Wood Chip Fungi:
Agrocybe putaminum in the San Francisco Bay Area

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Abstract

Agrocybe putaminum was found growing on wood chips in central coastal California; this appears to be the first record for North America. A short description of the species is given. Its habitat plus the characteristics of wood chip denizens are discussed.

Wood chips are the fast food of the fungal world. The desirable wood is exposed, there is a lot of it, and often the supply is replenished regularly. It is an especially good habitat for mushroom species that like it hot because a thick layer of wood chips is warmed relative to the surrounding environment by the activity of bacteria and microscopic fungi (Brown, 2003; Van den Berg and Vellinga, 1998).

Thirty years ago wood chips were a rarity, but nowadays they are widely used in landscaping and gardening. A good layer of chips prevents weeds from germinating and taking over, which means less maintenance and lower costs. Chips also diminish evaporation and keep moisture in the soil. Trees and shrubs are often shredded and dumped locally, but there is also long-distance transport of these little tidbits. Barges full of wood mulch cruise the Mississippi River, and trucks carry the mulch from city to city.

This fast food sustains a steady stream of wood chip fungi that, as soon as they are established, fruit in large flushes and are suddenly everywhere. The fungi behave a bit like morels after a fire—they come and fruit in huge numbers but also deplete the substrate quickly. In the second year following the deposit of new chips, the numbers of mushroom fruitbodies are significantly down in comparison to the first year. Their fruiting strategy indicates that they are rapid colonizers, depending on spores to conquer new substrates. In fact, it is suggested that they fruit only when the substrate is (almost) depleted of nutrients to make sure that the species survives (Bridge and Prior, 2007). Many wood chip fungi use mycelial cords to cover their substrate, but spores probably play much more of a role than cords in jumping to new territory. By contrast, dry rot fungi like *Serpula lacrymans* rely on mycelial cords to bridge an inhospitable barrier, such as concrete, in order to reach a new source of wood.

However, Shaw and Kibbey (2001) suggested that the species are present as mycelium in wood chips before they are sold and shipped around. This does not explain outbreaks of fungi on locally produced chips. Probably both scenarios play a role, with competition for this easy substrate being the determining factor in shaping the communities. Those who come first will probably prevail, and prevent the colonization by later species.

A small set of species is found on wood chips. Amazingly, the same set occurs, almost in identical species composition, in different parts of the world.

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Figure 1. Agrocybe putaminum *in its wood chip habitat. Photographed 22 Oct. 2007, California, Alameda Co., Berkeley, UC-Berkeley (east side), by Else C. Vellinga.*

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Only a few Ascomycetes are found on the wood chips: a big brown *Peziza* is common, and sometimes, especially in newly landscaped areas, *Morchella rufobrunnea*.

In the San Francisco Bay area, where I live, common species on wood chips are the ubiquitous members of the group of *Tubaria furfuracea, Melanoleuca verrucipes, Stropharia percevalii,* some *Psathyrella* species and *Coprinopsis lagopus, Volvariella gloiocephala* (a.k.a. *V. speciosa*), several bluing *Psilocybe* species, *Pluteus* and *Agrocybe* species. *Melanotus horizontalis* is often found on *Eucalyptus* chips, together with the yellow-stemmed *Pluteus romellii* (aka *Pluteus lutescens*).

Melanoleuca verrucipes is a relative newcomer, as Arora (1986) does not mention it. It has also expanded in Europe (e.g. Tjallingii, 1996; Legon and Henrici, 2005) and is present in Japan (Kasuya et al., 2007). Part of its success might lie in the presence of fierce-looking cystidia on the rhizomorphs, a good defense against fungivores (Kasuya et al., 2007).

Stropharia percevalii also has been known only for a few years but is now abundant. It has spread in European countries as well (e.g. Rald, 1989; Shaw and Kibby, 2001; Arnolds and Van den Berg, 2005).

Indeed, examples of the rapid expansion of the wood chip species are rampant. Take *Agrocybe rivulosa,* which was described in 2003 as a new species (Nauta, 2003). It is a big, pale yellowish-brown *Agrocybe* with a wrinkled pileus that is glutinous when young, and it starts out with a conspicuous whitish ring. Clavate cystidia on the lamellae, a gelatinized hymeniderm, and spores ranging from 10 to 14 µm in length are its microscopic characters. *Agrocybe rivulosa* was first spotted fruiting in Rotterdam (the main port city of the northern European continent) in 1999 and subsequently was found in various other places in the Netherlands, beginning in the west, but later also in the eastern parts (Dam, 2003). It has established itself in England (Lovett, 2006), Belgium (De Haan, 2004) and Luxembourg (Nauta, 2003), and was observed in Denmark in October 2007 (in a garden where it had already been established for a while; Læssøe, 2008, pers. comm.). One possibility is that it came by ship to Europe, but where its voyage began is a mystery.

Stropharia aurantiaca (a.k.a. *Naematoloma* and *Hypholoma aurantiacum*) is a very showy species that cannot be confused with anything else. Its spread has been well documented in several countries, including the Netherlands, where the first records were made in the sixties, followed by a rapid spread throughout the country and eastwards into adjacent Germany (Daams, 1991). Its range has continued to increase, and its success story is not over (Arnolds and Van den Berg, 2005). This orange-capped species is now widespread in Europe (e.g. Shaw, Web site; Pegler and Legon, 1998b; Kreisel, 2005), Australia (Cleland, 1934, as *Psilocybe ceres*), New Zealand (Shirley, Web site), South Africa (Reid and Eicker, 1999) and the western U.S.A. (Arora, 1986; Bojantchev, Web site; pers. obs.). It is not featured in the monograph on *Naematoloma* species by Smith (1951), so it probably did not occur in the U.S.A. at that time, and it is still not in some modern mushroom guidebooks with an eastern bias, like Lincoff (1981), Bessette et al. (1997), and Miller and Miller (2006). There is one record in the NAMA voucher data base, from the 1998 foray in California (as *Hypholoma aurantiaca*; http://fm1.fieldmuseum.org/name/?page=viewandid=330). But, as there is no national checklist nor record-keeping, and local checklists are scattered or nonexistent, it is hard to tell how widespread it is and when it arrived in the U.S.A.

Also unclear is where it originates. European mycologists have proposed an Australian origin, but as the species there also only occurs in man-made habitats, this is disputed (see Daams, 1991, for discussion).

To investigate whether *S. aurantiaca* resides in the soil and fruits only when wood chips or mulch are laid on top, Bridge and Prior (2007) tested soil and wood chips for its DNA. They found that the species was present in the soil only when it was also present in the chips directly above, but it could be present in the chips without being present in the soil. The idea of a persistent reservoir in the soil is therefore unlikely.

One last note on this species is that the name has just been changed, as the name *S. aurantiaca* is based on an orange variety of another species, *S. thrausta* (Schulzer ex Kalchbr.) Sacc. (see Fortey, 2004, for an extensive discussion). The newly proposed name for this easy to recognize species is *Leratiomyces ceres* (Bridge et al., 2008), based on a species described from Australia, which is identical with what we call *S. aurantiaca*.

Last fall I suddenly realized that the *Agrocybe* with a velvety stipe and pileus I was seeing was one I could name, viz. as *A. putaminum* (Maire) Singer, another of those species that has exploded on the wood chips. Originally it was described in France from garden soil rich in plum pits (Maire, 1913, as *Naucoria putaminum*). The next record came from the Netherlands (Bas, 1958), where again it was growing in a garden, this time without plum pits. As soon as it made the jump to wood chips, a rapid expansion started. De Haan (1998) described a fruiting of hundreds of specimens in western Belgium. Again, there are records on wood chips from England (Pegler and Legon, 1998a; Shaw et al., 2004), the Netherlands (Nauta, 2005), Italy (La Chiusa, 1998) and Denmark (Rald, 1989), though in the last country, almost twenty years after its initial discovery, it is still only known from one or two localities (Læssøe, 2008, pers. comm.).

In the San Francisco Bay area it is not uncommon, and it has been around for several years—probably at least since 2000 (Wood, 2007, pers. comm.)—prior to the "Aha moment" that made me realize its identity.

Agrocybe putaminum can be recognized in the field (Fig. 1, see

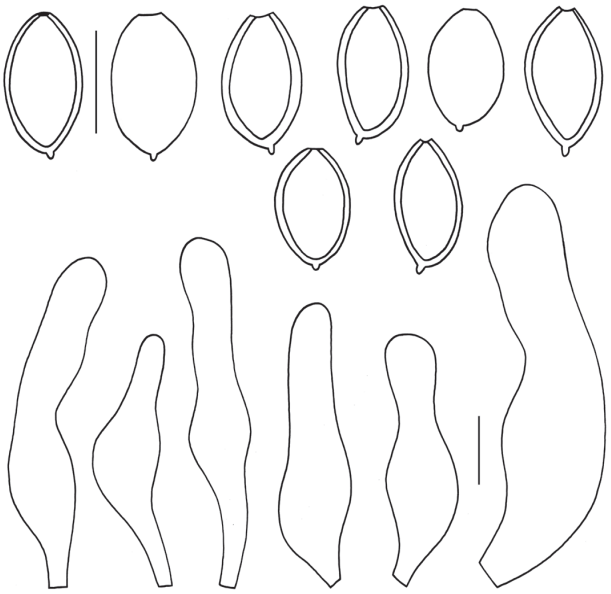

Figure 2. Agrocybe putaminum, *microscopical characters from collection ecv3652 (19 Oct. 2007, same locality as specimen in Fig. 1; collection in UC): spores and cheilocystidia. Scale bars are 10 µm.*

page 5) by typical yellow-brown *Agrocybe* colors, the velvety, matte pileus which starts out rather triangular in cross section, and the stipe, which is grooved and completely covered in cystidia, making a floccose-velvety impression, and its strongly bitterish mealy (farinaceous) taste. Microscopically, it is characterized by the big, ellipsoid spores with an apical germ pore, four-spored basidia, abundant lageniform to utriform cheilocystidia and utriform to broadly clavate pleurocystidia, the hymeniform pileipellis with some pileocystidia, the caulocystidia on the stipe resembling the cheilocystidia, and the abundant clamp connections.

Other, eastern North American species resembling *A. putaminum* differ in either the absence of pleurocystidia (*A. hortensis*), smaller spores and absence of pileocystidia (*A. sororia* and *A. amara*), and equally sized spores but without pileocystidia (*A. smithii,* which is a more robust species); none of those species is said to have a cystidiose-floccose and grooved stipe (Watling and Bigelow, 1983). A key to the species group is given by Watling and Bigelow (1983).

I look forward to hearing whether this velvety *Agrocybe* has been found in parts of the U.S.A. other than just central coastal California. Furthermore, I would like to ask everybody to keep your eyes open for the arrival of *A. rivulosa* in North America. Please let me know if you find it.

In conclusion, the arrival of the wood chip as a common garden-cover agent has paved the way for an influx of exotic and colorful mushrooms whose origins are in most cases obscure. Whether these fungi could persist in their new countries if wood chips are a passing fad is an open question.

One last remark—isn't it time to start a central databank or a checklist for the U.S.A. where records of fungal finds can be deposited and consulted?

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