PHAEOLEPIOTA AUREA, A BEAUTIFUL AND MYSTERIOUS MUSHROOM

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Is it a *Pholiota* or *Lepiota*? Is it edible or poisonous? This beautiful and almost golden luminous mushroom is easily recognisable, but rare. Many mushroom aficionados on both sides of the Atlantic have never seen it. It was not for nothing that this rare species had a place of honour at the Mushroom Exhibition 2000, organised by the Société Mycologique de la Riviera, in the town of Vevey, situated on the shores of Lake Geneva in Switzerland.

Indeed, the organisers of the said exhibition had been lucky enough to find a large group of this golden-coloured mushroom, and could, therefore, present it at different stages of its development (Fig. 1). The cap diameter of the largest specimen was 15 cm, whereas the stalk was more than 20 cm long and about 2 cm thick. The whole mushroom was covered by a granulose sheath, breaking in older specimens to form a funnel-like ring, which later dropped to form a kind of skirt. The colour of both stipe and pileus was golden brown to orange-tan. The flesh was yellowish. Gills were attached, orange brownish in colour. The spore print was a pale yellow-brown. The mushroom's strong odour was reminiscent of bitter almonds and its taste was mild.

A rare species

This extraordinary mushroom looked rather like a giant *Cystoderma amianthinum*. Among the visitors at the exhibition, most had never seen it. They were surprised to learn that it was the pholiote dorée, the French common name for *Phaeolepiota aurea* (Matt. : Fr.) Maire, also known as *Cystoderma aureum* Kühn. & Romagn. The mushroom had been found along a road, at a site called Les Paccots, in the Canton of Fribourg, where it grew in a large fairy ring amidst nettles (*Urtica*) (Fig. 2, see issue's front cover). Several mycologists and experienced amateurs readily admitted that they had never seen this *Phaeolepiota*. Some did recognise it, having seen illustrations in their favorite field guides. In 45 years of mycological activity we had ourselves seen it only once. That was in The Netherlands, in 1975, where we discovered it near the City of Utrecht, on the slope of a dike, amidst nettles under elder shrubs. At that time, identification was not so easy, because the spectacular mushroom was not mentioned in the available Dutch and German field guides. However, upon consulting the Dutch adaptation of Morton Lange's *Illustreret Svampeflora*, we found a description and an illustration that matched: our find was *Phaeolepiota aurea*, a rare species, related to *Cystoderma*, but having ochre-coloured spores.

Often absent from the literature

Confronted for the second time in our lives with this remarkable mushroom, we decided to do a literature search to learn more about it. First we checked with what frequency the species was mentioned in field guides, textbooks and encyclopaedia on mushrooms edited between 1860 and 2000. Of course, we confined ourselves to the more important volumes, excluding booklets having a too narrow scope such as *The best edible mushrooms*, *Petit Atlas des Champignons, etc.* We found that *Phaeolepiota* (*Pholiota*) *aurea* was described and sometimes illustrated in 30 out of 80 books consulted. The species proved often absent from German, Swiss, Austrian and English literature, but it was invariably mentioned in Canadian and American field guides. Checking the oldest books revealed a consistent confusion with *Gymnopilus* (*Pholiota*) *spectabilis*, the Giant Gymnopilus, a large and similarly coloured species, but that distinguishes itself from *Phaeolepiota* by growing in large clusters on stumps of deciduous trees and also by its pronounced bitter taste. In their *Flore des Champignons supérieurs de France*, edited in 1909, the authors Bigeard & Guillemin described the habitat of *Pholiota aurea* as 'growing in clusters at the base of trees in sandy soils'. The same error was made by Costatin & Dufour in *La nouvelle flore des champignons*, an early pocket guide used for a long time by amateurs throughout Europe. In the edition of 1912, it is even said to have a very bitter taste.

In a recent article, the French mycologist Régis Courtecuisse called the mushroom 'la lépiote des Pyrenées', a name that had not been used since 1887, when the famous Quélet baptised it *Lepiota pyrenaea*. Indeed, the most frequently used French common name is 'pholiote dorée'. The Dutch call it 'Goudparasol' (Golden Lepiota), the Germans 'Glimmerschüppling', whereas some American authors label it as 'Alaskan gold', because this mushroom is more often found in that State than elsewhere in the U.S.A.

The mushroom is rare both on the Continent and in the U.K. Erna Bach's monograph on the species (1956) reports only two collections for England and three for Ireland. However, in recent years it has been signaled more frequently, notably in Liverpool, and a splendid photograph of the species has once graced the cover of *The Mycologist.*

A search on the Internet revealed that *Phaeolepiota aurea* is mentioned there 44 times. Japanese sites often give beautiful photos of the mushroom which is called 'koganetake'.

Pholiota, Lepiota or *Cystoderma*?

European mycologists have never agreed on the taxonomic position of this strange mushroom. It was first described in 1779 as *Agaricus aureus* by the Czech author Mattuschka, and the Swede Elias Fries, the father of mycology, placed it in the genus *Pholiota*, because of its ochre-coloured spore print. We have already seen that Quélet considered it a *Lepiota*, whereas Maire created for this single species the new genus *Phaeolepiota*. More recently, Kühner and Romagnesi preferred to call it *Cystoderma*. The latter author considered the species as an oversized representative of this genus, and stated that *Phaeolepiota* Maire was only acceptable as a subgenus.

Could chemistry help?

It is well-known that the study of chemical characteristics has been most valuable in systematic mycology. For example, many mushrooms produce urea—a nitrogen waste product also secreted by mammals—at concentrations that increase with the age of the fruitbodies. This feature may be used to delimit a genus, *e.g. Panaeolus* spp. produce ample quantities of this metabolite, whereas it is absent in members of the genus *Psathyrella*. Within a genus, certain subsections are characterised by the presence of urea. A good example is *Coprinus*, in which only the ringed Shaggy Mane (*C. comatus*) and *C. sterquilinus* produce urea. Those Inky caps were formerly grouped within the subsection *Volvocoprinus*. Recently, molecular taxonomy based on DNA sequencing has revealed that those taxa are in fact far closer to the genus *Agaricus* all members of which readily produce urea!

Similarly, the development of gaseous hydrogen cyanide (HCN in the chemist's jargon) seems to be characteristic for certain genera among the Tricholomataceae, although one also finds a number of Polypores capable of producing this toxic gas.

Moreover, mushrooms also differ in their capacity to take up certain metals from their substratum. For example, the Blue-green Anise Mushroom, *Clitocybe odora* is loaded with copper, whereas *Gomphidius* species seem to exclude this metal. Among the genus *Agaricus* one finds many species which gobble up mercury and cadmium. Furthermore, since the Tchernobyl nuclear accident we know that mushrooms also differ tremendously in their affinity for the radioactive caesium isotopes.

This table compares chemical characteristics of *Pholiota* spp., *Phaeolepiota aurea* and some macrofungi belonging to the genera *Lepiota*, *Macrolepiota* and *Cystoderma*. It is clear that the *Phaeolepiota* is rather close to the latter. Not only does it produce much urea, but it also shares the affinity for the heavy metals silver, mercury and cadmium (which are only weakly represented in the genus *Pholiota*). These results, especially the high cadmium concentrations in both *Phaeolepiota* and *Cystoderma* confirm Romagnesi's taxonomic point of view. Nevertheless, its HCN production makes *Phaeolepiota* special. (Fig. 3.)

Chemical features	Genus *Pholiota* 6 species	*Phaeolepiota aurea* 3 collections	*Lepiota* and *Macrolepiota* 10 species	*Cystoderma* 3 species
Synthesis of urea	nil	intense	intense	intense
Production of Hydrocyanic acid	nil	intense	nil	nil
Radiocaesium uptake	weak	nil	nil	nil
Content of zinc	34–54 (44)	63–121 (90)	55–176 (114)	62–87 (69)
copper	30–65 (42)	47–80 (69)	21–191 (116)	38–89 (62)
silver	0,30–0,64 (0,44)	1,35–2,38 (1,79)	0,67–28,0 (3,54)	0,89–11,0 (4,06)
mercury	0,12–0,70 (0,39)	3,2–7,3 (4,9)	0,75–6,2 (2,94)	0,80–4,5 (2,18)
cadmium	0,50–1,10 (0,77)	4,1–30,0 (18,1)	1,28–7,2 (3,45)	2,9–24,5 (14,8)

All values in mg/kg on dry matter. Average values between brackets.

Edible choice or a toxic mushroom?

In some French and Swiss handbooks *Phaeolepiota*, although a rare species, is nevertheless presented as a good and even excellent edible mushroom. On the other hand, American and Canadian guides are more cautious since it is supposed to cause gastric trouble in some people. Since the 1960s, annual reports from North American mycological associations regularly mention cases of mild intoxications (vomiting and diarrhoea) caused by this mushroom. However, when consulting classic and modern manuals on mushroom poisoning, one discovers that *Phaeolepiota aurea* is never mentioned. Perhaps the species is too rare in Europe to show up in the statistics!

The Belgian mycologist Paul Heinemann discovered in 1942 that the mushroom contains hydrocyanic acid (HCN), a metabolite that is also encountered in several edible species, *e.g. Marasmius oreades*, *Clitocybe geotropa*, *Clitocybe gibba* and *Pseudoclitocybe cyathiformis*, to mention only a few. Even cultivated mushrooms like the Golden Oyster (*Pleurotus citrinopileatus*), *P. eryngii*, and even good old Shiitake (*Lentinula edodes*) produce measurable quantities of this toxic compound.

A few years ago, we had the opportunity to study those 150 edible mushrooms which are admitted on the Swiss and German markets. Our results showed that only 14 species (or about 9%) tested consistently positive for HCN. The amounts produced ranged from 7 to 268 mg/kg. For the three economically most important mushrooms, *i.e.* the White button (*Agaricus bisporus*), the Oyster (*Pleurotus ostreatus*) and the Paddy Rice straw mushroom (*Volvariella volvacea*), the test was negative.

To check whether HCN constituted a health risk to the consumer, we subjected several mushrooms to various processing and culinary preparation procedures. Invariably, the toxic compound had entirely disappeared from the prepared dish.

Still, better abstain!

Since at the end of the afore-mentioned mycological exhibition we disposed of five specimens of *Phaeolepiota aurea*, we took advantage of this lucky occasion to study its chemical constituents, including HCN. We were rather surprised to discover that it contained not less than 510 mg/kg, a concentration twice as high as that reported for *Marasmius oreades*, which is generally thought to be the cyanogenic mushroom 'par excellence'. Moreover, after having prepared our *Phaeolepiota* according to a recipe given for *Macrolepiota procera* (Parasol mushroom), we found that the dish still contained about 200 mg/kg, which contradicts the generally accepted idea that heat readily volatilises the toxicant. Of course, we are aware that HCN does not occur as such

Figure 1. *Phaeolepiota aurea* in various stages of development.

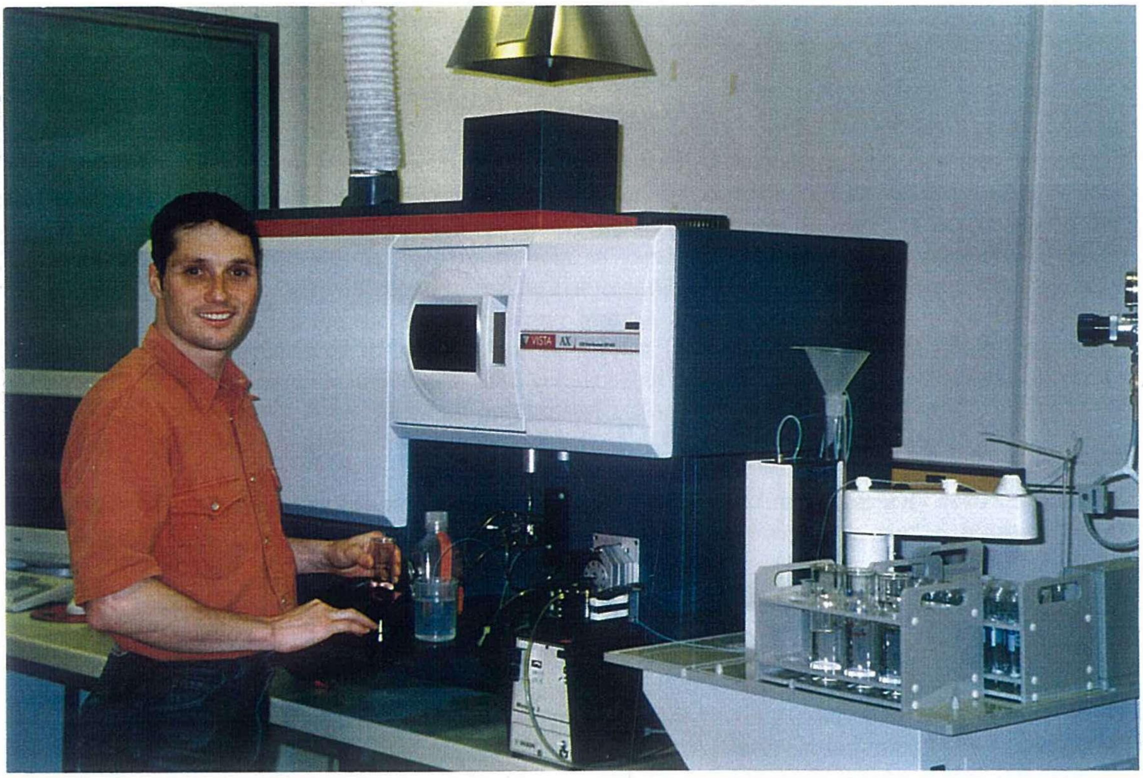

Figure 3. Author Daniel Andrey doing multi-element analysis in his laboratory.

in the mushroom, but as a precursor, from which it is only slowly released. The chemical nature of this as yet unknown cyanogenic compound may differ with the mushroom species.

Japanese researchers have reported a similar observation for the exotic mushroom *Tricholoma giganteum*, a rather common species in Japan and Australia. In their experiments the residual HCN content was also found to be appreciable. In fact, the authors thought it high enough to provoke a mild poisoning syndrome in sensitive people. Perhaps this explains why *Phaeolepiota* has occasionally caused discomfort upon consumption.

Moreover, we have seen that this mushroom also takes up heavy metals, notably the very toxic cadmium. Analysis of our collections revealed appreciable concentrations of this metal, and unpublished data communicated by the Italian mycochemist Luigi Cocchi show that it can be as high as 41 mg/kg on dry matter, an amount that readily exceeds the European maximum limit for cultivated mushrooms!

We should therefore just admire this beautiful mushroom and abstain from eating it.

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