21st Century Guidebook to Fungi, Second Edition of the online version, by David Moore, Geoffrey D. Robson and Anthony P. J. Trinci

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Chapter 11: Exploiting fungi for food

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Fungal biomass is a high-quality food source because it contains a good content of protein (typically 20-30% crude protein as a percentage of dry matter), which contains all of the amino acids which are essential to human and animal nutrition. Add characteristically low fat content to the protein, a chitinous wall as a source of dietary fibre, useful vitamin content, especially of B-vitamins, and carbohydrate in the form of glycogen and a good food source can be considered an ideal food. Judging from archaeological and similar finds, mushrooms, toadstools and bracket fungi have been used by man since before recorded history for both food and medicinal purposes.

We currently depend on fungi and fungal products every hour of every day and this chapter will concentrate on the human fungal foodstuffs in current use (Moore, 2001; Zied & Pardo-Giménez, 2017). However, before turning to this aspect we want to deal with the ways that other animals make use of fungi.

Fungi feature prominently in food webs, and wild fungi are picked commercially, too. But it's not solely a matter of 'picking mushrooms'; fungal cells and mycelium are used as human food, and fungi are used to prepare many commonly-used fermented foods, so there is a need to consider several different industrial cultivation methods. Finally, to make the point that we are not the only animals that cultivate fungi, we will discuss the relationship between gardening insects and their fungi, though we will describe these **mutualisms** in detail in Chapter 15.

11.1 Fungi as food

Fungus fruit bodies are used as food by many invertebrates and are large enough to be used by many mammals, including large mammals like deer and primates (Hanson *et al*., 2003). In most soils, though, there is such a large amount of fungal mycelium that hyphae make a major contribution to **food webs** by being eaten by invertebrates including insects, mites, nematodes and molluscs. Microarthropods are responsible for shredding organic matter in soil (and so prepare it for the final mineralisation processes carried out by microbes), but about 80% of the tens of thousands of microarthropod species in forest soils are **fungivores** (or **mycophagous**); meaning they depend on the fungal mycelium for food. We have introduced many of these small animals before, in Chapter 1 (Section 1.5; see Haynes, 2014), and if you have not already done so, we suggest you check out the YouTube videos to which we refer in the following **Resources Box**.

Resources Box

Life in the soil

Two excellent YouTube videos that will remind you about life in the soil are:

Deep Down & Dirty: The Science of Soil. A close-up of creatures living beneath the soil, made by the British Broadcasting Corporation: https://www.youtube.com/watch?v=gYXoXiQ3vC0

The Living Soil Beneath Our Feet. Made by the California Academy of Sciences: https://www.youtube.com/watch?v=MlREaT9hFCw

In this Chapter we will illustrate some of the most important features with a short foray into the outside world. Nothing too strenuous; join us on a short walk to the bottom of our suburban garden in Stockport, Cheshire (Fig. 11.1).

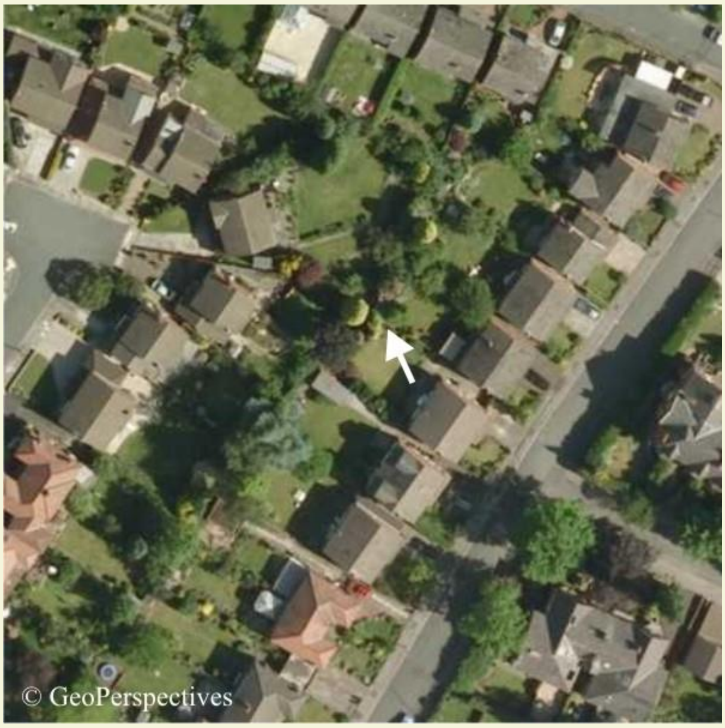

Fig. 11.1. The suburban location of the fruiting mycelium of *Clitocybe nebularis* which is illustrated in Figs 11.2 to 11.10. This biological survey was completed in my back garden and the aerial map image shows the site of the observations (arrow) and makes the point that biology and natural history extends to the urban environment. Image © GeoPerspectives; kindly supplied by James Burn of the Sales Team at www.emapsite.com.

11.2 Fungi in food webs

Many of the saprotrophic Basidiomycota that are involved in plant litter recycling, particularly in woodland, form extensive **mycelial networks at the soil-litter interface**. At the growing fronts individual hyphae are evident in these mycelia, but elsewhere the hyphae often aggregate into strands and cords specialised for translocation of water and nutrients between locations. We have described this before (Chapter 9, in the section titled Linear structures: strands, cords, rhizomorphs and stipes), but here we want to emphasise the size of this mycelial network both in terms of the quantity of mycelial biomass and its physical extent over the ground. This is where we venture into the garden. In the Autumn of 2006 a troop of *Clitocybe nebularis* (common name: Clouded Agaric or Clouded Funnel) appeared in a secluded suburban garden in Stockport, Cheshire, UK (Fig. 11.2).

Fig. 11.2. A troop of *Clitocybe nebularis* fruit bodies in a suburban garden in Stockport, Autumn 2006. Observations began on October 21 and continued for 29 days to November 19. Fruit bodies of *Coprinellus micaceus* emerged, matured and decayed around October 26 and November 1 (one such instance arrowed on the left above). At bottom right note the corner of a paving slab which was raised to reveal the mycelium shown in Fig. 11.3. Photograph by David Moore.

Fig. 11.3. Removal of the paving slab revealed the extensive mycelium of *Clitocybe nebularis* growing beneath it. Numerals show the locations of Figs 11.4 to 11.8. Photograph by David Moore.

Observations began on October 21 and continued for 29 days to November 19. At the start, the fruit bodies were young but close to maturity (5 cm diameter), Fig. 11.2 shows the troop on October 29. The first overnight frosts of the season occurred on October 31 and November 1; temperatures were otherwise generally above average throughout October in that year. Some of the mushrooms were close to a paved area and when one of the paving slabs was lifted the mycelium that had penetrated beneath it was evident (Fig. 11.3, photographed, as were other mycelium images, on November 1).

Mycelium was evident throughout both soil and litter layer (Fig. 11.4), and mycelium beneath the 60 cm square paving slab covered soil particles, leaves and dead and dying roots with a lush growth of fine **hyphae** (Figs 11.5, 11.6) that aggregated into **strands** and **cords** where it colonised the more discrete, and patchily distributed, debris such as root fragments and larger leaves (Figs 11.5, 11.7, 11.8). As this mycelium is supporting growth of the fruit bodies shown