o species without universal and partial veils.

- **Closed** basidiomata of spherical, egg-shaped (Fig. 9), tuber-like or pear-like shapes (Fig. 8), enclosed by a protective layer (peridium). Here belong the so called gasteromycetes.

- Basidiomata with **shrub-like** (coral-like) and **bat-like** shapes. The basidiomata may be branched with shrub-like shape (*Ramaria*) (Fig. 14) or unbranched, bat-like (*Clavariadelphus*). The spore-bearing layer is situated on the external surface in the upper part of the basidiomata. Some of the species in this group are edible, but this group is not included in the present textbook.

The basidiomata comprise of a spore-bearing (hymenial) layer and a sterile part consisting of vegetative hyphae. Morphologically peculiar structures, typical for the basidiomycetes, are the so called **clamp-connexions** (shortly **clamps**) – arc-shaped connections between two cells (Fig. 33). The hyphal morphology is of great importance for the systematics of basidiomycetes. In the formation of basidiomata three **types of hyphae** take part, which differ by their structure and functions:

- **generative hyphae** – thin-walled hyphae with septa, branches, with or without clamps;
- **skeletal hyphae** – thick-walled hyphae without septa and mostly unbranched. They ensure rigidity of the basidioma;
- **connecting (binding) hyphae** – thick-walled hyphae without septa, heavily branched and with limited growth. They are found outside the zone of growth of the basidiomata.
The primordia (‘germs’ of basidiomata) appear on the mycelium or in mycorrhizal fungi – directly on the mycorrhizal roots, in the form of small tubers or swellings. They are often difficult to be detected in nature and therefore their study is done in pure cultures.

The surface of the basidiomata, which bears the hymenial layer, is called hymenophore. The hymenial layer is a layer composed of basidia (structures where the sexual reproduction takes place – Fig. 34) and sterile cells (cystidia).

As it was already mentioned, the hymenophore may be lamellate, tubular, spiny, etc. For instance, in agarics the hymenial layer is on the vertical faces of the gills, in boletes it is in a spongy mass of downward-pointing tubes, in puffballs it is internal, in stinkhorns it forms internally and then is exposed in the form of a foul-smelling gel.

It consists of subhymenial layer (thin layer with relatively uniform structure, laying under the hymenium) and hymenophoral trama (basic part of the hymenophore, building its interior).

The basidia of the species presented in this textbook are one-celled. Each basidium usually bears four basidiospores (Fig. 29). The latter are connected to the basidia through thread-like or horn-like structures – sterigmata.
The basidiospores mature gradually and that is why hymenium contains at the same time basidia with not fully developed sterigmata, fully mature basidia with sterigmata and spores, and basidia with already separated spores.

The shape of the basidiospores varies: globose, subglobose, globose with a germ pore, ovoid, ellipsoid, cylindrical, sausage-shaped, bullet-shaped, angular, almond-shaped, spindle-shaped, lemon-shaped, lanceolate; most often they are asymmetric.

The spore shape, size and the characters of their wall, the occurrence or lack of a germ-pore, are important taxonomic characters. The spores may be smooth or ornamented (verruculose, echinulate, striate, verruculose-reticulate, etc.). For the representatives of some genera, e.g. Russula and Lactarius, the spore ornamentation is an important diagnostic feature.

Of special interest for the identification of fungi is the colour of the spores as determined after obtaining their print on a piece of paper. It may belong to one of the following groups:
- white to cream,
- pinkish to red,
- ochraceous to clay,
- reddish brown,
- purplish,
- black.

Of course, there might be some exceptions from the above groups (e.g., ascomycetes with green spores), but they are not included in this textbook. In order to obtain a good spore print, one needs a fresh mushroom specimen (it cannot be produced from a dried specimen) and then to act as follows: Place the cap on sheet of paper and cover with glass. Leave for several hours or overnight to allow the spores to be released. On inspection, the print left by the spores on the paper will mirror the spaces that exist between the gills. Some manuals even recommend that the cap is placed half on white, half on black paper, especially when the approximate colour of the spore print is not known in advance. Thus, light-coloured spore prints
will show up better on darker paper and vice versa. In addition, spores release may be facilitated if a drop of water is placed on the cap before covering it.

In the ascomycetes, included in the textbook, the **ascomata** are either born above the ground apothecia, or underground, closed, tuber-like bodies.

The ascoma of the morels (*Morchella* spp.) is an **apothecium**. It comprises of spherical, spherical-elongated or conical pileus with a honeycomb-like outer surface, and a rigid, stipe-like structure. On the upper surface the hymenial layer is situated which contains the structures where the spores are born (called **asci**).

The ascomata of the truffles (*Tuber* spp.) are hypogeous (formed into the soil), and usually subglobose.

### 1.4. Life cycles

![Life cycle of a mushroom](image)

**Fig. 35.** Life cycle of a mushroom (Drawing: T.T. Denchev).

**Basidiomycetes**
The life cycle of basidiomycetes starts from a **basidiospore** (Fig. 35). The spore may germinate if suitable humidity and temperature are available. After germination the spore gives raise to primary **haploid mycelium** (whose cells have a single nucleus each). It is short-living and soon replaced by secondary **dikaryotic mycelium** (each cell possesses two nuclei) through a process called **plasmogamy**, which requires the fusion of two sexually compatible haploid mycelia. Hence, the cell protoplasm from the two parent mycelia coalesce, but not the nuclei. They form **dikaryons** and after that they undergo divisions synchronously. During this first stage of the **sexual process**, there are no typical specialized gametes (sexual cells) and sexual organs. The fungus could persist for a long time as dikaryotic mycelium. When the environmental conditions are favourable, **basidiomata** initials (primordia) appear and shortly after the mature basidioma are formed. Formation of **basidia** happens in the tip-cells of the fertile **hymenial layer** of the basidioma. The process finishes with **karyogamy** (i.e., fusion of nuclei), resulting in one **diploid nucleus**, and subsequent **meiosis**, which leads to the formation of four **haploid nuclei**. The haploid nuclei in each basidium give rise to usually four **basidiospores**, which are created on the exterior of the basidium. The spores are further dispersed by the wind from the surface of the basidioma.

**Morels**

When suitable temperatures and favorable humidity are available, the morel **spores** germinate to produce hyphae; this **primary (haploid) mycelium** spreads through the soil. At a later stage, primary mycelia can coalesce, giving rise to **secondary, dikaryotic mycelium**. By the mycelium the fungus feeds by producing enzymes that digest nutrients. It is accepted that morels are saprotrophs, but there are also some suggestions that they might form symbiotic relationship with trees and are therefore mycorrhizal fungi. The morel mycelium forms **pseudosclerotia**. The pseudosclerotium is a relatively large structure (up to 5 cm in diameter) which consists of a tough, compact mass of hyphae, composed of large cells with very thick walls in which nutrients are concentrated. In this stage the fungus survives through unfavorable
seasons (such as winter) or environmental conditions. The pseudosclerotia may give rise to vegetative mycelia, or when suitable conditions are available – to morel ascomata. However, the formation of ascomata may only happen when certain conditions are achieved – moisture, temperature, etc. On the surface of the ascomata as a thin layer are formed the sexual structures, called asci. In the interior of each ascus, eight ascospores are formed. The spore-bearing surface of each ascoma may release vast amount of spores, some of which will later germinate.

**Truffles**

The life cycle of truffles is not yet fully understood, which is due to their mycorrhizal, underground lifestyle, which makes the observation of some developmental stages extremely difficult. The asci with ascospores are released in the soil after destruction of the ascoma when it is fully mature. Alternatively, the ripe hypogeous ascomata are eaten by small animals which digest them and then ascospores are dispersed through their excrements. The ascospores which come in close proximity to plant roots germinate and give rise to primary (haploid) mycelium. The later comes into contact and colonizes tree roots, thus forming mycorrhiza. The details of the sexual process to follow are yet unknown. After its occurrence secondary (dikaryotic) mycelium is formed on which appear the primordia of truffle ascomata, which will later mature and produce asci with ascospores. Adult ascomata are composed of asci and sterile hyphae.

**1.5. How many species?**

A hypothesis for the estimation of the number of fungi on earth was suggested by Hawksworth (1991, 2001). An approach based on a ratio of the known fungi to plant species in two well-studied regions, UK and Hong Kong, was implemented. For these two regions, a ratio of 5.3 : 1 was established. Based on these calculations, the expected number of fungal species was estimated to **1.5 M** while currently, only **100,000** are catalogued representing no more than 7% of the estimated total.
Nowadays many authors consider Hawksworth’s approach as conservative (e.g., Crous et al. 2006; Blackwell 2011). The main reason for that is the fact that numerous potential fungal habitats and localities remain understudied. Furthermore, in some cases, different species of fungi morphologically may look the same. Apparently, classifying them requires application of molecular tools. The use of molecular methods will increase the expected number. O’Brien et al. (2005) assumed that the number could be considerably greater, 3.5 to 5.1 M.

Table 2. Number of species of ascomycetes and basidiomycetes in selected countries.

<table>
<thead>
<tr>
<th>Taxonomic groups</th>
<th>Italy¹</th>
<th>Bulgaria²</th>
<th>Greece³</th>
<th>Turkey⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascomycota (non-lichened and</td>
<td>5000</td>
<td>&gt; 1600</td>
<td>&gt; 400⁵</td>
<td>165⁵</td>
</tr>
<tr>
<td>lichenized)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basidiomycetes</td>
<td>6500</td>
<td>1551</td>
<td>approx. 2000</td>
<td>1883</td>
</tr>
<tr>
<td>Total number of ascomycetes and</td>
<td>11500</td>
<td>&gt; 3151</td>
<td>&gt; 2400</td>
<td>—</td>
</tr>
<tr>
<td>basidiomycetes (proper)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated number of fungal species</td>
<td>35000</td>
<td>20670</td>
<td>30740</td>
<td>—</td>
</tr>
</tbody>
</table>

¹After Venturella et al. (2011).
³After Zervakis et al. (1998, 1999, 2008) and Dimou et al. (unpublished data).
⁴After Sesli & Denchev (2012 ‘2009’).
⁵Only macroscopic species of ascomycetes.

The number of the known and expected species in Italy, Bulgaria, Greece, and Turkey is given in Table 2. For this comparison, the following approach was applied: for instance, there are 3900 species of vascular plants in Bulgaria. If the Hawksworth’s fungus–plant ratio of 5.3 : 1 (Hawksworth 2001) is applied, the total fungal diversity of Bulgaria might be estimated at 20670 species (Denchev et al. 2005; Denchev 2011).
1.6. Nutrition

Fungi are heterotrophic organisms and need organic substrata. In contrast to animals, they are not mobile and cannot seek out their food. If fungal spores fall on a suitable substrate, they germinate and form mycelium which grows into that substrate. Usually their substrates are composed of complex, organic compounds (like cellulose and lignin) which need to be broken down into simpler compounds (such as simple sugars). For this purpose, the fungi secrete enzymes, absorb the food in a soluble form, and transport it through their mycelium.

Depending on the source of nutrients, the fungi are divided in two main groups: *saprotrophs* (also called *saprobionts*) and *biotrophs*. The saprotrophic species absorb nutrients from dead organic matter. The biotrophs need living organisms (vascular plants, animals, algae or other species of fungi).

Based on their nutritive adaptations, the fungi can be divided as follows:

- **Saprotrophs**
  - *obligate saprotrophs* (no capacity for biotrophy);
  - *facultatively biotrophic saprotrophs* (normally saprotrophic but with some ability to become biotrophic).

- **Biotrophs**
  - *obligate biotrophs* (no capacity for saprotrophy);
  - *facultatively saprotrophic biotrophs* (normally biotrophic but with some ability to become saprotrophic).

The fungi are predominantly decomposers of dead organic remains, absorbing nutrients for growth. Fungi are the major agents of decomposition, particularly in the organic layers of the forest soils where they play the most important role in the biological decomposition of litter, and for the humus production. The fungal species possess enzymes that break down hemicellulose or cellulose, and especially, basidiomycetes have ability to break down lignin. Many fungal species take part in
the degradation of other organic substrates: dung, horns, hoofs, feathers, nails, in many cases making damages (from a human, commercial point of view, e.g. destroying raw and manufactured materials, such as timber and wood in houses, food products, paper, cotton, leather, etc.) or being a source of diseases (mycoses) of human or domestic animals.

The case of a relationship in which both organisms benefit by the association is termed **symbiosis**. **Parasitism** is a case of a relationship in which one organism, a parasite, lives in or on another living organism, a host, and the host serves as an energy source and a habitat (Figs. 36 & 37). There are two main groups of biotrophs:

- **Symbionts**
  - mycorrhizal fungi;
  - lichenized fungi;
  - fungi in symbiosis with animals.
- **Parasites**
  - obligate (e.g., downy mildews, powdery mildews, rust fungi);
  - facultative.
Figs. 36 & 37. A smut fungus (*Ustilago cynodontis* on *Cynodon dactylon*; Bulgaria, near Asenovgrad; photo: C.M. Denchev), and *Armillaria mellea* (Bulgaria, the Rhodopes; photo: C.M. Denchev).

On the bases of the interrelation between the fungal hyphae and the root cells, there are two main types of mycorrhiza:

- **ectotrophic mycorrhiza** – the mycelium forms an external hyphal sheath around the root and often penetrates between the cells of the root cortex to develop an interwoven net of hyphae (the Hartig net); commonly found on pine, spruce, oak, beech, elm, birch, chestnut, and other trees;

- **endotrophic mycorrhiza** – the fungi predominantly grow within the cortical cells of the root and do not form an external hyphal sheath.
1.7. Ecology

*Saprotrophic fungi*

Many mushrooms have saprotrophic lifestyle, which means that they rely on decomposing dead matter for obtaining nutrients to build their own ‘body’. They represent a vast ecological group, which includes members of various taxonomic entities playing an enormous role in nature, ensuring the nitrogen and carbon cycles in the ecosystems. Being such a diverse group, they may show broader or stricter specialization to the substrates they use as a source of nutrients. Many saprotrophic fungi degrade plant leaf litter, and are called litter saprotrophs. Others, called humus saprotrophs, take the nutrients from already partly degraded organic material present in the upper soil horizons. Wood saprotrophic fungi develop on dead wood, ensuring its degradation (not to be confused with wood-destroying parasitic fungi). Wood degrading fungi may occur on wood of various trees (e.g., *Stereum hirsutum*), or might be found on wood of particular tree species. Some species are confined to even more “exotic” substrates. One distinct group of fungi are the coprophilous fungi, which inhabit dung of various animals. The species of the genus *Strobilurus* develop on dead cones of conifers. The ascomycete (cup-fungus) *Lanzia echinophila* is another peculiar species, which occurs on rotting spiny fruit-covers of the Sweet Chestnut (*Castanea sativa*) and occasionally on acorns of Turkey Oak (*Quercus cerris*). The mushroom *Tubaria dispersa* grows solely on soil-buried fruits of Hawthorn (*Crataegus* spp.). Many fungi could be found exclusively on charcoal in old fireplaces. Some of them can go even further, as for example one species of coal fungus (*Daldinia vernicosa*), whose ascomata occur on the branches of the shrubs of gorse (*Ulex* spp.) only after these are burnt. A great number of species specializes in inhabiting dead leaves, some of them being rather specialized and restricted to a few or even a single plant species. *Marasmius quercophilus* grows on dead leaves of oaks (*Quercus* spp.), and more rarely beech (*Fagus* spp.) and sweet chestnut (*Castanea sativa*). *Marasmius androsaceus* is found in leaf litter of different conifers. *Marasmius*
M. hudsonii is restricted to leaves of the European Holly (Ilex aquifolium) and M. buxi occurs only on dead leaves of European Box (Buxus sempervirens).

**Mycorrhizal fungi**

Many wild mushrooms have a symbiotic lifestyle, being in close relationship with vascular plants. During their evolution fungi developed the ability to form symbiosis with plants, while fungal hyphae come into contact with plants roots. This particular symbiosis is called ectomycorrhiza. The hyphae envelop the roots in a dense layer, creating a mycorrhizal sheath. The roots gradually lose their root hairs, which are responsible for the intake of water and nutrients from the environment. The fungus then takes the responsibility for supplying the roots with the necessary compounds. In general, mycorrhizas are beneficial to both fungus and plant. The fungal hyphae gain access to carbohydrates sources. The plant on the other hand benefits from the increased capacity to absorb water and minerals, due to the large surface of the mycelium. Fungal hyphae can also access phosphates from the soil, which are unreachable for the plant if alone. Plants growing in mycorrhizal relationship are more resistant to drought and diseases. It is also presumed that the two partners may exchange compounds that regulate their growth. Research studies have revealed that some wild fungi possess substances similar to the gibberellins, which are responsible for the growth regulation in plants.

Mycorrhizas are very diverse and their occurrence depends on both fungus and host plant. Many wild mushrooms are capable of building ectomycorrhizas with plants that belong to different genera and families. The fungi of the genera *Laccaria*, *Scleroderma*, and *Pisolithus* are typical examples for such broad ectomycorrhizal specialization. Another fungal genus with relatively broad specialization is *Leccinum*, whose species form ectomycorrhizas with trees and shrubs of the families *Betulaceae*, *Salicaceae*, and *Fagaceae*. For example, *Leccinum corsicum* is a symbiotic species of Mediterranean shrubs (*Cistus* ssp.). Some other fungi are restricted to plants of one family, as for example some of the slippery jacks (*Suillus* spp.), which grow with trees of the *Pinaceae* family and especially pines. Other mushrooms of this genus can only form ectomycorrhizas with larch. Finally, ectomycorrhizal fungi may
be restricted to a few and even to one single host plant species. Good examples for this are *Suillus sibiricus* and *S. placidus*, which only grow with five-needled pines. Wild edible mushrooms restricted to specific plant species are the saffron milk caps – *Lactarius deliciosus* is linked to pines (*Pinus*), *L. deterrimus* to spruce (*Picea*), and *L. salmonicolor* only grows under fir (*Abies*).

A number of mycorrhizal fungi are choice edible mushrooms and there have been many attempts to introduce them in culture and establish sustainable production, which would not rely on natural resources. It would be enough to mention truffles (*Tuber* spp.), the most valuable and expensive mushrooms in the world. It is noteworthy that establishment of artificial plantations for the production of truffles was met with success. Mycorrhizal fungi are also the boletes (*Boletus* spp.), chanterelles (*Cantharellus* spp.), saffron milk caps (*Lactarius deliciosus* group), all of them being in a high demand and bringing substantial income when collected in the wild. Unfortunately, so far the attempts to establish cultures of those mushrooms are largely unsuccessful; despite the fact that there are some successful attempts for establishment of mycorrhization with chanterelles, saffron milk caps and boletes, their large scale production is yet to be achieved.

**Parasitic fungi**

Many fungi use as a source of food live tissues of various organisms and cause diseases. Such fungi are called parasitic. They may grow on plants, animals, insects, etc. or on other fungi. Many parasitic fungi are microscopic, but quite a lot of them do form basidiomata, i.e. they are proper mushrooms, which use plants or much more rarely other fungi as hosts. Many of these are known to be pestilential for many tree species and some of them may devastate a forest if heavy infestation occurs. A typical example of such aggressive parasite is the Honey fungus (*Armillaria mellea*), which almost inevitably leads to death of the infested trees. Other species are weak parasites and may not cause significant damage to their hosts, as for example *Omphalotus olearius* (jack-o’-lantern mushroom), which commonly occurs in olive orchards and *Quercus* spp. stumps. In some cases such fungi do not produce
basidiomata after the death of the host, but in many others basidiomata may appear long after the death of the host, which means that they begin their lifestyle as parasites and move to saprotrophic nutrition after the death of their hosts. Such are for example many wood-destroying fungi. Some parasitic fungi are ubiquitous and grow on various hosts, but other may be highly specialized and need a particular host for their development.

1.8. Factors influencing the occurrence and the production of wild mushrooms - Major habitat types in the areas of interest

It is well known from practice that the productivity of WEM tends to vary greatly from season to season and from one place to another. Table 3 shows examples of this variance for a few popular wild edible mushrooms in different countries in Europe and from different habitats.

Table 3. Yields of some species of WEM in different countries.

<table>
<thead>
<tr>
<th>Country of study</th>
<th>Minimum yield¹ kg/ha/year</th>
<th>Maximum yield kg/ha/year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boletus edulis</strong> group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulgaria</td>
<td>0.2</td>
<td>95.3</td>
</tr>
<tr>
<td>Belarus</td>
<td>30</td>
<td>500</td>
</tr>
<tr>
<td>Russia</td>
<td>3</td>
<td>54</td>
</tr>
<tr>
<td>Russia</td>
<td>0.6</td>
<td>102.8</td>
</tr>
<tr>
<td>Russia</td>
<td>1</td>
<td>36.5</td>
</tr>
<tr>
<td>Spain</td>
<td>3.5</td>
<td>65</td>
</tr>
<tr>
<td>Spain²</td>
<td>3</td>
<td>94</td>
</tr>
</tbody>
</table>

| **Cantharellus cibarius** group | | |
| Russia | 0.02 | 1.25 |
| Russia | 0.1  | 11   |

| **Lactarius deliciosus** group | | |
| Russia | 0.1 | 35.0 |
| Spain² | 0.15 | 53.57 |

| **Leccinum scabrum** group | | |
| Russia | 0.04 | 8.2 |
| Russia | 0.1  | 83.9 |
Chapter 1: Introduction to Mushrooms

<table>
<thead>
<tr>
<th>Country of study</th>
<th>Minimum yield(^1) kg/ha/year</th>
<th>Maximum yield kg/ha/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leccinum aurantiacum group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td>5.7</td>
<td>85.1</td>
</tr>
<tr>
<td>Suillus spp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td>0.9</td>
<td>10.1</td>
</tr>
<tr>
<td>Russia</td>
<td>0.02</td>
<td>21.5</td>
</tr>
</tbody>
</table>

\(^1\)Zero yields excluded.
\(^2\)Autumnal (weeks 35–50) production in forests of different age classes.

The question about what rules the mushroom productivity is without any doubt one of the most frequently asked by mushroom practitioners. It is certainly of a great importance as this knowledge would allow a certain degree of planning or more likely predicting the production and the yields of wild edible mushrooms. The growth requirements for many cultivated mushrooms are nowadays mostly known and for most commercial species and even for some strains, there are protocols, describing the necessary conditions which must be provided in order to expect high yields, extended production of basidiomata, etc.

Even more difficult is the answer to that question for wild mushrooms, which live in free environment and experience therefore the influence of a great variety of factors. No two forests are exactly the same and the habitats of one species may differ by their altitude, soil, slope, exposure, etc. It might be supposed that in nature fungi will be affected also by their interaction with different organisms (the so called biotic factors). Thus it may be presumed that the fungal growth will be affected by the characteristics of the forest stands – their composition, age, canopy, etc. To make things even more perplexed, some ecosystem processes should be also taken into account, e.g. the movements and the availability of nutrients, for example nitrogen and carbon content, phosphorus, etc. Finally, the productivity of mushrooms may depend on various human activities, such as various forestry and management practices, i.e., logging and thinning the forest stands, trampling and disturbance of the soils, collecting of mushroom basidiomata, etc.
There have been several attempts to exclude many of these variables, while looking on others. Researchers have studied the growth of mycelia of a number of wild fungi in lab conditions. However, those experiments cannot help much in understanding the production of basidiomata in nature as mycelia in laboratory may require different conditions for production of basidiomata, than those in nature. Moreover, not all mushrooms may be successfully kept in pure culture and many of them do not produce basidiomata in Petri dishes at all. Also, the behavior of mycelia in culture may depend on the composition of the nutrient media.

There have been numerous attempts to explain the factors influencing the occurrence of basidiomata and mushroom productivity. A brief overview of the results available so far is given below. However, it must be noted from the beginning that the researchers agree that our current knowledge regarding mushroom productivity is far from complete and that further research is needed to get more clear understanding of this matter.

**Climate variables**

The climate variables have been always overseen as important factors controlling the production of WEM. The purposeful research in this field dates back to at least the middle of the last century, when the first studies tried to find relations between climatic parameters and WEM production.

There are many observations that have shown the relation between the precipitation and mushroom crops, and presently there could be no doubt that the mushroom productivity is higher in years with higher amounts of rain. Current studies use statistics to backup and confirm those observations. The relation between the water availability and mushrooms yield has been shown both for the overall productivity and for that of some particular species. There are some suggestions that not only the precipitation of the current year is important, but also the rainfalls in certain months of the previous year. Thus, one study demonstrated that in boreal forests of Canada, the rainfall in June of the current year and in May of the previous year are both important for mushroom production.
The importance of the water supply was confirmed by different types of experiments, performed in different parts of Europe. In the frame of a particular study carried out in Spain artificial drought was induced in holm oak forests. The result was dramatic (on average over 60%) decrease of the mushroom productivity. A team of Finnish scientists studied the effect of irrigation on basidioma production of larger fungi. They found that the additional water supply increased the biomass of the basidiomata of some species, while others were unaffected by this treatment.

Temperature (soil, air) was also thought as possibly important factors for production of basidiomata, and some studies have confirmed this relation. However there are other publications, which could not correlate productivity and temperatures. So, at present this question remains open for discussion.

Although recognized as very important, existing studies have demonstrated that the climatic factors alone cannot satisfactorily explain the observed mushroom productivity, which greatly varies from year to year. Therefore scientists try to detect other possible factors which may interfere in this process.

**Biotic factors**

Fungi are never alone in the environment and a number of biotic factors dictate their distribution and occurrence. In the very first place, there are the various types of habitats. Each habitat provides different conditions for living and therefore each habitat harbors a variety of fungi, many of which occur exclusively or preferably in it. Among the most important characteristics is the composition of plants in the habitats and this is easily understandable as many fungi are mycorrhizal and able to live only in association with certain plants. Not only mycorrhizal fungi are influenced by the habitat, but also the saprotrophic. This is due to the interaction between the plant-hosts and the environment, which creates unique living conditions that may be suitable for some saprotrophic fungi and not so suitable for others. Moreover, saprotrophic fungi may be highly specialized and grow only on a specific substrate, e.g., on the leaves of a particular tree species. Not only the composition of the plant communities is important but so is their age, which is especially true for the forest
communities. It is known that the composition of fungi changes with the forest age, as a result of the changing environmental conditions or the changes in the physiological condition of the host tree. It is also acknowledged that the size of the tree stand is important for fungi, larger stands being richer in species. It is difficult to enumerate and explain all the biotic factors that influence the occurrence and basidioma formation in mushroom fungi; moreover, many of those factors are not yet fully understood.

As for the purposes of this manual it will be more convenient to present a brief description of the ‘fungal’ properties of different major habitat types in MYCOTICON’s participating countries.

1. **Oak forests.** The oak forests are possibly the most widespread forest type in southern Europe. They occur in many places and under various conditions of growth, i.e., deciduous forests at lower altitudes, on either calcareous or siliceous bedrock, on more or less shallow soils, capable of enduring high temperatures and drought in the summer. They may be either pure or mixed stands of various oak species, e.g. Turkey Oak (*Quercus cerris*), Hungarian Oak (*Q. frainetto*), Eastern White Oak (*Q. pubescens*), etc. (Figs. 38 & 39). This type of forests has been subjected to severe human influence since many years ago. They are often degraded coppice woodlands or the oaks are mixed with numerous other tree species. Further south in the continent, forests of evergreen oaks, such as the Kermes Oak (*Quercus coccifera*) and the Holm Oak (*Q. ilex*), occur. These are forests growing under severe summer drought conditions of the greater Mediterranean Basin. At slightly higher altitudes different type of oak forests occur, characterized by the more mesophytic nature due to the more even distribution of rainfall through the year.
Oaks trees favouring mycorrhiza formation, being capable of building associations with many fungi, and that is why oak forests are both rich in number of species and in terms of quantities of edible mushrooms. High quality edible mushrooms typical for oak forests are *Amanita caesarea*, the *Boletus edulis* group (especially the more warm-loving *B. aereus* and *B. reticulatus*), *Cantharellus cibarius* and related species, *Craterellus cornucopioides*, *Hydnum repandum*, *H. rufescens*, *Infundibulicybe geotropa*, *Macrolepiota procera*, *Russula cyanoxantha*, *R. virescens*, etc. In addition, oak forests are places where one may expect to find the most prized edible mushrooms, namely the truffles. However, several dangerous poisonous mushrooms appear in oak forests, the most notable of them being the Death Cap (*Amanita phalloides*) and the Destroying Angel (*Amanita verna, A. virosa*). Other typical species of fungi for this type of habitat are *Gymnopus quercophilus*, *Laccaria laccata*, *Lactarius chrysorrheus*, *Mycena pura*, *M. rosea*, *Russula vesca*. Wood decaying species are very common, especially *Daedalea quercina*, *Fistulina hepatica*, *Ganoderma lucidum*, *Peniophora quercina*, *Piptoporus betulinus*, *Trametes hirsuta* and *T. versicolor*. The evergreen Mediterranean oak forests share a great number of common species with the previously referred deciduous ones, however some characteristic and sometimes rare ectomycorrhizal representatives of such habitats.
are known to exist in Greece and Italy, e.g. *Amanita proxima*, *Boletus fragrans*, *B. impolitus*, *B. lupinus*, *Cortinarius caligatus*, *Lactarius atlanticus*, *L. rugatus*, *Leccinum lepidum*, *Russula ilicis*, *R. prinophila* and *Xerocomus dryophilus*.

2. **Sweet chestnut forests.** This type of forests are usually found in warmer climates, normally in places with well pronounced summer drought, on deep or shallow soils (Figs. 40 & 41). Sometimes the sweet chestnut clearly prevails and may form almost pure stands, but in many places it may be mixed with oaks, beech, oriental hornbeam, hophornbeam, etc. Taking into account the summer drought, chestnut forests usually have two well pronounced mushroom seasons – one in the spring and early summer, and another one in the autumn, both of them connected with the rain maxima. Sweet chestnut forests are normally very rich in wild edible mushrooms (and in fungi in general), as it is well-known that chestnut trees are capable of forming ectomycorrhizas with many different fungal species. Some typical WEM found there are *Agaricus* spp., *Amanita caesarea*, the *Boletus edulis* group (*B. aereus* and *B. reticulatus*), *Cantharellus cibarius* and related species, *Craterellus cornucopioides*, *Hydnum repandum*, *H. rufescens*, *Infundibulicybe geotropa*, *Macrolepiota procera*, *Russula cyanoxantha*, *R. virescens*, etc. The sweet chestnut forests thus have very similar species composition to that of the oak forests, especially as concerns the choice edible mushrooms. Some less popular edible mushrooms are also found, e.g., *Armillaria mellea*, *Boletus regius*, *Fistulina hepatica*, *Laccaria laccata*, *Lactarius volemus*, the *L. piperatus* group, *Lepista nuda*, *Macrolepiota rachodes*, *M. konradii*. Apart of these, there is a number of inedible species, exclusively connected to sweet chestnut, most notably the cup fungus *Lanzia echinophila*, which occurs on rotting fruitcovers of sweet chestnut. Some other species are also very common, which are observed in beech or oak forests, for example *Amanita citrina*, *A. phalloides*, *A. rubescens*, *Boletus rhodoxanthus*, *Lycoperdon echinatum*, *Omphalotus olearius*, *Xerula pudens*. Several more rare hydnoid fungi are often seen in chestnut forests, especially *Hydnellum concrescens*, *Phellodon melaleucus*, and *Sarcodon joeides*. The bracket fungi in chestnut forests are
rather diverse and a number of species are frequently noted there, e.g., *Daedalea quercina*, *Fomes fomentarius*, *Hymenochaete rubiginosa*, *Pycnoporus cinnabarinus*, *Trametes hirsuta*, *T. versicolor*.

3. **Beech forests.** They constitute a major forest type in this part of Europe usually composed of pure stands of beech (*Fagus* spp.) (Figs. 42 & 43) since these trees tend to form a vast and very dense crown, which stops the light from reaching the lower forest layers, thus suppressing the growth of other plant species. Beech forests appear with two major subtypes. The first one occurs in the middle mountain altitudes, developed on deeper soils, under higher humidity and cooler climate. Generally speaking those forests are darker, colder and more humid. The second type occurs mostly at lower altitudes, on more dry soils, and in more exposed situations, very often on limestone. The beech forests are rich in fungi, including edible mushrooms. WEM often found here are the *Boletus edulis* group (most often *B. edulis*, more rarely *B. reticulatus*), *Cantharellus cibarius* and related species, *Craterellus cornucopioides*, *Hydnum repandum*, *Infundibulicybe geotropa*, *Pleurotus ostreatus*, *Russula cyanoxantha*, *R. virescens*, etc. Beech forests are sometimes mixed
with some coniferous trees and fungi like the two following saffron milk caps may occur – *Lactarius deterrimus* may be expected, when spruce (*Picea abies*) is present or *L. salmonicolor*, when fir (*Abies* spp.) occurs in the stand. Other typical and often observed fungi in beech forests are *Coprinus picaceus*, *Hebeloma sinapizans*, *Hypoxylon fragiforme*, *Laccaria amethystina*, *Lactarius blennius*, *Lepista nebularis*, *Marasmius alliaceus*, *Mycena pelianthina*, *Oudemansiella mucida*, *Russula cyanoxantha*, *R. fellea*, *R. foetens*, *R. virescens*, *Strobilomyces strobilaceus*, *Volvariella bombycina*, as well as some wood-destroying bracket fungi, e.g. *Fomes fomentarius*, *Pycnoporus cinnabarinus*, *Trametes hirsuta*, and *Trametes versicolor*, although most of the latter are not limited to this particular type of forests.

4. *Scot’s Pine forests and other mountain pine forests in south Europe.* This type of forests is a mountainous one, occurring at higher altitudes, on both siliceous bedrock and limestone. They are usually light forests due to the peculiar crown of the Scot’s Pine (*Pinus sylvestris*) (Fig. 44). Normally Scot’s Pine forests will occur on shallow soils on steeper slopes, due to the conditions preferred by the tree. Among the most typical edible mushrooms here are the boletes and especially the more temperate species *Boletus pinophilus* and *B. edulis* (the later however prefers mostly spruce forests). Another very characteristic edible mushroom is the *Lactarius deliciosus*, which only grows with pines and generally fruits abundantly in cooler mountain
conditions. Also typical for this type of forests are the slippery jacks, and especially *Suillus bovinus*, *S. luteus*, and *S. granulatus*. The Charbonnier (*Tricholoma portenosum*) is a typical pine mushroom, although it may also be seen sometimes in broadleaf forests. The chanterelles, and *Cantharellus cibarius* in particular may also occur in those coniferous forests, albeit more rarely than in broadleaf ones. Among the typical mushrooms in pine forests are also *Boletus badius*, *Chroogomphus rutilus*, *Fomitopsis pinicola*, *Gomphidius glutinosus*, *Hygrophorus hypothejus*, *Lactarius rufus*, *Marasmius androsaceus*, *Phellinus pini*, *Russula sanguinea*, *Tapinella atrotomentosa*, *Trichaptum abietinum*. A number of species are associated with the cones of pines, e.g. *Auriscalpium vulgare*, *Baeospora myosura*, and *Strobilurus tenacellus*. In the mountains, Scot’s pine forests are often intermixed with birches and therefore species of the *Leccinum scabrum* group and *L. aurantiacum* group may be often seen there. In addition, *Lactarius torminosus* (claimed as inedible or even poisonous) and *L. pubescens* (known as poisonous) occur often with birch. In the Balkans and in Italy, the Scot’s pine may also grow mixed with other mountain pine species, most notably Black Pine (*Pinus nigra*), Macedonian Pine (*P. peuce*) (Fig. 45), Dwarf Pine (Fig. 46) and Bosnian Pine (*P. heldreichii*). As some of those pines have specific ectomycorrhizal fungi, these may appear in Scot’s pine forests, when these tree species are intermixed. As for example, *Suillus sibiricus* is found with the five-needled Macedonian Pine, and the very interesting cup fungus *Zeus olympius* occurs only on dead branches of Bosnian Pine. However, the number of good edible mushrooms restricted to those other pine species is rather limited and they are similar to those, which grow with Scot’s Pine. Pines are usually valued in forestry for they may grow on rather poor and eroded soils. In some countries it is common practice to create artificial pine plantations for fighting soil erosion. Some characteristic fungal associates are also transferred by the pine plants and artificial pine plantations may sometimes yield considerable quantities of edible mushrooms, such as *L. deliciosus*, *Suillus luteus*, and *S. granulatus*. 
5. Spruce forests. They form mountain forests, which appear either as pure stands of European Spruce (*Picea abies*) or sometimes mixed with pines (*Pinus* spp.), fir (*Abies* spp.) and even beech (*Fagus sylvatica*). In most cases they occur on richer and more humid soils than the rest of the coniferous forests (Fig. 47). This makes them an important habitat for fungi. Many edible mushrooms occur in spruce forests, but among the most widespread and also most valuable are the boletes (*Boletus edulis* and *B. pinophilus*), which very often tend to appear in large quantities. Other valuable edible mushrooms in spruce forests are the saffron milk caps (mostly *L. deterrimus*, but also other species if pines or fir are present in the stand as well). Chanterelles and especially *Cantharellus cibarius* are found in spruce forests, although they rarely appear in such large quantities as in broadleaf forests. Other typical or common
mushroom species occurring in spruce forests are *Boletus subappendiculatus*, *Chroogomphus helveticus*, *Fomitopsis pinicola*, *Gomphus clavatus*, *Hydnellum suaveolens*, *Lactarius aurantiacus*, *Marasmius androsaceus*, *Micromphale perforans*, *Porphyrellus porphyrosporus*, *Russula queletii*, *Strobilurus esculentus*, *Xerocomus ferrugineus*.

6. **Birch forests**. They are widespread in central and north Europe, but rather rare in south Europe; they occur mostly in high mountains. However, birch is valued in forestry as a beautiful pioneer tree and is therefore widely planted. Fortunately, natural birch forests and even artificial birch plantations host a wide variety of mushrooms. Most notable and with somewhat higher economic value are different species of birch boletes, namely those in the groups of *Leccinum scabrum* and *L. aurantiacum*. Other include *Lactarius pubescens* and *L. torminosus*, which also count among the most common mushrooms (although not edible) in birch plantations. Among the poisonous toadstools, common species found with birch (but not only) is the Fly Agaric (*Amanita muscaria*). Other species commonly encountered are: *Lactarius turpis*, *L. vietus*, *Russula betularum*, *R. claroflava*. In addition, some bracket fungi are related to birches, especially *Lenzites betulina* and *Piptoporus betulinus*.

![Figs. 48 & 49. Pinus halepensis and P. pinea (Greece, left), and P. brutia (Cyprus, right)](photos: E. Polemis)
7. Mediterranean pine forests. Such type of habitats are widespread in the south part of Europe and throughout the Mediterranean basin; they are found from the costal zone to the continent and up to an altitude of 600 m (exceptionally up to 1000-1200 m in the south limit of their range). These forests were evolved to cope with the xerothermic conditions characterized by long summer droughts, and they are mainly comprised of three tree species: the Aleppo pine (P. halepensis) and the Italian Stone pine (Pinus pinea, found in Italy, western and continental Greece) (Fig. 48), and the Turkish pine (P. brutia, found in the eastern islands of the Aegean archipelago, Crete, Cyprus and Turkey) (Fig. 49). Under the canopy of these pine trees, the kernel oak (Quercus coccifera), arbute-trees (Arbutus unedo and A. andrachne) and various shrubs (most commonly Cistus spp.) usually occur. Urban and touristic development exercised large pressure in coastal areas and together with the extensive burning of such forests, a remarkable degrading or loss of huge parts of them was noted during the last decades. The most commonly collected ectomycorrhizal WEM species are the orange to red-milked Lactarius spp., i.e. L. deliciosus, L. sanguifluus and L. semisanguifluus which can be often found in large quantities, and they are also a subject of more or less extensive commercialization in particular islands and coastal areas. Moreover, in such pine forests and in early spring, black morels (Morchella elata group) also appear and they are very much appreciated and extensively collected for commercial purposes. Other fleshy mushrooms that are extremely common in such habitats are the ectomycorrhizal and edible but of mediocre quality Suillus spp. (S. bellini, S. mediterraneensis, S. collinitus, S. luteus and S. granulatus) which are usually collected for personal consumption only. Other WEM are Amanita ovoidea, (which produces massive basidiomata, which however often grow together with the similar-lookiing and poisonous A. proxima), the “forest loving” Agaricus silvicola (it can be easily confused with the deadly poisonous Amanita verna), several Tricoloma spp. such as the aromatic choice edible T. caligatum, the small-sized but good edible grey T. myomyces (and the non edible orange to rusty coloured species of the T. fracticum group), as well as Hydnum repandum, Infudibulicybe geotropa, Lepista nuda, Melanoleuca spp. Other characteristic species of these habitats are the
ectomycorrhizal *Chroogomphus rutilus*, *Hygrophorus hypothejus*, *Rhizopogon luteolus*, *R. roseolus* and *Russula delica*. Furthermore, various saprotrophs that are equally common in broadleaved and coniferous forests such as *Clathrus ruber*, *Cystoderma granulosum* *Lycoperdon perlatum*, *Mycena pura* appear together with wood-decay species mostly associated with coniferous trees such as *Fomitopsis pinicola*, *Tapinella panuoides* *T. atrotomentosa* and *Trichaptum abietinum*, and the small but common (and exclusively growing on pine cones) *Mycena seynesii* and *Strobilurus tenacellus*, and the pine trees parasites *Porodaedalea* (*Phellinus*) *pini* and *Phaeolus schweinitzii*.

**Figs. 50 to 53.** *Quercus ilex*, *Q. coccifera*, *Cistus* spp. and shrublands (Greece; photos: E. Polemis; from top left to bottom right).
8. Mediterranean scrubland and maquis. A typical element of the Mediterranean vegetation is the so called “maquis” comprised by small evergreen trees such as the kernel oak (Quercus coccifera), Cretan Maple (Acer sempervirens), arbute-tree (Arbutus unedo), heaths (Erica arborea and E. manipuliflora) and the low spiny or aromatic shrubs that are known as “phrygana” (Calycotome villosa, Genista acanthoclada, Sarcopoterium spinosum, Corydothymus capitatus, Satureja thymbra, Cistus spp. etc.) (Figs. 50 to 53). As it is the case for most of the Mediterranean coastal land and islands, these habitats are formed as a result of a prolonged disturbance caused by humans and their domestic animals since the ancient times. Therefore, a serious degradation can be detected in forests that once covered extended areas, consisting particularly of deciduous and evergreen oak trees (Quercus pubescens and Q. ilex) as well as pines like those previously mentioned. These low-height trees or shrubs were evolved to overcome the prolonged summer draught as well as the grazing from various domesticated herbivores especially goats, by developing acute spines or by producing volatile essences that make them inedible or poisonous if consumed. In many cases such scrublands are observed in abandoned (previously cultivated) areas and are very common in all Greek islands. Although draught prevails for the longest part of the year, the hygrothermic conditions are suitable for mushroom appearance during late autumn and winter, and many mushroom species grow at this period. Shrubs of the genus Cistus (C. creticus, C. incanus, C. monspeliensis, C. salviifolius etc., known as “lavdania” in Greek) often dominate in such habitats, and it is well evidenced that they support a large diversity of ectomycorrhizal macrofungi such as Hebeloma album, H. cistophilum, Lactarius cistophillus, L. tesquorum, Leccinum corsicum, Russula cistadelpha, several Inocybe and Cortinarius spp. which exclusively form ectomycorrhizas with these particular plant species. Other ectomycorrhizal mushrooms with a wide range of hosts like Amanita vaginata, Hebeloma crustuliniforme, Hygrocybe virginia, Pisolithus arrhizus, Scleroderma verrucosum may occur in Cistus dominated plant communities. In addition, popular WEMs could be also detected, e.g. Amanita ponderosa (known in east Mediterranean from only one
Greek islet, i.e. Oinoussa), the black truffle *Tuber melanosporum*, *Laccaria laccata* and *Boletus aereus*. All these species are commonly associated to various evergreen and deciduous Mediterranean oaks. In scrublands and abandoned fields that are often grazed by herbivores (sheep and goats) several WEMs occur as well, such as *Agaricus campestris*, *A. litoralis*, *Macrolepiota excoriata*, *M. phaeodisca*, *Melanoleuca excissa*, *Volvariella gloiocephala*, while the choice edible *Pleurotus eryngii* var. *eryngii* and *P. eryngii* var. *ferulae* grow mostly in association with *Eryngium* and *Ferula* plants. Other common saprotrophs are *Crinipellis scabella*, *Coprinus vosustii*, *Colus hirudinosus*, *Conocybe semiglobata*, *Contumyces rosellus*, *Stropharia coronilla* and some Mediterranean wood-rotting species like *Perenniporia meridionalis*, *Phellinus torulosus* and *Polyporus meridionalis*.

9. **Grassland habitats.** These are extremely widespread, very diverse and their general characteristics could not be easily presented (Figs. 54 & 55). What is common for all grassland habitats is that they generally have poorer mushroom diversity than forests. This peculiarity is partially explained by the fact that a few mushrooms may develop mycorrhizas with grassy plants, much less than those with trees. Grasslands as habitats are incomparably more exposed to heat and sunlight than forests and scrub biotopes, and this could be limitation factor for non-mycorrhizal mushrooms. Nonetheless, a number of valuable edible mushrooms are typical grassland elements, e.g., the *Agaricus campestris* group, *Calvatia gigantea*, *Macrolepiota procera*, *Marasmius oreades*, *Pleurotus eryngii*. Other characteristic grassland fungi are *Bovista* spp., *Calocybe gambosa*, *Hygrocybe* spp., *Psathyrella* spp., *Psilocybe* spp., *Vascellum pratense*, *Volvariella gloiocephala*. Grazing may be an important factor in grasslands, as there are many mushrooms that favor the nitrogen enrichment, which comes as a consequence of grazing. Such nitrophilous species are for example the *Agaricus* spp., as well as many coprophilous fungi (e.g., *Panaeolus* spp., *Coprinus* spp.). Other species may depend on grazing animals for propagating their spores and they will occur more often in grazed grasslands. A good example for such fungus is the edible *Calvatia utriformis*. 
Human-related factors

It is presumed that several human-induced factors may alter the mushrooms productivity in nature. For example, numerous concerns have been raised within the scientific community on whether increased collecting of wild edible mushrooms may harm their populations and lead to serious decline. However, a recent long-term study in Switzerland found no evidence for either decrease of mushrooms productivity or species richness. This allowed the team of scientists to conclude that mushroom collecting does not influence future harvests. It was also shown that the method of collecting (picking, cutting) does not exercise influence on the productivity. It was found though, that trampling of the forest floor reduces the number of mushroom basidiomata.

Other studies have tested the impact of different forestry techniques on mushroom productivity. A study in Italy has revealed that thinning influences the production of *Boletus edulis*. It was suggested that frequent light thinning of forest stands maintains in a better way the productivity of mushrooms rather than infrequent heavy thinning. Similarly, a study performed in Spain reported that thinning of forest stands leads to changes of the productivity of the saffron milk caps (*Lactarius deliciosus* group). It was shown that light thinning leads to increase of the mushroom productivity, while heavy thinning leads to decrease of the basidioma production. Moreover, it was evident that the effect of thinning is immediate as
yields of the saffron milk caps raised sharply two months after the treatment was implemented. A very interesting thinning experiment was carried out in Switzerland between 1977 and 2006. The thinning and the evaluation of the mushroom productivity was combined with measuring of the annual tree-ring width, which is well-known to correspond to the annual tree growth. After thinning, tree growth becomes more intensive due to the increased availability of resources. This intensive tree growth corresponds to wider tree-rings. The study of the Swiss scientists has found very good correlation between the number of basidiomata and the width of the tree rings. It was thus concluded that mushroom production from ectomycorrhizal fungi is related to the growth of their associated host tree.

1.9. Collecting fungi for identification

Collecting fungi for identification is an important stage of this process and attention must be paid. For collecting specimens one will need some consumables and suitable equipment. First of all suitable paper bags or plastic boxes are needed to store the specimens when collecting in the field. Plastic bags are not recommended as mushrooms tend to disintegrate or change features. Alternatively aluminum foil may be used to carefully wrap the basidiomata, gathered for identification. If the specimens could not be processed on the same day, they might be kept for a certain time in a fridge, but freezing is not suitable. When collecting mushrooms for identification, basidiomata and ascomata of different ages should be collected, when this is possible, as in many fungi there might be striking differences between young and mature mushrooms. As in some of them certain characters might be ephemeral and disappear in a few hours, taking photographs in the field is most recommended.

Attention to the habitat and especially on the surrounding vegetation should be paid, since the knowledge about this may greatly aid the identification.

When the specimens are taken home, the next important step is to carefully take notes on vital characters, which are important for achieving correct identification. Taking notes of as much characters as possible, e.g., features of the
pileus (size, colour, surface, shape, margin), stipe (size, shape, colours), veil (presence or absence, type, remnants), flesh (colour, colour changes, surface, smell, in certain cases the taste might be important, but one should never taste any unknown mushroom as to avoid poisoning), hymenophore (type, colour, colour changes, shape, attachment, etc.), is very important for subsequent identification as explained in *Morphology*. In many cases, for arriving at the correct identification, the micromorphological characteristics of specimens should be examined with the aid of a microscope. Anatomical features (e.g. spores, cystidia, basidia, basidioles, hyphal systems, hyphal walls, septations, hyphal branching, hyphal inflations and specialized hypha) could be thus evaluated. In addition, the use of chemical reagents is often necessary, i.e. 95% ethanol (v/v in water), 3% potassium hydroxide, 5–10% ammonium hydroxide, Teepol, acetocarmine, chloral hydrate, Congo red, cotton blue, cresyl blue, fuchsin, guaiac, hydrochloric acid, Melzer’s reagent, methylene blue, sodium hydroxide, sulphobenzaldehyde and sulphuric acid. Finally, a spore-print should be prepared. After all this is done, one may proceed with the identification using suitable guides and identification handbooks. In many cases precise identification may be only achieved after the study of fungal specimens under a microscope.

In certain cases, specimens may be stored, especially when a scientific study is intended. Specimens are dried either in open, or in dryers, and it is recommended that drying temperature do not exceed 45 °C. After drying the samples are kept in a dry place, in paper packages, labelled with the name of the species, if known, the locality of collection, the date and the name of the collector.
Chapter 1: Introduction to Mushrooms

Literature cited and suggested


[66]


This page was left intentionally blank.
Chapter 2

“CHOICE WILD EDIBLE MUSHROOMS”

Descriptions and information on selected mushroom species and allies which are common in MYCOTICON’s participating countries

Elias Polemis and Georgios I. Zervakis
Agricultural University of Athens, Greece
(with contributions by G. Venturella, and C.M. Denchev and B. Assyov as regards species occurring in Italy and Bulgaria respectively)

October 2012
1. *Amanita caesarea* (Scop.) Pers.

**Etymology:** From Latin “Caesar”, “Caesar’s Amanita”, because it is was a favourite of the early Roman Emperors.

**Common Greek names:** “piperouska” (Grevena); “genitsara” (Kastoria); “kokkinouska” (Grevena, Pieria Kozani); “kokkino” (Kilkis); “avgouta” (Kastoria, Pieria); “augitis” (Pieria, Thasos isl.); “augomilakia” (Chalkidiki); “kaisaritis” (Kozani); “neratzaki” (Pilion - Magnisia); “kokkinomanitaro” (in various regions).

**Common Italian names:** Ovolo buono, Fungo reale.

**Common Bulgarian name:** Булка гъба (Boulka guba).

![Figs. 1 & 2. Amanita caesarea (photos by E. Polemis).](image)

**Description**

**Basidioma development:** In early stages, the mushroom looks like a chicken’s egg of white colour, as it is enclosed within a membranous universal veil (Fig. 1). The veil progressively raptures at the top and the orange cap appears developing to the umbrella-like form with a distinct cap and stem (Fig. 2).
Chapter 2: Choice wild edible mushrooms

**Pileus (cap):** (5-) 7-20 (-23) cm wide when fully expanded, initially ovate to hemispherical, soon convex, later expanded to almost plane, rarely with slightly uplifted margin at maturity; bright orange-red fading to yellowish with age; smooth, slightly viscid, silky, finely but distinctly striate at the margin (10-30% of the radius); cuticle separable, sometimes with velar remains, appearing as large, thick, whitish membranous patches.

**Lamellae (gills):** Free, 7-16 mm broad, fairly crowded and yellow from the beginning, sometimes forked at margin.

**Spore print:** White to slightly yellowish.

**Stipe (stem):** 6-15 × 2-3 cm, cylindrical, narrowing at top, with somewhat swollen base; golden yellow; smooth below the ring and slightly striated above, hollow when mature. The ring is pendant, golden yellow, membranous and thick; slightly striated on the upper side and felted on the lower side. The base of the stem is emerging through a relatively large volva up to 6 cm high and up to 4 or 5 cm broad; membranous, thick and rather firm, attached to the stem only at its base and remote at the upper portion, white on the outer surface, white or orange on the inner, yellow at the point of contact with the stem.

**Context (flesh):** White and firm, yellowish beneath the cuticle of cap and stem, smell faint; taste pleasant, nutty.

**Habitat/ecology:** In Greece, Italy and Bulgaria, it appears more often in broadleaved oak (mostly), beech and chestnut woods, rarely in coniferous woods such as cephalonian fir (*Abies cephalonica*, Greece), "exotic" conifers (Bulgaria) and pines. It is a symbiotic mushroom species (like all members of the genus *Amanita*) and forms ectomycorrhizae with the trees species mentioned above.
Distribution: Common throughout the mainland of Greece and known also from some large Aegean islands (Euboea, Lesvos). Widely distributed in Italy (including some islands of Tuscany and Aeolian archipelago, Pantelleria); it grows at altitudes ranging from 0 to 2000 m. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 3, 4, 5(c, e), 6, 7, 8, 15, 16(w), 17(w, e), 18, 19, 20 (please see explanatory note at the end of this Chapter).

Fruiting-season: It is a warm-loving species that fruits from spring (May) to autumn (October), common during the summer months (July and August) in the mountains of north and central Greece up to the altitude of 1000 m, while in Lesvos it could be found until November. In Italy, it occurs up to 1500 m in beech forests.

Possible confusion
The combination of orange cap, yellow gills and stem, as well as the large white loose volva makes the identification of this species quite easy, noticeably being the only widely recognized species of the genus *Amanita* by amateur mushroom collectors. In rare cases, it could be confused with the “fly agaric” *Amanita muscaria*, but the latter has typically deep red cap covered with many white warty patches, white gills and stem and a completely different volva; the stem in not encased in a membranous and loose sheath as in Caesar’s Amanita, but it consists merely of a compact bulb covered by concentric warty bands. Possible confusion of these two species is more probable after a heavy rain since the white patches on the red caps of *A. muscaria* could be washed out while the cap color may also fade to orange-yellowish. In such rare occasions, the differences at the stem base and the color of gills are good discriminating characters. When *A. caesarea* is collected at the “egg stage”, then it can be confused with deadly toxic species such as *Amanita phalloides* or *A. verna* from which it can be safely differentiated if the “eggs” are cut lengthwise to reveal the orange cuticle of the cap and the yellow gills present in the edible species.
Notes on edibility

Caesar’s Amanita is one of the most widely recognized and highly valued wild edible species (WEM). Its culinary excellence is well known in the Mediterranean region. Ancient Greeks and especially Romans appreciated this mushroom so much that they considered it as the “food of gods” equivalent to “ambrosia” and they believed it was providing immortality to those who consumed it. It is reputed to be Julius Caesar and Emperor Claudius favorite mushroom. It can be eaten raw when still very young and it is delicious when cooked in various ways, roasted or panned.

Preservation

Mature basidiomata do not last too long, but young ones, especially at the egg-stage, can be preserved in the refrigerator at 4-6 degrees for several days, in deep freeze for months, and canned in olive or brine for even longer.

Commercialization

This species is collected in Greece mainly for private consumption; only rarely is commercialized in some regions in the north. In Italy is rarely commercialized (particularly in North Italy) and the price is ca. 25-30 €. In Bulgaria, it is collected and sold on local, national and international markets.

Conservation status

Common and widespread species in Greece and Italy, not under threat. In Italy, it is forbidden to collect A. caesarea at the egg stage. Vulnerable in Bulgaria.
2. *Agaricus campestris* L. var. *campestris*

**Etymology:** From Latin “campus” which is derived from the Greek word “kamos” (= open field, plain), the “field mushroom”.

**Common Greek names:** “provio”, “mantara”, or “gouva” (Grevena); “striftari” (Chalkidiki); “drostari” (Chalkidiki, Thasos); “vathila” (East Attica); “drositis”, “tsiminitis”, “paparitis” or “chouchlitari” (Lesvos); “kokkinomanitis”, “aspritis”, “mavritis” (Cyclades); “krasomanitis”, “mpoumpouri” (Crete); “leivaditis” (many places).

**Common Italian names:** Prataiolo, Agarico campestre.

**Common Bulgarian name:** Полска печурка (Polska pechourka).

![Fig. 3. Agaricus campestris var. campestris (photo by E. Polemis).](image)

**Description**

**Basidioma development:** Baby mushrooms (“primordia”) look like buttons, resembling the cultivated white mushroom (*Agaricus bisporus*). At that stage of development the stem is hardly visible as it is fused with the cap and if the
mushroom is cut lengthwise one can see the gills that are still white coloured and the partial veil connecting the inrolled cap’s margin and stem, at that time the flesh is very hard and aromatic. In the following stage the cap raptures, its skin is characteristically overhanging at the margin, by then the stem is clearly visible and the partial veil is left on it like a transient membranous ring, while the gills are coloured vividly pink and the flesh start softening (Fig. 3). As the mushroom matures the cap opens fully becoming convex, then almost flat or even uplifted in the end, the stem becomes longer and the ring almost disappears, the gills are becoming progressively darker brown and finally very dark chocolate-brown to almost black, the flesh softens more and eventually becomes dirty white and stinking as the decomposition begins.

**Pileus (cap):** (4-) 5-9 (-12) cm wide when fully expanded, initially almost hemispherical, then convex, later expanded to almost plane, finally with uplifted margin; white, or creamy white, with or without light brown fibrils at centre, it might also discolour to faint yellowish with age or with bruising (var. *equestris*); smooth, and silky, finely fibrous or with minute scales at centre, with an overhanging denticulate margin.

**Lamellae (gills):** Remotely free, very crowded, white, then vividly pink, progressively brown and finally dark purplish-brown to almost black. Gill-edge same coloured and even.

**Spore print:** dark purple-brown.

**Stipe (stem):** 2.5-8.5 × 1-1.5(-2) cm, spindle-shaped, thicker at centre and thinning towards the edges, base never bulbous, but often somewhat pointed; white at first, then purplish brown at the upper half; smooth, fibrous. The ring is thin, white, membranous, simple and evanescent, soon collapsing on the stem and becoming
almost invisible. The stem is easily detached from the cap as is happens with all species of the genus *Agaricus*.

**Context (flesh):** White and very firm at first, discolouring light pink or not when cut, smell strong aromatic and typical "mushroom-like", taste pleasant, nutty.

**Habitat/ ecology:** As its name says, it is a mushroom of open fields and pastures. It is a nitrophilous saprotrophic species that benefits from the presence of sheep and goats manure. It seems to have a preference for loamy soils and calcareous background. It often appears in rings. Agricultural practices such as ploughing and application of fertilizers and fungicides have a negative impact on the populations of this species, as well as many other mushrooms that can be found aplenty in naturally established grasslands.

**Distribution:** One of the commonest WEM throughout Greece, Italy and Bulgaria in fields, pastures, forest clearings and lawns, from the sea-level to the alpine zone.

**Fruiting-season:** In both Italy and Greece, it fruits almost all year round depending on the altitude and region. In north Greece and in high mountain plains, it appears often in big quantities in spring, summer and early autumn, while in lowlands and in the islands it is mostly found in late autumn until January.

**Possible confusion**
There are several species of *Agaricus* which resemble the “field mushroom”; in many cases it is almost impossible to identify them without the aid of a microscope, but since all similar looking species are good edible mushrooms there is no potential danger in consuming them. Equally common in Greece is *A. pampeanus* which is almost identical, mainly differing in its larger spores. Caution must be taken for some slightly toxic species of the genus such as *A. xanthodermus* and its relatives (i.e.
Agaricus pseudopratensis and A. moelleri). These species are characterized by the intense yellowing of pileus surface and ring when bruised, the yellowing of the flesh at the stem base when cut and the very prominent odour of phenol (Indian ink, or iodine), which becomes more evident if cooked. In addition, those toxic species of Agaricus, have always a more slender habit, longer stem, more persistent membranous ring and enlarged or bulbous stem base. Although such a misidentification is not very dangerous as the symptoms are not severe and never last for more than some hours, the collection of a white Amanita (A. verna or A. virosa) may be a fatal mistake, therefore special care must be taken to recognize the key characters of the genus Amanita when collecting any white Agaricus species for the table.

Notes on edibility

Agaricus campestris is a delicious mushroom, and despite its commonness is one of the choice edible species and therefore it is appreciated a lot in most regions of Greece. Its taste resembles the cultivated white mushroom (A. bisporus) albeit even more intense. The younger the mushrooms are the more flavour they have, and their firm white flesh makes them edible even raw in salads (but then they should never be eaten in large quantities). It is mostly eaten fried but it can also be cooked in various recipes. It makes an excellent “a la crème” sauce for pasta, while it can accompany meat or vegetable dishes. Larger mushrooms can be also cooked upside-down in the oven, plain or stuffed on top with the remains of stems cooked with onion, garlic and spices. Field mushrooms are excellent when their cups are still closed, good when the cups are opening and the gills are still pink, but they become less tasty in maturity when the gills become darker. Overripe mushrooms with dark brown gills and softened flesh are better left in the field as they are often attacked by maggots and bacteria.
Preservation
Although *A. campestris* is best eaten as fresh as possible it can be easily preserved in various ways. Mushrooms can be maintained in the refrigerator up to 4-5 days if the they are collected in a young stage of development and left in open containers. Longer preservation can be achieved if they are cut in slices and dried, or even frozen. Preservation in olive oil after short cooking in boiling water is also a common practice and gives a very good home-made canned delicacy.

Commercialization
This species is mostly collected in Greece and Italy for private consumption, by shepherds, hunters and enthusiastic mushroom pickers. Commercialising of this species exists only to some extend in the area of Grevena, Greece. In Bulgaria, it is collected and sold on local markets.

Conservation status
It is a common and widespread species not threatened in Greece and Bulgaria. Although in several regions intensive agricultural practices have declined considerably its habitats, in other regions abandonment of arable fields has led to an increase of its populations.

= *Agaricus macrosporus* (F.H. Møller & Jul. Schäff.) Pilát

**Etymology:** From Latin “urina + sentire” (= urine + sense), i.e. the urine smelling mushroom, from the characteristic smell of the ripe basidiomata.

**Common Greek names:** “Ageladini”, “Glompos”, “German helmet” (Grevena).

**Common Italian names:** Prataiolo.

**Common Bulgarian name:** Миризлива печурка (Mirizliva pechourka).

---

**Fig. 4.** *Agaricus urinascens* (photo by E. Polemis).

**Description**

**Basidioma development:** A massively fleshy mushroom which presents a similar to the *Agaricus campestris* development, however the stem base is enlarged right from
the beginning, then it becomes club-shaped and the ring is thick, persistent and very wide (Fig. 4).

**Pileus (cap):** 10-25(-30) cm wide when fully expanded, initially hemispherical, or trapezoidal, often resembling the “German soldier’s helmet”, then and for long time convex with inrolled margin, later expanded to almost plane with always depressed centre; white, or creamy white, silky-fibrous, with or without cream fibrils throughout its surface, discoloring yellow when bruised, some times cracked with a surface resembling crocodile’s skin, margin strongly overhanging fimbriate to denticulate.

**Lamellae (gills):** Remotely free, very crowded, greyish-white, then flesh coloured, dark rose, progressively brown and finally dark purplish-brown, black. Gill-edge white coloured and even.

**Spore print:** Dark purple-brown.

**Stipe (stem):** 6-12 × 2-3.5(-4) cm, fleshy and stout, club-shaped, enlarged towards the base, always shorter than the diameter of cap; white and smooth at top, initially whitish and fibrous towards the base, then ochre-brownish, scaly, with floccose ring-zones at the base. The ring is wide, thick membranous and pending, white, smooth above and fleecy below, simple but persistent, fragile, yellowing when handled. The stem is easily detached from the cap as is happens with all species of the genus *Agaricus*.

**Context (flesh):** White and very firm at first, discoloring light pink to reddish at the base of stem when cut; smell when young strong aromatic of bitter almonds or anise, in extreme maturity disgusting reminiscent of the smell of urine; taste pleasant, nutty.
Habitat/ecology: It is a species of natural grasslands appearing in forest clearings, meadows and pastures. It seems to have a preference for calcareous background. Often appearing in rings.

Distribution: In Greece is known from the mainland only, and it is found to be more common in northern parts of the country in mountains, plains and subalpine grasslands. In Italy, it is collected in pastures and glades of woods. In Bulgaria, it is found on rich soil in grassy places in the floristic regions encoded as follows: 5(c), 16(e, w), 17(w), 18.

Fruiting-season: It fruits in spring (from April) until late autumn (November). In north Greece and high mountain plains appears often in big quantities in spring, summer and early autumn. In Italy, it fruits from the late summer to autumn-winter.

Possible confusion
The massive habit of this mushroom make it very distinguishable, however caution must be taken to avoid the yellowing Agaricus xanthoderma which has an intense yellow discolouration of the flesh at the stem base and the characteristic smell of ink or iodine.

Notes on edibility
Agaricus urinascens is another remarkably tasty mushroom (despite its bad reputation due to its name as this applies only to the overripe basidiomata). The younger the mushrooms are again the most flavour they have, and the firm white flesh with the anise or bitter-almond odour and taste is excellent. The large size of mushrooms and their abundance make it a very good edible species that deserves to be among the most popular. It is mostly known in north Greece and particularly in the Grevena region. The species is known in the entire Italian territory.
**Preservation**

Young mushrooms can be maintained in the refrigerator in open containers up to 4-5 days. It can be frozen or dried in slices.

**Commercialization**

This species is mostly collected in north Greece, especially around Grevena, by shepherds, hunters and enthusiastic mushroom pickers for private consumption. Commercialising of this species exists only to some extent in Grevena. In Italy, it is mostly collected for private consumption only. In Bulgaria, it is collected and sold on local markets.

**Conservation status**

Common and widespread species not threatened in Greece and Italy. Ploughing of natural mountain grasslands and seeding with cereals is a potential threat factor for its populations. In Bulgaria, it has no conservation status.
Chapter 2: Choice wild edible mushrooms

4. *Macrolepiota procera* (Scop.) Singer var. *procera*

**Etymology:** From Latin word “procerus” (= very tall, high) because of the slender habit of the basidioma, which is due to the very long stem.

**Common Greek names:** “Zarkadisio”, “gidio”, “tsikriki” (Grevena); “katsperdika” (Epirus); “gastsiarki” (Florina); “elafina” (Imathia); “bablitsa”, “omprela” (Chalkidiki); “kostantas” (Thessaly); “koukoulitis” (Lesvos, Andros); “kalamara” (Ikaria); “Chouchougeri”, “staromanitis” (Viotia); “alekati” (Laconia); “drygitis” (Crete); “adraxtitsa”, “adraxtitis” (many places).

**Common Italian names:** Bubbola maggiore, Mazza di tamburo, Parasole.

**Common Bulgarian name:** Обикновена сърнела (Obiknovena surnela).

![Fig. 5. *Macrolepiota procera* var. *procera* (photo by E. Polemis).](image)

**Description**

**Basidioma development:** At the early stages of development the basidioma looks much like a large brown drumstick; a long and hard stem grows progressively taller.
having the cap closed like a ball or an egg at top (Fig. 5). After the stem has reached its maximum height, the cap opens until it obtains a hemispherical shape and finally plane or sometimes depressed at centre. The cap’s skin which is initially tight and almost uniform brown showing some cracking, tears up as the cap expands and the brown remnants of the skin are left on the surface like roof tales on a pale, whitish-cream fibrous background. The opening of the cap leaves a very large, complex and sturdy ring on the stem.

**Pileus (cap):** 10-30(-45) cm wide when fully expanded, initially hemispherical or egg-shaped, then opens to become hemispherical, convex, finally plane with uplifted margin, flat at the centre or somewhat projecting to a shallow umbo; the skin is initially almost uniformly dark brown, soon breaking into upturned scales that look like roof-tales on a whitish or cream background, while at the centre remains unbroken. The margin of the cap is strongly denticulate and exceeding the gills, hanging.

**Lamellae (gills):** Free and attached to a collar around the stem, crowded, white at first and turning greyish cream, finally brown spotted.

**Spore print:** White.

**Stipe (stem):** 10-30(-40) × 1-2(-4) cm, cylindrical but with a bulbous swollen base, hollow, fibrous and very firm; when young the surface is uniformly brown, but soon disrupts into snakeskin-like zigzag markings revealing a paler greyish cream background, the bulbous base is covered by rich white woolly mycelium. The ring is very conspicuous and large, double, white above and brown below, loosening from stem and easily moving up and down. The stem with some care can be pulled out of the cap without any damage of both parts.
**Context (flesh):** white and tender in the cap, unchanging when bruised or when cut, fibrous and darker greyish or brown when old in the stem; smell when young weak of boiled milk or nutty; taste pleasant, nutty.

**Habitat/ecology:** It grows solitary or in small groups, it often appears within woods, in clearings and paths, but it prefers grassy places especially well-manured grass.

**Distribution:** Widespread throughout Greece and Italy, from north to south as well as in all of major islands. In Bulgaria, it is found in the floristic regions encoded as follows: 3, 5(w, e), 6, 7, 8, 14, 15, 16(w, e), 17(w, c, e), 18, 19, 20.

**Fruiting-season:** It fruits in spring (from April) until early winter (December). In Italy, the fruiting period could be extended throughout the year long if the weather conditions permit.

![Image](image.png)

**Fig. 6.** *Macrolepiota mastoidea* (photo by E. Polemis).
Related species

*Macrolepiota mastoidea* (Fr.) Singer: it looks much like a small sized *M. procera* with cap 4-12(-15) in diameter and stem 8-15(-20) × 1-1.5 cm; it has often a more pronounced umbo and less prominent scales on cap, faint snakeskin markings on stem, and a thinner but also movable ring (Fig. 6). It may be seen in similar habitats with *M. procera* and it is common and widespread in Greece and Italy. It is edible and as good as *M. procera* although it has a much thinner flesh.

Possible confusion

The shape and size of *Macrolepiota procera* makes it a species that is easily recognized and hardly mistaken. Apart of the size, the distinct uplifted brown scales on cap, the adder-like markings on stem, the large movable ring, and the characteristic smell of boiled milk all make a very good set of discriminating characters. *Chlorophyllum rachodes* is also a large-sized mushroom that looks similar to *M. procera* and it may be found in the same habitats at times; although it is also edible, some of its varieties have been blamed for mild stomach upsets and therefore it is better to be avoided. The main discriminating features of this species are the absence of the snakeskin marking on stem, which is smooth, white or brownish and the reddening of the flesh when cut especially at the base of stem. Some species belonging to the genus *Lepiota* are known to be seriously poisonous, all of them have a very small size, caps never exceeding a diameter of 6-7 cm, and much shorter and thinner stems without a movable ring. Therefore, when collecting an edible *Macrolepiota*, picking specimens which have caps smaller than 10 cm should be avoided.

Notes on edibility

*Macrolepiota procera* is one of the most popular edible mushrooms throughout the north hemisphere. It is excellent to eat and it is a very pleasant gift of nature, thanks
to its abundance and size. The stems are so fibrous and firm that cannot be eaten, therefore it is advisable to remove them and take only the caps. The younger specimens have a more pronounced nutty flavour that may disappear as they get older. It can be boiled with little butter or coated in egg and breadcrumbs to form a shallow-fried like “schnitzel”, which seems to be one of the most preferable cooking recipes.

**Preservation**

Young mushrooms with closed cups can be maintained in the refrigerator in open containers up to 4-5 days. It can also be dried or frozen.

**Commercialization**

This species is much sought after in many places in Greece and it is sold (raw) in shops and markets. Recently dried and/or powdered *Macrolepiota procera* is sold or exported as flavouring or soup ingredient. The species is sometimes sold in local markets of northern Italy. In Bulgaria, it is collected and sold on local markets.

**Conservation status**

Common and widespread species, not threatened in Greece, Italy and Bulgaria.
5. *Agrocybe cylindracea* (DC.) Maire

= *Agrocybe aegerita* (V. Brig.) Singer

**Etymology:** From Greek “kylindrikos” (= cylindrical) because of the shape of stem. The older epithet of this fungus “aegerita” derived from the ancient Greek word “Aegeiros” (= poplar) because of the common appearance of this particular mushroom on poplar stumps and trunks.

**Common Greek names:** “aspros kavakitis”, “leykitis” (Lesvos).

**Common Italian names:** Pioppino, Piopparello.

**Common Bulgarian name:** Тополово агроцибе (Topolovo agrotsibe).

![Figs. 7 & 8. Agrocybe cylindracea (photos by E. Polemis).](image)

**Description**

**Basidioma development:** The young mushrooms (“primordia”) appear as tufts of small brown hemispherical buttons, emerging from cavities of the colonized trunk, their cap colour is initially dark brown and the stem is poorly developed. Soon after the stem elongates and simultaneously the cap opens until it gets almost plane, its colour fades to beige or cinnamon at centre and cream to whitish towards the margin (Figs. 7 & 8). It finally darkens again as the brown spores ripe and the whole
basidioma decomposes. The flesh is very firm and fragile at the beginning, becoming gradually softer and finally rotten as maggots quickly attack it.

**Pileus (cap):** (2-)4-10(-12) cm wide when fully expanded, initially hemispherical, then convex, later expanded to almost plane; greyish-brown when young, later becoming lighter brown, cinnamon or beige, ochre, cream to white towards the margin which eventually darkens again to brown in maturity, surface naked, when young somewhat velvety soon bald and mat, never shiny, smooth or more often somewhat wrinkled and cracked at centre; margin enrolled for a long time, finally plane and wavy.

**Lamellae (gills):** Adnate to shortly decurrent, white when young, but soon becoming beige, finally greyish-brown with white fimbriate edges.

**Spore print:** Tobacco-brown.

**Stipe (stem):** 4-10(-15) × 1-1.5(-2) cm, cylindrical of more or less the same diameter lengthwise, or somewhat thinning towards the base; white at first, then dirty whitish-ochre to brownish at the base in maturity, often dusted cinnamon-brown from the fallen spores, surface strongly fibrous to longitudinally striate; firm and hard-fleshed, fragile, compact eventually hollow. The ring is located high on the stem and is thick membranous, persistent and hanging, white at first but soon becomes dusted brown because of the falling spores.

**Context (flesh):** Very firm and fragile, white at the cap and ochre to darker brown from the apex towards the base of stem. Odour pleasant floury or somewhat rancid and taste mild, nutty.
Habitat/ecology: It is a wood-rot fungus, attacking dead wood and for that reason is mostly found in large tufts on stumps and trunks of poplars (*Populus* spp.). It has also been recorded in Greece on planes (*Platanus orientalis*), mulberries (*Morus* spp.) and castor-oil plant (*Ricinus communis*). In Italy, it grows also on *Quercus ilex*, *Fraxinus ornus*, *F. angustifolia*. In Bulgaria, it grows on wood of broadleaf trees in open places, scrub and woodlands.

Distribution: Very common in south and insular Greece and Italy in the vicinity of rivers and wet streams, as well as in poplar plantations and orchards, deciduous and evergreen oak woods, mixed broad-leaved woods. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 5(w), 10, 18.

Fruiting-season: It fruits in relatively warm periods from April to November (or during warm winter months) after heavy rains.

Possible confusion
The tufted habit and its presence commonly on poplar wood is very characteristic of this mushroom species, which can only be confused with other species of the genus growing on wood that are also edible such as *Agrocybe dura*. Other similar *Agrocybe* species, e.g. *A. paludosa* and *A. praecox*, grow on soil and have lighter ochre cap.

Notes on edibility
*A. cylindracea* is a choice edible mushroom, with a firm tasty flesh that retains its hardness after cooking. Younger mushrooms can be eaten raw in salads, or cooked variously in soups, sauces and other recipes with pasta or rice. The mushrooms are better collected young; by the time the base of stem has become brown they are overripe and usually heavily attacked by maggots. The stems of older mushrooms are quite tough and it is better to be discarded before cooking.
Preservation

*A. cylindracea* is easily preserved by drying or in vinegar (pickled). Young mushrooms can be preserved in the refrigerator for several days or they can also be frozen.

Commercialization

It is sporadically collected in Greece, quite familiar in Lesvos and some other islands but generally is neglected by mushroom enthusiasts. Trade of wild mushrooms of this species does not exist, while no attempts have been made to cultivate it at a commercial scale although it is one of the easiest to cultivate mushrooms on wood-based or on agricultural residues substrates. In Italy, some cultivation tests were carried out by farmers in Basilicata and Emilia Romagna. The productive chain was subjected to problems in commercialization due to the fragility of badiomata. Dried imported *A. cylindracea* has appeared in some shops in Athens but the quality of the product is rather poor.

Conservation status

Common and widespread species, not threatened in Greece. In Bulgaria, it has no conservation status.
6. *Calocybe gambosa* (Fr.) Singer

**Etymology:** The etymology of the genus *Calocybe* originates from the Greek words kalos+kybos (= beautiful head/cap), the epithet “gambosa’ derives from the Latin “gambo” (= leg, stem) because of its robust -in relation to the cap size- stem.

**Common Greek names:** “moschomanitaro” (Kastoria); “aigiorgitiko” (Grevena).

**Common Italian names:** Fungo di S. Giorgio, Maggiolino.

**Common Bulgarian name:** Майска гъба (Mayska guba).

![Fig. 9. Calocybe gambosa (photo by D. Dimou).](image)

**Description**

**Basidioma development:** At their early stages (“primordia”), mushrooms are often invisible as they grow partly imbedded within the soil, or hidden by leaves and grass. Initially, they have a strongly incurved margin, but they do not posses any kind of veil,
being naked throughout during all stages of development. Progressively the cap and stem grow bigger and the white gills are emerging underneath as the cap expands and the margin unfolds (Fig. 9). Their flesh is relatively dry and very firm remaining so until maturity. They grow slowly and because of the early fruiting season, at relatively low temperatures, they are nearly always free of maggots, the older mushrooms might look somewhat shabby, but they are as good in quality as the young ones.

**Pileus (cap):** 4-12 cm wide when fully expanded, convex or domed at first, later expanded to almost plane; whitish, cream, ochre with darker beige or brownish centre or patches; surface totally naked, mat, particularly smooth and satiny soft to the touch, eventually often cracked; margin enrolled for a long time, finally plane and wavy.

**Lamellae (gills):** Emarginated, thin and very crowded, white to pale cream; they are very shallow and look disproportionately small in relation to the very thick fleshy cap.

**Spore print:** White to cream.

**Stipe (stem):** 3-8 × 1-1.5(-2) cm, robust, cylindrical or club-shaped, thicker towards the base up to 3 cm broad; often eccentrically attached to the cap; same colour as cap, whitish or cream, surface mealy at top with minute fibrils towards the base; compact, firm and hard-fleshed.

**Context (flesh):** Very firm at first and then somewhat softer and dry, white or whitish-cream all-over, with out any colour changes when cut. Odour very characteristic, mealy, strong and penetrating, pleasant (or unpleasant for some individuals).
Habitat/ecology: This mushroom appears mostly in grassy fields and permanent grasslands, old pastures or loans, but it can also be seen in forest edges, paths and clearings. Characteristic of this species is the fact that mushrooms grow in rings, although mostly not seen complete but as rows or semicircular parts.

Distribution: Very common in north Greece from Epirus to Thrace and not uncommon in Sterea Ellas. It is said to be common in grassy habitats under poplars in western Makedonia. Very common and widespread in Italy as well, where it is considered as a “traitor” species for *Boletus edulis*: “If the St. George’s mushroom is on the field, porcini are surely in the surroundings” according to the relevant popular saying. In Bulgaria, it is found in the floristic regions encoded as follows: 2, 3, 5(w), 6, 7, 8, 15, 16(w), 17(w), 18, 20.

Fruiting-season: It fruits exclusively in spring starting from late April until early June. In continental Europe, it first appears around the 23rd of April (i.e. St. George’s Day), hence the name that is widely used in various countries, as well as in the Grevena region, “St. George’s mushroom” (agiorgitiko).

Possible confusion
The fruiting season and the presence of this mushroom in grasslands makes it possible to confuse it with few but highly toxic species, mainly fleshy members of the genus *Entoloma* that also appear in spring such as *E. sinuatum*. The latter fruits in Greece from May to November, it is a very poisonous mushroom which also has a mealy smell but it is mostly found in forests. Less common in Greece is *E. clypeatum* that also grows exclusively in spring from April to June, associated with trees such as apples, prunes and other members of the Rosaceae family. All *Entoloma* species are characterized by wider, less crowded gills, that soon after their caps are fully opened turn flesh-coloured or reddish due to the colour of their spores (typically pink).

Notes on edibility
Chapter 2: Choice wild edible mushrooms

*Calocybe gambosa* is a very popular edible mushroom throughout Europe, with a firm flesh and delicious taste; its strong aroma that some people dislike, faints after cooking. Because of the period they appear (i.e. when few other mushrooms can be found), they are highly appreciated being regarded as “season’s gift”. They may occasionally turn out to be “heavy” to digest if consumed in large quantities. They possess mild hypoglycaemic properties, but they cannot be used as a substitute for insulin. Cooking with garlic, butter and cream is said to suit St George’s mushrooms perfectly.

**Preservation**

*C. gambosa* is easily preserved by drying or in vinegar (pickled). Young mushrooms can be preserved in the refrigerator for several days and they can also be frozen.

**Commercialization**

During the last ten years it is largely collected predominantly in north Greece, being sold in specialized shops and markets or even exported to some west European countries. However, it is still not so well known in the rest of the country. In Italy the mushroom is collected only for personal consumption and it is commercialized in the Trento market (northeastern Italy). In Bulgaria, it is collected and sold on local, national and international markets.

**Conservation status**

Common and widespread species, not threatened in Greece and Italy. In Bulgaria, it has no conservation status.
Chapter 2: Choice wild edible mushrooms

7. *Infundibulicybe geotropa* (Bull.) Harmaja

≡ *Clitocybe geotropa* (Bull.) Quél.

**Etymology:** From the Greek words geo+tropi (= turned towards the earth) because of the characteristic inrolled cap’s margin that is pointing downwards.

**Common Greek names:** “piperitis” (Achaia); “neuromanitis” or “neuritis” (Euboea and Ikaria); “agladomanitis” (Euboea), “lagaritis” (Lesvos).

**Common Italian names:** Agarico geotropo.

**Common Bulgarian name:** Едра орешарка (Edra oresharka).

![Infundibulicybe geotropa](photo by E. Polemis)

**Description**

**Basidioma development:** Its shape and form changes significantly as it matures. Initially the mushrooms have a disproportionally tall stem, with an engorged club-shaped base and a relatively small in diameter cap that often has a characteristic
blunt “umbo” (shallow but prominent ledge at the centre of the cap). The margin of the cap is very intensively inrolled at the beginning, remaining so for long time. Finally the cap expands to reach a diameter equal to the length of the stem (or bigger), its shape turns to a deep funnel with the umbo still visible and the margin unfolds almost completely (Fig. 10).

**Pileus (cap):** (5-) 8-20 (-30) cm wide when fully expanded, convex or domed at first, at most times with a characteristic blunt and shallow but prominent umbo (variants without umbo also exist), later expanded to a deep funnel shape; creamy-white, ochre-yellowish, or flesh-coloured, at the end somewhat darker at the centre and lighter “silky frosted” at margin; margin intensively inrolled for a long time, finally plane or even upturned, wavy or lobed; surface naked, mat, smooth and satiny to touch, downy when dry but shiny and looking waxy when wet.

**Lamellae (gills):** Strongly and characteristically decurrent, fairly crowded, sometimes forked, almost same coloured as the cap, whitish at first to pale cream-yellowish at the end; edges same-coloured and blunt.

**Spore print:** White.

**Stipe (stem):** 8-15 (-20) × 1.5-3 cm, long and strong, club-shaped or almost cylindrical, enlarged at base; centrally attached to the cap; same colour as cap or slightly paler, whitish-cream to ochre-yellowish, surface fibrous or sometimes mealy at top, base enveloped in a downy white mycelial mass; compact, firm and hard-fleshed initially becoming spongy with age.

**Context (flesh):** Very tough at first and then somewhat softer, always dry, white, without any colour changes when cut. Odour strong characteristic and complex
sweetish and pleasant, reminiscent of incense, flowers of iris, sometimes more cyanidic; taste mild not very distinctive.

**Habitat/ecology:** In groups, rows, often in rings; in deciduous woodland but also in forest clearings and edges. It prefers calcareous base-rich soils.

**Distribution:** Very common throughout mainland Greece as well as in many larger islands. A very common species in Italy as well. In Bulgaria, it is found in the floristic regions encoded as follows: 3, 5(w), 8, 16(w), 18.

**Fruiting-season:** Appearing in summer (from July) in north Greece and fruits during autumn until early winter in lowlands of southern and insular Greece. In Italy, the fruiting period is from autumn to winter.

**Possible confusion**

The species *Clitocybe gigas* is a close relative to *I. geotropa* and it is quite difficult to discriminate among them; however both have the same edibility characteristics and are equally safe to consume. *C. cavipes* has a cap that can reach a diameter of up to 7 cm, cap and stem have a dark greyish-brown colour contrasting to the white gills, stem is more prominently enlarged at base and its flesh is softer. *C. cavipes* is not poisonous but is considered edible either because of its consistency, which has been described like “wet cotton”. Other -mostly white- *Clitocybe* which are severely dangerous and highly toxic are always much smaller in size or they have different habitat and growth-mode; therefore confusion is easily avoided if attention is paid to the presence of the diagnostic key-characters of *I. geotropa*, namely: size, shape, elongated tough stem, colour, smell and occurrence in rings in woodland.
Notes on edibility

*Infundibulicybe geotropa* is a very good edible mushroom, but care should be taken to avoid specimens that are heavily attacked by maggots. For this reason the stem is cut from the base towards the cap until the flesh is found free of insect cavities. It has been known traditionally and much appreciated in some regions like Attica, Euboea and Lesvos, and in all Italian regions. The tough flesh makes it perfect for cooking in the pot, in soups, sauces and many more recipes.

Preservation

*Infundibulicybe geotropa* is easily preserved in the refrigerator for several days, while it can also be frozen. Drying is not recommended for this mushroom but preservation in vinegar (pickled) might be an option.

Commercialization

No commercialization exists for this species and it is only collected for personal consumption by some mushroom enthusiasts. In some Italian regions (mainly in Sicily) *I. geotropa* is sold in local markets at a price of 12-15 € per kg.

Conservation status

Common and widespread species, not threatened in Greece. In Bulgaria, it has no conservation status.
8. *Lactarius deliciosus* (L.) Gray

*Lactarius salmonicolor* R. Heim & Leclair, *Lactarius sanguifluus* (Paulet) Fr., *Lactarius semisanguifluus* R. Heim & Leclair

**Etymology:** From the Latin word “deliciosus” (= delicious), for its excellent taste; from the Latin words “sanguis” (= blood) + “flux” (= flow), literally meaning the bleeding *Lactarius*; the Latin prefix “semi” (= half, almost) is used to show that it is a species that looks much like *sanguifluus*.

**Common Greek names:** Mostly for *L. deliciosus* or *L. salmonicolor* in some cases, “karoto” or “karotina”’’ (Grevena); “koumaritis” (many Aegean islands); “Peukitis” (Lesvos and elsewhere); “marila” (Attica – of Albanian origin). For *L. sanguifluus* “krasoulitis” or “kokkinitis” (Lesvos).

**Common Italian names:** Agarico delizioso, Lapacendro buono.

**Common Bulgarian name:** Рижика (Rizhika).

![Fig. 11 & 12. *Lactarius deliciosus* (photos by D. Dimou and A. Saitta).](image)

**Description**

**Basidioma development:** Initially convex, then flattening and depressed, finally funnel-shaped; margin at first strongly inrolled, unfolding slowly and becoming plane
at the end, as the mushrooms grow older they show greenish spots and patches in various places (Figs 11 & 12).

**Pileus (cap):** 5-12 (-20) cm wide when fully expanded, convex at first, later almost plane, at the end funnel-shaped; saffron, orange, with concentric rings and patches of darker colour, sometimes greening at places when old; margin strongly inrolled in the beginning, then curved and finally almost plane, at times slightly wavy; surface naked, minutely felty when dry, waxy and shiny when wet.

**Lamellae (gills):** From almost adnate to slightly decurrent, fairly crowded, sometimes forked, saffron-orange; if bruised (or gradually with age) with green spots and patches. When damaged exuding orange latex (a milk-like liquid).

**Spore print:** Light ochre, pale pinkish buff.

**Stipe (stem):** 3-7 (-20) × 1.5-2.5 (-3) cm, hard and brittle, almost cylindrical, enlarged at base; same colour as cap with darker pits of variable size, when bruised and in maturity also with greenish spots and patches; compact at first but hollow later on with an irregular cavity.

**Context (flesh):** Firm and brittle, breaking up like a piece of chalk; as soon as it is exposed to air orange over the gills and close to the surface of stem, paler to almost white in the central parts; after cut, the orange parts turning slowly paler ochraceous orange and after several hours greyish green. Odour pleasant, slightly sweetish like carrots (or cumarine); taste mild.

**Habitat/ecology:** Solitary or in small groups, but often in large populations in pine forests, preferring calcareous or neutral soils.
**Distribution**: Very common throughout mainland Greece and Italy as well as in many larger islands. In Bulgaria, it is found in the floristic regions encoded as follows: 3, 5(w, c, e), 6, 7, 8, 15, 16, 17(w, c, e), 20.

**Fruiting-season**: Appearing from May and during the summer months in north Greece until early winter (December – January) in lowlands of south and insular Greece. In Italy, the fruiting period is mainly autumn-winter, but sometimes it could also appear in spring and summer (North Italy)

![Lactarius salmonicolor](image)

**Fig. 13. Lactarius salmonicolor** (photo by M. Triantafyllou).

**Related species**

**Lactarius salmonicolor** R. Heim & Leclair: This species is hardly distinguished from *L. deliciosus* as it has the same colours but it shows slight or no greenish tints when damaged or with age, it has less prominent zonation on cap, which is best observed in the part close to the margin (Fig. 13). Its smell is sweet at first like tangerine but then becoming disagreeable like clotted blood; the taste is mild and agreeable at first but then is astringent and disagreeable. Probably, the most important discriminating
character is that it only grows in association with fir and never with pines. It is common in Greece in mountainous fir forests from Thrace to Peloponnese, especially in southern Mediterranean cefalonian fir (Abies cephalonica) biotopes. It fruits during summer and autumn until November. Although a edible and widely collected species mainly in southern Greece and in Italy, it is not considered as good as *L. deliciosus* and its taste is even unpleasant for some individuals.

*Fig. 14. Lactarius sanguifluus* (photo by D. Dimou).

**Lactarius sanguifluus** (Paulet) Fr.: Similar in overall appearance to *L. deliciosus*, it is often found in the same habitats at the same period; it is distinguished by its wine-red or purplish-russet tints on cap and stem, as well as by the dark wine-red, or reddish-brown latex, as opposed to the orange latex of all other similar *Lactarius* species (Fig. 14). Moreover, only the cap turns slightly greyish-green when old and the flesh or gills show no greening when bruised or cut. Its flesh has a very faint smell, mild taste that becomes slightly bitter and acrid after a while. It is a thermophilous ectomycorrhizal species, which is associated with pines species either in the lowlands in typical Mediterranean habitats or in mountainous habitats,
preferably on calcareous soils. Less common than *L. deliciosus* in Greece, but widespread from Makedonia to Peloponnese and in many Aegean and Ionian islands. It is a widespread mushroom in Italy. It is considered as the tastiest of all *Lactarius* species extruding orange or red latex. The truth is that the epithet “deliciosus” was given to the wrong species since it is known that Linnaeus named it as such by mistake (he confused it with *L. sanguifluus*). In Bulgaria, it is found in the floristic regions encoded as follows: 6, 14, 17(c, e).

*Lactarius semisanguifluus* R. Heim & Leclair: It differs from *L. sanguifluus* by the latex colour, which is orange as soon as the flesh or the gills are cut, but it changes to wine-red after 5-10 minutes. It can be separated from both *L. deliciosus* and *L. sanguifluus* by producing somewhat smaller pilei, by the violet tinges in the cap and the quick intense greenish discolouring of the whole basidioma (Fig. 15). Its smell is faint but sweetish and its taste very similar to *L. deliciosus*. Although not very common, it is known from mainland Greece, exclusively associated with pines, fruiting during summer and autumn. A very common species in Italy. In Bulgaria, it is found in the floristic regions encoded as follows: 5(w, c), 7, 9, 14.

![Fig. 15. Lactarius semisanguifluus (photo by D. Dimou).](image-url)
Possible confusion

In Europe, all species of *Lactarius* with orange or red latex are edible and sometimes may be found together. Another common species in Greece is *L. deterrimus* Gröger, which is considered not edible, although harmless, because of its bitterness. It forms symbiotic associations with firs and spruce but not with pines; therefore, it is more commonly found together with *L. salmonicolor*, from which it differs in the intense green discolouration of all parts of the basidioma after bruising or frost damage; the zonation of the cap is even less prominent or totally absent, and the stem has no darker pits at all (Fig. 16). The only toxic species of *Lactarius* that can hardly been confused with all above mentioned edible species is *L. torminosus*, which has similar ochraceous-brown or orange colours on cap and stem, the surface of cap is hairy, especially the margin, its milk is white unchangeable, the gills are pale ochraceous-buff, the flesh pale salmon and it has a burning hot taste. *L. torminosus* is rather rare species in Greece known only from mountains of the northern Makedonia and Thrace where forests of birch and spruce exist. In Italy, it is an infrequent species.

![Fig. 16. Lactarius deterrimus (photo by B. Assyov).](image)
Notes on edibility

*Lactarius* species exuding orange or red latex may be classified according to their edibility as follows: *L. sanguifluus* excellent, *L. deliciosus* and *L. semisanguifluus* good, *L. salmonicolor* mediocre and *L. deterrimus* not worth eating. The first four species are very popular in Greece and Italy, and they are collected by many people, as they are easily distinguishable mushrooms with no poisonous look-alikes, thanks to their unique colour of the milk that they exude. Young basidiomata with their thick friable, and firm flesh are better since when the get older the flesh softens and the greenish appearance make them disagreeable. They should not be cooked for too long, a good way is to boil them quickly. Baking them by cutting them in half with little butter and salt in a covered dish is also a very nice way to prepare, but in Greece the most common preparation is fried. It should be also noticed that eating *L. deliciosus* causes urine to turn somewhat red, but this is not an indication of negative effect to the consumer.

Preservation

Due to their firm flesh *Lactarius* species can be maintained in the refrigerator for several days. Drying is not recommended for these mushrooms as well as freezing because they turn green. Some also boil them and preserve them in vinegar (pickled).

Commercialization

In several regions of Greece and especially in the islands of east Aegean *Lactarius* are very popular and there are many farmers and shepherds who sell these mushrooms raw in open markets in the street, while taverns often serve them fried as a seasonal delicacy. The same situation exists in Italy as well. In Bulgaria, all representatives of the group of *L. deliciosus* are collected under the common name “Rizhika” and sold on local, national and international markets, without distinguishing the species.
Conservation status

Common and widespread species, not threatened in Greece, Italy or Bulgaria.
9. *Russula cyanoxantha* (Schaeff.) Fr

**Etymology:** From the Greek words “cyanos” (= blue) + “xanthos” (= blond), for its cap that usually has a mix of blue and yellow colours.

**Common Greek names:** Not existing.
**Common Italian names:** Russula iridescente, Colombina maggiore.
**Common Bulgarian name:** Сиво-виолетова гълъбка (Sivo-violetova gulubka).

![Fig. 17. *Russula cyanoxantha* (photo by D. Dimou).](image)

**Description**

**Basidioma development:** The cap is initially hemispherical to convex, then flattening and at then depressed; margin at first facing downwards and then straight; flesh hard and brittle but softening as it matures (Fig. 17).
Pileus (cap): 5-15 cm wide when fully expanded, hemispherical to convex at first, later almost plane, depressed at the centre finally; very variably coloured with cloudy mixes of blue, purple, olive, greenish, lilac, ochre or white in various combinations; margin slightly inrolled, pointing downwards initially, then normally straight, smooth, without or faintly wrinkled, sometimes cracked; surface smooth, mat, slightly sticky or greasy in wet conditions, pellicle can be peeled off easily.

Lamellae (gills): Almost adnate but some almost free, crowded, forked, white, browning at the edges in maturity, somewhat greasy, soft and flexible to the touch and not brittle as in most other species of *Russula*.

Spore print: White.

Stipe (stem): 5-10 × 1.5-3(-4) cm, hard and brittle, almost cylindrical, or tapering downward; mostly white, but sometimes flushed with violet hue, compact at first but with irregular cavities when old.

Context (flesh): Firm, somewhat elastic on cap and brittle in the beginning at the stem that brakes up like a piece of chalk, later softens and become spongy; white, commonly turning greyish brown when old. Odour weak, indistinguishable; taste totally mild.

Habitat/ecology: Solitary or in small groups, in deciduous woodlands. A symbiotic species like all species of *Russula*, it forms ectomycorrhizal association with various deciduous trees, most commonly oak, beech and chestnut in Greece and Italy.

Distribution: Very common throughout mainland Greece and Italy as well as in some larger islands. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 2, 3, 4, 5(w, c, e), 6, 7, 8, 14, 15, 16(w), 17(w, e), 20.
**Fruiting-season:** Appearing from May until October.

**Possible confusion**
The mushrooms of the genus *Russula* are characterized by the brittle flesh that breaks up like chalk and the absence of milk exudation; they never have ring or volva and they are classified in many different species, being at most times difficult to tell one from another. The only toxic but not seriously poisonous *Russula* species has a hot spicy taste. If a collector is familiar in recognizing the members of the genus in general, a test of quick nibbling the cap edge can be made for determining if it is acrid (and in such case discard it as inedible) or if it is mild then it can be eaten. Moreover *R. cyanoxantha* is distinguished from all other similar *Russula* species thanks to its elastic gills that do not break when running a finger over them.

**Notes on edibility**
*R. cyanoxantha* is a good edible species with a mild delicate nutty flavour. The firm flesh texture, especially when young, makes it very pleasant and absolutely safe to eat raw in salads or after slight cooking. Older specimens with spongy and soft flesh that are often attacked by slugs and maggots are better to be avoided.

**Preservation**
Usually eaten fresh and raw, but can be preserved in refrigerator for some days or in vinegar (pickled).

**Commercialization**
In north Greece it is served in some specialized restaurants but no other commercialization exists for this species. It belongs to a wide group of WEM that is usually sold in the market of the town of Trento (North-east Italy). It is widely collected for personal consumption.
Conservation status

Common and widespread species, not threatened in Greece, Italy or Bulgaria.
Chapter 2: Choice wild edible mushrooms

10. *Russula virescens* (Schaeff.) Fr.

**Etymology:** From the Latin word “viridis” (= green) the epithet “virescens” meaning becoming green, because of the greenish colours of cap.

**Common Greek names:** Not existing.

**Common Italian name:** Colombina verde.

**Common Bulgarian name:** Зелена гълъбка (Zelena gulubka).

![Russula virescens](photo by B. Assyov).

**Description**

**Basidioma development:** The cap is initially hemispherical to convex, then flattening and at then depressed; margin at first facing downwards and then straight; flesh hard and brittle but softening as it matures.
**Pileus (cap):** 5-15 cm wide when fully expanded, almost globular or trapezoidal at first, then convex with more or less flattened, depressed at the centre finally; initially whitish to yellowish, then yellowish green, pale green, green, olive green, or pistachio green, some times with darker green colours at centre; margin not distinctly inrolled, pointing downwards initially, then normally straight, smooth at first, radially striate wrinkled finally; surface at the beginning smooth, mat, pellicle can be peeled off easily, progressively becoming typically cracked up to the half of the radius or all over, with characteristic scaly green patches on a paler ochre-green background (Fig. 18).

**Lamellae (gills):** Almost free to shallowly adnate, crowded at first but then more spaced, forked and with transverse connections, white or creamy, with a pale pinkish hew, becoming ochre browning when handled and in maturity, very brittle.

**Spore print:** White.

**Stipe (stem):** 4-8 × 1.5-4(-5) cm, hard compact when young, becoming spongy and brittle later, almost cylindrical, or tapering downward; mostly white, ochre-brownish when handled, surface smooth and minutely hairy at top in the beginning then somewhat rough all over.

**Context (flesh):** Firm and hard when young, brittle at the stem that brakes up like a piece of chalk, later softens and become spongy; white, turning ochre when old. Odour fruity pleasant, then somewhat disagreeable; taste totally mild.

**Habitat/ecology:** Solitary or in small groups, in deciduous woodlands. A symbiotic species like all species of *Russula*, it forms ectomycorrhizal associations with various deciduous trees, preferably with oak and chestnut in Greece and rarely with beech too. It is a common species in all forest ecosystems of Italy.
**Distribution:** Common throughout the mainland of Greece reported also from Lesvos Island. It is collected throughout Italy. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 2, 5(w, c, e), 6, 7, 15, 16(w), 17(w, e), 20.

**Fruiting-season:** Appearing from May until October.

**Possible confusion**
*Russula virescens* is an easily recognized species of this genus thanks to its greenish colours and the characteristic cracking of the cap surface. If one pays attention to the key features of the genus i.e. the brittle flesh that breaks up like chalk and the absence of milk exudation, total absence of ring or volva then there is no danger in confusing this species with the deadly poisonous often greenish as well *Amanita phalloides*.

**Notes on edibility**
*R. virescens* is an excellent edible species with a mild delicate nutty flavour. The firm flesh texture, especially when young, makes it very pleasant and absolutely safe to eat raw in salads as well. Older specimens with spongy and soft flesh that are often attacked by slugs and maggots are better to be avoided.

**Preservation**
Usually eaten fresh and raw, but can be preserved in refrigerator for some days or in vinegar (pickled).
Commercialization

In north Greece it is served in some specialized restaurants but no other commercialization exists for this species. In Italy, it is sometimes sold in the Trento (NE-Italy) market. In Bulgaria, it is sold on local markets.

Conservation status

Common and widespread species, not threatened in Greece, Italy and Bulgaria.

**Etymology:** From Latin word “ostreum” derived from the Greek “ostrakon” (= oyster); the epithet means ‘oyster or cell like’ because of the mushroom shape.

**Common Greek names:** “xerakomanitis” (Fokida); “pita” (Arcadia); “vlantra, tipari” (Achaia); “drygiadolachano” (Crete); “mavros kavakitis” (Lesvos); “elatomanitis”, “karveli”, “pleuritis”, “skotaria” (various places).

**Common Italian names:** Agarico ostreato, Gelone.

**Common Bulgarian name:** Обикновена кладница (Obiknovena kladnitsa).

![Figs. 19 & 20. Pleurotus ostreatus (photos by G. Zervakis & G. Koutrotsios).](image)

**Description**

**Basidioma development:** Young mushrooms (primordia) appear in wood cavities or under the bark as many tightly packed dark bluish grey pins, soon growing larger as compact clamps and as the caps are engorged the white gills appear on the underside and the margin remain inrolled, then they continue grow bigger until the lateral or rudimentary stems elongate and emerge and the margin slowly unfolds and become
wavy; at the end the colour of cap fades to pale greyish, buff, cream or some times almost white (Figs 19 & 20).

**Pileus (cap):** 4-12(-25) cm wide when fully expanded, initially convex with strongly inrolled margin, then flattens and becoming tongue-shaped, fan-shaped or petal-shaped, with unfolded margin, finally oyster like depressed at centre with uplifted wavy margin; the colour is very variable and much darker when young blackish-violet, violet-brown, grey-blue, fading to greyish-brown, yellowish-brown, beige, cream or almost white; surface completely smooth and shiny; margin may be plicate at the end.

**Lamellae (gills):** Deeply decurrent, crowded, often forked or interconnected with transverse veins close to the stem, creamy white at first, later with greyish or ochre tinge, edges smooth.

**Spore print:** White to cream-beige.

**Stipe (stem):** Rarely almost central (when growing from an horizontal substrate surface), eccentric, more often pleural or rudimentary; 0.5-4(-6) × 1-2 cm, irregularly cylindrical, often bended, sometimes rooting in the substrate and then spindle-shaped, compact, fibrous, whitish or cream; surface with faint longitudinal grooves, and covered by woolly mycelium at the base.

**Context (flesh):** Almost white and tender at first, becoming elastic and fibrous in the stem as the basidioma matures; smell fragrant and pleasant when young but faints and become unpleasant when old; taste mild, pleasant.

**Habitat/ ecology:** It mostly grows in large tufts on logs, tree stumps, or fallen trunks of various broadleaved and coniferous trees; mostly found in humid forests, in
Greece and Italy it is known to grow on fir, oak, beech, poplar, chestnut as well as several other deciduous trees.

**Distribution**: Widespread all over the countries (Italy, Greece) from the north to the south as well as in all of the major islands. In Bulgaria, it is found in the floristic regions encoded as follows: 2, 3, 5(w, c, e), 6, 7, 8, 14, 15, 16(w), 17(w), 18, 20.

**Fruiting-season**: It fruits during late autumn and winter and it is known to be a cold-loving species often surviving in early frosts.

![Fig. 21 & 22. Pleurotus pulmonarius and P. fuscosquamulosus](photos by E. Polemis & G. Kallontzis).

**Related species**

*Pleurotus pulmonarius* (Fr.) Quél.: Very similar in appearance to *P. ostreatus*; however, it has usually paler colours (yellowish brown to light brown to cream cap) and it prefers much warmer weather (Fig. 21). It appears in late summer up to autumn on stumps and logs of various deciduous trees, being much more rare than *P. ostreatus* in Greece, but it is an equally good edible species.

*Pleurotus fuscosquamulosus* D.A. Reid & Eicker (*P. cystidiosus* O.K. Mill., *sensu lato*): Very similar to the preceding species and a good edible (Fig. 22). It has been scarcely
recorded in Attica and in the islands of Salamina and Lesvos growing on dead wood of fig and poplar trees. Greece is the only European country where this species is found.

**Possible confusion**

*Pleurotus ostreatus* is a very easy identifiable mushroom and can hardly be mistaken. *Lentinellus castoreus* (Fr.) Kühner & Maire may reminiscent *Pleurotus* species as it also grows laterally on wood or on woody debris. However, it has warm reddish brown cap, ochre to beige gills that have characteristically irregularly toothed edge and always rudimentary stem; it is not poisonous but neither edible due to its tough and very bitter flesh. *Panellus stypticus* (Bull.) P. Karst. is another pleurotoid species that grows on wood, has an ochre to beige cap that never becomes larger than 4 cm in diameter, and it is also inedible because of its bitterness.

**Notes on edibility**

*P. ostreatus* is a very popular edible mushroom that has been cultivated artificially for very long time and gained the reputation as a “gourmet mushroom” world-wide. However, the wild growing *Pleurotus* mushrooms are considered to have much stronger (and better) flavour then the cultivated. They can be cooked and prepared in many different ways. It is better to collect young specimens that retain their delicate flavour and discard the tough leathery stems that remain so after cooking as well.

**Preservation**

Young mushrooms can be maintained in the refrigerator in open containers up to 4-5 days. It can also be dried, or frozen. In Italy is also preserved in olive oil.
Chapter 2: Choice wild edible mushrooms

Commercialization

This species is sought after in many places of Greece and Italy but mostly for private consumption and they are rarely sold, as it is easy to find the cultivated products in very reasonable price almost anytime and everywhere in Greece and Italy. In Bulgaria, it is collected and sold on local markets.

Conservation status

Common and widespread species, not threatened in Greece, Italy or Bulgaria.
12. *Pleurotus eryngii* (DC.) Quél. var. *eryngii*

*Pleurotus eryngii var. ferulae* (Lanzi) Sacc., *Pleurotus nebrodensis* (Inzenga) Quél.

**Etymology:** From the scientific name of the umbelliferous plant of the genus *Eryngium* (that it is associated with), in other words the *Pleurotus* that is pertaining on *Eryngium*.

**Common Greek names:** “gaidourisio” (Kastoria); “ftitsi” (Chalkidiki, Kavala, Evros); “galautia” (Euboea); “lagoudautia” (Crete); “agkathitis” or “agkathomanitis” (Crete and other islands), “autia” or “autakia” (various places).

**Common Italian names:** cardoncello.

**Common Bulgarian name:** Ветрогонова кладница (Vetrogonova kladnitsa).

![Pleurotus eryngii](photo by E. Polemis)

**Description**

**Basidioma development:** similar to *P. ostreatus* but not growing on wood; instead it seems to arise from the soil but in reality it grows on the plant residues (roots and...
base of the stem) of the umbelliferous plant which has colonized during the previous vegetation period (Fig. 23).

**Pileus (cap):** 3-10(-12) cm wide when fully expanded, initially almost hemispherical to convex with inrolled margin, then flattens and finally depressed at centre with uplifted wavy margin; the colour is variable ranging from brown, greyish, dirty white, or speckled grey-brown on a paler beige to whitish background becoming paler as it ages with several darker squamules; surface delicately felty when young then smooth and shiny; margin often plicate.

**Lamellae (gills):** Deeply decurrent, crowded, often forked or interconnected with transverse veins close to the stem, whitish at first, later with greyish or ochre tinge, edges smooth.

**Spore print:** White to light cream-beige.

**Stipe (stem):** Always present and almost central to eccentric; 0.5-4(-6) × 1-2 cm, compact and elastic; irregularly cylindrical, often bended, rooting in the ground; whitish or cream then greyish; surface with longitudinal grooves, and covered by woolly mycelium at the base.

**Context (flesh):** Almost white and tender, elastic and fibrous in the stem; smell fragrant and pleasant; taste mild, pleasant.

**Habitat/ecology:** In fields, pastures and poor grasslands; in Greece and Italy it is mainly associated with annual plant species of the genus *Eryngium* (i.e. *Eryngium campestre* and *E. maritimum*); it grows on the remnants of roots and stems of dead *Apiaceae* plants.
Distribution: Widespread all over the countries (Italy and Greece) from the north to the south and from sea level up to an altitude of 800-1500 m; fairly common in many large and smaller islands. In Bulgaria, it is found in the floristic regions encoded as follows: 3, 7, 8, 16(w), 19.

Fruiting-season: It fruits from the end of summer in the north part of the country but it continues fruiting during autumn and winter, sometimes found in early spring in lowlands or in the Aegean and Italian surrounding islands.

Related species

Fig. 24. Pleurotus eryngii var. ferulae (photo by E. Polemis).

Pleurotus eryngii var. ferulae (Lanzi) Sacc.: Almost identical with the typical variety but considerably larger in size, with a cap reaching a diameter of up to 30 cm (Fig. 24). This variety appears during the same season as the preceding but it presents a more southern and insular distribution. The host plant on whose remnants grows on is known with the scientific name Ferula communis (and hence the name of the mushroom variety was derived); this plant is also known in Greece as “narthikas” and
in common language “artikas”; for that reason the *Pleurotus* mushroom variety that grows in association with is commonly called “artikitis”.

**Pleurotus nebrodensis** (Inzenga) Quél.: Similar to the preceding species but rare and endangered. It is equally big in size but it has a whitish to cream coloured cap and fruits only in spring from late April to early June (Fig. 25). The plant species that it grows in association with is another member of the family *Apiaceae*, namely *Cachrys ferulacea* and exists only in open mountain meadows at an altitude above 1300 m. *P. nebrodensis* took its name from the Nebrodi mountains in Sicily from where it was originally described due to a wrong interpretation of Italian botanists which confused the Nebrodi and the Madonie mountainous chains, and until lately was considered to exist only on the Madonie Mts. Recent findings revealed its occurrence in Greece as well (only in mountains of north Peloponnese).

![Fig. 25. Pleurotus nebrodensis](photo by G. Venturella).

**Possible confusion**

All *Pleurotus* species that grow in association with Umbelliferous plants (family *Apiaceae*) are very distinguishable because of their habitat and there is no other mushroom that can be confused with.
Notes on edibility

All the three mushroom taxa are highly prized edibles. They are all very appreciated by the local mushroom hunters since they possess a much thicker flesh and a flavour that is even more pronounced than in P. ostreatus. In addition, their stems are less fibrous and tough, so they can be eaten as well. Especially P. nebrodensis, which is traditionally a unique delicacy for the Sicilians, it can be eaten raw in salads as well and it is sold at a price of 50 € per kg.

Preservation

These mushrooms may be maintained in the refrigerator in open containers for several days. They are never preserved dried as their aroma and flesh texture deteriorate, but some people like to preserve them frozen. P. eryngi is also an cultivated species and it has recently been introduced to the Greek market imported from Asia; however, commercial cultivation has not been established yet in Greece. In Apulia (Italy) “cardoncello” obtained the label of PGI (Protected Geographical Indication).

Commercialization

This species is sought after in many places of Greece and Italy, mushroom hunters compete with each other for finding them, but mostly for private consumption. It is rarely an object of trade in Greece (and then only in limited scale and "hand by hand"). It is cultivated in many Italian regions and sold at a price of 10-12 € per kg. In Bulgaria, it is collected and sold on local markets.

Conservation status

Pleurotus eryngii and P. eryngii var. ferulae are common and widespread species, not threatened in Greece and Italy. In Bulgaria, P. eryngii has no conservation status. However, P. nebrodensis is quite rare both in Sicily and Greece. This species is
included in the “red-list” of threatened European mushroom species by ECCF (European Council for the Conservation of Fungi). Furthermore, it is the only mushroom species which was listed by the IUCN under the "Critically Endangered" category. Therefore, a set of regulations should be set in the collection of this species in Greece as well, following the example of the Sicilian authorities.
13. *Cantharellus cibarius* Fr. var. *cibarius*

**Etymology:** from the Latin word “cibus” (=food) meaning edible, pertaining to food.

**Common Greek names:** “kitrinouska” (Grevena); “gaitsa” (Ioannina); “galeta” (Florina); “pernarites” (Kefalonia); “neratzaki’ (various regions).

**Common Italian names:** Gallinaccio, Finferlo.

**Common Bulgarian name:** Обикновен пачи крак (Obiknoven pachi kрак).

![Fig. 26. Cantharellus cibarius](photo by D. Dimou).

**Description**

**Basidioma development:** This mushroom does not change so much during its growth, apart from getting bigger and with more pronounced stem and cap, moreover it grows significantly slower from most fleshy mushrooms. However the
cap at the beginning is convex, or domed with inrolled margin, becoming gradually flattened and eventually funnel-shaped, with uplifted and often eroded margin. The consistency remains the same for long time being compact and elastic. The colour of the cap fades (sometimes) from intense yellow or yellowish-orange to ochre or whitish in full maturity (Fig. 26).

**Pileus (cap):** 2-10 (-15) cm wide when fully expanded, hemispherical, convex or domed at first, sometimes even irregularly shaped, then flattened, finally funnel-shaped; bright egg-yellow, fading to ochre-yellowish then whitish; margin inrolled at first, becoming plane, sinuous, thin and irregularly lobed, which makes it friable; surface naked, either mat and minutely downy when dry, but shiny and looking waxy when wet.

**Lamellae (gills):** There are no true gills, but shallow vein like ridges, that are strongly forked and anatomising, characteristically deeply decurrent, same colour as the cap.

**Spore print:** Light ochre-yellow.

**Stipe (stem):** 2-8(-20) × 0.5-2(-3) cm, tapering downwards, as the pseudo-gills are so deeply decurrent cover a great proportion of the stem’s length; same colour as cap or paler, ochre-yellowish, often with whitish patches, or whitish throughout giving the mushrooms a two-coloured appearance; surface smooth or slightly downy; compact, elastic.

**Context (flesh):** Compact, fairly fibrous in the stem, dry, always paler than the surface whitish to yellowish, with out any colour changes when cut but becoming paler on drying. Odour faint but characteristic of apricots; taste mild to slightly bitter or spicy.
Habitat/ecology: At most trooping in large groups in deciduous and coniferous woodland, in dump places such as ditches and hollows. A symbiotic mushroom species with a wide range of hosts preferably beech and oak, but also with birch, chestnut, pines and firs less commonly with several other trees, recorded also with evergreen oaks (*Quercus ilex*).

Distribution: Very common throughout the mainland of Greece and Italy as well as in some larger islands (Euboea, Lesvos, Ikaria, Aeolian Archipelago, Tuscany Archipelago, Pantelleria). In Bulgaria, it is found in the floristic regions encoded as follows: 1, 2, 3, 5(w, c, e), 6, 7, 8, 14, 15, 16(w), 17(w, c, e), 18, 20.

Fruiting-season: Appearing in Greece and Italy as early in spring as in March more often from May to as late in the winter as in January but mostly until November.

Possible confusion

Many varieties of this species have been described and there are few more but rare look-alike species of *Cantharellus* recorded in Greece, that are barely differing in the colour shades and they are all edible and good as *C. cibarius*. *Omphalotus olearius*, a very poisonous species quite common in south Greece in olive groves and woods of evergreen oaks, has similarly coloured decurrent true gills (and not vein-like wrinkles) and dark orange to brick-cloured cap. *Hygrophoropsis aurantiaca* often referred as “false-cantherelle” because it is commonly misidentified by collectors as a cantherelle; it is smaller, thin-fleshed, has true gills; lacking the aroma of *C. cibarius*. Although it is considered edible it has a flaccid tasteless flesh.

Notes on edibility

*C. cibarius* is a choice edible species and the one of the wild mushrooms that retains its shape, colours, consistency and aroma for much longer time, even after cooking. It is also a mushroom species that seems to be neglected by snails and maggots and
remain impact for long time in the wood. It is a highly prized species for its edibility, however its firm flesh and delicate flavour require gentle, slow cooking.

Preservation
Fresh mushrooms of *C. cibarius* can be perfectly preserved in the refrigerator for many days, even weeks and they can also be frozen. Drying is also possible and a common practice for preserving them but the quality is decreasing as the dried mushrooms are not very absorbent and remain rather tough after soaking.

Commercialization
Highly commercialized species in Greece, Italy as well as in many places of the world. It is sold raw or dried, but particularly in Grevena district even sweets and liqueur has been produced with *C. cibarius* being world originality. In Bulgaria, it is collected and sold on local, national and international markets.

Conservation status
Common and widespread species, not threatened in Greece, Italy or Bulgaria.
14. Cantharellus cinereus (Pers.) Fr.

Etymology: “cinereus” is an adjective of Latin language meaning ‘ash grey’ and is given to this mushroom species due to the colour of its fertile surface (hymenium).

Common Greek names: Not existing.
Common Italian names: Cantarello cinereo.
Common Bulgarian name: Сив пачи крак (Siv pachi kрак).

Fig. 27. Cantharellus cinereus (photo by D. Dimou).

Description

Basidioma development: This mushroom does not change so much during its growth, apart from getting bigger and with more pronounced stem and cap, the cap
is convex at first but soon is becoming funnel-shaped and the margin is initially inrolled then unfolded to almost plane and wavy (Fig. 27).

**Pileus (cap):** 2-5 (-6) cm wide when fully expanded, initially convex, soon with a depressed centre, then deeply funnel-shaped with small crater like hole at centre that continues to the hollow stem; dark greyish-black to greyish-brown; margin inrolled at first, becoming plane and irregularly wavy; surface radially fibrous, wrinkled and mat.

**Lamellae (gills):** There are no true gills, but shallow vein like ridges (pseudo-gills), that are strongly forked and occasional transverse interconnections, decurrent, whitish, ash-grey, or greyish brown, always lighter and contrasting to the dark pileus and stem surface.

**Spore print:** White.

**Stipe (stem):** 3-7 (-8) × 0.5-1 cm, almost cylindrical, somewhat tapering below; same colour as the cap, greyish-black to greyish-brown; surface fibrous and longitudinally striated; hollow, elastic.

**Context (flesh):** Thin flesched, somewhat paler than the surface, with out any colour changes when cut. Odour faint but pleasant fruity like plums; taste mild.

**Habitat/ecology:** Trooping in large groups; a symbiotic mushroom species found in Greece and Italy in beech and oak forests, often together with *Craterellus cornucopioides*. 
**Distribution:** Rather uncommon in Greece, known from Makedonia and Sterea Ellas. It is infrequent in Italy as well. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 2, 5(w), 6, 16(w).

**Fruiting-season:** Appearing in Greece and Italy from April to December.

**Possible confusion**

*Craterellus cornucopioides* is an excellent and edible mushroom species that may be seen at the same time in the same habitats; it is similarly coloured, but differs in the almost smooth fertile surface, with out prominent vein like pseudo-gills, and a cap that has a much wider crater-like hole. *Craterellus tubaeformis* is another close relative and good edible mushroom species as well and it differs in the brown colour of cap and the yellow pseudo-gills and stem. *Faerberia carbonaria* is a relatively rare edible mushroom species that is always found in burned places, growing solitary or in small groups; it is very similar to *C. cinereus* in aspects of colour and general shape, as its true-gills are relatively shallow and strongly forked as well, and the cap is also funnel-shaped, however there is no hole at the centre of cap and the stem is compact and not hollow.

**Notes on edibility**

*Cantharellus cinereus* is a good edible species however its uncommonness and small size make it a rather poor candidate for extended collection.

**Preservation**

*C. cinereus* is preferably and perfectly preserved dried.

**Commercialization**

No commercialization exists for this species in Greece and Italy.
Conservation status

Uncommon to rare species, but not specified as threatened in Greece, Italy and Bulgaria.

**Etymology:** from the Latin words “cornu” (= horn) + “copiose” (= plentiful) because the mushrooms shape reminiscent the “horn of plenty”.

**Common Greek names:** “mauri trompeta” (Grevena, Kastoria and elsewhere).

**Common Italian names:** Corno dell’abbondanza, Trombetta dei morti.

**Common Bulgarian name:** Обикновена тръбенка (Obiknovena trubenka).

![Figs. 28 & 29. *Craterellus cornucopioides* (photos by E. Polemis & B. Assyov).]

**Description**

**Basidioma:** This mushroom cannot be divided to a distinguishable cap and stem as it is forming a continuous funnel, mostly running down to a point, with an overall shape that reminiscent a trumpet. Its height is 6-10 (-20) cm and the diameter of the upper portion that bends outwards and forms a vague limb is 2-5 (-8) cm. The inner surface of the funnel is greyish-brown to black, smoothly wrinkled and towards the surface of the limb it is minutely scaly; the outer fertile surface is running along to the base of the indistinguishable stem, it is greyish and almost smooth or vaguely wrinkled, but with out any trace of pseudo-gills, rarely with some faint anastomizing ridges (Figs. 28 & 29).
Spore print: yellowish.

Context (flesh): Very thin fleshed, dark greyish, with any particular odour and a slightly astringent taste.

Habitat/ecology: Trooping in large groups of tufted basidiomata; a symbiotic mushroom species found in Greece and Italy primarily under deciduous trees such as beech, oak and chestnut, in damp places. It is often invisible as it is hidden under the fallen leaves.

Distribution: Very common throughout the mainland of Greece from Thrace to Peloponnese and Italy too. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 2, 5(w, e), 8, 15, 16(w), 17(w).

Fruiting-season: Appearing in Greece and Italy from June to November.

Possible confusion
It is a unique mushroom and it can hardly be misidentified since there is no look-alike.

Notes on edibility
*Craterellus cornucopioides* is a gourmet mushroom that is appreciated very much everywhere; its delicate flavour makes it much better from all other dark coloured cantherelles. It makes excellent soups and white sauces, while it can be a side-dish accompanying meat or fish, or even used to stuff meat in some delicatessen French recipes.
Preservation

*C. cornucopioides* is very suitable for drying and its delicate flavour is greatly intensified by drying. However, these mushrooms should be consumed within the first few months after drying since if they are preserved for too long, they may turn rancid.

Commercialization

Highly commercialized species in Greece and even exported, always dried. In Italy it is collected for personal consumption and sometimes locally commercialized (i.e. the mushrooms market of Trento, North-east Italy). In Bulgaria, it is collected and sold on local, national and international markets.

Conservation status

Common and widespread species, not threatened in Greece and Italy. In Bulgaria, it has no conservation status.
16. *Craterellus tubaeformis* (Fr.) Quél.

**Etymology:** from the Latin words “tuba” (= trumpet) + “forma” (= shape), meaning trumpet-like and referring to the shape of such mushrooms that reminisce a trumpet.

**Common Greek names:** “kitrini troumpeta” (Grevena).
**Common Italian names:** Cantarello a tromba.
**Common Bulgarian name:** Сиво-жълта тръбенка (Sivo-zhulta tubenka).

![Fig. 30. *Craterellus tubaeformis* (photo by C.M. Denchev).](image)
**Description**

**Basidioma development:** This mushroom does not change so much during its growth, apart from getting bigger and with more pronounced stem and cap, the cap is convex at first but soon is becoming funnel-shaped and the margin is initially inrolled then unfolded to almost plane and wavy.

**Pileus (cap):** 2-6 cm wide when fully expanded, initially convex, soon with a depressed centre, then deeply funnel-shaped with small crater like hole at centre that continues to the hollow stem; greyish-yellow, olivaceous-yellow, yellow-brown to greyish-brown with ochre margin; margin inrolled at first, becoming plane and delicately wavy; surface smooth when young, then radially grooved, with minute scales close to the centre, mat or slightly lubricous (Fig. 30).

**Lamellae (gills):** Pseudo-gills decurrent, strongly interveined in large specimens, pale yellowish, yellowish-grey, at times with greenish tint, greyish brown at the end.

**Spore print:** White.

**Stipe (stem):** 2-8 (-10) × 0.5-1 cm, almost cylindrical but often becoming compressed, somewhat thinner towards the base; greyish-yellow to yellowish-brown; surface dry, silky, with longitudinal grooves; hollow, elastic.

**Context (flesh):** Thin fleshe d, whitish to sepia-yellow, with out any colour changes when cut. Odour particularly absent; taste mild.

**Habitat/ecology:** Trooping in large groups often forming big colonies of tufted fruit-bodies in rows and rings; a symbiotic mushroom species found in Greece and Italy in both deciduous and coniferous forest, especially around stumps and roots of living
trees in damp places. It is often difficult to spot these mushrooms since they are hidden under the leaf canopy.

**Distribution**: Rather common in north and central Greece, known from Makedonia and Thessaly. Common species in Italy. In Bulgaria, it is found in the floristic regions encoded as follows: 8, 14, 15, 17(w, c).

**Fruiting-season**: Appearing in Greece and Italy from July to December, often surviving early frosts.

**Possible confusion**

*Craterellus lutescens* is a very similar edible species, which differs in the almost smooth fertile surface, without prominent vein-like pseudo-gills, orange shades on cap, bright yellow stem and a fruity smell.

**Notes on edibility**

*Craterellus tubaeformis* is a good edible species, with its slightly elastic consistency making it ideal for an excellent omelette ingredient. However, because of its faint smell is less preferred than *Cantharellus cibarius* by some individuals.

**Preservation**

*C. cinereus* is very suitable for drying.

**Commercialization**

No commercialization exists for this species in Greece and Italy, although in other European countries there is extensive commercial collection (i.e. Scandinavia).

**Conservation status**

Common species, not threatened in Greece and Italy. In Bulgaria, it has no conservation status.
17. *Hydnum repandum* L.

**Etymology:** from the Latin word “repandum” (= repand) describing the caps that have bent, uneven and waved margin.

**Common Greek names:** “agkathaki”, “perdikomanitaro” (undefined localities).

**Common Italian names:** Steccherino dorato.

**Common Bulgarian name:** Жълта рогачка (Zhulta rogachka).

![Figs. 31 & 32. Hydnum repandum (photos by D. Dimou & B. Assyov).](image)

**Description**

**Basidium development:** This mushroom does not change so much during its growth, apart from getting bigger and with more pronounced stem and cap. Initially the cap is almost hemispherical to convex with thick inrolled margin, becoming gradually flattened and irregularly plane to depressed at the end.

**Pileus (cap):** 3-12 (-20) cm wide when fully expanded, hemispherical, convex or domed at first, sometimes even irregularly shaped, then flattened, finally somewhat depressed; white, cream to pale pinkish buff, turning yellow when bruised and with age; margin thick and persistently inrolled, splitting and finally lobed or wavy;
surface velvety or suede-like at first, becoming smooth and shiny when dry, not zoned (Figs. 31 & 32).

**Spines**: Adnate or slightly decurrent, at least at one side of the stem going down, crowded, white or whitish with a pinkish tint, thin, 4-8 mm long and 2-3 mm thick, pointed, soft and fragile, easily breaking when touched and detachable from the cap surface.

**Spore print**: White.

**Stipe (stem)**: 2-7(-8) × 1.5-3(-4) cm, may be central, but mostly eccentric, thick and stocky, cylindrical, or swollen below; whitish, paler than cap, becoming pinkish or brownish with age; surface smooth or base covered by rich mycelial mass; solid.

**Context (flesh)**: Thick, compact but relatively soft and fragile, white, sometimes turning pinkish or pinkish-yellow when cut or bruised. Odour faint somewhat fruity; taste mild but in aged specimens slightly hot or bitter after a short interval.

**Habitat/ ecology**: Solitary or mostly in large groups, sometimes in circles, often several mushrooms growing together tufted, in deciduous and coniferous forests. A symbiotic mushroom species with a wide range of hosts, preferably beech, oak and birch, but also with pines.

**Distribution**: Common throughout mainland Greece and Italy as well as in some large islands. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 2, 5(c, e), 7, 8, 11, 14, 15, 16(w), 17(w, c), 20.
**Fruiting-season:** Appearing in Greece and Italy from late summer (August) until November sometimes later up to December, as it can withstand temperatures as low as -5 °C.

**Possible confusion**
Some scientists regard *Hydnum rufescens* solely as a variety of *H. repandum* while others consider it a different species; nevertheless, it only differs by the darker colour of cap that may be salmon-pink to orange, paler at margin and as it ages. All other mushrooms with spines under the cap might be inedible, but not poisonous, and belong to different genera which are easily discriminated from *Hydnum* species.

**Notes on edibility**
*Hydnum repandum* is an excellent edible species, especially when harvested young and in good condition. The flesh hardens and becomes bitter in older specimens; however, the bitterness gets less pronounced after prolonged cooking, therefore it is recommended first to blanche the mushrooms and discard the cooking water.

**Preservation**
*Hydnum repandum* dries easily and can be preserved for long periods; however, its quality decreases when dried mushrooms are rehydrated prior to cooking since they do not absorb water well and remain rather tough after soaking. In addition, due to its firm flesh it can also be pickled in vinegar, while it can be perfectly preserved in the refrigerator for many days or be frozen.

**Commercialization**
Not or poorly commercialized in Greece, in many regions it is not well known for its edibility. In Italy, it is collected for personal consumption and sometimes it is locally
commercialized (i.e. the mushrooms market of Trento, northeastern Italy). In Bulgaria, it is collected and sold on local, national and international markets.

**Conservation status**

Common and widespread species, not threatened in Greece, Italy or Bulgaria.
18. *Boletus edulis* Bull.

*Boletus aereus* Bull., *Boletus reticulatus* Schaeff., *Boletus pinophilus* Pilát & Dermek:

**Etymology:** From Latin “edulus” (=edible) meaning the edible bolet; from Latin “aereus” (= bronze), i.e. the bronze coloured bolet; from Latin “reticulatus”, i.e. “the reticulate bolet”; and from Latin “pinus” (= pine) + Greek “philos” (= friend), meaning the pine-loving bolet.

**Common Greek names:** Mostly for *B. edulis* and *B. reticulatus*: “vasiliko” (Grevena, Kastoria, Kozani); “vasilikara” (Pieria); “vasila” or “vasilomanitaro” (Pilion - Magnisia); “vasilaina”, “vasilikaria”, “vasilikoules” (in various regions). More often for *B. aereus*: “vasiliko kalogeraki” (Kozani); “kalogritsa” (Peloponnissos); “kalogeraki”, “kaloiraki”, “kalogeroudi” (in many places).

**Common Italian names:** Porcino, Brisa.

**Common Bulgarian name:** Обикновена манатарка (Obiknovena manatarka).

---

**Figs 33 & 34.** *Boletus edulis* (photos by E. Polemis and B. Assyov).

**Description**

**Basidioma development:** Young mushrooms are very smaller than the mature ones, they have well defined cap and stem but the stem is often quite larger than cap in the
early stages and the flesh very firm; the pores are white at first, becoming yellow later.

**Pileus (cap):** 5-20 (-30) cm wide, very fleshy, initially hemispherical, then convex, later expanded to almost plane, sometimes even depressed at centre; variously and not uniformly coloured, whitish, cream, beige, light brown to chestnut brown; smooth or slightly roughened, distinctly viscid or sticky in humid weather, never velvety, cuticle exceeding the margin slightly, not or hardly separable (Figs. 33 & 34).

**Tubes/Pores:** Tubes almost free to emarginated, easily detachable from cap; at first white, then yellowish- greenish yellow, finally greenish to olive-green, not changing colour when cut. Pores roundish, very small, the same colour as the tubes and similarly changing with age, not discoloured when touched.

**Spore print:** Olive-brown.

**Stipe (stem):** 5-15 (-20) × 3-7 (-15) cm, robust and fleshy, mostly barrel-shaped in young fruit-bodies, then often club-shaped, enlarged at base, sometimes almost equally cylindrical and curved; whitish, shaded with beige or light brown colours, decorated with a fine white or later cream coloured reticulum contrasting to the slightly darker background, most easily visible on the upper half of stem.

**Context (flesh):** Very thick and firm in unripe basidiomata, becoming softer as they mature; white, reddish-brown to violet under the cap-cuticle, not changing colour when cut; odour very pleasant, taste sweet and pleasant.

**Habitat/ecology:** In mountain forests with deciduous trees often beeches, birches or conifers (firs, spruce and mountain pines) in lower altitudes with broadleaved oaks.
and chestnuts, secondarily with hornbeams or hazels. It is a symbiotic mushroom species like all bolets, it forms ecomycorrhizas with the trees mentioned above.

**Distribution:** Common throughout mainland of Greece and known also from some large Aegean islands (Euboea, Lesvos). Very common in Italy. In Bulgaria, it is found in the floristic regions encoded as follows: 4, 5(w, c, e), 6, 7, 8, 14, 15, 16(w), 17(w, c); at least part of the records probably refer to other species of *B. edulis* – group.

**Fruiting-season:** It is a wet-loving species that prefers humid areas, fruits in summer and autumn (more often during August - September), after heavy rains.

![Boletus aereus](image)

**Figs. 35 & 36. Boletus aereus** (photos by D. Dimou and B. Assyov).

**Related species**

*Boletus aereus* Bull.: distinguished from *B. edulis* mainly due to its velvety, never viscid cap, initially very dark to almost black but fading as it matures to bronze-brown or sepia; it also has a more prominent mesh reaching the base of stem (Figs. 35 & 36). This bolet is found in much more warm and dryer habitats and only with deciduous trees preferably oaks and chestnuts, known also from evergreen oaks (*Quercus ilex*) in some Aegean islands (Crete, Euboea, Andros, Ikaria) and small Italian islands. Widespread in Italy it seems to be more common in south Italy. In Bulgaria, it
is found in broadleaf (oak) forests in the floristic regions encoded as follows: 1, 2, 4, 5(w, c, e), 6, 7, 10, 16(w), 17(c), 20.

**Boletus reticulatus** Schaeff.: closely related to *B. edulis* as the only differentiating features are the dry velvety cuticle of the cap, that is often cracked and the clearly defined mesh that covers all the surface of stem (Fig. 37). This species fruits earlier in season from May and it is common in woods with broadleaved oak, beech, chestnut, and hazel, less common in coniferous woods (firs and pines). It is widespread in the mainland of Greece known also from the islands Euboea and Lesvos. Widespread in Italy. In Bulgaria, it is found in broadleaf (oak) forests in the floristic regions encoded as follows: 1, 2, 5(w, c), 6, 7, 8, 9, 11, 15, 16(w), 17(e).

![Figs. 37 & 38. Boletus reticulatus and B. pinophilus (photos by D. Dimou & B. Assyov).](image)

**Boletus pinophilus** Pilát & Dermek: this species is characterized by the reddish colour of the cap, ranging from dark pomegranates colour to chestnut reddish-brown, with a rough surface and a mesh extending from the top to the middle of stem (Fig. 38). It grows typically in mountain pine forests but also known form spruce, beech, chestnut and birch woods. Rather rare in Greece known form Makedonia, Thessaly and Peloponnese. Widely distributed in Italy. In Bulgaria, it is found in coniferous (spruce, pine) forests in the floristic regions encoded as follows: 5(c, e), 8, 14, 15, 17(w, c).
Possible confusion

Toxic species of the genus *Boletus* are easily recognized thanks to the reddish pore surface and their flesh that becomes more or less blue when cut. The combination of white unchanging flesh colour, the white tubes and pores in young fruit-bodies and the presence of a more or less distinct mesh on the stem surface are very good discriminating characters for the group of species that are related to *Boletus edulis*. The “bitter bolet” *Tylophilus felleus* (Bull.) P. Karst. is not toxic, but it is not edible as well due to its very bitter taste. It differs from all mild tasting edible bolets by the dark brown coarse mesh on the stem, as well as by the pores which are distinctly wider, white but soon turning pinkish red and not yellow or greenish. It appears at the same habitats with *Boletus edulis* and it is an apparently rare species in Greece known to date only from few localities in Makedonia. Another bolet with whitish pores and flesh is *Gyroporus castaneus*, it is edible but not as good as the members of the “edulis” group. It is a small mushroom with caps never exceeding 10 cm in diameter, the stem is uniformly brown coloured without any mesh and the flesh is white, unchanging when cut but characteristically hollow at stem. It is a warm loving species occurring in north and central Greece and in Italy as well as in some Aegean (Andros, Lesvos) and Italian islands.

Notes on edibility

Bolets such as *Boletus edulis* and its allies are by far among the most popular and famous WEM throughout the northern hemisphere widely known by the Italian term “porcini”. They are considered to be some of the most delicious mushrooms and for some individuals they are simply the best of all. Some people prefer very young specimens, that are good for preservation as well, but the matured ones are significantly bigger and the flavour is stronger. Unfortunately, as the mushrooms mature and get softer, worms often attack them and then their quality falls rapidly. Only fresh, healthy specimens that still have their delicious aroma should be
collected. All others including overripe, soft and/or infected by worms and moulds specimens should be better left in the wood.

**Preservation**

Edible bolets are collected and distributed fresh in restaurants and markets, but most commonly they are sliced and air-dried; this is the best preservation method. The slices are up to 1 cm thick and drying can be performed in dryers, ovens, or by just exposing them in the sun during the warmer seasons (until the moisture is approximately 10% or the pieces are easily cracked). Kept in air-free containers like this, they can last for years, keeping their aroma intact. Dried mushrooms can also be ground and the powder produced can be used as flavouring “spice”, or it can be utilized in pasta production. Young specimens are often preserved canned in olive or brine, or even in various “pate” mixed with other mushrooms.

**Commercialization**

In Greece, edible bolets were quite overlooked in the south of the country, while they still remain unknown in the islands. Until lately they have been only collected widely in the northern part. However, in the last two decades bolets have been introduced in the gourmet cult of the cities as imported “porcini”. Nowadays a large commercial collection business is taking place in most mountains of north and central Greece and the market grows rapidly while several Greek labels of commercialized dried bolets already exist. In Italy, the price of wild edible porcini varies from 15 to 30 € per kg. The PGI label for Porcini of Borgotaro (or Borgo Val di Taro) was assigned to *Boletus* growing in the territory of this town which is located in the province of Parma (Emilia-Romagna). A consortium was established to protect the PGI label. Additional information are available in www.fungodiborgotaro.com. In Bulgaria, edible bolets are collected and sold on local, national and international markets.
Conservation status

All species are common and widespread, hence not threatened in Greece, Italy and Bulgaria with the exception of Boletus pinophilus which can be considered rare. Therefore it is one of the species for which a protection framework should be set in order to limit the amount of harvested quantities for commercial purposes.

For all species, it is advisable not to collect very young specimens, as this can affect the spores production and consequently the propagation of the fungus. It is also wise to leave all overripe specimens in the wood, as they are essential food resource for many small animals, insects and microbes (in addition to their role in propagating the species itself).
19. *Calvatia gigantea* (Batsch) Lloyd
≡ *Langermannia gigantea* (Batsch) Rostk.

**Etymology:** from the Greek word “gigantios” (= gigantic) referring to the enormous size of the mushroom.

**Common Greek names:** “moschomantaro” (Kastoria); “Aigiorgitiko” (Grevena).

**Common Italian names:** Vescia gigante.

**Common Bulgarian name:** Гигантска пърхутка (Gigantska purhoutka).

*Fig. 39. Calvatia gigantea* (photo by H. Hillewaert, source: Wikipedia).
Description

**Basidioma development**: As in all mushrooms of this type, basidiomata (‘puff-balls’) have a more or less spherical, potato or pear-like shape; there is no cap and stem and there is no free fertile surface like gills, tubes or spines. Originally the mushrooms are like white balls with undifferentiated, white and spongy flesh enclosed into a leathery skin that remains intact until the basidioma is completely ripe (Fig. 39). Progressively the flesh become softer, the colour turns to grey-greenish and the consistency gets more watery and degenerated. Eventually and in full maturity the skin raptures on the upper side of the basidioma, and then the flesh is transformed into a brown dust-like mass of spores and a mesh of very thin threads.

**Basidioma**: It usually grows up to 10-25 cm height and 10-30 (-50) cm wide and up to 1.5 kilos, but extremes such as 90 cm diameter and 25 kilos have been encountered in exceptional cases. The skin consists of two distinct layers; the outer layer is white, then cream, dirty yellowish-cream, and greenish or olive-brown at maturity; initially smooth but soon cracked and in maturity ruptured in large patches and an inner skin-layer appears which is very thin and smooth, which soon breaks to expose the mass of spores, while it remains intact only at the base making the whole mushroom look like an open bowl.

**Spore mass**: Olive-brownish.

**Stipe (stem)**: There is no stem, but the base of the basidioma is often wrinkled towards a fine mycelial strand that connects to the underground mycelium of the fungus, which expands through the soil.

**Gleba (flesh)**: The flesh is the fertile part of the mushroom and remains enclosed until the end of its development. It is white, uniform elastic and dry in the beginning, resembling soft cheese (or tofu) in texture, it then has a weak smell and a mild taste;
as the basidioma matures it turns yellowish, greenish, becoming watery and finally is transformed to a dusty mass of spores.

**Habitat/ecology:** This mushroom appears mostly in grassy fields, often in high altitudes and alpine grasslands and pastures with a rich soil; it is rarely found in parks, gardens or within woods on rich soil. It appears either solitary or in small groups.

**Distribution:** It is rather uncommon in Greece reported from mountains in Makedonia, Sterea Ellas and Peloponnese, exclusively above 1000 m. Widely distributed in Italy. In Bulgaria, it is found in the floristic regions encoded as follows: 2, 3, 6, 15.

**Fruiting-season:** It fruits mainly in autumn, but it may be found from May until October.

**Possible confusion**
When a maximum diameter of more than 10-15 cm is reached, then such ball-like mushrooms are more likely to be *Calvatia gigantea*. The very similar species *C. utriformis* (now *Lycoperdon utriforme*) rarely exceeds 18 cm in diameter, while its outer skin has never smooth surface but consists of shallow pyramidal flakes, and the whole basidioma looks more like a pear than a ball. Nevertheless, *L. pyriforme* is another good edible species with same characteristics of flesh. Other puff-balls classified to the genera *Lycoperdon* or *Bovista* are even smaller and also edible when young. Other puff-balls resembling mushrooms that have dark purple-brown or black flesh when young and a tough skin are classified to the genus *Scleroderma*, and they are all poisonous. The consistency of a puff-ball should be always examined by cutting in half the whole mushroom to ensure that the flesh is uniformly white and for eliminating the risk to be the egg-stage of deadly poisonous *Amanita* since in such case the internal part of the “egg” will look like a small undeveloped mushroom with
cap, stem and gills. It is essential to cut the puffballs to check for the condition and the maturity of the flesh as well.

**Notes on edibility**

*Calvatia gigantea* is a good edible mushroom, its large size makes it a very good find and it is said that whole families are fed to a single exceptionally large puff-ball, which is absolutely true if it is a 10 kilos specimen. The mushrooms are edible and good only for as long as the flesh is white, becoming unpalatable when the colour changes to yellowish-green. Puff-balls that are soft in touch should be avoided since they are most likely overripe for consumption. The white flesh is absorbing liquids fast; therefore it is suitable for cooking in the stew pot, where it becomes tasteless and soggy, but most suited for the frying pan, preferably in minimal oil or butter, and it is excellent as base for an omelette.

**Other uses**

Apart from the culinary uses this mushroom, *C. gigantea* (as well as other puff-balls), possesses some therapeutical properties as well. The spore-mass of the overripe mushrooms has strong haemostatic and anti-inflammatory characteristics known from the old times, therefore peasants used to store such specimens for years and when necessary to apply them onto an open wound or burnt skin to stop bleeding and for curing purposes. Last, by using ammonia as a mordant, *C. gigantea* can be applied to dye textiles or paper with a red-brown colour.

**Preservation**

*Calvatia gigantea* is mostly and preferably cooked and eaten raw, while it can also be preserved dried in cut slices or in powder for soups (but it is never as tasty as other dried mushrooms). Cut pieces of a big and young mushroom can be preserved in plastic bags in the refrigerator for several days.
Commercialization

There is no commercialization of this species in Greece and Italy. In Bulgaria, it is collected and sold on local markets.

Conservation status

Common and widespread species, not threatened in Greece and Italy. In Bulgaria, it has no conservation status.
20. Morchella elata Fr.

Morchella conica Krombh.
Morchella esculenta (L.) Pers.

Etymology: from the Latin word “elatus” (= long) because of their elongated habit; from Greek word “conos” (= cone) referring to the conical shape of the cap; from Latin “esculentus” (= edible) for its well known edibility.

Common Greek names: “mourtseki” (Kastoria, Grevena) “artsivourtzi” (Trikala); “kouzouki” (Kavala, Chalkidiki); “kapsalitis” or “skoufaki” (Cephalonia); “koukouliantra” (Fokida); “kourmekia” (Achaia); “koilies” or “probokoilies” (Peloponnese); “koukoumela” (many places).

Common Italian names: Spugnola.

Common Bulgarian names: Morchella elata – Висока смръчкула (Visoka smruchkoula), M. esculenta – Обикновена смръчкула (Obiknovena smruchkoula).

Description

Ascoma development: the mushroom does not change so much during its growth, apart from getting bigger; it is divided into a cap which has the typical honeycomb appearance, with ridges and furrows that progressively get wider and a stem that
grows taller and its colour changes from white at first to dirty whitish, and finally brown as it matures.

**Pileus (cap):** It accounts for 1/2 to 1/3 of the length of a whole mushroom, 2-6(-8) cm tall and 2-5(-6) cm broad, narrowly to broadly conical, occasionally more rounded, obtuse-conical to ovoid-conical; surface of parallel to meandering ridges and cross-ribs, pubescent when young in some forms; colour at first greyish to ochre-brown, occasionally pinkish to blackish overall; with age the ridges dark-grey to blackish-brown, the pits lighter ochre to grey-brown; margin when young, overlapping the stem attachment, less so in age (Figs. 40 & 41).

**Stipe (stem):** 2-5(-7) × 1.5-3 cm, hollow, cylindrical somewhat enlarged above, mostly thickened and with longitudinal folds towards the base; surface typically whitish to ochre, pinkish to blackish in some forms, darkening with age, mealy, becoming scurfy in age.

**Spore powder:** Whitish.

**Context (flesh):** Whitish, thin, firm and elastic at first, becoming brittle with age, interior hollow throughout the mushroom; odour fine and penetrating, earthy to fungal, pleasant.

**Habitat/ecology:** Solitary, scattered, clustered, occasionally in very large numbers almost exclusively the spring following a forest fire and preferably those fires in which trees have been only partially consumed, thus leaving some shade and needle cover for morels to develop. It can appear in large numbers on disturbed soil as well, such as along the edges of dirt roads or in recently logged areas; occasional in coniferous woods, from the sea-level Mediterranean pine-forests to the mountainous fir forests.
**Distribution:** Common throughout continental Greece and Italy as well as in most islands with pine forests and broad-leaved woods. In Bulgaria, it is found in the floristic regions encoded as follows: 8, 14, 15, 17.

**Fruiting-season:** Only in spring, appearing in Greece from late March in the lowland pine-forests until May in the mountainous regions. The fruiting period in Italy is from spring to autumn.

**Fig. 42. Morchella conica** (photo by E. Polemis).

**Related species**

*Morchella conica* Krombh.: Several taxonomists tried to separate black morels into various species and varieties based on macroscopical features, while others suggested that there are no robust/reliable differences and they are merely different forms of the same species (Fig. 42). This is the case for *M. conica*, which is considered as synonymous to *M. elata* according to some scientists. Recent studies employing DNA methodologies demonstrated the existence of many cryptic species of black
morels related to *M. elata* but without any discernible macroscopical characters to distinguish them with accuracy. For the morel collector what counts is that all black morels are choice edible mushrooms regardless of their exact taxonomical status.

*Morchella esculenta* (L.) Pers.: The main appearance of this species is similar to *M. elata*. However the shape of the cap is more rounded, egg-shaped, rarely somewhat pointed and bigger, 3-9(-12) cm long and 3-10 cm broad; the colour ranges between yellow, honey, yellowish-brown, brown, or greyish; the pits are larger and more irregular in shape as (the cap looks like a sponge); the stem may also be larger 4-6(-13) × 1.5-3.5(-7) cm (Fig. 43). This species has a different habitat/ecology since it is never found with conifers but mostly under deciduous trees by the banks of rivers that occasionally flood, but also in gardens with fruit-trees, grassy forest edges, garbage heaps and roadsides. It fruits in spring from March to early June, and it is widespread throughout mainland Greece and in some of the larger islands. In Bulgaria, it is found in the floristic regions encoded as follows: 2, 8, 10, 14, 15, 16, 17, 18.
Possible confusion

Among the edible look-alikes of morels, *Mitrophora semilibera* and *Verpa bohemica* should be mentioned. The former is a morel with mediocre culinary qualities. It has similar cap shape and colour with *Morchella elata* from which it differs in having a longitudinally ridged, only slightly pitted cap, of much smaller size in relation to the stem, a partially detached cap margin, free to about half the distance to the stem apex. It is found with various hardwoods along stream drainages in the spring mush like *Morchella esculenta*. It is common in north Greece but not recorded elsewhere. *Verpa bohemica* has a longitudinally wrinkled, not pitted cap, the latter is attached to the stem only at one point at its apex. It reportedly causes digestive upsets in some individuals and must be eaten with caution. More distantly related are the “False Morels” species of *Gyromitra* and *Helvella*, some of which are toxic. These can be
separated by their lobed, wavy, or saddle-shaped caps that reminiscent brain or turban.

Notes on edibility
All *Morchella* species are choice edible mushrooms, highly priced and much sought after throughout the world. Especially *M. esculenta* is considered one of the most delicious edible mushrooms, having a strong flavour and a firm, elastic consistency. It is excellent in dishes containing cream, but due to the hollow nature of the mushrooms it can easily be stuffed in various ways. Caution must be taken to the fact that all morels are seriously poisonous when eaten raw or not cooked well, therefore prolonged cooking is always required (then there is not even a slight risk of poisoning since the toxic substances totally disappear with heat).

Preservation
Morels are very easily and commonly preserved dried for long periods.

Commercialization
Highly commercialized species in Greece, it is gathered and sold in big quantities to traders by individual collectors. Morels from Greece are also exported to several European countries, while others from Bulgaria, Turkey, or Asia are imported as well. Collected for personal consumption in Italy the species is also sold in some local markets. In Bulgaria, the morels are collected and sold on local, national and international markets.

Conservation status
All species are considered common, widespread and not threatened in Greece and Italy. In Bulgaria, *Morchella elata* and *M. esculenta* have no conservation status.

*Tuber brumale* Vittad., *Tuber melanosporum* Vittad.

**Etymology:** From the Latin word “aestas” (= summer) referring to the season of fruiting, i.e. pertaining to summer; “brumalis” (= wintry) because of its appearance in the winter; and from the Greek words “melanos” (= black) + “sporos” (= spore) because of the black colour of spores and flesh of this truffle.

**Common Greek names:** “kalokairini troufa”, “mavri troufa”, “hydno” was the ancient Greek word for truffles and used both for members of the genera *Tuber* and *Terfezia*.

**Common Italian names:** Scorzone, Tartufo nero estivo.

**Common Bulgarian names:** *Tuber aestivum* – Летен трюфел (Leten tryufel), *T. brumale* – Зимен трюфел (Zimen tryufel).

![Fig. 44. Tuber aestivum (photo by D. Dimou).](image)

**Description**

**Ascoma:** Subterranean, almost spherical, 2-9(-12) cm in diameter, blackish-brown to black, surface with conspicuous warts 3-12 mm across, pyramidal, 4-6-sided, often depressed at the apex, vertically fissured (Fig. 44).
Gleba (flesh): Firm, solid, white when immature, becoming light brown, dark brown at maturity, marbled with numerous, thin, white, meandering, branching veins that do not change colour when exposed to the air. Odour slight and pleasant at first, like roasted malt, becoming strong, seaweed-like with age. Taste mild, reminiscent of nuts (walnuts, hazelnuts).

Habitat/ecology: It grows in compact and clay soils, usually in sunny places, inhibits plants growing and makes conspicuous "burns". Black summer truffles grow quite superficial and their presence is detected through the cracks in the soil. They are sometimes found under leaf litter. Like all members of the genus Tuber, it is a symbiotic ectomycorrhizal species associated with the roots of several trees, e.g. oaks, beeches, poplars, hazels, pines and many more trees and shrubs.

Distribution: Common in Greece and Italy and known from all regions of the country at an altitude of 80 m up to 1500 m. Known from Bulgaria.

Fruiting-season: Usually the truffles are harvested from May to July, but they can be found until December if moisture conditions are suitable.

Related species

Tuber melanosporum Vittad.: Ascomata are growing deeper in the ground than T. aestivum, similar in outline, globose in loose soils, irregular in stony soils, initially reddish then blackish-brown. The flesh (gleba) differs in being whitish at first, becoming purplish-black at maturity, marbled with numerous, thin, white, branching veins that turn red at maturity or when exposed to air. Its odour is strong, distinctive, and not always pleasant; taste is equally strong, distinctive, persistent and a little bitter. It grows in well aerated, rich in calcium and alkaline soils with high porosity. It is associated with the same tree species as T. aestivum. Truffles ripen in winter, from
December to March. It is a species still considered rare in Greece. Together with *T. magnatum* is one of the most appreciated and prized truffle species in the Italian market. The area of Norcia (Umbria, Central Italy) is a selected territory for black truffle hunting and commercialization. Not recorded in Bulgaria.

*Tuber brumale* Vittad.: Very similar to *T. melanosporum*, often with a basal depression and warts usually smaller and easily whipped off when the truffle is brushed. The flesh is also similar but typically presenting fewer, broader and more widely placed veins, clearly distinguished from those of *T. melanosporum* because they are not changing colour when exposed to air, remaining pure white. It may be found in the same places as *T. melanosporum* associated with the same tree species, but seems to prefer hazel and linden, while it may be recorded in more humid soils, fruiting during the winter from November until March. It is known to be rather common in north Greece in altitudes between 80 to 800 m. In Italy, it is frequently found in hazel tree cultivation. Known from Bulgaria.

**Possible confusion**

Truffles grow always subterranean and due to the method of detection (and excavation) by pigs or more commonly by trained dogs on the basis of their characteristic smell, there is a slight possibility to misidentify one edible species from another. At times, toxic mushrooms of the genus *Scleroderma* are thought to be truffles but those only superficially resemble truffles. They are always detected on the soil surface, they are smooth outside and they have a thick leather like skin enclosing a purplish black gleba, which remotely resembles but doesn't smell like truffle at all.

**Notes on edibility**

All truffles are considered as the highest prized of all mushrooms since they are incomparable and unique, the “black diamond of cuisine”. Their strong fragrance and flavour make them a identical ingredient for offering a new dimension to any type of
dish even if in very small quantities. Sometimes truffles are macerated and cooked with eggs leading to the preparation of the so-called “truffle-omelette”.

**Preservation**

Truffles are not to be dried, they are better preserved in olive oil when they are still fresh and the have their full aroma. Several methods of preservation are known as putting them in honey or keeping them in airtight containers in the refrigerator but in such those cases they can not preserved for a very long time.

**Commercialization**

During the last decade several people bought truffle-dogs and the knowledge of their presence and abundance in Greece became a shared secret. Nowadays there are several truffle-hunters in Greece and they make a very good business by harvesting, trading and exporting them. The commercialization of truffle in Italy is ruled by a national Law. In Bulgaria, *Tuber aestivum* and *T. brumale* are collected and sold on national and international markets.

**Conservation status**

The true distribution and commonness of truffles is not well known in Greece but it seems they are not threatened at present. No threatened species are reported for Italy.
22. *Tuber magnatum* Pico

*Tuber borchii* Vittad.

**Etymology:** From the Latin word “magnates, -atum” (= of the lords).

Common Greek names: “hydno”, “lefki troufa”.

**Common Italian names:** Tartufo bianco.

![Fig. 45. *Tuber magnatum* (photo by D. Donnini).](image)

**Description**

**Ascoma:** Irregular, tuber-like, sometimes compressed, lobed, with small hollows, gibbose-knotty, 2-20 cm or more, pale straw yellow, light ochre, sometimes shaded
greenish. Peridium whitish in section, surface rarely smooth, finely granulose or papillate (Fig. 45).

**Gleba (flesh):** Firm, whitish in unripe ascomata then light straw, light ochre, ochre-brown, sometimes light pink or fuliginous reddish, marbled with several lighter, whitish, thin and convoluted sterile veins. Taste pleasant, odour complex of methane gas or fermented cheese, or garlic.

**Habitat/ecology:** Marly soils, sandy or sandy-clay, symbiont of broad-leaved plants such as oaks, willows, poplars, etc. Variable in altitudes from 0 to 800-1000 m.

**Distribution:** Common in Italy (Piedmont, Marche, Emilia Romagna, Tuscany, Basilicata, Umbria, Lombardy). Not recorded from Bulgaria.

**Fruiting-season:** July up to late autumn, sometimes in winter.

![Fig. 46. *Tuber borchii* (photo by D. Donnini).](image-url)
Related species

*Tuber borchii* Vittad.: Ascomata tuberiform, lobed or knotty, 2-7 cm in diameter, surface slightly pubescent, especially in hollows, or smooth in ripe ascomata, dirty white to ochre-brown, with dark, reddish spots (Fig. 46). Peridium thin, 0.1-0.2 mm thick, in section with the same surface colour, several hairs prominent from the surface, 60-120 μm long. Gleba whitish then beige, reddish-brown with wide and whitish veins. Odour typical, sweet, of truffle. This species is very common in Europe. It grows in mixed forests, mainly on calcareous soils, symbiont of conifers and broad-leaved plants. The fruiting period is usually from November to May. Not recorded in Bulgaria.

Possible confusion
Like in the case of the previous species.

Notes on edibility
Like in the case of the previous species.

Preservation
Like in the case of the previous species.

Commercialization
Like in the case of the previous species.

Conservation status
Like in the case of the previous species.
Explanatory Notes:


2. Conservation status for mushrooms in Bulgaria is based on Red Data Book of Republic of Bulgaria (Peev et al. 2011).

Literature used:


Pantidou, M. 1990. Mushrooms from the Greek forests. Goulandris Natural History Museum, Athens, p. 197 [in Greek]


Chapter 3

“POISONOUS MUSHROOMS”

Descriptions and information on selected poisonous mushroom species and allies which are common in MYCOTICON’s participating countries

Elias Polemis and Georgios I. Zervakis
Agricultural University of Athens, Greece
(with contributions by G. Venturella, and C.M. Denchev and B. Assyov as regards species occurring in Italy and Bulgaria respectively)

October 2012
DEADLY POISONOUS AMATOXIN - CONTAINING MUSHROOMS

1. *Amanita phalloides* (Vaill. ex Fr.) Link.

**Etymology:** From Greek words “Phallos” (= phallus) + “ides” (= look alike); because of the phallic shape of the young mushroom.

**Common Greek names:** “thanatitis”, “famelitis” (various places).
**Common Italian names:** Tignosa verdognola, Tignosa velenosa.
**Common Bulgarian names:** Зелена мухоморка (Zelena mouhomorka).

![Figures 1 & 2. Amanita phalloides (photos by E. Polemis).](image)

**Description**

**Basidioma development:** At early stages, the mushroom looks like an egg of white colour as it is enclosed within a membranous universal veil. The veil progressively raptures at the top and the pileus appears developing to the umbrella like form with distinct cap and stem.
**Pileus (cap):** 5-15 cm wide when fully expanded, initially almost hemispherical, soon convex or somewhat conical, later expanded to almost plane; yellowish green, olive green, yellowish brown, olivaceous grey, greenish brown, rarely almost white; smooth, slightly viscid, silky, with characteristic radiated innate fibrils or streaky appearance, not striate at the margin; cuticle separable, rarely with white velar remains, appearing as large, thick, membranous patches (Figs. 1 & 2).

**Lamellae (gills):** Free, fairly crowded, white, with yellowish green reflexion at maturity.

**Spore print:** White.

**Stipe (stem):** 5-15 (-20) × 1-2.5 cm, cylindrical, narrowing at top, with somewhat swollen base; white, or often with strips of zig-zag like ornament, colour same as pileus, greyish green, or yellowish green. Ring (annulus) is white, membranous and thick, slightly striated on the upper side. The base of the stem is emerging through an ample sack-like volva; white, membranous, persistent, adhering to the whole bulbous base of stem but free at the upper part.

**Context (flesh):** White and firm; smell at the beginning sweet resembling honey or rose petals, then becoming stronger and unpleasant; taste (not to be tested!) somewhat acidic, but not unpleasant.

**Habitat/ ecology:** In Greece, Italy and Bulgaria almost exclusively in broadleaved oak, beech, chestnut, hazel woods, also with evergreen oaks (*Quercus ilex*), rarely in pine forests.

**Distribution:** Common throughout the mainland of Greece and known also from several islands (i.e. Euboea, Andros, Lesvos, Ikaria, Crete). In Italy, it is widely
distributed in all regions and in some surrounding islands. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 3, 5(w, e), 6, 7, 8, 15, 16(w), 17(e), 20 (please see explanatory note at the end of this Chapter).

**Fruiting-season:** It fruits from spring (May) and during summer in north Greece and Italy and higher elevations, more commonly in autumn and up to December in lower altitudes and the islands.

**Possible confusion**

When basidiomata of this species are developed and the typical colours are evident, then it is easy to identify *A. phalloides* if the typical characteristics of the genus are noticed, i.e. the white free gills, the pendulous membranous white ring and the ample sac-like volva. Among the edible species described in this publication, only some greenish forms of *Russula cyanoxantha* might resemble *A. phalloides* but only superficially since *Russula* species possess nor a ring neither a volva and their stem is characteristically brittle (it breaks up like "a piece of chalk"), and it is never fibrous as it is the case for all *Amanita* species. White forms of *A. phalloides* can easily be misidentified for some all-white *Agaricus* species that may be found within forests if the volva is not noticed (as it might be the case in their initial stages of development), while the gills are still white and have a very similar appearance. However, neither *Agaricus campestris* nor *A. urinasens* can be found within woody habitats. When *A. phalloides* is still at the stage of the “egg” it might be confused with *Amanita caesarea* if the “egg” is not cut lengthwise for noticing the typical orange pileus colour and yellow gills of the latter species.
2. *Amanita verna* (Bull.) Lam.

**Etymology:** From Latin word “Veris” (= spring) and the derived adjective “vernus” (= pertaining to spring) because of the common appearance of this species during spring.

**Common Greek names:** Not existing.

**Common Italian names:** Tignosa di primavera.

**Common Bulgarian name:** Бяла мухоморка (Byala mouhomorka).

![Fig. 3. Amanita verna (photo by G. Konstantinidis).](image)

**Description**

**Basidioma development:** As in *Amanita phalloides*. 
**Pileus (cap):** (4-) 6-8 (-11) cm wide when fully expanded, initially almost hemispherical, soon convex or somewhat conical, later expanded to almost plane; pure white or whitish cream; smooth, slightly viscid in wet conditions, silky and dry otherwise, not striate at the margin; cuticle separable, rarely with white velar remains, appearing as large, thick, whitish membranous patches (Fig. 3).

**Lamellae (gills):** Free, fairly crowded, white.

**Spore print:** White.

**Stipe (stem):** 4-10 (-12) × 1-2 (-4 at base) cm, cylindrical, narrowing at top, always with an almost abruptly bulbous almost spherical base; white all over; smooth or with fine scales; the ring is pending, white, membranous thin and not very persistent, fragile and tearing at maturity; volva white, membranous, fragile, adhering to the bulbous base of stem but free at the upper part.

**Context (flesh):** White and firm, then softer, smell and taste weak and indistinguishable.

**Habitat/ecology:** In Greece and Italy, it is known from broadleaved woods of oak, chestnut and evergreen oak (*Quercus ilex*). In Bulgaria, it is found in broadleaf, mixed and coniferous forests.

**Distribution:** Uncommon in Greece and Italy, known in the mainland from the north of the country to Peloponnese and from the Euboea and Lesvos islands. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 5(e), 15, 17(w), 20.

**Fruiting-season:** It fruits in spring (April -May) till early autumn (October).
3. *Amanita virosa* (Fr.) Bertill.

**Etymology:** From Latin adjective “virosus” (= stinking, poisonous) because of the bad smell and its early recognized toxicity.

**Common Greek and Italian names:** Not existing.

**Common Bulgarian name:** Мигилева мухоморка (Mirizliva mouhomorka).

![Fig. 4. *Amanita virosa* (photo by M. Biraghi; source: http://www.funghiitaliani.it).](image)

**Description**

**Basidioma development:** As in *Amanita phalloides*.

**Pileus (cap):** 3-8 (-11) cm wide when fully expanded, hemispheric when young, soon conical to bell-shaped, finally convex, or almost plane but with a broad umbo, not
symmetric (with an irregular shape, not circular, often lobed); white, sometimes pale cream, or with yellowish or pale orange tints in the centre when aged; smooth, viscid in wet conditions, silky and shiny when dry, not striate at the margin; cuticle separable, without velar remains, or with some patches left on the margin of the developing cap (Fig. 4).

**Lamellae (gills):** Free, fairly crowded, white, or creamy.

**Spore print:** White.

**Stipe (stem):** 4-10 (-12) × 1-2 cm, compact or with a hollow pith; cylindrical, narrowing at top, enlarged at base to a bulbous almost spherical or egg-like shape; white all over; surface characteristically fibrous to floccose or scaly below the ring, scales sometimes robust, arranged in concentric rings and somehow overlapping each other; ring is pending, white, membranous thin and not persistent, fragile and often collapsing at maturity; volva white, sometimes with a pinkish tint at maturity, membranous, adhering to the bulbous base of stem but free at the upper part, very fragile and usually collapsing against the stem base.

**Context (flesh):** White, thin and delicate; smell like old roses or honey but not pleasant; taste said to be bitter.

**Habitat/ecology:** It was rarely recorded in Greece, in fir forests and chestnut orchards. In Italy, it is collected in wet conifers and broad-leaved woods, particularly on siliceous soils. In Bulgaria, it is found in broadleaf, mixed and coniferous forests.

**Distribution:** Rare in Greece, known from Mt. Parnitha (Attica), Mt. Dirfys (Euboea), and from Mt. Oxya (Fthiotida). Infrequent but abundant in several regions of Italy. In Bulgaria, it is found in the floristic regions encoded as follows: 16(w), 17(c).
**Fruiting-season:** Spring-Autumn.

**Possible confusion**
All white forms of *Amanita phalloides*, *A. verma* and *A. virosa* can easily be confused with purely white *Agaricus* species that exist in woods; Therefore anyone who collects mushrooms in forests must be extremely careful with all white mushrooms having this typical form. The basidiomata should be carefully removed from the forest soil and then checked for the presence of a volva which is the most critical diagnostic feature of the genus *Amanita*. Especially for *A. virosa* more caution must be taken to identify the remnants of the volva (if it has already collapsed).

**Notes on toxicity**
*Amanita phalloides*, *A. verma* and *A. virosa* are all deadly poisonous species, notably the most dangerous among all mushrooms They are responsible for more than 90% of the fatal poisonings from mushroom consumption. Their toxicity and fatality does not change if cooked, dried or frozen. More than twenty different poisonous compounds have been identified from these mushrooms, known with the general term amatoxins. The severity of poisoning and the chances of survival depend on the amount consumed; generally less than one gram of mushroom per kilo of body weight can be fatal for an adult.
4. *Lepiota subincarnata* J.E. Lange

*Lepiota brunneoincarnata* Chodat & C. Martín, *Lepiota castanea* Quél.,

*Lepiota helveola* Bres., *Lepiota pseudolilacea* Huijsman

Common Greek, Italian and Bulgarian names: Not existing.

![Image of Lepiota subincarnata](photo by E. Polemis).

**Fig. 5. Lepiota subincarnata** (photo by E. Polemis).

**Description**

**Basidioma development:** Initially mushrooms look like small pins with brownish colour, the pileus is almost hemispherical with rough reddish-brown surface, its margin is inrolled and fused with the stem. Later, the stem expands and the cap opens revealing the white gills, while its skin raptures and the surface is covered with small pinkish scales on a light pinkish-cream background (only at centre the skin remains uniformly pinkish-red to reddish brown).
**Pileus (cap):** 2-5 (-7) cm wide when fully expanded, hemispherical when young with inflexed margin, then convex with or without a shallow umbo and finally almost plane with straight margin; initially uniformly reddish-brown, but soon scaly except for the centre that remains intact, with minute scales of pinkish colour on a pale pinkish-cream background, paler towards the margin; margin with white remnants of veil when young (Fig. 5).

**Lamellae (gills):** Free, moderately crowded, white or creamy when mature.

**Spore print:** White.

**Stipe (stem):** 2.5-5 (-6) × 0.5-0.7 (-1) cm, compact with a hollow pith, almost cylindrical or slightly enlarged towards the base, white all over; on the upper half fibrous, pale cream or pinkish, the lower half starting from approx. the middle with girdle- or ring-like zones of pinkish brown scales on a whitish cream background.

**Context (flesh):** White, thin, smell sweetish, taste unpleasant astringent.

**Habitat/ecology:** It was rarely reported in Greece, in parks, gardens and deciduous oak forests, on humus and organic-rich soil. In Italy, it is reported from conifer and broad-leaved woods.

**Distribution:** Rather rare in Greece, known from the continental part and from some Aegean islands. Widely distributed in Italy. Not recorded in Bulgaria.

**Fruiting-season:** Fruiting in autumn from October until December.
Related species

*Lepiota brunneoincarnata* Chodat & C. Martín: Similar to preceding species differing by the more conical shape and darker brown colour of the cap whose skin also breaks up to form concolorous scales, and by the somewhat broader (0.5-1 cm) stem that also possesses a dark brown ring zone, scales and girdles on its lower half. It is equally uncommon to rare in Greece, known from Makedonia and the island of Lesvos, fruiting in summer and autumn (until November); it appears in parks and forest margins on humus. In Italy, this is a common species growing also in parks and gardens. In Bulgaria, it is found in the floristic regions encoded as follows: 5(c), 17(e).

*Lepiota castanea* Quél.: This a far more common species in Greece and Italy, and it can be found in broadleaved and coniferous forests, in humid humus rich and calcareous soils during summer and autumn (until December). It is even smaller than the previous species, with pileus not exceeding 4 cm in diameter, similarly scaly when expanded and of orange brown colour; the stipe is up to 5 cm long and 0.6 cm broad with scales of the same colour as cap. In Bulgaria, it is found in the floristic regions encoded as follows: 6, 8, 18.

---

*Fig. 6. Lepiota helveola* (photo by E. Polemis).
**Lepiota pseudolilacea** Huijsman: A rather uncommon species as well in Greece, it was recorded in the north part of the mainland as well as in some Aegean islands, in various forests and grassy places under trees. It produces very small fruit bodies with a cap hardly exceeding 4 cm in diameter and stem up to $5 \times 0.3$ cm; the cap has purple brown scales and the stem bears a rather prominent but narrow and transient ring. In Bulgaria, it is found in the floristic regions encoded as follows: 7, 19.

**Lepiota helveola** Bres.: A Mediterranean species that is only known in Greece from two collections in Andros island in a seashore grassland in November, and by a rural roadside on bare soil. It resembles *L. pseudolilacea* in many aspects (colour and even smaller size) (Fig. 6). In Italy, *L. helveola* is a common species growing in the clearings of the woods. In Bulgaria, it is found only in the floristic region ‘19’.

**Possible confusion**

Mushrooms of the genus *Lepiota* may be confused with some edible *Macrolepiota* species with a pileus smaller than 10 cm in diameter. However all *Macrolepiota* species have a larger stem with bulbous bas, with a very characteristic prominent ring that is membranous and detachable from the stem, so that can be moved up and down on it. The choice *Macrolepiota procera* is much bigger in size with a unique decoration on the stem that resembles snakeskin and it is rather impossible to be confused with the tiny sized species of the genus *Lepiota*.

**Notes on toxicity**

All the *Lepiota* species that are referred above contain amatoxins, even in larger concentrations than in *Amanita* species; therefore they are all dangerous and even deadly poisonous mushrooms. However due to their small size there are rarely collected and poisoning from these mushrooms is extremely rare.
Amatoxin Poisoning Symptoms

Symptoms following the ingestion of amatoxin-containing mushrooms occur in four phases. No symptoms usually appear for the first 6 and up to 24 hours post-ingestion. Gastrointestinal phase is starting after that period and is characterized by abdominal pain, vomiting and severe diarrhea. Period of “well-being” starts in 24 to 48 hours post-ingestion. This phase is very dangerous as usually the victim thinks that has overcome poisoning, while the hepatic and renal function deteriorates. If within the first 48-72 hours of poisoning the victim has not been hospitalized and the poisoning has not been diagnosed, then the last and most serious phase cannot be avoided. Hepatic phase starts within 3 to 5 days post-ingestion, this means that serious hepatic and renal failure takes place and death is very likely to occur after 6 to 16 days.

Amatoxin Poisoning Treatment

As soon as symptoms of the gastrointestinal phase appear, the case of being poisoned by amatoxin-containing mushrooms must be considered, the victim should be attended by a physician and a mycologist should be notified, if possible, about the incident for examining any mushroom remains. If there even a slight possibility that amatoxin-containing mushrooms have been consumed, the patient must be transferred to the hospital as soon as possible. A special treatment based on the use of an antidote, namely ‘sylbin’, can help in such poisonings, but only if the hepatic failure is in its early stages, otherwise death can be hardly avoided.
POISONOUS MUSHROOMS RESPONSIBLE FOR THE
“PANTHERINE SYNDROME”

*Amanita pantherina* (DC.) Krombh.

*Amanita muscaria* (L.) Lam. *var. muscaria*

**Etymology:** From the Latin word “panthera” derived from the Greek “panther” (= the homonymous wild animal) because of the spotted brownish cap.

**Common Greek names:** For both *A. pantherina* and *A. muscaria*: “zarnitsevo” (of slave Macedonian origin Kilkis); “roditis” (Pieria); “l lokal manitis” (Andros); “zourlomanitaro” (many places) for *A. pantherina* “alafomanitaro” (Rhodos); “kafe zourlomanitaro” (unconfirmed origin).

**Common Italian names:** Tignosa bigia, Tignosa rigata, Agarico panterino.

**Common Bulgarian name:** Пантерка (Panterka).

Figs. 7 & 8. *Amanita pantherina* (photos by E. Polemis).
Description

**Basidioma development:** In the early stages, the mushroom looks like an egg or ball of white colour, enclosed within a universal veil consisting of shallow densely distributed pyramidal warts that are soon disrupted and reveal the brown cap cuticle. As the cap grows bigger the warts are more loosely distributed throughout its surface and at the same time the pileus develops to the umbrella-like form with distinct cap and stem with a ring and a tight volva at base.

**Pileus (cap):** 5-12 cm wide when fully expanded, initially almost hemispherical, soon convex, later expanded to almost plane; dark brown, hazel-brown to pale ochraceous brown; cuticle separable, with white warts that are easily removed, smooth underneath, viscid and shiny when wet, but soon drying and mat, clearly striate at the margin (up to 15% of the radius) (Figs. 7 & 8).

**Lamellae (gills):** Free, crowded, white, greyish at maturity.

**Spore print:** White.

**Stipe (stem):** 5-15 (-20) × 1-2.5 cm, cylindrical, narrowing at top, enlarged towards the base, which is bulbous round, onion or egg like; white all over; surface finely floccose, later smooth above the ring, remaining slightly floccose below, sometimes with scales forming ring-like zones close to the base. The ring is white, membranous, narrow and soon collapsing to the stem, smooth; volva white, membranous, fragile, tight, ending to a collar on the joint of the stem, like a rolled sock.

**Context (flesh):** White and firm; smell weak of humus or radish like; taste mild indistinguishable.
**Habitat/ecology:** In broadleaved oak (also with evergreen oaks, i.e. *Quercus ilex*), in beech, chestnut, hazel, and coniferous fir and pine forests.

**Distribution:** Common throughout mainland Greece and Italy, and known also from several islands (i.e. Euboea, Andros, Lesvos, Ikaria, Rhodos, Aeolian Archipelago, Tuscany Archipelago, Pantelleria). In Bulgaria, it is found in the floristic regions encoded as follows: 1, 2, 5(w, e), 6, 7, 8, 15, 16(w), 17(w, c, e).

**Fruiting-season:** It fruits in spring (May), during summer in north Greece and Italy and at higher elevations, more commonly in autumn and up to December in lower altitudes and in the islands.

**Possible confusion**
None of the edible mushrooms mentioned in the accompanying report could be confused with *A. pantherina*. Only in rare occasions, the purely violet brown coloured pileus of *Russula cyanoxantha* can be reminiscent of an *A. pantherina* basidioma with the warts whipped off, looking brown and smooth above; in such cases, the consistency of the stem, the absence of ring and volva are clear distinguishing characters. Other edible species of the genus *Amanita*, e.g. *A. rubescens* could be more easily confused with *A. pantherina* therefore it is wise for someone not to collect them for eating without knowing them really well.

**Related species**
*Amanita muscaria* (L.) Lam. var. *muscaria*: the common “fly-agaric” is one of the most famous mushrooms worldwide; it is widespread in most mountains of Greece in broadleaved and coniferous forests. In Bulgaria, it is found in the floristic regions encoded as follows: 5(w), 6, 8, 14, 15, 17(w, c). Thanks to its bright red cap with the
white warts it is unique and very easily distinguishable. Nevertheless, it is not rare to find pilei without warts on their upper surface and a faded red to orange colour due to the effect of a heavy rain. In such a case, it could be confused with *Amanita caesarea*, however the yellow gills, the yellow stem and the large and loose saccate volva are clear distinguishing characters of the latter edible species since *A. muscaria* possess always white gills and stem as well as a volva which is merely a bulb with a ring of warts on the joint of the stem (Figs 9 & 10).

![Figs. 9 & 10. *Amanita muscaria* (photos by G. Koutrotsios & E. Polemis).](image)

**Notes on toxicity**

Both *Amanita pantherina* and *A. muscaria* are responsible for the “pantherinic syndrome” poisoning caused by toxins that affect the central nervous system. The main and characteristic effect of this poisoning are the mild to severe hallucinations, but several other side-effects are also common. The toxicity of individual pilei of those Amanitas is very variable. In general *A. pantherina* is much more potent and has been accused for some fatalities as well, while *A. muscaria* poisoning is not reported to be fatal.
Pantherine Syndrome Symptoms

The set of symptoms may be described as follows (they may vary considerably): first effects appear 30 minutes to two hours after consumption and may be nausea and vomiting; later confusion and delirium, incoordination and dizziness, progressive deep coma-like sleep, with hallucinations or visual distortions follow. In more severe poisonings from *A. pantherina*, muscle fasciculation with cramps and spasms and rarely generalized seizures may be encountered. Usually the duration of symptoms is 8 to 24 hours and may be followed by hangover headaches.

Pantherine Syndrome Treatment

The key elements in the treatment of the pantherinic syndrome are:

- Avoid overtreatment
- Emesis or stomach lavage within the first four hours of ingestion
- Activated charcoal
- Providing supporting care
POISONOUS MUSHROOMS RESPONSIBLE FOR THE
“GASTROINTESTINAL SYNDROME”

1. *Agaricus xanthodermus* Genev.

*Agaricus moelleri* Wasser

**Etymology:** From the Greek words “xanthos” (= blond) + “derma” (= skin); because of the intense yellow discolouration of the cap skin when bruised.

**Common Greek and Italian names:** Not existing.

**Common Bulgarian name:** Карболова печенка (Karboleva pechourka).

![Fig. 11. Agaricus xanthodermus (photo by E. Polemis).](image)
Description

**Basidioma development:** A large fleshy mushroom, which has a similar development with other *Agaricus* species with thick, persistent ring on stem and gills that remain whitish for quite a long time during development.

**Pileus (cap):** 5-12(-15) cm wide when fully expanded, initially hemispherical or more commonly trapezoidal, then convex with inrolled margin, later expanded to almost plane, variable depending on shading; shaded pilei may be pure white or creamy white, but more typically greyish brown at centre, silky-fibrous, with or without fibrils ending to a smooth white margin; it readily discolours and becomes intensively yellow when bruised; margin overhanging fimbriate to denticulate (Fig. 11).

**Lamellae (gills):** Remotely free, very crowded, white, then greyish-white, pink, progressively brown and finally dark blackish-brown. Gill-edge white coloured and even.

**Spore print:** Dark purple-brown.

**Stipe (stem):** 6-12 (-15) × 1-2 (-2.5) cm, compact or with hollow pith, slender, almost cylindrical to slightly club-shaped, often with enlarged to almost bulbous base; white and smooth, shiny above the ring, sometimes yellowing when bruised especially at the base. The ring is wide, membranous, rather thin and floppy, pending, white, smooth above and below but fleecy near the margin which is conspicuously thickened with a "double lip", intensively yellowing when handled.
**Context (flesh):** White and firm at first, discolouring faintly yellowish, but strongly at the base of stem, when cut; smell strong unpleasant of ink, iodine or carbolic; taste similar disagreeable.

**Habitat/ecology:** Scattered, gregarious or in broad arcs in a variety of habitats; under conifers, hardwoods, forest clearings, in rich grasslands and in gardens.

**Distribution:** Common throughout mainland Greece and Italy as well as in many islands. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 5(c), 7, 16(e), 17(w, c), 18.

**Fruiting-season:** It fruits in spring (from April) until late autumn (December).

**Related species**

*Agaricus moelleri* Wasser: this is a much smaller mushroom with a cap hardly exceeding 8 cm in diameter and stem up to $8 \times 1.5$ cm. The cap is dark greyish brown at the centre and the rest is covered with minute fibrillose scales (Fig. 12). It has similar colour changes on the cap surface, ring and the flesh and it smells and tastes exactly as *Agaricus xanthodermus*. It is more commonly found in mixed woods or under shrubs, in parks and gardens as well, on rich humus, in humid places. It is a common species throughout Greece and Italy as well. In Bulgaria, it is found in the floristic regions encoded as follows: 16(w), 17(w, c), 18, 19, 20.
Possible confusion

All species of the genus *Agaricus* are edible and mostly of good quality except *A. xanthodermus* and related species that are often toxic, although not very dangerous, and therefore they must be always avoided. The overall resemblance of *Agaricus* species make it quite possible that some of these toxic species to be confused with the edibles. The key characters that distinguish all toxic *Agaricus* species are the intense yellowing on the cap margin, the ring and the flesh of the stipe base and secondly their typically strong carbolic, ink-like smell. It is always advisable to test the smell of any *Agaricus* basidiomata, by crushing the base of stem and check for the possibility to possess such a discriminating unpleasant smell before putting it to the basket.

Notes on toxicity

*Agaricus xanthodermus* and related species are mushrooms that may cause mild gastrointestinal poisoning. The toxin is said to be phenol, however it has been reported that some individuals eat them without any symptoms. Anyway, it is advisable to avoid consuming them.

= *Entoloma lividum* Quél.

**Etymology:** From the Latin word “sinuatus” (= sinuate, wavy); describing the wavy margin of pileus.

**Common Greek names:** Not existing.

**Common Italian names:** Agarico livido.

**Common Bulgarian name:** Отровна сливовка (Otrovna slivovka).

---

**Description**

**Basidioma development:** Young mushrooms have a conical to convex cap with distinctly incurved margins, which soon becomes almost flat with irregularly wavy
margin; the gills are yellowish at first then with a flesh-pink or salmon tint due to the ripening of the spores.

**Pileus (cap):** 3-15 (-25) cm wide when fully expanded, conical to convex at first, later plane, with or without a broad shallow umbo; pale livid-grey, ochraceous-grey, or cream; surface smooth and shiny; margin inrolled at first, finally often irregularly concave and wavy (Fig. 13).

**Lamellae (gills):** Adnate to emarginated, moderately crowded, relatively broad, yellow at first then salmon-yellow, ochraceous-pink but retaining the yellow colour for long especially at their margins.

**Spore print:** Pink.

**Stipe (stem):** 4-15 × 0.5-2 (-3.5) cm, cylindrical often distinctly swollen towards the base (which however gets thinner at its apex), straight or bended, sometimes compressed; often eccentrically attached to the cap; white or tinged cream to greyish as the cap; surface mealy at top, smooth downwards with minute; compact, firm and hard-fleshed at first then becoming softer and hollow.

**Context (flesh):** Firm at first and then softer. Odour strong, unpleasant acidic or floury; taste mild but disagreeable.

**Habitat/ecology:** Solitary or in small groups in deciduous forests, preferably oak and beech.

**Distribution:** Uncommon in Greece but widespread throughout the mainland, known from the islands of Euboea, Andros and Crete as well. Widespread in several Italian
regions. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 5(w), 7, 8, 15, 16(w), 17(c), 20.

**Fruiting-season:** It fruits from late spring (May) until autumn (November).

**Possible confusion**

*Entoloma sinuatum* as well as all fleshy species belonging to the genus *Entoloma* should be considered toxic or potentially toxic. Their main diagnostic features are the following: gills are attached to the stem typically with a short decurrent tooth (emarginated), relatively broad and not very crowded, they may be white at first but always have a pinkish colour at maturity, and they produce a cinnamon or pink spore-print. Some *Entoloma* species fruit only in spring, e.g. *Entoloma clypeatum* (L.) P. Kumm. (Fig. 14), which often grows in rings under trees and shrubs of the family Rosaceae (with several fruit trees like prunes, almonds and cherries, being recorded in such orchards in Greece and Turkey). It is rather rare in Greece, reported from Mt. Pelion, Grevena and the island of Andros. Such species of *Entoloma* as well as other that also appear in spring are likely to be confused with *Calocybe gambosa* since they some features in common; however, *C. gambosa* gills never become pink, they are shallow and very crowded and the spore print that they produce is white.
Notes on toxicity

*Entoloma sinuatum* has been cited as being responsible for ca. 10% of all mushroom poisonings in Europe. Indicative cases are those recorded in Grevena (NW Greece) where 70 people required hospital treatment in 1983, or that Entoloma accounted for 33 out of 145 cases of mushroom poisoning within a five-year period at a single hospital in Parma (Italy). Poisoning is mainly gastrointestinal in nature. The identity of the toxin(s) is unknown, but chemical analysis has established that alkaloids are present in these mushrooms. On the other hand, *E. clypeatum* has a dubious reputation, considered by some as harmless (or even edible) or poisonous by others. The conclusion is that it is always better to avoid all *Entoloma* species.
3. *Omphalotus olearius* (DC.) Singer

**Etymology:** From the Latin word “olea” deriving from the Greek “elea” (= olive tree); meaning pertaining to olive tree.

**Common Greek names:** Not existing.

**Common Italian names:** Fungo dell’olivo.

**Common Bulgarian name:** Горчива миризливка (Gorchiva mirizlivka).

![Figs. 15 & 16. *Omphalotus olearius* (photos by E. Polemis).]

**Description**

**Basidioma development:** Initially mushrooms have convex dark brown caps that become reddish brown brick-coloured as they expand to become funnel shaped orange to yellowish orange; the margin is initially inrolled but unfolds becoming uplifted and somewhat wavy at the end.

**Pileus (cap):** 5-10 (-15) cm wide when fully expanded, initially convex with strongly inrolled margin, then flattens with unfolded margin, finally funnel shaped with uplifted wavy margin; dark reddish brown at first, brick coloured then, reddish ochre
or reddish yellow at the end; surface smooth and shiny, with innate fibrils, marginally cracked with age and in dry conditions (Figs. 15 & 16).

**Lamellae (gills):** Deeply decurrent, crowded, often forked close to the stem, yellow or yellowish orange, edges smooth. A special feature of the gills of this mushroom is that they are known to glow in the dark showing bioluminescence.

**Spore print:** White.

**Stipe (stem):** 4-15 × 1-2 (-3) cm, central or eccentric; cylindrical, tapered towards the base, sometimes rooting spindle-shaped, compact; yellow or yellowish orange; surface fibrous finely hairy or scaly.

**Context (flesh):** Yellow or yellowish orange, darker in the stem, elastic; smell fragrant and pleasant; taste astringent, unpleasant.

**Habitat/ ecology:** In south Greece and Italy, it is a common weak parasite of olive trees; mushrooms grow in tufts on the base of trunks of living trees, or atypically they can appear on the ground under the trees but arising from roots. It is also known to colonize other broadleaved trees such as deciduous and evergreen oaks, eucalypts, chestnuts and hornbeams.

**Distribution:** Widespread throughout Greece (incl. all major islands), but it is more common in olive orchards in south Greece and in Italy. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 3, 5(w, e), 7, 16(w), 17(e), 18, 20.

**Fruiting-season:** It fruits from late spring (May) but more commonly in autumn (until November), known to be a rather warm loving species.
Possible confusion

*Omphalotus olearius* can be confused with *Cantharellus cibarius* because of the similar colours and the more or less funnel-like shape common in both mushroom species. However, the true gills of *Omphalotus* are easily discernible as opposed to the vein-like “pseudo-gills” of all *Cantharellus* species; furthermore, the flesh of *Omphalotus* is yellow or orange while in *Cantharellus* is white.
4. **Boletus satanas** Lenz


**Etymology:** The meaning of the word “satanas” (= Satan) is obvious and refers to the poisonous nature of this species.

**Common Greek names:** for most of the red pored bolets: “sinaki” (Grevena, Kozani); “siniakas” (Chalkidiki).

**Common Italian names:** Porcino malefico.

**Common Bulgarian name:** Дяволска манатарка (Dyavolska manatarka).

![Fig. 17. Boletus satanas (photo by G. Koutrotsios).](image)
Basidioma development: when young the cap is more whitish and hemispherical becoming greyish or beige and flat in age; pores have somewhat dark/deep red colour at first and then become more reddish orange; the stem is initially almost spherical to barrel shaped and then club shaped; the flesh is firm and later becomes softer.

Pileus (cap): 6-20 (-30) cm wide, fleshy, initially hemispherical, then convex, later expanded to almost plane; variously and not uniformly coloured, whitish, greyish, beige to light brown often reddish at margin; smooth and silky, slightly viscid or sticky in humid weather, cuticle exceeding the margin slightly, not or hardly separable (Fig. 17).

Tubes/Pores: tubes emarginated, easily detachable from cap; yellowish, greenish yellow, rapidly bluing when cut. Pores roundish, very small, bright red to orange yellow close to the margin, becoming greenish blue and the blackening when bruised.

Spore print: olive-brown.

Stipe (stem): 5-10 (-15) × 4-6 (-10) cm, robust and fleshy, mostly barrel-shaped in young basidiomata, then club-shaped, often enlarged to a markedly bulbous base; yellowish at top, scarlet red the rest of the surface and decorated with a fine yellowish red reticulum.

Context (flesh): Very thick and firm in young basidiomata, becoming softer as they mature; whitish, yellow to ochre, bluing faintly when cut; odour disagreeable like rotting flesh (especially in old basidiomata), taste mild.

Habitat/ecology: In Greece, it is mainly reported from dry oak forests, and only once in association with chestnut. It appears solitary or scattered and prefers calcareous
soils. In Italy, it is reported as widely distributed in several woods including chestnut. In Bulgaria found in warm broadleaf forests, under oaks.

**Distribution:** Uncommon in Greece known from Makedonia, Epirus and Peloponnese. An infrequent species in Italy. In Bulgaria, it is found in the floristic regions encoded as follows: 5(w, e), 7, 8, 15.

**Fruiting-season:** It is a warm-loving species that fruits during summer and early autumn.

**Conservation status:** Vulnerable in Bulgaria.

**Possible confusion**

All good edible bolets like *Boletus edulis* and its allies have either white, yellow, or greenish yellow pores, their flesh is white and never become blue when cut, therefore confusing them with *B. satanas* and other red-pored bolets is not likely to happen.

Although there are some red-pored bolets that are edible, it is advisable to avoid them and consume the easily identifiable species of the *B. edulis* group.
Related species

All red pored Boletus species (referred above) incl. Boletus rhodoxanthus (Fig. 18) are more or less similar in possessing red to purplish red pores, yellow to greenish yellow tubes which are bluing on handling, white or yellowish flesh that turns variously greenish blue when cut, yellow or reddish yellow stems with a fine to coarse red to purplish red reticulum. The colour of pileus may vary considerably both between and within species. They can be found in both broadleaved and coniferous forests and most of them are uncommon to rare. In Bulgaria, B. rhodopurpureus is found in warm oak forests in the floristic regions encoded as follows: 1, 16(w), 19 (an Endangered species); B. rhodoxanthus is also known from warm broadleaf (oak, beech, sweet chestnut) forests, recorded from the following regions: 1, 5(w), 9, 15, 16(w), 17(e) (an Vulnerable species); B. legaliae is known from broadleaf forests, under oaks from the following regions: 1, 6, 7; and B. luridus – from broadleaf, mixed and coniferous forests, parks and gardens, occasionally also under solitary trees and shrubs in lawns, from the following regions: 1, 2, 5(w, c, e), 7, 8, 14, 15, 16(w, e), 18.
Notes on toxicity

*Boletus satanas* and its allies are more or less toxic mushrooms that can cause rather mild gastrointestinal poisonings. One of its toxic compounds that was isolated is a very stable glycoprotein called bolesatine, which is known to inhibit in vitro protein synthesis in cells; however, it is not clear if it is actually responsible for the gastrointestinal irritation observed in people that consumed *B. satanas* mushrooms. Poisoning from *B. satanas* is not common as it is rarely collected because of its bluing flesh and disagreeable odour. Even if *B. satanas* is reported as edible (when cooked well) in parts of Italy and the former Czechoslovakia, it is prudent to avoid all members of this group.


**Etymology:** The genus name derives from the Greek words “skliros” (= hard, tough) + “derma” (= skin) referring to the tough leathery skin (peridium) of all species of the genus.

**Common Greek names:** Not existing.

**Common Italian names:** Vescia, Pet ed lov.

**Common Bulgarian name:** Обикновена лъжлива пърхутка (Obiknovena luzhliva purhoutka).

![Fig. 19. Scleroderma citrinum](www.virtualmuseum.ca)

**Description**
**Basidioma development:** The mushrooms develop at first underground and have an almost spherical, potato-, or pear-like shape; pileus and stem do not exist and there is no free fertile surface like gills, tubes or spines. Later they start appearing on the soil surface (at the beginning) still closed and eventually (in full maturity) the skin develops a hole at the top of the basidioma while the internal part degenerates to a dark greyish brown to purplish black spore-mass.

**Basidiomata:** They usually grow 3-8 (-12) cm in diameter; almost spherical, or flattened with a potato-like shape, often with a basal wrinkle that leads to a stem-like apophysis. The skin is leathery, elastic and 2-4 mm thick (thicker towards the basal part) ochre-whitish turning reddish when cut; surface dark to lemon yellow, to ochre yellowish with yellowish brown spots at maturity, initially almost smooth but soon cracked into a polygonal mosaic form, finally presenting uplifted flakes, in maturity with a roundish or irregular opening at top (Fig. 19).

**Spore mass:** Dark greyish brown to purplish black.

**Stipe (stem):** There is no stem but the base of the basidioma is often wrinkled towards a thick mass of mycelium expanding into the ground.

**Context (flesh):** The flesh is the fertile part of the mushroom and remains enclosed until the end of its development. It is yellowish white, in the very young still subterranean basidioma, but it soon turns purplish red and as soon as the basidioma emerges from the ground the surface becomes purplish black, marbled with white strands. The flesh is very tough and remains so until full maturity when it turns to a greyish-purplish black spore mass.
**Habitat/ecology:** It fruits solitary or in small groups, and it is a symbiotic ectomycorrhizal species which can be found within various hardwood and coniferous woods.

**Distribution:** It is a continental to boreal species, rather uncommon in Greece (it was reported from north and central Greece in oak and beech forests). Widely distributed in Italy. In Bulgaria, it is found in the floristic regions encoded as follows: 1, 2, 6, 7, 8, 14, 16(w), 17(w, c).

**Fruiting-season:** It fruits in autumn (September to November).

**Possible confusion**

All species of the genus *Scleroderma* may hardly be confused with edible mushrooms that form similar spherical basidiomata (e.g. members of the genera *Calvatia*, *Lycoperdon* or *Bovista*). In fact their similarity is only superficial as the tough leathery skin as well as the purplish black flesh are very clear differentiating characters; in all edible “puff-balls” the skin is much thinner, paper-like and the flesh is white when the basidiomata are still fresh. In addition, *Calvatia gigantea* is always much bigger in size than all *Scleroderma* species and it is found in completely different habitats, namely open grasslands of mountain plains.

Sometimes *Scleroderma* species may resemble truffles, because of the colour of their flesh. However, truffles never have such a leathery skin and they are always characterised by their unique odour. Furthermore, truffles are developed entirely underground, while *Scleroderma* species always appear over the soil surface at least at their late stages of development.

**Related species**
Species of the genus *Scleroderma* share some common features, i.e. their tough leathery skin, the dark purplish black and hard flesh, marbled with white strands or network and they occur in woods in association with conifers, hardwoods and shrubs. *Scleroderma cepa* is very similar to *S. citrinum* but sometimes it presents a larger stem in the form of an appendage at its base projecting into the ground. Moreover, it is a more warm-loving species and its occurrence is largely confined in Greece (it is recorded to date only in the Mediterranean pine and evergreen oak woods of Attica and Andros); not recorded from Bulgaria. The commonest species in Greece is *S. verrucosum*, which differs from *S. citrinum* in having a stem-like ending at the bottom of the basidioma that leads to a dense mass of thick strands developing underground, while the spherical part is lying above the soil surface. It is known from chestnut, oak and fir forests as well as from Mediterranean scrublands with evergreen oaks. In Bulgaria, *S. verrucosum* is found in forests, scrubland, parks and gardens in the floristic regions encoded as follows: 1, 4, 5(c, e), 6, 7, 14, 15, 16(w), 17(w, c, e), 18. *Scleroderma bovista* and *S. meridionale* are closely related species characterized by a skin 3-8 (-10) mm thick which in maturity splits up irregularly forming 5-7 rays; these either spread or have their ends turned under and they give a “star-like” appearance to the basidioma. Both species are found in sandy soils; the first is widely distributed in continental Greece but it is also recorded in some islands (Andros) in various hardwood and coniferous forests, while the second is a typical Mediterranean species known from Thessaly in oak and beech forest and from several islands (where it is common growing in association with evergreen oaks). Both species are widely distributed in Italy. In Bulgaria, *S. bovista* is found in the floristic regions encoded as follows: 1, 6, 8, 17(w), while *S. meridionale* is not recorded.
Notes on toxicity

*Scleroderma* species are all toxic mushrooms that can cause rather mild gastrointestinal symptoms. They are rarely collected, and only in the rare circumstances that they are eaten in large quantities they can cause serious stomach upsets including vomiting, diarrhea and abdominal pains.

**Gastrointestinal Poisoning Symptoms**

Although gastrointestinal poisonings may vary from one species to the another, in general they are never fatal, the symptoms begin from 15 minutes until 2 hours after the meal and last (in the majority of cases) from 8 to 12 hours, but they may linger on for a couple of days. Nausea, vomiting, diarrhoea and abdominal pains are the main symptoms that may be accompanied by a sense of anxiety with cold sweat, clammy extremities and tachycardia.
Gastrointestinal Poisoning Treatment

Since the majority of toxins are direct gastrointestinal irritants, removing them from the stomach as rapidly and completely as possible is the mainstay of treatment. Rapid resolution of the symptoms generally follows emesis or lavage. Activated charcoal is also helpful and intravenous fluids may be required when fluid loss from vomiting and diarrhea or both has been excessive (especially for children and elderly patients who are more vulnerable to dehydration). Antispasmodics can be used for the relief from abdominal pains.
MUSHROOMS RESPONSIBLE FOR THE “GYROMITRINE POISONING”

Gyromitra esculenta (Pers.) Fr.

Gyromitra gigas (Krombh.) Cooke, Gyromitra infula (Schaeff.) Quél.

**Etymology:** From the Latin words “esculentus” (= edible) although it is well known that it may be deadly poisonous this species was considered edible when first described in the 19th century.

**Common Greek names:** “Makaronaki” (Mt Pelion – Magnesia); “koutsoukaki” (Fokida); ‘pratomanitaro” (Euriatania); “artikomana” (Lesvos); “katsikokoilia” or “gidokoilia” (Achaia).

**Common Italian names:** Giromitra esculenta, Spugnola falsa, Marugola.

**Common Bulgarian name:** Обикновена дипленка (Obiknova diplenka).

Figs. 21 & 22. *Gyromitra esculenta* (photos by A. Saitta & E. Polemis).
Description

Ascoma development: The mushroom is divided into a cap and stem, however initially the cap envelops large part of the stem making it almost invisible. The cap looks like human’s brain with a reddish brown colour that darkens at places as it matures. The stem grows taller with age and becomes dirty ochre-brown when fully mature (Figs. 21 & 22).

Pileus (cap): 3-6 cm tall and 5-10 cm broad, generally globular but often irregular and shapeless, with many lobes and convolutions; the presence of swollen twisting veins makes it looking like human’s brain; the colour is at first yellowish brown, then chestnut-brown or reddish brown, often with darker blackish brown patches as it matures; it is hollow inside like a loosely folded up piece of paper.

Stipe (stem): 2-5(-6) × 1.5-4 cm, hollow and attached to the cavity of the cap, cylindrical, always thickened and with longitudinal folds towards the base; surface typically whitish to flesh coloured, darkening with age to ochre brownish, mealy, becoming scurfy when old.

Spore powder: Whitish.

Context (flesh): Whitish, thin, firm and elastic at first, becoming brittle with age, interior hollow throughout the ascome; odour pleasant and fruity when fresh, earthy to fungal, pleasant.

Habitat/ecology: Solitary, scattered, or in groups in coniferous forests, often around roots and trunks or in clearings on chippings and sawdust, in contact with rotten wood.
Distribution: common throughout mainland Greece and Italy. In Bulgaria, it is found in the floristic regions encoded as follows: 8, 10, 14, 15, 17.

Fruiting-season: Only in spring, it appears in Greece and Italy from late March (in low altitude pine-forests) until June (in mountainous black pine and fir forests).

Related species

_Gyromitra gigas_ (Krombh.) Cooke: It looks very similar to _G. esculenta_ except of being bigger in size with cap reaching 15 cm across and a much wider and more prominently folded stem 2-5 × 4-8 (-10) cm. It is rather common in Greece and Italy in coniferous forests (i.e. same habitats as _G. esculenta_), and it prefers sandy soils fruiting from April to June. In Bulgaria, it is found in coniferous or rarely in broadleaf forests in the floristic regions encoded as follows: 8, 15, 16; an Endangered species.
**Gyromitra infula** (Schaeff.) Quél.: Cap 3-15 cm high and 2-12 cm broad, initially saddle-shaped with the margin free, eventually the margin becomes fused to the stipe and grows together with other marginal areas, finally obtaining an irregularly globose shape; surface finely pubescent, smooth to undulating or weakly rugose, pale brown, gray-brown or chestnut-brown (Fig. 23). Stem to 10 x 3 cm, hollow, rubbery-brittle, surface pruinose or more irregularly roughened, pale tan often with a pinkish tinge and a sparse, yellowish (when dry) tomentum at base. Flesh pale gray, brittle, with weak and rather pleasant smell. It is found coniferous and deciduous forests, often along streams, commonly on rotten wood, but also on bare soil or among mosses. Common in mainland Greece and Italy, it fruits in autumn. In Bulgaria, it is found in coniferous forests in the floristic regions encoded as follows: 8, 14, 15, 17.
Possible confusion

_Gyromytra esculenta_ and _G. gigas_ are often found together at the same place and time with _Morchella_ species; therefore sometimes they are erroneously collected by inexperienced morel hunters (although the shape of the cap hardly resembles the honeycomb like cap of _Morchella_ species). _G. infula_ is more distant for the reason that it never appears in spring as all morels do.

Notes on toxicity

Despite its epithet "_esculenta_" and the fact that it was long considered as edible and it still collected and eaten in some areas, _G. esculenta_ is in fact a seriously poisonous species (and even potentially fatal). The toxicity of this mushroom can vary considerably as well as the sensitivity of a particular person. While some people always eat it, often regularly and in large quantities without any ill effects, several children have died after eating it for the first time. The toxic compound which is responsible for poisoning is an hydrazine called gyromitrin; it attacks the liver and destroys haemoglobin causing severe anemia. Even in the case when no signs of poisoning are discernible, the accumulation of this toxin by the liver makes someone more susceptible to future poisoning. Gyromitrin is very volatile and water-soluble substance, therefore it can be removed from mushrooms by drying and boiling. Some individuals who continue eating this mushroom boil it and discard the water twice before eating it. However, boiling hides another hazard for the person who cooks since if the kitchen is not well aerated it may become filled with toxic vapors. Drying the mushroom makes it much less poisonous because of the volatile nature of the toxin; however, it never becomes totally innocuous.
Gyromitrin Poisoning Symptoms

Gyromitrin poisoning has similar symptoms with those of amanitin poisoning, and they follow the same protracted path although the poisonous agent differs. After a latent period of 6 to 12 hours following the meal, symptoms of a very unpleasant gastrointestinal phase occur, lasting for 6 to 48 hours with abdominal fullness and pain, nausea, vomiting and diarrhea. For the majority of patients with gyromitrin intoxication, the illness never progresses beyond this stage, and spontaneous recovery occurs in a few days. Patients who are more severely poisoned develop signs of liver toxicity within 36 to 48 hours. The liver and spleen enlarge and the former becomes sensitive to palpation. For most patients, the two phases of illness merge imperceptibly; however, in a few individuals a period of relative well-being may precede the onset of hepatic toxicity. Intravascular haemolysis may also occur in certain cases leading to anemia in a similar way as it sometimes happens with the ingestion of fava beans. Renal failure also develops in some patients but rarely in this type of poisoning. Patients who have ingested large dose of gyromitrin go through terminal phase with neurological symptoms including fever, delirium, spasms, seizures, mydriasis and stupor. In such serious cases coma and death from respiratory and circulatory collapse follow within two or three days. Fatalities from gyromitrin poisoning happens in 14% of the registered cases.

Gastrointestinal Poisoning Treatment

A patient who suffers from gyromitrin poisoning could be treated by a physician if the symptoms are only gastrointestinal. However, it is wise to be hospitalized for dealing with possible hepatic toxicity and haemolysis. The key elements of the treatment are the following:
- Activated charcoal
- Fluid replacement
- Pyrodoxin (Vitamin B6): 100 mg/day
- Folic acid 20-200 mg/day
- Management of liver failure as for acute hepatitis
- Blood transfusion/exchange for haemolysis
- Diazepam for seizures
- Renal dialysis for kidney failure.
Explanatory Notes:


2. Conservation status for mushrooms in Bulgaria is based on Red Data Book of Republic of Bulgaria (Peev et al. 2011).

Literature cited and suggested


This page was left intentionally blank.
Chapter 4: Collection, processing, preservation and trading of wild edible mushrooms

Giuseppe Venturella and Maria Letizia Gargano

Department of Environmental Biology and Biodiversity

University of Palermo, Italy

October 2012
1. Collection of WEM

Because of their composition, all edible mushrooms are not easily/readily digestible. It is therefore necessary to follow some precautions to reduce the cases of discomfort as a result of their use for culinary purposes. First, the collector of mushrooms must be absolutely certain of the edibility of mushrooms. Basidiomata and ascomata that are very ripe, moldy or otherwise altered, invaded by pests or soaked in water should not be collected as well as mushrooms growing near pollution sources (landfills, waste piles, busy roads, crops, etc.).

For becoming an expert mushroom picker one needs time, dedication and modesty. For consuming wild mushrooms, giving them away or offering them as food to friends or family, one must be absolutely certain of what he/she collected. Clearly the difficulties and, consequently, the level of preparation that the collector of mushrooms must have, increase in proportion to the number of species that are to be recognized and used, since for each one of them not only the individual morphological characters but also those any similar species with which it might be confused should be known.

In Italy, the collector that has doubts about the edibility of mushrooms may contact the “Ispettorato Micologico” (Mycological Inspectorate) belonging to the “Unità Sanitaria Locale” (Local Health Company), where his/her basket of mushrooms could be checked for free. The Mycological Inspectorates were introduced in Italy with a Decree of the Ministry of Health of the Italian Republic. People who are interested to become a Mycological Inspector should attend a course of 240 hours (120 hours of theory and 120 hours of exercitations). During the course, participants attend lessons on edible and poisonous mushrooms (didactic material consists of fresh mushrooms for examination, slides, posters, etc.) in order to be able to recognize the essential features for identifying fungi. The final examination is composed of practical tests. Participants stay in front of a table on which various mushrooms selected by the Commission of Experts are placed. Each participant
should separate the mushrooms in three piles. The central pile is made of the edible fungi, on the right side the participant must put the poisonous specimens while on the left side he/she places the mushrooms that cannot be identified with certainty. The most serious mistake of the exam is to place a non-edible mushroom in the pile of the edibles.

On the field, collected wild edible mushroom should be cleaned of forest debris (without washing them) with a knife or brush. The mushrooms should be transported in rigid well-aerated containers as described by the pertinent Law. The mushrooms should be also stored in a cool and well ventilated area prior to their preparation.

There are six categories of mushrooms according to their edibility: a) deadly poisonous, b) toxic or poisonous, c) suspicious, d) not edible, e) poisonous when raw but edible when cooked and, f) edible.

The mortal poisonous species if swallowed can cause death of the individual, regardless of dosage. The severity of intoxication can vary depending on the species consumed, the amount ingested, the state of health of the person and other variables. The poisonous toxic species cause disturbances of various types and nature, but without causing death (except in cases of high dosages or high sensibility of the individual). Inedible mushrooms are those that cannot be eaten because of their bitter or spicy taste or tough consistency or unpleasant odor.

Some mushrooms are poisonous if they are eaten raw or if they are fried or grilled; instead they are edible if boiled for 20-30 min or if they are pre-boiled before cooked. Edible mushrooms are those that, if properly prepared, stored and consumed in moderation by adults in good health do not cause any disturbance.

For beginners or for people who collect mushrooms for personal consumption the most important rule that applies is to collect only mushrooms that they know and if in doubt refrain from the collection. It is also good not to spend too much time between harvesting and cooking. The mushrooms must be thoroughly cleaned from impurities (grass, earth residues, etc.). If the stipe is tough or the cuticle is sticky, they should be discarded right away at the time of collection.
2. Processing and preservation of wild edible mushrooms

The mushrooms should be cleaned with a damp cloth to remove debris/impurities, while washing with water is avoided since that might affect the flavor and aroma of mushrooms. Mushrooms invaded by insects should be discarded. In the case of “porcini” mushrooms (Boletus sp.), it is possible to use them after drying because this process drives away insects' larvae.

Consumption of raw mushrooms is possible (and even recommended for certain choice edible species) but it is advisable to be exercised with the following species only: Amanita caesarea, Calocybe gambosa, Coprinus comatus and Pleurotus nebrodensis. Raw truffles can also be eaten (i.e. Tuber aestivum, T. borchii, T. brumale, T. brumale var. moscatum, T. macrosorum, T. magnatum, T. melanosporum and, T. uncinatum) but in moderate amounts. There are cases of food intolerance and allergic reactions to people who had eaten raw Boletus of the edulis group.

For mushrooms that are toxic when eaten raw (e.g. Amanita rubescens, Armillaria mellea, Boletus luridus, etc.) cooking for at least 30 minutes or pre-boiling for 5-10 minutes in water is indispensable. Besides the usual cooking method for species that are not toxic when raw, other types of cooking could be used such as frying or grilling.

Cooked mushrooms are highly perishable and should be stored in a refrigerator at a temperature between 1 and 4 °C for short periods only.

In general, mushrooms consumption should always be practiced with moderation (especially when eaten raw), while children below 6 years, pregnant women and people with digestive problems or food intolerance it is better to avoid eating wild mushrooms.

Wild edible mushrooms are a seasonal product that appears within a limited period of the year. Most species appear roughly between April and November, but
the best season is autumn. However, in order to have them available throughout the year for culinary purposes, they should be preserved in the right way.

When drying is selected as preservation method, mushrooms must be fresh, in good condition and properly cleaned. They should be cut into thin slices (3-5 mm) then placed on a surface suitable for contact with food and left to dry under the sun. When weather does not permit natural drying (as it normally occurs in autumn), then an electric dryer for fruits and vegetables is useful. Once fully dried, the mushrooms must be placed in clean and dry containers, equipped with hermetic closure, in order to prevent absorption of air humidity and potential post-drying infestation by moths or other insects.

Alternatively, dried mushrooms could be stored in refrigerators (-18 °C, the water content in mushrooms is low and therefore freezing does not occur), always within bags or airtight containers. This system allows the maintenance of the original mushrooms' colors and flavors and protects them from the attack of pests.

Dried mushrooms could be preserved for 12-18 months. Before cooking, they are immersed in a sufficient quantity of warm water for a few hours. Not all species, however, are suitable for drying; for example *Cantharellus cibarius* mushrooms tend to become tough and do not absorb water well when rehydrated. It should be noted that the drying treatment never transforms toxic species to edible.

For freezing mushrooms, specimens must be thoroughly cleaned, washed and dried when fresh (these operations cannot be easily performed after mushrooms thawing). Then they should be cut to pieces in any not too small size, and placed in the freezer within suitable for food bags. When ready to be used, they should be put directly for cooking without defrosting, which would make them lose their texture and flavor.

The little fleshy mushrooms or mushrooms with soft flesh consistency are not suitable for freezing. *C. cibarius*, *Hydnum albidum* and *H. repandum* may instead obtain a bitter taste at the time of consumption. There are also species such as *A. mellea* that, if frozen without an adequate cooking pre-treatment (parboiling), may
be toxic even in the case when the heat treatment conducted after thawing is prolonged. For the above reasons it is recommended to freeze only fresh mushrooms that are fleshy, not too ripe and not very tough, such as those belonging to the genera *Boletus* and *Agaricus*.

Mushrooms can also be frozen after pre-cooking. For that, they must be cleaned and cut into pieces of various sizes. Then mushrooms are cooked in a pan over low heat to make sure that they expel much of the water they contain. Heat is maintained until the evaporation of most of the mushrooms' water content.

Once cooled, mushrooms can be sealed in an envelope and frozen in a thin layer. The package must indicate the date of freezing. Addition of salt, oil, garlic and other seasonings is recommended only after thawing (oil in particular may become rancid after storage at -18 °C).

This type of preservation has the advantages of significantly reducing the volume occupied by fresh mushrooms, of being suitable for species that are toxic when raw and for obtaining a food product that, after thawing, needs only some heating and the possible addition of seasonings and flavorings.

Preservation of mushrooms in oil or vinegar is widely used although it is not the best method to enhance the aromatic qualities or the differences between the various types of mushrooms. For these preservation techniques fleshy mushrooms are best suited since they retain substantially good palatability even at the end of the various treatments (e.g. mushrooms of the genus *Albatrellus*).

However, this type of procedure presents some poisoning risks from *Clostridium botulinum*. The only heat treatment, generally led to "water bath", is not in fact able to destroy spores of *C. botulinum* which may be present, and after finding suitable conditions for germination, they could produce the dangerous toxin. To avoid any risks, the following precaution steps should be made:

1) thorough cleaning of mushrooms since *C. botulinum* is a bacterium found in the soil as well;
2) careful acidification of the product (pH < 4.2), which can be obtained with the addition of vinegar or other acidifying agent.

3. Trade of wild edible mushrooms

In Italy, mass distribution does not include wild edible mushrooms. In many Italian regions small local markets of wild edible mushrooms can be observed particularly near the main areas of collection. These small markets are managed by vendors selling fruits, vegetables and some forest products (broccoli, artichokes, asparagus, chestnuts, etc.). In most cases, these are people that collect mushrooms themselves or they buy them from pickers. These batches of mushrooms often defy sanitary examinations and so potential buyer needs to be careful. The wild edible mushrooms that are found more frequently in these small markets are *Boletus edulis*, *B. aereus*, *Amanita caesarea*, *Macrolepiota procera*, and sometimes *Cantharellus cibarius*. Some local communities also appreciate the red pore boletes (*Boletus erythropus*, *B. luridus*, *B. queletii*) a type of sale that would require more responsibility by the seller in alerting the buyer of the risks associated with the non pre-boiling of the mushrooms.

In Trentino Alto Adige, wild edible mushrooms are fundamental elements of the local kitchen. The city of Trento is perhaps the most famous market in Europe. All forests of Trentino mountains are generous producers of mushrooms of all types. In the historic center of Trento, Piazza delle Erbe, there is even a daily market for mushrooms during the harvest season. It is a market of historic significance, through which over two hundred different mushroom species are marketed throughout the year. Every morning at dawn the harvest is brought directly to the market by the collectors and it is tested before being authorized for sale by specialists who perform quality control. What is exposed is absolutely secure. The owners of selling stalls are also very experienced and skilled in particular to suggest different ways of preparing the mushrooms. The most common mushrooms in Trentino are primarily
Cantharellus cibarius, Boletus edulis (brisa in dialect), B. pinicola, various Agaricus species and Amanita caesarea.

Table 1. Prices for truffles in Italy (2013).

<table>
<thead>
<tr>
<th>Truffle</th>
<th>Period of collection</th>
<th>Weight 0-15 g</th>
<th>Weight 15-50 g</th>
<th>Weight more than 50 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuber magnatum</td>
<td>October 1st - December 31st</td>
<td>€ 2800/kg</td>
<td>€ 3300/kg</td>
<td>€ 3800/kg</td>
</tr>
<tr>
<td>Tuber melanosporum</td>
<td>December 1st - March 15th</td>
<td>€ 500/kg</td>
<td>€ 600/kg</td>
<td>€ 700/kg</td>
</tr>
<tr>
<td>Tuber borchii</td>
<td>January 15th - April 30th</td>
<td>€ 200/kg</td>
<td>€ 250/kg</td>
<td>€ 300/kg</td>
</tr>
<tr>
<td>Tuber aestivum</td>
<td>May 1st - December 31st</td>
<td>€ 400/kg</td>
<td>€ 450/kg</td>
<td>€ 500/kg</td>
</tr>
</tbody>
</table>

In October-November, the truffle market is the heart of the exhibition dedicated to the white truffle (Tuber magnatum) in the town of Alba (Piedmont, North Italy), the place where one can really know all about truffles in a fragrant and unique atmosphere. Each truffle on sale at the market is controlled by a Commission before opening to the public. At Christmas, the restaurants in Langhe, Monferrato and Roero present a menu with white truffles. The two thirds of national production (about 600 tons of truffles of all types) is covered by the territory of Acqualagna. The Exhibition of the black truffle (Tuber melanosporum) of Norcia (Umbria, central Italy) takes place in the last two week-ends of February. The truffle stock market provide truffle prices (http://acqualagna.com/fiere-tartufo/borsa-tartufo/). Indicative prices for truffles appear in Table 1.

In Greece, and especially in the northwestern part (i.e. Grevena and Kastoria regions), the number of wild edible mushroom (WEM) species harvested by local collectors increased from ca. 10 to almost 100 during the last 10 years. The following
mushrooms are widely commercialized and sold in large quantities: *Agaricus* spp., *Amanita caesarea*, *Boletus* spp., *Cantharellus cibarius*, *Craterellus cornucopioides*, *Macrolepiota procera*, *Marasmius oreades*, *Morchella* spp., *Tricholoma portentosum*, *T. myomyces*, *Tuber aestivum*, *T. uncinatum*. In addition, other 50 mushroom spp. are objects of commercialization at a lower degree. Commercial WEM are sold fresh, frozen, dried, preserved in olive oil, brine, or pickled; boletus powder is used in pasta making and ready-made risottos, while cantharels are also used for making sweets and liqueur (Polemis and Zervakis, unpublished data).

WEM products from one particular trader in Grevena are sold in 180 shops throughout Greece and are also exported to various Balkan countries, Cyprus, Germany and Belgium. One particular family-business trades up to 30 tons of *Boletus* spp. annually. Hence, harvest and trade of WEM constitutes a lucrative part time income (as well as a well-paid job in family businesses) for many people living in Grevena and Kastoria regions. In this particular area, annual consumption of *Boletus* spp. is estimated at 10–30 kg/person (Polemis and Zervakis, unpublished data).

One important point is the sale of imported fresh wild mushrooms. In several countries, it is quite common that the domestic production is not sufficient to meet the consumers demand. Therefore, the majority of wild mushrooms that are sold in countries like Italy and France originate from Romania, Serbia and China even though their foreign origin is usually hushed up.

Indeed existing laws do not require the declaration of the country of origin because wild mushrooms are not agricultural products, for which this requirement applies. Imported wild mushrooms are not necessarily of lower quality but have to endure a long trip with the relevant deterioration risks.
This page was left intentionally blank.
EUROPEAN UNION
LEONARDO DA VINCI – TRANSFER OF INNOVATION

"MYCOTICON" (MYCOTa Intereuropean COoperation Network)

“Identification and sustainable exploitation of wild edible mushrooms in rural areas”

Grant Agreement no: 2011-1-GR1-LEO05-06802

Chapter 5
“CULTIVATION OF SELECTED EDIBLE MUSHROOMS”

Georgios I. Zervakis\textsuperscript{1}, Elias Polemis\textsuperscript{1} and Giuseppe Venturella\textsuperscript{2}

\textsuperscript{1}Laboratory of General and Agricultural Microbiology, Agricultural University of Athens, Greece
\textsuperscript{2}Department of Environmental Biology and Biodiversity, University of Palermo, Italy

October 2012
1. Introduction

There are at least 12,000 species of fungi that produce large (macroscopically visible) basidiomata/ascomata or mushrooms, among which ca. 2,000 species present various degrees of edibility. Furthermore, over 200 species have been collected from the wild and used for various traditional medical purposes, mostly in the Far East. About 35 mushroom species have been cultivated commercially, and of these, around 20 are cultivated on an industrial scale.

*Agaricus bisporus* (partly replaced by *A. bitorquis* in regions with Mediterranean climate) is by far the most commonly cultivated mushroom around the world. In the mid 1970s the *Agaricus* crop accounted for over 70% of total global mushroom production. Today, it accounts for about the 35% even though production tonnage has tripled in the intervening period. The biggest change during the last thirty years has been the increasing interest shown in a wider variety of mushrooms. The so-called "exotic" mushrooms have now penetrated the market and *Lentinula edodes* (shiitake), *Pleurotus* spp. or even *Auricularia auricula-judae*, *Flammulina velutipes* and *Volvariella volvacea* are routinely to be found alongside *Agaricus* in many European and North American supermarkets. Most of these mushrooms are supplied fresh; otherwise, preserved mushrooms are imported as canned or dried products. In some markets the demand for fresh mushrooms is so great that it exceeds the ability of the domestic mushroom industry to satisfy it and the current efficient transport system for chilled products enables the import of good quality products. The rather low mushroom production costs (which is due to the fact they are cultivated on substrates composed of residues and by-products from agricultural or forestry activities) in conjunction with great organoleptic and dietetic characteristics are among the main reasons for the large increase in their consumption.
Lentinula edodes was first cultivated in China between 1000 and 1100 AD, Agaricus bisporus in France in ca. 1600, and Pleurotus ostreatus in the USA in the beginning of the previous century. Techniques for the culture of the other less popular mushrooms were developed in China between 600 and 1800 AD. However, it is only over the past three decades that there has been major development in basic research and practical knowledge for the creation of a significant worldwide industry. One of the main reasons for the fast growth of this sector was mushrooms distinct dietary and medicinal properties. In general, mushrooms contain 90% water and 10% dry matter, their protein content typically varies between 20% and 30% (d.w.), carbohydrates are less than 60% (d.w.), and lipids 2–8% (d.w.), while their total energetic value of mushroom pilei is 1.05–1.50 J/kg of fresh mushroom. Furthermore, mushrooms are a good source of dietary fibres, vitamin B, β-carotene, tocopherol and other valuable nutrients and antioxidants. They also contain a number of biologically active compounds which were shown to modulate the immune system, inhibit tumour growth and inflammation, have hypoglycaemic and antithrombotic activities, lower blood lipid concentrations, prevent high blood pressure and atherosclerosis, and present antimicrobial and other activities.

In modern times, the cultivation of mushrooms has steadily increased, and recently the annual production exceeds 24 million metric tons.

Italy is among the leader countries in the cultivation of edible mushrooms. Champignon and oyster mushrooms are widely cultivated in all the Italian regions while the cultivation of “cardoncello” (Pleurotus eryngii) is more localized in southern Italy. With the exception of the latter, the prices of cultivated mushrooms are quite low and the sector is experiencing a period of constant crisis.

Mushroom growing in Greece has just over 45 years of history and presents a progressive development, including stages of setting up (1966-1975), expanding (1976-1985), showing a stagnant period (1986-1995), and a fast-growing era (1996 to
date). The introduction of the so-called "satellite system" (2003) facilitated the rapid expansion of *Pleurotus* cultivation by non-expert farmers or entrepreneurs. As a result, *Pleurotus* cultivation grew significantly; it is now distributed in many small-scale units scattered all over Greece (albeit a few of the old units including substrate preparation are still in operation), and it accounts for over the half of the total fresh mushroom production in Greece. In contrast, *Agaricus* cultivation subsided and is mainly carried out by one big unit in central Greece since this particular sector faced serious antagonism from less expensive fresh product imported mainly from Poland.

2. Cultivation of selected mushrooms

2.1. *Agaricus bisporus* (and *A. bitorquis*, both under the common name "button mushroom or champignon").

Mushroom cultivation involves several different operations, each of which must be carefully performed. The first stage is to obtain a pure mycelium of the preferred mushroom strain. The mycelium is usually purchased from several specialized germplasm commercial companies, and it is developed on cereal grain, e.g., wheat, rye or millet, which is called “spawn”. Alternatively, it can be obtained after the germination of basidiospores or from a piece taken from the interior part of a basidioma; however, this process has to be carried out under controlled (aseptic) conditions and it could be implemented only in small-scale (or “amateur”) cultivation. The purpose of using spawn in this form (i.e. cereal grains colonized by the fungus mycelia) is to achieve a quick and homogeneous bulk-growth of the fungus in the cultivation substrate. The success of mushroom production depends heavily on the quality of the spawn, which must have been prepared under sterile conditions to avoid contamination of the substrate.
Although many researchers have reported the suitability of numerous (i.e. more than one hundred) types of agricultural, forestry and agro-industrial wastes and by-products as substrates for the production of edible mushrooms, the cultivation of *Agaricus* species is performed in standard (albeit complex) media. In fact, the raw ingredients of the substrate have to undergo through a composting process (i.e. a controlled solid-state fermentation which favours the growth of thermophilic aerobic microorganisms).

The mushroom is the fruiting structure of a fungus and since fungi are heterotrophic microorganisms they need to obtain organic compounds from their growth substrates. Mushrooms extract their carbohydrates and proteins from a rich medium made of decaying organic residues. These residues derive mainly from animal manure (horse or chicken) and cereal straw (mainly wheat) supplemented with small quantities of other materials. At the initial stages of *Agaricus* cultivation they are transformed to suitable nutrient-rich substrates by the growers through composting. When correctly made, nutrients from such substrates become available exclusively to the mushroom and would not support the growth of other organisms. At a certain stage in the composting process, the mushroom grower stops the process and inserts (inoculates) the desired mushroom material (spawn) into the compost so it soon becomes the dominant organism in this particular environment.

The *Agaricus* production stages include Phase I and Phase II composting, spawning, spawn colonization (Phase III), casing, case run, pinning (formation of mushrooms initials), and mushroom harvesting. The specific criteria (temperature set points, carbon dioxide concentrations, etc.) involved in each stage will change depending on different mushroom crops and different mushroom growers, but the basic concepts and methods of mushroom production remain constant. Although mushroom growing (as described in pertinent books and cultivation manuals) may seem simple, the process of preparing a composted substrate and its pasteurization is quite complex.
The substrate is prepared in two-stages: In the first stage or Phase I, a mixture of raw materials, usually wheat straw, animal manure (such as horse bedding or poultry manure) and gypsum are wetted and then formed into a windrow. More water is added when needed and the windrow is disassembled and reformed at intervals through the use of self-driven compost turners (or remains intact in those cases where relevant facilities possess forced aeration systems). In the second stage or Phase II, pasteurization takes place which aims at disinfecting the substrate and at transforming it into a selective growth medium where Agaricus could thrive.

Each one of the first two stages has distinct objectives. The management of starting ingredients and the proper conditions for composting make growing Agaricus mushrooms particularly demanding. As earlier mentioned, straw-bedded horse manure and wheat straw were previously the common bulk ingredients. Nowadays, the prime ingredient is not straw-bedded horse manure but instead chicken manure. All compost formulas require the addition of nitrogen supplements and gypsum. Chicken manure is probably the most common and economical source of nitrogen. A variety of meals or seeds, such as cottonseed meal, soybean meal, or brewer’s grain may also be used. Inorganic or non-protein nitrogen sources such as ammonia nitrate and urea are also used, but only in small amounts when high-carbohydrate bulk ingredients are used. Gypsum is added to buffer the pH of the compost early in the composting process.

A field area made of concrete is required for composting. In addition, a compost turner to aerate and water the ingredients and a tractor-loader to move the ingredients to the turner are needed. Water used during a substrate preparation operation can be recycled back into the process. Water runoff into the environment is nonexistent on a properly managed substrate preparation process.
Conventional Phase I composting begins by mixing and wetting the ingredients as they are stacked. Most farms have a preconditioning phase in which bulk ingredients and some supplements are watered and stacked in a large pile for several days to soften, making them more receptive to water. This preconditioning time may range from 3 to 15 days. The piles are turned daily or every other day. After this pre-wet stage, the compost is formed into a windrow. A compost turner is typically used to form this pile. Water is sprayed onto the pile as its materials move through the turner. Nitrogen supplements and gypsum can be spread over the top of the bulk ingredients and are thoroughly mixed by the turner. Once the pile is wetted and formed, composting commences as microbial growth and reproduction naturally occur in the bulk ingredients. Heat, ammonia, and carbon dioxide (CO$_2$) are released as by-products during this process. As temperatures increase up to 65-70°C, microorganisms cease growing and a chemical reaction begins. Concentrating and preserving complex carbohydrates is one goal of Phase I. The quantity and the quality of nitrogen in the system are changed to a type of nitrogen that Phase II microorganisms and, eventually, the mushroom will use as food.

Adequate moisture, oxygen, nitrogen, and carbohydrates must be present throughout the process; otherwise, the process will stop. This is why water and supplements are added periodically and the compost pile is aerated as it moves through the turner. Oxygenation is achieved in conventional outdoor ricks by natural convection. The exclusion of air results in an airless (anaerobic) environment, which is detrimental for the process itself but mostly for the quality of the end product. Adequate aeration is usually accomplished either by using a fan to force air up through a series of evenly distributed holes built on the floor ("aerated floor") and into the substrate material or through the use of a compost-turner machine.

Phase I is considered complete as soon as the raw ingredients become pliable and are capable of holding water, the odour of ammonia is sharp, and
Chapter 5: Cultivation of selected edible mushrooms

the dark-brown colour indicates that caramelization of carbohydrates and browning reactions have occurred. At the beginning of Phase I, the substrate is bulky and yellow. At the end of Phase I substrate preparation, the substrate should be dense, chocolate brown in colour, and have a strong odour of ammonia. The substrate still has some structure so aeration can be maintained during Phase II composting.

Once Phase I is complete, the substrate will be filled into a system for Phase II substrate preparation and to grow the mushrooms. Phase II takes place in one of three main types of mushroom-growing systems, depending on the type of production system used. The difference in the mushroom-growing systems is the container in which the crop is processed and grown. With a multizone system, the substrate is filled into boxes or trays and moved from room to room. Each room has a different heating, ventilating, and air-conditioning system designed for a specific stage in crop development. A single-zone system consists of several large, stacked beds or shelves within a single room. The substrate is filled into these beds after Phase I, and the crop remains in the one room throughout the process. Bulk pasteurization or tunnels are systems where the substrate is filled into elongated well-insulated chambers with perforated floors and no covers on top of the compost (i.e. pasteurization tunnels). Phase II and, occasionally, the next phase of growing are carried out within these tunnels. The substrate may then be filled into a tray, shelf, or even plastic bags for the remaining part of the process.

Phase II composting is the second step of compost substrate preparation. The first objective of Phase II is to pasteurize (heat-treat through the application of steam) the composted substrate. The composted substrate is pasteurized to reduce or eliminate harmful microorganisms as well as insects, nematodes etc. This is not a complete sterilization but a selective eradication of pests that will compete for food or directly attack the mushroom. At the same time, this process minimizes the loss of beneficial microorganisms. The second
goal of Phase II is to complete the composting process. Completing the composting process means consuming all remaining simple soluble sugars and gaseous and soluble ammonia created during Phase I composting. Since ammonia is toxic to the mushroom mycelium, it must be converted to food the mushroom can use. Most of this conversion of ammonia and carbohydrates is accomplished by the growth of microorganisms in the compost; eventually the mushroom uses these packets of nutrients as food.

The Phase II process takes anywhere from 7 to 18 days, depending on how the air and compost temperatures are managed to control microbial activity. Pasteurization (peak heat) should be completed toward the start of Phase II, while during the rest of the process a “conditioning” phase takes place. In general, air and composted substrate temperatures should be raised together to 60°C for at least 2 hours, and this is a “time vs. temperature” relationship. The beneficial microorganisms grow best at temperatures from 40°C to 55°C (i.e. just after the peak heat stage); the more ammonia-utilizing microbes grow best in the temperature range of 47–49°C. The longer the microbes in the composted substrate remain in this optimum range with all the critical growth requirements available, the faster the ammonia will be converted. Understanding how these microbes grow and work in composted substrate should make the management of Phase II a little easier. The process of going through this temperature range will produce the most protein or the maximum amount of food for the mushroom.

On Agaricus cultivation units, spawn and supplements are broadcast over the surface of the substrate. Uniformity of this distribution is critical to achieve even spawn growth and temperatures. On tray or bulk farms, spawn is usually metered into the substrate during the mixing operation. Spawning is the cleanest operation performed on a mushroom farm. All equipment, baskets, tools, etc. should be thoroughly cleaned and disinfected before spawning. The amount of spawn used depends on the length of the spawn-growing period and
compost fill weights. The use of more spawn will result in a quicker colonization and more efficient use of substrate nutrients. Improved colonization of substrate will help ensure that the mushroom mycelia will grow quicker than other fungal competitors.

During the spawn-growing period, heat is generated and supplemental cooling is required. Substrate temperatures should be maintained at 26–28°C and relative humidity should be high to minimize drying of the substrate surface. Under proper conditions, mycelia will grow out of the spawn grain as a network of fine filaments (“hyphae”) expanding throughout the substrate. A complete spawn run usually requires 14 to 21 days. The spawn-growing period is considered complete when spawn has completely colonized the substrate and the metabolic heat surge is subsiding.

The compost has to provide the mushroom mycelium with the appropriate amount of food. Not only the lignin-humus complex and cellulose are essential, but protein, fat, and oils are also important. The dead cells of thermophilic fungi, bacteria, and actinomycetes are the packages that deliver protein and fat to the mushroom. In addition, the presence of any delayed-release supplements further enhances the protein and lipid content of the compost for the mushroom. Many of these supplements consist of a high-protein oil material, such as soybean meal, cornmeal, or feather meal, that has been treated to delay the availability of the nutrient for the mushroom. If an untreated supplement is added to the compost at this time, it often enhances the growth of other microbes or competitor molds. These molds grow more rapidly than the mushroom mycelium and can quickly colonize the compost, competing with the mushroom for nutrients. Care should be taken with substrates that are not selectively prepared; in such cases, nutrients become more available to competitor microorganisms.
For triggering the shift of the mushroom fungus from the vegetative phase (mycelium growth) to a reproductive state (mushroom formation) a cover of a suitable material—called the “casing layer”—is applied onto the surface of the spawned compost. The casing also functions to supply and conserve moisture for the mushrooms and their mycelia and acts to transport dissolved nutrients to the mushrooms. Casing supports the mushrooms and compensates for water lost through evaporation and transpiration. Usually, most mushroom growers use sphagnum peat moss or aged sphagnum peat moss buffered with limestone. Pasteurized clay loam field soil; reclaimed, weathered, spent compost; and spent sugar beet lime are other materials used by growers. However, peat moss–based casing does not need pasteurization because it is inherently free of mushroom disease spores and pests. Distributing the casing so that its depth and moisture are uniform over the surface of the compost is important. Such uniformity allows spawns to move into and through the casing at the same rate and, ultimately, for mushrooms to develop at the same time.

Spawn run compost at casing (CAC) is used to inoculate the casing during the mixing or application of the casing, and it is often used to improve crop uniformity, crop cycling, mushroom quality, and yields. CAC is now produced by those who produce and supply spawn to growers. This process is called casing inoculum. By adding the mycelia uniformly throughout the casing, the spawn growth into the casing is quicker and more even. The time from casing to harvest is reduced by 5–7 days so that the rooms can be cycled faster or more breaks can be harvested in the same the surface. Yields are improved since the mushroom growth is uniform and crop management is easier. Managing the crop after casing requires that the compost temperatures until fructification will be held at spawn growing temperatures. After appearance of the mushroom initials, compost temperatures are lowered and air temperature becomes the primary control point. Throughout the period following casing,
water administration should be regulated with great care in order to ensure the appropriate substrate moisture. Knowing when and how much water to apply to casing is an element that readily separates experienced growers from beginners. Watering the crop is one of the most delicate operations in mushroom growing. Although each grower may have his or her own preference, no specific casing-management practice and casing material are universally accepted.

Water constantly moves throughout the cropping period: water is lost through evaporation and transpiration, and the mushroom takes up water into its cells; water is replaced when watering the casing layer. The increase in the weight of the mushroom from pinning to maturing is related to the rapid uptake of water from the casing and compost. The mushroom doubles in size two days before harvest; as the mushroom matures during a flush, its weight gain is attributed to the accumulation of nutrients and water from the substrate.

Mushroom initials (or “primordia”) develop after big conspicuous threads of hyphae (often called “rhizomorphs”) have formed in the casing; then they grow and expand passing through a “pre-button” stage until they become fully mature mushrooms. Mushroom harvesting begins 15–21 days after casing, which is normally 7–8 weeks after composting started. The cultural practices used during primordia development and cropping include the management of air and compost temperatures and CO₂ content of room air, and is often dependent on the strain and number of pins the grower wishes to form and develop. Air-handling and ventilation systems regulate the amount of fresh air entering the room and temperatures within the room. Air temperature is usually maintained in a range of 15–17°C; CO₂ levels range from 1,000 to 2,500 ppm during the primordia and cropping stages. The most critical stage of the mushroom’s development for fresh quality and yield improvement is during the rapidly expanding stage, when the mushroom doubles in size every 24 hours.
This expansion stage depends on temperature, moisture of the compost, and casing. Mushroom size is dependent on the number of pins that develop for a break or flush and by how the crop is prepared and managed.

Mushrooms are harvested over a 2–4 day period in a 7–10-day cycle called flushes or breaks. When mature mushrooms are picked, an inhibitor to mushroom development is removed and the next flush moves toward maturity. Timing of the breaks or flushes is managed by control of the watering, CO₂, and temperatures. The first two flushes account for the majority of the total yield, with the subsequent flushes resulting to relatively low levels of production (ca. 10-20%). Mushrooms are usually harvested by hand. Some consumers seem to prefer closed, tight mushrooms, while others prefer stronger-flavoured, more mature, open-cap mushrooms. Mushroom maturity is evaluated by how open the veil is, not by its size. Mature mushrooms could be both large and small, although both farmers and consumers favour medium to large mushrooms. Diseased, malformed, and fly-damaged mushrooms are considered second-grade and are discarded. Alternatively, when appropriate, they could be treated with registered chemicals, biopesticides, or common disinfectant materials such as salt or alcohol.

When a room becomes unproductive, the crop is usually terminated. Before removing the spent substrate from the mushroom house, the grower sanitizes it with steam to kill any microorganisms or insects that could interfere with a neighbouring growing room or subsequent crop. The steaming-off procedure is accomplished by maintaining a compost temperature of 60–70°C for anywhere from 8 to 24 hours. The spent compost should be removed from the farm to reduce the chances of contaminating the subsequent mushroom crops at the farm.

Spent mushroom substrate or compost (SMC) is the soil-like material remaining after a crop of mushrooms has been harvested. Spent substrate is
high in organic matter, making it desirable for use as a soil amendment or soil conditioner.

2.2. Cultivation of Pleurotus mushrooms (usually *P. ostreatus*, but also *P. pulmonarius*, *P. djamor*, *P. eryngii*, etc.; common name: “oyster mushroom”).

*Substrate preparation.* In Europe and in USA, the primary ingredients used for *Pleurotus* spp. production are chopped wheat or barley straw supplemented with wheat bran and/or flours from leguminous fruits/seeds. In some cases, cottonseed hulls and corn-cobs might be used in mixtures with the main ingredients previously mentioned. For preparation of the wheat straw based substrate, the material is milled to a length of about 2 to 4 cm while simultaneously water is added to increase the moisture content. Then the wet mixture is left outdoors for 1-3 days; during this period it is regularly mixed (usually through the use of front-end loader) and watered until its moisture content reaches 70-73%.

*Pasteurization.* While in some small-scale commercial mushroom farms, ingredients are fed into revolving mixers, water is added to the desired level, and live steam is injected into the mixer while in operation, most medium and large units employ especially constructed pasteurization tunnels made of concrete and/or galvanized metal and insulating foam walls with perforated floors. The substrate is pasteurized with aerated steam at 58-65°C for one to two hours by passing the air-steam mixture through the substrate from top to bottom. After pasteurization is complete, filtered air is passed through the substrate for gradual cooling. The whole pasteurization process is performed by slowly increasing and decreasing temperatures in order to enhance the growth of beneficial (thermophilic) microorganisms which undertake the initial task of
Chapter 5: Cultivation of selected edible mushrooms

Partially decomposing the lignocellulosic compounds and preparing a selective substrate for the growth of the mushroom fungus (see also the pertinent part in *Agaricus* cultivation).

**Filling plastic bags with substrate.** The pasteurized substrate is spawned and usually filled into clear or black perforated polyethylene rectangular blocks (weighting ca. 17-18 kg each) or into cylindrical bags (weighting ca. 12-15 kg). In modern production units, the substrate spawning and blocks filling processes are fully automated and are carried out in specially designed rooms where the contamination risk from environmental sources is minimized. However, in many other cases they are performed manually in sheds without any particular provisions for keeping out fungal (mainly) or bacterial contaminants during a particularly sensitive stage of the cultivation cycle.

**Substrate incubation.** The next step involves substrate incubation at 21 to 24°C (air temperature) for 15 to 21 days for most *P. ostreatus* strains. Of particular importance at this stage is to maintain the substrate temperatures at values that do not exceed 32 to 33°C or otherwise the mycelium growth decreases considerably or even dies (at higher temperatures). The other environmental parameters are of no particular importance since the fungus is growing within the container (block or bag); in any case, incubation is performed in the dark, no aeration is provided, while high hygienic conditions are maintained in the growth chamber/room.

**Mushroom production.** When the fungal mycelium has colonized the whole volume of substrate (its entire surface obtains a white to light cream colour), then the blocks/bags are moved into the production rooms. This transfer is common since the environmental requirements for the appearance and growth
of mushrooms are very different from those of the incubation phase. Hence, most growers prefer to maintain two types of rooms, and in such cases incubation is conducted separately from the fructification process.

In most cases, for inducing the appearance of mushroom initials, the fungus should receive some type of environmental stimulus which will provide the necessary signal(s) to make it pass from the vegetative to the fructification phase. The complete colonization of the substrate is a common signal indicative of the soon-to-arrive depletion of nutrients; hence, the organism has to produce reproductive organs to survive this event. However, usually the lack of adequate food is not enough by itself to cause the formation of mushrooms, and it should be combined with the suitable environmental conditions.

Therefore, for the initiation of fructification, aeration (fresh air, \( \text{CO}_2 < 800 \text{ ppm} \)), illumination and a high air-humidity (95-98\% RH) environment are provided; in addition, for most \textit{Pleurotus} species temperature is lowered by several degrees depending on the strain under cultivation (12-18°C). After a few days, mushroom primordia (young immature basidiomata) are formed on the exposed part (block/bag holes) of the substrate, which soon develop into fully grown mushrooms. This process usually lasts from one to two weeks, and when the crop is in full development the environmental parameters have to be re-adjusted in order to meet the requirements of the maturation phase. Mushrooms are harvested before they overripe; this mean that their pileus margins should be intact (without scissures) and pointing downwards.

After the completion of harvest, blocks/bags are left into the cultivation rooms since a second crop (“flush”) is anticipated. Indeed, after a few days, the substrate produces again mushroom albeit in lower yields than previously. The majority of growers harvest the second flush and then empty the room for making space for new/fresh substrates to come in. The spent substrate is either discarded or transported to another nearby site for continuing production in
lesser and lesser quantities. Alternatively, it could be used for the generation of a high quality organic fertilizer or soil amendment after being composted with other agricultural/forestry by residues.

**Literature cited and suggested**


Zervakis, G.I. 2011. *Introduction to the Cultivation of Edible Mushrooms*. University lectures in the frame of the lesson “Microbial Biotechnology - Fermentations”. Agricultural University of Athens, Department of Agricultural Biotechnology. [in Greek]
EUROPEAN UNION
LEONARDO DA VINCI – TRANSFER OF INNOVATION

"MYCOTICON" (MYCOTa Intereuropean COperation Network)

“Identification and sustainable exploitation of wild edible mushrooms in rural areas”

Grant Agreement no: 2011-1-GR1-LEO05-06802

Chapter 6
“NUTRITIONAL VALUE AND HEALTH PROMOTING EFFECTS OF WILD EDIBLE MUSHROOMS”

Giuseppe Venturella and Maria Letizia Gargano
Department of Environmental Biology and Biodiversity
University of Palermo, Italy

October 2012
Chapter 6: Nutritional value and health promoting effects of wild edible mushrooms

1. NUTRITIONAL VALUE OF MUSHROOMS

Starting from ancient times edible mushrooms were consumed by many societies. In modern times, the cultivation of mushrooms has steadily increased, and nowadays the annual production is more than 24 million metric tons (Chang & Wasser 2012).

Wild mushrooms are becoming more important in human diet due to their nutritional value, related to the high protein, low-fat/energy contents and the presence of several bioactive compounds (Diéz & Alvarez 2001; Agahar-Murugkar & Subbulakshmi 2005; Barros et al. 2007).

In Food Science books, mushrooms are often included among the foods of plant origin. The composition of mushrooms is similar to that of vegetables: content of proteins, lipids and carbohydrates. From the data available in literature, mushrooms are a good source of vitamins and minerals for humans. In particular, they contain vitamins such as B1, B2, B6, B12, D, H, niacin, and pantothenic acid which are less abundant in higher plants (Prakash et al., 1982). The importance of vitamin B12 in fungi has not been sufficiently highlighted, but since cyanocobalamin is absent in plant organisms, its presence in fungi may be a useful alternative in diets where foods of animal origin are poorly represented or, in vegetarian ("vegan") diets.

The assessment of the nutritional value of mushrooms requires the analysis of their composition and the study of nutrients (spectrum amino acid, vitamins, mineral elements, growth factors, etc.). Data reported in literature on the composition, chemistry and nutritional value of mushrooms vary widely. This is primarily due to the genetic diversity of isolates, to environmental factors, such as the nature of the substrate, and the method of cultivation. In addition, mushrooms continue to show metabolic actions even after the collection and this is another factor to be taken into account in the assessment of their nutritional value (Crisan & Sands, 1978).

Most of the information available on the nutritional value of mushrooms comes from research on species of the genus Agaricus, but data are also available on
the nutritional value of *Pleurotus* referring in particular to *P. ostreatus* (Bano and Rajaratnam, 1982).

According to La Guardia et al. (2010) the water content varies from 93 g per 100 g of the fresh edible part in *Agaricus bisporus* to 75.8 g in black truffle (*Tuber melanosporum*). *T. melanosporum* showed the highest protein content (6.0 g/100 g of edible portion) when compared with other edible mushrooms. The fat content is minimal in the champignon (*Agaricus bisporus*) and reaches the maximum value of 0.8 g/100 g in *Leccinum aurantiacum*. Among the edible mushrooms the highest value of carbohydrates (4.5 g/100 g) was detected in *Pleurotus ostreatus*. Furthermore, *T. melanosporum* (8.4 g/100 g), *Morchella esculenta* (7.0 g/100 g), *Leccinum scabrum* (6.5 g/100 g), and *Lactarius deliciosus* (5.5 g/100 g) have a high content of dietary fiber if compared with other edible mushrooms.

The iron content in mushrooms is equal to 0.8-1.6 mg/100 g. The copper content in mushrooms is equal to 0.12-0.66 mg/100 g. The zinc content in mushrooms is equal to 0.5-1.5 mg/100 g. The content of mineral salts is not high except the potassium content in some species such as *T. melanosporum* (526 mg per 100 g), *M. esculenta* (390 mg per 100 g) and *L. scabrum* (362 mg per 100 g). However, we must consider that the content of mineral salts in mushroom is highly dependent on the respective contents in the growth substrate. A relatively high iron content is found in *Tuber melanosporum* (3.5 mg per 100 g) (La Guardia et al. 2010).

The vitamin content is generally high especially as regards the niacin and vitamin B₁₂. La Guardia et al. (2010) reported a general view of the vitamin contents in edible mushrooms without indicating the species to which the values refer. The content of vitamin D is 1.3 μg/100 g. The total activity of the vitamin E expressed in mg of α-tocopherol per 100 g calculated in mushrooms is equal to 110-190. In mushrooms thiamine or vitamin B₁ is present in quantities of 0.05 to 0.38 mg per 100 g. Other vitamins reported for mushrooms are: riboflavin or vitamin B₂ (0.06-0.72 mg per 100 g), vitamin B₆ or pyridoxine (65-120 g per 100 g), vitamin B₃ or niacin (2-14.70
mg per 100 g), vitamin H or biotin (16-46 g per 100 g) and cobalamin (4.20-4.80 g per 100 g).

As a result of their low content in carbohydrates and fats, mushrooms present a low calories content, and this makes them very suitable for the diet of obese and/or diabetic people. This is particularly important if one considers that the above-mentioned diseases are widespread and present a significant increase in Western societies. Among other things, one of the problems of diet of obese patients is the palatability of foods, the mushrooms from this point of view, could certainly be a food that improves the "compliance" of these patients, i.e. the acceptance of a patient to the medical, pharmacological or non-pharmacological (diet, way of life, periodic monitoring, etc.) requirements established by the doctors. If we consider data from literature the greater number of calories (31) is obtained from the consumption of T. melanosporum while the lowest is detected in M. esculenta (10).

Basidiomata and ascomata are appreciated for their texture, flavour, chemical and nutritional features (Manzi et al. 2001). The wild mushrooms are traditionally used as food, but there is limited information on their nutritional composition. *Amanita caesarea, Boletus edulis, B. aereus, Leccinellum corsicum, Pleurotus eryngii var. eryngii, P. eryngii var. ferulae, P. eryngii var. elaeoselini, P. eryngii var. thapsiae* and *P. nebrodensis* are sold in local markets of many European countries and are of great economical interest for the local people because they are a source of income. In addition, *Fistulina hepatica, Infundibulicybe geotropa, Laetiporus sulphureus, Macrolepiota procera var. procera* and *Suillus granulatus* constitute a significant portion of the local population’s diet.

The nutritional composition of cultivated *Lentinula edodes* (Berk.) Pegler and different species of *Pleurotus* was analysed by Manzi et al. (1999) as was the nutritional value of fresh and processed mushrooms widely consumed in Italy (i.e. *A. bisporus, P. ostreatus* and *B. edulis* group) (Manzi et al. 2001). Such mushrooms are a good source of dietary fibers and glucans for food supplements.
Cultivated *Pleurotus* mushrooms show valuable organoleptic qualities that are very similar to those of the wild relatives. For example, Palazzolo & Venturella (1996) have shown that the differences, from the point of view of the chemical composition, among basidiomata of wild and cultivated *P. nebrodensis* are minimal and that this mushroom is characterized by a significantly higher content of elements such as Ca, K and P than that of other mushrooms collected in nature and related to the genera *Agaricus*, *Amanita* and *Boletus*.

La Guardia et al. (2005) analyzed cultivated basidiomata of *Pleurotus eryngii* var. *eryngii*, *P. eryngii* var. *elaeoselini*, *P. eryngii* var. *thapsiae* and *P. nebrodensis*. In addition, La Guardia et al. (2005) demonstrated that mushrooms of *Pleurotus taxa* growing on *Apiaceae* are suitable in every type of diet, including the hypocaloric, thanks to their low energy content and gastronomic value. Besides, these fungi are a good source of vitamins and mineral salts.

Based on the results reported by Palazzolo et al. (2012), *F. hepatica* (Schaeff.) With., *I. geotropa* (Bull.) Harmaja, *L. sulphureus* (Bull.) Murrill, *M. procera* (Scop.) Singer var. *procera* and *S. granulatus* (L.) Roussel could be considered valuable natural products well worth including in many types of diets. In *L. sulphureus* the protein and calcium contents are higher than that of milk, eggs, cereals, fresh fruit, meat, fish, *Boletus* species, *P. eryngii*. Vitamin B\textsubscript{12} content is higher in *F. hepatica*, *I. geotropa* and *M. procera* var. *procera* than in cultivated *Pleurotus* species. The carbohydrate content of the above-mentioned species is higher than that of eggs, meats.

### 2. MEDICINAL EFFECTS OF MUSHROOMS

Mushrooms comprise a vast and yet largely untapped source of powerful new pharmaceutical products. Besides they represent an unlimited source of polysaccharides with antitumor and immunostimulating properties (Wasser, 2002).
Many pharmaceutical substances isolated from medicinal mushrooms are not strictly pharmaceutical products but rather represent a novel class of dietary supplements (DSs) or “nutraceuticals”. Mushrooms-based DSs are products originating from either the mycelia or the basidiomata, and they are consumed in the form of capsules, tablets, or extracts (Wasser et al., 2000).

*Ganoderma lucidum* (Curtis) P. Karst. (Reishi), *Lentinula edodes* (Berk.) Singer (Shiitake), *Inonotus obliquus* (Ach. ex Pers.) Pilát (Chaga) and many others have been collected and used for hundreds of years in Korea, China, Japan and eastern Russia.

The chemical structure of antitumor and immunostimulating polysaccharides of some of the most important WEM was investigated by several authors. Kiho et al. (1992) reported $\alpha$-(1→3)-glucan and $\beta$-(1→6)-glucan in *Armillaria tabescens* (Scop.) Emel while Yoshida et al. (1994) isolated linear $\alpha$-(1→3)-glucans in *Agrocybe cylindracea* (DC.) Maire. The presence of $\beta$-(1→6)-glucan was also detected in the basidiomata of *Lyophyllum decastes* (Fr.) Singer (Ukawa et al., 2000).

Nanba et al. (1987) isolated $\beta$-(1→3) and $\beta$-(1→6)-glucans from *Grifola frondosa* (Dicks.) Gray. while Mizuno et al. (1986) reported for the same mushroom species the presence of mannxyloglucans. Mizuno (1999) reported galactoxyloglucans, xylans, mannoglucoxylans and glucoxylans from basidiomata of *Hericium erinaceus* (Bull.) Pers. Xyloglucans were isolated by Mizuno et al. (1986, 1992) from *G. frondosa* and *Albatrellus confluens* (Alb. & Schwein.) Kotl. & Pouzar.

The content of mannogalactoglucans in basidiomata of *Pleurotus cornucopiae* (Paulet) Rolland was reported by Kim et al. (1994). The presence of galactomannoglucan in *Flammulina velutipes* (Curtis) Singer and *Leucopaxillus giganteus* (Sowerby) Singer was respectively investigated by Ikekawa et al. (1982) and Mizuno et al. (1995). Galactoglucomannans are also reported by Fujii et al. (1979) in *L. edodes*. Zhuang et al. (1994) reported mannanagalactofucans from *G. frondosa* while Zhang et al. (1994) isolated arabinogalactans from *Pleurotus citrinopileatus* Singer.
As reported by Beelman et al. (2003) *P. ostreatus* (Jacq.) P. Kumm. contain statins and other hypocholesteremic substances, and *L. edodes* is well known for containing medically functional antitumor and immunomodulating polysaccharides. *Agaricus arvensis* Schaeff. basidiomata stimulates digestion and cures hypertension (Didukh et al., 2003). *Agaricus bisporus* (J.E. Lange) Imbach also contain high levels of substances of possible medicinal importance such as tyrosinase, aromatase inhibitor(s), and immunomodulating and antitumor polysaccharides. Didukh et al. (2003) documented antidiabetic properties of *Agaricus campestris* L. var. *campestris* and activity against Sarcoma 180 and Ehrlich solid cancers. Besides *A. campestris* contains vitamins (B₁, C, PP, etc.), trypsin, maltase, and proteolytic enzymes, which cure indigestion. *A. campestris* also demonstrates antihypertensive, antiviral, antibiotic, anticoagulatory, and immunological activities. Basadalin, isolated from *Leucoagaricus leucothites* (Vittad.) Wasser, demonstrates cytotoxic activities against lymphatic leukemia cells L1210 (Huff et al., 1994). *Agaricus semotus* Fr. contains antitumor-active substances and is moderately active against *Staphylococcus aureus* (Suay et al., 2000).

*Macrolepiota procera* (Scop.) Singer contains 18 amino acids, eight of which (isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine) are essential. Taken regularly *M. procera* helps digestion and promotes health (Ying et al., 1989). Basidiomata extracts possess antitumor and antibacterial activity. *Macrolepiota rhacodes* (Vittad.) Singer exhibits slight antibacterial active against *Staphylococcus aureus* (Suay et al., 2000). This species inhibits growth of Sarcoma 180 and Ehrlich carcinoma (Reshetnikov et al., 2001).

The following therapeutic effects of *Auricularia auricula-judae* (Bull.) Quél. were reported by Wasser & Weis (1999): antitumor, blood pressure regulation, cardiovascular disorders, hypercholesterolemia, hyperlipidemia. The same author highlighted the antifungal and antitumor properties of *Agrocybe cylindracea* (DC.) Maire that is also used against hypercholesterolemia and hyperlipidemia and also used as nerve tonic.
Literature cited and suggested


This page was left intentionally blank.
EUROPEAN UNION
LEONARDO DA VINCI – TRANSFER OF INNOVATION

"MYCOTICON" (MYCOTa Intereuropean COoperation Network)
“Identification and sustainable exploitation of wild edible mushrooms in rural areas”

Grant Agreement no: 2011-1-GR1-LEO05-06802

Chapter 7
“USE OF WILD EDIBLE MUSHROOMS IN THE SERVICES SECTOR”

Julia Georgi¹, Cvetomir M. Denchev², Boris Assyov² and Giuseppe Venturella³

¹School of Architecture, Land and Environmental Science
Neapolis University of Pafos, Cyprus
²Institute of Biodiversity and Ecosystem Research
Bulgarian Academy of Sciences, Sofia, Bulgaria
³Department of Environmental Biology and Biodiversity,
University of Palermo, Italy

October 2012
ECO-TOURISM – AGRITOURISM with emphasis on wild edible mushrooms collection and cultivation

1. INTRODUCTION

Tourism industry is a large business which interests both the entrepreneurs and tourists around the world for its roles variously affecting to the global economy system. Data reported from UNWTO World Tourism Barometer, April 2010, concluded that international tourism has strongly recovered in 2010 as presented in Figure 1.

![Figure 1: The international tourism situation in the period 2008 – 2010 (UNWTO World Tourism Barometer, 2011)](image)

Figure 1 shows that the international tourism situations in 2008 - 2010 were 940 million tourists. Furthermore according to World Tourism Organization: UNWTO the situation is continually rising up.
Development of rural tourism and affirmation of rural areas in countries of Europe and the United States was begun in the mid-sixties of last century. In Europe, it was further accelerated by economic trends and the European Union enlargement. Rural tourism is a valuable contributor to rural economy since it allows diversification and favors protection and enhancement of European heritage. Rural Areas agro-tourism is often defined as any activity, enterprise or business related to agricultural production, services and expectations in tourism. "agro-tourism Industry" is one of the fastest growing sectors in the travel industry and tourism for Europe, particularly in southern Europe.

Europe has the largest share of tourism arrivals and maintains a positive growth. Changes in travel behavior are favourable to rural tourism: e.g. growth in independent travel, desire for new experience, more intra-regional and domestic travel. Other changes in tourist behavior are also favorable: e.g. accommodation other than hotel. People are more interested in how their food is produced and want to meet the producers and talk with them about what goes into food production and more.

Children who visit farms and forests mostly come from city and often haven’t had a chance to pick an apple right off the tree or collect a mushroom etc. agro-tourism involves the recruitment of tourists in the farmer jobs. agro-tourism includes the opportunity to help with farming and foresting tasks during the visit. agro-tourism is often practiced in wine growing regions, as in Italy and Spain. In America, agro-tourism is widespread and includes any farm open to the public at least part of the year.

Tourists, except for using the classic service such as relax and bed, catering, etc. can harvest fruits and vegetables, mushrooms, ride horses, taste honey, learn about wine, shop in farm gift-shops and farm-stands for local and regional produce or handcrafted gifts, and much more.

Agro-tourism is based on the landscape, tradition and family from which a complete competitive tourism product emerges. Basic criteria for defining agro-tourist
destination (Dončić, 2006) are: local attraction, homogeneity or heterogeneity, the number of visitors and the level of development of tourist destinations.

Elementary variables and factors of attractiveness of any destination and the main elements of the tourist product and its further development as an agro-tourist destination are: elements of accommodation; attractiveness of tourist destination; environmental elements; socio-cultural; elements of the offer; infrastructure facilities; political stability; the local involvement in tourism; elements of promotion; marketing; information system. Resulting from these is a definition of agro-tourist destination, which represents a kind of amalgam and combination of interrelated elements of attraction, accommodation facilities, courtesy domestic population and condition of infrastructure, as well as tourist information system.

Table 1. Concept of the agro-tourist product (Source: Waithe, 2006).

<table>
<thead>
<tr>
<th>Fixed Attraction</th>
<th>Events</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Historic Plantation</td>
<td>• Agricultural fairs</td>
<td>• Farm tours</td>
</tr>
<tr>
<td>• Agricultural museums</td>
<td>• Local festivals</td>
<td>• Rural bed and breakfast</td>
</tr>
<tr>
<td>• Village run shop</td>
<td>• Special events</td>
<td>• Alternative medicines</td>
</tr>
<tr>
<td>• Herb/Exotic Gardens</td>
<td></td>
<td>• Agro-processing</td>
</tr>
<tr>
<td>• Produce and Cran Markets</td>
<td></td>
<td>• Agro-trade with Tourism Operators</td>
</tr>
</tbody>
</table>

Marketing in agro-tourism is taking place through four known variables: price, product, marketing and promotion, and the uncontrolled variables are the political, legal, economic and cultural environment. Specificity of agro-tourist marketing is in the conception of sustainable development through the protection of flora and fauna, the understanding of the social dimension of the area, minimizing the impact on the physical and cultural environment, a profit based on the service with a
positive environmental output and tourist experience of environment. agro-tourist product includes: defined attractions, events and services (Table 1).

The key terms in agro-tourism are: definition of agro-tourism (with its types or forms), definition of agro-tourist destination and agro-tourist product, but also marketing and management in agro-tourism. OECD has designed a methodology for agricultural policy and its implementation, which defines objectives and agro-political measures, reforms, positive effects, monitoring and evaluation, etc. agro-tourism is often identified with the farmer tourism, and is part of rural tourism and eco-tourism. However, many theorists and practitioners tend to define the concept and forms of agro-tourism. Example of classification scheme of agro-tourism is stressed by Waith (2006) (Fig. 2).

![Fig. 2. Forms or types of agro-tourism. (Source: Waithe, 2006)](image)

- **Farm-based Tourism** can be described as the act of visiting a working farm or any agricultural, horticultural or agribusiness operation to enjoy, be educated or involved in activities. Agro-Ecotourism is travel undertaken to witness sites or regions of unique natural or ecological quality or the provision of services to facilitate such travel. Both includes: farm tours; hands on farming tasks; self-harvesting of produce; horse, pony or donkey rides; farm animal zoos and trails; overnight stays in rural bed and breakfast; ecology- dive tours.
• **Community Tourism** is one or a combination of tourist products offered at a community-level to domestic or international visitors. It usually refers to visitor interaction with local people in the rural areas outside of the traditional tourist areas but can also be linked to urban neighbourhoods (village rum shops; parish/district parks; community festivals; special events; stay with a host family in a local village).

• **Agro-Heritage Tourism** can be described as many measures that promote the heritage, history and interpretation of early and contemporary agriculture (agro-museums; plantation tours; craft making; indigenous art showcases or workshop; agricultural festivals).

• **Agro-Trade Tourism** consists of any act of negotiation that facilitates the exchange of goods and services among local community stakeholders, tourism enterprises, and visitors of foreign interests (produce markets; craft markets; floriculture; agro-processing; marketing to hotels, restaurants and other agencies).

• **Culinary Tourism** and workshops; food festivals; tasting/buying packaged local products; farmer's markets is a subset of agro-tourism that focuses specifically on the search for, and enjoyment of, prepared food and drink (dinner and theatre-package; culinary schools; tour a food/wine/beer factory).

• **Health and Wellness Tourism** can be described as the process of combining the goal to look and feel better with travel, leisure and fun activities (spa treatment; specialty surgeries; alternative medicines; herbal remedies; therapeutic holidays).

It should be underlined that definition of the agro-tourism form and the elaboration of its content depend on the characteristics and heterogeneity of the tourist product and agro-tourist destination.

### 2. INSTRUCTIONS OF AGRITOURISM AND SUSTAINABLE DEVELOPMENT

Sustainable development is a process having economic, social, cultural and environmental-ecological dimensions. This process is perceived as a development in all respects for both urban and rural societies. Its main characteristics are increasing
impoverishment of rural society, as well as the problems of deforestation, erosion and soil productivity loss by misuse of funds, which further emerge problems of migration, poverty and hunger. 

Development of appropriate agricultural and environmental policies should be ensured to protect and develop agricultural lands, to increase agricultural productivity and marketing agricultural products, to create job opportunities in agricultural and non-agricultural sector, to increase the contribution of agricultural productivity to national income and rural people. 

Rural areas are multifunctional dynamic systems. They include different land use and activities such as settlement, transportation, industry, forestry, tourism and recreation. Agro-tourism is one of the best ways of affirmation, improvisation and existence of the village, and sustainable development in the country.

Advantages of agricultural and ecological tourism are:

- Helps to protect the agricultural and forest areas, cultivation lands and rural land
- Creates diversity in forestry and agricultural pattern and job opportunities in rural areas
- Provides opportunities for marketing the forest and agricultural products
- Increases welfare level of local people
- Establishes social and economic relations between urban and rural dwellers
- Provides a bridge between rural and urban areas
- Meets the tourism and recreation needs of urban people
- Rises the respectability of agricultural activity from the urban peoples’ point of views
- Introducing agricultural activities to urban people is a way to educate urban people in the sense of contribution of agriculture to quality of life and economy (Apkinar, 2003)

Key points in development of agro and eco-tourism are:

- defining the nature of the product/service mix;
• identifying agencies and local groups involved;
• Describing significant trends and observations;
• Identifying potential development possibilities.

Essential characteristics of sustainable development in villages are promotion (flyers and bulletins), honest business, competitive prices, pay farmers on time; minimize debts, use laborers, healthy plants, good service, prime locations, word of mouth, family business, etc.

Success factors in agro-tourism and ecotourism are:

• Service excellence
• Long term planning
• Right recipe for tours
• Community spirit
• Repeat business
• Clean environment
• Strong management team
• Good stuff
• Brilliant tour guides
• Hard work
• Exciting rural tour
• Team work
• Good food (Waithe, 2006)

Moreover, alternative Tourism is not only an economical tool that help the locals in the touring sites to be employed and gained higher income but also help enhance the tourism development stably in the future. (Suwanchai Huannaklang, 2005).

Tourism factors which are mainly brought to make a plan to achieve the tourism’s goal consist of 6 components i.e. available package, Accessibility, Attraction, Amenities, Activities, Ancillary Services (Pike Steven, 2008).
For Agro-Tourism concept, Ramiro Lobo (2011) defines that Agricultural Tourism means visiting farming or other agricultural activities, gardening, or the process of agricultural business aiming to entertainment learning and or participating in the activities or in the process of the farming. Any tourism development can be based on stable tourism (The World Tourism Organization (UNWTO), 2007).

Besides this, the community participation in tourism depending on:

- Areas
- Stable Management;
- Environment and resources
- Activity Types and Touring Activities and
- Organization;
- Community’s participation in tourism administration and management (Tourism Authority of Thailand, 2001).

In tourism potential concept, Sommat Sengsui et al. (2008) have pointed to the tourism potential management in agro-agriculture which means tourism management in four aspects:

- Nature; build up the activities such as sightseeing
- Pace way of living; agricultural culture applied for touring services such as home stay living with the locals’ accommodations
- Production process; agricultural attraction refers to local wisdom or local technology that is the highlight of the touring sites and activities according to the tourism administration and management in studying excursion and training, and
- Marketing; mainly focus on the agricultural products probably same or different from those in other areas which these products can directly affect to the market through the exact income.
Marketing blenders which help reach the tourism’s success are: Product, Price, Place/Process of Delivery, Promotion, Physical Environment, Purchasing, Process, Packaging, and Partnership/Participation (Chalongsi Pimonsompong, 2007).

3. MYCOTOURISM

During the last few decades, the tourism is changing towards the development of more nature-friendly and sustainable forms. The so called ecotourism becomes more and more popular recently and it seems that this is a trend that will continue in future. Today there are many varieties of ecological tourism, most notably bird-watching and plant-watching, as well as other more general “green” forms, such as rural and agro-tourism.

Myco-tourism is little explored but there is a great opportunity for generating additional income, especially in rural areas, by offering unusual and highly attractive product; moreover there are very few places in Europe, where myco-tourism is now offered in a long run. There are very few prerequisites required to practice myco-tourism, but one must not forget that in order to be attractive, the particular area must have vast and well-preserved natural habitats, which harbor a variety of fungi.

Myco-tourism as a family business

This form of myco-tourism is especially interesting for owners of small hotels and guest houses in the countryside. For them it may be a good opportunity to make their tourist product more interesting by offering to the tourists an opportunity for learning and collecting wild mushrooms and tasting mushroom dishes, made from their own collected mushrooms. Alternatively, this product might be offered to people, interested in nature photography in general or mushroom photography in particular. This form of myco-tourism will normally require very little investments, but the providers must be people, interested in wild mushrooms themselves. In this case, they will require only a number of books and probably a small microscope, to
make their knowledge on fungi more profound as they must not only be capable of identifying mushrooms, but have to expect a number of questions, to which they will have to give in-debt answers.

**Myco-tourism as a group experience**

This form of myco-tourism is of interest for a larger number of people as if properly exploited, it could provide additional income to a number of businesses in a particular area. It focuses on people with steady interests in mushrooms, and particularly on the different societies of mushroom lovers and the professional mycological societies. It is common practice that those societies organize once a year or more often excursions for collecting and studying fungi, including wild mushrooms. The number of visitors depends much on the society itself, but if proper organization is ensured, a high number of visitors may be expected, which will require accommodation, food and other services. This form of myco-tourism is more difficult to achieve, as it requires good relationships with local societies. On the other hand, logistically it is easier to organize, as at least some of the visitors will be well-experienced in the matter and so, no additional guidance on fungi will be required in most cases. However, the hosts must understand well the peculiarities of the process and be ready to provide more specific services than in the case of casual tourists. For example, in most cases space will be required to install microscopes and to arrange an exhibition of the collected species. Also it might be necessary for the hosts to provide multimedia equipment or at least to be ready to arrange space suitable for meetings during the excursion. If properly organized, this form of myco-tourism may even become a regular event, which will provide to some degree an income to those involved.

**Myco-festivals**
Myco-festivals are probably the most sophisticated form of myco-tourism and also the most profitable one, which may be held every year. However, they are also the most difficult to organize and are therefore a community business. An organization of a mushroom festival is a tricky task and its initiation will require an active core of owners of local business and if possible non-governmental organizations, which will be capable of successfully organizing the event. It also requires an immense support by the local authorities as they play a key role in organizing and promoting such events. The active involvement of municipalities and/or national or nature parks is necessary to make a festival really successful and sustainable in the long run.

Public relations are also crucial for success and the authorities will normally have enough experience in these matters, or they will be able to allocate funding for engaging a public relations company. Funding is required also for some other aspects, as for example creating and setting up learning exhibitions, and this is again something that local authorities will be expected to help with as they will have access to funding opportunities, which will be otherwise unreachable for businesses. Although requiring a lot of effort, mushroom festivals are probably the most attractive form of myco-tourism for the business. They are held annually and as public events could be much more sustainable than attracting individual myco-tourists. They also attract visitors of rather different ages and interests (this is generally a family-friendly tourism), which is beneficial not only to those providing food and accommodation, but also to various other local businesses offering goods or services.

4. DEVELOPING WILD EDIBLE MUSHROOM COLLECTION AND CULTIVATION

Mushroom collection from natural areas and their farming are forms of economic activities with a lot of interesting functions: process, production, harvesting, products processed to various types of product. Additionally the knowledge to develop the
ability of the mushroom farming for agro-tourism in European countries can be learning processes where not the formal activity is at the moment. For developing mushroom farming and collection of wild edible mushrooms in forests in order to support the agro-tourism and especially the eco-tourism needs to develop the concepts in agro- and eco-tourism planning and management. The process of Destination Zone Planning consists of: Identify Sponsorship and Leadership, Set Goals, Investigate Strengths and Weaknesses, Develop Recommendation, Identify Objective and Strategies, Assign Priorities and Responsibilities, Stimulate and Guide Development, Monitor Feedback (Wanna Silpa-archa et al, 2002).

4.1 Swot Analysis of wild edible mushroom collection and farming

Following a swat analysis concerning mushroom collection and farming we are concluding:

**Strengths**

1) Many mushrooms are of high nutrition value and their properties could be exploited for medicinal purposes.
2) Most mushroom farms bring the synchronous interesting technology that is used in production.
3) Many mushroom species are associated with particular plant species in forest habitats.

**Weaknesses**

1) Mushroom collectors even mushroom farmers still lack of knowledge to develop the potential of the mushroom farming in order to support the agro-tourism.
2) Most mushroom collectors and farmers in Greece and Cyprus aim to produce the products for trading rather than supporting the agro-tourism.
3) Most collectors are only interested in the amount of mushrooms they are going to harvest and they use tools (e.g. rakes) that destroy fungal mycelia in the upper soil part as well as unripe mushrooms (Cyprus).

4) Several mushrooms collectors do not know how to identify poisonous mushrooms, and as a result several mushrooms consumers end up at the hospital every year (Cyprus).

5) Most mushroom farmers have not the experience/knowledge to diversify their production with other types of mushrooms.

6) Most mushroom farms have an inadequacy of personnel to work in their farms.

7) Development of mushroom farming needs high budget for establishment

8) The farmers as well as the collectors sometimes seems to have lack of marketing public relations

Opportunities

1) Cyprus, Greece, Italy and mountainous places in Bulgaria are places where tourists from Northern Europe usually visit.

2) Forests that produce mushrooms and Mushrooms Farms are usually located not so far from the cities; tourists are able to visit them.

3) Currently tourists are more interested for wellness tourism than in the past time

4) Offices involved in tourism are ready to help enhancing the potential development of the mushroom farming in order to support agro-tourism, to relate and introduce mushroom farming areas as the new alternatives of touring destinations.

Threats

1) Particular weather conditions such as heavy rains or long dry seasons usually have a negative role at mushroom production.

2) Tourists visiting Greece, Cyprus and Italy are not particularly interested in agro-tourism.
4.2 Guidelines for supporting Agro-tourism and Eco-tourism with mushroom products

4.2.1 Product
a) Touring Activities in the mushroom growth and farming areas should include trade of fresh and/or processed mushroom products.
b) Touring services in the mushroom farming areas should provide good quality restaurants in the community.
c) Mushroom farming areas should have public sanitation facilities.

4.2.2. Price
It should be a specific price policy as announcement for touring services and accompanied activities in the mushroom farming areas alternatively for tourists’ decision.

4.2.3. Place/Process of Delivery
Should present agro-tourism in the mushroom farming areas conducted by the salespersons.

4.2.4. Promotion
Should have marketing promotion conducted by salesperson for example: events for selling products.

4.2.5. Physical Environment
The owners of each farm should establish their hospitality to tourists.

4.2.6. Purchasing Process
Being good farms’ reputation to be more well-known.
4.2.7. **Products collection management in Tourism**

Should provide agro-tourism programs of the mushroom growth area and the mushroom farming areas in accordance with the other interesting agriculture areas in the community.

4.2.8. **Business co-operation in Tourism**

Tourism Authorities should have business co-operation with NGO’s and touristic agencies in each country.

4.3. **Developing Plan**

4.3.1. **Vision**

The vision should be clear for each country touring resources of each country (Greece, Italy Cyprus, Bulgaria. Furthermore the common vision could be ‘to live and promote a lifestyle that is sustainable for our environment and our society. To foster growth in our community, environment, and society harmoniously with the existing ecosystems and cultures.”

Furthermore the Agro Tourism’s Vision for the Future could be:

- Develop an Awareness Programme which empowers people to think differently and know the importance of living and working organically and sustainable in harmony with nature and each other.
- Empower village women to know and value their skills and capabilities and to earn money themselves, for example by providing home-made food and stay accommodation.
- Education and train farmers and promote Eco-Tourism so that individuals and communities can build towards and grow their potential.

4.3.2. **Mission**
Intensively develop the potential of the mushroom growth areas and mushroom farms to be touring resources of each country for agro-tourism learning with full services for health. The mission could be to share mushroom Agro-Tourism experiences as a different way to enjoy the long waited vacation. In this way when somebody get to those destinations, can have a well formed idea of what it is going to find.

4.3.3. Goal

One of the main goals of eco-tourism is to increase the awareness tourists have about the social conditions surrounding a travel destination and to develop the potential of the mushroom farms to be touring resources for agro-tourism learning with fully healthy standard services (Sawettachat Nakachat 2012). According to these, ecotourism's goals are:

1) Conservation of natural and cultural resources
2) Improvement of local community welfare (economically and culturally)
3) Empowerment and enrichment of tourist's experience
4) Economical and business profitability

4.4. Proposed Management Plan for Mushroom agro-tourism and eco-tourism

An eco-tourism management plan is a tool to guide the development of tourism in a protected area by synthesizing and representing the vision of all the stakeholders while fulfilling the conservation objectives for the site. It should result in a document expressing the stakeholders’ recommendations for how ecotourism is to be carried out in a particular protected area. Typically, an Eco-tourism Management Plan will be a detailed continuation of general guidelines established in a general management plan. The general management plan usually determines that ecotourism is the kind of tourism that is desired for a particular protected area and that ecotourism, or perhaps public use, will be a specific program to be carried out by protected area managers. The general management plan will also define the zoning configuration for
the area, which in turn will designate those sectors that will be available for tourism purposes.

Certain fundamental issues must be considered:

1) To manage the closed system of areas that can be collected mushrooms as well as for mushroom farming in order to stably support the agro tourism
2) To readjust the surroundings focusing on beauty, cleaning, putting circumstances in order and matching with the environment in the mushroom farms
3) To build up distributing gift shops for health with processed mushroom and also other various kinds of products made in the community mainly for health
4) To build up restaurants for health with especially mushroom recipe and vegetables for health
5) To build up Tourist Service Center to welcome visitors and to give information, knowledge, regulations related to mushroom farm visiting
6) To make signs and notices in the proper sections where tourists can make understanding by themselves
7) To facilitate the disables e.g. toilet, path and slope way (Sawettachat Nakachat 2012).

4.5. Proposed management of touring activity programs in order to support the agro-tourism and eco-tourism

While agro-tourism activities are frequently offered as ways to supplement or diversify income, a variety of ‘other’ motivations abound such as education, for the fun of it, & community involvement. These motivations may be just as important to agro-tourism businesses as the economic incentives. They also indicate a greater emphasis on social sustainability rather than purely economic profitability. Accordingly touring activities divided into four programs as follows:
1) Outstanding Mushroom Collectors and Cultivator: tourists are able to acquire and participate in producing process, harvesting intensively advised by the specialists

2) Terrific Chef: tourists are able to learn and join harvesting the products including cooking mushroom recipe

3) Mushroom Buffet: Tourists are able to participate in mushroom processing related to production and they are allowed to try out tasting various kinds of ready processed mushroom products as many as they can buy and take home

4) Mushroom Shop: Tourists are able to learn producing process and test the product from mushrooms

4.6. Proposed development for personnel in order to support the agro-tourism project

1) To adapt the organization structure matching and according with tourism management by putting in a touring administration management section directly responsible to tourism.

2) To hold up seminars on touring management in farms, administration process in mushroom farm touring to all sections in farms for being in the same knowledge and understanding.

3) To hold up seminars on mushroom cultivation processes.

4) To provide the English communication skills training to touring personnel to be able to communicate with overseas tourists.

4.7. Proposed development plan of marketing and public relations for mushroom farms project

1) Create up the websites, Facebook’s of mushroom farms

2) Create up folders introducing mushroom farms and touring documents e.g. mushroom farm touring booklet, brochures telling knowledge and mushroom cultivating process, and values of mushroom etc.
3) Participate in any other product distributing events
4) Advertise mushroom farm touring in newspaper, magazines, journals
5) Cooperate with government and non-government services i.e. the Tourism Authorities, restaurants, touring companies, gift shops, hotels, other touring destinations for brochure distribution and public relations
6) Public relations made through other various touring websites such as those of government and non-government services, other local governments, touring companies, touring companies, hotels etc.

4.8. Proposed development plan of attraction and touring services project

Once the ecological and social assessments are completed, a tourism plan can be developed that sets parameters for infrastructure development (roads, trails, camp sites), the number and location of tourist visits, and responsibilities for implementing and monitoring the plan. Consider the following when establishing management guidelines:

- Decide on the primary audience--general visitors, tour operators, user groups.
- Identify the theme or key thrust--environmental protection, increased cultural awareness.
- Include guidance for visitor behavior and use--campgrounds, hiking, boating.
- Consult with guides and drivers who escort tourists into target areas.
- Obtain technical assistance from scientists who have studied tourism impacts.
- Organize meetings or workshops with stakeholders in tourism development, and form a committee of residents, resource managers, guides, commercial operators, lodge owners, service personnel, tour drivers, and local

In order to be more specific concerning the mushroom ecotourism:
- Determine visiting routes in mushroom farms with process and systematically continuously
• Give suggestions and regulations to farm owners or touring mushroom collector runners before admission to the farms. Cultivate each farm should several species of mushrooms.

• Collect or to produce mushroom processed into various kinds of product to distribute as gifts, memoirs in each farm which these products should be underneath of controlled standard showing trademark to support specific touring groups.

• Present mushroom farms should innovations in mushroom cultivation such as cultivation on alternative substrates (mushrooms cultivated on paper wastes) to raise tourists’ attraction.

• Get dressed properly the personnel in mushroom farms in same uniforms for orderly arrangement and beautiful touring sites

• Follow good agricultural practices, e.g., agriculture without the use of pesticides by mushroom farms need

• Keep farms clean orderly and safe from poisonous reptiles or animals for instance snakes etc

• Respect and protect the forest (by mushroom collectors), and respect harvest regulations for wild mushrooms (see other Chapters) in order to protect and promote the mushroom biodiversity as well as the forest biodiversity.

• Distribute in the forests for mushroom collection in order to protect the forest soil and the forest vegetation (Sawettachat Nakachat 2012) by mall groups of tourists.

5. CONCLUSION AND FUTURE RECOMMENDATION

In many cases ecotourism offers a combination of adventure, cultural and natural history features. Ecotourism appeals to a growing market in Europe. Since international eco-tourists come primarily from heavily industrialized countries to visit destinations that offer unique natural environments, remote locations and the
absence of large-scale industrialization in the far north can be an asset for cultivating the ecotourism market.

However, the development of a sustainable ecotourism industry requires a planned approach that recognizes and addresses environmental and social impacts as part of its overall strategy for growth. In the absence of a management plan for tourism development opportunities, and the economy built upon them, are no more secure than any other single resource economy (Ontario Nature 2005).

Guidelines should also be developed for tourists, who need and usually appreciate information how to use and conserve protected area resources as followed:

- Present the Agro-Tourism as developed activity to the potential of mushroom farming areas in Greece, Italy, Cyprus and Bulgaria
- Support agro-tourism not only leads as new alternative for tourists who visit the touristic areas, but also distributes income from tourism to locals.

Since a well-built and thoughtful approach to ecotourism will add sustainability, dimension and depth to a region’s economy the guidelines should be presented of the potential development of the mushroom farming areas in order to support the agro-tourism, farmers who are interested in developing the mushroom collection and the mushroom farming in such the ways researched can take these guidelines to apply to use in their farms to establish managing agro-tourism process more systemically.

Furthermore, this can create the various touring activities up to increase tourists’ attraction or arrange linkages to other touring destinations nearby.

6. Literature cited and suggested


Chapter 7: Use of wild edible mushrooms in the services sector

World Development Indicators. 2008. The World Bank. Washington, USA


Zunić L. 2011. The impact of agro-tourism on sustainable development of Bosnia and Herzegovina.

Internet sources:
http://www.indexmundi.com
http://www.garveylibertyhall.com/IICA/Agrotourism/WhyAgro-Tourism.htm
http://www.europeagritourism.com/
http://www.statemaster.com/encyclopedia/Agritourism
http://www.ecotourdirectory.com/agrotourism.htm
http://www.organsko.ba/
http://www.ekapija.com/
http://www.worldatlas.com/webimage/countrys/europe/ba.htm; etc
APPENDIX - Recipes with mushrooms

1. Originating from Bulgaria

**Soups**

**Soup of fresh mushrooms**

*Ingredients.* 600 g fresh mushrooms (one species or mix), 2/3 cups sour cream, 1 medium-sized onion, 1–2 bay leaves, 10–12 small potatoes, 1 1/2 tablespoons butter, parsley, 10 black pepper fruits, 3 l water, salt.

*Directions.* Clean carefully the mushrooms and wash them good in cold water. Slice the larger mushrooms and put in cold water to boil. After some boiling (check when the mushrooms have become softer, add the finely cut and gently stewed in butter onion, bay leaves, black pepper and peeled and cut potatoes. Add salt and boil until potatoes are ready. Optionally add some noodles. Before serving remove the bay leaves and add a bit of sour cream and chopped parsley.

**Soup of dried mushrooms and rice**

*Ingredients.* 30 g dried mushrooms by choice, 0.5 l water, 1 medium-sized onion, 2 small-sized carrots, 25 g melted butter or olive oil, 40 g rice, parsley.

*Directions.* Wash the mushrooms, cover with water and leave for 4 hours to restore. Boil in the same water until mushrooms become ready. Sieve the broth, chop the mushrooms and return into the broth. Gently fry the finely chopped onion in melted butter and add to the soup. Add the sliced carrots and boil until nearly ready. Add rice and boil until ready. While boiling, add water to restore the initial 0.5 l. Before serving add chopped parsley.

**Soup of beans and mushrooms**

*Ingredients.* 250 g white beans, 300 g fresh mushrooms, 2 medium-sized carrots, 1 medium-sized onion, 2.5 l water, salt, parsley.

*Directions.* Wash the beans, cover in water and soak for 4 hours, then boil in the same water until ready. Wash mushrooms, chop them and stew in vegetable oil until
ready. Puree the chopped onion and carrots with some vegetable oil. Add the fried mushrooms and the puree to the broth. Boil for 5 min. Before serving add chopped parsley.

**Soup of dried mushrooms with yellow cheese**

*Ingredients.* 150 g dried mushrooms (ceps or birch boletes are best), 2 medium-sized onions, 4–5 small-sized potatoes, 30 g vegetable oil, 1–2 bay leaves, 5–10 black pepper fruits, 100 firm yellow cheese.

*Directions.* Wash the mushrooms and soak in water for 2 hours, after which chop in large pieces. Cover with water, add salt, black pepper and bay leaves and boil for 1 up to 1 1/2 hours. When ready, add chopped in small pieces potatoes. Boil for another 15 minutes and add finely chopped onions and parsley. Boil for 15 minutes. When ready, add grated yellow cheese. Before serving add sour cream and freshly chopped parsley.

**Puree soup of mushrooms with onion and tomatoes**

*Ingredients.* 500 g fresh mushrooms (ceps or chanterelles are best), 500 g tomatoes, 5 medium-sized onions, 2 big carrots, 1 small parsley root, 30 g melted butter, 30 g flour, 200 g sour cream, 2 yolks.

*Directions.* Wash mushrooms, cover with water and boil. Chop the tomatoes in a saucer pan, cover and leave to simmer. Chop the parsley root and onion, add melted butter, cover and stew to golden colour. Add the stewed vegetables into the tomatoes. Stew slowly until dark red. Add butter and flour and stir well. Half an hour before serving puree everything and add the remaining mushroom broth. Boil until the desired thickness is achieved. Before serving mix well the yolks with sour cream. Add to the very hot, but not boiling soup and stir well.

**Salads**

**Mushroom salad with eggs**
Ingredients. 250 g fresh or canned mushrooms, 3 eggs, 1 large-sized red onion, 150 g vegetable oil, 1 tablespoon vinegar, small amount of vegetable oil for stewing, chives, parsley or dill.

Directions. Stew the mushrooms in a saucer pan, adding some vegetable oil. Boil the eggs very well and chop them into small pieces. Chop the onion and chives and mix with the mushrooms and eggs. Add vegetable oil and vinegar. Mix well again. Keep in cold place. Decorate with parsley or dill (not chopped) before serving.

Mushroom salad with Soya sauce

Ingredients. 300–400 g tough mushrooms (chanterelles are best), salt, 1–2 bay leaves, 5 black pepper fruits, 5 white pepper fruits, dill, lemon juice, Soya sauce.

Directions. Wash the mushrooms and put in well-salted boiling water with bay leaves and black and white pepper. Boil for 20 minutes. Remove the water with spices and chop mushrooms into small pieces. Add equal amounts of Soya sauce and lemon juice to half-cover the mushrooms. Leave for at least 2 hours (better overnight) in refrigerator. Before serving, add chopped dill, mix well and give half an hour at room temperature.

Salad of canned mushrooms

Ingredients. 300 g canned mushrooms, 5–6 boiled potatoes, 3 boiled eggs, 3–4 pickles, 4–5 tablespoons mayonnaise, parsley.

Directions. Peel the potatoes and chop into small pieces. Grind the canned mushrooms and the eggs and mix with the potatoes. Chop pickles into small pieces and add to the mixture. Add mayonnaise and decorate with chopped parsley.

Salad of mushrooms and chicken

Ingredients. 200 g fresh mushrooms (one species or mixed), 1/2 chicken, 50 g vegetable oil, 1 peeled tomato, 1 medium-sized onion, 30 g peas, 250 g rice, 1/2 l chicken broth, 1 teaspoon lemon juice, salt, black or white pepper, celery.
Directions. Wash and boil the mushrooms. Chop into small pieces and soak with the lemon juice. Chop onion and celery into very small pieces and stew. Mix the stew with salted mushrooms, add ground black or white pepper. Add rice and stew, mixing carefully until rice becomes transparent. Add a cup of chicken broth. Stew for 10 minutes and add peas. Stew until the mixture absorbs all water. Put off the fire and mix with chopped boiled chicken and fresh tomatoes. Cover and leave in refrigerator for an hour. Serve cold.

**Salad of canned mushrooms, rice and olives**

*Ingredients.* 200 g canned mushrooms, 1 cup rice, 1 tin olives, 3–4 tablespoon olive or other vegetable oil, 1–2 tablespoons lemon juice, ground black pepper.

*Directions.* Wash the canned mushrooms, chop them into fine pieces and warm a bit in vegetable oil. Remove the stones of the olives and chop the latter. Boil rice until ready, let it cool and mix with mushrooms and olives. Prepare dressing of vegetable oil, ground black pepper, salt and lemon juice. Shape the salad and pour the dressing on the top. Leave in refrigerator for at least 30 minutes. Serve cold.

2. Originating from Italy

**Noodles with porcini**

*Ingredients* (4 persons):

440 g Porcini mushrooms, 1 clove of garlic, a sprig of parsley, 40 g grated Grana Padano cheese, 1 or 2 mashed chili, extra-virgin oil as required, a pinch of salt and pepper.

Fry the garlic in a pan with 2-3 tablespoons of oil (making sure it does not darken too). Add the porcini mushrooms cut into thin slices and cook for fifteen minutes, stirring occasionally with a wooden spoon. Add salt, pepper, seasoned with a little
mashed chili and fry for a few minutes. Boil the noodles in salted water. Drain the pasta “al dente” (not overcooked) and sauté for a minute in the pan with the mushrooms, after being sprinkled with chopped parsley. Brought to the table and serve, adding a bit of grated Grana Padano cheese.

Chanterelles with cheese
Ingredients (4 persons):
800 g of chanterelles, 40 g butter, 80 g bacon, 1 onion, 3 spoons of cream, 1 spoon of flour, a pinch of salt and pepper, a pinch of cumin, 75 of Emmenthal cheese, chopped parsley.
Clean the mushrooms and cut them in half. Fry in hot butter the diced bacon until it becomes transparent, add the onion sliced thin and let it brown. Then add the chanterelles, stir and let it cook. The cooking time depends on the size of mushrooms. Cream together the flour and cream associated with this sauce. Finally add salt, pepper and cumin, stir gently Emmenthal cheese and sprinkle with chopped parsley.

Beef fillet with truffles
Ingredients (4 persons): 4 slices of fillet (thick 3 cm), extra virgin olive oil, 50 g of black truffles, balsamic vinegar, a pinch of salt and pepper.
Cook the fillet on the grill as usual. Put in a pan with oil, salt, pepper and a few drops of balsamic vinegar. Add the truffle slices and lay the fillet cooked and sliced. Hold on a minute over high heat to spice up the thread.

3. Originating from Cyprus

Cyprian Mushrooms
Ingredients: 500g White Button Mushrooms, Butter, Commandaria wine (or Port), Rosemary, Black Pepper, Salt, Demerera sugar
Directions: Chop mushrooms into quarters, melt butter in a pan and add commandaria wine, rosemary, pepper, salt and demerera sugar. Heat until the sauce thickens and caramellises, approximately 10 minutes. Add sliced mushrooms and fry until brown and the sauce has been absorbed by the mushrooms, approximately 7-8 minutes. Do not over cook.

Cyprus Mushrooms with colander

Ingredients: 1 lb Fresh Shiitake Mushrooms (you can mix different verities of mushrooms), 1/4 cup corn oil (or Olive Oil), 1/2 cup dry red wine, 3 tsp crushed coriander seeds, Dash Mushroom Garlic Seasoning salt and black pepper, to taste.

Directions: Trim and wipe the mushrooms clean with a dry cloth -- do not wash. Leave whole and fry in oil about 3 or 4 minutes. Sprinkle with Mushroom Garlic Seasoning. Reduce heat; add red wine and salt and pepper to taste. Cover and simmer for 5 minutes. Add crushed coriander seeds, cook for another 2 minutes and serve. Serve hot as a vegetable accompaniment to grilled or roast lamb, pork, veal or chicken. Note: Pistol River "Mushroom Ultimate" is excellent on Lamb, Pork and Veal.

Fungi (Mushrooms In Sauce) Byzantine recipe

Ingredients: 1 pound fresh mushrooms, mixed (e.g., white and Portobello), 1/2 teaspoon ground pepper, 2 cups white wine, 1/2 cup vinegar, 1/2 cup olive oil

Directions: Boil the white wine in a saucepan for half an hour, or until liquid is reduced by approximately half. Meanwhile, wash, trim and slice mushrooms, mix pepper, reduced wine, vinegar, and oil and pour over mushrooms, allow to marinate for at least an hour before serving, and preferably overnight.

Lenten Koupepia (Lenten Dolmades)

Ingredients: 400g button mushrooms, finely chopped 2 onions, finely chopped 4 globe artichokes, finely chopped 2 carrots, grated 200g short-grain rice 1/2 tbsp flat-leaf parsley, finely chopped 1/2 tsp ground cinnamon 1/2 tsp freshly-ground black
pepper 6 tomatoes, grated juice of 2 lemons salt, to taste olive oil 185ml passata (tomato sauce) 70 to 80 vine leaves.

Method: If using tinned or preserved vine leaves then wash and drain. If using fresh, wash them well then place in a large bowl of warm water to soften. In the meantime, prepare the filling. Heat the olive oil in a pan, then add the onion and fry for about 4 minutes, or until soft. Add the carrots, artichoke pieces and mushrooms. Continue cooking until the mushrooms release their liquid and this liquid evaporates. Stir in the rice and season with cinnamon and black pepper then add the tomatoes and lemon juice. Season to taste with salt and stir to combine. Bring to a simmer, cover and cook gently for 10 minutes then take off the heat and set aside to cool. Once the filling mixture has cooled take a teaspoon at a time and place near the stem end of a vine leaf. Fold over the two sides then roll the leaf up tightly so that the meat filling is securely held in the middle. Tightly pack all the koupepias in a 4l casserole dish (arrange in multiple layers, if necessary). Sit a plate on top to hold then in place then pour in the passata. Add just enough water to cover the koupepias then bring to a gentle simmer over low heat, cover with a tight-fitting lid and cook for about 30 minutes, or until the rice is tender and the koupepias are cooked through. These can be served warm as an accompaniment or they can be cooled and served as a snack or as part of a salad.

Afelia with Meadow Mushrooms

Ingredients: 1 lb. lean pork, cut into 1” cubes, 1 lb. new yellow potatoes, 1 med onion, sliced, 1 lb. Agaricus campestris buttons, cleaned & halved (or other Agaricus, 6 T. vegetable oil, 1.5 C. good red wine, 2 T. coriander seed, well crushed, 1 stick cinnamon, salt & fair amount of pepper.

Methods: Marinate the pork overnight in the refrigerator with the wine, coriander, cinnamon, salt and pepper, drain meat & pat dry, reserving the marinade, heat 2 T.
oil in a large deep skillet (not cast iron) with fitting lid. Add the whole potatoes and lightly brown on all sides over medium-high heat. Remove potatoes & set aside, add 2 more T. oil to pan and brown the pork on all sides. Remove pork & set aside with potatoes, add last 2 T. oil and sauté the onion until almost browned, then add the mushrooms and sauté 2-3 minutes. Reduce heat to low, and add pork, potatoes and reserved marinade back to pan, cover and simmer 45 minutes or until pork & potatoes are tender and sauce is very thick. Correct seasoning.

**Mushrooms Afelia (Mushrooms in Red Wine with Coriander)**

Ingredients: 1/2 lb small mushroom, rinsed and drained, 1/4 cup olive oil, 1/2 cup red wine, salt and black pepper, to taste, 1 tablespoon coriander seed.

*Methods*: Heat olive oil in a skillet over medium heat, add the mushrooms and cook until browned all over, about 5 minutes, stirring continuously. Add wine to skillet and let it come to a boil, allowing it to remain at a hard boil for 1 minute. Turn heat down and let it simmer, uncovered, for 8 minutes. Season with salt, pepper, and coriander seeds, and cook for 2 more minutes. Cool slightly before serving.
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

EUROPEAN UNION
LEONARDO DA VINCI – TRANSFER OF INNOVATION

"MYCOTICON" (MYCOTa Intereuropean COoperation Network)

“Identification and sustainable exploitation of wild edible mushrooms in rural areas”

Grant Agreement no: 2011-1-GR1-LEO05-06802

Chapter 8
“AN OVERVIEW OF EXISTING LEGISLATION ON COLLECTION, TRADING AND CONSERVATION OF WILD EDIBLE MUSHROOMS”

Giuseppe Venturella¹, Maria Letizia Gargano¹ and Georgios I. Zervakis²

¹Department of Environmental Biology and Biodiversity,
University of Palermo, Italy

²Laboratory of General and Agricultural Microbiology,
Agricultural University of Athens, Greece

October 2012
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

1. RULES AND REGULATIONS (INTERNATIONAL AND EUROPEAN) FOR WILD EDIBLE MUSHROOMS COLLECTION AND TRADING

1.A. Indicative cases from the USA and other countries outside Europe.

Wild edible mushroom (WEM) harvesting is performed worldwide either for personal consumption or for trade purposes. Especially as regards the latter activity, which is considered as a global enterprise, its potential impacts concern mainly forest managers wherever harvesting occurs. Regulations often are tailored to local land tenure and traditions concerning access to harvesting opportunities. In Canada and Mexico, mushroom hunting is largely unregulated by government even though there are many mushroom pickers. In contrast, in the western United States, harvest of wild mushrooms is more intensively regulated and surveilled than perhaps anywhere else.

In USA (Pilz and Molina 2002, Alexander et al. 2011), all citizens and companies are entitled to equitable access to commercial resources since Federal forest lands are publicly owned. Most National Forests (USDA-FS) sell commercial harvest permits to individuals at set prices. Permits usually allow unlimited collection during a specified season because rules limiting the quantities collected would be difficult to enforce. In some cases the number of permits are restricted. For example, matsutake (Tricholoma magnivelare) fruiting in the Oregon Dunes National Recreation Area is fairly reliable and harvesters can estimate how much they will be able to collect in a season thus, a limited number of permits are issued by sealed bid auction. The USDI-BLM sells contracts for mushroom harvesting, which stipulate the species that can be harvested, maximum quantities for each, specified areas for harvesting, and a limited time frame depending on the amount sold and number of anticipated harvesters. Contract prices are set at the maximum of either 10% of the wholesale value or the calculated results of a formula that includes items, such as shed price, purchaser’s
potential profit and risk, labor costs, transportation, and road maintenance. Some districts have minimum contract prices or quantities. All these methods have advantages and disadvantages for both managers and harvesters, but equity and compliance are improving as procedures are refined by experience and communication.

Most Federal forests also have areas off-limits to commercial activities; these include wilderness areas, research natural areas, mushroom research areas, designated recreation areas, or other areas of special environmental concern. All National Parks (USDI) in the region prohibit commercial mushroom harvesting. Some industrial and nonindustrial private forest landowners prohibit or restrict commercial harvesting on their properties. Even in areas where commercial activities are allowed, managers will sometimes rotate areas where collection is permitted to provide fallow periods. Adherence to various harvest restrictions is not uniform; compliance is influenced by mushroom prices, access difficulty, harvester attitudes about regulations, and enforcement.

In Canada (Berch et al. 2007), one of the most interesting regions for commercial mushroom harvesting is the forested land of British Columbia. Despite the fact that timber harvesting is managed under various tenures (e.g., tree farm licences, timber sales, woodlots, and community forests) and the provincial government collects revenues, no tenure system exists for non-timber forest products (NTFPs) such as mushrooms, and no revenues are collected. In addition, no regulations govern the management of NTFPs, although Section 168 of the Forest and Range Practices Act (in which they are called “botanical forest products”) allows for such regulations to be made (B.C. Ministry of Forests and Range 2003). Despite this lack of tenure and regulation, management of pine mushroom habitat is starting to be incorporated into forest management.

In northwestern British Columbia, the Nisga’a Lisims government has adopted a land use plan for their First Nations treaty land that designates a special
management area for pine mushroom (*Tricholoma magnivelare*) and a botanical forest products zone within the area designated for forest resource use (Nisga’a Lisims Government 2002). In addition to pine mushroom, the prescribed NTFPs include black morel (*Morchella elata*), oyster mushroom (*Pleurotus ostreatus*), king bolete (*Boletus edulis*), blue chanterelle (*Polystellus multiplex*), funnel chanterelle (*Craterellus tubaeformis*), lobster mushroom (*Hypomyces lactifluorum*), chicken-of-the-woods (*Laetiporus sulphureus*), hedgehog mushroom (*Hydnum repandum*), and cauliflower mushroom (*Sparassis crispa*). The policy requires that forest management decisions take into account the cumulative effects of land use on NTFP habitat. In 2005, permits were issued for commercial harvesters and buyers of NTFPs.

In Korea (Berch et al. 2007), matsutake (*Tricholoma matsutake*) harvesting on national and public forests has traditionally been carried out by people living in the neighbourhood. Since the 1990s, however, this neighbourhood system has broken down because more and more people are harvesting matsutake. Because of increasing conflicts, harvesting regulations were developed. Harvesting rights for forests owned nationally or publicly are now being sold to neighbourhoods. The cost of these harvesting rights is one-tenth of the value of the mean production over a 4-year period, which takes into account the annual variation in productivity. Officially, harvesting rights must be sold through open public tender to people living close to the matsutake forest, but most of the rights are in fact privately contracted to local residents, who are often the village head. The village head then holds the rights and the village residents organize teams to harvest in the allocated area.

Korea’s Songyi Use Restriction Notice for matsutake went into effect when exportations to Japan started in 1967 since at that time all matsutake had to be exported to Japan to acquire foreign currency. The notice established open and public education and qualification criteria for matsutake sorters and buyers, for selection of equipment, and for sorting grades. However, the notice was deregulated in 1995 as the government eased its restrictions on export, and a portion of the
matsutake harvest was sold on the domestic market. Because all other wild-harvested mushrooms in Korea have much less value than matsutake, no regulations apply to their harvest.

1.B. Indicative cases from European countries.

There are widely differing rules and policies on the collection of wild edible mushrooms. In Sweden and elsewhere in Europe there is a long tradition of access to private property for collecting edibles, such as mushrooms. Scandinavia has open access: anyone can pick mushrooms as long as they do not harm property. This policy has been challenged by economic migration from neighbouring countries (i.e. former Soviet Union), and the availability of cheap labour for collecting wild mushrooms and wild berries. Similar changes in eastern Europe have created new opportunities for commercial harvesting and led to concern about unsustainable harvests and how to regulate collections.

After World War II (Boa 2004), the Finnish government encouraged harvesting of wild mushrooms and continues to promote the use of this underutilized resource. Open access to the countryside is a tenet of life in Sweden and Norway and controlling the collection of mushrooms (and other NTFP) would require a fundamental change in national policies. In Switzerland, Egli et al. (1995) proposed standardizing wild edible mushroom collection regulations because each canton stipulated different days of the week for collecting mushrooms, and individuals raid each other’s cantons when they are prohibited from collecting locally.

In Castilla León in northwest Spain (de Román and Boa 2006), the permit system for collecting *Lactarius deliciosus* collapsed when only four people bought permits in 2002, at a cost of US$30 for a six-week season. The other collectors decided this was no longer necessary, mainly because the guards from the Servicio de Protección de la Naturaleza proved to be increasingly ineffective in checking permits. Local collectors were concerned about the influx of outsiders to collect mushrooms.
and were insulted when asked to show their permits. There is no obvious friction between the local people and visiting collectors from nearby villages, but several people said the permit system should be reinstated since they were worried about the long-term prospects for mushroom production.

Around Borgo Val de Taro, Parma, in northern Italy (Zambonelli 2002), the permit system appears to work more effectively. The local authority publishes the regulations each year, stating the conditions and costs of collecting wild edible mushrooms. The rates vary from around 3 euros for a one-day permit for local residents with slight increases for non-residents. The differences are more marked for the six-month permits, with non-residents paying up to twice as much as local people. Collecting is restricted to three or four days a week and a daily harvest of between 3 and 5 kg. In Italy, each province regulates who has the right to collect truffles (*Tuber* spp.). Collectors have to pass a simple test that confirms they are aware of how and where to harvest. Around 30,000 licences were issued in Emilia Romagna in 2001. Especially as regards Italy, pertinent legislation is provided in Appendix I for presenting in detail a case of detailed regulation of relevant issues in a European country.

In France (Bérelle 2002), the increase in people collecting wild mushrooms has prompted the introduction of more formal rules regarding when and how much can be collected. Daily limits of 5 kg are stated with no collecting allowed on Tuesdays and Thursdays. A yearly permit costs around 100 euros.

In Belgium (Fraiture 2010), collecting mushrooms is totally prohibited in dominical forests of the Flemish Region (“Bosdecreet”) and, since 2009, of the Brussels Region. In the dominical forests of the Walloon Region, there is an interdiction of circulating outside of the roads and paths and a restriction of the amounts of mushrooms collected. The decision concerning mushroom picking in the private forests is left to the owner of the forest.

In the Grand Duchy of Luxembourg (Garnier-Delcourt 2010), fungi (incl. lichens) are protected since 1989 under a National Law on the integral and partial
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

protection of certain plant species of the wild flora. Mushrooms, considered in this legal frame as part of the flora, are partially covered. Collecting mushrooms for non-commercial purposes is allowed for ca. 50 species which are listed in an annex of the Law, of which 1 kg (fresh weight) per person and per day can be collected, whereas collection for commercial use is subjected to prior authorization from the Ministry of Environment. Only three specimens of all other species (i.e. those not listed in the annex) can be collected.

Furthermore, the expansion of commercial harvesting in Europe has resulted in the introduction of regulations in Poland, Serbia, Romania and other countries. Information about the success of these schemes is sketchy and highlights the general difficulty of monitoring the conditions set by a permit. They often state how much can be collected in a fixed time but it is difficult to check this and collect penalties for transgressions. Especially as regards Serbia (Ivančević et al. 2012), the need to protect certain species of mushrooms was recognized relatively early (late eighties). The rapid growth of interest in WEM led at that time to a significant increase of economic investments and financial flows related to the activities of organized collecting and purchase of wild mushrooms. For a while, ex-Yugoslavia was the world’s largest exporter of bolete mushrooms. Hence, there was a legitimate concern that the uncontrolled collecting of mushrooms in large quantities may lead to a decrease in their number. On the other hand, the interest of the state administration was to place harvesting of WEM under control in order to collect taxes from this activity. Although there were expert draft proposals relating primarily to mushroom protection, these were not included in the early adopted legislations. When they were eventually included, they were in a modified form or without tools that could enable control of their application.

Adopted measures aimed primarily at ensuring a regular payment of taxes for the mushroom wholesale trade, and initially, to provide more favorable conditions of mushroom commerce to companies from Serbia by limiting administratively the maximum purchase price for the collected mushrooms. Allegedly, the low purchase
price was supposed to make the picking of wild mushrooms unprofitable, and thus protect them from over-exploitation. Despite the early expressed concern for the protection of fungi, the precautionary protection measures turned out to be ineffective. Based on the Nature Conservation Law from 1988, certain species of mushrooms (collected on a large scale for commercial purposes) were for the first time placed under protection in 1991, as “natural rarities threatened by exploitation and trade”. This regulation included a ban on collecting young and underdeveloped sporophores and a ban of harvesting more than 90% of a “total number” in the area of picking. However, no provisions were made on how to implement the control of these two measures of fungal protection, and expert proposals that involved additional measures of protection were not included in the regulations. The initial positive effect of such regulations, which showed to the public the threat to wild mushrooms, was lost over the years, and even turned into the opposite, based on the opinion that when something was paid for (tax for collecting wild mushrooms) then it may be fully disposed of without much regard. The effect of the prescribed measures on wild mushroom protection was not significant and did not prevent the removal of huge amounts of fruiting bodies from nature in certain territories, accompanied with habitat disturbance and a number of harmful side effects.

The first major changes occurred with the adoption of the Law on Nature Protection in 2009, which finally placed under protection the rare and endangered species of fungi and their habitats, in addition to the commercially-exploited species. Owing to the provisions of this Law, the first study was drafted with the aim of protecting an area exactly because it was a habitat of strictly protected species of wild mushrooms (i.e. Ada Ciganlija near Belgrade). In conclusion, the evolution of legislation concerning wild mushroom protection in Serbia has become closer to the stage when acceptable and more effective modes of protection are being prescribed, but it took unnecessarily too long, and changes that would allow the optimum state of affairs are yet to be undertaken.
In FYROM (USAID 2008), there is regulation on the collection of NTFPs (including wild mushrooms) which consists of: a. Forest Law – It authorizes the public enterprise “Makedonski sumi” to manage all natural resources in forest areas; b. Regulation on the methods for use and collection of NTFPs, where the companies are expected to pay for exploiting forest resources, based on the previously signed Contract with the public enterprise or the Ministry of Environment; c. Nature Protection Law that regulates the protection of biodiversity through the establishment of measures for protecting wild species, their habitats and ecosystems and for securing their sustainable use. The Law regulates the existence and compilation of red lists of threatened fauna and flora (including wild mushrooms), as well as the system of permits for trade (export) of threatened species by issuing the appropriate export permits and/or trade certificate; d. Strategy for protection of FYROM biodiversity with Action Plan, adopted in 2004 providing directions for sustainable use of the natural resources.

In Bulgaria (Denchev 2010), a specific document (law or decree) regulating the collection, purchase, sale, and export of wild fungi is lacking, and those activities are regulated only by the means of the Forestry Act. Any person is permitted to collect up to 5 kg of fresh wild mushrooms free of charge and no special permit is required. Any larger quantity is assumed to be for trade and for this special permit is required from the Forestry Commission, obtainable after fee is paid. The fee is negligible, e.g. for boletes it is approximately 20 Eurocents per kg. None of these regulations apply for private lands, where there are no limitations for collecting. The absence of a special document that would particularly focus on collecting of mushrooms remains a serious issue in this country. So far collecting of fungi in Bulgaria is absolutely free and uncontrolled, and has greatly escalated since 1990.
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

2. CONSERVATION STATUS FOR FUNGI (INCL. WEM) IN EUROPE

The following information derived mainly from the contents of Newsletter 15 (2010) issued by the European Council for the Conservation of Fungi (ECCF), and is based on the reports of either national representatives at ECCF and/or other experts from European countries, which were suitably updated where possible.

Armenia (S. G. Nanagulyan)

More than 1200 species of macromycetes have been reported from the territory of Armenia. Until recently, no Red Book for Fungi in Armenia existed. No fungal species was included in the first edition of the Red Book, which was published about twenty years ago (Red Data Book of Armenia, 1990). Five mushroom species (from the total of 33 species, which are candidates for listing in Appendix 1 of the Bern Convention), were discovered in Armenia. Recently, experts from the Armenian Mycological Society and the Department of Botany of Yerevan State University have proposed the inclusion of 40 species of macromycetes into the second edition of Red Book of Armenia.

Belgium (A. Fraiture)

Belgium has no national checklist for fungi. A first critical checklist of macrofungi of northern Belgium has been published recently (Walleyn & Vandeven 2006). A national checklist of Uredinales is also in the process of publication (Vanderweyuen & Fraiture 2007, 2008, 2010). A regional red list has been published for the Flemish Region : (Walleyn & Verbeken 2000), which covers only some groups of macrofungi: i.e. Geoglossaceae s.l., Poronia and many fleshy Pezizales, Amanitaceae, Hygrophoraceae, Tricholoma, Collybia s.l., Marasmius s.l., Russulaceae, Boletales, Pleurotaceae, Cantharellaceae, hydnoid fungi and epigeous Gasteromycetes.

Mushrooms are protected in natural reserves, together with all other organisms, and there is only one natural reserve created especially for their...
protection. It is the richest waxcap grassland of the country with about 30 *Hygrocybe* / *Hygrophorus* species and 12 clavarioid species. In addition, in northern Belgium, a network of (rather small) forest reserves has been created in 1995 and consisted, in 2004, of about 1500 ha strict (= unmanaged) reserves, which is favourable for wood inhabiting fungi.

**Bulgaria (C. Denchev & M.M. Gyosheva)**

Fungi were for a long time neglected by the Nature Conservation officials and thus not even mentioned in the *Biodiversity Act* despite of the numerous critical notes and proposals submitted when the law was passed in 2002. In 2007 after continuous lobbying, amendments to the Act were proposed by members of the Bulgarian Mycological Society. All the amended texts were consequently approved by the Bulgarian Parliament. It is worth noting that in the *Biodiversity Act* the word ‘fungi’ was included, as an analogous term of ‘plants’ and ‘animals’, which in itself was an important step. However, the proposal to add fungal species to the Appendix 3 – *Species protected by the Law*, was rejected. Instead of that 10 fungi were listed in Appendix 2a. Those must be protected by the means of protection of their habitat and localities, including the possibility of declaring of new protected territories. No fungi were added also on the list of species, whose collection and marketing is restricted.

A complete Checklist of the larger basidiomycetes in Bulgaria was recently prepared (Denchev & Assyov, 2010). In the checklist, the total number of accepted names of species of larger basidiomycetes in Bulgaria is 1537. A checklist of Bulgarian *Pezizales* was previously published (Dimitrova & Gyosheva, 2009). It includes information about the distribution across the country, literature sources, and trophic affiliation of 191 species. Thirty-two species of them have conservation status at national level. A contribution to the knowledge of the hypogeous ascomycetes in Bulgaria was also published by Dimitrova & Gyosheva (2008).
A project for preparation of a three-volume Red Data Book of Republic of Bulgaria (2004–2010) was assigned by the Ministry of Environment and Water of Republic of Bulgaria. In the framework of that project and especially, for the purpose of its first volume, dealing with threatened plants and fungi, the necessary information about 146 larger fungi was included within the following groups: 37 Critically Endangered (CR), 105 Endangered (EN), and 4 Vulnerable (VU) species. Every single species has been appropriately illustrated with a distribution map and colour illustration. In the third volume, Natural habitats in Bulgaria, characteristics and threatened species of fungi are given for 108 habitats.

**Estonia (I. Saar & I. Sell)**

Three threat categories exist for fungi (categories I, II and III), and 46 fungal species protected with law in Estonia. According to the Nature Conservation Act, all localities of the species of I category must be protected, not less than 50 % of the localities of the II category species, and not less than 10 % of the localities of the III category species. For this, in addition to the protection in numerous Protected Areas, many new special Species Protection Sites have been organized in 2004.

Information about the distribution of fungal species in Estonia is available at homepage of Estonian Species Registry (http://elurikkus.ut.ee/), while check-lists were prepared by Järva and Parmasto E. (1980) and Järva et al. (1998). A rather recent Red Data List of Estonian Fungi including 168 fungal species was compiled in 2008 and authorized by Minister of the Environment of the Estonian Republic (Minister’s Decree no. 1048, 26 June 2009).

**Greece (G. Zervakis)**

There is no legislation for the conservation of macrofungi neither for harvesting and trade of wild edible mushrooms. In 2007, the Ministry of Agriculture asked to a technical committee to submit a proposal/plan on the sustainable management of edible mushrooms, but this initiative did not yield any applicable deliverables.
Despite the fact that two national check-lists were published on macrofungi (Zervakis et al. 1998, Zervakis et al. 1999), no red-data list exists.

**Republic of Ireland (H. Fuller)**

In a very few cases (e.g. The Curragh, Co. Kildare and Ballyprior, Co. Laois) fungi (wax cap group) are specifically mentioned in relation to protection of those sites. More typically fungi would be protected as a consequence of the habitat being protected.

There is a published checklist of the British and Irish Basidiomycota (Legon et al. 2006); in addition, Muskett & Malone series of papers (Census Catalogue of Irish Fungi) in the Proceedings of the Royal Irish Academy (1950’s -60’s), a series of papers by O’Connor on the Irish mycobiota, published largely in Proceedings of the Royal Dublin Society, and thousands of Irish fungal records in the Fungal Records Database of Britain & Ireland (FRDBBI) managed by the British Mycological Society. There is no red-data list for fungi.

**Iceland (G. G. Eyjólfsdóttir)**

No fungi are protected by law but important habitats for fungi have been protected as National parks or Nature reserves based on the need to conserve habitats for birds, lichens and plants.

A checklist of Icelandic microfungi was published (Hallgrímsson & Eyjólfsdóttir 2004). The latter part, checklist of the basidiomycetes (Agaricomycotina) in Iceland (Hallgrímsson & Eyjólfsdóttir, manuscript) is still unpublished but it was used in Funga Nordica (Knudsen & Vesterholt 2008) and species from the subarctic/subalpine or arctic/alpine zone marked IS in the text are known from Iceland. When the checklist is ready a red list of Icelandic macrofungi will be prepared.

**Italy (G. Venturella)**

Italian mycologists contributed to different Biodiversity Assessment and Strategy initiatives (Blasi et al. 2009). A check-list of Basidiomycota, including 4296 taxa, were
published by Onofri et al. (2005) while regional check-lists are available for many Italian regions. In Italy, 56 fungi are considered endemic and 87 taxa are rare. Preliminary red-data lists for macrofungi at a national and regional level have also been carried out (Venturella et al. 2002; Antonini & Antonini 2006). Italian mycologists have also contributed to a project for mapping Important Plant Areas by providing information on 42 macromycetes and 394 georeferenced records highlighting eight important areas for fungi at a national level. *Pleurotus nebrodensis* is a critically endangered species (Gargano et al. 2011) being included in the IUCN Red List of Threatened Species (www.iucnredlist.org). A report on the current status of fungal biodiversity in Italy was recently published by Venturella et al. (2011). Fungi are protected by law at national and regional level (see Appendix I).

**Latvia (I. Daniele)**

Checklists of fungi are available for some protected areas (Agaricales s.l. Gasteromycetes and Polyporales s.l. are included) Gauja National Park, Kemeri National Park. In this territories fungi are regarded as distinct organisms.

Two checklists on fungi (Dāniele & Krastiņa 2002, Meiere 2002), and one red-data list (Andrušaitis 1996) on macrofungi are published so far.

**Lithuania (R. Iršėnaitė)**

The *Law on Protected Animal, Plant and Fungi Species and Communities (1997)* set up the protection of rare and endangered species, including fungi and their communities. According to this national legislation, actions leading to the deterioration or destruction of species and habitats of the populations of these species are prohibited. This law is rather difficult to apply for conservation of fungi, due to lack of information on occurrence of the rare species. Private land owners claim that they don’t know about the presence of rare species in their forests and therefore are not obliged to take any measures. The *Law on Protected Animal,... (1997)* had scheduled creation of state register of protected species. It was
later proposed to create a database of protected species, but the real work has not started yet. Protocols should be created regarding data entry, identification quality assurance and question of depositions of voucher specimens is also important. Some information about rare species came from private initiative of biologists and ecologists working in State Protected Areas and was randomly published in edition —Raudoni lapai (Red Lists) starting in 1993. Another problem in legal protection of fungi is associated with fines for law breaking. They are not adequate and it is not clear how they were set. There is a set of penalties applicable only in case of destruction of fungus species, but not their habitat. It seems that today protection of fungi in Lithuania is more formal than real.

The Red Data Book in Lithuania is managed by the Red Data Book Commission under the Ministry of Environment. A total of 68 species of fungi have been included into the Red Data Book published in 1992. In 2003 the list has been extended to cover 134 fungi, from agaricoid, aphylloroid, gasteromycetes and pezizales groups. Species were included on the basis of their abundance and deterioration of their ecological conditions. A total of 112 fungi species were included in the last (2007) edition of Red Data Book and every year commission revises information about allocation of species to the correct categories. However, without evaluation of all macromycetes found in Lithuania according to IUCN criteria some definitely rare species of clavarioid fungi or Cortinariales were still not included into the recent Red Data Book edition.

**Luxembourg (M. Garnier-Delcourt)**

There is no —red list as such for mushrooms in Luxembourg, unless one considers the list annexed to the NNPP as an equivalent. Collaborations with neighbouring countries concerning the occurrence and distribution of certain species exist, e.g. Belgium (Fraiture 2006), France (Courtecuisse 1994) and Germany (Krieglsteiner 1991), as well as in the frame of establishing the species list of the Bern Convention’s first appendix (Dahlberg & Croneborg 2006). The recording and informatised data
management of the data concerning the occurrence of species present on the national territory is ongoing since 2002, via the Recorder application.

**Russia (T. Svetasheva & A. Kovalenko)**

There is no general checklist for Russia. Checklists of separate regions and some federal districts exist. Fungi have legal protection. This protection is often implicit, i.e. in the frame of protected areas where all organisms are protected, whereas it could be considered as explicit in legislative documents such as Red Books or approved red lists.

Nowadays, Russia has a recent national Red Data Book on plants and fungi (2008), while Russian regions (about 70 out of 89) possess their own Red Data Books. Most of these editions are official legislative documents containing data on threatened species as well as rules for conservation. Most of the Red Data Books and approved lists for conservation include fungi, but their number is very different in various regions and usually they are not extensive (in average 20-30 species) in comparison with plants and animals. They include mostly basidiomycetes (agarics, polypores, clavarioid fungi, gasteroid fungi) and ascomycetes (discomycetes).

**Republic of Serbia (I. Ivancevic)**

The present official Law on Nature Conservation, which became accepted and formally valid in 2009, includes fungi (including lichens) as a general group of organisms. The presently ongoing process of preparing additional sub-law regulations and rulebook will result in a precise list of species that will be treated and protected as explicit taxa. These regulations will include 38 strictly protected species and 26 protected species of macromycetes (total of 64 species), as well as 37 strictly protected lichen species and 3 species and 1 genus of protected lichens. These lists have already been accepted by the appropriate Ministry, while the regulations will become formally valid in 2010.
The status of “Strictly protected species” is given to threatened species included in the Red List of Fungi of Serbia, with prescribed special measures of conservation and protection. The status of “Protected species” includes species with commercial importance, and the law regulates the proper way of harvesting and quantities that may be harvested, further trade, transport etc.

**Slovenia (T. Grebenc & D. Jurc)**

Fungi in Slovenia are protected by the "Act on protection of naturally occurring fungi" - Uredbe o zavarovanju samoniklih gliv Ur.l. RS, t. 38/1994 (44/1995, 30/1996, 57/1998). A check list of the Fungi of Slovenia exists (Jurc et al. 2005). In addition, preparation of new legislation for fungal protection including an updated red-data list (a common work of Mycological Society of Slovenia, Institute for Systematics of Higher Fungi and Slovenian Forestry Institute - who contributed to the preparation of list or to subsequent comments) which included macromycetes (Basidiomycota, Ascomycota).

**Switzerland (B. Senn-Irlet)**

The Red List of threatened macrofungi of Switzerland published in 2007 lists all ascomycetes and basidiomycetes, classified as macrofungi and known to occur in the country, together with their categories of threat according to the IUCN criteria. Of the 2956 evaluated species of the Swiss macromycetes flora, 937 (32 %) are threatened. 1 of these is at present extinct in Switzerland (RE), 81 (2,7 %) are considered as critically endangered (CR), 360 (12,1 %) as endangered (EN) and 495 (16,7 %) as vulnerable (VU). An additional 143 (4,8 %) species are listed as nearly threatened (NT) and 1876 species (63,5 %) are not threatened (LC). Due to missing data a total of 2004 species (40,4 %) could not be classified (DD).

The highest percentages of Red List species are found in dry grassland and bogs and mires. The alpine zone has several threatened species due to overall small populations in small areas. In woodlands the percentage of threatened species is
comparable small. However nutrient input from the air threatens the habitat quality especially for mycorrhizal species, especially so in the Swiss plateau. Numerous threatened species are wood-inhabiting species.

Ukraine (V. Hayova)
Ukraine has no official law or regulations for collecting, sale or purchase of wild growing edible mushrooms. There is however other sort of restrictions, sadly famous Chernobyl accident and radioactive pollution preventing consumption of mushrooms in many regions of the country for more than 20 years. Nevertheless picking mushrooms has many centuries of tradition and remains very popular nowadays.

A check-list of Fungi of Ukraine was prepared by Minter and Dudka (1996). At the end of 2009 the third edition of the Red Data Book of Ukraine was also published. Plants, algae, fungi and lichens are published in one volume. All included species are protected by law, and destruction of their habitats is prohibited. The list of species in the third edition has extended to include 57 species of non-lichenized fungi (Ascomycota – 6 and Basidiomycota – 51) and 51 species of lichenized fungi. Among non-lichenized fungi 23 species are listed as rare, 11 – vulnerable, 20 – endangered and 1 – extinct. Attempts of using IUCN categories were made, however, the species were not strictly evaluated against the IUCN criteria yet and still many species are classified as rare due to their abundance in observations.
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

Literature cited and suggested


United States Agency for International Development. 2008. Profile of the "Macedonian" WGP value chain. USAID’s AgBiz Program, p. 56.


APPENDIX I

Pertinent Italian legislation follows as an indicative example for the regulation of relevant issues in European countries.

LEGISLATION

MINISTRY OF HEALTH – Decree of the President of Italian Republic
(D.P.R. 14 July 1995 n. 376)

Regulations concerning the discipline of gathering and marketing of fresh and preserved epigeous mushrooms (Official Gazette n. 212/11 September 1995).

Article 1

Mycological Inspectorates

1. The Ministry of Health, by decree, within 31 December 1996, indicate the criteria and modalities for the issuance of the title of mycologist.

2. The regions and autonomous provinces of Trento and Bolzano shall establish and organize, as part of Local Health Units, one or more centers of mycological public control (Mycological Inspectorates).

Article 2

Sale of fresh wild mushrooms

1. The sale of wild fresh mushrooms is subject to municipal approval.

2. The municipal authorization is granted only to seller who have been recognized suitable in the identification of fungal species which are marketed by the competent services of the region or territorial autonomous provinces of Trento and Bolzano.

3. The sale of fresh cultivated mushrooms remains subject to local regulations for fruits and vegetables.
4. To sale, processing, preservation and packaging of the different species of fungi, an authorization for health approval provided for by law.

**Article 3**

**Health certification**

1. The sale of fresh wild mushrooms for retail is allowed, upon certification as inspected by the Local Health Units, as laid down by regional authorities and the autonomous provinces of Trento and Bolzano.

**Article 4**

**Marketing of mushroom species**

1. It is allowed the marketing of the species of fresh wild and cultivated mushrooms, listed in Annex I.

2. The regions and autonomous provinces of Trento and Bolzano integrate with its own measures, the list of species included in Annex I with other edible species recognized as fit for marketing locally, and communicate it to the Ministry of Health that provides its publication in the Official Gazette.

3. It is allowed the marketing of other species of fresh wild and cultivated mushrooms from other countries provided as edible recognized by the competent authority of the country of origin. To this end, the local Inspectorate carries out inspections performs checks on consignments to survey items on the market.

**Article 5**

**Dried mushrooms**

1. The designation of “dried mushrooms” means the product which, after drying naturally or mechanically, has a moisture content not exceeding 12% +2% m/m and under that name may be marketed fungi belonging to the following species:
a) *Boletus edulis* and related group (*B. pinicola*, *B. aereus*, *B. reticulatus*);

b) *Cantharellus* (all species except *C. subcibarius*, *C. tubaeformis var. lutescens* and *C. muscigenus*);

c) *Agaricus bisporus*;

d) *Marasmius oreades*;

e) *Auricularia auricula-judae*;

f) *Morchella* (all species);

g) *Boletus granulatus*;

h) *Boletus luteus*;

i) *Boletus badius*;

l) *Craterellus cornucupioides*;

m) *Psalliota hortensis*;

n) *Lentinus edodes*;

o) *Pleurotus ostreatus*;

p) *Lactarius deliciosus*;

Q) *Amanita caesarea*.

2. The species recognized as fit with subsequent Decrees of the Minister of Health, in consultation with the Minister of Industry, Trade and Handicraft, as well as those from other EU countries and the member countries belonging to the European Economic Area Agreement can also be sold, provided that lawfully marketed in those countries.

3. Dried mushrooms, from other EU countries and from eveloped countries which are parties to the European Economic Area may also be marketed under other names that refer to the treatment of dehydration suffered if these are allowed in these countries.

4. The durability of dried mushrooms may not exceed 12 months from packaging.

5. The percentage of defective units or altered in each package, should not exceed, depending on the qualitative category referred to paragraph 5, the range of 25-40% m/m, divided as follows:
a) mineral impurities, not more than 2% m/m;

b) organic impurities of plant origin, not more than 0.02% m/m;

c) Mycetophilidae dipteran larvae, no more than 25% m/m;

d) blackened fungi, not more than 20% m/m.

6. The sales description of dried mushrooms under paragraph 1, letter a) must be accompanied by qualifying expressions satisfying the requirements of the mushrooms, set by the Minister of Industry, Trade and Industry by June 30 1996.

Article 6
Packaging of mushrooms

1. Dried mushrooms are sold whole or chopped, in unopened packages with easily visible indication of the scientific name accompanied by the words of Article 5, paragraph 6.

2. The companies and individuals, individual or associated, involved in the preparation or packaging of dried wild mushrooms or preserved indicate in the request for authorization, under Article 2 of Law 30 April 1962, no. 283, and related amended and additions, including the identity of the mycologist under whose control is the identification species as reported in article 5. Companies already operating on the date of entry into force of Law 23 August 1993, no. 352, shall abide by the provisions of this paragraph before June 30, 1998.

3. Contravention of the provisions of paragraph 2 shall be punished by a fine in payment of a sum of € 258.00 to 516.00.

Article 7
Porcini mushrooms

1. It prohibited the retail sale of dried mushrooms in bulk, with the exception of mushrooms belonging to the species Boletus edulis (porcini) and related group, as reported in article 5, paragraph 1.
2. With the name "porcini mushrooms" may be marketed only fungi belonging to the species *Boletus edulis* and related group.

3. The sale of dried mushrooms in bulk is subject to regulatory communal, pursuant to article 2.

**Article 8**

**Ranges of nominal quantity**

1. By decree of the Minister of Industry, Commerce and Handicrafts may be established ranges of nominal quantities of pre-packages of dried mushrooms for the consumer.

2. The ranges referred to in paragraph 1 may be amended or supplemented by the Minister of Industry, Trade and Handicrafts.

**Article 9**

**Treatment of mushrooms**

1. Mushrooms of the species listed in Annex II may be stored in oil, vinegar, and in brine, frozen, or otherwise prepared.

2. The list in Annex II may be amended by the Minister of Health, after consultation with the Minister of Industry, Trade and Handicraft.

3. It allowed the marketing of other species of fungi preserved or dried or otherwise prepared, from other countries, provided that edible mushrooms are recognized by the competent authority of the country of origin.

4. The mushrooms contained in paragraphs 1 and 3 shall be subjected to heat treatment times and temperatures acts to inactivate spores of *Clostridium botulinum*, and/or acidified to values of pH below 4.6 and / or containing added inhibitory adapted to prevent spore germination.

5. The provision in paragraph 4 shall not apply to frozen mushrooms, frozen or dried.

6. Each package can contain one or more species of fungi.
Article 10

Labelling of mushrooms


2. For the designation of the mushrooms the scientific names of the species should be used.

3. The labeling of bulk or prepackaged fresh mushrooms, which cannot be eaten raw, must bear the indication of the duty of cooking.

4. The words "contain mushroom" or similar, used in the labeling of food products based on fungi, should not require additional specifications.

Article 11

Supervision

1. The monitoring of the implementation of Law 23.8.93, no. 352, without prejudice to the powers of the regions and autonomous provinces of Trento and Bolzano, is entrusted, according to current regulations and their respective responsibilities, to the staff of the State Forestry Corps, the nuclei Commodities and Health of the Carabinieri, the guards provincial hunting, law enforcement agencies, urban and rural, the Local Health Units, the rural guards, the guards of the forest associations and special agencies, the security guards and volunteers to the health offices maritime, air and land border of the Ministry health.

2. The security guards assigned to the tasks of supervision, must meet the requirements of Article. 138, Royal Decree 18 June 1931, no. 773, and be recognized by the Prefect responsible for territory.

Article 12
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

Transitional rules.

1. This Regulation shall enter into force on the day of its publication in the Gazette. However, it is permitted the use of labels and packaging do not comply with provided for in this Regulation, provided they meet the rules previously in force, for six months from the date of entry into force of this Regulation. Fungi as packed may be sold until the expiration of the period of minimum conservation reported on its pre-packages.

Article 13

Final rules

From the date of entry into force of this Regulation shall cease to have effect: art. 9, paragraph 1, Article. 11, article 14, article 15, article 16, article 17, article 18, article 19, article 20, article 21 and Article. 22 of Law 23 August 1993.

Annexes:

Annex I provided by Article. 4, paragraph 1 first sentence

Annex II Provided by Article 9, paragraph 1 first sentence

ANNEX I

1) Agaricus arvensis;
2) Agaricus bisporus;
3) Agaricus bitorquis;
4) Agaricus campestris;
5) Agaricus hortensis;
6) Amanita caesarea;
7) Armillaria mellea;
8) Auricularia auricolaria judae;
9) Boletus aereus;
10) Boletus appendiculatus;
11) *Boletus badius*;
12) *Boletus edulis*;
13) *Boletus granulatus*;
14) *Boletus impolitus*;
15) *Boletus luteus*;
16) *Boletus pinicola*;
17) *Boletus regius*;
18) *Boletus reticulatus*;
19) *Boletus rufa*;
20) *Boletus scabra*;
21) *Cantharellus* (all species except *C. subcibarius*, *C. tubaeformis* var. *lutescens* and *C. muscigenus*);
22) *Clitocybe geotropa*;
23) *Clitocybe gigantea*;
24) *Craterellus cornucopioides*;
25) *Hydnum repandum*;
26) *Lactarius deliciosus*;
27) *Leccinum* (all species);
28) *Lentinus edodes*;
29) *Macrolepiota procera*;
30) *Marasmius oreades*;
31) *Morchella* (all species);
32) *Pleurotus cornucopiae*;
33) *Pleurotus eryngii*;
34) *Pleurotus ostreatus*;
35) *Pholiota mutabilis*;
36) *Pholiota nameko mutabilis*;
37) *Psalliota bispora*;
38) *Psalliota hortensis*;
39) Tricholoma columbetta;
40) Tricholoma equestre;
41) Tricholoma georgii;
42) Tricholoma imbricatum;
43) Tricholoma portentosum;
44) Tricholoma terreum;
45) Volvariella esculenta;
46) Volvariella volvacea;
47) Agrocybe aegerita (Pholiota aegerita);
48) Pleurotus eringii;
49) Stropharia rugosoannulata.

ANNEX II

1) Agaricus arvensis;
2) Agaricus bisporus;
3) Agaricus campestris;
4) Amanita caesarea;
5) Armillaria mellea;
6) Auricularia auricula-judae;
7) Boletus aereus;
8) Boletus badius;
9) Boletus edulis;
10) Boletus granulatus;
11) Boletus luteus;
12) Boletus pinicola;
13) Boletus reticulatus;
14) Cantharellus (all species except C. subcibarius, C. tubaeformis var. lutescens and C. muscigenus);
15) Clitocybe gigantea;
16) Clitocybe geotropa;
17) Craterellus cornucopioides;
18) Hydnum repandum;
19) Lactarius deliciosus;
20) Lentinus edodes;
21) Macropiota procera;
22) Marasmius oreades;
23) Morchella (all species);
24) Pholiota mutabilis;
25) Pholiota nameko mutabilis;
26) Pleurotus ostreatus;
27) Psalliota hortensis;
28) Psalliota bispora;
29) Tricholoma columbetta;
30) Tricholoma equestre;
31) Tricholoma georgii;
32) Tricholoma imbricatum;
33) Tricholoma portentosum;
34) Tricholoma terreum;
35) Volvariella volvacea;
36) Volvariella esculenta;
37) Agrocybe aegerita (Pholiota aegerita);
38) Pleurotus eringii;
39) Stropharia rugosoannulata

NOTE: Some Regions have partially integrated the list of species in the Annexes of the Presidential Decree, i.e. Sardinia (Terfezia), Marche (Amanita ovoidea, Russula ssp., Tricholoma sp.), Tuscany (Hygrophorus marzuolus, Calocybe gambosa), Emilia
Romagna (Cortinarius praestans, Russula ssp., Tricholoma ssp.), Lombardia (Russula cyanoxantha, R. virescens, Lactarius ssp.)
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

Ministry of Health

Ordinance of 20 August 2002

Prohibition collection, marketing and preservation of the epigeous mushroom called *Tricholoma equestre*. (Official Gazette No. 201 of 28 August 2002)

Given the Law of 30 April 1962, n. 283, which regulates the hygienic production and sale of foodstuffs and beverage;

Given the Order of the President of the Republic March 26, 1980, No. 327, including the executive regulation of Law April 30, 1962, no.283, and subsequent changes on hygiene control of the production and sale of foodstuffs and beverages;

Given the Legislative Decree 26 May 1997, n. 155;

Given the law of 23 August 1993, n. 352, laying down the framework for the collection and marketing of epigeous fresh and preserved mushrooms;

Given the Order of the President of the Republic July 14, 1995, 376 on the Regulations concerning the discipline of gathering and marketing of fresh and preserved epigeous mushrooms;

Viewed in particular Article. 4, paragraph 1, allowing the marketing of the species of fresh wild and cultivated mushrooms listed in Annex I;

Viewed. 9, paragraph 1, which allows the preservation of mushrooms in olive oil, vinegar, pickled, frozen, frozen or otherwise prepared as listed in Annex II;

Considered that in Annexes I and II is present the epigeous fungus called *Tricholoma equestre*;

Considered that have been reported in the literature 12 cases of poisoning in France, with three deaths, rhabdomyolysis, linked with the consumption of *Tricholoma equestre*; Given that some regions and autonomous provinces have required to delete the epigeous mushroom *Tricholoma equestre* from the positive lists reported in Annexes I and II of the Decree of President of the Republic n. 376/1995;

Given the opinion of the Higher Institute of Health on 3 July 2002, which proposed to eliminate, as a precaution, and by Annex I and II of the Decree of the President...
of the Republic n. 376/1995 *Tricholoma equestre*, after consulting the most accredited sources in biomedical science;

Considering that it is necessary, in order to protect public health, urgent precautionary health measures;

Considering that the change by ordinary way of the decree of President of Republic no. 376/1995 does not allow early intervention in order to protect public health;

Given the article 32 of the Law December 23, 1978, n. 833;

Given the article 117 of the Legislative Decree 31 March 1998, n. 112;

Order:

Article 1 The gathering, marketing and preservation of the epigeous mushroom called *Tricholoma equestre* is forbidden throughout the country.

This Ordinance shall be published in the Official Gazette of the Italian Republic and shall enter into force on the day of its publication.

Rome, August 20, 2002 Minister: Sirchia
Law 23 August 1993, n. 352

Framework standards for collection and marketing of fresh and preserved epigeous mushrooms

Chapter I
Mushrooms collection

Article 1

1. The regions under Article 1 of Law 22 July 1975, n. 382, and Articles 66 and 69 of Presidential Decree of 24 July 1977, n. 616, with its laws shall govern the collection and marketing of epigeous wild mushrooms, while respecting the fundamental principles established by this the law. The special administrative regions and autonomous provinces of Trento and Bolzano provide according to exclusive jurisdiction within the limits established by the respective statutes.

2. It is subject to applicable general law on the regulation hygienic production and sale of foodstuffs and beverages

Article 2

1. The regions shall perform administrative functions for the obligations pursuant to using this law for municipalities, provinces and mountain communities, through the cooperation of relevant national or regional mycological associations.

2. The regions with their own rules governing the procedures for collection authorization of epigeous fungi also determining the benefits in favor of citizens which carry out the collection in order to supplement the income normally received.

3. The facilities referred to in paragraph 2 shall apply to farmers, to any title, and all those who have in managing their use of the forest, including users of the goods for civic use and property group, and members of agriculture and forestry cooperatives
Article 3
1. In order to protect the collection activities of the fungi in areas classified as mountain, the Regions may determine, on the advice of municipalities and mountain communities, the areas included in the above-mentioned areas, where harvesting is allowed to residents in derogation from the limits laid down in Article 4, paragraphs 1 and 2.
2. The regions, at the request of people reported in Article 2, paragraph 3, may authorize the establishment of areas, delimited by special tables, where the collection of mushrooms is allowed for economic purposes.

Article 4
1. The regions, after hearing the provinces, municipalities and mountain communities, determine the maximum amount per person, total or relative to individual species or variety, the daily collection of epigeous fungi, in relation to the traditions, practices and local needs and within the maximum limit of three kilograms in total.
2. The regions prohibit the collection of immature basidomata of *Amanita caesarea* (closed by universal veil) limiting the maximum size for the collection of all other species, hearing the opinion of provinces, municipalities and mountain communities.

Article 5
1. In the collection of epigeous fungi is forbidden to use rakes, hooks or other means can damage the layer of humus in the soil, the fungal mycelium or the roots of the vegetation.
2. The basidioma collected must retain all morphological features allow for the safe determination of the species.
3. It prohibited the willful destruction of any species of fungal basidiomata.
4. The mushrooms should be stored in suitable containers to permit the spread of spores. It is prohibited in any case the use of plastic containers.

5. It prohibited the collection and removal, including for trade, of turf surface of the soil, except for works of water regulation, for routine maintenance and repairs of streets and passages and the cultural practices. The mushroom pickers are in any case obliged to restore the former condition of natural places.

Article 6

1. Mushroom picking is prohibited, except as otherwise required by the relevant management bodies:
   a. in the integral natural reserves;
   b. in areas falling within the national parks, nature reserves and regional parks identified by its management bodies;
   c. in areas specifically forbidden by the competent forestry authority for forest cultivation reason;
   d. in other areas of particular environmental and scientific value, identified by regional bodies and local authorities.

2. The collection is also prohibited in the gardens and grounds of the property attributable to residential properties adjacent to the same, except the owners.

Article 7

1. Regions may, for reasons of protection of the ecosystem, have time limits to the collection of epigeal fungi only for defined periods and consecutive.

2. Regions may also prohibit, for limited periods, the collection of one or more species epigeal fungi in danger of extinction, having heard the opinion or at the request of provinces, municipalities and mountain communities for your jurisdiction.

Article 8
1. In case of exhibitions, seminars and other events of mycological and naturalistic interest the President of the Regional Board, after hearing the assessor for jurisdiction, may issue special permits to harvest for reasons of scientific interest. These authorizations are valid for a period not exceeding one year and are renewable.

Article 9

[paragraph 1 repealed – replaced by article1 of Decree of the President of Italian Republic 14 july 1995, n° 376]

1. In order to protect public health, the regions, within one year from the date of entry into force of this Law, organize, within the local health units, one or more public mycological control centers (mycological inspectorates), making use, as a transitional measure, however, excluding the establishment of employment relationships, mycological and naturalistic associations of national or regional significance.

2. The centers referred to in paragraph 1 are made using facilities already operating and personnel already in employment.

3. To implement the provisions of paragraphs 1 and 2, the regions are taking advantage of available funds have been allocated to them, without any additional costs for the state budget.

Article 10

1. The regions, provinces, municipalities and mountain communities, also through mycological and naturalistic associations of national or regional significance, and the State Forestry Corps, may promote the organization and conduct of training courses, conferences and study of cultural and scientific aspects that relate to conservation and environmental protection related to the collection of epigeous fungi and fungi protection.
2. The activities referred to in paragraph 1 shall be organized and carried out within the resources already available, without the additional burdens of the state budget.

Article 11

[repealed by article 13 Decree of the President of Italian Republic 14 July 1995, n° 376]

1. The monitoring of the implementation of this law is entrusted to officers of the Corps State Forest. They are also responsible for overseeing the implementation of this law, in addition to the Commodities nuclei of the Carabinieri, the provincial hunting guards, law enforcement bodies with qualification of local urban and rural, the professional supervision and inspection of local health units with qualification of health alert or equivalent, the rural guards, the guards of consortia of companies and special forest guards and volunteers.

2. The guards must meet the requirements of Article 138 of the consolidated of public safety laws, approved by Royal Decree of June 18, 1931, n. 773, and take an oath before the prefect.

3. In national and regional protected areas the surveillance is carried out under the coordination of the management entities.

Article 12

1. Regions adapt their legislation to the provisions of this law within one year from the date of its entry into force.

Article 13

1. Any violation of the rules adopted by the regions under this chapter involves the confiscation of the fungi collected, subject to the right to prove the legitimate origin, and the application by the competent authorities, the administrative sanction for payment of a sum of between 50000 ITL (25.82 euro) to 100000 ITL
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

(51.65 euro), and, in cases determined by the regions, the revocation of the authorization referred to in Article 2.

2. It is subject to the application of criminal laws in force where the violation to the provisions contained in this chapter constitute the crime.

Chapter II
Mushrooms marketing

Article 14
[repealed – replaced by article 2 Decree of the President of Italian Republic 14 july 1995, n° 376]
1. The sale of wild fresh mushrooms is subject to municipal approval.
2. The sale of cultivated mushrooms remains subject to local regulations for fruit and vegetables.

Article 15
[repealed – replaced by article 3 Decree of the President of Italian Republic 14 july 1995, n° 376]
1. The retail sale of wild fresh mushrooms is allowed, upon certification as inspected by the local health unit, in the manner prescribed by local rules of hygiene.

Article 16
[repealed – replaced by article 4 Decree of the President of Italian Republic 14 july 1995, n° 376]
1. It is allowed the marketing of the following species and varieties of wild fresh mushrooms:
   a. *Boletus edulis* and related group (*B. edulis, B. pinicola, B. aereus, B. reticulatus*);
   b. *Cantharellus cibarius*;
   c. *Cantharellus lutescens*;
   d. *Amanita caesarea*;
e. *Morchella* (all species);
f. *Clitocybe gigantea*, *C. nebularis*, *C. geotropa*;
g. *Tricholoma georgii*;
h. *Pleurotus eryngii*;
i. *Armillaria mellea*.

2. The list referred to in paragraph 1 shall be integrated with other species recognized as fit to marketing by the Minister of Industry, Trade and Handicrafts in agreement with the Minister of Health, after consulting the Conference Standing Relations between the State, regions and autonomous provinces of Trento and Bolzano, to be issued within twelve months from the date of entry into force of this Act.

**Article 17**

*[repealed – replaced by article 5 Decree of the President of Italian Republic 14 July 1995, n° 376]*

1. With the designation of "dried mushrooms" can be marketed mushrooms belonging to the following species and varieties:
   a. *Boletus edulis* and related groups (B. edulis, B. pinicola, B. aereus, B. reticulatus);
   b. *Cantharellus* (all species);
   c. *Agaricus bisporus*;
   d. *Marasmius oreades*;
   e. *Auricularia auricula-judaet*

2. It can also be placed on the market other species which are considered edible by Decree of the Minister of Industry, Trade and Handicraft, in consultation with the Health Minister, after consultation with the Permanent Conference for Relations between the State, regions and autonomous provinces of Trento and Bolzano, to be issued within twelve months from the date of entry into force of this Act.
3. With the designation of "porcini" may be marketed only fungi belonging to the species *Boletus edulis* and related group.

4. It is mandatory labeling of dried mushrooms with the diction: "Content complies with the law".

5. The trade description must be accompanied by qualifying terms satisfying the requirements that are established within twelve months from the date of entry into force of this Act by the Minister of Industry, Trade and Handicraft.

**Article 18**

*repealed – replaced by article 6 Decree of the President of Italian Republic 14 July 1995, n° 376*

1. Dried mushrooms are sold, with the easily visible indication of the scientific name of the mushroom, in unopened packages with at least half front transparent, so as to allow control of the content, within the meaning of Law of 30 April 1962, n. 283, as amended, and Decree 27 January 1992, n. 109.

2. Each package must contain the same species of fungi.

3. Companies and individuals or associated persons that perform activities associated with preparation or packaging of dried mushrooms or preserved indicate in the request for authorization referred to in Article 2 of Law 30 April 1962, n. 283, as amended, including the identity of the expert in the field or Hesper, duly registered at the Chamber of Commerce, Industry, Handicraft and Agriculture of the province, under whose control the processing and packaging takes place. Companies already operating on the date of entry into force of this Act shall abide by the provisions of this subparagraph within the period of twelve months from that date.

4. Contravention of the provisions referred to in paragraph 3 shall be punished by a fine in payment of a sum of 500000 ITL (258.23 euro) and 1000000 ITL (516.46 euro).

**Article 19**
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

[repealed – replaced by article 7 Decree of the President of Italian Republic 14 July 1995, n° 376]

1. It is prohibited the retail sale of dried mushrooms in bulk, with the exception of fungi belonging to the species Boletus edulis and related group (porcini) that have properties classified as extra (whole sections, and perfectly white flesh). These mushrooms are sold prior authorization issued by the municipality, after consultation with the Commission under Article 11 of Law 11 June 1971, n. 426.

2. It is allowed the sale of chopped dried mushrooms satisfying the requirements provided for in Article 17, paragraph 5.

Article 20

[repealed – replaced by article 8 Decree of the President of Italian Republic 14 July 1995, n° 376]

1. By decree of the Minister of Industry, Trade and Handicraft, to be issued within twelve months from the date of entry into force of this Act, shall be determined ranges of quantities and nominal capacities of containers of pre-packages dried mushrooms.

2. The humidity value of the prepacked product can not be more than 12 % +/- 2 m/m.

Article 21

[repealed – replaced by article 9 Decree of the President of Italian Republic 14 July 1995, n° 376]

1. The mushrooms preserved in oil, pickled in brine, vacuum, natural, frozen, or otherwise prepared must belong to species easily distinct and preservable. Each package can contain one or more species of fungi.

2. Each packaging should be reported in an easily visible way the scientific names of contained species of fungi and the respective amounts, expressed in percentage descending order, pursuant to Article 8 of Law April 30, 1962, no.283, as

**Article 22**

[repealed by article.13 Decree of the President of Italian Republic 14 July 1995, n° 376]

1. For each fungal species stored, in the manner provided for in Article 21, the local health authority shall, after verification of requirements of this Act, releases a special authorization, details of which are indicated on the label of the product stored.

2. The authorization referred to in paragraph 1 is valid throughout the national territory.

**Article 23**

1. The violation of the rules referred to in this Chapter, except as provided by Article 18, paragraph 4, involves the application by the competent authorities, the administrative sanction for payment of a sum of between 500,000 ITL (258.23 euro) and 2,000,000 ITL (1032.91 euro).

2. It is subject to the application of existing criminal laws when violations provisions contained in this chapter constitute the crime.

This Law, bearing the seal of the State, shall be included in official normative acts of the Italian Republic. It is mandatory for anyone up to observe and enforce it as law of the State.

Rome, 23 August 1993

SCALFARO

Ciampi, President of the Council of Ministers

Approved by the Keeper Conso
MINISTRY OF HEALTH

Regulation on criteria and modalities for the issue of a certificate of mycologist.

(Published in Official Gazette n.11, 15 January 1997)

The Minister of Health

Given the law of 23 August 1993, n. 352 on framework standards for collection and marketing of fresh and preserved epigeous mushrooms;

Given the Decree of the President of the Republic July 14, 1995, n. 376, on the collection and marketing of fresh and preserved epigeous mushrooms and in particular Article 1;

Given the report by the Board of Health at its meeting on January 17, 1995;

Having regard to Article 17, paragraph 3, of 23 August 1988, n. 400;

Having heard the opinion of the State Council made during the Assembly of July 25, 1996;

Considered not necessary to adhere to the advice of the Council of State, on the prediction of a simplified procedure for issuing the certificate of mycologist to persons included in the lists of experts or experts from chambers of commerce, as the rules transitional listed in the decree is to safeguard the position acquired by those who currently play in different ways, in public or private activities recognition and control of fresh and preserved epigeous fungi and not also the status of those who, while enrolled in these lists, do not perform such activities;

Having regard to the Communication of the Presidency of the Council of Ministers made on 13 September 1996;

ADOPT

The following regulation:
**Article 1**

*Scope*

1. This Regulation establishes, under Article 1, paragraph 1 of the Decree of President of the Republic July 14, 1995, n. 376, the criteria for issuing the certificate of mycologist and how to attain it.

**Article 2**

*Certificate of Mycologist*

1. For the purposes of this regulation, the activities of recognition and control of epigeous fungi, in public or private, is held by persons in possession of the certificate of mycologist issued by the regions and autonomous provinces of Trento and Bolzano.

2. The issuance of the certificate of mycologist is subject to passing a final examination which is open to candidates who have attended at least 75% of the scheduled hours for the course referred to in Article 4.

**Article 3**

*Training*

1. The regions and autonomous provinces of Trento and Bolzano plan the training for mycologist.

2. The public or private entities who wish to organize training courses for mycologist submit, for approval, to region or autonomous province competent territorially the request of the management of the course.

They, in any case, must have at least:

a) adequate facilities for the conduct of educational;

b) qualified teachers in sufficient numbers.

3. The subjects of the courses are, at least, those listed in Annex A.

4. Public or private show to region or autonomous province which has territorial jurisdiction, at the end of the course, an activity report, accompanied by a list
of candidates who have passed the course, and the declaration to comply with Annex B completed in its entirety.

5. The courses run by public or private entities are subject to verification and control of regions and autonomous provinces, according to their respective jurisdictions.

**Article 4.**

*Modalities of participation and training*

1. For admission to the mycologist degree the participants must hold a high school diploma.

2. The theoretical-practical course lasts a minimum of 240 hours and takes place in two sessions and should provide candidates with specific training on mycological topics of the program shown in Annex A.

3. The practical part consists of at least 120 hours.

4. Applications for admission to the mycologist degree must be submitted to the organizer of the course.

5. Persons living in other region or province autonomous can attend the course organized by other region or autonomous province.

6. The certificate of participation should be conform to that reported in Annex C.

**Art. 5.**

*Examining Committee*

1. The jury for the final exam is appointed by the region or autonomous province with territorial jurisdiction and is composed of:
   
   a) a representative of the region or autonomous province, with the grade of director or officer, acting as chairman;

   b) an official of the Department for Prevention of Local Health Authority or his delegate, in whose district takes place the course;
c) an expert mycologist appointed by the local health authority in whose area the organizative structure is located;

d) a teacher of the course;

e) a representative of the Ministry of Health or National Institute of Health.

2. Acts as secretary an employee of the organizer of the course.

3. The examination consists of a written test and a practical test.

4. The regions and autonomous provinces of Trento and Bolzano shall keep a register in which are recorded in sequential numerical order the names of candidates who have the certificate of mycologist. These names, together with details of registration, are communicated to the Ministry of Health that provides enrollment in a national registry.

Article 6.

Transitional rules

1. Those who at the date of entry into force of this Regulation are in possession of a certificate of recognition to the epigeous fungi, whose training lasted no less than 100 hours, and have control functions in the Local Health Units are entitled to the issue of mycologist by region or autonomous province of membership, provided that their activity is substantiated by the records of the same documentation acquired by the Local Health Units.

2. The regions and autonomous provinces of local courts, following a request concerned, shall issue the certificate of the mycologist subject to paragraph 1, even after resignation or retirement, provided them carry out control functions in Local Health Units at the time of entry into force of this Regulation.

3. Those who at the date of entry into force of this Regulation are not possession of a certificate of recognition of epigeous fungi and play in continuously for at least five years, control functions at the mycological centre in the Local Health Units may continue to perform the above activities, provided the same, there is evidence documentation acquired by the acts of the same, up to when they are
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

not in possession of the certificate of mycologist, to be issued in accordance with procedures established to paragraph 4.

4. The regions and autonomous provinces of local courts, following a request concerned, made within six months from the date of entry into force of this Regulation, shall issue the mycologist certificate to persons whose paragraph 3, by the opinion approval of the Director General of the Local Health Unit.

5. Those who, at the date of entry into force of this Regulation, have mycological control functions within companies of preparation or packaging of epigeous fungi that are not covered in paragraph 7 of the forecast can continue to perform these activities up to when they come into possession of the certificate of mycologist, to be achieved within 24 months from the date of entry into force of this Regulation.

6. The person referred to in paragraph 5 shall provide for the issue of mycologist, an application for final examinations of the courses referred to in Article 3, as from private.

7. Those who at the date of entry into force of this Regulation are in possession of a certificate for the recognition of hypogeous fungi issued by a public or private institution after the following of a training course lasting at least 240 hours are entitled to a release of the certificate of mycologist by the regions or provinces of the autonomous territorial competent, following request of the interested, to be presented within six months from the date of entry into force of this Regulation.

Rome, 29 November 1996

The Minister: BINDI

Visa, the Keeper: Flick.

Registered at the Court of Auditors January 7, 1997.

Register n. 1 Health, Paper n. 1

Annex A
(article 3 paragraph 3)

COURSE OF MYCOLOGY

The main topics covered are as follows:

- general information about mushrooms. biology of fungi. Thallus and cell organization. Reproduction. biological cycles
- Role of fungi in nature. Concepts of ecosystems and food chain.

Biological balance;
- importance of fungi into the human economy;
- Nutrition, Pathogens, Saprobes;
- meaning and importance of mycorrhiza;
- recognition of the main tree species of the Italian flora;
- Morphology of fungi: sporocarps, cap, stipe, veil, lamellae, tubules, ring, spines, pores, flesh, spores;
- Classification of fungi. Signs of systematic and nomenclature;
- Diagnostic characters for the identification of fungi: mycological books, microscopi and reagents;
- Criteria for the identification of Basidiomycetes and Ascomycetes (slides and fresh materials);

Signs for mushrooms cultivation

- Poisonous fungi. Comparisons and possible confusion between edible and toxic species. Signs of mycotoxicology and role of mycologist;
- inactivation of toxins of fungi;
- collection and marketing of mushrooms;
- health legislation concerning the collection, processing, marketing and sale of mushrooms.
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

Annex B

(Article 3, paragraph 4)

Statement of School for Region / Province Independent

Stamp of school

We hereby declare that

Mr/Ms ................................ born in........................................
date................................ presented himself to the exams of the course for mycologist
established by act n........of............
as a student/privately (1) has passed the final exam.
The secretary of the commission

...............................................................  
The President of the Commission .........................

(1) Delete where not interested

Annex C

(Article 4, paragraph 6)

Region................................../Autonomous Province........................................

Having regard to official records, it is certified.................................................................

that Mr/Ms .................................. born in........................................ date..........................

achieved, in accordance with Decree of the President July 14, 1995, n. 376, the certificate of mycologist.................................................................

and was entered in the regional/provincial register to the n....................
The regional manager of the autonomous province

Stamp

Town and date..........................................................................................
National Law 16 December 1985, n°752

Collection, cultivation and trade of truffles fresh or stored for consumption

THE PRESIDENT OF REPUBLIC

PROMULGATES

The following Law:

Article 1

The regions in implementation of Article 1 of Law 22 July 1975, n. 382, and the provisions of Articles 66 and 69 of Presidential Decree 24 July 1977, n. 616, with its law shall regulate the collection, cultivation and marketing of truffles, fresh or preserved in accordance with the principles and criteria established by this law.

In respect of the powers that in this matter belongs to the special administrative regions and autonomous provinces of Trento and Bolzano.

It 's done, also, save the current general regulation on the hygiene of the production and sale of foodstuffs and beverages in the law April 30, 1962, n. 283, and its implementing regulation.

Article 2

Truffles for fresh consumption must belong to one of the following genera and species, being prohibited the marketing of any other:

1) Tuber magnatum Pico, commonly called white truffle;

2) Tuber melanosporum Vitt., commonly called valuable black truffle;
3) *Tuber brumale* var. *moschatum* De Ferry, commonly called muscat truffle;

4) *Tuber aestivum* Vitt., commonly called summer truffle or scorzone;

5) *Tuber aestivum* var. *uncinatum* Chatin, commonly called hamate truffle;

6) *Tuber brumale* Vitt., commonly called winter black truffle or black trifola;

7) *Tuber borchii* Vitt. o *Tuber albidum* Pico, commonly called whitebait or marzuolo;

8) *Tuber macrosorum* Vitt., commonly called smooth black truffle;

9) *Tuber mesentericum* Vitt., commonly called ordinary black truffle.

The botanical and organoleptic characteristics of commercial species above are given in Annex 1 which is an integral part of this Act.

The examination of truffle species can be made exposed according to the characteristics described in Annex 1 and, in case of doubt or dispute, with microscopic examination of spores carried by the Experimental Center of Sant’Angelo in Vado (belonging to the Ministry of Agriculture and Forestry), or by the Center of Investigation of Mycology of Soil belonging to the National Council of Research of Turin or by the specialized laboratories of the Faculty of Agricultural Sciences or Forestry or Natural Science at the Universities by the issuance of written certification.

**Article 3**

The collection of truffles is free in the woods and uncultivated land.
The property right on truffles produced in truffle orchards or controlled truffles orchards is extended to all those who cultivated it, such property right extends to all the truffles, of whatever species they are, provided the owners of the cultivated field have affixed the appropriate tables demarcating the truffle orchards.

Tables should be placed at least 2.50 meters above the cultivated field, along the site boundary, at a distance as to be visible from all points of access and so that each sign is visible from the previous and the next, with the written letters clearly visible from the ground: "Collection of truffles is reserved."

Regions, at the request of those who have the title, issuing certificates of recognition of controlled truffles orchards or cultivated truffle orchards.

The term “controlled” is applied to field of natural truffles production improved and increased by planting of a large number of plants inoculated with truffles. The term “cultivated truffle orchards” is applied for new inoculated plants growing.

Nothing has innovated on the provisions reported in Articles 4 of the Law of 16 June 1927, n. 1766, and 9 of the Royal Decree of 26 February 1928, n. 332.

**Article 4**

The owners of agricultural and forestry farms or those who, for whatever reason, may cultivated it can organize voluntary consortia for the defense of truffles, its harvesting and marketing as well as for the planting of new truffle orchards.

In the case of contiguità of their cultivated fields the tables could be limited to periphery of the land belonging to the consortium.
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

The consortia are eligible for grants and loans provided for individual conductors of truffle orchards. The tables in the individual fields of cultivation and in the consortia are not subject to registration tax.

**Article 5**

To practice the collection of truffles, the collector must undergo an examination to ascertain his fitness.

Those who are already bearing the badge on the date of entry into force of this Act are exempted from examination.

The regions are therefore expected to issue rules for the examination and for providing a special identification card authorizing to practice the research and collection of truffles.

The card must contain the generality and photography.

The minimum age for truffle hunting must not be less than 14 years.

**Authorization are valid in all the Italian territory.**

Truffles should be collected with the aid of a trained dog, carried out with the appropriate tools and must be limited to the point where the dog has excavated.

**On private property the owners are not subjected to obligations set out in the previous paragraphs**

In any case is prohibited:
a. The tillage during the season of truffles collection;
b. The collection of unripe truffles;
c. Refrain from covering the holes opened by dogs;
d. The research and collection of truffles during the night from one hour after sunset an done hour before dawn, , except as otherwise provided in relation to regional local customs.

Article 6

The regions shall provide for the protection and enhancement of public truffles heritage.

Furthermore the regions shall adopt, within six months after entry into force of this Act, rules for the regulation of schedules, timetables and methods of collection and the monitoring.

The collection of truffles is allowed in the periods mentioned below:

1. *Tuber magnatum*, from October 1\textsuperscript{st} to december 31;
2. *Tuber malanosporum*, from November 15\textsuperscript{th} to March 15\textsuperscript{th};
3. *Tuber brumale var. moschatum*, from November 15\textsuperscript{th} to March 15\textsuperscript{th};
4. *Tuber aestivum*, from May 1\textsuperscript{st} to November 30\textsuperscript{th};
5. *Tuber aestivum var. uncinatum*, from October 1\textsuperscript{st} to december 31;
6. *Tuber brumale*, from January 1\textsuperscript{st} to March 15\textsuperscript{th};
7. *Tuber albidum or borchii*, from January 15\textsuperscript{th} to April 30\textsuperscript{th};
8. *Tuber macrosporum*, from September 1\textsuperscript{st} to December 31;
9. *Tuber mesentericum*, from September 1\textsuperscript{st} to January 31.
Regions may provide, by appropriate ordinance, to vary the timetable of truffle collection after consulting the specialized research centers reported in Article 2.

It is banned all trade of different species of fresh truffles in the periods in which no harvesting is allowed.

Article 7

The fresh truffles, to be offered for sale to the consumer, must be distinct by species and varieties, ripe and healthy, free from foreign matter and impurities.

Truffles should be kept separate from the truffles broken.

"Piece" and "tritured" truffles must be sold separately, landless and foreign matter, separated by species and variety.

Pieces of truffles are considered the portions of truffle larger than 0.5 cm in diameter and "tritured" the truffles of smaller size.

On fresh truffles, whole, chopped or "tritured", for sale, must be indicated on a special card printed in Latin and Italian the name of each species and variety, according to the official name given in Article 2, and the geographic area of collection. The demarcation of the area shall be established by decision of the regional administration, after hearing the provincial governments.

Article 8
The processing of truffles, for storage and subsequent sale, can be carried out by:

1. by firms registered with the Chamber of Commerce, Industry, Handicrafts and Agriculture, by industries producing canned food, and only for the species listed in Annex 2;
2. consortia mentioned in Article 4;
3. by cooperative for conservation and marketing of truffles.

Article 9

The preserved truffles are sold in hermetically sealed containers bearing a label with the name of the company that prepared them, the location of the plant headquarters, the name of the truffle in Latin and Italian according to the description contained in Article 2 and according to the specification contained in the final paragraph of Article 7, the rank and the net weight in grams of truffles drained, and an indication of "peeled" when the truffles were released from the peel.

Article 10

The preserved truffles are classified as Annex 2, which forms an integral part of this Act.
Article 11

The preserved truffles are packed with added water and salt or just salt, still optional addition of wine, liqueur or brandy, whose presence must be reported on the label, and must be sterilized at about 120 °C for time required in relation to the size of the containers. The use of other substances, provided they are not harmful to health, besides those mentioned, or a different system of preparation and storage, must be indicated on the label with terms relevant and understandable.

Is prohibited in any case the use of coloring substances.

Article 12

The net weight shown in the package must match that of truffles drained with a maximum tolerance of 5 percent.

Article 13

The contents of the cans and bottles should meet the following specifications:

a. liquid of storage or liquid medium of dark color in *Tuber melanosporum*, *brumale*, *moschatum*, and more or less dark yellowish in *Tuber magnatum*, *aestivum*, *mesentericum*;

b. pleasant smell and taste delicious typical of the species;

c. free from soil, sand, worms and other foreign matter;

d. exact match with the species and classify reported on the label.
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

Article 14

It is forbidden to trade truffles preserved in containers without labels, or immature, or unhealthy, or not well cleaned, or other species than those mentioned in Article 2 or with quality or characteristics different from those indicated in the labeling or corresponding to the classification reported in Annex 2, attached to this law.

Article 15

The monitoring of the implementation of this law is entrusted to officers of the State Forestry.

Responsible for enforcing this law are also provincial hunting guards, organs of local urban and rural police, voluntary security guards designated by cooperatives, associations, organizations that have as their institutional target the protection of nature and the safeguard environment.

The guards must meet the requirements specified in Article 138 of the consolidated public safety laws, approved by Royal Decree of June 18, 1931, n. 773, and take an oath in front of the prefect.

Article 16
For violations of this law is accepted for payment in discharge of any obligation of a sum to a lesser extent, equal to the third part of the ultimate sanction, within a period of sixty days from the personal dispute or, if there is was, by notification.

This payment is excluded in cases where it is not allowed by the criminal provisions.

The regions, for the income derived from violations of this law will establish a special budget chapter.

**Article 17**

The regions, in order to achieve the financial resources necessary to reach the purposes intended by this law and those reported in the regional laws, are authorized to establish a regional annual license fee, pursuant to Article 3 of Law 16 May 1970, n. 281, to obtain the qualification referred to in Article 5. The payment will be made in the ordinary way on a giro account at the treasury of the region.

The license fee may not apply to collectors of truffles on their property, however, they conducted, nor to the gatherers which belongs to the consortium in accordance with Article 4, if they collect truffles in other funds belonging to the same consortium.

**Article 18**

Any violation of this Act, subject to the requirement of the complaint to the court for offenses under the penal code whenever it fulfills the extremes, involves
the confiscation of the product and is punished with administrative sanctions and fines.

The tillage of soil and the opening of holes in excess or not covered after collection and for every five holes or fraction of five open and unfilled state of the art

The regional law determines measures and methods of administrative penalties and fines for each of the following violations:

a. the collection of truffle in a prohibited period or without the help of trained dogs or without adequate tools or without the prescribed identification card;
b. The tillage of soil and the opening of holes in excess or not covered after collection and for every five holes or fraction of five open and unfilled state of the art;
c. The collection in reforested areas for a period of fifteen years;
d. The sale to the public market for truffles without observing the prescribed rules;
e. The collection of unripe truffles;
f. The collection of truffles during the night

g. trade in fresh truffles out of the collection period;
h. the marketing of preserved truffles without complying with the standards prescribed unless the fact constitutes no crime under Articles 515 and 516 of the Penal Code;
i. the collection of truffles in reserved areas under Articles 3 and 4.

For violations of Articles 515 and 516 of the Penal Code, a copy of the minutes shall be forwarded by the provincial to the district court with territorial jurisdiction.

Article 19
Regions, within one year after entry into force of this Act, must adapt its legislation.

Article 20

The law of July 17, 1970, n. 568, is repealed.

This Law, bearing the seal of the State, will be included in the official collection of laws and decrees of the Italian Republic. It is mandatory for anyone to observe and enforce it as law of the State.


COSSIGA

CRAXI, President of Council of Ministers
Chapter 8: An overview of existing legislation on collection, trading and conservation of wild edible mushrooms

Law 17 May 1991, n° 162.

Amendments to Law 16 December 1985, n. 752, legislation establishing the framework for the collection, cultivation and sale of truffles fresh or stored for consumption.

The Chamber of Deputies and the Senate of the Republic have approved:

THE PRESIDENT OF REPUBLIC

PROMULGATES

The following law:

**Article 1**

1. The number 5) of first paragraph of article 2 of law 16 December 1985, n° 752, is replaced by the following: "5) Tuber uncinatum Chatin, commonly called "hamate truffle".

2. In number 5) of third paragraph of article 6 of law 16 December 1985, n° 752, the words:"Tuber aestivum var. uncinatum" are replaced by: "Tuber uncinatum".

3. The letter a) of article 13 of law 16 December 1985, n° 752, is replaced by the following: "a) liquid of storage or liquid medium clear, of a dark color in Tuber melanosporum, brumale, moschatum, e giallastro more or less dark yellowish in Tuber magnatum, aestivum, uncinatum, mesentericum;"

4. The number 5) of Annex 1 of law 16 December 1985, n° 752, is replaced by the following: "5) Tuber uncinatum Chatin, commonly called “hamate truffle” or”black truffle of oak (Quercus trojana Webb). Peridium warty, black, warts undeveloped, gleba or pulp dark hazel to chocolate color, well pronounced lattice, spores broadly alveolate cases in 1 to 5 asci, papillae long and curved
like a hook. Gives off a pleasant scent. Mature from September to December ".

5. In Annex 2 of law 16 December 1985, n° 752, the following modifications are made:

a. Next to the rank: "Third choice (washed or peeled)" the following items are added: "Tuber aestivum Vitt., Tuber uncinatum Chatin and Tuber macrosporum Vitt.";

b. Side of the charts: "Pieces of truffle and tritured truffle", after the entry: "Tuber aestivum Vitt." are inserted: "Tuber uncinatum Chatin, Tuber macrosporum Vitt.".

This Law, bearing the seal of the State, shall be included in the official acts of legislation of the Italian Republic. It is mandatory for all concerned to observe it and make it known as the law of the State.

Rome, 17 May 1991

COSSIGA

ANDREOTTI, President of Council of Ministers
TRANSFER OF INNOVATION

Grant no: 2011-1-GR1-LEO05-06802

MYCOTICON Textbook

Editors:
Denchev, C.M.,
Venturella, G.,
Zervakis, G.

Publisher: TEI Thessaly