Mushrooms and Economic Botany[1]

David Arora*,[2] and Glenn H. Shepard, Jr.[3]

[2]Dept. of Forest Science, Oregon State University, 3200 Jefferson Way, Corvallis, OR 97331, USA
[3]Biological Sciences, University of East Anglia, Norwich, U.K.
*Corresponding author; e-mail: arora_david@yahoo.com

Mushroom. Fungus. Toadstool. Depending on the context and the company, these words may evoke chuckles, raised eyebrows, an avaricious gaze, frowns of apprehension, legal censure, or murmurs of delight. A haiku by Shigetaka (cited in Arora 1991) celebrates the matsutake ("pine mushroom") as an almost erotic fantasy come true:

> It is no dream
> matsutake are growing
> on the belly of the mountain

Russian writer Konstantin Paustovskiy evokes the sensory experience of mushroom gathering: "The mushroom-scented air of the birch groves is far dearer than the fragrance of the magnolia" (cited in Arora 1991:262).

The British poet Percy Bysshe Shelley (cited in Arora 1986:2), by contrast, portrays wild mushrooms as embodiments of death and decay:

> And agarics and fungi, with mildew and mould
> Started like mist from the wet ground cold
> Pale, fleshy, as if the decaying dead
> With a spirit of growth had been animated

The tendency to use the word "mushroom" pejoratively persists widely in modern English. To paraphrase the late Stephen Jay Gould, prosperity and the arts "flower" while urban crime "mushrooms." Many people in the United States are familiar with the schoolyard rhyme, "There's a fungus among us/And *we must stamp it out*!!" How different is the sense of awe and wonder expressed in a Nahuatl saying from Morelos, Mexico: *Tlategüini, xcaguigan, in mogüitlaxcactia in nanagamé*—"It is thundering, listen you all, the mushrooms are putting on their shoes" (de Avila and Guzman 1980:312).

Jared Diamond (1989:19), who has spent years documenting the detailed botanical and zoological knowledge of the Foré people of New Guinea, admits to a sudden sense of apprehension when his hosts served him forest mushrooms:

> [We] were starving in the jungle... one of the men brought in a large rucksack full of mushrooms that he had found and started to roast. Dinner at last! But then I had an uncomfortable thought: what if the mushrooms were poisonous?.. [I told them that] although we were all hungry, it just wasn't worth the risk. At that point my companions got angry and told me to shut up and listen while they explained some things to me. After I had been quizzing them for years about the names of birds and frogs, how could I insult them by assuming they didn't have names for different mushrooms? Only Americans could be so stupid as to confuse safe and poisonous mushrooms. They went on to lecture me about 29 types of edible mushrooms, of which 15 grew on trees and 14 grew on the ground.

The irony is clear: even someone who has made a career of studying and eulogizing native knowledge about the biological world is not immune to a cultural taboo so powerful that he was willing to endure hunger while offending his hosts' intelligence and refusing their generosity.

By contrast, many mushroom hunters *lack* generosity when it comes to revealing the locations of their favorite mushroom patches. And legend has it among the Bisa people of central Africa that their ancestors split into different groups, one called the Mushroom Clan, because some of them refused to share edible mushrooms with the others (Merrett 2008).

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While several 19th-century writers noted differing cultural attitudes toward wild mushrooms, the first detailed exploration of the subject owes its genesis to the 1927 honeymoon of R. Gordon Wasson, an American journalist and banker, with his Russian émigré bride, Valentina Pavlovna. Her boundless (and typically Russian) enthusiasm for gathering and cooking wild mushrooms shocked Wasson, whose Anglo-American upbringing taught him to loathe them:

> She knelt before those toadstools in poses of adoration like the Virgin hearkening to the Angel of the Annunciation... I called to her: "Come back, come back to me! They are poisonous, putrid. They are toadstools. Come back to me!" She only laughed the more: her merry laughter will ring forever in my ears. (Wasson et al. 1978:13)

This honeymooners' spat led not to divorce, but to a long collaborative research project culminating in the landmark *Mushrooms, Russia, and History* (Wasson and Wasson 1957), which effectively launched the field of ethnomycology by contrasting and examining "mycophilic," or mushroom-loving, societies with "mycophobic," or mushroom-loathing, ones. Wasson (1957) also published a widely-read article in *Life* magazine about the hallucinogenic "magic mushroom" ritual in Mexico. This helped to spark the psychedelic revolution of the 1960s and also pointed the field of ethnomycology overwhelmingly toward the study and pursuit of psychotropic (psychoactive) mushrooms—a relatively minor use of mushrooms worldwide.

After his wife's death in 1958, Wasson continued to pursue psychotropic mushrooms around the world and through history, notably the fly agaric (*Amanita muscaria*), which he identified as the enigmatic Soma sacrament of ancient Indo-Aryan religious texts (Wasson 1968), and ergot (*Claviceps* spp.), which he implicated in the Eleusinian Mystery rites of ancient Greece (Wasson et al. 1978). Wasson also speculated that widespread ritual usage of psychotropic mushrooms in ancient times, and later religious suppression, gave rise to the sharp dichotomy of mycophobia versus mycophilia found in modern Europe, Asia, and the Americas.

This special issue of *Economic Botany* is dedicated to human knowledge and usage of wild mushrooms. The use of mushrooms as psychoactive agents appears, in a more objective analysis, to be relatively restricted compared with their widespread culinary, economic, and even medicinal importance. Thus we hope this issue will broaden the scope of ethnomycology, building upon the Wassons' contributions while critically evaluating their legacy and breaking new ground in research themes, regions, methods, and theory. Its genesis goes back to a cultural encounter strikingly similar to the Wassons' 1927 honeymoon, in which Glenn H. Shepard, a budding ethnobotanist, went on a camping trip in Virginia in 1987 with a Polish girlfriend, taking only a sack of corn flour, a stick of butter, a frying pan, and a fishing rod to provide the weekend's nourishment. She was as distrustful of his fishing prowess as he was of her ability to safely identify the wild mushrooms she gathered to stave off certain starvation. But in the end both were vindicated, sharing a hearty meal of batter-fried bass and sautéed mushrooms.

This initial exposure to mushroom gathering led Shepard to the mountains of Poland in 1988, and then to the highlands of Chiapas in 1992, where he launched an investigation into the edible mushrooms of the Tzeltal and Tzotzil Maya. There, he contacted mycologist and field guide author David Arora, resulting in the collaborative work published for the first time in this issue (Shepard et al. 2008). Their approach, combining folk taxonomy with mycological field surveys, allowed the two to better appreciate and understand the detailed knowledge many people maintain about mushroom morphology, taxonomy, ecology, and cuisine. The two (but especially Arora) applied similar methods in studies of mushroom gathering and usage in Asia and elsewhere. The idea for a special issue on ethnomycology emerged in 2005, when *Economic Botany* received, by coincidence, three papers concerning wild mushrooms. Initially asked to be reviewers, Shepard and especially Arora began contacting their colleagues to invite additional submissions that would justify a special issue. Authors began submitting manuscripts, the word spread to others who submitted more manuscripts, and the issue "mushroomed" into its current form.

The two dozen articles in this issue consist of original work by specialists from 16 different countries and a wide range of disciplines, representing fieldwork and research undertaken in all the inhabited continents across a variety of

ecological zones—moist, dry, tropical, temperate, boreal—and ranging from near-pristine forests to heavily-impacted or intensely-managed habitats such as secondary and regenerating forests, orchards, and tree plantations. Following three cross-cultural studies, the articles are more or less geographically arranged. The issue also includes two reviews of recent books relevant to ethnomycology as well as a number of color photos documenting mushroom gathering around the world and the emergent global wild mushroom industry (Arora 1999).

Given the Wassons' legacy and the publication of their groundbreaking *Mushrooms, Russia and History* a half-century ago, it is especially fitting that the lead article in this issue is authored by Russian anthropologist (and mushroom enthusiast) Sveta Yamin-Pasternak, who documents sharply contrasting attitudes toward wild mushrooms among indigenous Siberian and Alaskan peoples of the tundra on opposite sides of the Bering Strait. Rather than reflecting ancient cultural heritage, however, the contrast is attributed to the Soviet-era Russian acculturation of Siberian peoples. The article by *Psilocybe* expert Gastón Guzmán returns to the early fieldwork of Wasson and others in order to resolve lingering questions about the identities of the various sacred mushrooms of Mexico. While Wasson focused on ritual and religious uses of *Amanita muscaria*, Rubel and Arora explore the *culinary* usage of this iconic mushroom, once widely eaten (after parboiling) before modern mushroom field guides labeled it as poisonous. Arora also documents the amused attitude of people in Yunnan, China, towards the *xiao ren ren* ("little people" or "little men"), diminutive beings who appear in multitudinous visions when certain widely-marketed culinary mushrooms are inadvertently undercooked. More generally, this special issue documents a far broader and more nuanced range of cultural attitudes toward mushrooms, in which complex cultural and ecological issues appear to shape different societies' attitudes toward and usage of wild mushrooms, in contrast to Wasson's dichotomous, monophyletic scheme of mycophilia versus mycophobia deriving from an ancient hallucinogenic mushroom cult.

Two articles in this issue apply the theories and methods of ethnobiology to indigenous mushroom taxonomies in widely-separated cultural and geographical regions. In one of these cultures—the highland Maya of Chiapas, Mexico (Shepard et al.)—wild mushrooms are an important food source, while in the other—the Nuaulu of Seram, Indonesia (Roy Ellen)—they are not, raising general questions about the status of mushrooms in folk biology and setting the stage for future comparative research. Also, Eglée Zent provides a unique account of the special role of mushrooms in the cosmology, pharmacopoeia, and ritual life of the nomadic Jotï of the Venezuelan rainforest—one of only a few published studies on mushroom usage in lowland South America.

Although wild mushrooms are far more diverse in forests and woodlands than in other habitats, this issue is notable for featuring articles on culturally and economically significant mushroom species found in treeless habitats that do not normally evoke visions of mushroom abundance: high-altitude grasslands (Winkler), Mediterranean scrublands (Oria-de-Rueda et al.), arctic tundra (Yamin-Pasternak), and even the deserts of southern Africa and Australia, where two teams of researchers led by James Trappe review historical data on the occurrence and native uses of desert truffles.

Ethnomycology and mushroom taxonomy have in many cases shown earlier progress in mycophilic countries and their regions of colonial influence (e.g., French-influenced western Africa) than in those areas with a long British colonial presence, such as south-central Africa. The most conspicuous edible mushroom of the latter region, *Termitomyces titanicus* Pegler & Piearce, is one of the largest edible mushrooms in the world, but was not scientifically described until 1980. Many important mushroom species remain undescribed even today. We take special pride in presenting, in this issue, ten new culturally-salient, economically-important mushroom taxa. Four new taxa are described from California alone, including that region's quintessential woodland mushroom, the California oak chanterelle, described by authors Arora and Dunham as the largest known chanterelle species in the world. Two new mushroom species from Madagascar are described by Buyck, one from southern Mexico by Arora and Shepard, and an additional three new Australian truffles (including one new genus) are provisionally named by Trappe et. al., but formally published elsewhere.

Several articles in this issue suggest that many of the edible mushrooms most valued by humans

thrive in disturbed or managed forests in close proximity to human settlements. Saito and Mitsumata, for example, describe a process in Japan whereby centuries of human disturbance of broadleaf forests (largely for firewood) favored the establishment of matsutake-rich pine groves; similarly, land practices in 19th century-Europe favored production of wild black truffles, which peaked in numbers at the end of the 19th century before steadily declining, largely due to changes in the landscape (Chevalier 2007).

These and other examples suggest that two processes of selection may have taken place with regard to human usage of wild mushrooms as food. The first occurred as humans established and expanded settlements, and the forests surrounding these settlements were impacted by their daily activities of creating footpaths, gathering firewood and herbs, hunting, herding, burning, and so on. Mushroom species that could not adapt to the changed environment presumably became scarce near settlements while other species thrived. A second selection process probably took place more or less concurrently as humans focused their food experimentation and procurement efforts on mushroom species that were dependably common or abundant close to their settlements; if anything, this process would be even more marked for mushrooms than for plants because of the narrow temporal window of wild mushroom availability. The result is that many of the mushrooms prized historically by humans as food are common inhabitants of second-growth forests or semi-degraded landscapes. Examples include morels, whose fondness for devastation (fire, flood, diseased trees) is well known; *Coprinus, Macrolepiota,* and *Agaricus* species, which favor pastures, disturbed soils, and roadsides; various wood and compost decayers; and many ectomycorrhizal species such as porcini that favor "edge" habitats and younger, actively-growing forests and woodlands over relatively undisturbed, older forests. These observations should provide inspiration for more rigorous, geographically extensive comparative tests on the relative cultural importance of wild mushrooms in primary versus secondary forests, and suggest the outlines of a generalized hypothesis of mushroom co-evolution with humans. Bart Buyck's study in this issue, for example, suggests that most of the economically important mushroom species in Madagascar may have recently and rapidly co-evolved with introduced tree species and new forms of human disturbance.

Roughly half of the articles in this issue deal directly or indirectly with the commercialization of wild mushrooms for local or regional markets (e.g., Pérez-Moreno et al. and Montoya et al. on wild mushroom markets in central Mexico), or for national and global markets (e.g., Sitta and Floriani on the import and export of Italian porcini, and Yang et al. on matsutake in Yunnan). The harvesting and brokering of wild mushrooms has made a huge contribution to rural income in some areas. This is dramatically illustrated by Daniel Winkler, who describes the commodification of *Cordyceps sinensis* in Tibet, where nearly half the total rural income derives from the sale of that single species. Similarly, Arora documents "the houses that matsutake built" in a remote corner of Yunnan transformed by the global mushroom economy. Furthermore, fundamental economic and land-use changes have occurred in the mere *anticipation* of future mushroom income, as Samils et al. document for Spain, where oak orchards have been inoculated with black truffles.

It should be pointed out that in modern usage, the word "mushroom" has several meanings depending on context, but is most frequently used to describe the reproductive structures or "fruiting bodies" of certain fungi belonging to the Basidiomycotina and Ascomycotina. Under this definition, mushrooms are not organisms per se, but *parts* of organisms, roughly analogous in function to the fruits of plants. For this reason we have avoided the term "wild edible fungi" (and the inevitable acronym, WEF; see Boa 2004), as it is somewhat misleading, akin to calling peaches and persimmons "edible trees." Rather, we use the terms "mushroom" and "wild mushroom" in the tradition of restaurant menus, to refer to a variety of fungal "fruits" including truffles (which are simply underground tuberlike mushrooms), morels, puffballs, boletes, and various shelflike or coral-like forms, in addition to the more familiar agarics or "gilled mushrooms."

Of all the harvested species featured in this issue, *Cordyceps sinensis* is the only one in which the entire organism is removed by harvesting. Therefore, the generally applicable analogy of mushrooms to *fruits* rather than to entire trees is especially important when considering both the impacts of mushroom harvesting and the varying cultural attitudes toward this activity. Harvest

studies cited by a number of the authors in this issue show little evidence that even intensive removal of wild mushrooms impacts their populations adversely, though the method of harvest (for example, deep digging) may. Moreover, it is unknown to what extent highly mobile human harvesters may contribute to spore dispersal. Nonetheless, the belief persists that commercial and even recreational harvesting of wild mushrooms represent a serious threat to forest biodiversity. Tsing and Satsuka shed further light on this subject through a social-historical comparison of the distinctive assumptions and trajectories of scientific research on matsutake in Japan, where matsutake production in managed forest landscapes is viewed as a quasi-agricultural endeavor, as opposed to North America, where wild mushroom harvest in federally-managed forests is interpreted through analogies with timber exploitation and in the context of an urban demand for "unspoiled" (i.e., unpeopled) wilderness.

While the emphasis of this issue is overwhelmingly on wild mushrooms, it should be noted that cultivation of saprotrophic species such as oyster mushrooms and shiitake has grown rapidly in recent decades, and dozens of species (edible, medicinal, and hallucinogenic) are now grown commercially worldwide. These newly cultivated mushroom species are often misleadingly labeled "wild" on store shelves and restaurant menus, when a better term for them is "exotic." Most of the truly wild, economically-valuable mushroom species, on the other hand, are ectomycorrhizal, meaning they form mutualistic relationships with the rootlets of trees and cannot exist in nature without their tree hosts which, likewise, are dependent on their fungal symbionts. Fleshy ectomycorrhizal mushrooms are especially prominent in temperate and boreal forests, whereas the heat and humidity of lowland tropical forests favor saprotrophic species with tiny or leathery fruiting bodies that are generally less likely to appeal to humans as food. Ectomycorrhizal species have historically resisted cultivation, but research on root inoculation and the establishment of mushroom-producing tree plantations or orchards continues to progress, as described by Samils et al. (for black truffles), Tsing and Satsuka (for matsutake), and Oria-de-Rueda et al. (for boletes). Though cultivation of ectomycorrhizal edible mushrooms is widely assumed to be desirable, it could have potentially adverse effects on rural peoples' ability to make a livelihood by redirecting the benefits that accrue from wild mushroom harvest toward those who own land (Dove 1993). Forest diversity might also be affected, as well as access rights to artificially-mycorrhized forests. These are fertile subjects for future investigation.

Land tenure and forest access, indeed, are crucial aspects of human-wild mushroom relationships. Saito and Mitsumata examine matsutake-gathering rights in Japan in the context of the community *iriai* tradition (somewhat akin to the English commons). In many countries, such as Canada, mushroom hunting is essentially unregulated by government, while in Sweden, Finland, and Norway there is a specific, fundamental understanding called "everyman's right" to gather wild mushrooms or berries on all lands except for a few national parks. But where strong preservationist tendencies prevail, mushroom gathering and other extractive activities such as berry picking are viewed with intense suspicion. This is especially the case in the western U.S., where mushroom hunters are subjected to more extensive surveillance than perhaps anywhere else in the world; some have even had their vehicles seized and impounded for picking in prohibited areas—a punishment more typically associated with drug trafficking.

In this issue, Rebecca McLain uses French philosopher Michel Foucault's theories of institutional power to describe the emergence of an all-seeing "wild mushroom panopticon" in Oregon, as the state bureaucracy seeks to extend its gaze to the forest floor and thus establish control over the entire forest landscape. In a complementary article, Arora documents how preservationist models of park management have created a "tragedy of *no* commons," where draconian laws forbid mushroom harvest even for personal consumption on almost all public lands in coastal California, and where furtive middle-aged mushroom hunters sneak around "like rodents hiding in the shadows to avoid notice."

While commodification can spur the maintenance or elaboration of traditional ecological knowledge, as observed by Pérez-Moreno et al. in their article on mushroom harvest in central Mexico, it is widely noted that traditional knowledge about plants, mushrooms, and other wild organisms and their habitats is in overall decline. In Burkina Faso, where wild mushrooms have little or

no economic value, this appears to be the case. The woodlands there that support the greatest diversity of mushrooms are disappearing due to deforestation and climate change, and Guissou et al. show that fewer and fewer people pick wild mushrooms, with a dramatic decrease in mushroom recognition skills across generations. More generally, as larger numbers of people throughout the world are raised in urban areas, field guides (both written and online) will increasingly supplant parents and village elders as the principal repositories and purveyors of mushroom knowledge. Yet as Rubel and Arora point out in their literature survey of *Amanita muscaria*'s edibility, even ostensibly modern, scientific field guides can perpetuate erroneous judgments for generations.

We are pleased and honored to present this collection of papers covering such a wide range of disciplines, themes, and geographical regions. Overall, the articles suggest that we may be in the midst of a three-step historical process with respect to wild mushrooms—and forest knowledge in general—in which mushroom gathering is first forsaken (as people move to the cities or mushroom habitats are destroyed), then forgotten (as their children grow up with little or no opportunity to gather mushrooms), and finally forbidden (as preservationist models of forest management severely restrict or prohibit people from maintaining or rediscovering foraging traditions). But the third step in particular need not be inevitable or irreversible, and we hope that these papers, both individually and as a group, will have a positive effect on these processes while helping to advance and redefine the field of ethnomycology. It is also our hope that this issue will inspire future investigations and interdisciplinary collaborations as environmental, ideological, cultural, and demographic changes accelerate around the world.

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