The Fascinating World of Mushrooms

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The fungal kingdom has an independent lineage similar to plant and animal kingdoms and became integral part of our ecosystem. Without photosynthetic ability like plants and gastrointestinal system like animals, fungi developed a strong enzyme complex to degrade detritus, recycle nutrients and clean up the environment. The global conservative estimate of fungal diversity based on angiosperm/fungus ratio is between 2.2 and 3.8 million species and currently only 3.76.4% of fungi are known indicating the vastness of fungal diversity. Many fungi are helpful in food processing, function as prebiotics, produce antibiotics, generate volatiles as biofuels, act as biopesticides and serve as bioprotectants against disease causing microbes. Fungi develop dense network to channelize nutrients in soils, share nutrients among plants, antagonistic to pathogens, gear up biogeochemical cycles, detoxify recalcitrant compounds, develop stress tolerance in plants and prevent soil erosion. Healthy tissues of almost all plants possess one or the other fungus as mutualist called endophyte to cope with defense against insect herbivory. Several tree roots associated with selected ectomycorrhizal fungi (mushrooms) and endomycorrhizal fungi (arbuscular mycorrhizae) to fulfill the requirement of absorption of water, phosphorus and several elements. Roots of orchids are in association with specific mycorrhizal fungi for their survival and perpetuation. Lichens by the union of algae with ascomycetous fungi and cyanobacteria develop morphologically distinct thalli and widen their geographic distribution even in extreme habitats (polar, temperate and tropics).

One of the delightful fungal branches in mycology is mushroom biology. Recent prediction of mushrooms in the ecosystems of the Indian Subcontinent is about 96,000, but about 14,500 are known point out the extent of mushroom diversity in India. Mushrooms are the macroscopic reproductive bodies (or fruit bodies) with mesmerizing shapes, structures, colors, metabolites, nutrients and symbiotic associations. Bird's nest, earth stars (Fig. 3), earth tongues, lion's mane, milky caps, shiitake, penny bun, trumpets, puff balls, turkey tail, bracket fungi (or hoof fungi), inky caps, wood ears, stinkhorns (Fig. 6), coral fungi (Fig. 8), dead man's finger, weeping mushrooms and death caps are some of the common names useful to distinguish mushrooms (Fig. 19). Similar to morphological versatility, mushrooms widely differ in size and volume or weight. For example, caps of some *Marasmius* species measure a few mm, while *Termitomyces titanicus* 1 m (with stipe length up to 57 cm). The fresh weight of several *Marasmius* species is as light as a few

mg, whereas *T. titanicus* 1 kg. *Phlebopus marginatus* (Fig. 7) has been considered as Australia's largest terrestrial mushroom as one fruit body from Victoria weighed 29 kg. Likewise, the stromal diameter of *Xylaria filiformis* attains ~0.5 mm, but the stroma *Xylaria acuminatilogissima* attains up to 5.5 cm wide. Termitomycetes (Fig. 9), truffles and morels are highly priced delicacy throughout the world. Many wild mushrooms are edible, medicinal and ectomycorrhizal (e.g. *Astraeus* species) (Fig. 1). Cultivated and wild edible mushrooms serve as high protein, adequate indispensible amino acids, high carbohydrates low lipid and high calorific value diets. Whole mushroom extracts, proteins, polysaccharides, polyphenols, sterols, toxins, pigments and beta-glucans have immense therapeutic value to combat several lifestyle diseases. Many mushrooms have therapeutic applications as nutraceuticals, cosmeceuticals, immunoceuticals and pharmaceuticals. Mushroom-derived tyrosinase facilitates removal of scars on the skin. *Ganoderma* species (Fig. 4) are extensively used in Chinese medicine for various therapeutic applications.

Insect-borne *Cordyceps* are highly valued owing to remedial applications and those are usually common in high altitude Himalayas. Surprisingly six species of *Cordyceps* (Fig. 2) occurred in and around scrub jungles of

Figures 1-9. Snaps of some interesting mushrooms in our region: Partially cleaned tender fruit bodies of *Astraeus hygrometricus* (1) (edible and mycorrhizal; in Karkala forests); *Cordyceps militaris* (2) (medicinal; grown on a cocoon in scrub jungles adjacent to Mangalore University campus); *Geastrum* sp. (3) (mycorrhizal; on soil in scrub jungles of Mangalore University campus); *Ganoderma applanatum* (4) (medicinal; on a wood stub, Yenepoya campus); *Lentinus squarrosulus* (5) (edible; on a dead wood in Nethravathi mangroves); *Phallus merulinus* (6) (edible; in the basins of coconut tree of Mangalore University campus); *Phlebopus marginatus* (7) (edible and mycorrhizal; in the basins of Burma bamboo, Yenepoya campus); *Ramaria* sp. (8) (edible and mycorrhizal; in the basins of coconut tree, Mangalore University campus); *Termitomyces fuliginosus* (9) (edible; from a termite mound of Yenepoya campus).

Mangalore University campus. A small campus like Yenepoya itself harbors over 60 species of mushrooms as revealed by single seasonal survey during 2016. Many mushrooms are deadly poisonous especially the *Amanita* species. But, several *Amanita* species are edible especially in tender stage. Thus, there is scope to trace amatoxin accumulation in different stages of fruit body development. Some mushrooms complete their life cycle underneath the soil in association with plant roots as ectomycorrhizas (e.g. truffles). The main carriers of their spores are wild animals those sense the location of fruit bodies in shallow or deep soil and dig the soil to fetch them as their food (e.g. bandicoots, squirrels and mongoose). However, not many studies have been carried out on truffles occurring in India.

Mushrooms are natural heritage of the Indian subcontinent. In addition to cultivated mushrooms, wild mushrooms provide food security and livelihood of many tribals throughout India. For instance, in the foothills of the Western Ghats (Karkala) edible ectomycorrhizal mushroom *Astraeus hygrometricus* (vernacular name, "Kallanabe"; tender fruit bodies similar to baby potatoes) (Fig.1) on pre-monsoon shower during April 2020 erupted in huge quantities and serve as nutritional delicacy among the mushroom consumers. This mushroom provides livelihood of tribals in and around Karkala and several such families are dependent on collection and trade during southwest monsoon season.

Mushrooms are the best candidates to recycle the lignocellulosic organic residues. Production of food from agricultural wastes is the first priority, production of biofuels from fungi/mushrooms is the second priority and growing medicinal mushrooms on agrowastes will be the third priority. All the above practices end up with production of spent material or compost with narrow C/N ratio ready to use as manure for plant production. Thus, cultivation of edible and medicinal mushrooms on agrowastes will be safe (rather than burning) and become cottage industry to cater the needs of food and medicine in future.

This short note has been ventured with a hope to develop interest or collaboration among those who are inclined to explore the diversity, nutritional versatility, medicinal properties and value-added metabolites of mushrooms occurring in around our environment.

Further reading

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