DIVERSITY OF MACROFUNGAL COMMUNITIES IN CHIKMAGALUR DISTRICT OF WESTERN GHATS, INDIA

KRISHNAPPA M*, SWAPNA S AND SYED ABRAR
Department of PG Studies and Research in Applied Botany, Jnana Sahyadri, Kuvempu University
Shankaraghatta 577451, Karnataka, India
krishnappan1007@gmail.com

ABSTRACT

Macrofungi form an integral part of all forest systems. The main goal of the present study is to expand the baseline database for macrofungal documentation, diversity and its distribution in the Western Ghats of Chikmagalur district for establishing an inventory of the macrofungi species.Twenty transects each measuring 50 x 20 m were laid in sampling stations of Chikmagalur district. The study sites were selected randomly and macrofungi were collected during 2007 to 2011. A total of 6,950 sporomas were collected. The relationship between macrofungal species richness and sampling plots was analyzed using linear regression. Dacrymycetaceae, Ganodermataceae, Polyporaceae and Russulaceae were found to be the most dominant families during study. *Armillaria, Calocera, Ganoderma, Panaeolus, Polyporus, Psathyrella* and *Russula* were the most dominating genera during five years study (2007-11). *Calocera viscosa, Ganoderma carnosum, Panaeolus fimicola, Psathyrella candolleana, Russulaatro purpurea, Scutellinia erinaceus, Termitomyces tylerianus* and *Trametes hirsuta* were the most predominating species. The Shannon and Simpson diversity indices were found to be highest during 2007 (H'=4.35; D=0.031), respectively.

Keywords: epigeous macromycetes, sporoma, diversity, dominance

INTRODUCTION

According to Hawksworth [1], the estimated number of fungal species worldwide is 1.5 million and less than 5% have been described. The number of fungi recorded in India exceeds 27,000 species and forms the largest biotic community after insects [2]. Fungi of various taxonomic groups producing conspicuous sporocarps are collectively known as macrofungi which include gilled fungi, jelly fungi, coral fungi, stinkhorns, bracket fungi, puffballs, and bird's nest fungi [3]. They grow prolifically and are found in many parts of the world [4]. Macrofungi studies are of interest to scientists due to their important role in food industry, in medicinally effective products and in biodegradation [5]. Despite their great ecological significance, the community ecology, biogeography, and conservation status of macrofungi are poorly known. In Karnataka, knowledge about diversity, abundance, fruiting pattern of mushroom and their ecology is scarce and only documentation has been done. Ecological studies of macrofungi based on sporocarps are hampered by the erratic nature of fruiting and the short duration of sporocarps.The present work has been undertaken to study the diversity of macrofungi in Chikmagalur district of Western Ghats. The climatic condition and humus formation favours the luxuriant growth of macrofungi in the study area.

MATERIALS AND METHODS

Study area

The study was conducted in Chikmagalur district, Karnataka, India, a part of naturally rich biodiversity, situated between 12°54'42'' and 13°53'53'' North latitude and 75°04'46'' and 76°21'50'' East longitude. The geographical area of the districtis 7201 sq. km with a forest area of 200485 ha. The average annual rainfall in the district is 1762 mm. The annual mean air temperature is 17 °C to 20 °C in winter and 32 °C to 35 °C in summer [6].

Survey

Macrofungi were identified by the presence-absence for sporomas and were limited to epigeous macromycetes of soil and wood-inhabiting macrofungi that were visible to the naked eye (>1mm). Survey can be performed just after the rain [7].

The difficulty was that only small proportions of macrofungi were visible on a single visit. Hence repeated surveys were done in all sampling plots during January 2007 to December 2011.

Sampling

The fruiting phenology of macrofungi varies all through the year, depending on temperature, relative humidity, different altitudes [8] and regions. To circumvent this, study sites were plotted in Chikmagalur district. Twenty transects were laid, each measuring 50 x 20 m. The study sites were selected randomly and macrofungi collected within transects and characterized for further analysis. The geographic coordinates of each study sites were integrated into ArcGIS9.2 software to generate a study map for spatial distribution of sampling locations in Chikmagalur district. The readings of latitude/longitude were taken using handheld GPS (Garmin GPSMAP® 76CSx).

Collection

Fresh specimens were collected with great care without any damage and soil debris was removed using a soft brush. Wood inhabiting macrofungi were collected along with the substratum [9]. The habitat and morphological characteristics of the macrofungi were noted [10] and photographed using NIKON D60 digital SLR camera for further diagnosis during the collection [11]. Fleshy sporomas were wrapped in waxed paper or newspaper [12] and labelled with the collection number.

Drying and preservation

The sporomas were dried in air-vented mushroom drier. The dehydrated collections were removed depending upon the delicate nature of specimens. Tough and pliable collections were kept for longer durations for drying and the dehydrated specimens were sealed in polythene covers containing napthalene balls which prevent the attack of mites and insects damage. The sealed sporomas were labelled with collection code and date of collection. The representative specimens were deposited in the Department of Applied Botany, Kuvempu University, Shankaraghatta, Karnataka.

Characterization

Macrofungi were assessed for the presence/absence of several morphological characters such as volva, annulus, gills/ pores, peridium and gleba. Accurate and consistent notation of sporomas, colour, including colour changes of mature sporomas and colours of different development stages were noted [13-18].

Morphological characters

Every morphological feature (basidiocarp, basidia, basidiospores, cystidia, ascocarp, asci, ascospores) has a taxonomic significance at different levels of taxonomic groups in classification. Colour notations were described from Kornerup and Wanscher [19]. They were identified in the laboratory using morphological features, appropriate keys and monographs. Taxonomic classification of species is zone according to Kirk *et al*. [20] and fungal nomenclature is based on Mycobank (http://www.mycobank.org/Biolomics.aspx? Table=Mycobank&Page =200&ViewMode=Basic).

Microscopical characters

The species were also identified based on observations of microscopic structures. The sporomas were cut into small fragments for free hand sectioning using a razor blade. The microscopic characters such as size, shape, ornamentation, clamp-connections were clearly observed for basidia, cystidia, asci, basidio/asco spores, capillitium, and exo/endoperedial elements. All the observations of the microscopic structures were made under an oil-immersion objective with an Olympus CX31 microscope. Microscopic measurements were calculated using calibration (with ocular and stage micrometer).

Data analysis

Qualitative analysis entails determining three attributes of the species in the community: density (number of sporomas per unit area), which is a measure of the numerical individuals relative to species; frequency (how many samples contain sporomas of a given species), which measures the commonness of the species and dominance, the incidence at which the species occurs most in the sampling area [21].

Density

Density is an expression of the numerical strength of a species where the total number of sporomas of each species in all transects is divided by the total number of transect studied. Density was calculated as follows

Density (De) = Total number of sporomas in all quadrats/ Total number of transect studied

Dominance and Abundance

Dominance (D) for genera and family were estimated by the highest number of species and species dominance was estimated by highest number of total sporomas. Abundance was estimated by number of sporomas of different species in the community per unit area. Sampling was done randomly at several places within transects and the number of sporomas of each species is summed for all transects divided by the total number of transects in which the species occurred. Dominance is represented by the equation

Abundance (A) = Total number of sporomas in all transects/ Number of transects of occurrence

Frequency

The term frequency refers to the degree of dispersion of individual species in an area and usually expressed in terms of percentage occurrence. Sampling was done randomly in the study area at several places within transects and recorded the name of sporomas that occurs in each sampling units. It is calculated by the formula.

Frequency (F) = Number of transects of species occurrence/Total number of transects studied

Alpha Diversity

Shannon-Weiner's diversity index, a measure of richness and evenness [22] and Simpson's diversity index of dominance [23] were measured for each year in Chikmagalur district and also each for the complete district.

Shannon-Weiner diversity Index = $H' = -\Sigma (pi \times \ln pi)$

Simpson's Diversity Index = $D = \Sigma \frac{ni\,(ni-1)}{N\,(N-1)}$

Where, 'i^{th}' species = one of all the enumerated species

Pi = the proportion of the 'i^{th}' species = (ni/N)

ni = number of individuals of the 'i^{th}' species

N = total number of individuals.

Regression Analysis

Regression analysis was determined through the statistical software (Minitab 15) in Chikmagalur district to discern whether the sampling plots influenced the species richness of sporomas. Transects are equally efficient in sampling macrofungi from a given sampling plots. Alternatively, macrofungi were strongly dispersal limited, they were sampled in a limited transects. Similarly, the dispersion-limitation predicted more species to develop in a restricted transect. The analysis was run separately

for each year of 5 year study (2007-2011) in overall Chikmagalur district. The statistical significance of the included variables was determined by R-Sq test with 0.05% significance as a criterion.

Principle Component Analysis

Principle component analysis was peformed on top 20 abundant species from four substrates (coprophyllous, folicolous, lignicolous and terricolous). The scores of first two components from the PCAs were used to compare differences of the macrofungal communities among the four substrates. The software Xlstat 13 was used to perform the statistical analysis.

Pearson Correlation Coefficient

The species richness of each family and genera of Chikmagalur district was subjected to analysis using Microsoft Excel 2007. The analysis was performed in terms of least significant difference ($LSD_{0.05}$) in species richness of each family and genera among the total rainfall.

RESULTS

Sporoma

A total of 6950 sporomas were collected in Chikamagalur district during 2007-2011 and maximum productivity was recorded during 2007 with 1832 individuals followed by 1620 individuals during 2009, 1404 during 2008 and 1175 in the year 2010. Lowest sporomas were encountered during last year of study (2011) with 905 individuals (Fig. 1)

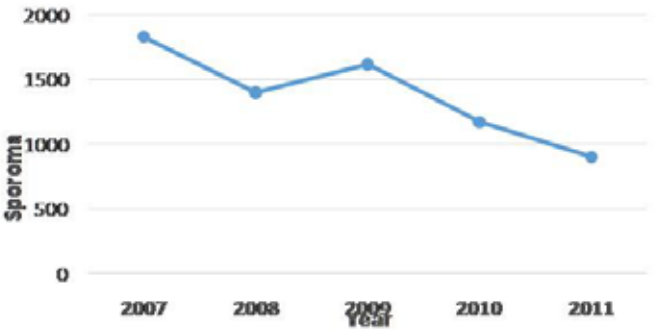

Figure 1. Total sporoma in Chikmagalur district during 2007-2011

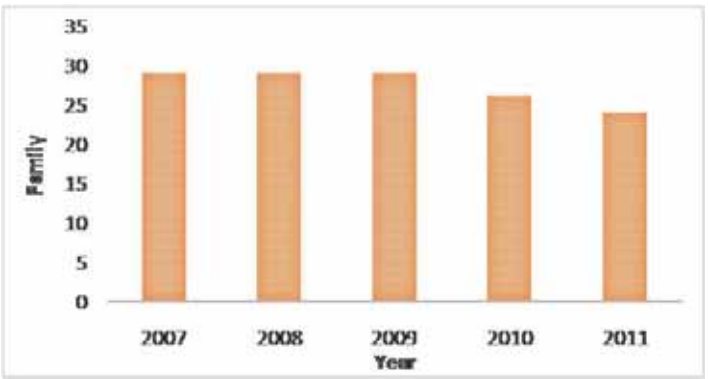

Figure 2. Total families occurring in Chikmagalur district during 2007-11

Families

A total of 29 families were enumerated from district during 2007-11. Species of 29 families were recorded during first three consecutive years (2007-2009) accounting for highest families followed by 26 and 24 families during 2010 and 2011 respectively (Fig. 2).

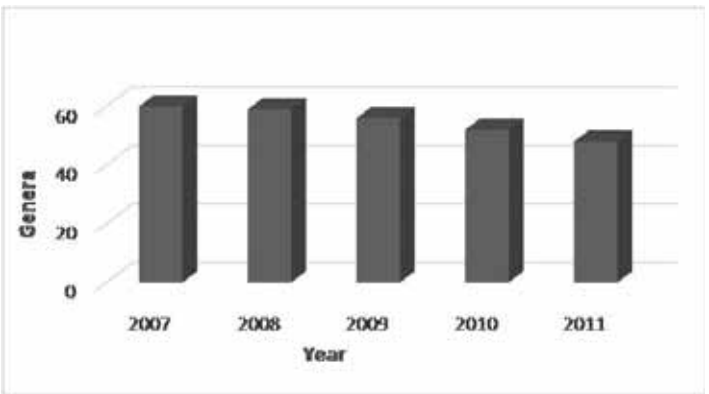

Figure 3. Total genera occurred in Chikmagalur district during 2007-2011

Genera

A total of 64 genera were encountered during 2007-11. Sixty genera were encountered during 2009 accounting for highest and 59 in 2007 followed by 56, 52 and 48 genera during 2008, 2010 and 2011, respectively (Fig. 3).

Morpho groups

Fleshy gilled fungi ranked first with 61% followed by bracket fungi (18%) and coral fungi (6%) (Fig. 4).

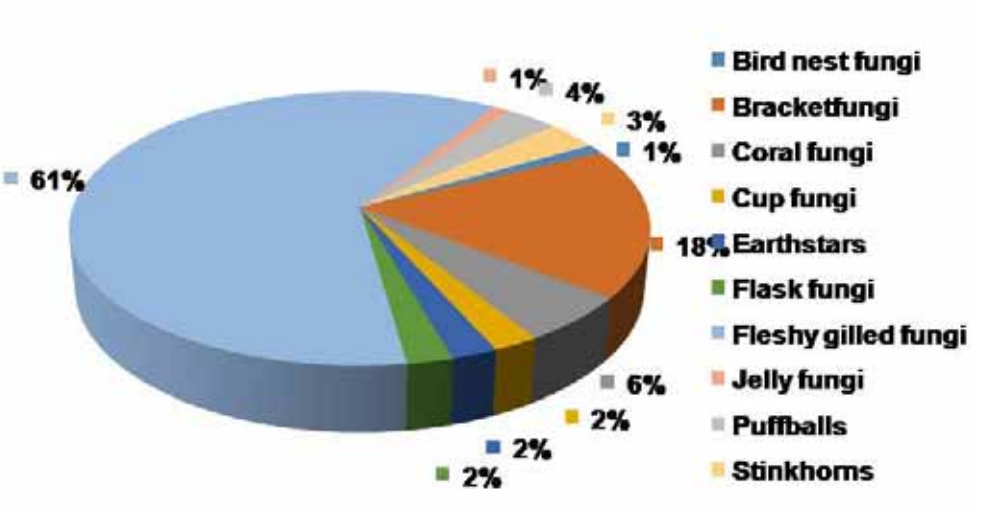

Figure 4. Macrofungalmorpho-group percentage of Chikmagalur district

Statistical analysis

Macrofungal species richness versus sampling plots

The relationship between macrofungal species richness and sampling plots of Chikmagalur district was analyzed using linear regression. The pooled data of five years were considered for analysis in Chikmagalur district. The linear regression plots indicated a strong positive association between macrofungal species richness and sampling plots The linear regression plots for macrofungal species richness versus sampling plots were analyzed for Chikmagalur district. Positive correlation was observed and found significant in the study area.

Table 1. Results of Linear regression analysis relating macrofungal species richness versus sampling plots surveyed in Chikmagalur district

Study area	*p*	R^2
Chikmagalur district	<0.000***	0.214

p < 0.05* *p* < 0.01** *p* <0.0001***

Table 2. Results of Linear regression analysis relating macrofungal species richness versus sampling plots surveyed in Chikmagalur district

Study area	*p*	R^2
2007	<0.000***	0.77
2008	<0.000***	0.76
2009	<0.000***	0.72
2010	<0.000***	0.78
2011	<0.000***	0.72

A total of 90 species occurred with 6950 sporomas in 5 years from 2007-2011 in Chikmagalur district. The linear regression plots of macrofungal species richness versus sampling plots was generated. Significant positive relationship was observed between the components in sampling plots of Chikmagalur district (Fig. 5).

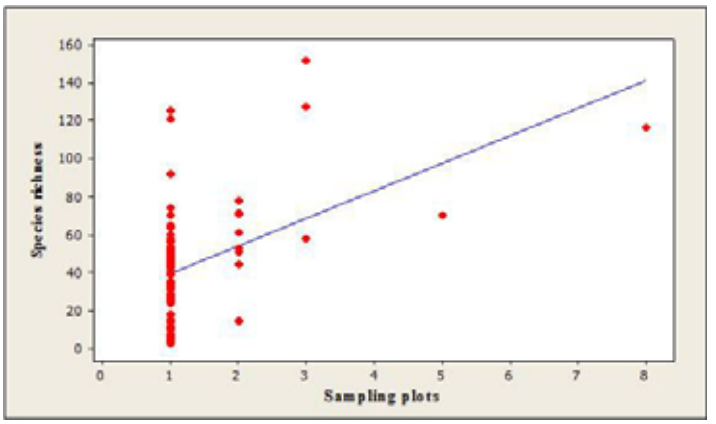

Figure 5. Correlation of macrofungal species richness versus sampling plots

Density

Family density

In Chikmagalur district, Agaricaceae was found to be the densest family during all the five years of study (2007-2011). During five years study, Agaricaceae ranked first followed by Psathyrellaceae being second and Polyporaceae third denser families in the study sites (Fig. 6).

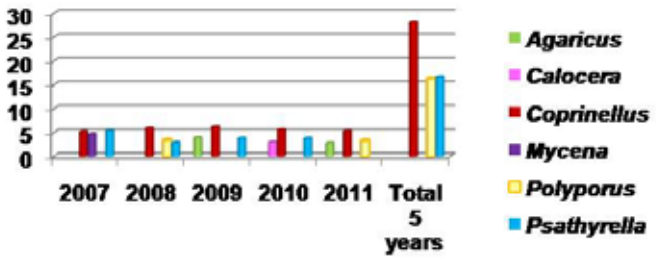

Figure 7. Dense genera of macrofungi in Chikmagalur district (2007-2011)

Species Density

In Chikmagalur district, *Psathyrella candolleana* (2007), *Cyathus striatus* (2008), *Microporus xanthopus* (2008), *Coprinellus disseminatus* (2009, 2010, 2011) and *Calocera viscosa* (2010) were found to be most dense species during respective years. During five years study, *Coprinellus disseminatus* emerged as first denser species with *Cyathus striatus* and *Calocera viscosa* being second and third denser species in the study sites of Chikm galur district (Fig. 8).

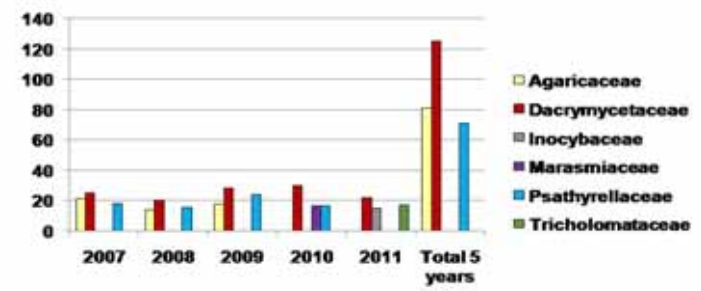

Figure 9. Abundant families of macrofungi in Chikmagalur district (2007-2011)

Genera Abundance

In Chikmagalur district, *Psathyrella* (2007), *Armillaria* (2008) and *Calocera* (2008, 2009, 2010, 2011) were found to be the most abundant genera during respective years. *Calocera*, *Armillaria* and *Psathyrella* ranked first, second and third most abundant genera in the study sites (Fig. 10).

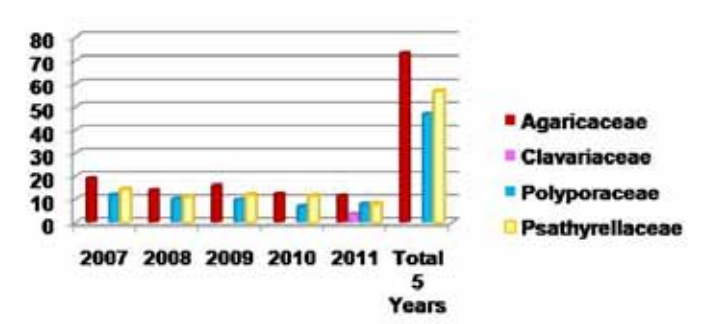

Figure 6. Dense families of macrofungi in Chikmagalur district (2007-2011)

Genera density

In Chikmagalur district, *Psathyrella* ranked first during 2007 and *Coprinellus* was most densest for four years during study (2008, 2009, 2010, 2011). During five years study, *Coprinellus*, *Psathyrella* and *Polyporus* ranked first, second and third denser genera respectively in the study sites (Fig. 7).

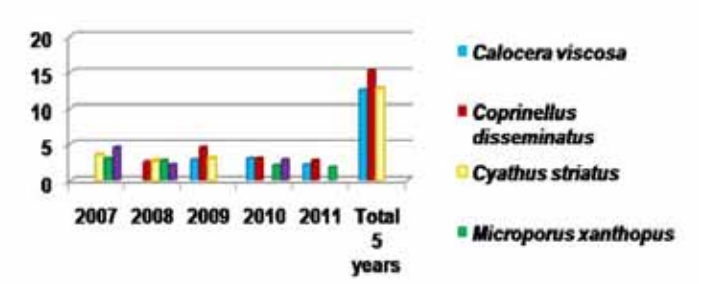

Figure 8. Dense species of macrofungi in Chikmagalur district (2007-2011)

Abundance

Family abundance

In Chikmagalur district, Dacrymycetaceae was found to be the most abundant family during 2007, 2008, 2009, 2010 and 2011. Dacrymycetaceae came forth as most abundant followed by Agaricaceae and Psathyrellaceae during five years study (Fig. 9).

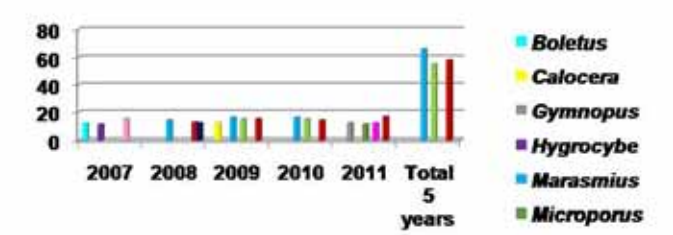

Figure 10. Abundant genera of macrofungi in Chikmagalur district (2007-2011)

Frequency

Family frequency

Polyporaceae ranked first during all the five years (2007-2011) and Agaricaceae shared first position during 2008 in the study sites of Chikmagalur district (Fig 11).

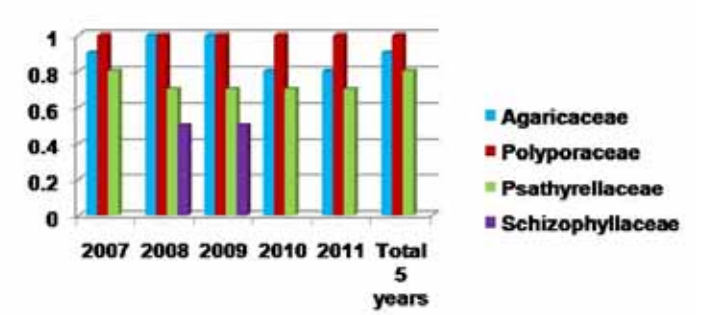

Figure 11. Frequent families of macrofungi in Chikmagalur district (2007-2011)

Genera frequency

Frequent genera of macrofungi occurring in Chikmagalur district was evaluated during 2007-2011. In Chikmagalur district, *Microporus* was found to be the most frequent genera during all the five years (Table 3).

Table 3. Genera frequency of macrofungi in Chikmagalur district (2007-2011)

Genera	Frequency					
	2007	2008	2009	2010	2011	Total
Abortiporus			0.1	0.1		0.1
Agaricus	0.4	0.4	0.4	0.3	0.3	0.4
Antrodia	0.1	0.1	0.1	0.1	0.1	0.1
Armillaria	0.1	0.1	0.1	0.1	0.1	0.1
Bjerkandera	0.1	0.1	0.1	0.1	0.1	0.1
Bovista	0.3	0.3	0.3	0.3	0.3	0.3
Calocera	0.1	0.1	0.1	0.1	0.1	0.1
Cantharellus	0.1	0.1	0.1			0.1
Chlorophyllum	0.1	0.1	0.1	0.1	0.1	0.1
Clavaria	0.2	0.2	0.1	0.1	0.1	0.2
Clavulinopsis	0.2	0.2	0.2	0.2	0.2	0.2
Clitocybe	0.3	0.3	0.3	0.2	0.2	0.3
Collybia	0.1		0.1			0.1
Cookeina	0.2	0.2	0.2	0.2	0.2	0.2
Coprinellus	0.5	0.4	0.5	0.5	0.5	0.5
Coprinopsis	0.1					0.1
Coprinus			0.1			0.1
Coriolopsis	0.1	0.1	0.1		0.1	0.1
Crinipellis	0.1	0.1	0.1			0.1
Cyathus	0.3	0.3	0.3	0.3	0.3	0.3
Daldinia	0.1	0.1	0.1	0.1	0.1	0.1
Fomitopsis	0.1	0.1	0.1	0.1	0.1	0.1
Ganoderma	0.2	0.2	0.2	0.2	0.2	0.2
Geastrum	0.2	0.2	0.2	0.2	0.2	0.2
Gloeoporus			0.1	0.1		0.1
Gymnopus	0.2	0.2	0.2	0.2	0.1	0.2
Hemimycena	0.1	0.1	0.1	0.1	0.1	0.1
Hygrocybe	0.1	0.1	0.1	0.1	0.1	0.1
Hypholoma	0.1	0.1	0.1	0.1	0.1	0.1
Laccaria	0.1	0.1	0.1	0.1	0.1	0.1
Lentinus	0.1	0.1	0.1	0.1	0.1	0.1
Lepiota	0.2	0.2	0.2	0.2	0.1	0.2

Genera	Frequency					
	2007	2008	2009	2010	2011	Total
Leucoagaricus	0.1	0.1	0.1	0.1	0.1	0.1
Leucocoprinus	0.2	0.2	0.2	0.2	0.2	0.2
Lycoperdon	0.1	0.1	0.1	0.1	0.1	0.1
Lysurus	0.1	0.1	0.1	0.1		0.1
Macrolepiota	0.1	0.2	0.1			0.2
Marasmius	0.2	0.2	0.2	0.2	0.2	0.2
Melanoleuca	0.2	0.1	0.2	0.1	0.1	0.2
Microporus	0.8	0.8	0.8	0.8	0.8	0.8
Mycena	0.3	0.3	0.3	0.3	0.1	0.3
Oudemansiella	0.1	0.1	0.1	0.1	0.1	0.1
Panaeolus	0.3	0.3	0.1	0.3	0.3	0.3
Paxillus	0.1	0.1		0.1		0.1
Phallus	0.2	0.2	0.2	0.2	0.2	0.2
Pleurotus	0.1	0.1	0.1	0.1		0.1
Pluteus	0.1	0.1	0.1	0.4		0.1
Polyporus	0.4	0.4	0.4		0.4	0.4
Porodaedalea	0.1	0.1	0.1	0.1	0.1	0.1
Psathyrella	0.2	0.2	0.2	0.2	0.1	0.2
Pycnoporellus	0.1	0.1	0.1	0.1	0.1	0.1
Pycnoporus	0.2	0.2	0.2	0.2	0.2	0.2
Ramaria	0.1	0.1	0.1	0.1		0.1
Rhodocybe			0.1			0.1
Schizophyllum	0.5	0.5	0.5	0.5	0.5	0.5
Scutellinia	0.2	0.2	0.2	0.2	0.2	0.2
Termitomyces	0.3	0.1	0.2	0.1	0.1	0.3
Trametes	0.1	0.1	0.1	0.1	0.1	0.1
Tricholomella	0.2			0.1	0.1	0.1
Tubaria	0.1	0.1	0.1		0.2	0.2
Vascellum	0.1	0.1	0.1			0.1
Xeromphalina	0.1					0.1
Xerula	0.1	0.1	0.1	0.1	0.1	0.1
Xylaria	0.1	0.1	0.1	0.1	0.1	0.1

Species frequency

Microporus xanthopus ranked first during five years study (2007-2011) and in total five years in the study sites of Chikmagalur district (Fig. 12).

Dominance

Family dominance

Dacrymycetaceae, Ganodermataceae, Polyporaceae and Russulaceae comprised of highest species accounting for dominant family in Chikmagalur district during each year from 2007-11.

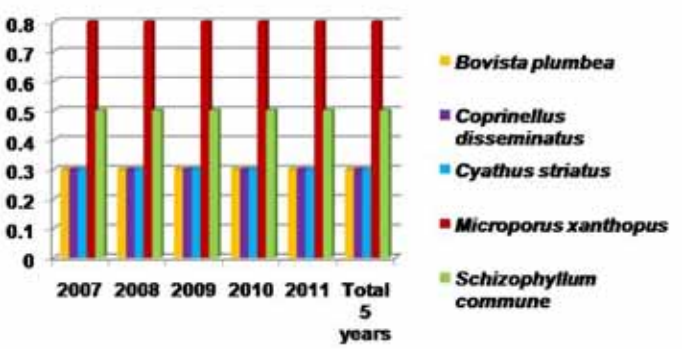

Figure 12. Frequent species of macrofungi in Chikmagalur district (2007-2011)

Genera dominance

In Chikmagalur district, *Armillaria*, *Calocera*,*Ganoderma*, *Panaeolus*, *Polyporus*,*Psathyrella* and *Russula* were found to be dominant during the study period.

Species dominance

In Chikmagalur district, *Psathyrella candolleana* accounted for most dominant species in for first two years during 2007 and 2008. In the next three years, *Calocera viscosa* became the most dominant species in the next three years during 2009, 2010 and 2011(Fig. 13).

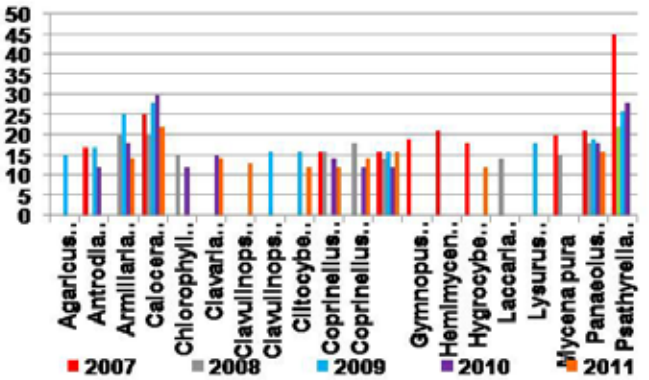

Figure 13. Dominant species of macrofungi in Chikmagalur district (2007-2011)

Species richness among trophic groups of macro fungi

In Chikmagalur district, *Coprinellus disseminatus* (CDI) featured highest and *Polyporus arcularius* (POR) was found to be lowest among represented taxa in lignicolous. *Cyathus striatus* (CYS) and *Bovista plumbea* (BPL) were prominant with former being highest and latter being lowest among represented variables in terricolous. *Marasmius praecox* (MPR) was the only species among foliicolous during five years study (Fig. 14).

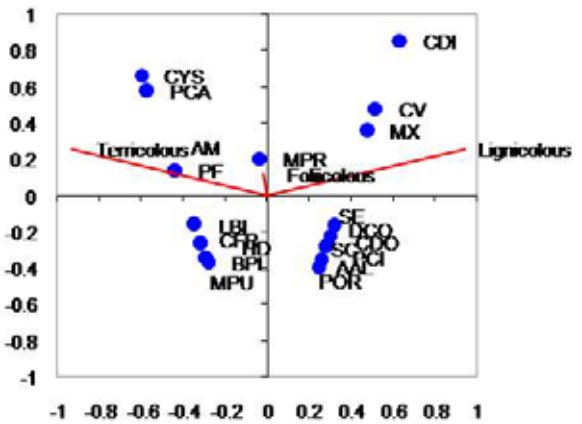

Figure 14. Species richness among trophic groups of macrofungi in Chikmagalur district (2007-2011)

Shannon-Weiner's diversity index

Shannon Weiner's diversity index of Chikmagalur district was found to be 4.35, 4.18, 4.32, 4.14, 4.01 during 2007, 2008, 2009, 2010 and 2011 respectively. Diversity reached its peak in the year 2007 (H'= 4.35). The Simpson diversity index was calculated and diversity was found to be more during 2007 (D= 0.015).

Simpson's diversity index

Simpson diversity index was calculated for Chikmagalur district for five years study. The index value was highest during 2007 (D= 0.031) showing maximum diversity followed by 2008-09, 2010 (D= 0.032) and 2011 (D= 0.033).

Influence of rainfall on macrofungal species richness

Three species in the study sites of Chikmagalur district were found to be significant with rainfall (Table 4).

DISCUSSION

The status and diversity of Chikmagalur was found to be found to be maximum during 2007-2011. We found that environmental factors like light, temperature and relative humidity greatly influence the growth and development of macrofungi. The reduction of the macrofungi sporulation occurs mainly due to reduction in rainfall and fruiting diversity depends on the tree populations. This diversity is due to luxuriant substrate humus and relative humidity in the study area. The Shannon diversity indices were found to be more in 2007 and gradually decreased over the years. The simpson diversity index increased with the value of 0.02 in five years. The family Agaricaceae, Polyporaceae and Psathyrellaceae was found to be dominant in all the five years (2005 to 2010). Our study revealed the loss of 29 species in Chikmagalur district. The

Table 4. Pearson correlation coefficient of macrofungal families in Chikmagalur district

Sl. No.	Family	Chikmagalur district	Sl. No.	Family	Chikmagalur district
1.	Agaricaceae	0.98293**	16.	Meruliaceae	0.56429
2.	Cantharellaceae	0.80566*	17.	Mycenaceae	0.86543
3.	Clavariaceae	0.84650	18.	Paxillaceae	0.97086
4.	Dacrymycetaceae	-0.0337	19.	Phallaceae	-0.36194
5.	Entolomataceae	0.13200	20.	Physalacriaceae	-0.09704
6.	Fomitopsidaceae	0.86416	21.	Pleurotaceae	-0.29383
7.	Ganodermataceae	0.24364	22.	Pluteaceae	0.16192
8.	Geastraceae	0.83430	23.	Polyporaceae	0.93821*
9.	Gomphaceae	0.80130	24.	Psathyrellaceae	0.49103
10.	Hydnangiaceae	0.79664	25.	Pyronemataceae	-0.02812
11.	Hygrophoraceae	0.69342	26.	Sarcoscyphaceae	0.91168*
12.	Hymenochaetaceae	0.86998	27.	Schizophyllaceae	0.23390
13.	Inocybaceae	-0.09872	28.	Strophariaceae	0.70525
14.	Lyophyllaceae	0.93450*	29.	Tricholomataceae	0.79695
15.	Marasmiaceae	0.97149*	30.		

* Significant 0.05 %; ** Significant 0.01 %

Table 5. Pearson correlation coefficient of macrofungal genera in Chikmagalur district

Sl. No.	Genera	Chikmagalur district	Sl. No.	Genera	Chikmagalur district
1.	*Abortiporus*	1	33.	*Leucoagaricus*	0.75823
2.	*Agaricus*	0.49486	34.	*Leucocoprinus*	0.58629
3.	*Antrodia*	0.76826	35.	*Lycoperdon*	-0.14098
4.	*Armillaria*	-0.02461	36.	*Lysurus*	-0.16284
5.	*Bjerkandera*	0.65707	37.	*Macrolepiota*	0.80566*
6.	*Bovista*	0.42256	38.	*Marasmius*	0.79787
7.	*Calocera*	-0.0337	39.	*Melanoleuca*	0.64065
8.	*Cantharellus*	0.80566*	40.	*Microporus*	0.75593
9.	*Chlorophyllum*	-0.04012	41.	*Mycena*	0.79645
10.	*Clavaria*	0.71219	42.	*Oudemansiella*	0.22030
11.	*Clavulinopsis*	0.26085	43.	*Panaeolus*	0.82919
12.	*Clitocybe*	0.81787	44.	*Paxillus*	0.97086
13.	*Collybia*	-1	45.	*Phallus*	-0.53134
14.	*Cookeina*	0.91168*	46.	*Pleurotus*	-0.29383
15.	*Coprinellus*	-0.19256	47.	*Pluteus*	0.161929
16.	*Coprinopsis*	0.89097*	48.	*Polyporus*	0.150434
17.	*Coprinus*	0.13200	49.	*Porodaedalea*	0.869982
18.	*Coriolopsis*	0.94279*	50.	*Psathyrella*	0.743252
19.	*Crinipellis*	0.97471**	51.	*Pycnoporellus*	0.144552
20.	*Cyathus*	0.90613*	52.	*Pycnoporus*	0.834348
21.	*Daldinia*	0.54663	53.	*Ramaria*	0.801306
22.	*Fomitopsis*	0.14329	54.	*Rhodocybe*	0.132004
23.	*Ganoderma*	0.24364	55.	*Schizophyllum*	0.233907
24.	*Geastrum*	0.83430	56.	*Scutellinia*	0.638913

Sl. No.	Genera	Chikmagalur district	Sl. No.	Genera	Chikmagalur district
25.	*Gloeoporus*	-1	57.	*Termitomyces*	0.942689*
26.	*Gymnopus*	0.82989	58.	*Trametes*	0.929818*
27.	*Hemimycena*	0.85424	59.	*Tricholomella*	0.538428
28.	*Hygrocybe*	0.69342	60.	*Tubaria*	-0.09872
29.	*Hypholoma*	0.70525	61.	*Vascellum*	0.997461***
30.	*Laccaria*	0.79664	62.	*Xeromphalina*	0.890978*
31.	*Lentinus*	0.19310	63.	*Xerula*	-0.41409
32.	*Lepiota*	0.83328	64.	*Xylaria*	-0.54664

* Significant 0.05 %; ** Significant 0.01 %; *** Significant 0.001 %

development in *Dictyophora cinnabarina* was found to be abnormal with the reduction in height of the sporocarp, length of inducium and many eggs did not open to give rise to receptacle. The species of *Xylaria polymorpha, Stereum ostrea, Daldina concentrica, Pycnocarpus cinnabarinus, Termitomyces* sp. and *Daedelopsis* sp. were observed because of climatic variation. Some macrofungi were found to be medicinally important (*Ganoderma lucidum, Cordyceps* sp.) few were edible (*Pleurotus, Termitomyces*) and some were poisonous. Some were found to be new to India. The culturing and chemical constituents of macrofungi investigation is under progress.

The present study was conducted from January 2007 to December 2011, is constituted first systematically. Long-term monitoring in Karnataka, although there were differences in species richness. The present study noticed species richness as well as number of sporocarps varied between years. The decrease in number of species and sporocarps from 2007 and 2011 may be due to a variation of weather conditions. A major problem for the accurate definition of macrofungal communities in a particular site is related to sporocarp production depending on weather conditions and the sporadic fruiting of species [24]. Finding species to be deleted in every subsequent sampling year from 2007 to 2011 is in agreement with other studies that recommended long-term monitoring to assess fungal species [25]. Highest fruiting bodies recorded (species and sporocarps) during the rainy season (July to October) and some fruiting in winter (November to February). This together with the correlation analysis, suggests that fruiting phenology of macrofungal species is directly related with weather conditions, especially with rainfall and relative humidity.

CONCLUSION

The present study conducted from January 2007 to December 2011, is first systematically constituted, long-term monitoring of macrofungi in Chikmagalur district. The contrasting patterns of macrofungal diversity are suggested to be a consequence of many macrofungal species, which is the result of fruiting of macrofungi, being unable to produce fruitbodies or to produce inconspicuous ones. Other explanations include large differences in reproductive and explorative strategies among macrofungi. In addition, the optimum fruiting conditions for some species may not have occurred during years. Despite these limitations, the current fruit body survey is still a useful way to assess the macrofungal diversity.

Among 90 macrofungi, 61 species were recovered during last year of study. Disappearance or loss of species was considered only based on visible fruitbodies and does not necessarily mean absence of mycelia of particular species in the habitat. Although, the loss of species cannot be revealed with precise lucidity, the field observation showed the disturbance in habitat was greatly affected by wood inhabiting species and human interference added to the loss of species in the study sites of Chikmagalur district.

Interpreting the results with ecological parameters has always remained a challenging task and the result has demonstrated that rainfall is statistically significant with available data and the information can be used as baseline for future prospects associated with climate change and conservation strategies owing to maintain the ecosystem health and stability. The information on common, threatened and rare macrofungi is very less in different parts of the country. Hence, the assessment and conservation of all macrofungal species has to be accomplished for local, state and national territories. The diversity,

distribution and development of macrofungi are definitely affected by the changing scenarios of the climate change. The scarcity of baseline data on the influence of climate change on fungal distribution has to be undertaken because of macrofungal interdependencies with other organisms. In this persuit, there is a need for long term monitoring of macrofungal species in Chikmagalur district for assessment of impact of ecological and other supporting parameters.

ACKNOWLEDGEMENTS

I thank Department of Science and Technology, New Delhi for the financial assisstance. I also thank DOS Botany, Kuvempu University for providing lab facilities. I thank macrofungi experts Miss. Swapna S and Mr. Syed Abrar for their marvelous help during field work and characterization of macrofungi. I also thank Prof. C. Manoharachary and Late Prof. Natarajan for their help.

REFERENCES

[1] Hawksworth DL. (2004). Fungal diversity and its implifications for genetic resource collections. *Studies in mycology.* 50: 9-18.

[2] Manoharachary C *et al*. (2006). Fungal biodiversity: Distribution, conservation and prospecting of fungi from India. *Current Science.* 89(1): 58-71.

[3] Bates SC. (2006). A preliminary checklist of Arizona macrofungi. *Canotia.* 2(2): 47-78.

[4] Smith AH. (1964). The Mushroom hunter's field guide, revised and enlarged. Ann Arbor: University of Michigan press.

[5] Ozturk C *et al.* (2003). Macrofungi of Alanya district. *Turk Journal of Botany.* 27: 303-312.

[6] Hunse TM. (2012). Ground water information booklet Chikmagalur district, Karnataka. Government of India, Ministry of Water Resources, Bangalore. http://cgwb.gov.in/District_Profile/karnataka/CHIKMAGALUR-BROCHURE. pdf. Accessed 17 September 2012.

[7] Metzler S and Metzler V. (1992) Texas Mushrooms. University of Texas press, Austin

[8] Lodge DJ *et al.* (1995). A Survey of Patterns of Diversity in Non-Lichenized Fungi, Mitt. Eidgenöss. Forsch. anst. *Wald SchneeLandsch.* 70: 157-173.

[9] Stojchev G *et al*. (1998). Some macrofungi species of European part of Turkey. *J Bot.* 22: 341–346.

[10] Kaya A. (2005). Macrofungi determined in Golbasi (Adiyaman) district. *Turk J Bot.* 29: 45–50.

[11] Fadime Y and Mustafa I. (2002).Macrofungi of degirmangobazy (Balikesir). *Turk J Bot.* 26: 161–164.

[12] Afyon A *et al*. (2005). A study of wood decaying macrofungi of the western black sea region Turkey. *Mycotaxon.* 93: 319–322.

[13] Dring DM. (1980). Contributions towards a rational arrangement of Clathraceae. *Kew Bulletin.* 35: 1-96.

[14] Largent DL. (1986). How to identify mushrooms to genus I: Macroscopic features. *Eureka*: Mad river press.

[15] Daniel ES. (1987). How to identify mushrooms to genus IV: Keys to families and genera. *Eureka*: Mad River Press.

[16] Pegler DN. (1977). A preliminary agaric flora of Eastern Africa. Kew Bull add Ser VI . Lubrecht & Cramer.

[17] Corner EJH. (1950). A monograph of *Clavaria* and allied genera. London:Oxford University press.

[18] Singer R. (1986). Agaricales in modern taxonomy 4thedn. Dehradun: Bishen Singh and Mahendra Pal Singh.

[19] Kornerup A and Wanscher JH. (1981). Matheun handbook of colours 3rdedn. London: Eyremetheun.

[20] Kirk PM *et al*. (2008). Ainsworth & Bisby's dictionary of the fungi 9thedn. UK: CAB International.

[21] Magurran A. (2004). Measuring biological diversity. Blackwell Publishing, Oxford, UK.

[22] Shannon CE and Weaver W. (1963). The mathematical theory of communications. University of Illinois press, Urbana.

[23] Simpson EH. (1949). Measurement of diversity. *Nature.* 163: 688.

[24] Ferris R *et al*. (2000). Macrofungal communities of low land Scot's pine and Norway spruce plantations in England: relationships with site factors and stand structure. *Forest Ecol Manag.* 131: 255–267.

[25] Dahlberg A *et al*. (1997). Species diversity and distribution of biomass above and below ground among ectomycorrhizal fungi in an old-growth Norway spruce forest in south Sweden. *Can J Bot.* 75: 1323–1335.