I. GENERAL INTRODUCTION

Fungi are among the most diverse and important groups of living organisms on earth, not only because of their vital roles in ecosystem function, but also because of their influence on humans and human-related activities (Alexopoulos et al., 1996, Mueller and Bills, 2004). Fungi are key functional components of forest ecosystems and the paucity of knowledge on their responses to forest fragmentation and degradation needs to be addressed. Fungi have a key role in the global carbon cycle in particular. They are the only organisms able to break down materials composed of lignin, releasing methylated gases during the decay process. This in turn helps in maintenance of other ecological related activities (Zhu and Miller, 2003). Fungi are being increasingly exploited by industries for enzymes, organic acids, vitamins, antibiotics and other useful substances, which they produce. Fungi are now generally accepted as the largest group of organisms on earth after the insects. The 1.5 million species hypothesized by Hawksworth (1991, 2001) is a commonly used figure. If this estimate is correct, less than 5% of the fungi have been described.

At an individual level, the role of fungi in mutualisms is well known, especially in the case of mycorrhiza formed with perhaps 90% of the world’s plants and the extent of involvement with insects is becoming clearer. Herbivorous mammals need fungi for their stomachs as a part of diet to aid the breakdown of cellulosic materials on which they feed. They are basal in complex food webs, not least in soil where they are the key food of many nematodes and collembolans.

Macrofungi for human consumption are perhaps one of the greatest hopes for feeding a spiralling world population (Harkonen, 2003). Their nutritional values rival those of most vegetables apart from legumes and in addition to being low in calories and saturated fatty acids, they are rich in amino acids and vitamins, including some otherwise obtainable only from animal products. It has been eloquently argued that the developing world now needs a mushroom-based Non-Green Revolution (Chang, 1999). Indeed, it is because of these multifarious contributions of fungi, a book on the role of fungi in sustainable development concludes ‘No fungi; No future’ (Palm and Chapela, 1997).
Fungi are not only beautiful but play a significant role in the daily life of human beings besides their utilization in industry, agriculture, medicine (Cowan, 2001; Bedigian, 2005), food industry, textiles, bioremediation, natural cycling, in recycling nutrients and decomposing the dead organic matter (Molina et al., 1993; Keizer, 1998; Pilz, 2002) in soil and litter (Hunt 1999; Gates et al., 2005), as bio fertilizers and many other ways. Fungal biotechnology has become an integral part of the human welfare (Manoharachary et al., 2005).

Basidiomycetes are an important group of fungi including harmful as well as useful species (Hwang, 2008). There is a large and diverse forms commonly called as mushrooms, boletes, puffballs etc. In nature Basidiomycetes play an important role in the decomposition of lignocelluloses and other wastes. The number of recognized macrofungi species has been reported to be 14,000, which is about 10% of the total estimated mushroom species on the earth (Hawksworth, 2001). China is estimated to have about 1500–2000 wild edible macrofungi species with 981 species identified. By 2002, 92 species have been domesticated while 60 of these have been commercially cultivated (Mau et al., 2004). However, mushrooms have nearly always been around, with a very long and interesting history. Mushrooms have been found in fossilized wood that is estimated to be 300 million years old and almost certainly prehistoric man used mushrooms collected in the wild as food. Recently, the importance and role of mushrooms in history was evident by the fact that the desert truffle, *Terfeziaarnenari*, was described in the Bible as “bread from heaven” (Pegler, 2002).

It may be interesting to have a charming mushroom poem: “Without leaves, without buds, without flowers, yet, they form fruit; as a food, as a tonic, as a medicine, the entire creation is precious” (Chang et al., 1989). In some ancient communities, the seemingly miraculous manner of its growth without seed, without leaf and without bud, its fruiting body’s sudden appearance after rain, especially after lightning and thunderstorms, its equally rapid disappearance and its curious umbrella like shape gave rise to a wealth of illusions and mythologies. There has been a recent upsurge of interest in mushrooms not only as a health vegetable (food) which is rich in protein but also as a source of biologically active compounds of medicinal value.

The fungal kingdom possesses certain natural advantages in terms of their dietary supremacy over the rest of the vegetarian platter. They are: (a) a good protein
content having all the essential amino acids thus capable of substituting meat, (b) chitinous wall to act as a source of dietary fibre, (c) high vitamin B content, (d) low in fat and (e) virtually free of cholesterol.

**Table- 1:** Numbers of species of wild edible and medicinal fungi (Boa, 2004).

<table>
<thead>
<tr>
<th>Category</th>
<th>No. of Species</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Edible only</td>
<td>1 009</td>
<td>43.0</td>
</tr>
<tr>
<td>2. Edible and medicinal</td>
<td>88</td>
<td>4.0</td>
</tr>
<tr>
<td>3. Food only</td>
<td>820</td>
<td>350</td>
</tr>
<tr>
<td>4. Food and medicinal</td>
<td>249</td>
<td>110</td>
</tr>
<tr>
<td>5. Medicinal only</td>
<td>133</td>
<td>6.0</td>
</tr>
<tr>
<td>6. Other uses (none of above)</td>
<td>29</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>TOTAL wild useful species</strong></td>
<td><strong>2 327</strong></td>
<td></td>
</tr>
</tbody>
</table>

ALL edible only (1+2)        | 1 097          |
ALL food (3+4)               | 1 069          |
ALL medicinal (2+4+5)        | 470            |

The word *mushroom* may mean different things to different people and countries. In a broader sense “mushroom is a macrofungus with a distinctive fruiting body, which can be either epigeous or hypogeous and large enough to be seen with naked eye and to be picked by hand” (Chang and Miles, 1992). Thus, mushrooms need not be Basidiomycetes or aerial or fleshy or edible. Mushrooms can be Ascomycetes, grow underground, have a non-fleshy texture, and need not be edible. This definition is not a perfect one but can be accepted as a workable term to estimate the number of mushrooms on the earth (Hawksworth, 2001). The most common type of mushrooms is umbrella shaped with a pileus (cap) and a stipe (stem), that is, *Lentinula edodes*. Other species additionally have a volva (cup), that is, *Volvariella volvacea*, or an annulus (ring), that is, *Agaricus campestris*, or both, that is, *Amanita muscaria*. Furthermore, some mushrooms are in the form of pliable cups; others are round like golf balls; some are in the shape of small clubs; some resemble coral; others are yellow or orange jellylike globs and some even very much resemble the human ear. In fact, there is a countless variety of forms.
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The structure that we call a mushroom is in reality only the fruiting body of the fungus. The vegetative part of the fungus, called the mycelium, comprises a system of branching threads and cordlike strands that branch out through soil, compost, wood log or other lignocellulosic material on which the fungus may be growing. Accordingly mushrooms can be grouped into four categories: (1) those which are fleshy and edible fall into the edible mushroom category (e.g., Agaricus bisporus), (2) mushrooms which are considered to have medicinal applications are referred to as medicinal mushrooms (e.g., Ganoderma lucidum) (3) those which are proven to be or suspected of being poisonous are named poisonous mushrooms (e.g., Amanita phalloides) and (4) a miscellaneous category, which includes a large number of mushrooms whose properties remain less well defined, may tentatively be grouped together as “other mushrooms.” Many kinds of mushrooms are not only edible but also possess tonic and medicinal qualities (Chang and Miles, 2004). Macrofungi are rich in important vitamins and minerals needed by human body. It contains important vitamins like vitamin D and vitamin B and minerals like copper, magnesium, potassium, etc. These vitamins and minerals play an important role to boost immune system and for other health benefits.

The greatest difficulty in feeding humans is to supply a sufficient quantity of the body-building material protein. The other three nutritional categories are the source of energy (carbohydrates and fats); accessory food factors (vitamins); and inorganic compounds which are indispensable to good health. Of course, water, too, is essential. The moisture content of fresh mushrooms varies within the range 70–95% depending upon the harvest time and environmental conditions. The protein content of cultivated species ranges from 1.75 to 5.9% of their fresh weight. This means that the protein content of edible mushrooms in general is about twice that of onion (1.4%) and cabbage (1.4%) and 4 and 12 times those of oranges (1.0%) and apples (0.3%), respectively. On a dry-weight basis, mushrooms normally contain 19–40% protein, as compared to 7.3% in rice, 12.7% in wheat, 38.1% in soybean and 9.4% in corn. Therefore, in terms of the amount of crude protein, mushrooms rank below animal meats but well above most other foods, including milk, which is an animal product. Furthermore, mushroom protein contains all the nine essential amino acids required by humans. In addition to their good protein, mushrooms are a relatively good source of the following individual nutrients: fat, phosphorus, iron and vitamins, including
thiamine, riboflavin, ascorbic acid, ergosterol and niacin. They are low in calories and calcium. It has also been reported that a total lipid content varying between 0.6 and 3.1% of the dry weight is found in the commonly cultivated mushrooms. At least 72% of the total fatty acids are found to be unsaturated in all the four tested mushrooms (Huang et al., 1985). It should be noted that unsaturated fatty acids are essential and significant for our diet and our health. In addition to nutritional value, mushrooms have some unique colour, taste, aroma and texture characteristics which attract their consumption by humans.

Macrofungal diversity is an important component of the global biodiversity, particularly community diversity, an essential part of fungal diversity (Shujiang, 2012). Though the occurrence of macrofungi is of diverse nature in India, they are not well known. The collections of mushrooms began in India four decades ago (Kamat et al., 1971). To date, about 1,200 species of fungi belonging to the order Agaricales, Russulales and Boletales are described in comparison to about 14,000 species of mushrooms reported worldwide that contributes 10% of the global macrofungal flora. So far, about 1,105 to 1,208 species of mushrooms belonging to 128-130 genera have been documented and among these, 300-315 species belonging to 75-80 genera are considered edible. The Western Ghats region is one of the globally recognized biodiversity hotspots forming a long mountainous region along the west coast of India (Manoharachary et al., 2005). It has an unestimated wealth of macrofungal biodiversity that needs to be tapped properly as there are still several undescribed species yet to be identified. Efforts need to be made to identify and exploit these mushroom floras for utility as their biodiversity and conservation strengthen the food security of a country (Lakhanpal, 1994).

*Termotomyces* species is one of the most important macrofungi in the vast aspect of sciences such as nutrition, pharmaceutics, ecology, forestry, evolutionary biology, economic, industry etc. In 1799 J. D. Koenig, the German naturalist for the first time reported, brain-like structure inside a termite nest. These structures later designated fungus combs or fungus gardens. On this plant structures, a fungus was developing under the form of mycelium and small white nodules, designated the mycotetes.
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Half a century later, the English cryptogamist, G. Gardner collected large Agaricales from a termite nest in Sri Lanka (Petch, 1913). Petch (1906) gave prominence to the relationship between the two fungal formations—mycotetes and sprocarps and demonstrated that these large mushrooms are cultivated by the termites inside their nests. Heim (1941) created a new genus for these fungi, that of Termitomyces, which contains all the “termitophilic Agaricales.” Grasse´ (1958) was the first to demonstrate that Termitomyces were associated only with a single family of termites (Macrotermiteinae) found only on the Asian and African continents and on the other hand, that it is a case of symbiosis since neither of the two partners can exist without the other.

Termitomyces is a white-rot fungus, belonging to the class of Basidiomycetes, order Agaricales, established an exo-symbiotic relationship with termites (subfamily Macrotermiteinae, Termitidae, Isoptera). This ‘agricultural’ mutualism is obligate for both partners: The fungal symbionts degrade complex substances such as lignin or cellulose into smaller substances that will be digestible food for termites and also Termitomyces mycelium acts as source of proteins. On the other hand, the termites provide the favorable environment for the fungus to grow, preventing the growth of intruders by constructing a hill structure and inoculation chambers inside the nest (Aanen, 2006). These fungus-growing termites play a major role in nutrient cycling as they affect the decomposition processes in most tropical and subtropical ecosystems.

Termitomyces grow on a special medium fungus garden or fungus comb which is maintained inside the nest. Fungus garden are constructed from dead plant material which passed quickly through termite gut (Bignell et al., 1994). During the rainy season Termitomyces exhibit the second phase of its life cycle due to development of fruiting structure that directly arising from spherules on fungus comb penetrates the soil and appear on top of the nest in the form of macrofungi that are safe for people to eat. These are highly valued edible mushrooms, widely collected and traded in many countries of Southern Africa and Southeast Asia. During the rainy season Termitomyces collection in Kodagu district is one of the major activity for the people of this area specially women and children. Indigenous people of this region prepared verities of food with this delicious macrofungi and extra mushroom is sold in local and road side markets.
Kodagu is a small district (4100 square Kilometers of land) in the Western Ghats of South Western Karnataka state. It is one of the 32 biodiversity hotspot regions in the world and receives appreciable amounts of rain fall during the months of June and Oct. Many species of Agaricales including *Termitomyces* species also are rich in this region and are being collected and consumed by local people for their medicinal and delicious value. Due to increased awareness of the pharmacological values and nutritional values of macrofungi, there is more demand and consumer preference for different varieties of macrofungi among the people and farmers that are urged to exploit the wild macrofungi for utilization. During the rainy season mushroom merchant collect large amount of the *Termitomyces* species from different part of the Kodagu district and sell on road side as well as local markets. Not much work has been done on the diversity of *Termitomyces* species of Kodagu region of Karnataka and hence this present research investigation envisaged documenting the rich diversity of *Termitomyces* species.