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Highlights on the Macrofungi of South West Coast of Karnataka, India

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ABSTRACT

This study addresses macrofungal composition of coastal habitats (scrub jungles, coastal sand dunes and mangroves) of south west coast of Karnataka. Up to 124 species of macrofungi have been recorded with a highest of 95 species in scrub jungles followed by coastal sand dunes (36 spp.) and mangroves (31 spp.). Ten species were common to all habitats and wood inhabiting *Dacaryopinax spathularia* was frequent. Edible macrofungi were highest (34 spp.) followed by ectomycorrhizal (26 spp.) and medicinal (21 spp.) macrofungi. Soil inhabiting *Lycoperdon utriforme* was edible, ectomycorrhizal and medicinal fungus. Many macrofungi were eaten based on traditional knowledge of local people. Habitat degradation is most threatening to macrofungi, which results in soil erosion, substrate depletion and elimination of host tree species. The current status and strategies of habitat conservation in favour of macrofungi have been discussed.

Keywords: Coastal sand dunes, conservation, ectomycorrhizae, mangroves, scrub jungles, traditional knowledge

INTRODUCTION

Nearly 30% of human population in the world has taken shelter in coastal regions (Hoagland and Jin, 2006). The Peninsular India encompasses coastline over 7,000 km and its magnitude further increases by considering the coastlines of islands (Andaman, Nicobar and Lakshadweep). Area of coast influenced natural habitats (west coast, east coast and islands) constitutes roughly 22,000 km^2 (Rodgers and Panwar, 1988; Mehta, 2000). Bioresources of such habitats drastically differ compared to other aquatic and terrestrial regions. The coastal region of southwest India is represented by a variety of ecological niches with unique flora, fauna and microbiota. Coastal ecosystems of the southwest India could be broadly classified into three major habitats: i) freshwater habitats; ii) marine habitats; iii) terrestrial habitats (Fig. 1). Sand dune forests, mangrove forests and river valley forests of coastal region play a key role in supporting unique life forms (Sridhar, 2017). Some of the major human interferences of the coastal region include resource depletion, soil erosion and urbanization. Thus, coastal regions need restoration, rehabilitation and revegetation for protection from storms, water purification and to derive sustainable agricultural products.

Macrofungi constitute important natural resource owing to their major role in decomposition, nutrient cycling, mutualistic association and other advantages (nutrition, medicine and metabolites). Mueller *et al*. (2007) predicted the global extent of macrofungi between 53,000 and 110,000. Due to geographically distinct climatic conditions, the Indian Peninsula encompasses up to 850 macrofungi (Manoharachary *et al*, 2006), the list is growing further by checklists and addition of new macrofungi especially from the Western Ghats and Himalayas (Bhosle *et al*., 2010; Mohanan, 2011; Farook *et al*., 2013; Prashar and Lalita, 2013; Senthilarasu, 2014; Gogoi and Prakash, 2015; Vishwakarma *et al*., 2017). Despite studies on various life forms of the coastal habitats, insights on macrofungi are fairly recent. The aim of this contribution is to compare macrofungi of lateritic scrub jungles, coastal sand dunes and mangroves of coastal regions of south west Karnataka to forecast future lines of research.

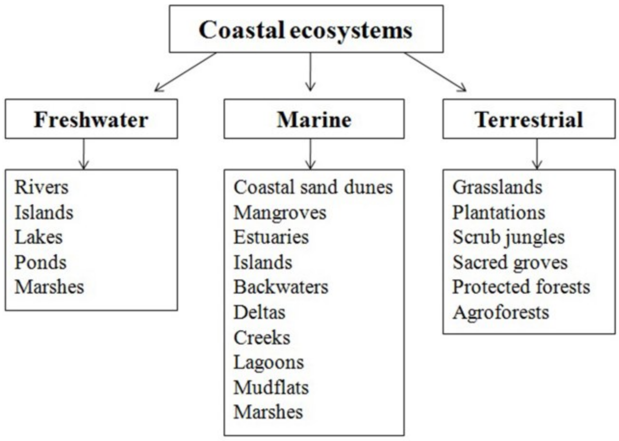

Fig. 1. Ecosystems of coastal region.

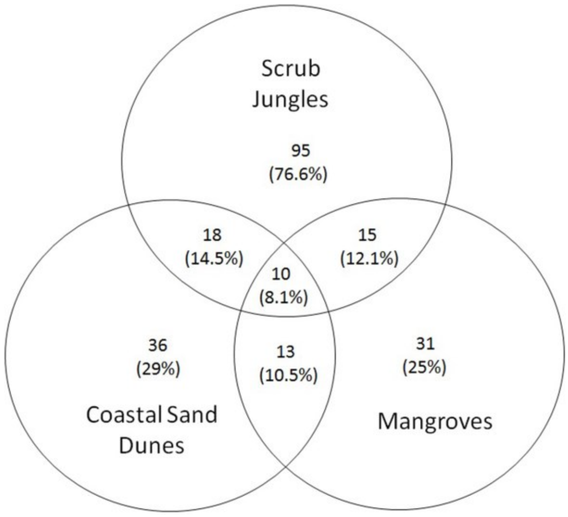

Fig. 2. Comparison of macrofungi occurring in lateritic scrub jungles, coastal sand dunes and mangroves of coastal region.

Assemblage and diversity

Among the three distinct habitats in coastal region, scrub jungles represent up to 77% of macrofungi (124 spp.) (Fig. 2) (Karun and Sridhar, 2016: Greeshma *et al*., 2016; Pavithra *et al*., 2016). In spite of saline conditions and disturbances, coastal sand dunes consist of 29% of macrofungi (Ghate *et al*., 2014; Ghate and Sridhar, 2016a). Although the wet and saline conditions in the mangroves hamper macrofungal growth, substrates like leaf litter and woody litter on the bunds above tide line during monsoon season support up to 25% of macrofungi (Ghate and Sridhar, 2016b). Common macrofungi between habitats ranges from 10.8% (coastal sand dunes and mangroves) to 14.5% (scrub jungles and coastal sand dunes). Ten macrofungi (8.1%) were common to all habitats, among them wood inhabiting edible macrofungi *Dacaryopinax spathularia* and *Lentinus squarrosulus* were dominant in all habitats (Table 1).

Table 2 presents edible, ectomycorrhizal and medicinal macrofungi in coastal region. The edible fungi were highest (34 spp.) followed by ectomycorrhizal fungi (26 spp.) and medicinal fungi (21 spp.) (Fig. 3). Fungi common to three coastal habitats ranges from 8.2% (edible and medicinal; ectomycorrhizal and medicinal) to 16.4% (edible and ectomycorrhizal). Thirty four edible macrofungi were recognized in coastal region. The soil inhabiting, edible, medicinal and ectomycorrhizal fungus *Lycoperdon utriforme* although rare it was common to all habitats (Table 2). About 15% macrofungi were edible, 31% medicinal and 54% were ectomycorrhizal in scrub jungles (Greeshma *et al*., 2016). In scrub jungles up to 47% macrofungi preferred soil, 38% preferred woody litter and 15% preferred leaf litter,

Table 1. Macrofungi occurring in three habitats of coastal region of southwest Karnataka

	Scrub jungles	Coastal sand dunes	Mangroves
Coprinus plicatilis	+	+	+
Crepidotus uber	++	+	+
Dacryopinax spathularia	+++	+++	+++
Ganoderma lucidum	+	+	+
Hexagonia tenuis	+	+	++
Lentinus squarrosulus	+++	++	++
Lycoperdon utriforme	+	+	+
Marasmius kisangensis	+	++	++
Microporus xanthopus	++	+	+
Thelephora palmata	++	+	+++

(+, rare; ++, common; +++, frequent).

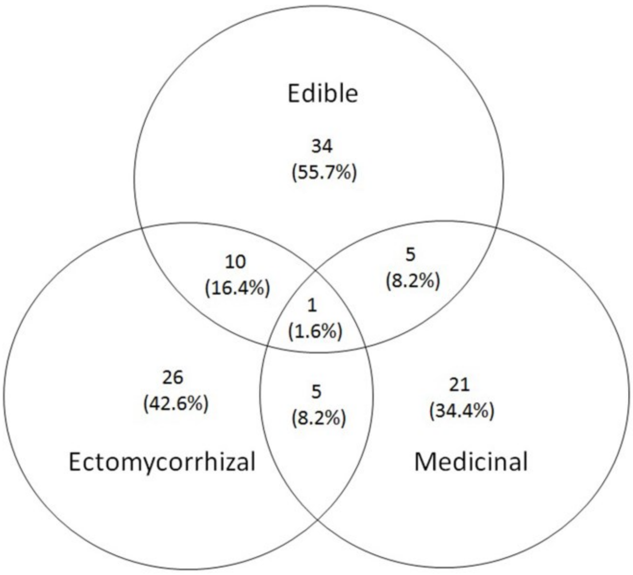

Fig. 3. Comparison of edible, medicinal and ectomycorrhizal macrofungi in coastal region.

Substrate and traditional knowledge

Substrate and substrate quality play important role in supporting macrofungi. Soil (lateritic soil, humus, compost, sandy loam, termite mound, ant-infested soil and decomposing leaf / woody litter mixed soil), fragile substrates (leaf litter, grass shreds, bark, twig, fine roots, grass and ferns) and stable (branch, trunk, stubs and standing dead trees) support a wide range of macrofungi. Besides dead substrates, live roots of many tree species mutualistically associated with ectomycorrhizal fungi. Thirty four edible macrofungi (20 genera) in coastal region grew on soil, woody litter and some were ectomycorrhizal. Twenty six ectomycorrhizal fungi (17 genera) were dependent many tree species especially *Anacardium occidentale, Artocarpus hirsutus, Carya arborea, Holigarna arnottiana, Hopea parviflora, H. ponga, Macaranga peltata, Phyllanthus emblica, Sapium insigne, Syzygium cmmini* and *Terminalia paniculata*. Twenty one medicinal fungi (15 genera) were recorded in coastal region and many of them grew on woody material. A few endemic trees of *Vateria indica* (Dipterocarpaceae) in scrub jungles served as host for two edible and ectomycorrhizal fungi (*Russula adusta* and *R. atropurpurea*) (Pavithra *et al*., 2017).

Several macrofungi serve as delicacy for the local people based on their traditional knowledge (e.g. *Astraeus* spp. *Pleurotus* spp. and *Termitomyces* spp.) (Pavithra *et al*., 2015; Karun and Sridhar, 2016). Termitomycetes are most preferred owing to their high delicacy followed by *Pleurotus* spp. and *Astraeus* spp. *Pleurotus* spp. grow profusely on the fronds of coconut (*Cocos*) and areca (*Areca*). *Astraeus* spp. occupy the lateritic pebble rich soil and tender fruit bodies develop below 1-2 cm (Pavithra *et al*., 2015). Being ectomycorrhizal they grow more profusely underneath several native tree species (e.g. *Artocarpus hirsutus, Holigarna arnottiana, Hopea parviflora, H. ponga, Phyllanthus emblica* and *Syzygium cumini*). Many of them are collected and eaten in tender stage based on traditional knowledge by the local people. Similar to *Astraeus* spp., *Amanita* sp. also occupies the pebble rich lateritic soils and it is ectomycorrhizal on several host tree species (e.g. *Acacia auriculiformis, A. mangium, Anacardium occidentale, Hopea ponga* and *Terminalia paniculata*) (Karun and Sridhar, 2014). This mushroom will also be eaten when it is in young stage especially prior to opening of volva or partially opened stage (Karun and Sridhar, 2016).

Table 2. Edible, mycorrhizal and medicinal macrofungi documented in coastal region of southwest Karnataka (*, edible, ectomycorrhizal and medicinal).

Edible	Ectomycorrhizal	Medicinal
Agaricus sylvaticus	*Amanita angustilamellata*	*Agaricus sylvaticus*
Amylosporus campbellii	*Amanita aureofloccosa*	*Amauroderma conjunctum*
Astraeus hygrometricus	*Amauroderma conjunctum*	*Amylosporus campbellii*
Astraeus odoratus	*Astraeus hygrometricus*	*Daldinia concentrica*
Auricularia auricula	*Astraeus odoratus*	*Ganoderma applanatum*
Auricularia auricula-judae	*Boletus edulis*	*Ganoderma colossus*
Boletus edulis	*Boletus hongoi*	*Ganoderma lucidum*
Boletus hongoi	*Boletus reticulatus*	*Lentinus betulina*
Boletus reticulatus	*Clavulinopsis dichotoma*	*Lentinus polychrous*
Collyba aurea	*Entoloma brihadum*	*Lentinus squarrosulus*
Coprinus plicatilis	*Entoloma vanajum*	*Lycoperdon lividum*
Dacaryopinax spathularia	*Hygrocybe astatogala*	**Lycoperdon utriforme*
Lentinus patulus	*Hygrocybe aurantioalba*	*Microcarpus xanthopus*
Lentinus squarrosulus	*Inocybe petchii*	*Phallus indusiatus*
Lenzites elegans	*Laccaria laccata*	*Pycnoporus sanguineus*
Lepista hyalodes	*Leucoagaricus rubrotinctus*	*Scleroderma citrinum*
Lycoperdon decipiens	**Lycoperdon utriforme*	*Scleroderma verrucosum*
**Lycoperdon utriforme*	*Macrolepiota dolichaula*	*Termitomyces microcarpus*
Macrolepiota dolichaula	*Macrolepiota rhacodes*	*Trametes versicolor*
Macrolepiota rhacodes	*Pisolithus albus*	*Xylaria hypoxylon*
Oudemansiella canarii	*Russula adusta*	*Xylaria nigripes*
Panus conchatus	*Russula atropurpurea*	
Phallus indusiatus	*Scleroderma citrinum*	
Phallus merulinus	*Scleroderma verrucosum*	
Pleurotus djamar	*Xylaria nigripes*	
Pleurotus flabellatus	*Thelephora palmata*	
Russula adusta		
Russula atropurpurea		
Termitomyces clypeatus		
Termitomyces microcarpus		
Termitomyces shimperi		
Termitomyces striatus		
Termitomyces umkowaan		
Tremella reticulata		

Disturbance and conservation

Human interference is most threatening to macrofungi of the coastal region. Macrofungi are habitat dependent, thus habitat destruction has major impact on their growth and perpetuation. Eliminating the host tree species by clear cutting leads to eradicate tree dependent mycorrhizal fungi. Ecosystem degradation is happening in alarming rate mainly due to clear cutting and transformation of forests (sand dune forests, mangrove forests and river valley forests) into plantations (e.g. areca, coconut and rubber). The habitats of native tree species are occupied by *Acacia spp*. Due to present government policies farmers are afraid of losing buffer zones adjacent to their agricultural lands (which supply organic matter, green manure and other products in support of agriculture and their livelihood) and started practicing clear cutting of *Acacia* trees. Along with *Acacia* trees native trees are also eliminated and thus scrub jungles succumb for severe soil erosion. Due to such devastating activities, there is severe threat for coastal agroforestry as well as agriculture.

In addition to soil erosion, extraction of fire wood results in depletion of macrofungal substrates. There will be a drastic shift in substrate preference (leaf litter, soil and woody litter) as well as type of macrofungi (edible, medicinal and mycorrhizal fungi) owing to the impact of fire episodes in scrub jungles during summer. Due to fire, ectomycorrhizal fungi reduced from 54% to 15% in scrub jungles (Greeshma *et al*., 2016). However, those fungi colonized the roots underneath the soil escape from the impact of fire and perpetuate on the onset of wet season. Similar to scrub jungles, coastal sand dunes are also threatened by fire due to human impact (clearing vegetation and accumulated debris for recreation purposes) and its impact on macrofungi is yet to be systematically investigated (Ghate *et al*., 2014; Ghate and Sridhar, 2016a).

Many soil and termite dependent macrofungi in plantations suffer due to application of pesticides and weedicides. There is a need to change the cultivation practices in plantations towards agroforestry / silviculture in favour of macrofungi. Conservation or cultivation of native tree species has major impact on ectomycorrhizal as well as other fungi. In addition, prevention of soil erosion, retention of termite mounds and allowing minimum woody litter on the ground support growth and perpetuation of several macrofungi. Many of the lateritic scrub jungles have been converted into quarries for extraction of laterite stones and they will be abandoned without proper revegetation. Similarly, coastal sand dunes, mangroves and river mouths are severely affected by sand mining, which is threatening the existing forest cover.

Outlook

Macrofungi being alternate source of nutrition / medicine / metabolites and ectomycorrhizal with valuable tree species needs more attention for their utilization. The coastal ecosystem is endowed with a variety of habitats like lateritic scrub jungles, mountain slopes and valleys, rocky escarpments, sacred groves, mangroves, coastal sand dunes, plantations and grass lands. In spite of human interference, many interesting and stress tolerant macrofungi survive in the coastal region. Some of them were not identified up to species level in coastal region indicates further scope for macrofungal research. Under the existing climatic conditions coastal region supports a variety of edible, medicinal and ectomycorrhizal fungi. Impact of human interferences on macrofungi needs further emphasis to understand their assemblage, diversity and distribution. Coastal habitats posses a variety of feed stock to grow macrofungi. For example, utilization of grasses (e.g. *Pennisetum),* weeds (e.g. *Eupatorium* and *Lantana)* and leaf litter (of several deciduous trees) is worth to cultivate desired macrofungi. Educating the public towards practice of environment friendly agroforestry /silviculture and change in the policies of government towards ecosystem protection is utmost important to preserve the ecosystem. The local educational institutes shoulder major responsibilities in educating people towards sustainable development by showcasing the biodiversity exists in their surroundings.

Conflicts of interest: The author stated that no conflicts of interest.

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