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Useful fungi of the world: the Shii-take, Shimeji, Enoki-take, and Nameko mushrooms

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In contrast to the cultivated mushroom (*Agaricus bisporus* (J. Lange) Imbach) which was first cultivated in the early 18th century in France, the famous Shii-take mushroom (*Lentinula edodes* (Berk.) Pegler) was cultivated in China centuries earlier, before being developed in Japan and extensively exported throughout the world. Other common names include the Oakwood mushroom, Japanese forest mushroom, Black mushroom, and Pasania. It is a mushroom long valued for both a unique flavour and as a medicinal tonic, for even in the Ming Dynasty (1368 – 1644 CE) it was claimed to be a general stimulant, curing colds, increasing blood circulation and lowering blood pressure.

It is found throughout much of eastern Asia, especially China and Japan, preferring an optimal temperature of around 24°C but also extending westwards as far as Kazackstan. It grows on the dead wood of a wide range of tree hosts. especially species of oak, beech, chestnut, hornbeam, walnut, *Elaeocarpus*, the Shii-tree (*Castanopsis cuspidata*), magnolia, pines and spruce.

The scientific description was based on a very poor specimen purchased from a shop in Japan and brought to England where, in 1877, the English mycologist Miles Joseph Berkeley thought it possibly represented a species of *Armillaria* or Honey fungus. Although a well-known species, the taxonomic position has remained in dispute over the past century, for it has been assigned to nine separate genera, including *Armillaria*, *Cortinellus*, *Lentinula*, *Lentinus*, *Lepiota*, *Pleurotus* and *Tricholoma*. It is not at all closely related to the cultivated mushroom. The convex to depressed. ochraceous tawny to dark vinaceous brown cap is 5-15 cm across, darker at the centre, dry and smooth then breaking up into triangular scales or deeply cracking. The gills are adnate to free, crowded and whitish whilst the short, stocky stem is solid, pale reddish brown, and slightly scaly below.

Reports of this wild edible mushroom go back a very long way. Early Japanese records date back to the Emperor Chuai who in 199 CE praised the mushroom. Chinese records are even earlier, when it was known as 'ko-ku' or 'hoang-mo'. The popularity of the mushroom was such that the quantity gathered from the wild was insufficient to meet demand. The cultivation of shii-take is thought to have started around 1000-1100 CE during the Sung Dynasty in China, and the story has become part of Chinese folklore. It is said that a poor farmer, called Wu San Kwang, living in southern China, hunted for mushrooms in the mountainous forests. He came across fallen branches on which grew edible mushrooms. To his great surprise, when he cut the logs additional mushrooms grew. When they stopped growing he became angry and beat the logs to force out more mushrooms. From this story, the cultivating technique of 'shocking the mushroom' by beating the logs was developed and later exported to Japan. In recognition of the benefit his discovery provided to his people, there now exist two temples dedicated to Wu San Kwang.

The Shii-take mushroom was introduced into Japan during the 15th century, where production was modified and much improved, by inoculating the logs with the mushroom spawn, to an extent that Japan now supplies two-thirds of the world's needs. Today, the use of wood logs in natural conditions (Fig 1) largely remains the means of production in Japan, with up to 170,000 farmers. Hong Kong is the major market.

It was indeed fortunate that the cultivated mushroom proved to be every bit as good both in appearance and in taste as the wild form. The great advantage of the Shii-take is that it has a firm texture and dries well, acquiring additional flavour when dried. It is therefore excellent for exporting. The dried mushrooms are much esteemed both in China and Japan, either consumed as a dish by themselves or as an addition to other dishes.

Much has been made in recent years of lentinan, a water extract of the mushroom, considered as an anti-cancer drug. It is claimed to play an important role in improving host defence activity and is therefore used for patients in an immuno-suppressed condition. There are additional reports that it is both an anti-tumour substance, and enhances resistance against bacteria,

viruses, fungi and parasites. Additional claims mention the lowering of cholesterol levels. The mushroom is widely used both as an aphrodisiac and as a cure for impotence.

Until recent years Shii-take was an exclusively Asian industry but is now cultivated throughout Europe, America, Australia and New Zealand, Thailand, Taiwan and Singapore. The development of the plastic-bag culture techniques means production can only increase. The volume in commercial production is exceeded only by the cultivated mushroom (*A. bisporus*). As long ago as 1874, the British Consul in Japan reported home that the export value of the shii-take mushroom was equivalent to €66,050. By 1953, the export volume had risen to 1,500,000 kilograms. World-wide, cultivated Shii-take production reached 234,436 tonnes in 1984, which was then valued at around €1,086,100,000.

A second Japanese cultivated mushroom has come to the fore in recent years. First cultivated in 1973, the Buna-shimeji, Yamabiko Hon-shimeji or Tami-motashi mushroom (*Hypsizygus tessulatus* (Bull.: Fr.) Sing.), although the name *H. marmoreus* (Peck) Bigelow is preferred in Japan, has become an increasingly popular species. The names *H. marmoreus* and *H. tessulatus* represent the same species, but *H. tessulatus* is the older, valid, and scientifically correct name. Cultivation also occurs in North America, where the name has been abbreviated to the Shimeji Mushroom, although shimeji refers to a number of species in Japan. The English name is the Elm Oyster, yet it is not really closely related to the Oyster Mushrooms (*Pleurotus* species), but rather to the wild, edible St. George's Mushroom (*Calocybe gambosa* (Fr.) Sing.). It is a species that can be found throughout the North temperate zone, and was known to have been eaten by the North American Indians. It has yet to be cultivated in Europe, and there are few records of it being eaten, probably because it is a rare species. Although the wild mushrooms are tough, the cultivated form has an excellent rich flavour, and a long shelf-life.

The Shimeji mushroom has a white to buff-yellow, finally greyish brown cap 5-15 cm across, which is smooth but marbled with water spots, later becoming cracked to form scales. The gills are adnexed to almost free, whitish becoming cream, and crowded, and the excentric, white stem is solid. It grows high on the trunks of deciduous trees, especially elm, also beech, sycamore, oak and willow. In Japan, it is said '*for fragrance Matsu-take, for flavour Shimeji*'.

The Enoki-take (*Flammulina velutipes* (Curtis: Fr.) Sing.) (Fig 2) and the Nameko mushroom (*Pholiota nameko* (T. Ito) S. Ito & Imai) are two commercially grown mushrooms which are very similar in many respects. Their cultivation is virtually limited to the Far East and, in particular, to Japan. They are usually referred to as low temperature mushrooms, in contrast to the Shii-take, Mu-erh and Silver ears mushrooms, which require higher temperatures for growth. Enoki-take means the 'Snow peak mushroom' in Japanese, and one of the western names is the 'winter mushroom'. The name 'Nameko' was originally used for several species of *Pholiota* and similarly looking fungi, including *Flammulina velutipes*, in which the cap surface was sticky or slimy. Today, however, Nameko refers only to *Pholiota nameko*, a species which is restricted to the Far East. It is almost certainly the glutinous aspect to the cap that has prevented these mushrooms from being developed in other countries, as it is a characteristic that offers little appeal to the western gourmet. Nevertheless, the slime on the Nameko mushroom disappears completely on cooking, and the surface cuticle is easily removed in the Enoki-take. It is the glutinous slime that enables these mushrooms to survive frost in the winter months, preventing their water content from turning to ice.

Both mushrooms occur in the wild during the autumn and winter months, growing on dead trunks, stumps and roots of leafy trees, rarely on conifers. The history of their cultivation therefore closely follows that of the Shii-take and Mu-erh, albeit as a far more recent development. Early cultivation was on cut logs, which has now been superseded by the indoor method using a sawdust mix in bottles.

In Europe and North America, *F. velutipes* is a familiar species and has been traditionally collected as an edible mushroom, although this is mainly because it is likely to be the only mushroom found when snow is on the ground. Only the young fruitbodies are edible. It forms dense clusters on the stumps and branches of leafy trees, usually elm, but also willow and poplar, and is a striking and beautiful species. The flattened cap grows up to 5 cm across, coloured tawny brown and is sticky when moist, darker when old, honey yellow at margin, whilst the gills are white and the stem is pale yellow above, becoming covered with a dark brown velvety layer below. For this reason it is often called 'Velvet shank' or 'Velvet foot'. The spore deposit is white. In order to prepare the wild mushrooms for consumption, the sticky pellicle of the cap must be first peeled away.

Cultivation using a sawdust mix in bottles began in Japan in 1928, and 1970 in Taiwan. An enormous expansion took place between 1960 and 1980, and now world production exceeds 60,000 tonnes although eighty per cent is still concentrated in Japan. The introduction of air-conditioning allows temperature to be regulated, so that cultivation can take place

throughout the year. The sawdust base is mixed with water and rice bran and placed in polypropylene bottles, to which is added the spawn. Once the mycelium has grown, the bottles are placed in darkness and the temperature is reduced to 10 – 12°C. This stimulates formation of the fruit-body primordia. Once the stems start to form they are toughened up by further reducing the temperature to 3-5°. Once the stems reach 2-3 cm long, a cylinder of waxed paper or plastic is placed around the neck of the bottle; this both supports the slender stems, and also increases the volume of carbon dioxide which is formed. The result is to inhibit production of the mushroom cap and to increase the stem length. The cultivated mushroom looks completely different from the wild form. The fruit-body is white, being grown in the dark, and the stems are very long, while the caps are tiny and scarcely formed. The mushrooms, which are generally used for soups, are rich in protein, minerals and vitamins, but less so in fats and fibre.

Fig 1 Shii-take mushroom (*Lentinula edodes*), cultivated on *Castanopsis* logs, Japan. Photo: D. N. Pegler.

Very few of the Scale heads (*Pholiota* species) are regarded as edible but the Nameko mushroom is an exception and much prized in Japan. It grows naturally in Japan and temperate China, on the stumps and logs of leafy trees, especially beech (*Fagus crenata*), more rarely on conifers. The cap is 3 – 15 cm across, convex soon flattened, smooth, bay brown at centre, paler at margin, and covered with a yellowish red slime, which gradually wears away as the cap expands. The pale gills become brown at maturity, and the spore deposit is brown.. The cylindrical, stem, with a swollen base, bears a fugacious, membranous, slimy ring attached towards the top. Cultivation started, using cut logs, in 1921 in Japan, and this changed in 1960 to using a sawdust and wheat bran mix, grown indoors. Today, some 20,000 tonnes are produced annually, exclusively in Japan.

For preparation for the dining table, the mushroom is normally cut into small pieces after cooking, when all the slime has disappeared, and then added either to stir-fry dishes or to miso soups. The mushroom has been shown to be particularly rich in vitamins and some medical interest is being shown in the presence of possible anti-tumour properties.

Fig 2 Enoki-take mushroom (*Flammulina velutipes*), growing wild, England. Photo: V. Fleming.