Some Data from the Ethnomycology of Pre-Slavonic and Slavonic Tribes on Polish Territory

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Mushrooms have played a hard-to-overestimate role in human history, with emphasis on folklore, legends, and religion. This preliminary presentation focuses on research on the ethnology of mushrooms and toadstools of Pre-Slavonic and Slavonic tribes of central Europe.

There are some known artifacts like an effigy of a mushroom carved into a rock engraving of Mount Bego in southern France (dated ca. 1800 B.C.); a 5th century B.C. bas-relief from Pharsalus (Thessaly) in Greece; mushroom stones from the Vinca site in Yugoslavia (dated ca. 4th century B.C.); and "mushroom trees" found in early and medieval Christian art works from churches and chapels in Tunisia, central France, and Germany.

The first artifacts were stone figures – "hags" (called in Polish, "baby"). They were grouped into Prussian stone figures, dated 12th–14th century, and east European (also on territory of Russia) stone figures dated 6th–9th century. The first group was found in the region of Iława and of Bartoszyce; the second kind of artifacts was found in the east region of Poland near Bukowiec, Cieśnica, Piszczac, Pratulin, Woskrzenice, and the best known figures were found in Neple. Their sources are either of older mushroom stones, or of stone hero monuments – "phalavans", or of penitential stones from early Christians. The second group of artifacts include stone figures of "Forever Saints" – "Świętowity" in old Slavonic tribes, dated 9th century, which are idols of old gods, e.g., "Perun" (Lord of Lightening bolt – lightening bolts are often connected with mushrooms). Head dressing of these idols are very similar to those of the Harran moon god Nannar and figures from Easter Island. These idols have been known from the territory of Ran tribe (Arkona) and from Podole in the Ukraine. The third artifacts are mushroom stones from the 2nd century from territory of Silingae tribe (now Silesia), best known for the great mushroom stone – "Grzyb" in Polish, from Ślęża Mountain. And the fourth group of artifacts are early Christian crosses from the territory of Sudovia from the 13th century (when Christianization of the Jaćwingowie tribe had taken place), with mushroom and toadstool relieves on the basis of the cross. There are also some uncertain artifacts, like circles from Podhale villager's cottages, similar to the wheel of life from other regions.

These findings can elucidate some mycolatric traditions in Pre-Slavonic and Slavonic tribes, and describe the interference of pagan traditions to early Christian traditions. We should also remember that German and Celtic tribes, called Slavonic tribes, were mushroom-eaters.

Medicinal Mushrooms of the Melghat Forest and Their Biotechnological Potential

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Melghat Forest is a Tiger Reserve situated in Satpuda mountain ranges in the Amravati district of Maharashtra (India). Melghat is located at a longitude of 76° 54' E to 77° 33' E and latitude of 21° 15' N to 21° 45' N, with an altitude of 350 m to 1178 m above sea level. The diversity of geographical and climatic conditions prevalent in the Melghat Forest makes the region a natural habitat for a number of edible and medicinal mushrooms. The Melghat Forest is a reserve forest; much of it is undisturbed and hence undiscovered. The biodiversity of the region is unique and is attributable to intermingling forests of medicinal plants like *Tectona grandis, Dendro-calamus strictus, Shorea robusta, Terminalia belerica, T. arjuna,* and *Emblica officinalis*. Coffee and pine plantation is also prevalent. Periodic visits during the rainy season were made for collection of mushrooms. Information on their edibility, occurrence, and medicinal use was gathered from the Korkus, who are the tribal forest dwellers. Various species of mushrooms, both edible and medicinal, were collected. The dominating mushrooms are *Ganoderma lucidum, G. applanatum, Schizophyllum commune, Agaricus campestris, A. arvensis, Pleurotus sajor-caju, P. ostreatus, Laetiporus sulphureus, Termitomyces heimii, Trametes versicolor, Morchella conica, Marasmius oreades, Cantharellus cibarius, Clavaria flava, Coprinus comatus, C. micaceus, Podaxis pistillaris,* and species of *Geatsrum, Scleroderma, Hydnum, Auricularia, Coriolus, Daldinea, Calvatia, Russula,* and other yet unidentified genera. Biogeography and speciation of these mushroom species can be evaluated using molecular phylogeny. Metabolites of medicinal mushrooms are important sources of nutraceutical and pharmacological products. Tools of biotechnology can be used to harness the potential of mushroom treasure of Melghat Forest.

Indigenous Knowledge on Edible, Poisonous, and Medicinal Macrofungi in Botswana

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Botswana, a semiarid country in the Kalahari Desert, is characterized by low and poorly distributed rainfall, low relative humidity, extreme daily temperature fluctuations and frequent droughts. The soils are mainly sandy or sandy loams that are low in organic matter and minerals such as N, P, and K. Compared to the tropical humid regions of Africa, conditions in Botswana do not seem ideal for growth and consumption of macrofungi. However, during seasons of good rainfall, there is diversity in macrofungi that grow. Compared to other countries in Southern Africa, the people of Botswana seem to have the highest degree of mycophobia probably due to lack of knowledge of the real edible and poisonous mushroom species.

The objective of the study was to assess the state of indigenous knowledge on edible, poisonous, and medicinal macrofungi in Botswana. Information on indigenous knowledge on macrofungi was collected through unstructured interviews with both urban and rural village dwellers. Respondents were shown photographs of macrofungi and then asked to indicate if the macrofungi were edible, poisonous, or medicinal. In addition, respondents were asked to indicate names of poisonous, edible, and medicinal mushrooms based on their experience.

In general, rural and urban people in Botswana know only two groups of macrofungi: edible macrofungi, collectively called *Mabowa* (large gilled mushrooms),

and *Mahupu* (desert truffles) in the *Setswana* language and poisonous or non-edible macrofungi collectively called *Dithuthutswane*. In Botswana, *Mabowa* are large mushrooms associated with termite mounds (probably *Termitomyces* sp) and anything smaller, even if it is near termite mounds, is called *Dithuthutswane*. The Kalahari Desert truffle (*Kalaharituber pfeilii*) is a popular source of food and income for the Botswana people, especially to the Basarwa living in the sandveld of western Botswana. The most common poisonous mushroom in Botswana is *Chlorophyllum molybdites*.

Medicinal use of macrofungi is rather limited in Botswana. The dried and powdered Kalahari Desert truffle is reported to be used to induce birth in humans and livestock; the fruiting body of *Phellinus gilvus* is reported to be used in the treatment of heart ailments, while *Ganoderma lucidum* and other bracket fungi are used for various ailments. Some of the non-edible macrofungi have Setswana names based on their characteristics. For example, stinkhorns are called *Sephinya tsa baloi* meaning the fart of a witch, while puffballs are called *matsukwa a mankgodi* (the tobacco (snuff) of witches or the hawk). Lack of knowledge has resulted in the under-utilization of edible and medicinal macrofungi such as *Ganoderma lucidum,* which has potential as a cash crop in Botswana.

Phallus impudicus: From Folk Medicine to Supportive Cancer Care

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Ancient Romans dedicated *Phallus impudicus* to Cerera - the goddess of fertility. Germans named it "a witch's egg". In the Middle Ages it was used for preparing so-called "amorous liquor". This mushroom has been used by quacks since antiquity. In Austria it is called "a podagra morel". Baltic and Slav people's medicine advises using Zemestauki (*Ph. impudicus*) for pains in abdomen, renal diseases, for bathing and treating wounds, as a remedy for rheumatism and podagra. In European countries folk medicine (Stinkhorn mushroom - English name) is usually used as a juice (from fresh fungi fruit bodies).

The Chinese were attracted to this fungus as a remedy for carcinoma of the lip. Among other things, *Ph. impudicus* was used, according to Dr. Karo from Berlin, as a successful treatment for carcinoma cutaneum and internal cancer. The Stinkhorn mushroom is an edible fungus. Young fruit bodies of an egg-stage can be used as food. Fried in oil, this mushroom has a fishy taste. Recent experiments and clinical studies show that Stinkhorn mushroom juice has antithrombogenic activity, which is very important in treating thromboembolic disease in the prevention of cancer.

Malignant tumors have an increased tendency towards blood coagulability and thrombogenesis. It has been established that antithrombogenic activity of the vascular wall in cancer patients decreased. The disorder of the functional properties of the vessel wall aids in its penetration in extravascular spaces and adds to the probability of metastatic locus. Platelets sticking to the surfaces of tumor cells enhance their resistance. The main acting agent is polysaccharide PL-2 found in *Ph. impudicus* juice (PhJ), which affects the platelet pathologic aggregation in the tumoral process.

The investigations were carried out on Wistar male rats. Sarcoma 180 was inoculated intramuscularly. The levels of platelet aggregation, spontaneous intravascular platelet aggregation, anti-aggregative and anticoagulative activity of the vascular wall were determined in the animals' blood. The results showed that Sarcoma 180 inoculated into animals aided in enhancing platelet aggregation by 53% with a 2- to 3-fold increase in functional platelet activity. Anti-aggregative activity of the vascular wall decreased by 25% and anticoagulative activity decreased by 29%. It was shown that PhJ exerts an affect on platelet functions and on the state of the vascular wall in rat-tumor-carriers. PhJ can exert preventive action aimed at a decline in dissemination of tumor cells in the body. Another investigation showed that *Ph. impudicus* could be a remedy for lymphedema prevention.

Lymphedema following mastectomy, with removal of the axilla and postoperative radiation of the axilla, is a frequent and extremely stressful complication. Sometimes lymphedema doesn't show up until years after cancer treatment has taken place. There is still no universally affective remedy for lymphedema. Based on experience in therapy for the post-thrombotic syndrome, we propose using *Ph. impudicus* in the treatment of lymphedema.

In this comparative study 206 women received preventive treatment over a period of 2 years and followed up for 6 years. Ninety-two percent of the afflicted women receiving *Ph. impudicus* prevention did not develop lymphedema during an observation period of 6 years. In the control group, however, only 59% did not develop lymphedema. An improvement in the clinical findings and in the subjective feeling of well-being was observed in 88% patients with developed lymphedema.

Supportive care of lymphedema with *Ph. impudicus* is well tolerated and easy to deliver. *Ph. impudicus* could relieve the symptoms of a persistant lymphatic obstruction. The mechanism of action of *Ph. impudicus* extract maybe explained by cytokines and inflammatory-relevant adhesion molecules' regulation, exudates viscosity reduction, recanalization of obstructive lymphatic vessels, and a decrease of internal pressure in the tissues and volume of the arm.

One more study was conducted on the *Ph. impudicus* effect on thromboprophylaxis in breast cancer patients undergoing chemotherapy and hormonal treatment.

Breast cancer patients with recurrent venous thromboembolic disease are usually maintained on anticoagulants for their lifetime. New prophylactic agents may be needed for adequate prevention in patients. *Ph. impudicus* has been a folk remedy for patients with advanced breast cancer since antiquity. Now, it is possible to speculate that *Ph. impudicus*'s long-term consumption can prevent thromboembolic complications without side effects in breast cancer patients as a remedy of supportive preventive nutrition.

How Mushrooms Can Help Save the World

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As we are now well engaged in the 6th Major Extinction ("6 X") on planet Earth, our biosphere is quickly changing, eroding the life support systems that have allowed humans to ascend. Unless we put into action policies and technologies that can cause a course correction in the very near future, species diversity will continue to plummet, with humans not only being the primary cause, but one of the victims. What can we do? I think fungi, particularly mushrooms, offer some powerful, practical solutions, which can be put into practice now.

We will discuss the evolution of mushrooms in ecosystems and how fungi can help heal environments. As environmental health and human health are inextricably interconnected, fungi offer unique opportunities that capitalize on mycelium's diverse properties. Forest dwelling mushroom mycelium can achieve the greatest mass of any living organism – this characteristic is a testimonial to its inherent biological power.

Mushroom mycelium can replace chemical pesticides, break down toxic wastes, including petroleum-based products such as diesel, dioxins, and numerous other toxins into non-toxic forms. Understanding mycelium's production of antibiotics is useful not only to compete with bacteria in nature but has also proven useful for treating animal diseases.

About a dozen species of medicinal mushrooms will be explored from a historical perspective leading to the clinical studies in which Paul is participating. Moreover, he will discuss his work with the U.S. Departments' Bioshield BioDefense program, wherein his extracts were the first natural products from hundreds of thousands of samples tested and found to be potent inhibitors of pox and other viruses. The field of mushroom-based medicines is rapidly expanding and shows how mycomedicines can be incorporated in daily living to improve the quality of life while protecting the biosphere.

Fungal Diseases of Humans: The Dark Side of Mycology

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Besides the many useful products and benefits we get from fungi, there is a dark side to mycology. Many fungi cause harm to humans or to our activities. These fungi may cause us harm by eating or touching them, but far worse are the problems caused by fungi directly growing on human tissues. These negative effects of fungi on humans can be broadly placed into four categories:

- Mycetismus—illness caused by eating the fungus, which contains toxins. (e.g., mushroom poisoning)
- Mycotoxicosis—illness caused by eating the metabolites of fungi, but not the fungus itself (e.g., aflatoxin)
- Mycoallergies—sensitivity of the immune system to fungal spores and metabolites
- Mycosis—fungus invades the human tissue

Until relatively recently, the first three were our major problems. People have suffered for millennia from eating poisonous mushrooms, with symptoms ranging from gastrointestinal upset to hallucinations to ecstasy to severe death. However, the problem of mushroom poisoning can be easily avoided by not eating mushrooms at all (of course you would then be deprived of all of the health benefits of mushroom eating) or at least not eating poisonous mushrooms. More insidious is the problem of mycotoxicosis, first brought to the forefront in the early 1960s in Great Britain, where thousands of turkeys died or had to be slaughtered because they ate peanut meal contaminated with aflatoxin produced by *Aspergillus flavus*. Now known to be a long-term liver carcinogen, aflatoxin is one of the most toxic known organic compounds on earth. There are many other mycotoxins, such as the trichothecenes produced by several *Fusarium* species that caused problems in eastern Europe in the middle of the twentieth century. Such mycotoxins are not as easily avoided in the diet, especially at low concentrations. Mycoallergies are becoming more common or at least more commonly diagnosed. Sick building syndrome is a big topic in the USA, in some part a product of hysteria drummed up by the press. Mold in buildings, however, is a growing problem, and more research needs to be done in this area to discern the exact human epidemiology.

The more recent problem, then, is that of mycoses, fungi growing directly on human tissue. In the "olden days", fungi were mostly known for causing only dermatological and nail problems, as well as annoying yeast infections. However, several factors came into play starting in the 1970s that led to the broadened compromise of human immune systems, leading to the rise of the fungi as deadly human pathogens: These include cytotoxins, such as those used in chemotherapy against cancers; immunosuppressive drugs, such as those preventing rejection of transplanted organs; more widespread cases of diabetes; possibly environmental pollutants; corticosteroids, used to treat asthma and rheumatoid arthritis; and especially Acquired Immune Deficiency Syndrome (AIDS) and HIV disease.

About 175 human pathogens are recognized among the approximately 73,000 known species of fungi. About 20 species, such as dermatophytes, are regularly isolated from cutaneous infections. A dozen species are commonly associated with severe subcutaneous localized disease. Four out of five women in the United States will get a yeast infection sometime during their lifetimes. About 20 species of fungi may cause systemic or deep infections, most of which are opportunistic pathogens that cause disease in debilitated or immunosuppressed patients. However, four species of fungi may cause disease in an immunocompetent host, causing histoplasmosis, blastomycosis, coccidioidomycosis, or paracoccidioidomycosis. All of these deep infections are caused by inhaling fungi into the lungs, where they can grow and spread to other parts of the body.

Modern medicine has lagged far behind in its study of fungal infections, with most physicians receiving almost no training in medical mycology. Under the worst-case scenario, the doctor assumes the patient's disease is bacterial in origin and prescribes antibacterial antibiotics. The antibiotics do their job of killing bacteria, leaving the fungi with no competition

and free to grow through the human tissues. Bacterial infections are relatively easy to treat. There are many differences between humans and bacteria that can be exploited as targets for killing bacteria without harming the human host. Fungal diseases are particularly difficult to treat because fungi and humans are both eukaryotic, sharing many more characteristics that make it difficult to kill the fungus without harming its host. Commercially available antifungal drugs mostly target ergosterol (which fungi have instead of cholesterol found in mammalian cell membranes), microtubules, and various components of the fungal cell wall, such as chitin, mannoproteins and beta-1,3-glucans. However, there are many side effects associated with many of these drugs.

It's a competitive world out there. It is well known that fungi produce a barrage of chemicals that help them defend themselves against other fungi, their main competitors for food and substrate. We have begun our search for antifungal drugs from fungal fruiting bodies, having screened more than 200 species for antifungal activity.