Edible Mushroom and Earthworm Culture

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First, What Is The Largest Organism From The Following List?

- Giant earthworm from Australia?
- Redwood tree from California?
- Mushroom from Oregon? (honey mushroom)
• **Honey Mushroom from Oregon**
  - the discovery of this giant *Armillaria ostoyae* in 1998 heralded a new record holder for the title of the world's largest known organism, believed by most to be the 110-foot- (33.5-meter-) long, 200-ton blue whale.
  - occupies some 2,384 acres (965 hectares) of soil in Oregon's Blue Mountains
  - outline of the giant fungus stretches 3.5 miles (5.6 kilometres) across, and it extends an average of three feet (one metre) into the ground. It covers an area as big as 1,665 football fields.
  - based on its current growth rate, the fungus is estimated to be 2,400 years old but could be as ancient as 8,650 years

http://findarticles.com/p/articles/mi_qn4158/is_20000806/ai_n14338782/
Mushrooms

Amanita muscaria

Boletus aureissimus

Collybia sp.

Geastrum saccatum

Edible Mushroom Examples

- Oyster Mushroom (*Pleurotus ostreatus*)
- Chanterelle (*Cantharellus cibarius*)
- “Yellow” Morel (*Morchella esculenta*)
- Shitake (*Lentinula edodes*)
- Field mushroom (*Agaricus campestris*)
II Overview: Classification

1. Animal, vegetable or mineral? You get 20 questions.

2. Whittaker’s Five Kingdoms

3. Animalia

4. Plantae

5. Fungi

6. Protista

7. Monera

III Characteristics of Microorganisms

B. fungi

1. general description:
   eukaryotic
   nonphotosynthetic
   cell walls
   most form spores
   sexual and nonsexual reproduction

http://www.micro.siu.edu/microforhighschoolteachers/workshopteachers.pdf
Mushrooms 101

Characteristics of Fungi

- Decomposers
- Mycelia
- Hyphae: large surface area
- Mycorrhizae: symbiotic relationship between fungi and plant roots

Fungi are Decomposers

http://crookbiology.googlepages.com/L_Ch.31_fungi.pdf
Mushrooms 101

**Phyla**

- **Chytridiomycota - chytrids**
  - Motile spores with flagella
- **Zygomycota – zygote fungi**
  - Zygosporangium at sexual stage
- **Ascomycota – sac fungi**
  - Sexual spores in asci (8 ascospores in each)
- **Basidiomycota – club fungi**
  - Mushrooms, shelf fungi, puff balls
  - Sexual structure – basidium
- **Lichens**
  - Symbiotic relationship between fungi and algae

**Table 31.1 Review of Fungal Phyla**

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Key Reproductive Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chytridiomycota (chytrids)</td>
<td>Motile spores with flagella</td>
</tr>
<tr>
<td>Zygomycota (zygote fungi)</td>
<td>Resistant zygosporangium at sexual stage</td>
</tr>
<tr>
<td>Ascomycota (Sac fungi)</td>
<td>Sexual spores borne in ascus (8 ascospores in each)</td>
</tr>
<tr>
<td>Basidiomycota (club fungi)</td>
<td>Sexual spores borne externally on club-shaped structures called basidium</td>
</tr>
</tbody>
</table>

**Phylum Chytridiomycota: Chytrids**

- Mainly aquatic
- Some saprobes
  - Decomposer
  - Absorbs nutrients
- Some parasitic
- Flagellated spores
- Most primitive fungi

http://crookbiology.googlepages.com/L_Ch.31_fungi.pdf
Phylum Zygomycota: zygote fungi

- Mostly terrestrial
- Soil or decaying organism
- Some form mycorrhizae
- Coenocytic hyphae
- Zygosporangium – resistant to freezing and drying
- Examples:
  - *Pilobus*
  - *Rhizopus*

http://crookbiology.googlepages.com/L_Ch.31_fungi.pdf
Mushrooms 101

Phylum Ascomycota: Sac fungi

- Marine, freshwater and terrestrial
- Mostly saprobes
- About half form lichens
- Some form mycorrhizae
- Produce asci (ascus)
  - Fruiting body – ascocarp
  - 8 ascospores in ascus
- Asexual spores – conidia
  - Produced in conidiophores

http://crookbiology.googlepages.com/L_Ch.31_fungi.pdf
Phylum Basidiomycota: club fungi

- Mushrooms, shelf fungi, puffballs, rusts
- Decomposers – plants
- Some form mycorrhizae
- Some parasitic (rusts, smuts)
- Basidiocarp – fruiting body
  - Basidia – source of sexual spores (on gills under mushroom)
  - Basidiospores – spread by wind
- Fairy rings

http://crookbiology.googlepages.com/L_Ch.31_fungi.pdf
Mushrooms 101

- Mushrooms are the **fruiting bodies** of certain fungi—the equivalent of the apple, not of the tree.
- The fungal organism which produces the mushrooms you encounter on your lawn or in the forest is called a **mycelium**. It is composed of **hyphae**, which are "chains" of fungal cells (singular: **hypha**).

http://americanmushrooms.com/basics.htm
Mushrooms 101

http://crookbiology.googlepages.com/L_Ch.31_fungi.pdf
Mushroom Cultivation

• Completely different to growing green plants
• Do not contain chlorophyll & depend on a substrate to decompose for their food
• Become familiar w/ life cycles of species of interest for production
• Outside production is possible
• Inside production provides more continuous fruiting but requires greater management
Steps In Mushroom Cultivation

Mushroom Cultivation In The Garden

• Use creativity and imagination when planting mushrooms in a garden

• Look for the "fundamentals," the necessities such as available substrates, microhabitats, sun, shade, wind, and humidity conditions
  – organic waste materials = substrates
  – tall plants = shade
  – a misting sprinkler = humidity
Choosing A Mushroom Species

• A mushroom cultivation kit is a handy way to begin to understand the fungal life cycle
• Afterwards purchase spawn that will grow on materials you have available
• design and test a system that duplicates the conditions favorable to all stages of growth
• oyster (*Pleurotus species*) is a good choice probably for most novices
Oyster Mushroom Example

Gray Oyster

Flamingo Oyster

Golden Oyster

Oyster Mushroom Production at E.C.H.O.
http://www.echonet.org/

Edible Mushroom Production Facility

Bag Culture Production
Edible Mushroom Production Facility
• wooden lattice shelving for mushroom bags placement
• Open ventilation
• Shaded
• Not air conditioned

Oyster Mushroom Production at E.C.H.O.
http://www.echonet.org/
Oyster Mushroom Production at E.C.H.O.
http://www.echonet.org/

Edible Mushroom Spawning Facility

Jar of spawn
Transfer table (laminar flow hood) for sterile mushroom spore inoculations of petrie plates and spawn jars. Blueprint for homemade version available at:


Refrigerator spawn incubator
Oyster Mushroom Production at E.C.H.O.
http://www.echonet.org/

Solar-heated substrate pasturization unit (i.e., a used, gutted refrigerator)
Other Edible Mushrooms Spp

• Shitake
  – are grown on logs, either inside or outside. Inside, they can also be grown on compressed sawdust logs or in bottles or bags

• Morel
  – possible to establish a morel patch by using a morel starter kit

http://botit.botany.wisc.edu/toms_fungi/morel.html
Know Your Mushrooms

• **DO NOT EAT WILD MUSHROOMS** unless you are ABSOLUTELY sure you have identified the mushroom correctly and KNOW that it is edible.

• As to lawn damage by mushrooms, they rarely cause landscape problems. Most lawn mushrooms are fungi that feed on decomposing grass clippings or mycorrhizal spp.

http://okeechobee.ifas.ufl.edu/News%20columns/Wild.Mushrooms.htm
Honorary Mention
In Largest Organism Quiz

- Giant Gipsland Earthworm (*Megascolides australis*) from Australia
  - can grow to 13 feet (4m) [Stretched]
  - 3/4 inch (2 cm) in diameter
  - live in a complex series of burrows up to 2m. deep
  - has a pinkish-grey body with a dark purple head
  - greatest threat to the Giant Gippsland Earthworm appears to be habitat degradation, e.g., agriculture
  - found only in a small region in Gippsland, Southeast Victoria, Australia

http://www.youtube.com/watch?v=DZig6EL5B6A
USA’s Earthworm Entry

• “Giant” Palouse Worm (*Driloleirus americanus*) From Washington State
  – white, lily-scented denizen of the region’s fertile, deep soils reportedly can grow to 3 feet long
  – might also be suffering from competition with European earthworms that reached the area with settlers as stowaways on plants.
  – found in remnant patch of Palouse Prairie of bunchgrasses

http://www.sciencedaily.com/releases/2008/05/080504195011.htm
Earthworm Culture
Earthworms 101

- Earthworms belong to a class of creatures called annelids or “ringed” creatures. An annelid is a creature with a cylindrical body which is segmented both outside and inside.
Earthworms 101

- There are over 3,000 species of earthworms around the world.
- Common name examples
  - Nightcrawlers
  - Field worms (also known as garden worms).
  - Manure worms (also known as bandlings, red wigglers, or angleworms because of their squirming reactions when handled).
  - Red worms

http://edis.ifas.ufl.edu/IN047
Earthworms 101

- Earthworm identification
  - diagram highlights all the physical features you’ll need to correctly identify your earthworms
  - online key available

http://www.naturewatch.ca/english/wormwatch/about/key/about_key_start.html
Earthworms 101

- Earthworms get their nutrition from many forms of organic matter in soil
  - decaying roots and leaves, tiny organisms that live in the soil, bacteria, and fungi
  - decomposing remains of other animals
  - can consume up to one-third of its own body weight in just one day!
Earthworms 101

Epigeic example: *Lumbricus rubellus* (leaf worms)

Endogeic example: *Aporrectodea caliginosa* (angle worms)

Anecic example: *Lumbricus terrestris* (nightcrawlers)

http://www.nrri.umn.edu/worms/identification/ecology_groups.html
Earthworm Benefits to Soil

"It may be doubted whether there are many other animals which have played so important a part in the history of the world, as have these lowly organized creatures." Charles Darwin 1881

- Stimulate microbial activity
- Mixing and aggregation
- Increase water infiltration
- Improve water-holding capacity
- Provide channels for root growth
- Bury and shred plant residue
Earthworm Benefits to Gardening

• Earthworm plays a significant role in suppressing several common soil-borne plant pathogens.

• A greenhouse study was carried out with asparagus, eggplant, and tomatoes grown in pots infected with common Fusarium and Verticillium plant diseases.

• In the pots that also contained earthworms, plant weights increased 60% to 80%, and estimates of disease severity declined 50% to 70%.

Earthworm Benefits Examples

• Some worms live in permanent vertical burrows. Others move horizontally near the surface, filling their burrow with casts as they move.
• Earthworms incorporate large amounts of organic matter into soil.
• Casts at the soil surface are evidence of earthworms shredding, mixing, and burying surface residue.
• *L. terrestris* mating, and earthworm cocoons. Earthworms mate periodically throughout the year, except when environmental conditions are unfavorable. *L. terrestris* cocoons are about a quarter inch long.
History of Earthworms

• During the time that glaciers covered much of North America, earthworms disappeared from the frozen soil. It would have taken centuries or longer for earthworms to become re-established on their own, but human actions speeded up the process.

• Farmers and gardeners brought potted plants from other places for planting, releasing earthworms that were in that soil.

• And when farmers tilled the soil to make it easier for tiny roots to grow, they also made it easier for the worms to tunnel through the soil. As worms increased, so did robins.
• Earthworms are sometimes considered an invasive species in northern temperate forests.

• This is because of their ability to change the soil structure and nitrogen levels.

• Invasive non-native species are of concern to ecologists because they can change the environments they invade.
Earthworm Garden Management

• Factors to increase earthworm populations
  ✓ Introduction
    • Nightcrawler spp more than shallow-dwelling spp respond to additions
  ✓ Food supply
    • Adding organic matter
  ✓ Mulch protection
    • Leaving a surface mulch, by no-till or other conservation tillage systems with plenty of residue cover
  ✓ Chemical environment
    • Soil pH should be maintained between 6.0 and 7.0 for optimum conditions, although lower pHs are tolerated by most species.

Earthworms and Crop Management, Purdue Univ. Extension
http://www.ces.purdue.edu/extmedia/AY/AY-279.html
Earthworm Garden Management

FIGURE 2. MANAGEMENT PRACTICES FAVORING/HURTING EARTHWORMS

PRACTICES FAVORING EARTHWORMS
- No-till
- Crop rotations
- Manure
- Organic amendments
- Surface crop residue
- Fertilizer
- Lime

PRACTICES HURTING EARTHWORMS
- Tillage
- Acidification
- Removal of crop residue
- Toxic products

Earthworms, Penn State University
http://pubs.cas.psu.edu/freepubs/pdfs/uc182.pdf
Vermicompost

Castings for potting mix & fertilizer use

Examples of worm bin designs
More Styles of Worm Bins

- Can-O-Worms Home
- Expandable Worm Tower
- Worm Chalet

Instructions for homemade version and operation at:
http://www.watershedactivities.com/projects/winter/wormbin.html
Vermicompost

• Not really a form of composting – in fact, earthworms are likely to die if true composting, a heat-producing process, occurs.
• Similar to composting, management is critical – e.g., moisture, pH, and aerobic conditions in the growing medium must be maintained to ensure healthy, growing worm populations.
• Many different materials can be used as feedstock for the worms.
• Produces worm castings which contain a highly active biological mixture of bacteria, enzymes, remnants of plant matter and animal manure, as well as earthworm cocoons (while damp). The castings are rich in water-soluble plant nutrients, and contain more than 50% more humus than what is normally found in topsoil.

Earthworm Castings Benefits

1. The humus in the worm castings extracts toxins and harmful fungi and bacteria from the soil. Worm Castings therefore have the ability to fight off plant diseases.

2. The worm castings have the ability to fix heavy metals in organic waste. This prevents plants from absorbing more of these chemical compounds than they need. These compounds can then be released later when the plants need them.

3. Worm Castings act as a barrier to help plants grow in soil where the pH levels are too high or too low. They prevent extreme pH levels from making it impossible for plants to absorb nutrients from the soil.

http://www.tastefulgarden.com/wormcastings.htm
Earthworm Castings Benefits

4. The **humic acid content stimulates plant growth**, even in very low concentrations. The humic acid is in an ionically distributed state in which it can easily be absorbed by the plant, over and above any normal mineral nutrients. Humic acid also stimulates the development of micro flora populations in the soil.

5. Worm Castings increase the ability of soil to retain water. The worm castings form aggregates, which are mineral clusters that combine in such a way that they can withstand water erosion and compaction, and also increase water retention.

6. Worm Castings increase the nitrogen levels in a state that the plant can easily use. Organic plant wastes usually have a carbon-nitrogen ratio of more than 20 to 1. Because of this ratio, the nitrogen is unavailable to plants, and the soil around the organic waste becomes acidic.

http://www.tastefulgarden.com/wormcastings.htm
Vermicompost

• Earthworms are either earthmovers or composters.
  – Earthmovers tend to be solitary species which tunnel through the earth
  – Composters live en masse in organic matter on the soil surface

• Recommended composter worm is *Eisenia fetida* or red worms

http://www.wormpost.com/worms/biology.html
Earthworm Farming

• Commercial production for markets:
  – fishing bait
  – composting operations
  – dietary supplement for ornamental fish or other difficult-to-raise fish species

• Most commercial worm beds are indoors to facilitate optimum management

http://edis.ifas.ufl.edu/FA016
If you are looking for the latest in fashion for gardening . . .

In Summary . . .

• If you’re looking for that special pet . . .

www.br-online.de/jugend/izi/english/publication/televizion/19_2006_E/wissen%20macht%20ah.pdf