# Chapter 17
# Local Communities and Edible Ectomycorrhizal Mushrooms

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## 17.1 Introduction

This chapter is about people: how they use wild edible mushrooms, the benefits they gain and the consequences of collecting and trading. It is about groups of people, often though not exclusively living in rural communities, who collect these mushrooms from the wild, usually from forests. It is a brief overview drawn from information published from many countries around the world. The majority of original sources are referenced in a review published some years ago (Boa 2004), in a publication that is freely available online in English, French and Spanish via the Food and Agriculture Organization (FAO) of the United Nations Web site.

There are two main uses for wild edible mushrooms and both are linked: you can sell them or you can eat them. Some species also have medicinal purposes, but this is an additional benefit rather than a main use. The bulk of medicinal mushrooms are cultivated, and this chapter will concentrate mostly on the potential monetary value of wild mushrooms as food. This is not an account of local markets or international trading, which is covered elsewhere in this book (see Chap. 20), but an examination of activities and events that precede the exchange of money.

There is an increasing awareness of the global diversity of edible mushrooms[1] (Boa 2004; Hall et al. 2003)—not only those that are ectomycorrhizal. Their indigenous or local uses and, more precisely, monetary or dietary value to local communities are less well known. While studies on wild edible mushrooms continue to be published, most recently in a special edition of Economic Botany

[1] Arora and Shepard (2008) argue for the term "wild edible mushroom" instead of "wild edible fungi", as used by Boa (2004). This chapter will also use "mushroom" to remain consistent with the title of the current book.

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published in 2008, there remains a poor understanding of how money earned or nutritional value to diets contributes to livelihoods and well-being.

The dietary contribution is difficult to assess because of the limited information about the relative importance of wild edible mushrooms compared to other sources and how consistent this is from one year to the next. However, there is no doubt, contrary to claims that mushrooms are "mainly water" (as are most fruits and vegetables), that mushrooms make important dietary contributions. In one of the few studies found which documents this contribution, 1.3 kg of dried leafy vegetables and/or dried wild edible mushrooms could feed a family of four for 2 weeks in Malawi (Abbott 1999). Nutritionally, they are an important source of digestible protein and fibre, especially in developing countries where options are limited by availability and cost (de Román et al. 2006).

This chapter will focus on developing countries, where our knowledge of the role played by wild edible mushrooms is weakest yet their potential economic importance is highest. This could mean a few extra dollars earned in a day, a day's wage in many places, or it could presage an economic bonanza, such as that associated with the widening discovery of *Tricholoma matsutake* (S. Ito & S. Imai) Singer throughout Asia driven by Japan's own declining national production. North Korea earned US$150 million over 5 years from its exports, a substantial sum by any measure but of national significance in an extremely poor country with restricted and limited opportunities for international trade.

There are large gaps in our knowledge of how habitat loss, particularly wooded areas and permission to harvest in existing areas affects local communities, and the degree to which they depend on collections of wild mushrooms as a source of income. Natural resource management includes studies of habitats as well as the edible mushrooms that grow there, yet there are too many studies which document long lists of species without due consideration to the ecological context. More regular consideration should be given to studies at landscape level and with the involvement of social scientists. A series of investigations in the Pacific Northwest over more than 10 years is a good example of a coordinated and rigorous attempt to explore all aspects of wild edible mushrooms in devising sensible evidence-based policy on EEMMs (Pilz and Molina 2002). The clear conclusion is that the study of human behaviour, markets and forest management is as important as the biology or ecology of mushrooms.

The collection and use of edible ectomycorrhizal mushrooms (EEMM) across the vast Miombo woodlands of southern Africa has been described previously by a number of authors (e.g., Morris 1987; Piearce 1981; Härkönen et al. 2003). These studies provide an introduction to a balanced overview of edible ectomycorrhizal mushrooms, which embraces biology, ecology and human perspectives, though funds for research were much smaller than research budgets in the Pacific Northwest. There is a useful contrast between Africa and the Pacific Northwest, where the value of the previously neglected *Tricholoma magnivelare* (Peck) Redhead also soared in response to Japan's needs, attracting migrant workers originally from Mexico and Cambodia, many with no previous experience or local knowledge of wild edible mushrooms. Mushroom collecting in Miombo has been going on for probably hundreds of years.

This is a short "balanced" introduction to the overall value of EEMM to local communities. Wherever possible, EEMMs are distinguished from wild edible mushrooms with different ecological niches, including saprobes (e.g., *Pleurotus* spp.) and pathogens (e.g., *Armillaria*). Such ecological distinctions are of little or no importance to collectors though clearly the continuing presence of host species is essential to the production of EEMM.

## 17.2 Local Knowledge

A knowledge of potential collecting sites and habitat preferences for various mushroom species is an advantage to a collector, as the following account by a market trader in Zomba, Malawi, suggests:

> There are lots of different *bowa* (edible mushrooms) and we have to know where to look. For example under *masuku* (*Uapaca kirkiana* Muell. Arg.) trees we find more than six different types e.g., *Nakasuku/ngundamsuku* (red or white); *Chipindi* (white and it has cracks outside and most insects and tortoises like to eat this, people know it must be edible when they eat it as it tastes like beef); *Nakatelesya*. Other *bowa* include the *utale/namichombo* which appear with the first rains. By the time farmers have started planting it is already finished. There is a certain black/brown *bowa* which white people only will buy. It grows under pines and *mkunguza* trees (mature ones). It is also found on golf ground.
>
> (Unpublished, collected by Janet Lowore, Kennedy Ndhlazi and Vicky Mzumara, March 2001)

In the above example, the person recognises an association between trees and edible mushrooms. However, collectors and traders are not always aware of the ecological interdependency. This is important because mushroom collectors compete with charcoal producers and other Miombo forest users who remove trees for fuel wood and other purposes.

Local knowledge embodies attitudes and beliefs about which species of wild edible mushrooms can be safely eaten. When local knowledge is challenged by scientific knowledge, confusion occurs. *Gyromitra esculenta* is a canned food in Sweden, yet many field guides warn severely of attempting to eat it. The mushroom is indeed poisonous when raw, but with careful cooking poses no less threat to humans than eating raw kidney beans or failing to prepare cassava so that cyanogenic compounds are removed.

Some examples of "poisonous mushrooms" will surprise those accustomed to eating boletes in Europe and North America. In certain parts of Tanzania, people will not eat mushrooms with pores because of a belief that they are unsafe (Härkönen et al. 2003). Some highly prized EEMM are simply ignored because of a lack of local knowledge. *Boletus edulis* Bull. grows freely under pine trees in Malawi, yet no one collects and eats it, though Italian traders are always on the lookout for new sources of this and allied species. These are examples where

missing or mistaken knowledge limits market opportunities and dietary options in countries where few alternatives for earning money exist.

Other valuable species are eaten and traded without receiving a price premium that new markets could offer. *T. matsutake* was traded at similar prices to other wild mushrooms in local markets in Bhutan until its value as an export species was identified by visiting Japanese (Nagoya, quoted in Boa 2004).

Local knowledge of where to collect, what to eat and how to prepare EEMM for cooking is acquired through experience and passed on through generations. However, these skills can be lost, particularly when people move to cities and lose their confidence in recognising mushroom species or acquire new prejudices. One city dweller in Malawi, and potential customers of mushrooms from a peripatetic trader, was suspicious of a commonly eaten species found in a nearby woodland. The enterprising trader would eat the mushroom in front of the potential buyer to show it was safe.

A knowledge of local markets is equally important to collectors, who often have to walk long distances to sell their produce. Success depends on the ability to deliver fresh mushrooms to market and thus favors the more robust species, such as *Cantharellus cibarius* and many African species, which can survive being carried over uneven surfaces, often in large, weighty baskets containing enough mushrooms to make the journey worthwhile.

As local knowledge of the value of *T. matsutake* to Japan became more widely shared in parts of China, communities started to compete for harvests, often with violent consequences. Fuelled by perhaps exaggerated stories of potential earnings, villagers in Sichuan engaged in sustained battles to determine local rights to matsutake sites culminating in the sabotage of water supplies—they were without water for 45 days—and destruction of a key bridge. One village threatened not only to continue their disruption of life in the rival village but to "hide the pieces of the water pipes in the forest so that they could not be repaired" (Yeh 2000).

There is no certainty that local knowledge is correct, as already noted above in the example of people not eating mushrooms with pores in Tanzania. Yet regardless of such misconceptions, the sum of what people know gives new insights and information on wild edible mushrooms that researchers may otherwise not be aware of. Such information could be used to improve and identify research gaps or plan interventions that help local communities manage their resources effectively and sustainably. Local knowledge suggests how to maximise opportunities for earning money and working with natural resource managers and local communities on sustainable harvesting.

Sound scientific knowledge is not always welcomed when it contradicts strongly held views. There is a widespread belief in some countries that EEMM can be "over-picked" and thus damage future harvests. Egli et al. (2006) have refuted this idea in Switzerland, yet there is continuing resistance to these findings by nature conservationists (Egli, personal communication). Some beliefs are difficult to change whatever the available evidence.

## 17.3 Diversity of Edible Species and the Relative Importance of Those that Form Ectomycorrhizae

Wasson and Wasson (1957) were the first to attempt a global overview of uses and traditions associated with wild mushrooms in *Mushrooms*, *Russia and History*, a two volume publication available only in a few specialist libraries. The book gives a broader description of the importance of mushrooms to people than the title suggests, though this early account was inevitably incomplete and soon overshadowed by the senior author's academic interest in psychoactive mushrooms.

The Wassons were the first to use the terms "mycophilic" and "mycophobic" to describe attitudes they associated culturally with different regions, though whether these remain useful descriptors today is unclear. The drift of people away from the land or local traditions within a region can rapidly erode confidence in identifying species and therefore the willingness to eat wild harvests.

With many more accounts published of wild edible mushrooms from around the world, there is now a better recognition of the incredibly rich range of species collected and eaten by humans (Fig. 17.1). During literature searches for Boa (2004), published records of edible mushroom species and "fungi with other uses" were stored in a database. Additional records were added for several years following publication, and there are now around 10,000 records from over 1,000 sources held in "WUFbase" (the wild useful fungi database). These records are not yet fully accessible on the Internet, but the intention is to do so soon. The source of each entry is recorded, and the database includes multiple records for the same species from different sources. There are around 6,500 species in the database, including poisonous relatives of edible mushrooms.

This more recent database was used by Boa (2010) to update numbers of wild edible mushrooms, and this appears in Table 17.1. There are 2,299 species of wild edible mushrooms. This includes EEMM species as well as other types. Hall et al. (2011) list 930 ectomycorrhizal species that are either edible or medicinal (or possibly both), most of which are in Boa (2004). Hall et al. do not give the properties or uses for all the species they include, and apart from those species taken from Boa (2004), all other records are taken from a 1991 Chinese publication.

An explanation is needed for the distinction made in Table 17.1 between "food", a use, and "edible", a property of a mushroom. Many fungi are edible but either insipid or worthless. It is their value as food, which is of interest. Mushroom field guides frequently fail to make the difference between a general property and confirmed use, and these publications and other published lists are the main source of records for which there is no supporting evidence that a species has actually been consumed by someone.

Because there continues to be much discussion about which species can be eaten, sources were checked for supporting evidence. There is a remarkably large number of species for which this evidence is missing. There are also many published records for which it is uncertain if they are even edible, giving a total of just over


**Fig. 17.1** Selling mushrooms outside the main station in Tallinn, Estonia (**a**). Collecting niscalos (*Lactarius deliciosus*) near Palencia, Spain, growing with *Pinus nigra* (background). The mushrooms were sold to traders who would drive overnight to get to markets in Barcelona and Valencia (**b**). Mushroom collector with traditional basket from Malawi (**c**). A day's collection of matsutake is weighed and graded before being flown from Oaxaca to Japan (**d**). Mushroom collectors Malawi (**e**). *Boletus edulis* (porcini) being packed in Borgo val di Taro, Italy. A majority of porcini are imported (**f**)

1,100 species. Many authors made it clear that species were eaten and a relatively small number (62) lacking full evidence but enough to be classified as "food".

Poisonous species are included for general comparison in Table 17.1. This category includes those which are mildly toxic as well as potentially fatal. The advice in all cases is do not eat.

The database includes more than one record for the more popular species, and this is where it became difficult to decide how to arrive at a final decision. In short, a series of rules were developed which gave precedence to credible claims that

**Table 17.1** Reported use and properties of 2,705 mushroom species from 90 countries

| Use or property | Number of species | % of total |
|---|---|---|
| Food | 1,118 | 41 |
| Food (uncertain) | 62 | 2 |
| Edible | 530 | 20 |
| Edible (uncertain) | 589 | 22 |
| Poisonous | 354 | 13 |
| Poisonous (uncertain) | 52 | 2 |

**Table 17.2** Number of edible ectomycorrhizal species in the top 15 genera by abundance, based on a preliminary analysis of Hall et al. (2011) and the unpublished "WUFbase"

| Genus | Number of EEMM species (Hall et al. 2011) | Number of EEMM species (WUFbase) |
|---|---|---|
| *Russula* | 110 | 72 |
| *Lactarius* | 84 | 58 |
| *Boletus* | 62 | 32 |
| *Amanita* | 55 | 36 |
| *Tricholoma* | 46 | 27 |
| *Cantharellus* | 44 | 32 |
| *Hygrophorus* | 40 | 14 |
| *Cortinarius* | 39 | 15 |
| *Ramaria* | 39 | 22 |
| *Suillus* | 30 | 19 |
| *Tuber* | 28 | 15 |
| *Leccinium* | 19 | 10 |
| *Lycoperdon* | 18 | 13 |
| *Xerocomus* | 15 | 8 |
| *Tylopilus* | 13 | 2 |

a species was poisonous over claims it could be eaten, erring always on the side of safety.

The aim behind this categorization is to encourage researchers and others making inventories to check carefully on uses and not to assume that a species recorded as edible in a field guide, for example, is always eaten—if at all. Assumptions may be valid (though still presumptive) for a well-known species in a well-known region, for example, northern Italy, but this is not a good practise to follow in the Himalayan foothills, where traditions are poorly understood.

The earlier statement that there were 2,299 edible mushroom species can now be qualified: there are 1,648 unequivocal records of mushrooms that can be categorised as either food or are edible and potential food. A preliminary count says that these fall into 285 genera, of which 117 form ectomycorrhizae, based on the list published by Hall et al. (2011). These numbers are likely to change, including the total number of species, when taxonomic revisions and new genera since 2004 are taken into account and new sources of information are checked.

Analysing the species listed by Hall et al. (2011), the three genera with the highest number of edible species are *Russula*, *Lactarius* and *Boletus*. Table 17.2 lists then next 12 genera in descending order of abundance and compares the

**Table 17.3** Number of species of edible mushrooms sold at local markets in Armenia, Mexico, Nepal and Tanzania combined with Zambia, adapted from Boa (2004)

| Country | All species | Ectomycorrhizal |
|---|---|---|
| Armenia | 13 | 4 |
| Mexico | 105 | 77 |
| Nepal | 20 | 13 |
| Tanzania and Zambia | 15 | 9 |

Original sources of information are available in Boa (2004), which includes selected information for 13 other countries. There is a major under-recording of species sold in local markets worldwide, and more information is needed on the quantities and values of this trade

number of species with those from wufbase. The order of genera stays more or less the same, but the abundance of EEMM drops significantly. The difference would appear to arise from Chinese records incorporated by Hall et al. (2011).

## 17.4 Local Markets and Sale of EEMM

It should be possible to demonstrate the value of EEMM to local communities through an analysis of local trade, giving a clearer indication of how many people benefit. Lists of species sold in 17 countries are given in Boa (2004), but these are clearly incomplete, and few new studies have been found. A snapshot of selected countries is shown in Table 17.3. Over half the species for sale are EEMM, though in volume and value they are likely to be a much larger part of the total trade in wild edible mushrooms.

The big markets are international, with supermarkets in better-off countries absorbing and sucking in industrial quantities of chanterelles from around Europe. There are few data on who receives money for collecting or trading on further down these long market chains.

The local selling of EEMM happens in small markets and by the roadside, the nearest opportunity for collectors to present their harvests once they have returned from their field visits. Some traders meet the collectors closer to their homes, but in Malawi there are especially women who will rise early to collect then walk up to 10 km to a market the same day, before returning home in the evening. Some sell directly but this takes time, and it is often easier to sell what you procure to a trader even though the money earned is substantially reduced compared to direct selling.

## 17.5 Conclusions

Edible ectomycorrhizal mushrooms account for the majority of sales and consumption of wild edible mushrooms around the world. Although their dependency on host plants marks them as biologically and ecologically different from other wild

edible species, the ultimate determinant of successful and sustainable management dependents on a thorough understanding of people. There are many gaps in our knowledge of who benefits from sales and consumption of these fungi, and future studies need to emphasise the critical role that people have in making choices and developing opportunities. Local communities benefit much from sales though uncertain demand and varying prices lead to unpredictable boom and bust cycles. EEMM and wild edible mushrooms are only one of many strategies that rural people use to earn a living. Their importance may well increase in times of financial hardship and weakened economies, putting further strains on natural resources that the rural poor increasingly fall back on when their options are limited.

## References

Abbott P (1999) Non-timber forest products harvesting: lessons for seasonally-sensitive management in Miombo. In: Ngulube MR, Mwabumba L, Chirwa P (eds) Community-based management of Miombo woodlands in Malawi. Proceedings of a national workshop, Sun and Sand Holiday Resort, Mangochi, Malawi 27–29 Sep 1999. Forestry Research Institute of Malawi, Zomba, Malawi, pp 70–89

Arora D, Shepard G (2008) Mushrooms and economic botany. Econ Bot 62(3):207–212

Boa E (2004) Wild edible fungi. A global overview of their uses and importance. FAO, Rome. http://www.fao.org/docrep/007/y5489e/y5489e00.htm

Boa E (2010) From *Chipho* to *Msika*: an introduction to mushrooms, trees and forests. In: Cunningham AB, Xuefei Y (eds) Mushrooms in forests and woodlands: resource management, values and local livelihoods. Earthscan, London, pp 1–20

de Román M, Boa E, Woodward S (2006) Wild gathered fungi for health and rural livelihoods. Proc Nutr Soc 65(2):190–197

Egli S, Peter M, Buser C, Stahel W, Ayer F (2006) Mushroom picking does not impair future harvests – results of a long-term study in Switzerland. Biol Conserv 129:271–276. doi:10.1016/j.biocon.2005.10.042

Hall IR, Stephenson S, Buchanan P, Wang Y, Cole ALJ (2003) Edible and poisonous mushrooms of the world. Timber, Portland, OR

Hall IR, Lyon T, Wang Yun, Buchanan P (2011). A list of putative edible or medicinal ectomycorrhizal mushrooms. http://www.trufflesandmushrooms.co.nz. Accessed 13 Feb 2012

Härkönen M, Niemelä T, Mwasumbi L (2003) Tanzanian mushrooms. Edible, harmful and other fungi. Finnish Museum of Natural History, Botanical Museum, Helsinki

Morris B (1987) Common mushrooms of Malawi. Fungiflora, Oslo, 108 pp

Piearce GD (1981) Zambian mushrooms–customs and folklore. Bull Br Mycol Soc 15(2):139–142

Pilz D, Molina R (2002) Commercial harvest of edible mushrooms from the forests of the Pacific Northwest United States: issues, management and monitoring for sustainability. For Ecol Manage 155:3–16

Wasson VP, Wasson RG (1957) Mushrooms, Russia and history, vol 2. Pantheon Books, New York

Yeh E (2000) Forest claims, conflicts and commodification: the political ecology of Tibetan mushroom-harvesting villages in Yunnan Province, China. China Q 161:225–278