DIVERSITY AND DISTRIBUTION OF POLYPORES IN THE MOIST DECIDUOUS FORESTS OF PEECHI-VAZHANI WILDLIFE SANCTUARY, KERALA.

By

MUHAMMED IQBAL, A.
(2011 – 17 – 110)

THESIS

Submitted in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE IN FORESTRY

Faculty of Forestry
Kerala Agricultural University

DEPARTMENT OF FOREST MANAGEMENT AND UTILIZATION
COLLEGE OF FORESTRY VELLANIKKARA, THRISSUR- 680656
KERALA, INDIA

2015

DECLARATION

I hereby declare that this thesis entitled **"Diversity and distribution of polypores in the Moist Deciduous Forests of Peechi-Vazhani Wildlife Sanctuary, Kerala"** is a bonafide record of research done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, fellowship or other similar title, of any other University or Society.

Vellanikkara
21/2/15

MUHAMMED IQBAL, A.
(2011-17-110)

CERTIFICATE

Certified that this thesis, entitled **"Diversity and distribution of polypores in the Moist Deciduous Forests of Peechi-Vazhani Wildlife Sanctuary, Kerala"** is a record of research work done independently by **Mr. Muhammed Iqbal, A. (2011-17-110)** under my guidance and supervision and it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

Vellanikkara
21/2/15

Dr. K. Vidyasagaran
Chairman
Advisory committee

CERTIFICATE

We, the undersigned members of advisory Committee of **Mr. Muhammed Iqbal, A. (2011-17-110)** a candidate for the degree of **Master of Science in Forestry** agree that this thesis entitled **"Diversity and distribution of polypores in the Moist Deciduous Forests of Peechi-Vazhani Wildlife Sanctuary, Kerala"** may be submitted by him in partial fulfillment of the requirement for the degree.

21/2/15

Dr. K. Vidyasagaran
Dean
College of Forestry,
Kerala Agricultural University
Vellanikkara, Thrissur, Kerala-680656.
(Chairman)

21/2/15

Dr. E. V. Anoop
Associate Professor and Head,
Department of Wood Science
College of Forestry
Kerala Agricultural University
Vellanikkara, Thrissur, Kerala-680656.
(Member)

21.2.15

Dr. P. N. Ganesh
Associate Professor
Department of Botany
Sree Krishna College
Guruvayur
(Member)

21/2/15

Dr. S. Beena
Professor
Department of Plant Pathology
College of Horticulture
Kerala Agricultural University
Vellanikkara, Thrissur, Kerala-680656.
(Member)

EXTERNAL EXAMINER
Dr P. Manimohan
Professor of Botany
Calicut University

ACKNOWLEDGEMENT

With deep respect I express my heartful gratitude and unforgettable owe to my major advisor ***Dr K. Vidyasagaran****, Dean, College of Forestry, whose meticulous help, forbearance, affectionate advice, valuable guidance, constructive suggestions, unfailing patience, amiable support throughout the study period made my research work an easy task. I express my heartfelt and sincere thanks to him. I express my deep sense of gratitude to* ***Kerala Agricultural University*** *for extending financial and technical support for pursuance of my study and research.*

I take this opportunity to express my deep sense of gratitude and indebtedness to ***Dr P. N. Ganesh****, Associate Professor, Department of Botany, Sree Krishna College, Guruvayur for his valuable guidance, support, inspiration, critical advise, encouragement and friendly cooperation throughout the course of my research work. Words are not enough to express my gratitude and respect for him. I consider myself lucky to have him as my advisor and my teacher.*

I extend my wholehearted thanks to ***Dr E. V. Anoop****, Associate Professor and Head, Department of Wood Science, College of Forestry and member of advisory committee for his keen interest and valuable suggestions he has provided throughout the course of my study.*

I owe my sincere thanks to my advisory committee member ***Dr S. Beena****, Professor, Department of Plant Pathology, College of Horticulture, for her cooperation and intellectual advice extended to me during the course of my study.*

I am whole heartedly obliged to ***Dr P. O. Nameer****, Associate Professor and Head, Department of Wildlife Sciences* ***Dr S. Gopakumar****, Associate Professor, Department of Forest Management and Utilization* ***Dr A. V. Santhoshkumar****, Associate Professor and Head, Department of Tree physiology and Breeding,* ***Dr T. K. Kunhamu****, Associate Professor and Head, Department of Silviculture and Agroforestry,* ***Dr V. Jamaludheen****, Associate Professor, Department of Silviculture and Agroforestry,* ***Dr C. M. Jijeesh, Sri Shaji, M. Sri K. Srinivasan, and Sri Binu, N. K,*** *Assistant professors at College of Forestry, for kindly providing me valuable advice and various facilities for the conduct of the study. I take this*

opportunity to place on record of my sincere thank to ***Dr K. Sudhakara,*** *Ex-Dean, College of Forestry for his support during the study.*

I sincerely thank ***Dr Kiran Kumar Ranadive,*** *Assistant Professor, Waghire College, Pune,* ***Dr Nileesh Dhanukar,*** *Scientist, Indian institute of Science Education and Research, Pune, and* ***Dr Mallakarjuna Swamy,*** *Scientist , Kerala Forest Research Institute Special mention for providing me literatures and valuable suggestions during the various stages of study.*

I express my sincere gratitude to ***Sri Y. N. Shajikumar*** *and* ***Sri Viju Vargheese,*** *Wildlife Wardens at Peechi-Vazhani Wildlife Sanctuary,* ***Sri Jayachandran*** *and* ***Sri Sanalkumar*** *Assistant Wlidlife Wardens,* ***Sri Vinod,*** *Deputy Range Officer,* ***Sri Shiju, Sri Rathesh*** *Foresters for providing watchers during the strenuous field works. Special thanks to* ***Sri Chacko, Kunjachan, Venugopal*** *and* ***Mahendran*** *for helped in my field work.*

I am whole heartedly obliged to ***Sri Sharma,*** *Private Secretary to Minister for Labour and Rehabilitaion,* ***Dr Thampi*** *and* ***Sri Sanal Kumar*** *for help me in availing the leave from Rehabilitation Plantations Limited for the completion of my Masters Degree. I sincerely thank* ***Ayana*** *and* ***Pradeep*** *my colleagues at Rehabiliation Plantations Limited for their constant encouragement and valuable advices during my study.*

I am extremely thankful to my dear friends ***Ajeesh, Fredy, Arun Raj, Bunny, Sreehari. R, Vinu Jacob, Sharon, Hariprashanth, Vishnu, Anish, Ashish, Remya, Yeshma, Aswathy, Mobin, Sreejith, Harikrishnan, Sarath, Akhil.R. Nadh, Jishnu, Adarsh, Anand Mohan, Nithin, Meghna, Jismy, Aby, Kiran Mohan, Sreekumar*** *and* ***Jeffin Koshy*** *for their help during my field study and thesis preparation. My special thanks to* ***Mrs Seena, Mrs Resmi, Mrs Jyothi, M. Prasanth, Mr Nishad, Mr Madhu and Mr Saji*** *for their patience in helping me during my work.*

At this juncture, I am deeply indebted to my loving parents and family members for their splendid moral support and blessings.

Above all I bow my head to ***THE ALMIGHTY*** *whose blessings enabled me to undertake this venture successfully.*

MUHAMMED IQBAL, A.

Dedicated to my beloved teacher
Dr P. N. Ganesh

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

INTRODUCTION

1. INTRODUCTION

The tropical regions are endowed with diverse types of forest ecosystems that support unique assemblage of biotic communities including wood decaying polypores. Polypores are distinguished from other groups of fungi by their macroscopic basidiocarps with pores. They decompose coarse woody debris like fallen trunks, branches, twigs and stumps and play a pioneer role in ecosystem system functioning such as nutrient cycling and transport. The ability to break down the lignocelluloses that help in wood decomposition appears to be mainly restricted to basidiomycete fungi. Based on this unique functional role, they have been divided into white rot fungi and brown rot fungi. Thus, the ecological role of polypores as decomposers and their dependency on wood for existence have been made them to regard as good indicators of conservation value (Niemela, 2005).

In contrast with the autotrophic plant communities, the distribution of the heterotrophic fungal community will be regulated by their demand for food resources, which will naturally tend to be diverse in supply and of limited duration. This may lead to the noticeable distribution of species over space and time. Most of the polypore fungi are widely distributed in both tropical and temperate regions, although, some species are confined to specific ecological zones. In tropical forests, polypores occur in different habitat types and are found with higher frequency and diversity (Nogueira-Melo *et al.*, 2014). The presence and abundance of fruit bodies and its diversity can be used to determine the species composition and community structure of polypores.

The fruiting and development of sporocarps of polypores happen only when the environmental and ecological conditions are advantageous, but their mycelia exist on the substrate unobtrusively for long period. Environmental factors especially rainfall, ambient temperature and relative humidity play a role in

growth of polypores. Fungal fruiting is a seasonal event controlled by climatic factors.

Likewise, tree species diversity and greater variety of different wood resources provide a greater number of functional role for wood inhabiting polypore fungi in the tropical forests. High tree diversity in turn supports high polypore diversity with broad host ranges. Unlike in temperate forests, the host specificity of polypores and other wood-inhabiting basidiomycetes is widely considered to be low in tropical areas (Lindblad, 2000). Opportunity for specialization of polypores may decreases with increase of host diversity, even though they may show preferences towards potential host species. Polypore species infect a given host species in a density dependent manner and host species with higher density supported greater fungal diversity (Gilbert *et al.*, 2002).

Each woody substrate constitutes a dynamic habitat that the fungi can only utilize for a limited time of microclimatic optima or stage of decomposition. Thus, different types of woody substrates like dead standing tree, fallen trunk, roots, branches and twigs constitute discrete patches where both species richness and composition change substantially over time due to deterministic succession of species accompanying the wood decomposition. Moreover, some polypores normally inhabit only in living trees and as when the tree dies, they are replaced by fungi which are better adapted to saprophytic nutrition. Besides the stage of decomposition, the size of the log is also an important determinant for polypores species composition. Renvall (1995) noted that many threatened polypores have distinct preferences for large logs in intermediate stages of decay. Thus, species richness and abundance of polypores depend on the qualities and quantities of dead wood.

The proportion of studies of species richness in tropical forests dealing with fungi in general (studies of polypores are in turn only a fraction of this proportion) is seldom reported. The geographical features of Kerala with peculiar physiographic, edaphic and climatic gradient have contributed significantly to the development of diverse types of forest ecosystem and moist deciduous forests

have maximum extent in the state with 44 per cent of total forest area (Mohanan, 2011).

Research is needed to unravel the influence of various factors (deadwood size, host and decay class) on the species richness of polypore fungi in the moist deciduous forests of Kerala. With the available data on the taxonomic studies undertaken on polypore diversity in the natural stands of Kerala, it is difficult to conclude the effect of deadwood, decay-class and climatic influence on diversity and abundance. No comprehensive studies on the diversity and distribution of polypore fungi in Kerala have been undertaken. A detailed analysis of the polypore fungi and their host species as well as the substrate features will give a better picture of the distribution pattern of these fungi.

Peechi-Vazhani Wildlife Sanctuary is located in the Thrissur district of Kerala with moist deciduous forest as major vegetation type. The sanctuary experiences typical South-east monsoon every year, hence, by comparing the observations and findings on polypores across different climatic seasons in the study area, it will be possible to unearth crucial data on the distribution and occurrence of polypore fungi in the moist deciduous forest. With this background, the objectives are framed to study the diversity, distribution and host preference of polypore fungi in the moist deciduous forests of Peechi-Vazhani Wildlife Sanctuary in three different seasons.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Fungi are a diverse group of organisms that cannot manufacture their own food through photosynthesis and absorb nutrients from the surrounding environment. Within the fungal groups, polypores or wood decaying fungi are essential for the functioning of forest ecosystems. Polypores are Basidiomycetes bearing club-shaped basidia typically on the inside of the hymenium lining pores or cavities of tubes formed on the under surface of fruiting body. Generally, polypores are wood inhabiting and grow either on trees or on timbers, though some are found on soil.

The mycelium of polypores at first grows well, ramifying the wood tissues, absorbing nutrients after breaking the cell wall constituents by enzymatic activity resulting in decay. Most dangerous is the 'heart rot' which establishes itself in the heartwood and progress with time. The fruitbodies are very conspicuous as brackets, mushrooms or crusts on standing or fallen wood or branches of trees on which they grow. Based on the nature of rot formation, the wood decaying fungi (polypores) are classified into 'white rot' fungi that decompose all components of the wood including lignin and 'brown rot' fungi that decompose the cellulose and its associated pentoses, leaving the lignin more or less unaffected. In the first, wood is reduced to a white fibrous spongy mass while in the second it becomes a mass of roughly cubical pieces in varying shades of brown (Peace, 1962).

In Europe and North America, detailed studies on wood decaying fungi have been performed for a long time and many taxonomic monographs based on morphology have been published (Gilbertson and Ryvarden, 1986; 1987; Ryvarden and Gilbertson, 1993; 1994). After the introduction of molecular techniques in species identification, the phylogeny and taxonomy of wood decaying fungi were modified to a great extent (Hibbett *et al.*, 2007), and many higher-level taxonomic ranks were put forward or established (Binder *et al.*, 2010; Cui *et al.*, 2011). Comprehensive researches on wood decaying fungi have been

carried out in Europe and North America with much attention to their ecological pattern (Junninen and Komonen, 2011) pathogenic potential (Asiegbu *et al.*, 2005) and industrial application (Cohen *et al.*, 2002).

The detailed understanding of polypore community in the tropical moist deciduous forests can be revealed through various comprehensive investigations on its diversity and distribution. Several taxonomic studies have been undertaken in various parts of the country and a few on the ecological aspects.

2.1 SYSTEMATIC POSITION OF POLYPORES

Polypores consists of three families namely Ganodermataceae, Hymenochaetaceae and Polyporaceae. The family Ganodermataceae Donk is characterised by species with spores which are invariably double walled with an inner verrucose to ornamented, thickened and usually coloured wall over which there is a thin hyaline outer wall and this unique structure of the spore wall prompted Donk (1948) to establish this family. Cunningham (1965), based on the hyphal system and presence of clamps than on spore characters, included *Ganoderma* under the tribe Ganodermae, *Amauroderma* under the tribe Polyporae, both belonging to sub-family Polyporoideae and *Elfvingia* under the tribe Fomiteae, belonging to the sub-family Fomitoideae in Polyporaceae. *Elfvngia* was considered as a synonym of *Ganoderma* while recognising *Amauroderma*, *Ganoderma*, *Haddowia* and *Humphreya* as separate genera in the family Ganodermataceae (Ryvarden and Jonansen, 1980).

Hymenochaetaceae Donk is a family of polypores characterised by species having setae and or dark coloured context becoming irreversibly black in KOH solution and generative hyphae without clamps. Donk (1948) established this family emphasizing on the absence of clamps. The family Hymenochataceae as conceived by Donk (1964) consisted of three sub-families viz. Asterostromatoideae Donk., Hymenochaetoideae Donk and Vararioideae Donk with a total of eighteen genera. Pegler (1973a) also recognised eighteen genera in

Hymenochaetaceae, distributed in three sub families viz., Asterostromatoideae, Hymenochaetoideae and Vararioideae. However, all the genera in this Hymenochaetaceae are not the same as those of Donk (1964). In his key to world genera of polypores, Pegler (1973b) has accepted only 12 genera in Hymenochaetaceae.

The term polyporaceae has been used with different connotations varying from a diverse assemblage of poroid species to the family Polyporaceae sensu stricto, which includes only poroid genera not included in other families of Aphyllophorales. According to Donk (1964), poroid genera in the order Aphyllophorales are distributed in about ten families and Polyporaceae is only one among ten families. Several efforts have been made since early times to divide Polyporaceae into smaller families and one result of these efforts was that some members of this family were assigned to the *Agaricales* (Leelavathy and Ganesh, 2000). Some mycologists Fries (1825; 1874), Patouillard (1890) gave much importance to hymenial configuration. Polyporaceous genera with more or less lamellate hymenophore such as *Lenzities* and some of the tubulate genera such as *Favolus* (P. Beauv) Fr. were shifted to agarics. According to Overeem & Weese (1924) certain typical species of *Polyporus* sensu stricto were related to agarics. The relation of *Polyporus* sensu stricto to agaricales was also supported based on the observations on the similarity in hyphal system of *Pleurotus* (Fr.) P. Kumm. and *Polyporus squamosus* (Huds.) Fr. (Corner, 1953). Several authors (Locquin, 1957; Singer, 1962; Kriesel, 1969) have transferred *Polyporus* sensu stricto to Agaricales. Donk (1964) criticized these transfers on the ground that they were not based on redefinition of the generic and family characters and preferred to maintain the artificial family Polyporaceae in a broader sense among Aphyllophorales until better solutions were found. Taxonomic studies carried out by several authors (Pegler, 1973 a, b; Ryvarden and Jonansen, 1980; Gilbertson and Ryvarden, 1986) use the term Polyporaceae in the sense used by Donk (1964), and by interpreting the same definiton the term Polyporaceae has been used in this study also.

2.2 ADVANCEMENT IN TAXONOMIC STUDIES IN POLYPORES

Fries (1821) started taxonomic studies of polypores exclusively based on morphological characters of the basidiocarps like colour, surface, texture and hymenial configuration which are readily seen. By giving emphasis on the hymenial configuration and macromorphological characters of basidiocarps, eight genera of polypores have been recognized (Fries, 1874). Several mycologists such as Gillet (1878), Karsten (1881), Quelet (1886), Lloyd (1898-1925), Patouillard (1900), Murrill (1907; 1908) extensively studied on polypores mainly based on external characters of basidiocarps including hymenial configuration, surface features, consistency, colour of basidiocarps and growth form i.e., annual, biennial or perennial and established several genera of polypores.

Patouillard (1900) initiated the taxonomic studies based on micromorphological characters like hyphal characters, characters of basidia, basidiospores and cystidia in taxonomic study of polypores. Later the micromorphological characters got much emphasis on the studies by eminent taxonomists namely Rea (1922), Bourdot and Galzin (1928), Donk (1933), Pilat (1936-1942), Bondertzev and Singer (1941), Imazeki (1943), Imazeki and Toki (1954).

Corner (1932) proposed the concept of hyphal system and studied the sporophore of *Polystictus xanthopus* Fr. and demonstrated the presence of different types of hyphae inside the basidiocarp. Corner (1953) classified the hyphae into 3 basic groups namely, generative, skeletal and binding hyphae ; and further described when only generative hyphae are present in a basidiocarp as monomitic; when two types of hyphae are involved (generative and either skeletal or binding hyphae), it is called dimitic; with all the three types of hyphae, the basidiocarp is called trimitic. De (2011) reviewed that later workers studied polypores based on macromorphology, anatomical features, habit, type of rot produced and also introduced some bio chemical tests including xanthochroic tests, gum guaic test, amyloidy, dextrinoidy etc. If hyphae and basidiospores are

stained with Melzer's reagent and they become yellow, they are called in amyloid, if they dextrinoid if become reddish brown. An amyloid species cannot be grouped with a dextrinoid or an in amyloid one.

Nobles (1958) first introduced cultural characters to solve the taxonomic problems of polypores and showed that cultural characters and certain biological characters have great taxonomic value in studying polypores. Nobles (1958; 1964; 1971) found that the macroscopic features of cultures vary greatly among the species of polypores. Apart from all the corresponding micromorphological features of a species occurring in its basidiocarps are also produced in culture. Van der Westhuizen (1963; 1971), Roy and De (1980), De and Roy (1981) and many others conducted correlative studies on the morphological, cultural and certain biological characters such as the type of rot and type of sexuality of a species in taxonomic study based on Nobles (1958).

Bondartzeva (1961) studied macromorphological and micromorphological features of cultures of a large number of polypores along with oxidase test, sexuality and inter fertility tests and formulated a hypothesis that white rotter polypores possess tetra polar sexuality and positive result in oxidase tests while brown rotter ones possess bipolar sexuality and negative result in oxidase tests. In modern taxonomic studies, type of sexuality is regarded as an important character in segregation of genera (De, 2011).

Electrophoretic analysis of fungal proteins was considered to be rather promising for comprehensive systematic investigation. Studies conducted by (Gams and Julich, 1984; Kammerer *et al.*, 1985; Papa and Polini, 1987; Bielenin *et al.*, 1988) revealed that for the morphological revision of taxa, protein analysis offers an additional taxonomic criterion.

In modern fungal taxonomy, molecular systematics has been shown to be a valuable tool. Among various molecular methods including DNA-DNA hybridization, RFLP, and sequence analyses, phylogenetic analyses of amino acid or DNA sequences are known to have the highest resolving power. In solving

taxonomic problems and phylogeny of polypores Internal Transcribed Spacer (ITS) rDNA sequence data have been introduced (De, 2011). Binder and Hibbert (2002) conducted rDNA studies and inferred a close relationship of *Polyporus squamosus* and *Datronia mollis*. Dai *et al.* (2003) has been ascertained the North Eastern China and South Western China isolates of *Heterobasidion annosum* through DNA fingerprinting and found that they are actually *Heterobasidion parviporum* and *Heterobasidion annosum*, which were so far identified only from Altai region outside Europe.

2.3 POLYPORE STUDIES IN INDIA

European scientists have initiated the taxonomic studies of Indian polypores by the middle of the nineteenth century. The study conducted by Klotzsch (1832) seems to be the earliest report on Indian polypores and a total of four polypores have been described. Klotzsch (1833) has again conducted extensive studies on polypores and described 25 species from the Himalayan valleys. Berkeley (1839-1872) who reported a large number of polypores based on his study of Dr. Hooker's extensive collection of macro-fungi from Sikkim-Himalayas and Khasi hills.

The history of Indian polypores can be traced back through the studies of Cooke (1876,1881,1891a,b,c) who was receiving the fungal specimen at Kew and describing considerable numbers of Indian fungi, while at the beginning of 19th century Hennings (1900-01) studied the specimen collected by Gollan in the United Provinces, and Massee (1901,1906,1908,1910) began the series " Fungi Exotici" in the Kew Bulletin, which included descriptions of various Indian species. Theissen (1911) reported collection of Bombay fungi received from his colleagues.

Bose (1919-46) was the first Indian Mycologist who collected and studied the polypores on a comprehensive scale. He made collections mainly from Bengal and described 143 species including nine new species in a series of papers

"*Polyporaceae* of Bengal" I-XI. His contributions also includes studies on the distribution of polypores at high altitudes (Bose, 1935), the geographical distribution and history of polypores in Bengal (Bose, 1922 b), study of abnormal structures in some polypores (1937a, b; 1939) and cultural studies of *Ganoderma lucidum* and *Hexagonia discopoda* from spore to spore (Bose, 1929 a, b). Further, from his wide experience with polypores, Bose (1944) suggested the use of certain characteristic anatomical features in addition to the characters of basidia and spores for the specific identification of these fungi.

Sundaramani & Madurajan (1925) reported several members of Polyporaceae from Madras, and by 1925 there were more than 300 reports on the Aphyllophorales. Butler and Bisby (1931) made a compilation of the Indian fungi in their classic work "The Fungi of India" and brought together all the records of Indian fungi, which includes 293 polyporoid species in 16 genera.

Banerjee and Bakshi (1945) published a detailed account of the life history, cultural characters, geographical distribution, host plants and influence of several external factors of six wood-rotting polypores of Bengal. The work on polypores of Bengal was continued by Banerjee and co-workers (Banerjee and Chakravarthy, 1945; Banerjee and Chatterjee, 1945 a,b,c; Banerjee and Ghosh, 1942). Other contributions are the studies on polypores of Sikkim-Himalayas (Banerjee, 1946; Banerjee and Ghosh, 1945) and devising a simple method for producing typical sporophores of *Polystictus sanguineus* (Banerjee and Sinha, 1955).

Polypores and its forest pathological aspects were widely studied and acknowledged at Forest Research Institute, Dehradun during the midst of Twentieth century. The polypores causing diseases of chir pine and other economically important forest trees were studied by Bagchee and Bakshi (1950; 1951). Bagchee (1953) extensively studied the diseases and decays on forest trees and the notable works includes identification of a new and noteworthy disease of *Gmelina arbórea* due to *Poria rhizomorpha*, description on the biology of

polypores which attack Sal trees causing sap and heart-rot (Bagchee, 1954) and information on the biology and morphology of the pathogen, symptoms and progress of the disease (which particularly endangers frost-affected forests), and control measure of heart rot of Sal caused by *Trametes incerta* and *Fomes caryophylli* (Bagchee, 1958; 1961).

Major contributions of Bakshi and co-workers are their new reports of polypores on forest trees of Himalaya and South India (Bakshi, 1956; 1965), studies on diseases and decay of conifers with fungal pathology, cultural characters, and control measures (Bakshi,1955), diseases of *Acacia catechu* and its preventive measures (Bakshi, 1957a), heart rot in relation to management of *Shorea robusta* (Bakshi, 1957b), root-rot disease of Sal caused by *Polyporus shoreae* results in top dying and death of trees in North Bengal and Assam (Bakshi and Boyce, 1959), heart rot in *Cassia nodosa* due to *Polyporus palustris* (Bakshi and Singh, 1961) and studies on a disease-complex in teak (Bakshi *et al.*, 1966). An outstanding review on the species of fungi causing heart rot, establishment of heart-rot fungi (the effects of precursors, inhibitors, moisture and temperature, and resistance factors), progress of heart rot in tree stands, decay detection, estimation and control exposed the threat of wood decay and polypores (Bakshi and Sujan, 1970). Other important contributions include the studies on *Trametes, Poria* and *Fomes* (Balwant, 1961; 1966 a, b; Balwant and Bakshi, 1961; Puri, 1956), on polypores of Andamans (Sujan *et al.*, 1961) and Nicobar Islands (Sehgal *et al.*, 1961) and on the temperature relationships of Indian Polypores (Sehgal *et al.*, 1966). Bakshi (1971) in his monograph "Indian Polyporaceae (on trees and timber)", gave an account of 355 species of polypores belonging to 15 genera. Several polypores including some new species on various angiosperm and gymnosperm wood sources from Western-Himalaya and Mussoorie Hills were reported and described (Thind and Chatrath, 1957; 1960; Thind *et al.*, 1957; 1970; Thind and Dhanda, 1978; 1979 a, b, 1980; Thind and Rattan, 1971 a, b, c; Reid *et al.*, 1959).

Anatomical features of *Trametes cingulata, Daedalea flavida, Polyporus adustus, Polyporus anthelminticus, Hexagonia discopoda, Hexagonia sulcata* have been studied and published in series (Roy 1968 a, b; 1969; 1971; 1972; 1975; 1976). Studies with regard to the identification of polypores in culture has been initiated during the same period (Bakshi *et al.*, 1969; 1970) while the infertility of *Polyporus grammocephalus* and taxonomy based cultural and morphological characters of some other important polypores has been carried out (Roy, 1981a, b; Roy and De, 1977; 1979; 1980; De, 1977; 1981; De and Roy,1978; 1980;1981).

Rattan (1977) published a book entitled "The Resupinate Aphyllophorales of the North Western Himalayas". Natrajan and Kolandavelu (1985) studied resupinate Aphyllophorales from South India and reported 82 species belonging to 48 genera of these fungi from Tamil Nadu. Of these, 39 species were reported for the first time from India. A good piece of work was done by Sharma (1995) on "Hymenochaetaceae of India". The manual entitled "Polyporaceae of India" by Roy and De (1996) was based on exhaustive studies on fungi belonging to the family Polyporaceae collected from different parts of India during the preceding 40 years. Special efforts were taken to publish the book entitled "Genera of Indian Polypores" by Sharma (2000), who gave an idea about the diversity of polypores from India.

Swapna *et al.* (2008) investigated the diversity of macrofungi including polypores in Semi-Evergreen and Moist Deciduous forest of Shimoga district, Karnataka with diversity indices. A total of 778 species of macrofungi belonging to 43 families, 101 genera were enumerated of which 242 species were identified to genus level and 73 were identified to species level. This record includes 88 polypore species belonging to 63 genera under three families. The Shannon diversity index and Simpson index were calculated to be 5.57 and 1.12 in semi-evergreen forest, which indicates the very high species richness of the study site. In moist deciduous forest, the Shannon diversity index was 5.42 and the Simpson index of dominance was 0.011.

Taxonomy and diversity of *Ganoderma* spp. from Western Parts of Maharashtra has been studied by Bhosale *et al.* (2010). Only 9 valid species have been reported from India but they have reported 15 species of *Ganoderma* and 3 varieties of *G.lucidum*, of which one variety remains unidentified. The species are each described and the fruit bodies, spore and cutis are illustrated.

A check list giving complete Aphyllophorales diversity data from Western Ghats of Maharashtra State was prepared by Ranadive *et al.* (2011). This checklist listed 256 species of aphyllophoraceous fungi from Maharashtra State including 170 species from 10 poroid families and 86 species from 20 non-poroid families.

2.4 POLYPORE STUDIES IN KERALA

The polypore fungal studies in Kerala have been started after the midst of 20^{th} century. Rangaswamy *et al.*, (1970) compiled the list of fungi in his work "Fungi of South India". The list included 44 polyporoid species representing 13 genera of which only five species were from Kerala. Mohanan (1994) identified a total of 44 polypores belonging to 18 genera associated with decay of various tree species in Kerala. White-rot fungi were the most widespread in evergreen, semi-evergreen and wet-evergreen forests in Kerala. Altogether, 35 fungi were identified as causing white-rot in various tree species. Roy and De (1996) reported only six polypore species from Kerala in their work "Polyporaceae of India".

Leelavathy and Ganesh (2000) conducted extensive study on the polypores of Kerala and reported 73 species belonging to 26 genera under families Ganodermataceae, Hymenochaetaceae and Polyporaceae. This is considered to be an excellent taxonomical work which considered the polypore specimens from both forest and no forest areas. The entire study was published in a monograph "Polypores of Kerala".

A survey of macro fungi occurring in the Peechi-Vazhani Wildlife Sanctuary has been conducted for a period of three years (1995-1997) and six hundred macro fungal specimens were collected (Florence and Yesodharan,

2000). Macro fungi are represented by 57 species belonging to 37 genera. Out of this 35 species of polypores belonging to 24 genera were recorded.

A study was conducted to identify the polypores and rot type they cause in some selected tree species (*Albizia odoratissima, Bridelia retusa, Delonix regia, Peltophorum pterocarpum* and *Swietenia macrophylla*) of local significance in Kerala (Imrose *et al.*, 2005). Two wood decay causing fungi were isolated and identified *viz Hexagonia tenuis* and *Phellinus gilvus*. More recently Mohanan (2011) identified and described a total of 89 species of polypores belonging to 32 genera from different forest ecosystems of Kerala.

2.5 HOST ASSOCIATION OF POLYPORES

In the terrestrial ecosystems, plant communities are the primary autotrophic component and are therefore one of the key determinants of overall ecosystem composition, function and biodiversity, reflecting site environmental conditions. As a result vascular plants have been frequently tested as surrogate taxa for estimating the diversity of other poorly known and inaccessible taxa (Pharo *et al.*, 1999; Saetersdal *et al.*, 2004). In tropical forests tree diversity are known to high, and it has been suggested that this diversity may in turn support high fungal diversity (Lodge and Cantrell, 1995). In theory, the greater variety of different wood resources found in species rich forest should provide a greater number of functional role for fungal species. The relationship between plant diversity and fungal diversity, however, may not be linear. As host diversity increases, opportunities for specialization may diminish because the probability of successful colonization decreases as hosts become increasingly rare and in case of polypores, the abundance of host material is not just determined by the size and number of dead individuals, but also by the length of time dead trees remain undecomposed as the decomposition rates are particularly high in the tropical forest (Ferrer and Gilbert, 2003).

2.5.1 Role of forest types in polypore distribution

Studies on the ecology of polypores have been carried out worldwide, often focusing on a single forest type (Gilbert *et al.*, 2002; Hattori 2005; Yamashita *et al.*, 2009; Junninen and Komonen, 2011). From the available literature, little, if any, comparison among different forest zones has been performed. Each forest zone has its own special and relatively steady climate conditions that directly determine the diversity of animals, plants, fungi and other component species (Zhou *et al.*, 2011). Gilbert *et al.* (2008) reported that polypores abundant in mangrove forests were distinct from those in freshwater swamp forests suggesting that a unique mycobiota exists in mangrove forests. Hymenochaetaceae species, especially *Phellinus rimosus* and its allies, are important mangrove-inhabiting fungi in Central and South America and in Micronesia (Gilbert and Sousa 2002; Baltazar *et al.*, 2009 a, b).

Kuffer and Senn-Irlet (2005) studied the ecology of aphyllophoroid wood-inhabiting basidiomycetes in Switzerland showed a remarkably high species diversity of both saprophytes and mycorrhiza forming species. *Phlebiella vaga*, a saprophytic species, and *Amphinema byssoides*, a mycorrhizal symbiont, were the two most abundant species. The results shows that different biogeographical regions of Switzerland showed different pattern of fungal species richness: while the Plateau at lower altitudes was found to be rather rich, the Northern Alps and Central Alps, with the highest amount of forests cover, yielded less species. Although the Southern Alps exhibited the lowest species richness, this region harbours a specific species set.

Zhou *et al.* (2011) investigated the ecological patterns of polypores with respect to a boreal forest zone, a temperate and warm temperate forest zone, and a tropical and subtropical forest zone in China and found that the tropical and subtropical forest zone harboured the highest polypore diversity. He has discussed the ecology of polypores in detail that the temperate and warm temperate forest

zone showed a greater similarity of polypore diversity to the boreal forest zone than to the tropical or subtropical forest zone, although the representative areas of temperate and warm temperate forest and tropical and subtropical forest zones are geographically closer. The species number and proportion of brown rot polypores decreased from the boreal forest to tropical and subtropical forest zone by 22 and 21.8 per cent respectively. Fallen trunks were the most attractive substrate for polypores in all three zones, but the proportion of polypores on fallen trunks decreased from the boreal forest to tropical and subtropical forest zone by 20 per cent. Generally, these distinctions could be explained by the varied proportion of gymnosperm and angiosperm trees, as well as different substrate diversity in the three forest zones with different climatic conditions.

Carlos *et al.* (2012) analysed results of fungal biodiversity studies from some selected Colombian Amazon forests in relationship to plant biodiversity and successional stages after slash and burn agriculture. The results revealed that macrofungal diversity was found to differ between forests occurring in two regions as well as between flooded forests and non-flooded forests in the study area and also macrofungal biodiversity differed between regeneration states of different age. Suitable substrates, especially dead wood that occurred as a result of recent slash and burn agriculture, resulted in the formation of many sporocarps of wood-inhabiting species.

2.5.2 Host preference and specificity

Many polypores and other wood-inhabiting fungi show host specificity or preference, their distribution patterns are related to those of their host species in temperate to boreal areas (Hattori, 2005; Yamashita *et al.*, 2010). In Europe, nearly one-third of the polypores have preferences for certain tree genera and only a limited number of species occur on both coniferous and hardwood trees (Ryvarden and Gilbertson, 1993; 1994). In contrast to the high polypore diversity in the tropical forests, strong host specificity of polypores and other wood-inhabiting basidiomycetes is widely considered to be low (Lodge, 1997; Schmit,

2005) because the probability of successful colonization decreases, as host trees become rarer in these areas with high species richness.

The host range exploration of wood rotting fungi in a Neotropical dry forests of Costa Rica support the assumption that most wood rotting fungi have broad host ranges in tropical areas (Lindblad, 2000). Sporocarps of 82 species of poroid and stereoid wood-inhabiting fungi (Aphyllophorales) were recorded on 44 tree species and only three of the 32 species with three or more records showed signs of host tree specialization. One cause of specialization may be strong competition for resources from other species, forcing each to increase its competitive ability by mastering a narrower range of resources.

Likewise, Gilbert and Sousa (2002) found that in the mangrove forests on the Caribbean coast of Panama polypore assemblage was strongly dominated by host specialized species. The results showed that 77 per cent of the 66 testable fungal taxa (those present two or more occurrences) showed a significant degree of host specificity, infecting their most commonly used host species more frequently than expected by chance.

Saprobic species of polypores and other aphyllophoraceous fungi on fallen logs of trees in Pasoh Forest Reserve, a lowland rainforest of Malaysia were recorded (Hattori and Lee, 2003). The study shown that many of the repeatedly occurring polypores did not show a preference for any particular tree family; most common species in Pasoh, *Ganoderma australe* was recorded on 15 tree families, *Nigroporus vinosus* on 13 families and *Rigidoporus microporus* on 10 families.

Gilbert *et al.* (2008) however, revealed strong host preferences among some polypores on mangrove trees in Micronesia. Of the 11 testable fungal species, nine (81%) showed host preferences, and of those nine, all except *Microporus affinis* also showed either statistically significant within habitat host preferences or strong numerical biases toward single host species. Therefore the population density (40 mangrove species) of the main tree species in mangrove forest should

be relatively high because of the low tree species richness compared with those in other forest types in the tropics. Mangrove tree species with denser populations supported more host specific polypores species, while most of the abundant polypores were generalists.

The ecological determinants of fungal diversity on dead wood in European forests were analysed (Kuffer *et al.*, 2008). The regression tree analysis for the host tree species shows two main groups of hosts: coniferous and deciduous trees. The results of this study revealed that the similarity within the fungal species inhabiting deciduous tree species is higher than within the fungal species inhabiting conifer tree species. Besides it was discussed that fungal species growing on coniferous wood had more time to evolve independently, than species growing on broadleaf wood, simply due to the older evolutionary age of coniferous trees (Strasburger *et al.*, 1991). Additionally, with the exception of *Abies alba* the different deciduous trees occupy more often the same habitats than the coniferous species and form more frequently common vegetation units (Ellenberg and Klötzli, 1972). However, Bieri *et al.* (1992) have also observed this pattern with the agaricoid fungal species, both in the saprophytic and the mycorrhizal species.

Yamashita *et al.* (2010) detected host specificity of fungal species at species and population level in broadleaf forest in cool temperate area of Japan. In that study five of the dominant wood-inhabiting fungal species were recorded only on oak and chest nut trees. Among them *Hymenochaete rubiginosa*, *Piploporous soloniensis*, *Xylobolus frustulatus* are completely restricted to *Quercus* and *Castanea*. *Fomes fomentarius* occurred frequently on *Fagus* spp. at the study site have also been reported from other temperate regions without beeches and suggested that its host preference on beeches is limited to the population level.

In Northeast China, occurrence and distribution of wood decaying fungi was studied to understand the preference pattern of wood decaying fungi on gymnosperm and angiosperm trees (Zhou and Dai, 2012). It has been derived that

similarity of polypore communities associated with gymnosperm trees was significantly higher than that associated with angiosperm trees; either of the similarities was significantly higher than that between the two tree groups.

Host specificity study on some wood rotting fungi in Western Ghats region of Maharashtra showed that the host trees belongs to wide range of Angiosperm families of economic importance were infected with wood rotting fungi (Vishal *et al.*, 2012). Out of 108 wood rotting specimens collected, 94.45 per cent were grown exclusively on dicotyledonous host whereas; only 5.55 per cent were grown on monocotyledone family. Also some infection of *Polyporous xanthopus* on live trunk of *Terminalia bellerica*, *Fomes albomarginatus* and *F. Fomentarius* with extensive colonization, dissolution and disintegration has been observed for first time.

A study based on thorough Indian literature survey concluded that *Phellinus* spp. has wide host range throughout the country and no specificity or preference was observed (Ranadive *et al.*, 2012). About 51 plant families shows infection of Phellinus spp. and amongst all families, genera of Caesalpiniaceae were found to be most susceptible, followed by Euphorbiaceae, Fabaceae, Mimosaceae, Rubiaceae, Sapindaceae, Moraceae and Myrataceae.

Imrose *et al.* (2005) studied the decay characteristics of polypores on some selected tree species of local significance in Kerala and observed signs of host preference. *Hexagonia tenuis* was found attacking the wood of all the five selected tree species. On the other hand, *Phellinus gilvus* was found attacking only *Peltophorum ferrugineum* timber.

Prevalence of decay and decay fungi were recorded from the sample plots selected in the evergreen, semi-evergreen and wet-evergreen forests of Kerala (Mohanan, 1994). *Fomitopsis palustris*, *Hexagonia sulcata* and *Rigidoporus lineata* exhibited restricted occurrence and narrow host range, while *Fomitopsis*

dochmius and *F. rhodophaeus* showed wide host range and widespread distribution.

2.5.3 Influence of substrate characteristics on polypore diversity

The substrate utilization by polypores has been shown to be critical for the species assemblage in the temperate forests (Kruys *et al.*, 1999; Norden *et al.*, 2004; Kuffer *et al.*, 2008; Juutilainen *et al.*, 2011). This research has shown that species vary in their preferences regarding the features of substrate they colonize in nature. Similar studies undertaken in Tropical forest shows that substrate features are determinant in the occurrence and preference of polypores (Hattori and Lee, 2003; Yamashita *et al.*, 2009).

Substrate size is an important factor that determines the occurrences of wood-inhabiting fungi occur on trees. Studies have shown that these fungi have different preferences for substrate diameter. Bader *et al.* (1995) suggested that log size significantly influenced total species number, number of threatened species, number of species per log, as well as the hymenial surface area per log. A positive correlation has been observed between the percentage of logs with fruit bodies and the diameter of logs and which in turn justifies the theoretical aspect that a large log is also able to collect more spores and to function as a substratum for fruit bodies over a longer period of time than a small log.

Lodge (1997) shows that almost all decomposer fungi were restricted to one or at most two similar types of substrata at El Verde in the Luquillo Mountains of Puerto Rico. Substrata were divided into the following classes: logs (> 10 cm diameter), branches (> 1 cm to 10 cm), twigs (< 1 cm), leaves (including petioles), roots, and soil. Some of these fungi might have appeared to be restricted to particular substrata because they were only collected once or a few times, but they often had opportunities to colonize other types of substrata that were in contact with their own.

The quantity and quality of dead Norway spruce trees and wood inhabiting cryptogams in a managed boreal forest landscape in northern Sweden has been surveyed (Kruys *et al.*, 1999). The results shows that size of dead trees are related to the substrate usage pattern of wood-inhabiting fungi, red-listed fungal species and locally rare fungal species show a marked preference for utilizing large diameter spruce dead wood.

In lowland rainforests in Malaysia, *Coriolopsis retropicta*, *Megasporoporia* sp., *Microporus xanthopus*, and *Trametes mimetes* are mostly restricted to twigs or small trunks (<10 cm in diameter), whereas *Ganoderma australe*, *Phellinus lamaensis*, and *Rigidoporus microporus* occur mostly on larger substrates (Hattori and Lee, 2003; Yamashita *et al.*, 2009) and these species are considered important decomposers of coarse woody debris in that ecosystem.

Norden *et al.* (2004) investigated the relative importance of coarse (diameter >10 cm) and fine woody debris (1–10 cm) for fungi in broadleaf forests in southern Sweden. The numbers of species per unit wood volume and per forest area were significantly higher for fine than for coarse woody debris for both ascomycetes and basidiomycetes.

The fine-scale ecological determinants for wood-inhabiting aphyllophoroid basidiomycetes were investigated with statistical analyses of the occurrence of fruit bodies on woody debris collected in Switzerland and Ukraine (Kuffer *et al* ., 2008). Substrate diameter has been considered as one of the descriptors along with degree of decomposition and host tree species. Analysis revealed the importance of very small sizes, which were not reported in the literature so far: the relevant diameter class limits were about 0.72 cm and 1.35 cm. This brought new insights on the ecology of many wood-inhabiting aphyllophoroid Basidiomycetes.

Urcelay and Robledo (2009) examined the relationship between log diameter and number of basidiocarps and volume of the fructification (as

surrogate of biomass) of the polypore community in Andean Alder forests from Northwest Argentina. The results have shown a positive relationship between log diameter and basidiocarp production in the whole community analysis and this pattern was also followed by dominant species (*Bjerkandera adusta, Trametes cubensis* and *T. versicolor*) which were analyzed individually. The relationship was generally higher for volume of fructification than for number of basidiocarps. Through these effects on basidiocarp production, higher log diameter could promote higher sexual spore production and dispersal hence a higher genetic variability and viable populations of wood-decay species.

The effect of tree diameter on establishment, diversity and richness of Bracket fungi in Golestan province forest, North of Iran have been studied (Rostamian and Kavosi, 2013). Results indicated that fungi establishment increased by increasing the trees diameters, and the stand trees with more than 80 cm diameter and fallen trees with more than 40 cm diameter have more bracket fungi than other trees. The consideration of richness with Margalef Index, indicated the most richness in diameter class >80 cm of stand trees and 40 cm of fallen trees. The examination of relationship of host trees diameter class with bracket fungi diversity indicated that there is significant difference between diameter class and bracket fungi diversity in 99 per cent reliance level, comparison of bracket fungi diversity in stand and fallen trees characterized that there is significant difference between bracket fungi diversity in stand and fallen trees.

A detailed study on coniferous forest sites in central Finland, in the south boreal zone addressed the question whether or not the traditional methodology to survey only coarse woody debris provides accurate estimates of the assemblages of wood-inhabiting fungi or the dead wood itself by including all dead wood pieces irrespective of the diameter (Juutilainen *et al.*, 2011). The results showed that the chosen minimum size of studied dead wood pieces has crucial importance for species recordings of wood-inhabiting fungi and for recording the number of dead wood items in boreal forests.

2.5.4 Importance of substrate decay class in polypore establishment

Among the variables related to the quality of dead wood, decay gradient has been identified as the strongest factor (Lindblad, 1998; Renvall, 1995). Compared to the diameter of woody substrate, the decay class is more subjective measure and therefore, decay class or decay stage has been measured in different studies. In decay class studies generally a hump-shaped trend has been observed with more species at the intermediate decay stages than at the early or the final stages (Bader *et al.*, 1995; Lindblad, 1998; Kruys *et al.*, 1999; Hattori and Lee, 2003; Junninen *et al.*, 2007; Jonsson *et al.*, 2008; Yamashita *et al.*, 2009).

In Norway spruce (*Picea abies*) forests in the boreal zone of Sweden, most of polypores seem to be associated with specific decay stages (Bader *et al.*, 1995). The most common species in the study site, *Trichaptum abietinum*, appeared to be associated with early stages of decay but did not show a preference for any particular diameter class. Compared with the threatened species, T. *abietinum* seems to be much more of a generalist. Another species, *Phellinus nigrolimitatus*, found particularly on highly decayed logs and is possibly a good indicator of continuity in the supply of large and highly decayed logs for total polypore assemblage.

Substrate utilization by wood-inhabiting fungi on dead Norway spruce trees in northern Sweden observed similar patterns in the utilization of decay classes by red-listed and frequent species (Kruys *et al.*, 1999). Both species groups show an increased utilization of intermediate to late decay classes, but red-listed species exhibit this pattern much stronger. This seems natural as most wood-inhabiting species have certain preferences regarding substrate quality and intermediate to late decay classes seem to provide a heterogeneous substrate. However, Lindblad (1998) surveyed the patterns of wood decaying fungi as to occurrence of sporocarps on naturally fallen logs of Norway spruce (*Picea abies*) in two nearby forest stands with different histories of management. The importance of dead wood for species diversity of wood inhabiting fungi was clearly demonstrated.

Presence of logs in later stages of decomposition increased the total species number in a natural forest stand compared to a survey of only newly fallen and weakly decayed logs. Presence of logs in later stages of decomposition also increased the diversity of the species pool colonising newly fallen and weakly decayed logs. The highest number of fruiting species was found on intermediately decayed logs and on logs lying in contact with the ground.

Many species in tropical forest also showed preferences for substrates at certain decomposition stages. Among the common species in lowland rainforests of Malaysia, *Cyclomyces tabacinus*, *Earliella scabrosa*, *Ganoderma australe*, *Microporus affinis*, and *Rigidoporus microporus*, were the first to appear during the early decomposition stages on substrates within 2 years after tree fall; these were followed by *Abundisporus fuscopurpureus*, *P. lamaensis*, and *Tinctoporellus epimiltinus* (Hattori and Lee 2003; Yamashita *et al.*, 2009). Similarly, *Antrodiella* spp., *Nigroporus vinosus*, *Postia* spp., and *Tyromyces* spp. occurred frequently on softened logs at later decomposition stages (Hattori and Lee, 2003).

Jonsson *et al.* (2008) studied the colonization and extinction patterns of wood-decaying fungi on Norway spruce forests in Sweden and illustrated the importance of life-strategies adopted by species that are present during different stages of wood decomposition. Early colonizers were primarily affected by the stage of decomposition; secondary colonizers were affected by a variety of within patch and/or between patch variables, maintaining high species coexistence within intermediate stages of decay.

2.6 SEASONAL EFFECTS ON POLYPORE DIVERSITY

Fungal fruiting is a seasonal event that depends on climatic factors, especially temperature and rainfall. High rainfall and mild temperatures in summer are normally considered to favour the formation of basidiocarps by the fungal mycelium (Arnolds, 1981). Numerous researchers have tried to find direct relations between fungal fruiting and climatic fluctuations. It has been revealed

that an important condition is a wet period after a dry period (Becker, 1956; Heim, 1969), and that excess water in the soil hinders production of fruiting bodies (Bujakiwicz, 1969). Karim *et al.*, (2013) found that some species of agaric fungi are known to live in canopies of rain forests, but fruiting may be rare and confined to the wet season and the disturbances from seasonal changes in rainfall and tree falls to hurricanes can differentially affect fungal species. In case of epiphyllous fungi similar influence by climatic factors has been observed in Panama (Hutton and Rasmussen, 1970). The results revealed that 8 of the 23 species they sampled had no epiphyllous fungi in common between the rainy and dry seasons and 10 plant species had only one epiphyllous fungus common to both seasons and was explained that epigeous sporocarp productivity greatly increases after the first rains of fall; many species produce sporocarps only during fall (Richardson, 1970).

Aragon *et al.* (2007) listed out various interactive factors that comes into play, before and during the autumn fruiting period, environmental (rainfall, air and soil temperatures, evapotranspiration, relative humidity, and water deficits or excesses), silvicultural (tree species, stand age, density and distribution, canopy cover), ecological (community composition, competitive interactions, reproductive strategies), landscape (altitude, aspect, slope) and anthropogenic (timber removal, controlled burns, wildlife management, grazing, introduced species).

Diversity of macrofungi in different Brazilian mangroves has been analyzed to find out the relationship between diversity, precipitation and area of collection. The results indicated that overall abundance and species richness did not vary significantly among areas, but varied according to time, being higher during the rainy season (Nogueira-Melo *et al.*, 2014). In Amazonian Forests, Gibertoni (2008) found that the composition of polyporoid fungi species was different in the rainy than in the dry season. This indicates that rainfall is a factor that influences the occurrence of species and species similarity. However, Drechsler-Santos *et al.* (2010) observed in caatinga (semi-arid region) in Northeast Brazil that rainfall did

not influence the occurrence of species of Hymenochaetaceae, mostly found in living hosts. The reason was explained that this is probably because they do not depend on environmental humidity as they are adapted to moisture hosts and fruit body is mostly perennial and woody types.

The study on relationships between morphological and ecological characteristics, climate factors and time of fruiting of annual short-lived basidiomycete fungi found a significant relationship between spore size and climate factors. It was hypothesized that the relationship is owing to water balance optimization, driven by water storage in spores as a critical factor for successful germination of primary mycelia in the drier micro environments found earlier in the fruiting season and/or in continental climates (Kauserud *et al.*, 2011).

Reviewing the literature, it was noted that studies regarding the influence of seasonal variations, role of substrate features and decay class on the diversity and distribution of polypores tropical forests was negligible compare to the temperate forests. The literature cites only few studies with respect to the host specificity and diameter class preference of polypores in tropical forests. Hence the present study is aimed to explore the above mentioned aspects and thus would be helpful in determining the ecological and functional role of polypores in tropical ecosystems.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

3.1 STUDY AREA

3.1. 1 Name, location and extent

Peechi-Vazhani Wildlife Sanctuary lies within the geographical extremes of latitudes10° 26'N and 10° 40'N and longitudes 76° 15'E and 76° 28'E in Thrissur District, Kerala State (Fig. 1). The sanctuary was established in 1958. The total extent of the sanctuary is 125 km^2 and it is contiguous with the forest areas of Nelliampathy and Palapilly forest reserves. The tract is bounded by portion of Bharanipachamala Reserve on the north; Moodal, Kuthiran, Vazhukkumpara Reserve, and areas of Paravattanimala Reserve on the south; and Machad Mala Reserve on the east and west.

3.1.2 Terrain

The terrain of the sanctuary is highly rugged and hilly; it is undulating with the altitude ranging from 45 m to 900 m above Mean Sea Level. The highest peak in the sanctuary is Ponmudi.

3.1.3 Climate

The sanctuary is blessed with copious rain, good sunlight and hot and humid weather.

3.1.3.1 Rainfall

The sanctuary receives showers from both northeast and southwest monsoons. Pre-monsoon showers are often received in the month of April. Southwest monsoons bring in precipitation from June till September. Heavy showers associated with thunderstorms are common. Northeast monsoons bring reasonable rains during October-November. Annual average precipitation in the sanctuary is 3000 mm (Table 1).

3.1.3.2 Relative Humidity

Mean relative humidity varies from 50 per cent to 91 per cent and attains maximum during the rainy season (Table 1).

3.1.3.3 Temperature

The sanctuary enjoys salubrious weather with cooler days during November to January and hotter days from February to May. The hilltops are relatively cooler when compared to the plains owing to altitudinal effects. Annual mean maximum temperature recorded is 39.4°C and mean minimum temperature is 21.3°C (Table 2).

3.1.3.4 Wind

The wind blowing through the Palakkad gap of the Western Ghats has a desiccating effect and causes heavy leaf fall, resulting in accumulation of combustible organic debris on the forest floor inducing forest fires.

3.1.4 Geology, Rock and Soil

The main geological formation is the metamorphic gnesis series. On the lower tracts, it tends to become lateritic. There are considerable extents of rocky blanks consisting of sheet rocks in the region. The ground is often very bouldery, chiefly in the deciduous areas. Oxisol or red ferrallitic soil, originated from weathering of crystalline rocks like granite, gneisses and charnockites. Surface soil is generally sandy loam in texture while the subsurface soil is loamy. Initial stages of laterization are observed where the soils are devoid of vegetal cover and erosion is active.

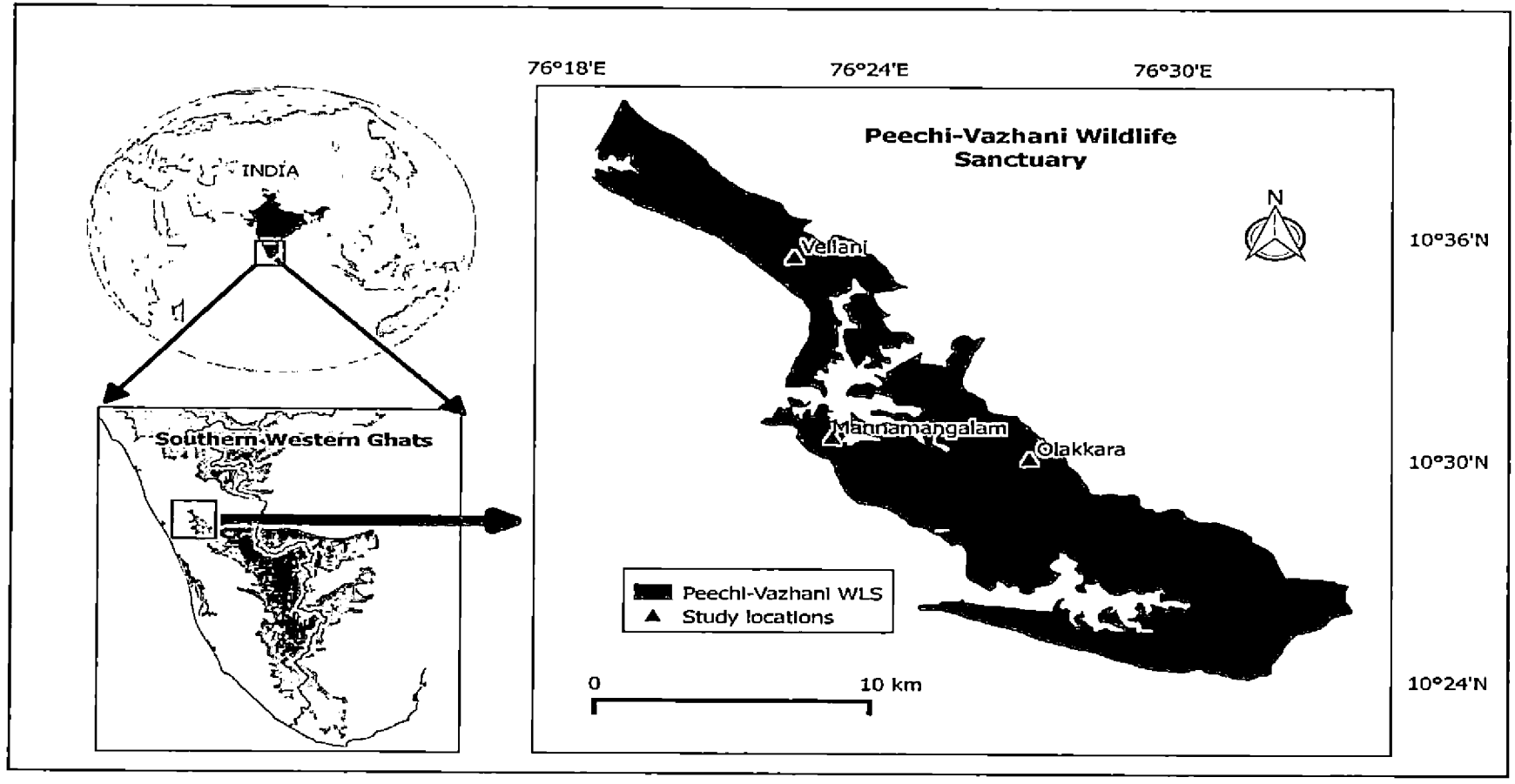


Fig. 1 Location map of the study area in Peechi-Vazhani Wildlife Sanctuary

Table 1. Average rainfall and relative humidity (Agro meteorology Station, Vellanikkara, KAU)

Month	Average Rainfall (mm)				Average Relative humidity (%)			
	2011	2012	2013	2014	2011	2012	2013	2014
January	0	0	0	0	58.0	58.0	52.0	51.0
February	77.5	0	84.4	6.0	55.0	54.0	57.0	56.0
March	10.0	3.5	14.6	0	64.0	67.0	64.0	55.0
April	207.1	101.9	0	61.0	73.0	73.0	71.0	73.0
May	198.5	117.3	99.1	323.6	77.0	76.0	77.0	77.0
June	799.6	551.5	1031.8	469.8	89.0	85.0	90.0	85.0
July	588.2	375.8	932.3	768.0	88.0	85.0	91.0	87.0
August	713.0	616.5	305.9	599.8	87.0	86.0	89.0	87.0
September	435.2	191.8	344.1	215.1	85.0	83.0	85.0	82.0
October	193.0	145.6	369.8	224.6	78.0	77.0	83.0	81.0
November	240.0	46.7	82.0	85.3	68.0	69.0	73.0	72.0
December	2.4	19.8	0.5	9.6	62.0	58.0	61.0	65.0

Table 2. Mean maximum and mean minimum temperature (Agro meteorology Station, Vellanikkara, KAU)

Month	Mean Max. Temperature (°C)				Mean Min. Temperature (°C)			
	2011	2012	2013	2014	2011	2012	2013	2014
January	32.7	32.8	34.1	32.9	22.2	21.3	22.3	23.0
February	33.7	35.1	34.7	34.7	22.0	22.1	23.3	22.9
March	34.8	35.2	35.4	36.7	23.9	24.2	24.4	24.2
April	34.3	34.7	34.9	35.3	24.5	24.8	25.1	25.7
May	33.0	32.6	33.6	33.2	24.9	25.3	25.2	24.2
June	29.3	30.1	28.5	30.9	23.6	23.9	22.7	24.4
July	29.1	30	28.4	29.5	22.5	23.7	22.7	23.1
August	29.4	29.2	29.9	29.5	22.9	23.0	22.9	23.2
September	30.0	30.4	30.0	31.3	23.1	23.3	22.2	23.2
October	31.1	32.1	30.8	31.9	23.5	23.5	22.6	23.7
November	31.4	32.5	32.6	31.6	22.9	22.4	23.9	23.2
December	31.9	33.0	31.9	31.9	21.9	23.2	22.3	22.5

Plate 1. Dead standing tree affected with *Fomitopsis feei*

Plate 2. Dead wood in the study plot

3.1.5 Vegetation

The sanctuary provides excellent habitat to moist deciduous, semi-evergreen, riparian as well as evergreen forests. Major portion of the sanctuary, nearly 80 per cent, is moist deciduous forest, 15 per cent is evergreen and semi-evergreen and the remaining five per cent is under teak and soft wood plantations.

Evergreen forests are found in higher slopes of the sanctuary and in patches at some places amidst moist deciduous forests. The dominant species found are *Pallaquium ellipticum, Cullenia exarillata, Mesua ferrea, Canarium strictum* and some canes and reeds. Semi-evergreen type of forests is restricted to valleys and moist pockets. The dominant species are *Artocarpus hirsutus, Toona ciliate, Hopea parviflora, Mangifera indica* and *Vitex altissima.* Moist deciduous type of forests is an intermediary stage between semi evergreen and dry deciduous forests. These forests are predominated by tree species like *Dalbergia latifolia, Xylia xylocarpa, Terminalia elliptica, Terminalia paniculata, Dellenia pentagyna* and *Lagerstroemia lanceolata.*

3.2 POLYPORE FUNGAL SAMPLING

3.2.1 Sample plots

Three permanent fixed size sample plots of 100m×100m were established in three different locations viz. Vellani, Mannamangalam and Olakkara sections of the sanctuary as per the methodology of earlier fungal studies (Yamashita *et al.*, 2010; Mohanan, 2011). Also subplots of 10mx10m were fixed in each permanent plot for detailed diversity analysis. The sample plots were visited during pre-monsoon, monsoon and post monsoon periods for the documentation of polypores including collection of sporocarps, labelling, rot character identification, taking photographs and recording macromorphological description and details of substratum in the Illustrated Data Sheet. A total area of 30,000 m^2 was surveyed in each of the three climatic seasons. The species recorded from the sample plot

Plate 3. Fungal collection and dead wood examination in the study area

Plate 4. Micromorphological study of polypores

only were considered for the diversity parameter analysis. Additional collection of polypores was also made from "off plots" in the study area. Thus, a combination of opportunistic and plot-based survey was carried out to maximize the documentation of polypore diversity and distribution. All the trunks and branches were enumerated using standard equipments. The decay stages of the logs were determined according to a 5-grade scale (based on decay classification system of Pyle and Brown, 1998).

3.2.2 Specimen collection and identification

The polypore specimens collected from the study area were kept in paper bags and brought to the lab. The specimens were properly air dried or oven dried and stored in polythene zip-cover under less humid conditions. The specimens were identified based on their macro and micro morphological features. The identification key provided by Bakshi (1971) and Leelavathy and Ganesh (2000) were used for the confirmation of polypore species. The micromorphological characteristics of the polypores were drawn with the help of camera lucida. Some of the specimens were compared with those in the Herbaria at Kerala Forest Research Institute, Peechi. All the specimens collected during the study period were catalogued and kept under less humid conditions in the Department of Forest Management and Utilization, College of Forestry at Kerala Agricultural University (Appendix 1).

3.2.3 Mycosociology

The polypore community has been quantitatively analyzed for their abundance, frequency, density and their relative values as similar to vegetation studies (Curtis and McIntosh, 1950). In order to determine the quantitative relationship between the polypore species, the following parameters were used. (Each basidiocarp is considered as an individual)

1. $Density\ (D) = \frac{\text{Number of individuals}}{\text{hectare}}$

2. *Relative density (R. D)* $= \frac{\text{Number of individuals of the species x 100}}{\text{Number of individuals of all spec ies}}$

3. *Abundance (A)* $= \frac{\text{Total no.of individuals of the species}}{\text{No.of quadrats of occurrence}}$

4. *Frequency (F)* $= \frac{\text{No.of quadrats of occurrence}}{\text{Total No.of quadrats of studied}}$

5. *Percentange Frequency (PF)* $= \frac{\text{No.of quadrats of occurrence x 100}}{\text{Total No.of quadrats of studied}}$

6. *Relative Frequency (R. F)* $= \frac{\text{Percentage frequency of individual species x 100}}{\text{Sum percentage frequency of all species}}$

3.2.4 Polypore fungal diversity

In addition to the quantitative analysis, the diversity of polypores was calculated using Shannon-Weiner and Simpson indices as similar to plant species diversity measurements (Magurran, 1988). The following formulae have used for determine the diversity of polypores.

1. a. Simpson Index, $D = 1 - \sum (n_i / N)^2$ (Simpson, 1949)

Where,

n_i – Number of individuals of the species

N – Total number of individuals in the plot

D- Diversity

b. Concentration of dominance, $Cd = \sum (n_i / N)^2$

2. a. Shannon-Weiner's index, $H' = 3.3219 (\text{Log } N - 1/N \sum n_i \log n_i)$

(Shannon and Weiner, 1962)

Where,

n_i – Number of individuals of the species

N – Total number of individuals

S- Total number of species

b. $H_{max} = 3.3219 \log_{10} S$

Where, H_{max} is the maximum dispersion taking into account the number of species present in the plot.

c. Equitability (E) = H'/ H_{max}

3.2.5 Sorenson similarity index

Similarity of each polypore community was calculated by the following equation:

QS= 2c/ a+b

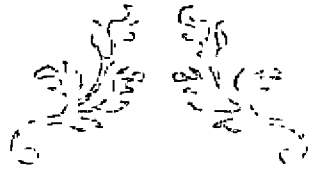
Where a and b represent the species numbers occurring in two different plots, and c, the species occurring in both plots (Sorenson, 1948).

3.2.6 Decay class analysis

The decay stage of the substrate was determined according to a 5-grade scale based on decay classification system of Pyle and Brown (1998).

3.2.7 Statistical Analysis

Llinear regression analysis was done in PAST 3.04 and Principal Component Analysis (PCA –Bi plot) and Correspondence Analysis were done in version 16.6.04 of XLSTAT 2014.



RESULTS

4. RESULTS

The study on diversity and distribution of polypores in Peechi-Vazhani Wildlife Sanctuary, Thrissur, Kerala was carried out during the period of 2012-2014. The results obtained from the study are explained below.

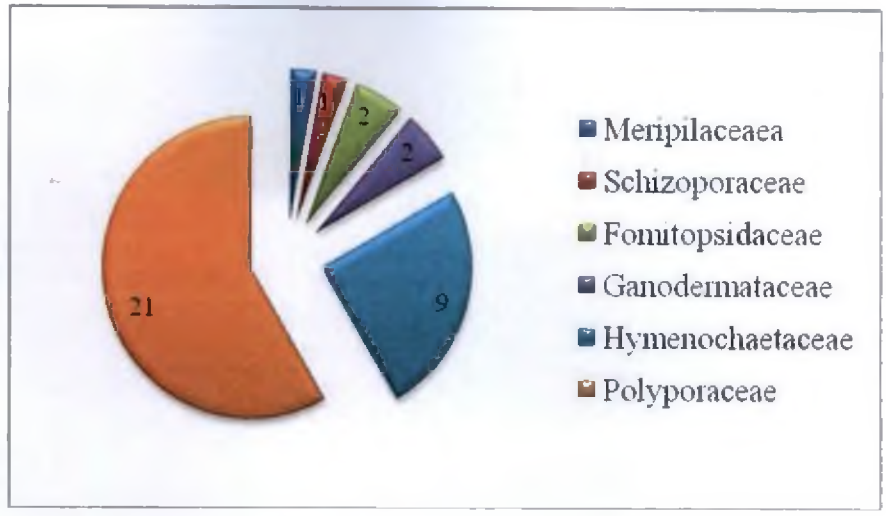
4.1 Species composition of polypores in Peechi-Vazhani Wildlife Sanctuary

An opportunistic sampling was carried out along with the plot based sampling in order to maximize the documentation of polypore distribution. The list of polypores identified is given in Table 3. A total of 36 polypore species in 21 genera belonging to six families were recorded. The family-wise, rot-wise and habit-wise distribution of polypores was also analyzed (Fig. 2). Out of the six families, Polyporaceae comprised of 21 species and Hymenochaetaceae consisted of 10 species while Ganodermataceae and Fomitopsidaceae consisted of two species each and Meripilaceae and Schizoporaceae comprised of one species each. Among the polypores recorded, 26 species were annuals and perennials were represented by ten species only. The rot characteristics of the polypores were also identified; the white rot polypores have significant dominance over brown fungi. Within the species list, 34 polypores were identified as white rotting and only two species were brown rotting.

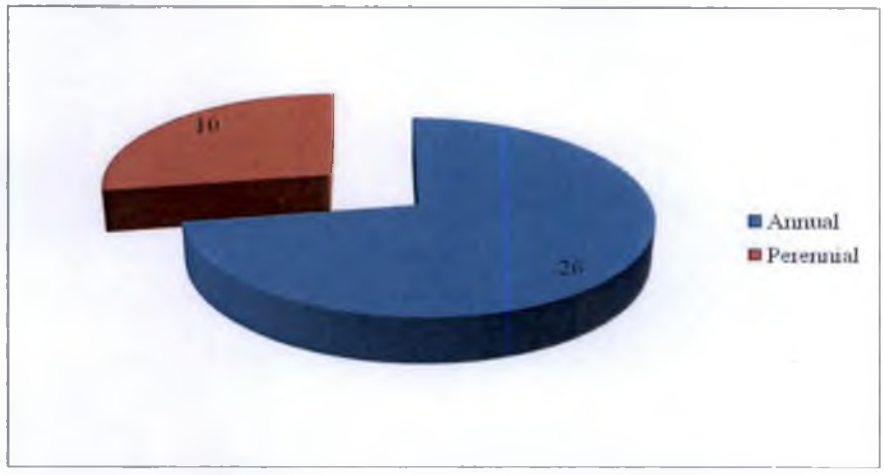
Table 3. Species composition of polypores in Peechi-Vazhani Wildlife Sanctuary

Sl.No	Species	Family	Habit	Rot type
1	*Coriolopsis sanguinaria* (Klotzsch) Teng.	Polyporaceae	Annual	White
2	*Coriolopsis telfarii* (Klotzsch) Ryvarden	"	"	"
3	*Daedalea flavida* Lev.	Fomitopsidaceae	"	"
4	*Datronia mollis* (Sommerf.) Donk	Polyporaceae	"	"
5	*Earliella scabrosa* (Pers.) Gilb. & Ryvarden	"	"	"
6	*Fomes psuedosenex* (Murrill) Sacc. & Trotter	"	Perennial	"
7	*Fomitopsis feei* (Fr.) Kreisel	Fomitopsidaceae	Annual	Brown
8	*Fulvifomes nilgheriensis* (Mont.) Bondartseva & S. Herrera	Hymenochaetaceae	Perennial	White
9	*Fuscoporia gilva* (Schwein) T. Wagner & M. Fisch.	"	Annual	"

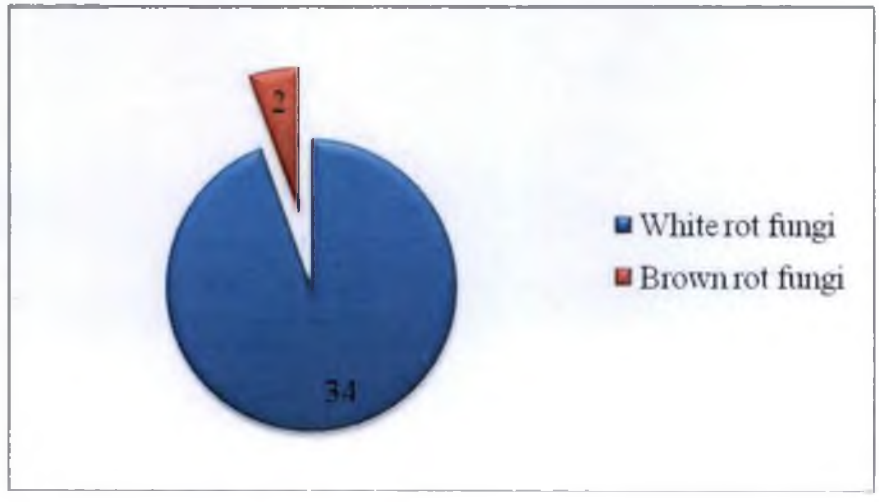
Sl.No	Species	Family	Habit	Rot type
10	*Fuscoporia senex* (Nees & Mont.) Ghobad-Nejhad	Hymenochaetaceae	Perennial	"
11	*Ganoderma australe* (Fr.) Pat.	Ganodermataceae	Annual	"
12	*Ganoderma lucidum* (Curtis.) P. Karst.	Ganodermataceae	"	"
13	*Hexagonia tenuis* (Hook.) Fr.	Polyporaceae	"	"
14	*Inonotus luteoumbrinus* (Romell) Ryvarden	Hymenochaetaceae	Perennial	"
15	*Melanoporia nigra* (Berk.) Murrill	Polyporaceae	"	Brown
16	*Microporus affinis* (Blume & T. Nees) Kuntze.	"	Annual	White
17	*Microporus xanthopus* (Fr.) Kuntze.	"	"	"
18	*Microporellus obovatus* (Jungh.) Ryvarden	"	"	"
19	*Nigroporus vinosus* (Berk.) Murrill	"	"	"
20	*Oxyporus mollissimus* (Pat.) D. A Reid	Schizoporaceae	"	"
21	*Phellinus dependens* (Murrill) Imazeki	Hymenochaetaceae	Perennial	"
22	*Phellinus fastuosus* (Lev.) S. Ahmad	"	"	"
23	*Phellinus ferrugineo-velutinus* (Henn.) Ryvarden	"	"	"
24	*Phellinus gilvoides* (Petch) Ryvarden	"	"	"
25	*Phellinus punctatus* (P. Karst) Pilat	"	"	"
26	*Polyporus arcularius* (Batsch) Fr.	Polyporaceae	Annual	"
27	*Polyporous dictyopus* Mont.	"	"	"
28	*Polyporus grammocephalus* Berk.	"	"	"
29	*Polyporus virgatus* Berk. & M. A Curtis	"	"	"
30	*Pycnoporus cinnabarinus* (Jacq.) P. Karst.	"	"	"
31	*Rigidoporus lineatus* (Pers.) Ryvarden	Meripilaceae	"	"
32	*Trametes cingulata* Berk.	Polyporaceae	"	"
33	*Trametes cotonea* (Pat. & Har.) Ryvarden	"	"	"
34	*Trametes hirsuta* (Wulfen) Lloyd	"	"	"
35	*Trametes lactinea* (Berk.) Sacc.	"	"	"
36	*Trametes marianna* (Pers.) Ryvarden	"	"	"



Family-wise



Habit-wise



Rot- wise

Fig. 2 Distribution of polypores in Peechi-Vazhani Wildlife Sanctuary

Coriolopsis sanguinaria

Coriolopsis telfarii

Daedalea flavida

Datronia mollis

Earliella scabrosa

Fomes psuedosenex

Plate 5. Polypore species recorded from Peechi- VazhaniWildlife Sanctuary

Fomitopsis feei

Fulvifomes nilgheriensis

Fuscoporia gilva

Fuscoporia senex

Ganoderma australe

Ganoderma lucidum

Plate 6. Polypore species recorded from Peechi-Vazhani Wildlife Sanctuary

Hexagonia tenuis

Inonotus luteoumbrinus

Melanoporia nigra

Microporellus obovatus

Microporus affinis

Microporus xanthopus

Plate 7. Polypore species recorded from Peechi-Vazhani Wildlife Sanctuary

Nigroporus vinosus

Oxyporus mollissiums

Phellinus dependens

Phellinus fastuosus

Phellinus ferrugineo-velutinus

Phellinus gilvoides

Plate 8. Polypore species recorded from Peechi-Vazhani Wildlife Sanctuary

Phellinus punctatus

Polyporus arcularis

Polyporus dictyopus

Polyporus grammocephalus

Polyporus virgatus

Pycnoporus cinnabarinus

Plate 9. Polypore species recorded from Peechi-Vazhani Wildlife Sanctuary

Rigidoporus lineatus

Trametes cingulata

Trametes cotonea

Trametes hirsuta

Trametes lactinea

Trametes marianna

Plate 10. Polypore species recorded from Peechi-Vazhani Wildlife Sanctuary

4.1.1 New records of polypores

During the present study, two species namely *Pycnoporus cinnabarinus* (Jacq.) P. Karst. and *Datronia mollis* (Sommerf.) Donk were found to be new records from South India and these species have been described based on the macro-morphology and micro-morphology.

4.1.1.1 *Pycnoporus cinnabarinus* (Jacq.) P. Karst.

Revue Mycologique Toulouse 3 (9): 18 (1881)

Boletus cinnabarinus Jacq., Flora Austriaca 4: 2, tab. 304 (1776)
Coriolus cinnabarinus (Jacq.) G. H. Cunn., Bull. N. Z. Dep. Industr. Res. 75: 8 (1948)
Fabisporus cinnabarinus (Jacq.) Zmitr., Mycena 1 (1): 93 (2001)
Hapalopilus cinnabarinus (Jacq.) P. Karst., Finlands Basidsvampar (11): 133 (1899)
Leptoporus cinnabarinus (Jacq.) Quél., Enchiridion Fungorum in Europa media et praesertim in Gallia Vigentium: 176 (1886)
Phellinus cinnabarinus (Jacq.) Quél., Flore mycologique de la France et des pays limitrophes: 395 (1888)
Polyporus cinnabarrinus (Jacq.) Fr., Systema Mycologicum 1: 371 (1821)
Polystictus cinnabarinus (Jacq.) Cooke, Grevillea 14 (71): 82 (1886)
Trametes cinnabarina (Jacq.) Fr., Summa vegetabilium Scandinaviae 2: 323 (1849)
Trametes cinnabarinus (Jacq.) Fr., Summa vegetabilium Scandinaviae 2: 323 (1849)

Fruit body annual, pileate, sessile, arising in small gregarious groups, sometimes solitary, imbricate, attached with a converging slightly broad base, dimidate to flabelliform, slightly conchate, sometimes marginally lobed, lobes overlapping, slightly tough when dry, 6-9 x 4-5x 1-1.5 cm. Pileus surface uneven, almost radially rugose, azonate, reddish grey to dark yellowish orange, grayish

yellow towards margin, shiny, glabrous, margin darker, round and undulating. Pore surface uneven, brick red to burned brick red, sometimes darker; pores visible to naked eye, round to angular rarely daedaloid towards margin, pores up to margin, 3-4 mm; dissepments thinner towards pore mouth; context brick red to reddish orange, uniform, 5-12 mm thick, darker in KOH; pores arising in uniform or wavy layer, up to 5 mm long, concolourous with the context.

Hyphal system trimitic; generative hyphae thin-walled, seldom branched, with clamps, 2-3(4) µm thick; binding hyphae yellowish, slightly thick-walled, branched, rarely septate, 4-6 µm thick; skeletal hyphae yellowish, long, reddish encrustations with broad lumen, unbranched, 6-8 µm thick; detached proterospores (chlamydospores) hyaline, thick-walled, without ornamentation, almost uniformin size and shape; 10x 8 µm; basidia and spores not observed (Fig. 3).

Decay: - White rot with scattered reddish patches in wood.

Specimen examined: - On decaying logs of *Dillenia pentagyna* (Dilleniaceae).

4.1.1.2 *Datronia mollis* (Sommerf.) Donk

Persoonia 4 (3): 338 (1966)

Daedalea mollis Sommerf., Supplementum florae lapponicae: 271 (1826)
Trametes mollis (Sommerf.) Fr., Elenchus Fungorum 1: 71 (1828)
Polyporus mollis (Sommerf.) P. Karst., Bidrag till Kännedom av Finlands Natur- och Folk 25: 280 (1876)
Antrodia mollis (Sommerf.) P. Karst., Meddelanden af Societas pro Fauna et Flora Fennica 5: 40 (1879)
Daedaleopsis mollis (Sommerf.) P. Karst., Finlands Basidsvampar (11): 135 (1899)
Cerrena mollis (Sommerf.) Zmitr., Mycena 1 (1): 91 (2001)
Trametes serpens Fr., Summa vegetabilium Scandinaviae 2: 324 (1849)

Trametes serpenti Fr. (1849)

Polyporus sommerfeldtii P. Karst. (1878)

Polyporus sommerfeltii P. Karst., Meddelanden af Societas pro Fauna et Flora Fennica 5: 53 (1879)

Daedalea lassbergii Allesch., Berichte des Botanischen Vereins Landshut 11: 23 (1889)

Fruit body annual, resupinate, slightly reflexed, leathery, 5-40 x 2-6 x 0.02-0.05 cm. Pileus surface creamy white to salmon to reddish yellow, slightly zonate , glabrous towards margin, margin smooth, thick and rounded. Pore surface uneven, yellowish red, sometimes slightly brownish, shiny; pores visible to naked eye, round to angular, sometimes daedaloid towards margin, sometimes daedaloid in centre portions, often confluent, pores absent towards margin, 3-4 per mm, dissepiments thinner towards pore mouth; context uniform, yellowish red, 0.2-0.4 cm thick pores arising in uneven sequence.

Hyphal system trimitic; generative hyphae thin-walled, branched, with clamps and seldom branched, 2-3 µm thick; binding hyphae yellowish, thick walled, closely branched, with a narrow lumen, 2.5-4 µm thick; skeletal hyphae yellowish, long, unbranched, thick-walled, with a narrow lumen, 4-6 µm wide. Basidium broadly clavate, 4-spored, 20 x 6 µm; sterigmata up to 2 µm long, encrusted cystidia present, hyaline, slightly thick walled, encrustations from half length upwards, 15-20x 8-10 µm. Basidiospores oval, hyaline, 6.5-7.5 x 3.5-4.5 µm (Fig. 3).

Decay: - White fibrous rot.

Specimen examined: - On decaying logs of *Xylia xylocarpa* (Mimosoideae).

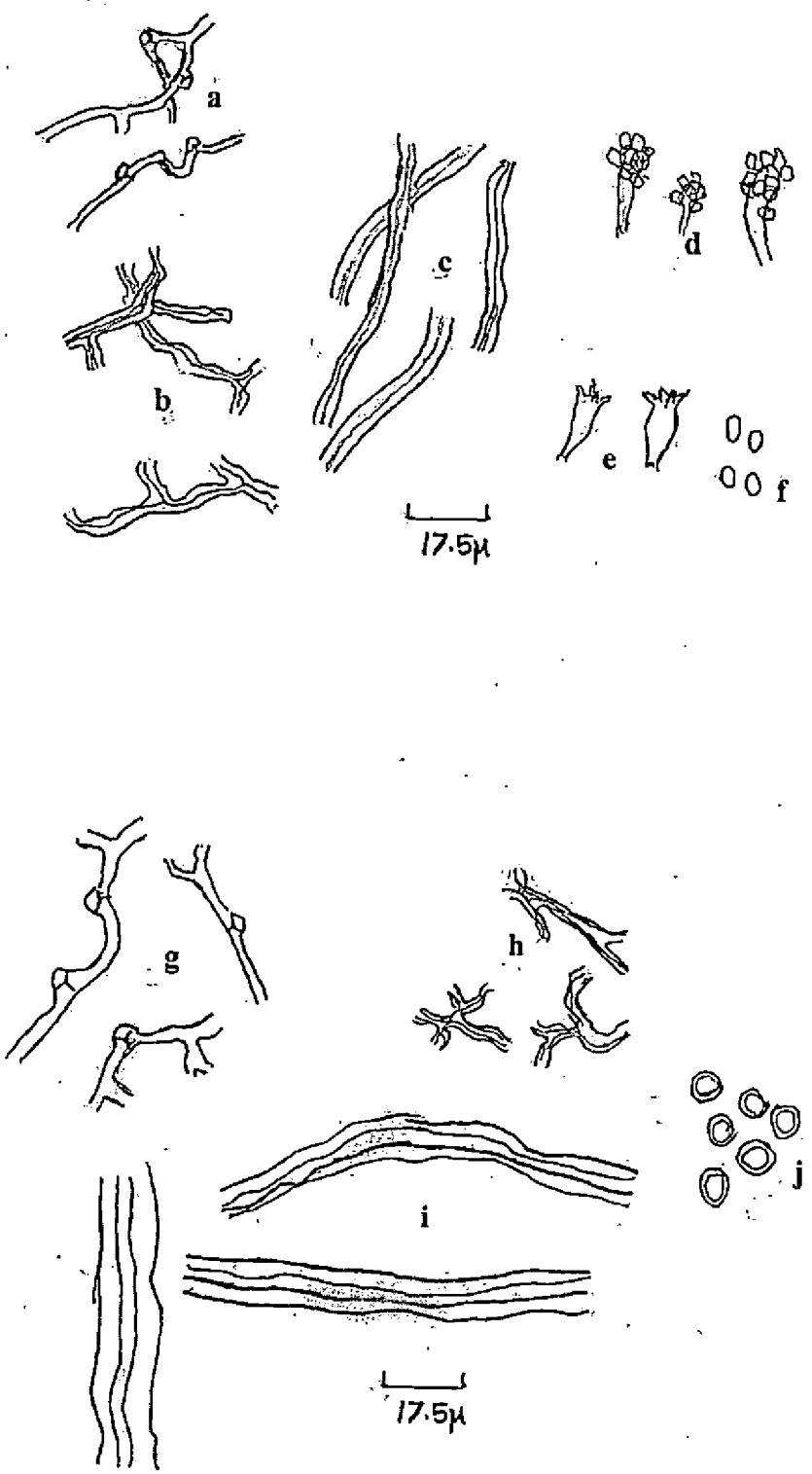


Fig. 3 Micromorphology of *Datronia mollis* (Sommerf.) Donk and *Pycnoporus cinnabarinus* (Jacq.) P. Karst.

Datronia mollis (a-f), a: generative hyphae ; b: binding hyphae; c: skeletal hyphae; d: cystidia; e: basidia; f: basidiospores.

Pycnoporus cinnabarinus (g-j)- g: generative hyphae; h: binding hyphae; i: skeletal hyphae; j: proterospores

4.2 Community structure of polypores

4.2.1 Abundance, Density and Relative density of polypores during different seasons

4.2.1.1 Pre monsoon period

During the pre-monsoon period, a total of 227 individuals of polypores per hectare belonging to 13 different species were recorded over the sampling area of 30,000 m^2 (Table 4). The structural analysis of polypore community indicated that *Daedalea flavida* had maximum relative density (24.08 %) followed by *Fuscoporia gilva* and *Microporus affinis* (13.80 % and 10.28 %). Lowest value was recorded for *Fuscoporia senex* (1.91 %). High abundance was recorded for *Daedalea flavida* (10.93) followed by *Fuscoporia gilva* (10.44) and *Fomitopsis feei* (9.50). Lowest abundance was represnted by *Trametes cotonea* (5.33).

4.2.1.2 Monsoon period

A total of 648 individuals of polypores per hectare representing 20 species were recorded (Table 5). Structural analysis indicated that *Fomitopsis feei* recorded the highest relative density (22.79 %) followed by *Daedalea flavida* (12.45 %) and *Trametes cotonea* (9.47 %). Lowest value was recorded for *Polyporus virgatus* (0.15 %). Out of 21 species *Fomitopsis feei* recorded the highest abundance (17.72) followed by *Daedalea flavida* (14.24) and *Trametes cotonea* (13.14). Lowest value was recorded for *Polyporus virgatus* (3.00).

Table 4. Abundance, Density and Relative density of polypores during pre-monsoon period

Sl.No.	Fungal species	Abundance	Density	Relative Density
1	*Daedalea flavida*	10.93	55	24.08
2	*Fomitopsis feei*	9.50	6	2.79
3	*Fulvifomes nilgheriensis*	8.20	14	6.02
4	*Fuscoporia gilva*	10.44	31	13.80
5	*Hexagonia tenuis*	8.75	12	5.14
6	*Melanoporia nigra*	9.00	6	2.64
7	*Microporus affinis*	7.78	23	10.28
8	*Microporus xanthopus*	8.00	21	9.40
9	*Nigroporus vinosus*	6.00	6	2.64
10	*Phellinus dependens*	7.63	20	8.96
11	*Fuscoporia senex*	6.50	4	1.91
12	*Trametes cotonea*	5.33	11	4.70
13	*Trametes hirsuta*	7.57	18	7.78
	Total	**105.64**	**227**	**100.00**

Table 5. Abundance, Density and Relative density of polypores during monsoon period

Sl.No.	Fungal species	Abundance	Density	Relative Density
1	*Daedalea flavida*	14.24	81.00	12.45
2	*Earliella scabrosa*	11.45	42.00	6.48
3	*Fomitopsis feei*	17.72	148.00	22.79
4	*Fulvifomes nilgheriensis*	9.00	15.00	2.31
5	*Fuscoporia gilva*	12.10	40.00	6.22
6	*Ganoderma lucidum*	13.00	9.00	1.34
7	*Hexagonia tenuis*	6.50	13.00	2.01
8	*Melanoporia nigra*	6.50	4.00	0.67
9	*Microporellus obovatus*	7.89	50.00	7.72
10	*Microporus affinis*	7.00	33.00	5.04
11	*Microporus xanthopus*	11.00	33.00	5.09
12	*Nigroporus vinosus*	2.67	3.00	0.41

Contd...

Sl.No.	Fungal species	Abundance	Density	Relative Density
13	*Phellinus dependens*	7.56	23.00	3.50
14	*Fuscoporia senex*	6.50	4.00	0.67
15	*Polyporus arcularius*	13.00	4.00	0.67
16	*Polyporus grammocephalus*	9.00	27.00	4.17
17	*Polyporus virgatus*	3.00	1.00	0.15
18	*Trametes cingulata*	10.33	31.00	4.78
19	*Trametes cotonea*	13.14	61.00	9.47
20	*Trametes hirsuta*	11.43	27.00	4.12
	Total	**193.03**	**648.00**	**100.00**

4.2.1.3 Post monsoon period

During this period, a total of 815 individuals of polypores per hectare belonging to 22 species were recorded (Table 6). Structural analysis during post-monsoon period showed that *Fomitopsis feei*, an annual polypore with highest relative density (26.50 %). Relative density recorded for *Daedalea flavida* and *Trametes cotonea* were 11.94 per cent and 8.34 per cent respectively. Lowest value was recorded for *Polyporus virgatus* (0.12 %).

Highest abundance during post monsoon season was recorded for *Fomitopsis feei* (13.78). The abundance value for *Daedalea flavida* and *Trametes cotonea* were 12.69 and 12.00 respectively. Lowest abundance value was recorded for *Polyporus virgatus* (3.00).

Table 6. Abundance, Density and Relative density of polypores during post-monsoon period

Sl.No.	Fungal species	Abundance	Density	Relative Density
1	*Coriolopsis sanguinaria*	11.00	7.00	0.90
2	*Coriolopsis telfarii*	12.50	8.00	1.02
3	*Daedalea flavida*	12.70	97.00	11.94
4	*Earliella scabrosa*	11.00	48.00	5.85
5	*Fomitopsis feei*	13.79	216.00	26.50
6	*Fulvifomes nilgheriensis*	6.86	16.00	1.96
7	*Fuscoporia gilva*	10.25	41.00	5.03
8	*Ganoderma lucidum*	10.00	10.00	1.23
9	*Hexagonia tenuis*	4.57	11.00	1.31
10	*Melanoporia nigra*	4.50	6.00	0.74
11	*Microporellus obovatus*	12.25	65.00	8.02
12	*Microporus affinis*	6.64	31.00	3.80
13	*Microporus xanthopus*	7.06	38.00	4.62
14	*Nigroporus vinosus*	5.40	9.00	1.10
15	*Phellinus dependens*	6.82	25.00	3.07
16	*Fuscoporia senex*	4.33	4.00	0.53
17	*Polyporus arcularius*	9.00	6.00	0.74
18	*Polyporus grammocephalus*	7.85	34.00	4.17
19	*Polyporus virgatus*	3.00	1.00	0.12
20	*Trametes cingulata*	9.82	36.00	4.42
21	*Trametes cotonea*	12.00	68.00	8.34
22	*Trametes hirsuta*	10.27	38.00	4.62
	Total	**191.61**	**815.00**	**100.00**

4.2.2 Percentage frequency and Relative frequency of polypores during different seasons

4.2.2.1 Pre-monsoon period

Distribution of polypores during the pre-monsoon period indicated the maximum relative frequency for *Daedalea flavida* (18.75 %) followed by *Microporus affinis* (11.25 %), *Fuscoporia gilva* (11.25 %), *Microporus xanthopus* (10 %) and *Phellinus dependens* (10 %). The lowest relative frequency value of

2.5 per cent was recorded for three species namely *Fomitopsis feei*, *Melanoporia nigra* and *Fuscoporia senex* (Table 7). In terms of percentage frequencies *Daedalea flavida* topped the figures with 5 per cent and lowest value was represented for three species namely *Fomitopsis feei*, *Melanoporia nigra* and *Fuscoporia senex* with 0.67 per cent.

4.2.2.2 Monsoon period

During the monsoon period, the distribution pattern of polypores showed a remarkable change with high percentage frequency and relative frequency values for *Fomitopsis feei* (8.33 % and 14.29 %). *Microporellus obovatus* and *Daedalea flavida* recorded relative frequency values of 10.86 per cent and 9.71 per cent respectively (Table 8).The lowest relative frequency was observed with *Polyporus arcularius* and *Polyporus dictyopus* (0.57 %). Percentage frequency values recorded for *Microporellus obovatus* and *Daedalea flavida* were 6.33 per cent and 5.67 per cent respectively and lowest value was recorded for *Polyporus arcularius* and *Polyporus dictyopus* (0.33 %).

4.2.2.3 Post monsoon period

The relative frequency worked out during the post-monsoon period indicated the maximum value for *Fomitopsis feei* (19.58 %) followed by *Daedalea flavida* (9.58 %) and *Trametes cotonea* (7.08 %). The lowest value of 0.42 per cent was recorded for *Polyporus virgatus* (Table 9). In terms of percentage frequency, *Fomitopsis feei*, *Daedalea flavida* and *Trametes cotonea* topped the figures with values 15.67 per cent, 7.67 per cent and 5.67 per cent respectively and the lowest value was observed with *Polyporus arcularius* (0.33%).

Table 7. Percentage frequency and Relative frequency of polypores during pre-monsoon period

Sl.No.	Fungal species	Percentage frequency	Relative frequency
1	*Daedalea flavida*	5.00	18.75
2	*Fomitopsis feei*	0.67	2.50
3	*Fulvifomes nilgheriensis*	1.67	6.25
4	*Fuscoporia gilva*	3.00	11.25
5	*Hexagonia tenuis*	1.33	5.00
6	*Melanoporia nigra*	0.67	2.50
7	*Microporus affinis*	3.00	11.25
8	*Microporus xanthopus*	2.67	10.00
9	*Nigroporus vinosus*	1.00	3.75
10	*Phellinus dependens*	2.67	10.00
11	*Fuscoporia senex*	0.67	2.50
12	*Trametes cotonea*	2.00	7.50
13	*Trametes hirsuta*	2.33	8.75
	Total	**26.66**	**100.00**

Table 8. Percentage frequency and Relative frequency of polypores during monsoon period

Sl.No.	Fungal species	Percentage frequency	Relative frequency
1	*Daedalea flavida*	5.67	9.71
2	*Earliella scabrosa*	3.67	6.29
3	*Fomitopsis feei*	8.33	14.29
4	*Fulvifomes nilgheriensis*	1.67	2.86
5	*Fuscoporia gilva*	3.33	5.71
6	*Ganoderma lucidum*	0.67	1.14
7	*Hexagonia tenuis*	2.00	3.43
8	*Melanoporia nigra*	0.67	1.14
9	*Microporellus obovatus*	6.33	10.86
10	*Microporus affinis*	4.67	8.00
11	*Microporus xanthopus*	3.00	5.14
12	*Nigroporus vinosus*	1.00	1.71
13	*Phellinus dependens*	3.00	5.14
14	*Fuscoporia senex*	0.67	1.14
15	*Polyporus arcularius*	0.33	0.57

Contd...

Sl.No.	Fungal species	Percentage frequency	Relative frequency
16	*Polyporus grammocephalus*	3.00	5.14
17	*Polyporus virgatus*	0.33	0.57
18	*Trametes cingulata*	3.00	5.14
19	*Trametes cotonea*	4.67	8.00
20	*Trametes hirsuta*	2.33	4.00
	Total	**58.33**	**100.00**

Table 9. Percentage frequency and Relative frequency of polypores during post-monsoon period

Sl.No.	Fungal species	Percentage frequency	Relative frequency
1	*Coriolopsis sanguinaria*	0.67	0.83
2	*Coriolopsis telfarii*	0.67	0.83
3	*Daedalea flavida*	7.67	9.58
4	*Earliella scabrosa*	4.33	5.42
5	*Fomitopsis feei*	15.67	19.58
6	*Fulvifomes nilgheriensis*	2.33	2.92
7	*Fuscoporia gilva*	4.00	5.00
8	*Ganoderma lucidum*	1.00	1.25
9	*Hexagonia tenuis*	2.33	2.92
10	*Melanoporia nigra*	1.33	1.67
11	*Microporellus obovatus*	5.33	6.67
12	*Microporus affinis*	4.67	5.83
13	*Microporus xanthopus*	5.33	6.67
14	*Nigroporus vinosus*	1.67	2.08
15	*Phellinus dependens*	3.67	4.58
16	*Fuscoporia senex*	1.00	1.25
17	*Polyporus arcularius*	0.67	0.83
18	*Polyporus grammocephalus*	4.33	5.42
19	*Polyporus virgatus*	0.33	0.42
20	*Trametes cingulata*	3.67	4.58
21	*Trametes cotonea*	5.67	7.08
22	*Trametes hirsuta*	3.67	4.58
	Total	**80.00**	100.00

4.2.3 Structural analysis of polypores in Peechi-Vazhani WLS

The distribution of polypores in the entire sanctuary irrespective season has been pooled. A total of 1691 individuals of polypores per hectare belonging to 22 different species were recorded over a sampling area of 30,000 m^2 (Table 10). Of which *Fomitopsis feei* recorded the highest abundance (15.00) followed by *Daedalea flavida* (12.69) and *Coriolopsis telfarii* (12.50). Least abundance value was recorded for *Polyporus virgatus* (3.00).

Structural analysis of polypore community indicated that *Fomitopsis feei* had maximum relative density (21.88 %) followed by *Daedalea flavida* (13.76 %) and *Trametes cotonea* (8.28 %). Lowest values were recorded for *Polyporus virgatus* (0.12 %). Distribution of polypores in the sanctuary indicated that the maximum relative frequency for *Fomitopsis feei* (14.95 %) followed by *Daedalea flavida* (11.11 %), *Microporus afflnis and Trametes cotonea* (7.47 %). The lowest relative frequency was recorded for three species namely *Polyporus virgatus, Coriolopsis sanguinaria and Coriolopsis telfarii* (0.40 %). The percentage frequency was worked out to be highest for *Fomitopsis feei* (24.67 %) followed by *Daedalea flavida* (18.33 %), *Microporus affinis and Trametes cotonea* (12.33 %), whereas lowest value was obtained for three species namely *Polyporus virgatus, Coriolopsis sanguinaria and Coriolopsis telfarii* (0.67 %).

Table 10. Structural analysis of polypores in Peechi-Vazhani WLS

Sl.No	Fungal species	A	D	RD	PF	RF
1	*Coriolopsis sanguinaria*	11.00	7.00	0.43	0.67	0.40
2	*Coriolopsis telfarii*	12.50	8.00	0.49	0.67	0.40
3	*Daedalea flavida*	12.69	233.00	13.76	18.33	11.11
4	*Earliella scabrosa*	11.25	90.00	5.32	8.00	4.85
5	*Fomitopsis feei*	15.00	370.00	21.88	24.67	14.95
6	*Fulvifomes nilgheriensis*	7.88	45.00	2.64	5.67	3.43
7	*Fuscoporia gilva*	10.90	113.00	6.66	10.33	6.26
8	*Ganoderma lucidum*	11.20	19.00	1.10	1.67	1.01
9	*Hexagonia tenuis*	6.24	35.00	2.09	5.67	3.43

Contd....

Sl.No	Fungal species	A	D	RD	PF	RF
10	*Melanoporia nigra*	6.13	16.00	0.97	2.67	1.62
11	*Microporellus obovatus*	9.89	115.00	6.82	11.67	7.07
12	*Microporus affinis*	7.05	87.00	5.14	12.33	7.47
13	*Microporus xanthopus*	8.36	92.00	5.44	11.00	6.67
14	*Nigroporus vinosus*	4.82	18.00	1.04	3.67	2.22
15	*Phellinus dependens*	7.29	68.00	4.02	9.33	5.66
16	*Fuscoporia senex*	5.57	13.00	0.77	2.33	1.41
17	*Polyporus arcularius*	10.33	10.00	0.61	1.00	0.61
18	*Polyporus grammocephalus*	8.32	61.00	3.61	7.33	4.44
19	*Polyporus virgatus*	3.00	2.00	0.12	0.67	0.40
20	*Trametes cingulata*	10.05	67.00	3.96	6.67	4.04
21	*Trametes cotonea*	11.35	140.00	8.28	12.33	7.47
22	*Trametes hirsuta*	9.84	82.00	4.85	8.33	5.05
	Total	**200.66**	**1691**	**100.00**	**165.00**	**100.00**

[Abundance (A), Relative density (RD), Percentage frequency (PF) and Relative frequency (RF)]

4.2.4 Seasonal influence on polypore association

A Principal component analysis was done to find the association among polypores during pre-monsoon, monsoon and post monsoon season based on their composition and density (Fig. 4). It was observed that all the three seasons are far from the centre, among this, the species composition during monsoon and post monsoon was close to each other and noticed significant positive correlation. In this, the horizontal axis is linked with monsoon and post monsoon, and the vertical axis with pre-monsoon season. The results showed that the distribution of *Daedalea flavida* was less influenced by monsoon and post monsoon seasons and more linked to the pre-monsoon period. Also species like *Microporus xanthopus*, *Microporus affinis*, *Phellinus dependens*, *Fuscoporia gilva* were linked more to the pre-monsoon season. The distribution pattern of *Fomitopsis feei* was highly contributed by the monsoon and post monsoon seasons. It was also observed that species like *Ganoderma lucidum*, *Microporellus obovatus*, *Polyporus*

grammocephalus, *Earliella scabrosa* and *Trametes cingulata* were linked to the monsoon and post monsoon.

4.3 Diversity of polypores in Peechi-Vazhani Wildlife Sanctuary

Season wise diversity indices for polypores obtained from the study area are given in Table 11 and Fig. 5.

4.3.1 Pre monsoon period

During the pre monsoon period, Simpson's index of diversity and concentration of dominance (Cd) were 0.88 and 0.12 respectively i.e, if 100 pairs of polypores were taken at random, 88 will comprise of different species. The Shannon-Weiner indices, H_{max} and Equitability (E) were 2.32, 3.70 and 0.63 respectively.

4.3.2 Monsoon period

Simpson's diversity index (D) and concentration dominance (Cd) during the monsoon period was found to be 0.90 and 0.10 respectively. Among three different seasons highest Simpson's index of diversity was indicated for monsoon period. The Shannon-Weiner indices, H_{max} and Equitability (E) were 2.56, 4.39 and 0.58 respectively.

4.3.3 Post monsoon period

During the post monsoon period, Simpson's index of diversity and concentration of dominance (Cd) were 0.88 and 0.12 respectively. The Shannon-Weiner indices, H_{max} and Equitability (E) were 2.56, 4.52 and 0.57 respectively.

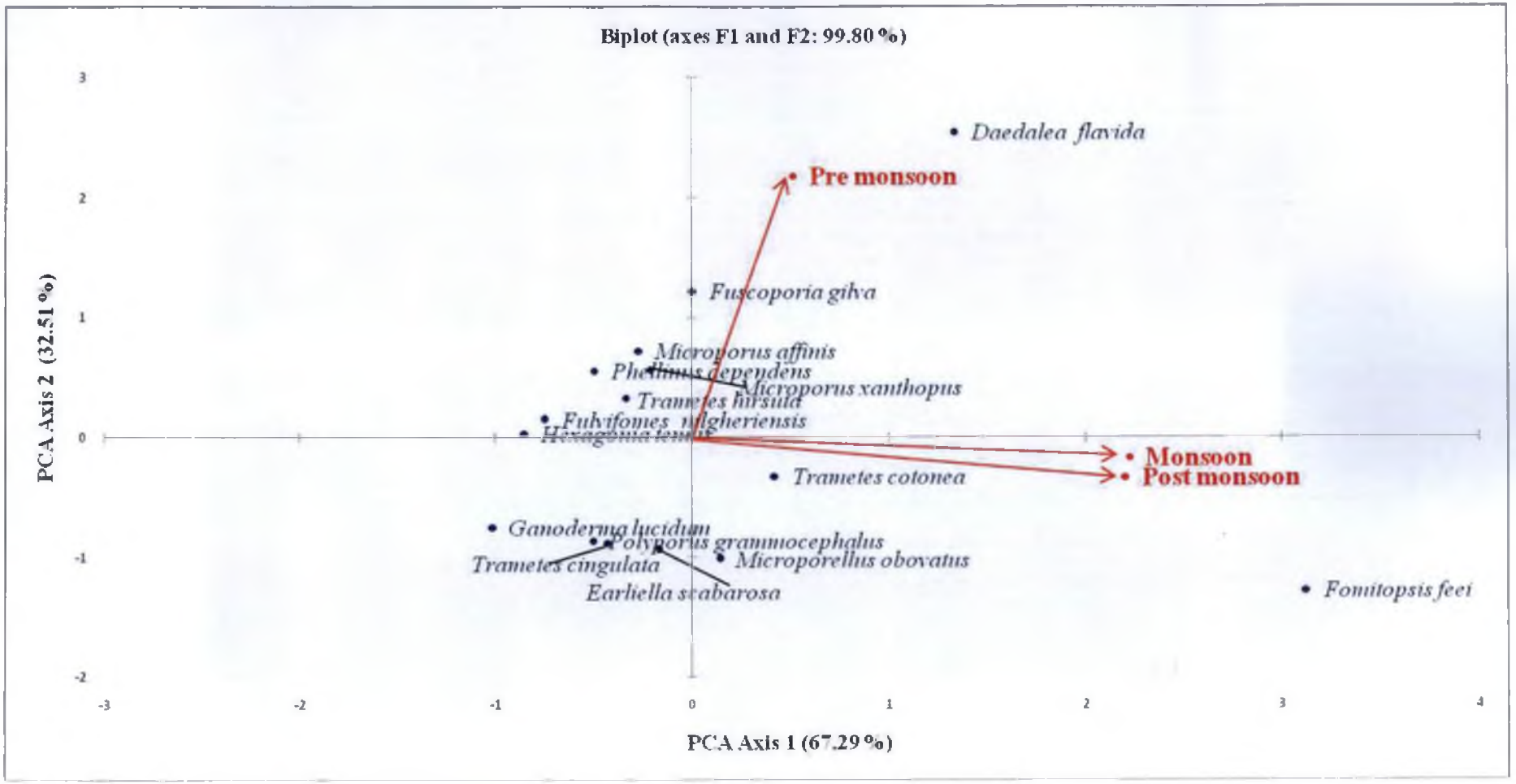


Fig. 4 PCA bi-plot of polypores in Peechi-Vazhani Wildlife Sanctuary during different seasons

Table 11. Diversity indices of polypores during different seasons

	Pre monsoon	Monsoon	Post monsoon
Simpson's Index	0.88	0.90	0.88
Concentration of dominance (Cd)	0.12	0.10	0.12
Shannon-Weiner Index	2.32	2.56	2.56
H_{max}	3.70	4.39	4.52
Equitability (E)	0.63	0.58	0.57

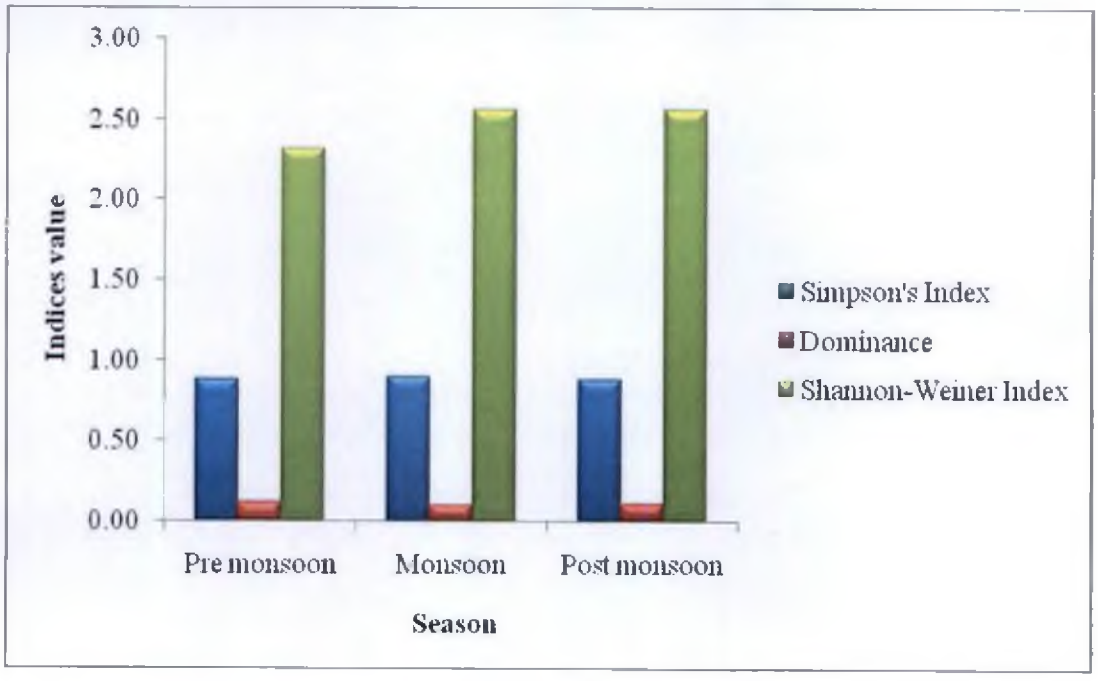


Fig. 5 Diversity indices of polypores during different seasons

4.4 Sorenson's similarity index

Sorenson's similarity index was worked out to find the similarity of polypore community in the study area with pair wise comparison of different seasons (Table 12). Similarity index calculated between pre-monsoon and monsoon revealed that highest similarity was observed in Mannamangalam (0.88) followed by Vellani (0.80) and Olakkara (0.76). Sorenson's similarity index between monsoon and post monsoon revealed a high level similarity among the polypore community; highest similarity was observed in Vellani (0.97) and similarity index recorded for Olakkara and Mannamangalam were 0.96 and 0.93 respectively (Fig. 6). Similarity index between pre-monsoon and post monsoon revealed that highest similarity was observed in Mannamangalam (0.81) followed by Vellani (0.77) and Olakkara (0.73).

Table 12. Sorenson's similarity index of polypore community in Peechi-Vazhani Wildlife Sanctuary

Sl.No	Location	Similarity index Pre-monsoon & Monsoon	Similarity index Monsoon & Post monsoon	Similarity index Pre monsoon & Post monsoon
1	Vellani	0.80	0.97	0.77
2	Mannamangalam	0.88	0.93	0.81
3	Olakkara	0.76	0.96	0.73

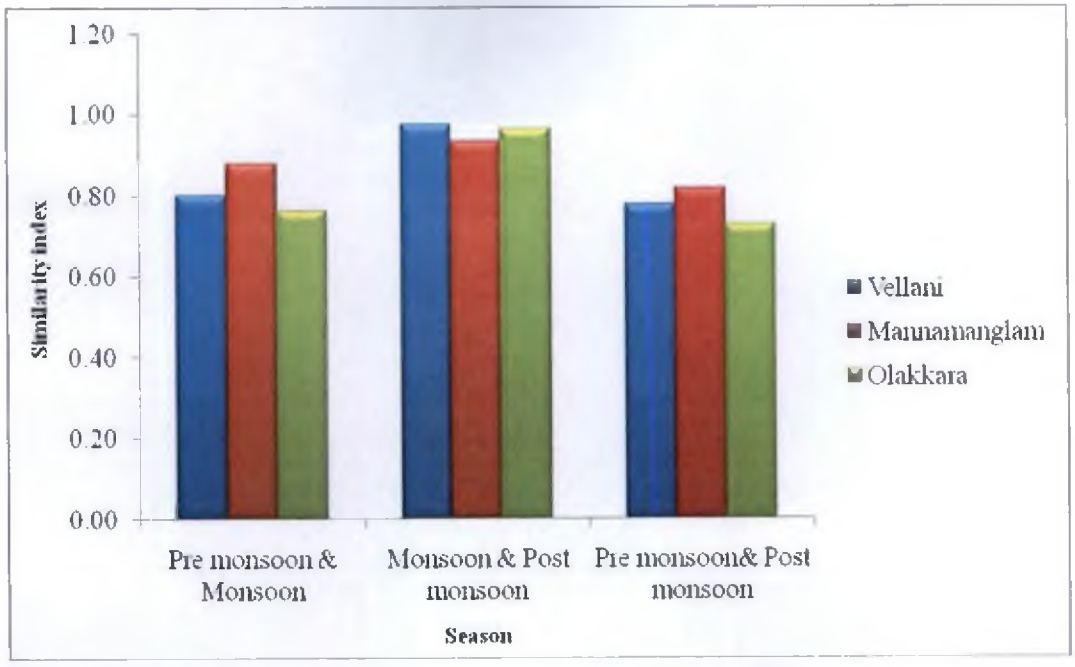


Fig. 6 Similarity index of polypore community in Peechi-Vazhani Wildlife Sanctuary

4.5 Host association of polypores

4.5.1 Distribution of tree host species

The distribution of different tree host species of polypores was studied in the sampled area. The tree species present in the study area was identified and divided into host and non-host tree species based on the presence and absence of polypores during the entire study period (Table 13). A total of 48 tree species belonging to 28 families were identified and out of this 17 species were host species and 31 species were non-host species (Fig. 7). Out of the 28 families, host species were comprised of 10 families. Out of these 10 host families, Euphorbiaceae and Combretaceae contributed four species each and they represented the major host families (Fig. 8).

Table 13. List of host and non-host tree species with respect to polypores in Peechi-Vazhani Wildlife Sanctuary

Sl.No	Species	Family	Status
1	*Albizia lebbeck* (L.) Willd.	Mimosoideae	Non host
2	*Albizia odoratissima* (L. f.) Benth.	Mimosoideae	Host
3	*Albizia procera* (Roxb.) Benth.	Mimosoideae	Non host
4	*Alstonia scholaris* (L.) R. Br.	Apocynaceae	"
5	*Anogeissus latifolia* (Roxb. ex DC.)	Combretaceae	"
6	*Bauhinia racemosa* Lamk.	Caesalpinioideae	"
7	*Bombax ceiba* L.	Bombacaceae	Host
8	*Briedelia retusa* (L.) A.Juss.	Euphorbiaceae	Host
9	*Callicarpa tomentosa* (L.) Murray	Verbanaceae	Non host
10	*Calycopteris floribunda* (Roxb.) Lam.	Combretaceae	Host
11	*Careya arborea* Roxb.	Lecythidaceae	Non host
12	*Cassia fistula* L.	Caesalpinioideae	Host
13	*Cleistanthus collinus* (Roxb.) Benth. Ex Hook. f.	Euphorbiaceae	"
14	*Dalbergia latifolia* Roxb.	Faboideae	"
15	*Dillenia pentagyna* Wight	Dilleniaceae	"
16	*Ficus exasperate* Vahl	Moraceae	Non host
17	*Grewia tiliifolia* Vahl	Tiliaceae	Host
18	*Haldina cordifolia* (Roxb.) Ridsd	Rubiaceae	Non host
19	*Holarrhena pubescens* (Buch.-Ham.) Wall. ex Don	Apocynaceae	"
20	*Lagerstroemia microcarpa* Wight	Lytheraceae	"
21	*Lannea coromandalica* (Houtt.) Merr.	Anacardiaceae	Host
22	*Macaranga peltata* (Roxb.) Muell.-Arg.	Euphorbiaceae	Host
23	*Mallotus philippensis* (Lamk.) Muell.-Arg.	Euphorbiaceae	Non host
24	*Melia dubia* Cav.	Meliaceae	Host
25	*Miliusa velutina* (Dunal) Hook. F. & Thoms.	Annonaceae	Non host
26	*Morinda pubscens* J.E.Smith	Rubiaceae	"
27	*Olea dioica* Roxb.	Oleaceae	"
28	*Pterocarpus marsupium* Roxb.	Faboideae	"
29	*Pterospermum reticulatum* Wight & Arn.	Sterculiaceae	"

Sl.No	Species	Family	Status
30	*Schleichera oleosa* (Lour.) Oken	Sapindaceae	"
31	*Spondias pinnata* (L. f.) Kurz	Annonaceae	"
32	*Sterculia guttata* Roxb.	Sterculiaceae	"
33	*Sterculia urens* Roxb.	Sterculiaceae	"
34	*Stereospermum chelonoides* (Roxb.) Benth.	Bignoniaceae	"
35	*Strychnos nux-vomica* L.	Loganiaceae	"
36	*Syzygium cumini* (L.) Skeels	Myrataceae	"
37	*Tabernamontana heyneana* (Wall.) Cooke	Apocynaceae	"
38	*Tectona grandis* L. f.	Verbanaceae	"
39	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	Host
40	*Terminalia elliptica* Willd.	Combretaceae	"
41	*Terminalia paniculata* Roth	Combretaceae	"
42	*Tetrameles nudiflora* R. Br.	Dastiscaceae	Non host
43	*Trewia nudiflora* L.	Euphorbiaceae	Host
44	*Vitex altissima* L.	Verbanaceae	Non host
45	*Wrightia tinctoria* (Roxb.) R. Br.	Apocynaceae	"
46	*Xanthophyllum arnottianum* Wight	Xanthophyllaceae	"
47	*Xylia xylocarpa* (Roxb.) Taub.	Mimosoideae	Host
48	*Zanthoxylum rhetsa* (Roxb.) DC.	Rutaceae	Non host

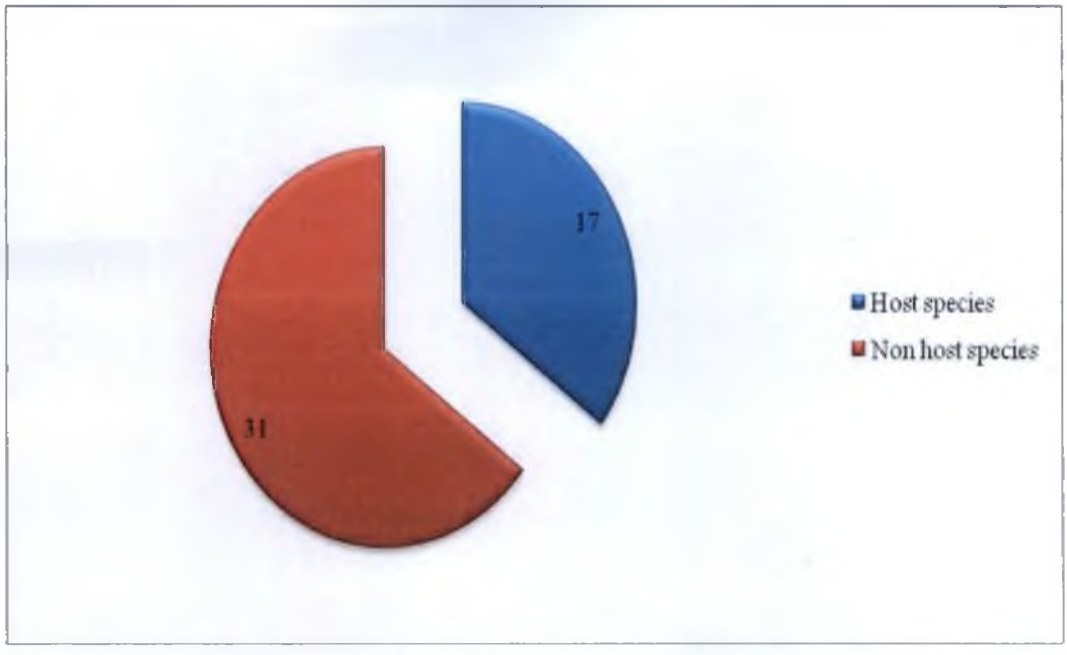


Fig. 7 Distribution of host and non-host tree species in Peechi-Vazhani Wildlife Sanctuary

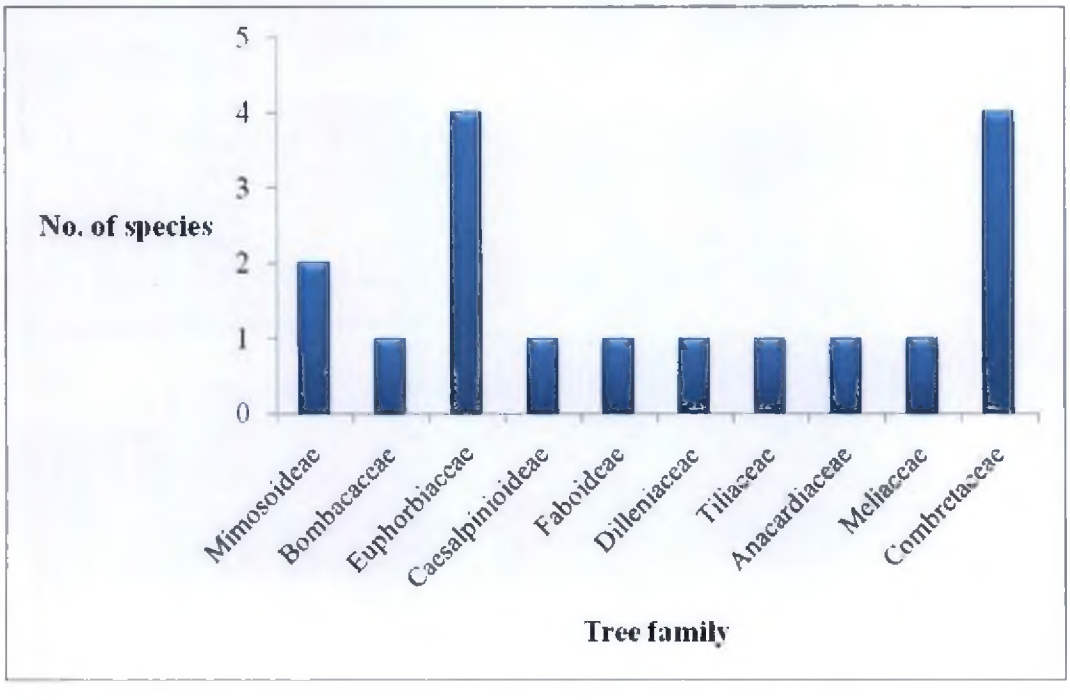


Fig. 8 Distribution of tree host species on different families

4.5.2 Density and occurrence of polypores on host trees

Density of polypores on different tree host species in the study area has been quantified (Fig. 9). The highest number of individuals was recorded from *Terminalia paniculata* (2252) followed by *Xylia xylocarpa* (742) and *Terminalia elliptica* (531). Lowest number of polypores was recorded from *Briedelia retusa* (6). Host species like *Lannea coromandelica, Calycopteris floribunda, Cleistanthus collinus* showed very less polypore density.

Occurrence of polypores on different tree host species in the sanctuary has been recorded (Fig. 10). The highest number of occurrence was observed in *Terminalia paniculata* (76) followed by *Xylia xylocarpa* (38) and *Terminalia elliptica* (28). Lowest occurrence of polypores was recorded for species like *Briedelia retusa, Lannea coromandelica, Calycopteris floribunda* and *Cleistanthus collinus*.

Density and occurrence of polypores on different host families was also studied (Fig. 11 & Fig. 12). Highest number of polypores individuals was recorded on Combretaceae (2979) followed by Mimosoideae (870) and Euphorbiaceae (393). Lowest density was observed for Anacardiaceae (12). In case of occurrence, polypores occurred highest in Combretaceae (107) followed by Mimosoideae (42) and Dilleniaceae (17). Lowest polypore occurrence was observed in Anacardiaceae (1).

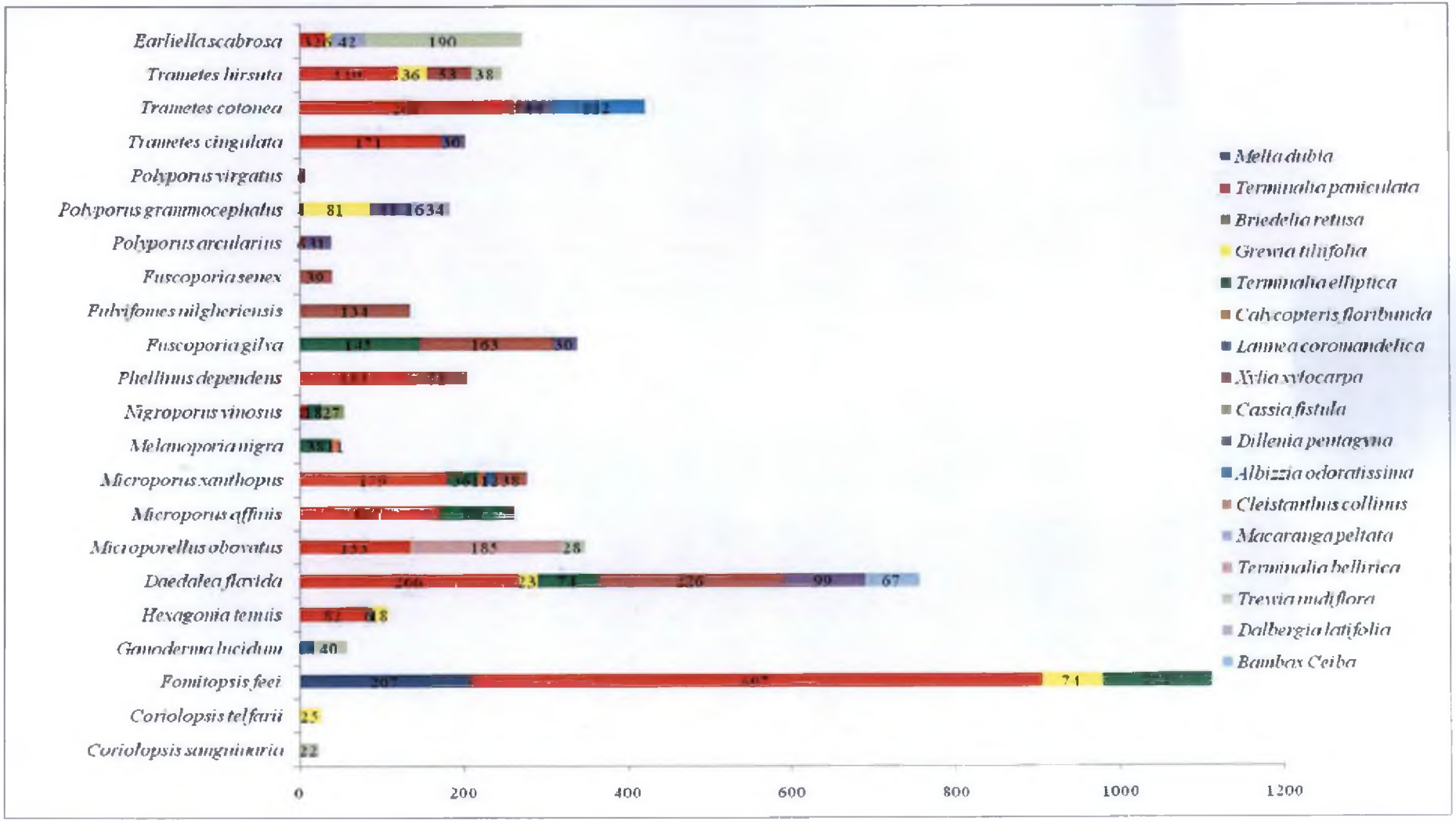


Fig. 9 Density of polypores on tree host species in Peechi-Vazhani Wildlife Sanctuary

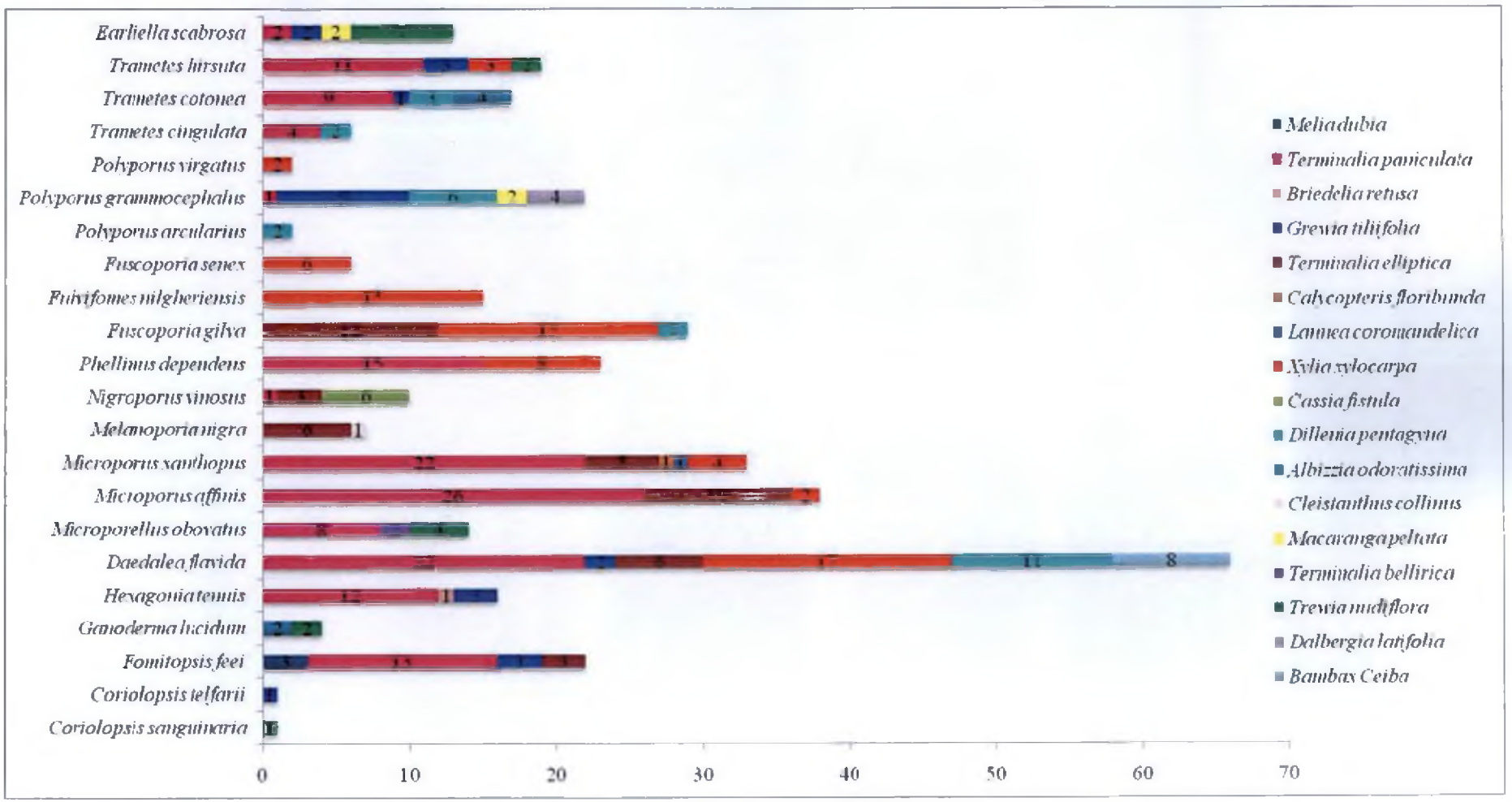


Fig. 10 Occurrence of polypores on tree host species in Peechi-Vazhani Wildlife Sanctuary

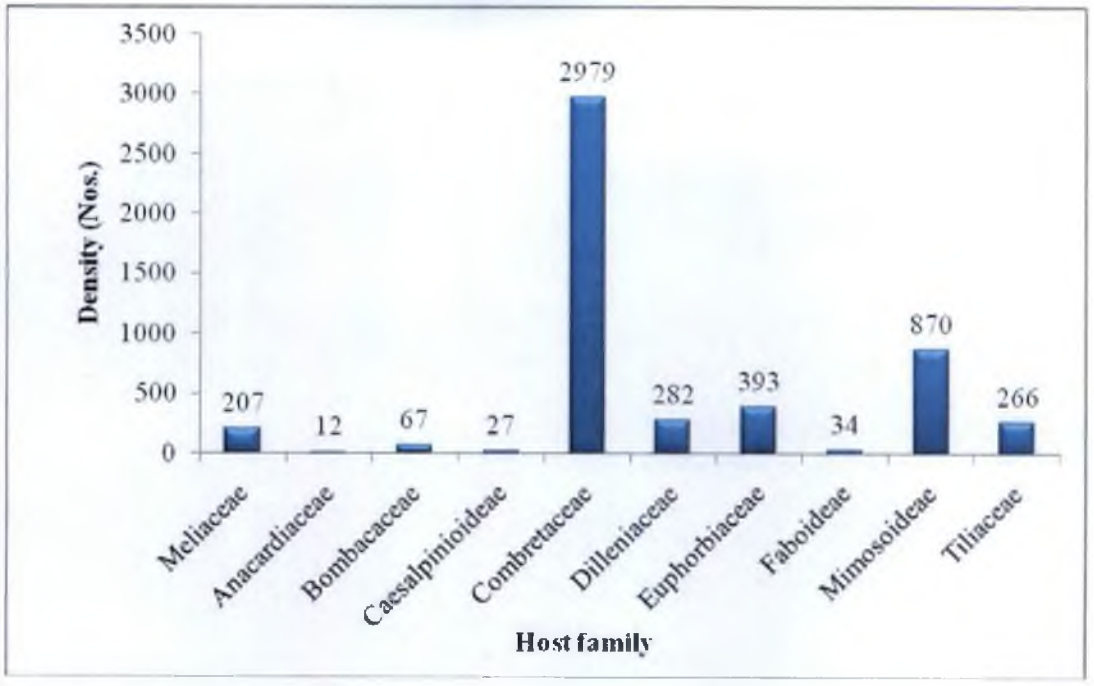


Fig. 11 Density of polypores on different host families

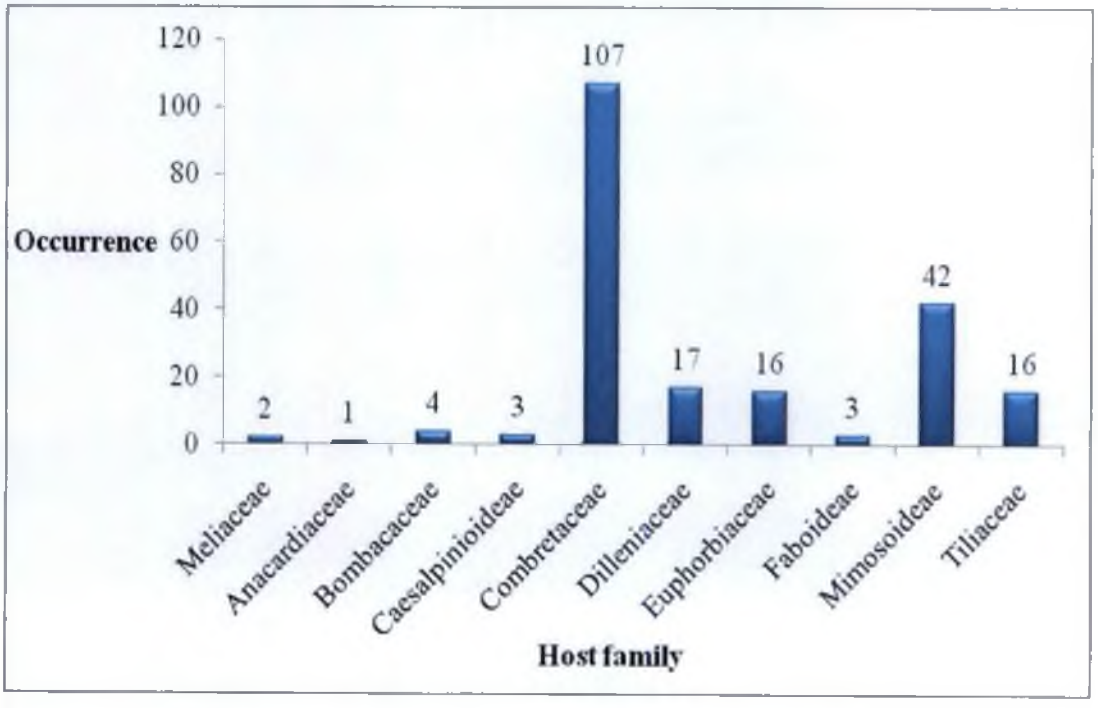


Fig. 12 Occurrence of polypores on different host families

4.5.3 Host density and polypore species richness

In order to understand the relationship between density of tree host species and polypore fungal diversity in the study area, number of logs belonging to each species and number of fungal species on logs were listed (Table 14). A total number of 144 logs of different size belonging to 17 host species were recorded. Out of this, highest number of logs recorded was of *Terminalia paniculata* (43) followed by *Xylia xylocarpa* (25) and *Terminalia elliptica* (21). Only one log each was recorded for four species namely *Lannea coromandelica, Briedelia retusa, Calycopteris floribunda* and *Cleistanthus collinus*.

Table 14. Association of polypores with host trees and their logs

Sl.No	Host tree species	No. of polypores species	No. of logs
1	*Albizzia odoratissima*	2	3
2	*Bombax Ceiba*	1	2
3	*Briedelia retusa*	1	1
4	*Calycopteris floribunda*	1	1
5	*Cassia fistula*	1	2
6	*Cleistanthus collinus*	1	1
7	*Dalbergia latifolia*	1	2
8	*Dillenia pentagyna*	6	12
9	*Grewia tiliifolia*	8	15
10	*Lannea coromandelica*	1	1
11	*Macaranga peltata*	2	3
12	*Melia dubia*	1	2
13	*Terminalia bellirica*	1	2
14	*Terminalia elliptica*	7	21
15	*Terminalia paniculata*	13	43
16	*Trewia nudiflora*	5	8
17	*Xylia xylocarpa*	10	25

Based on this a regression has been plotted, it has been found that there was significant positive relationship between the polypore fungal diversity and density of host tree species (Fig. 13). The slope of the graph has shown that the diversity of polypores has increased linearly with the availability of more logs of a host i.e. density of host.

4.5.4 Host preference and specificity of polypores

The host preference of polypores has been analysed in the study area by the presence or absence of polypore species on each log and all fruiting bodies of the same species on a log were treated as one occurrence, irrespective of the number of fruiting bodies. Also if there were several clusters, they were treated as one occurrence. The fungal species have more than 50 per cent occurrence on a particular host has also been considered for detailed analysis. A total of 22 fungal species on 17 host tree species have been recorded and out of this 12 species showed a possible preference for a tree host (Table 15). Out of the host species *Terminalia paniculata* was highly preferred by the polypores followed by *Xylia xylocarpa*.

Table 15. Polypore fungal species and their preference on different tree host species

Sl.No	Host tree species	No. of polypores species	Preference
1	*Albizzia odoratissima*	2	1
2	*Bombax Ceiba*	1	0
3	*Briedelia retusa*	1	0
4	*Calycopteris floribunda*	1	0
5	*Cassia fistula*	1	0
6	*Cleistanthus collinus*	1	0
7	*Dalbergia latifolia*	1	0
8	*Dillenia pentagyna*	6	1
9	*Grewia tiliifolia*	8	1
10	*Lannea coromandelica*	1	0
11	*Macaranga peltata*	2	0

Contd.....

Sl. No.	Host tree species	No. of polypores species	Preference
12	*Melia dubia*	1	0
13	*Terminalia bellirica*	1	0
14	*Terminalia elliptica*	7	1
15	*Terminalia paniculata*	13	4
16	*Trewia nudiflora*	5	1
17	*Xylia xylocarpa*	10	3

Table 16. Relationship between host trees and polypores

Sl.No	Fungal species	No. of host tree species	No. of occurrence of polypores
1	*Coriolopsis sanguinaria*	1	1
2	*Coriolopsis telfarii*	1	1
3	*Fomitopsis feei*	4	15
4	*Ganoderma lucidum*	2	3
5	*Hexagonia tenuis*	3	9
6	*Daedalea flavida*	6	35
7	*Microporellus obovatus*	3	9
8	*Microporus affinis*	3	21
9	*Microporus xanthopus*	5	19
10	*Melanoporia nigra*	2	5
11	*Nigroporus vinosus*	3	7
12	*Phellinus dependens*	2	11
13	*Fuscoporia gilva*	3	15
14	*Fulvifomes nilgheriensis*	1	7
15	*Fuscoporia senex*	1	3
16	*Polyporus arcularius*	2	2
17	*Polyporus grammocephalus*	5	14
18	*Polyporus virgatus*	1	2
19	*Trametes cingulata*	2	4
20	*Trametes cotonea*	4	9
21	*Trametes hirsuta*	4	12
22	*Earliella scabrosa*	4	7

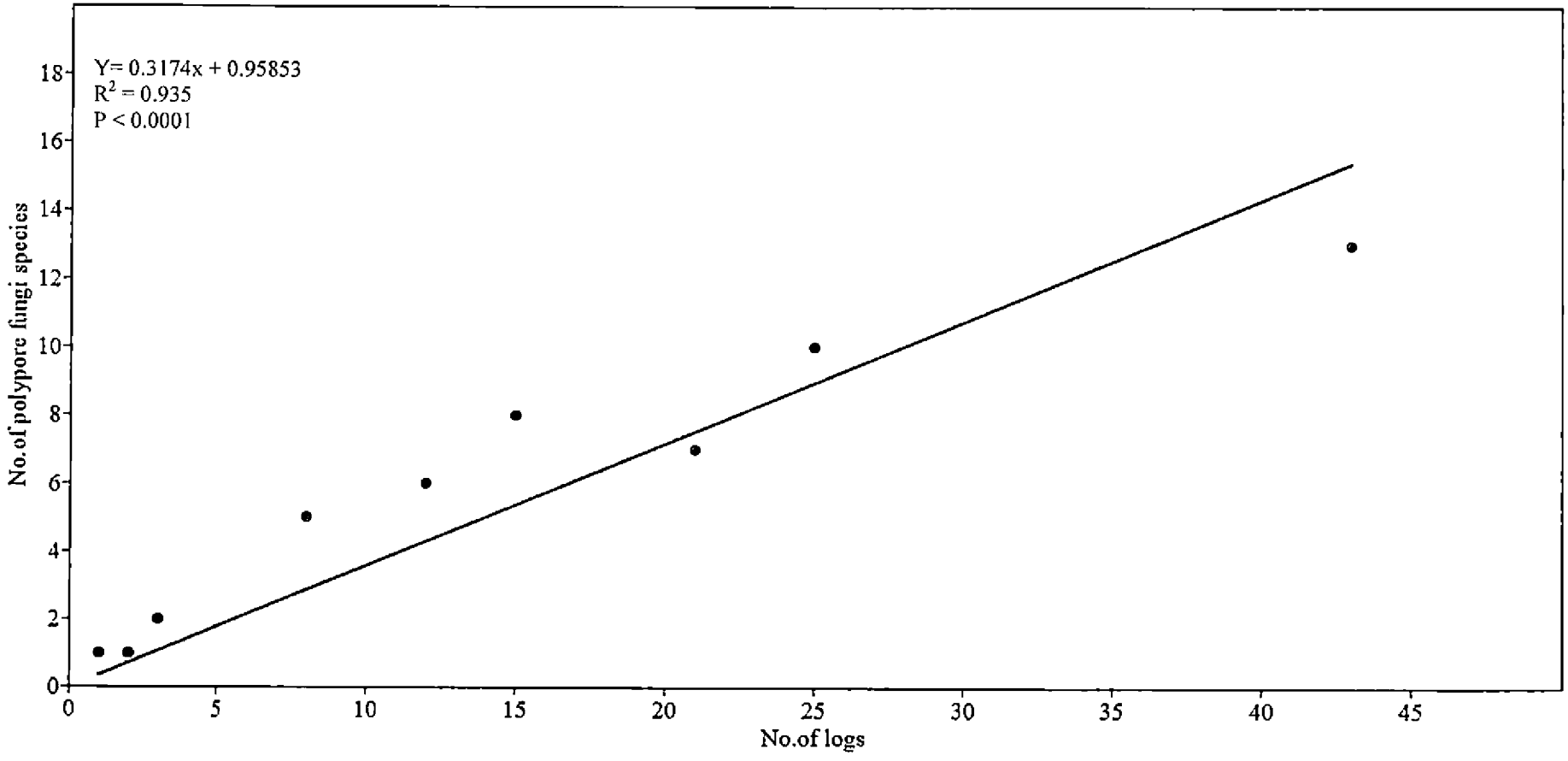


Fig. 13 Relationship between species richness of polypores and host density

The total number of occurrences of each polypores species on host species were listed (Table 16). Out of the 22 species, *Coriolopsis sanguinaria* and *Coriolopsis telfarii* were found only once and the host specificity of these two species must be considered as unknown. In order to understand the host specificity, a linear regression has been plotted by natural logarithm of number of host tree species against natural logarithm of number of occurrence of polypores (Fig. 14). The graph showed that the overall number of host tree species increased linearly with the number of occurrence of polypores. The number of host trees and the number of occurrence of polypores were transformed into natural logarithm to make their distributions close to normal and to avoid disproportionate influence of few abundant species in the analysis. The relationship was significant ($R^2 = 0.592$, $P < 0.0001$). In the regression graph, it is found that deviation of three species from the regression line.

4.6 Substrate features and polypore assemblage

4.6.1 Substrate diameter and polypores distribution

The density of polypores on different diameter classes have been studied (Table 17). All the available substrates were divided into seven different diameter class viz. 0- < 10 cm, 11- < 20 cm, 21- < 30 cm, 31- < 40 cm, 41- < 50 cm, 51- < 60 cm and 61cm & above. The maximum species density has been recorded to 21- < 30 cm diameter class (1788 individuals) followed by 11- < 20 cm diameter class (1073 individuals) and 31- < 40 cm diameter class (980 individuals). Lowest species density was observed in 51- < 60 cm diameter class.

Species like *Fomitopsis feei, Daedalea flavida* and *Microporellus obovatus* contributed maximum number of individuals in 21- < 30 cm diameter class and in 11- < 20 cm diameter class major contribution was also by *Fomitopsis feei* and *Daedalea flavida.* In 31- < 40 cm diameter class maximum number of individuals was contributed by *Fomitopsis feei* and *Fuscoporia gilva.*

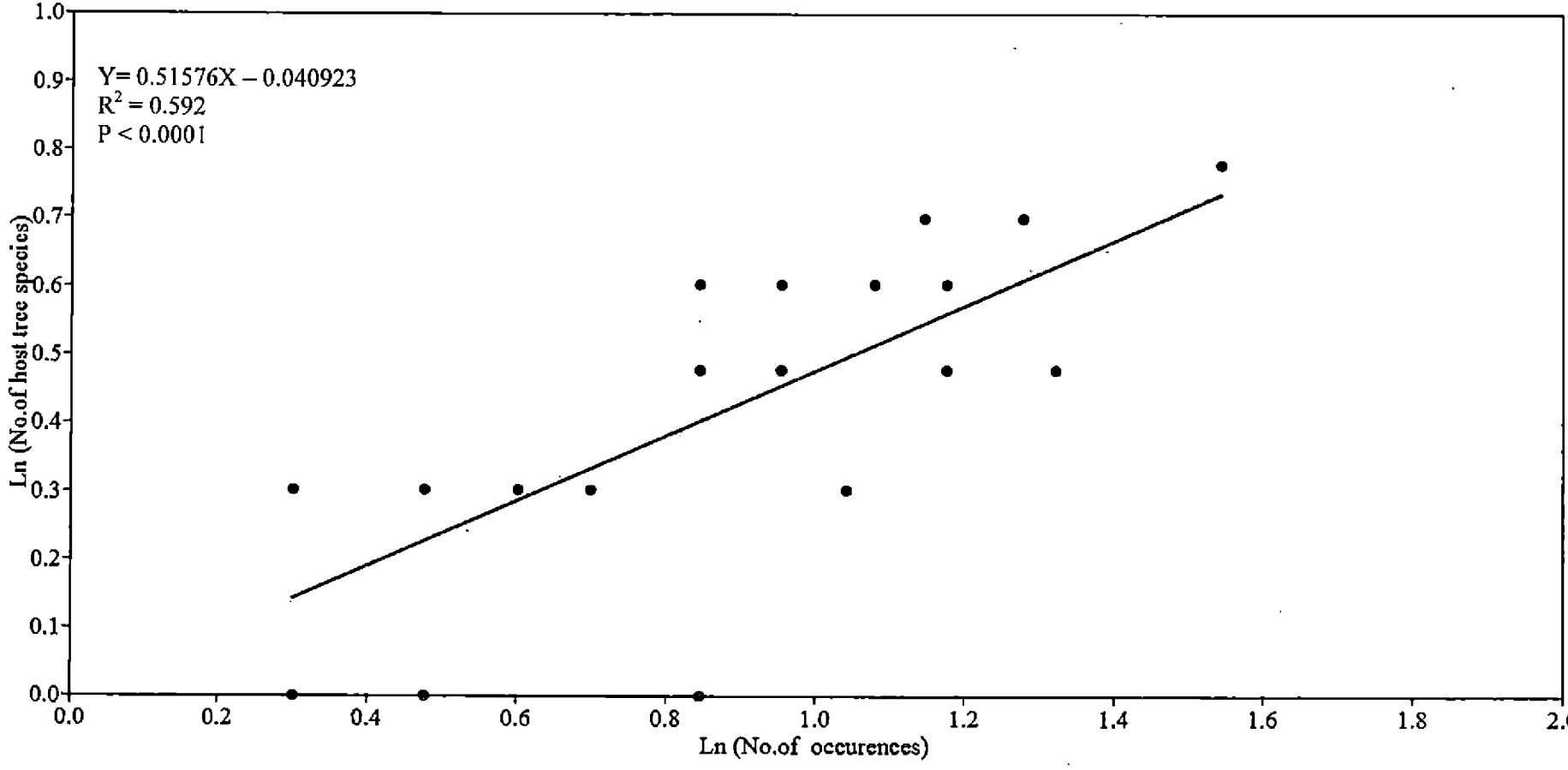


Fig.14 Host specificity of polypores in Peechi-Vazhani Wildlife Sanctuary

4.6.2 Occurrence and diameter class preference of polypores

The occurrences of polypores on different diameter classes of host trees were recorded (Table 18). The occurrences of polypores showed a different pattern of distribution. Species like *Daedalea flavida*, *Earliella scabrosa* and *Fomitopsis feei* have wide range of diameter class, while species like *Hexagonia tenuis* and *Microporus xanthopus* have only very narrow range of diameter class (Fig. 15). Among these, species like *Coriolopssi telfarii* and *Coriolopsis sanguinaria* were found only once and cannot considered for the diameter class range. All other species were observed with intermediate range of diameter class.

An attempt was also done to understand the diameter class preference of polypores (Table 19). Polypores with more than ten total occurrences on different diameter classes only were considered. Out of this, more than 50 per cent occurrence on a particular diameter class was selected as preference for diameter class. A total of seven polypore species have shown preference for a particular diameter class. *Hexagonia tenuis*, *Microporus xanthopus* and *Microporus affinis* showed preference for 0- < 10 cm diameter class while *Trametes hirsuta* preferred 21- < 30 cm diameter class. Species like *Fulvifomes nilgheriensis*, *Fuscoporia gilva* and *Phellinus dependens* preferred 31- < 40 cm diameter substrates. No preference of polypores was observed for higher diameter classes like 51- < 60 cm and 61cm & above.

Table 17. Density of polypores on different diameter classes

Sl.No	Fungal species	Substrate diameter class						
		0-<10 cm	11-<20 cm	21-<30 cm	31-<40 cm	41-<50 cm	51-<60 cm	61 cm & above
1	*Coriolopsis sanguinaria*	-	22	-	-	-	-	-
2	*Coriolopsis telfarii*	-	-	25	-	-	-	-
3	*Daedalea flavida*	77	242	319	60	-	-	-
4	*Earliella scabrosa*	39	117	76	38	-	-	-
5	*Fomitopsis feei*	-	207	515	326	-	-	62
6	*Fulvifomes nilgheriensis*	-	-	-	81	29	24	-
7	*Fuscoporia gilva*	-	-	105	178	55	-	-
8	*Fuscoporia senex*	-	-	-	21	-	18	-
9	*Ganoderma lucidum*	-	56	-	-	-	-	-
10	*Hexagonia tenuis*	106	-	-	-	-	-	-
11	*Melanoporia nigra*	-	22	11	16	-	-	-
12	*Microporellus obovatus*	-	28	263	55	-	-	-
13	*Microporus affinis*	213	24	-	24	-	-	-
14	*Microporus xanthopus*	276	-	-	-	-	-	-
15	*Nigroporus vinosus*	-	53	-	-	-	-	-
16	*Phellinus dependens*	-	26	82	96	-	-	-
17	*Polyporus arcularius*	-	31	-	-	-	-	-
18	*Polyporus grammocephalus*	89	80	14	-	-	-	-
19	*Polyporus virgatus*	6	-	-	-	-	-	-
20	*Trametes cingulata*	-	-	165	36	-	-	-
21	*Trametes cotonea*	-	112	107	-	-	-	201
22	*Trametes hirsuta*	38	53	106	49	-	-	-
	Total	**844**	**1073**	**1788**	**980**	**84**	**42**	**263**

Table 18. Occurrence of polypores on different diameter classes

Sl.No	Fungal species	Substrate diameter class						
		0-<10 cm	11-<20 cm	21-<30 cm	31-<40 cm	41-<50 cm	51-<60 cm	61 cm & above
1	*Coriolopsis sanguinaria*	0	1	0	0	0	0	0
2	*Coriolopsis telfarii*	0	0	1	0	0	0	0
3	*Daedalea flavida*	7	25	24	3	0	0	0
4	*Earliella scabrosa*	2	4	4	4	0	0	0
5	*Fomitopsis feei*	0	3	9	8	0	0	2
6	*Fulvifomes nilgheriensis*	0	0	0	9	3	3	0
7	*Fuscoporia gilva*	0	0	8	18	3	0	0
8	*Fuscoporia senex*	0	0	0	3	0	3	0
9	*Ganoderma lucidum*	0	4	0	0	0	0	0
10	*Hexagonia tenuis*	16	0	0	0	0	0	0
11	*Melanoporia nigra*	0	4	1	2	0	0	0
12	*Microporellus obovatus*	0	4	6	4	0	0	0
13	*Microporus affinis*	28	4	0	3	0	0	0
14	*Microporus xanthopus*	29	0	0	0	0	0	0
15	*Nigroporus vinosus*	0	10	0	0	0	0	0
16	*Phellinus dependens*	0	3	8	15	0	0	0
17	*Polyporus arcularius*	0	2	0	0	0	0	0
18	*Polyporus grammocephalus*	10	10	2	0	0	0	0
19	*Polyporus virgatus*	2	0	0	0	0	0	0
20	*Trametes cingulata*	0	0	4	2	0	0	0
21	*Trametes cotonea*	0	5	6	0	0	0	6
22	*Trametes hirsuta*	2	3	10	4	0	0	0

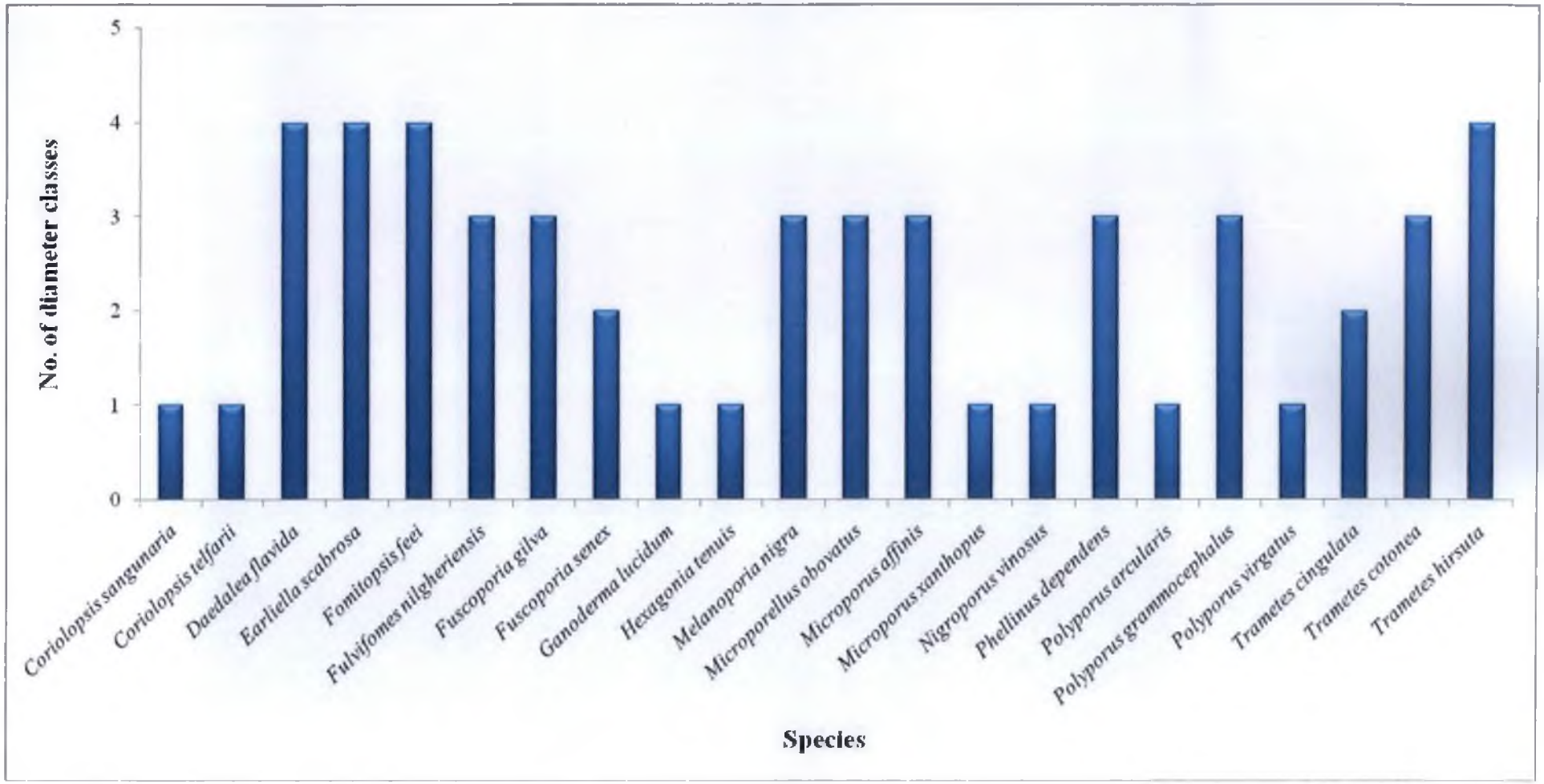


Fig. 15 Occurrences of polypores on different diameter class

Table 19. Diameter class preference of polypores

Sl.No	Fungal species	Occurrences	No. of diameter class	Preference
1	*Coriolopsis sanguinaria*	1	1	0
2	*Coriolopsis telfarii*	1	1	0
3	*Daedalea flavida*	59	4	0
4	*Earliella scabrosa*	14	4	0
5	*Fomitopsis feei*	22	4	0
6	*Fulvifomes nilgheriensis*	15	3	1
7	*Fuscoporia gilva*	29	3	1
8	*Fuscoporia senex*	6	2	0
9	*Ganoderma lucidum*	4	1	0
10	*Hexagonia tenuis*	16	1	1
11	*Melanoporia nigra*	7	3	0
12	*Microporellus obovatus*	14	3	0
13	*Microporus affinis*	35	3	1
14	*Microporus xanthopus*	29	1	1
15	*Nigroporus vinosus*	10	1	0
16	*Phellinus dependens*	26	3	1
17	*Polyporus arcularius*	2	1	0
18	*Polyporus grammocephalus*	22	3	0
19	*Polyporus virgatus*	2	1	0
20	*Trametes cingulata*	6	2	1
21	*Trametes cotonea*	17	3	0
22	*Trametes hirsuta*	19	4	1

4.6.3 Substrate type and distribution of polypores

Distribution of polypores on different substrate type were recorded (Table 20). The substrates were divided into four types based on their nature of material viz. Snag (dead standing tree), Living tree, Log and Branch/twig. Among the substrate types, maximum number of individuals was observed in log (2480), followed by branch/twig (1469) and snag (1012). The living trees supported only very few polypores individuals (113). Also specificity was observed with the substrate types, living trees supported only two species *Phellinus dependens* and *Fulvifomes nilgheriensis* and no other species were observed in the living trees during the entire study period.

A box plot analysis was also done for the association of polypores with substrate types (Fig.16). The box plot revealed that the distribution of polypores in different substrate types. In case of snag, the polypore density varied with a minimum of 13 individuals to the maximum of 543 individuals while in case of living trees also, the density varied with a minimum of 32 individuals to the maximum of 81 individuals. In case of log, the density of polypores varied by 8 to 565 individuals and in case of branch/twig, the density ranged with a minimum of 6 to the maximum of 276 individuals.

Table 20. Density of polypores on different substrate types

Sl.No	Fungal species	Snag	Log	Branch/twig	Living tree
1	*Coriolopsis sanguinaria*	0	0	22	0
2	*Coriolopsis telfarii*	0	25	0	0
3	*Daedalea flavida*	0	468	242	0
4	*Earliella scabrosa*	0	112	169	0
5	*Fomitopsis feei*	543	565	12	0
6	*Fulvifomes nilgheriensis*	53	0	0	81
7	*Fuscoporia gilva*	161	206	0	0
8	*Fuscoporia senex*	22	18	0	0
9	*Ganoderma lucidum*	0	26	0	0
10	*Hexagonia tenuis*	0	0	42	0
11	*Melanoporia nigra*	0	22	23	0
12	*Microporellus obovatus*	0	272	86	0
13	*Microporus affinis*	0	24	242	0
14	*Microporus xanthopus*	0	0	276	0
15	*Nigroporus vinosus*	13	8	32	0
16	*Phellinus dependens*	161	0	12	32
17	*Polyporus arcularius*	0	31	0	0
18	*Polyporus grammocephalus*	0	48	145	0
19	*Polyporus virgatus*	0	0	6	0
20	*Trametes cingulata*	0	211	0	0
21	*Trametes cotonea*	0	288	122	0
22	*Trametes hirsuta*	59	156	38	0
	Total	**1012**	**2480**	**1469**	**113**

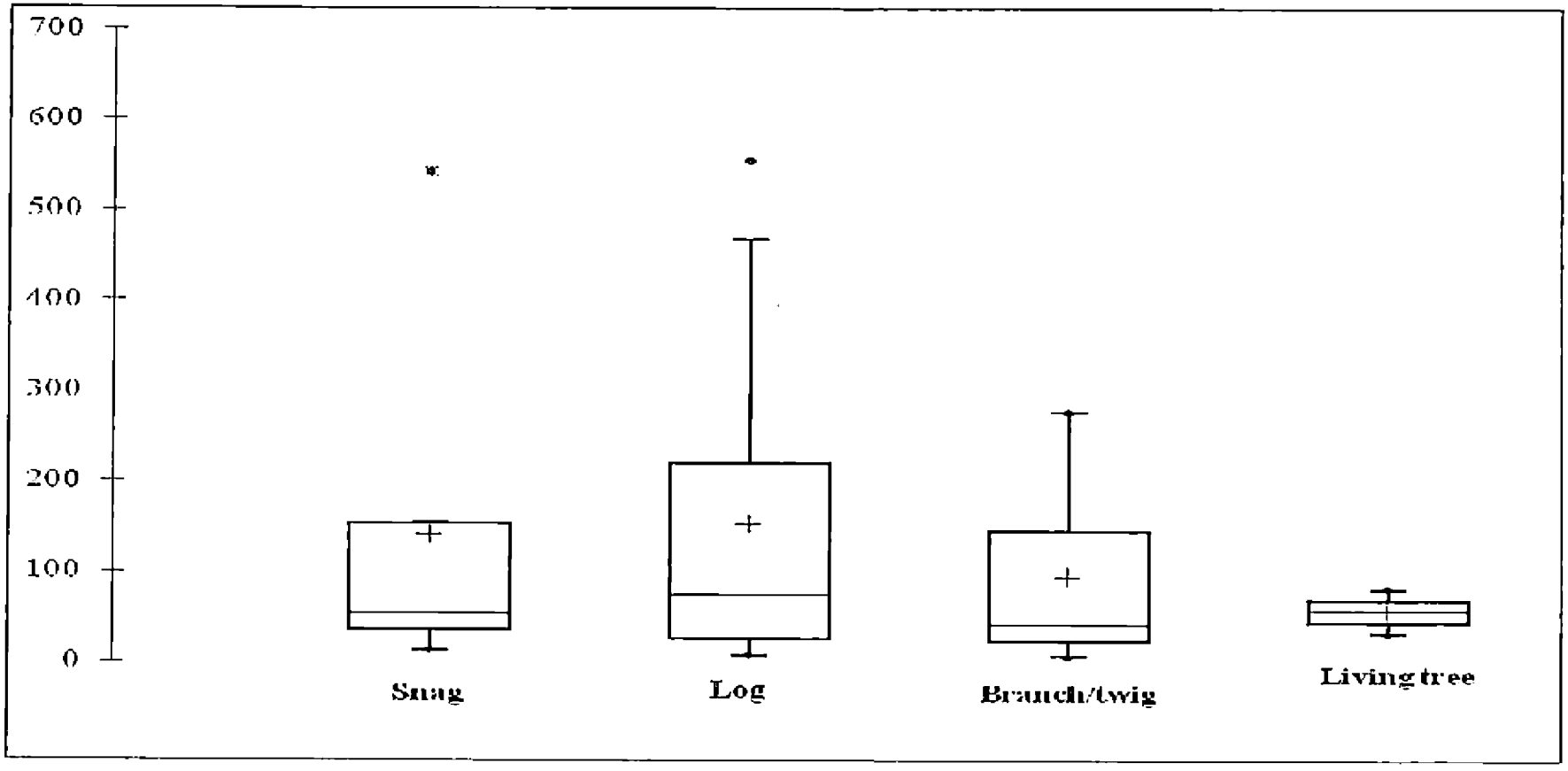


Fig. 16 Distribution of polypores species on different substrate type

4.6.4 Substrate decay class and distribution of polypores

A Chi square test was conducted to find out the association between decay class and distribution of polypores in Peechi-Vazhani Wildlife Sanctuary during three different seasons. It was observed that there was a significant association between decay class and polypores distribution. As the Chi square test was found significant for the association between decay class and polypore distribution during different seasons, based on this, correspondence analysis has been done for all the three seasons.

4.6.4.1 Pre-monsoon period

The correspondence analysis for pre-monsoon season indicated the decay class 1 and 3 determined the first axis and the decay class 2 determined the second axis because of the levels of contribution (Fig. 17). The species like *Microporus affinis, Microporus xanthopus* and *Melanoporia nigra* were positioned highly close indicated a similarity in their association to a particular decay class and polypores like *Phellinus dependens, Fulvifomes nilgheriensis,Fuscoporia gilva, F. senex* and *Trametes spp.* were positioned far away from these species. It was understood that *M. affinis, M. Xanthopus* and *M.nigra* have a strong association with decay class 3 and the proximity of *Phellinus dependens, Fulvifomes nilgheriensis, Fuscoporia spp.* to decay class1 and *Trametes spp.* to decay class 2 indicated that these species have higher frequency of interaction with decay class 1 and 2.

4.6.4.2 Monsoon period

During monsoon season, the decay class 1 was associated with the first axis and the decay class 2 and 3 was associated with the second axis (Fig. 18). Species newly present during the monsoon period like *Earliella scabrosa, Trametes cingulata, Ganoderma lucidum* and *Microporellus obovatus* were shown strong association with decay class 2. The position of species in the map

clearly indicated that, *Fomitopsis feei*, *Microporellus obovatus* and *Trametes hirsuta* have high similarity between each other and *Polyporus arcularius* and *Polyporus grammocephalus* and *Microporus affinis* also have close association for a particular decay class. It has also indicated a similarity among the decay class, the decay class 3 and 4 shown almost similar pattern of association with polypores. Decay class association of *Phellinus dependens, Fulvifomes nilgheriensis, Fuscoporia spp.* has remained unchanged from the pre-monsoon season and these species were more associated with decay class 1. The change in position of some species like *Microporus xanthopus* has shown some signs of decay class shift.

4.6.4.3 Post monsoon period

The correspondence analysis for post monsoon season indicated the decay class 1 determined the first axis and the decay class 2 and 3 determined the second axis (Fig. 19). Newly appeared species after monsoon have shown close association with decay class 2. Apart from other seasons, an interesting shift was observed for decay class of *Microporus xanthopus*, that the species was equally associated with decay class 2 and 3. But during pre-monsoon this species was highly associated with decay class 3 only. It has also indicated a similarity among the decay class, the decay class 3 and 4 shown almost similar pattern of association with polypores. Decay class association of *Phellinus dependens, Fulvifomes nilgheriensis, Fuscoporia spp.*has remained unchanged from the other two seasons.

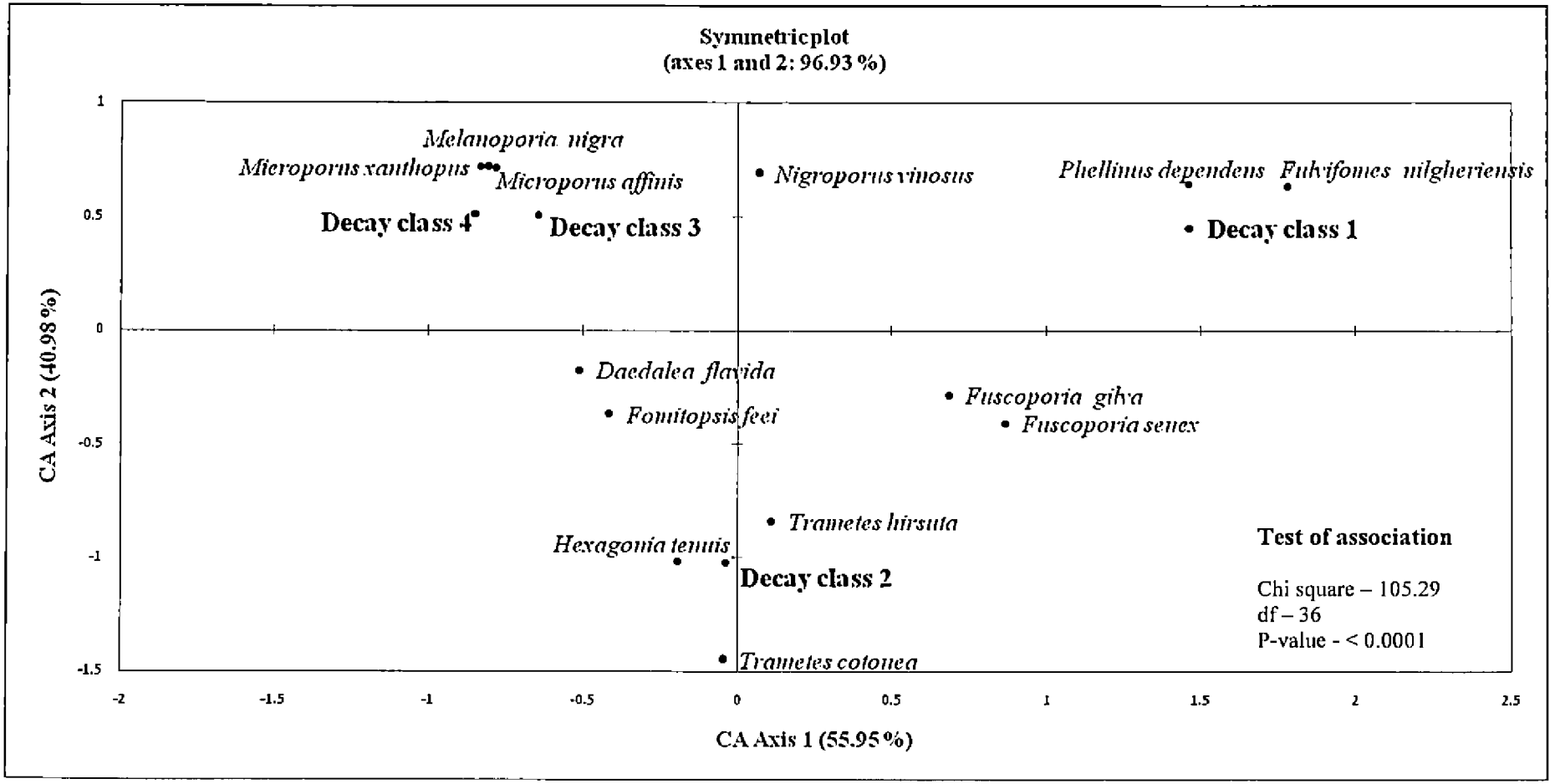


Fig. 17 Correspondence Analysis for the decay class association of polypores during pre-monsoon period

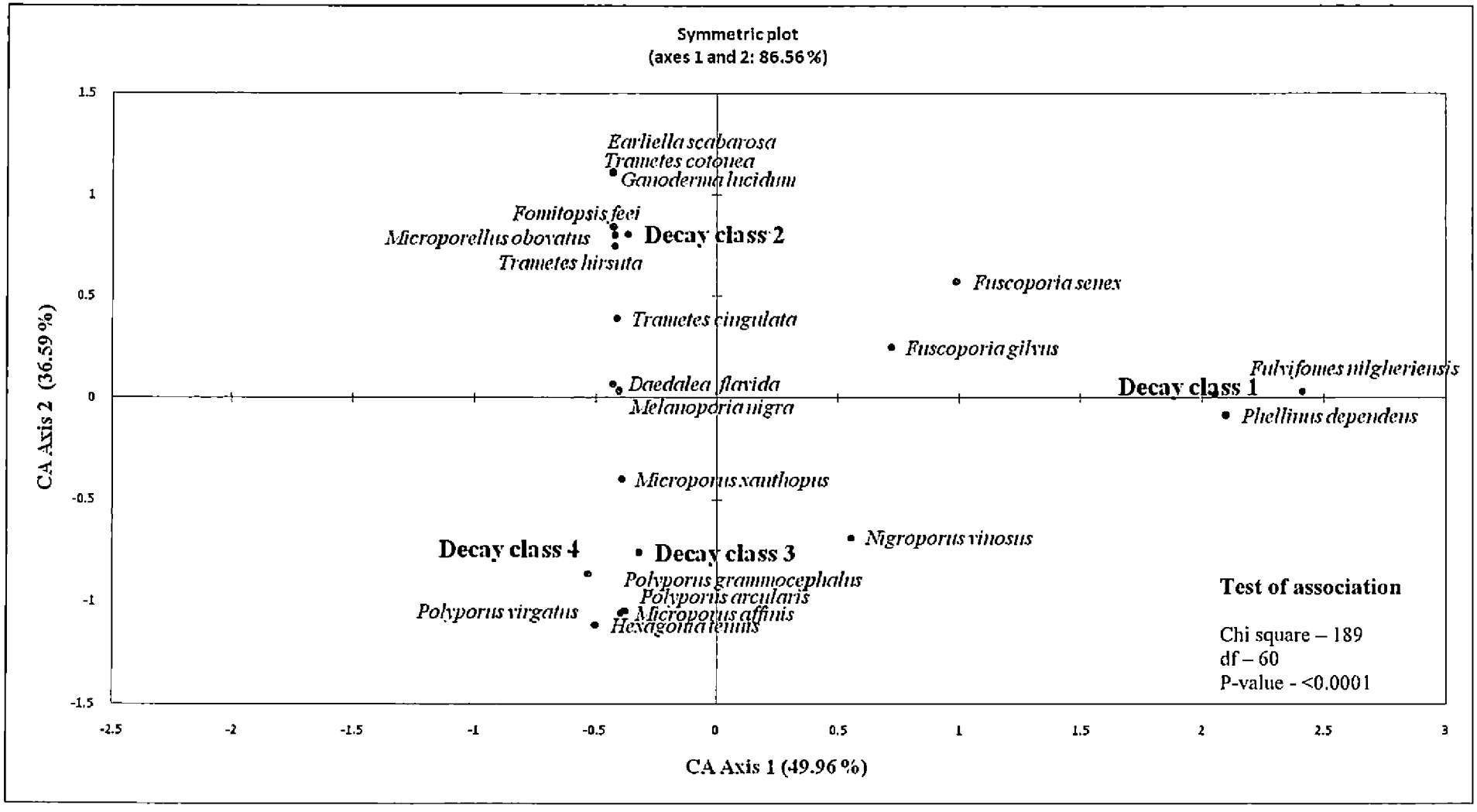


Fig. 18 Correspondence Analysis for decay class association of polypores during monsoon period

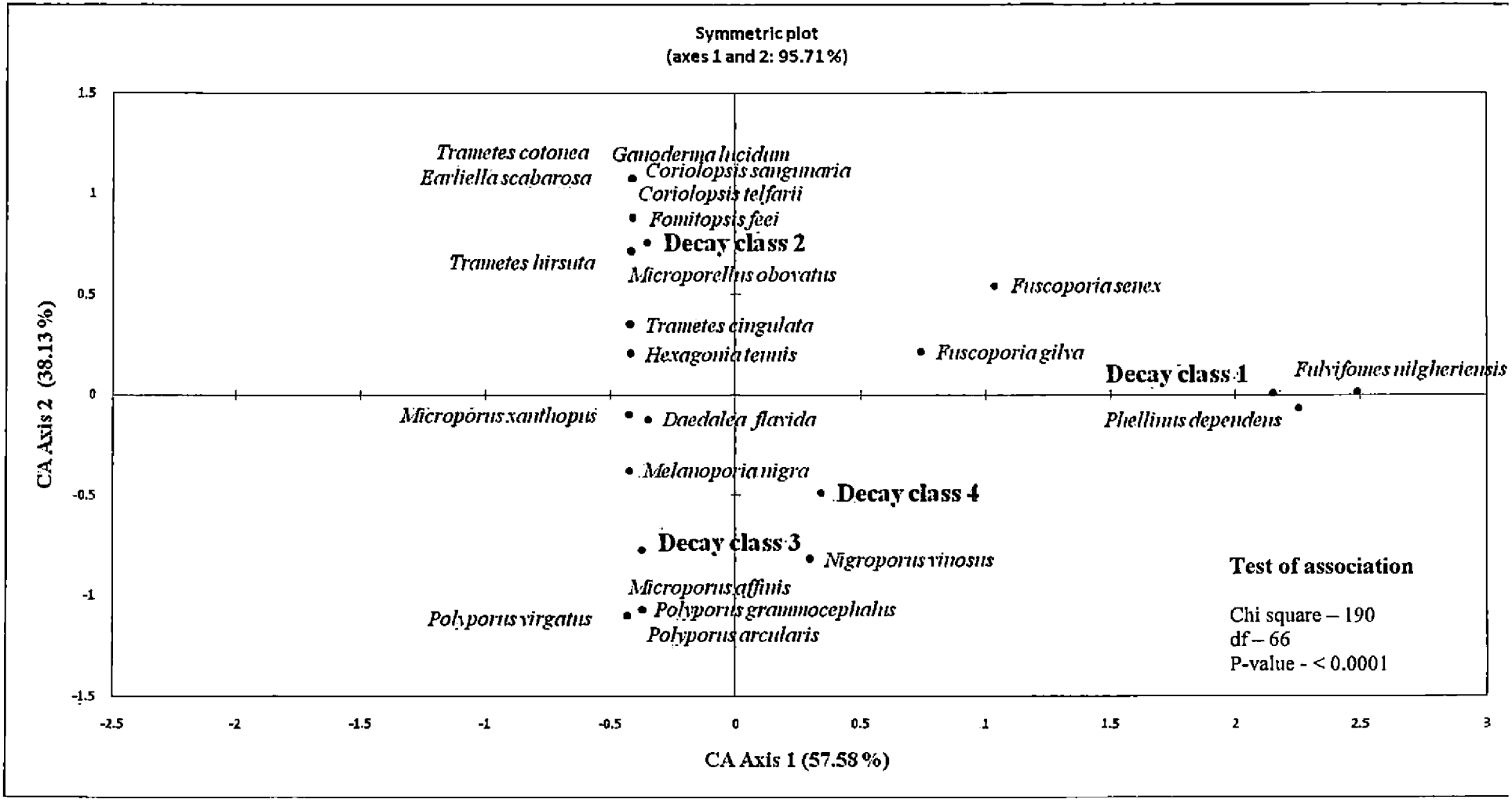


Fig. 19 Correspondence Analysis for decay class association of polypores during post monsoon season

4.7 Ecological strategies of polypores

The primary ecological strategies were studied to understand the natural distribution of polypores in the moist deciduous forests based on the ecological determinants. The ecological determinants includes host association, and substrate features like diameter of substrate, substrate type and substrate decay class (Table 21). Based on this, the observed polypores were found to belong to any of the three categories listed below (Fig. 20).

4.7.1 R-selected polypores

Polypores species like *Polyporus grammocephalus, Polyporus virgatus, Polyporus arcularius, Microporellus obovatus, Earliella scabrosa, Coriolopsis telfarii* and *Coriolopsis sanguinaria* were polypores with short-lived and fleshy fruitbodies, no preference or specificity for host trees, mostly found in substrate small diameter class and intermediate to late decay stages and produced fruitbodies only at the favourable environmental conditions.

4.7.2 S-selected polypores

Daedalea flavida, Microporus xanthopus, Microporus affinis, Hexagonia tenuis, Melanoporia nigra and *Nigroporus vinosus* were the species with persistent and moderately hard fruitbodies, found in all climatic seasons, moderate level of growth and germination during the entire life cycle and *Daedalea flavida* was found in all stages of decay. *Microporus xanthopus, Microporus affinis, Hexagonia tenuis, Melanoporia nigra* spend their life in small diameter class substrates and substrate type such as branches and twigs.

4.7.3 C-selected polypores

Species like *Phellinus dependens, Fulvifomes nilgheriensis, Fuscoporia gilva, Fuscoporia senex, Ganoderma lucidum, Fomitopsis feei, Trametes cotonea and Trametes hirsuta* are with long-lived, woody and corky fruitbodies, some

species showed preference for host tree species, found abundant in early decay stages (decay class 1 and 2), preferred wide range of diameter class substrates and rapid growth and spore germination during the monsoon and post monsoon season.

Table 21. Behavioural attributes of polypores in moist deciduous forests

Sl. No	Species	Behavioural attributes											
		Characters of fruit body					Host association	Substrate diameter			Substrate decay class		
		Long lived	Short lived	Persistent & moderately hard	Woody &corky	Fleshy	Host specific	Small	Intermediate	Large	Early decay	Interme diate decay	Late decay
1	*Coriolopsis sanguinaria*		✓			✓		✓				✓	✓
2	*Coriolopsis telfarii*		✓			✓		✓				✓	✓
3	*Daedalea flavida*	✓		✓				✓			✓	✓	✓
4	*Earliella scabrosa*		✓			✓		✓				✓	✓
5	*Fomitopsis feei*	✓		✓	✓			✓	✓	✓	✓		
6	*Fulvifomes nilgheriensis*	✓		✓	✓		✓	✓	✓	✓	✓		
7	*Fuscoporia gilva*	✓		✓	✓			✓	✓	✓	✓		
8	*Ganoderma lucidum*	✓		✓	✓			✓	✓	✓	✓		
9	*Hexagonia tenuis*	✓		✓				✓			✓	✓	✓
10	*Melanoporia nigra*	✓		✓				✓			✓	✓	✓
11	*Microporellus obovatus*		✓			✓		✓				✓	✓
12	*Microporus affinis*	✓		✓				✓			✓	✓	✓
13	*Microporus xanthopus*	✓		✓				✓			✓	✓	✓
14	*Nigroporus vinosus*	✓		✓				✓			✓	✓	✓
15	*Phellinus dependens*	✓		✓	✓			✓	✓	✓	✓		
16	*Fuscoporia senex*	✓		✓	✓		✓	✓	✓	✓	✓		
17	*Polyporus arcularius*		✓			✓		✓				✓	✓
18	*Polyporus grammocephalus*		✓			✓		✓				✓	✓
19	*Polyporus virgatus*		✓			✓		✓				✓	✓
20	*Trametes cingulata*	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
21	*Trametes cotonea*	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
22	*Trametes hirsuta*	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓

Contd...

Sl.No	Species	Environmental influence		
		Fruitbody production during favourable condition	Rapid growth and germination	Moderate growth & germination
1	*Coriolopsis sanguinaria*	✓		
2	*Coriolopsis telfarii*	✓		
3	*Daedalea flavida*			✓
4	*Earliella scabrosa*	✓		
5	*Fomitopsis feei*		✓	
6	*Fulvifomes nilgheriensis*		✓	
7	*Fuscoporia gilva*		✓	
8	*Ganoderma lucidum*		✓	
9	*Hexagonia tenuis*			✓
10	*Melanoporia nigra*			✓
11	*Microporellus obovatus*	✓		
12	*Microporus affinis*			✓
13	*Microporus xanthopus*			✓
14	*Nigroporus vinosus*			✓
15	*Phellinus dependens*		✓	
16	*Fuscoporia senex*		✓	
17	*Polyporus arcularius*	✓		
18	*Polyporus grammocephalus*	✓		
19	*Polyporus virgatus*	✓		
20	*Trametes cingulata*	✓	✓	
21	*Trametes cotonea*	✓	✓	
22	*Trametes hirsuta*	✓	✓	

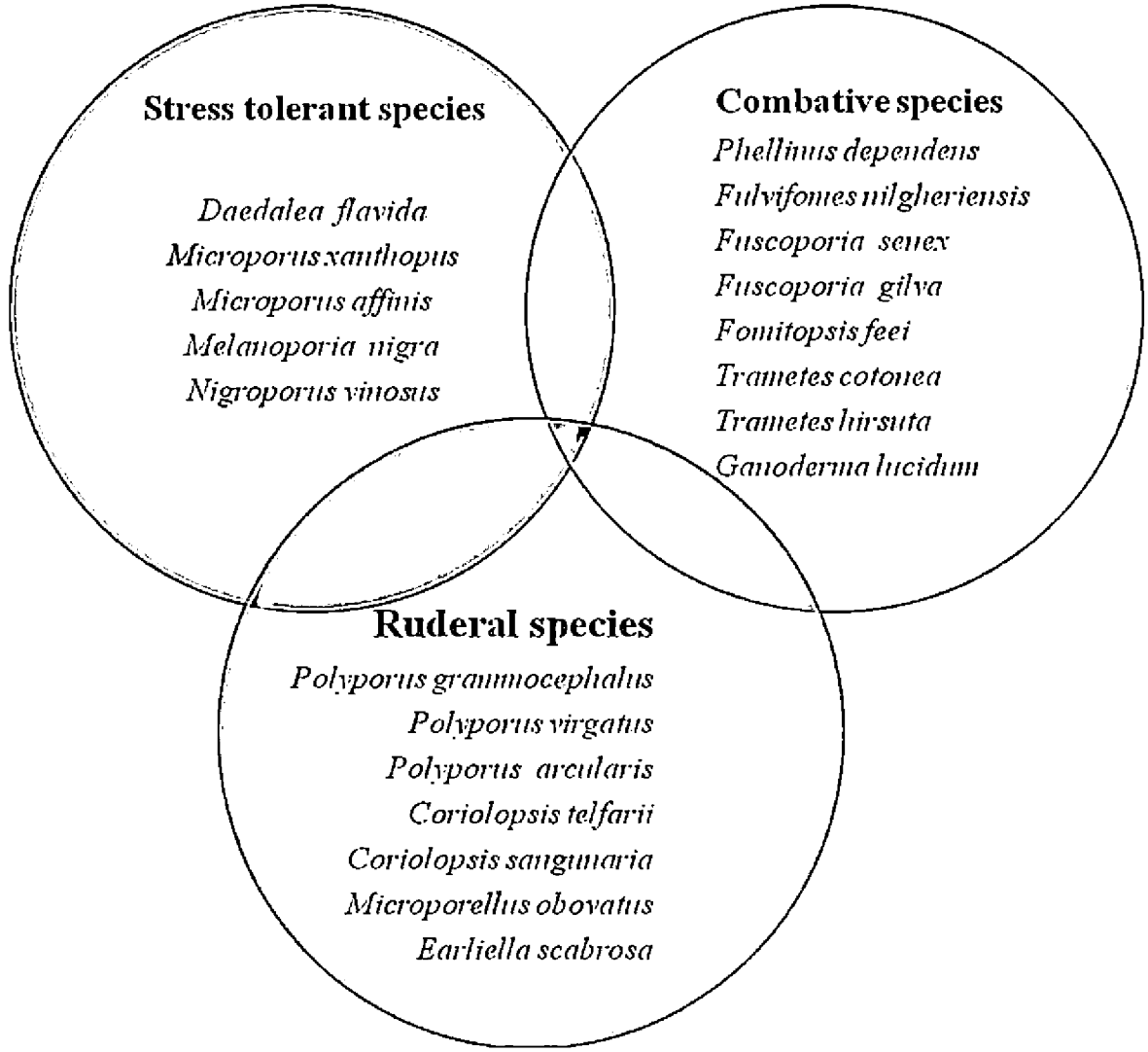


Fig. 20 Primary ecological strategies of polypores in moist deciduous forests

DISCUSSION

5. DISCUSSION

The results obtained from the study on diversity and distribution of *polypores* in the Moist Deciduous Forests of Peechi-Vazhani Wildlife sanctuary are discussed in this chapter.

5.1 Species composition of polypores

The species composition of polypores in the sanctuary revealed that the species belonging to the family Polyporaceae was more common than other five families. Out of the 36 species confirmed, 58.33 per cent were belonging to Polyporaceae and 25 per cent were belonging to Hymenochaetaceae, while Ganodermataceae and Fomitopsidaceae were comprised of 5.56 per cent each and Meripilaceae and Schizoporaceae were consisted of 2.78 per cent each. In case of decay rot, white rotters were found to be more in number than brown rotters. Out of the total species reported, white rotters comprised of 94.44 per cent and brown rotters were 5.56 per cent only. The species composition of present study confirms the findings of previous studies conducted on different forest stands of Western Ghats especially Kerala, Leelavathy and Ganesh (2000) explained 53 species of polypores belonging to 26 genera from both the forest and non-forest areas of Kerala and in that study Polyporaceae was the major family and 90 per cent of the species were white rotters. Noteworthy that, Florence and Yesodharan (2000) reported 31 species of polypores from the Peechi-Vazhani Wildlife Sanctuary and out this, Polyporaceae was the major family and more than 90 per cent of the species were identified as white rot fungi. More recently, Mohanan (2011) described macrofungal flora of Kerala which comprised of 89 polypores species with Polyporeceae as major family and 90 per cent were identified as white rotters.

It was considered that the brown rot fungi are more adapted to coniferous habitats than white rot fungi and more efficient than white rot in acquiring food resources from wood (Gilbertson, 1980). An evolutionary flash back was suggested by Worrall *et al.* (1997) that white rot fungi were highly specialized for

the wood environment, brown rot fungi apparently arose from them in many groups, most especially in the polypores.

By comparing the previous study at Peechi-Vazhani Wilflife Sanctuary, the present study added 18 more species to the checklist of polypores in the sanctuary. During the present study two polypore species viz. *Pycnoporus cinnabarinus* (Jacq.) P. Karst. and *Datronia mollis* (Sommerf.) Donk were recorded newly to South India. These species were confirmed by comparing the characters described for the specimens collected by Bakshi (1971) and Ryvarden and Gilbertson (1993). The present collection of *Pycnoporus cinnabarinus* agrees with that of Bakshi (1971), but the hyphae are broader. Bakshi (1971) reported this species as *Polyporus cinnabarinus* Jacq. ex Fries. The presence of detached proterospores (chlamydospores) is first reported during the present study. Bakshi (1971) reported *Datronia mollis* as *Trametes serpens* Fries. for his collections from Uttar Pradesh and West Bengal. Micro morphology of this species from India is first described during the present study. The present collection of *Datronia mollis* showed similarity to morphological features of North American collections but for the light coloured pore surface (Ryvarden and Gilbertson, 1993). An identification key has also been provided for the polypores recorded from the study area (Appendix 2).

5.2 Community structure of polypores

The number of species reported during pre-monsoon, monsoon and post monsoon showed a wide variation. During pre monsoon period, 13 species were recorded while during monsoon and post monsoon period the number of species were 20 and 22 respectively. A total of 13 species were common in all the three seasons. A significant positive correlation has been noticed in the species composition during monsoon and post monsoon season and this was attributed due to the presence of annual species (Fig. 3). In the pre-monsoon, long lived species with woody fruitbodies like *Phellinus dependens, Fulvifomes nilgheriensis, Fuscoporia senex, Fuscoporia gilva* and *Daedalea falvida* were the

major species. During monsoon season, seven more species has been recorded from the pre monsoon period. It is due to the fact that annual species like *Earliella sacbrosa*, *Ganoderma lucidum*, *Microporellus obovatus*, *Polyporus arcularius*, *P. grammocephalus*, *P. virgatus* and *Trametes cingulata* had been germinated during the monsoon season. It was also noticed that during post monsoon season two more species have been recorded in addition to the species encounted during monsoon season. The annual, with fleshy fruitbody species like *Coriolopsis telfarii* and *C. sanguinaria* were observed during post monsoon period. This could be due to differences in the time lag between the onset of advantageous fruiting conditions and fruit body production between the different species of polypores(Cooke and Rayner, 1984).

The diversity and distribution of macrofungi in the Mount Cameroon region has shown the similar pattern of species distribution, where species richness was higher in the rainy seasons (134 species) than in the early dry seasons (89 species) and Eighty-eight species were recorded only in the rainy seasons, 43 species in the early dry seasons only, and 46 species were common to both seasons. It was explained that most of the fleshy macrofungi were recorded in the rainy seasons as this period is favourable for their production, since there is adequate moisture, favourable temperature, relative humidity and sunshine, which also aids the macrofungi in the decomposition of dead organic matter. While the early dry season there is decrease in rainfall and relative humidity, increase in temperature and sun shine, most of the fleshy macrofungi cannot withstand these conditions. The long lived, woody and corky fruit bodied species found during dry seasons have unique adaptations of surviving for several years producing a new layer of spore producing surfaces thus elevate above the ground ensuring a continuous supply of food material. It might also be probable that these species are not readily eaten by insects and other animals, thus the increase in their abundance (Andrew *et al.*, 2013).

The present study corresponds to Karim *et al.* (2013) in deciduous forest of Iran and it was explained that seasonal changes in rainfall, temperature and moisture are essential factors in distribution of macrofungi. The maximum numbers of macrofungal species were found in wet season. During the present study, it was discussed that an increase of 32 per cent in the number of species from pre-monsoon to monsoon period and 41 per cent from pre-monsoon to post monsoon. Temperature and precipitation during growing season explained 24-90 per cent variation in the occurrence of wood rotting fungi in various forests of India (Sharma, 2006).

Different fungal species exhibits different fruiting phenologies, which vary from year to year and maximum richness of fruiting species occurs only during brief periods and differs among years (Lodge *et al.*, 2004). Likewise, density and frequency percentage of occurrence of polypores over three different seasons demonstrated a remarkable variation in the community structure. During the pre-monsoon period, polypore density was 227 individuals per hectare but during the monsoon period the number of individuals has been increased tremendously to 648 individuals per hectare and the same pattern has also been followed during post monsoon period with a density of 815 individuals per hectare. In case of percentage frequency, during pre-monsoon period 26.66 per cent and observed a wide spread during monsoon and post monsoon with 58.33 per cent and 80.00 per cent respectively. The rapid increase in the number of individuals and percentage frequency over the season signifies that certain conditions especially the spore release, dispersal and germination has been influenced by the climatic variations. Falling water drops and relative humidity of the atmosphere plays an important part in basidiospore liberation and dispersal (Ingold, 1965). Sporocarps of some higher fungi including many woody and leathery bracket fungi are formed only on a damp substratum but can survive considerable periods of desiccation and will commence to shed spores again with a return of moist conditions (Hawker, 1965).

The frequency percentage of occurrence and density of each polypores species during different seasons showed an interesting fruiting pattern. The

density of *Fomitopsis feei*, a brown rot fungus during pre-monsoon period was 6 and it has distributed extensively with a density of 148 and 216 during monsoon and post monsoon respectively. The present study analyzed that the distribution of *Fomitopsis feei* was highly controlled by the climatic variations and those of *Ganoderma lucidum*, *Microporellus obovatus*, *Earliella scabrosa*, *Polyporus grammocephalus* and *Trametes cingulata* were also associated with the climatic fluctuations. In case of perennial species like, *Phellinus dependens*, *Fuscoporia gilva*, *Fuscoporia senex* and *Fulvifomes nilgheriensis*, their density and percentage frequency pattern has not been influenced by the climatic factors. The density and frequency of occurrence of *Daedalea flavida* during pre-monsoon, monsoon and post monsoon was 55, 81, 97 and 5.00, 5.67, 7.67 respectively. Therefore, it was not so much evident that climatic fluctuations have an influence on the distribution. Hence, all these species which were observed in all the three seasons and are more linked to the pre-monsoon period (Fig. 3). Environmental conditions, particularly seasonal fluctuations act distinctly on different fungi to operate in the selection of species available for community development and but also to act differently upon different phases in the life history of a single species. Thus germination, growth, reproduction, spore release, dispersal and survival may not all be influenced in the same direction by a given factor at a given level (Park, 1968).

A fluctuating environment may facilitate co existence of basidiomycetes fungi, the primary decomposer of wood with the functional groups white and brown rot fungi which differ with respect to decay strategy and high species richness may be important for maintaining ecosystem processes under changing environmental conditions (Toljander *et al.*, 2006). However, the diversity parameters like Simpson's index of diversity, Concentration of dominance (Cd) and Shannon-Weiner index derived for the polypores species during different seasons revealed the species diversity interaction among them in the Moist Deciduous Forests. The Simpson's index of diversity for three seasons viz. Pre-monsoon, monsoon and post monsoon were 0.88, 0.90 and 0.88 respectively

(Table 11). It showed that for every hundred individuals of polypores taken at random in different seasons, 88, 90, 88 individuals belong to different species. In case of Concentration of dominance (Cd), it was recorded as 0.12, 0.10 and 0.12 respectively while the Shannon-Weiner index, the parameter which explains both the species richness as well as species evenness was recorded as 2.32, 2.56 and 2.56 respectively. The Shannon-Weiner index for monsoon and post monsoon season has no significant difference as it has increased from the pre-monsoon season. Hence, it was revealed from the present study that the species appeared during the pre-monsoon season has been co-existed with species that emerged during the monsoon and post monsoon season.

Notably, Pradhan *et al.* (2013) found almost similar pattern of species richness for macrofungi in the deciduous forests of West Bengal that Simpson's index of diversity was 0.923 (with evenness of 92.28) and Shannon Weiner index was 3.73. It was also showed that the dominance of a particular macrofungi upon others counterparts was less. The present study corresponds to Andrew *et al.* (2013) in the seasonal variation in species diversity and evenness of macrofungi in the Mount Cameroon region. It was observed that the Simpson's index for dry season varied from 0.73 to 0.92 and during wet season it varied from 0.84 to 0.93. During dry season Shannon Weiner index varied from 2 to 2.86 and in wet season it was varied from 2.6 to 3.2.

Mehus (1986) discussed the fruit body production of macrofungi in forests of North Norway during the late summer and autumn and it was hypothesised that in good seasons, there is a higher similarity in species than in poor seasons. Here, similarities in species composition of polypores between different seasons were analysed using Sorensen's similarity index. Sorensen's similarity index ranges from 0.73 to 0.97. The result of Sorensen's similarity index worked out in Peechi-Vazhani Wildlife Sanctuary (Table 12) showed that the similarity between pre-monsoon and monsoon ranges from 0.76 to 0.88, similarity between monsoon and post monsoon ranges from 0.93 to 0.97 and the similarity between pre-monsoon

and post monsoon ranges from 0.73 to 0.81. Compared to other season pairs, the similarity between pre-monsoon and post monsoon was low, while the similarity between monsoon and post monsoon was very strong and near to almost 100 per cent. This may be due to the fact that during monsoon and post monsoon seasons, the short lived annual polypores were produced extensively and get disintegrated during the pre-monsoon period due to change in temperature. Seasonal change in temperature has an important immediate influence in fungi with limits outside the range are automatically excluded and give a cyclical pattern to the community (Park, 1968).

5.3 Host association of polypores

The distribution of tree species in the study area revealed that out of the total tree species (both live and dead) 35 per cent was belonging to host species category. In case of family of tree species, out of the 28 families, recorded host species were comprised of 10 families. Euphorbiaceae and Combretaceae contributed four species each and they represented the major host families. In lowland rainforest of Malaysia several polypores show preference for Dipterocarpaceae trees that are easily accessible (Hattori *et al.*, 2012). Pradhan *et al.* (2013) observed that the macrofungi shown a preference for *Shorea robusta* (Family: Dipterocarpaceae) in the Sal dominate deciduous forests of West Bengal. Hence it can be ascertained that host tree distribution is related to the forest type at which the study was conducted.

The host and fungus interaction is governed by the inoculum potential of fungus, susceptibility of host tissue to fungi and the environmental conditions that favours the microbial growth. Among the environmental conditions, oxygen is critical to fungal growth since fungi are obligate aerobes and wood moisture content of at least 28-30 per cent (based on dry wt.) equal to the fibre saturation point is required by wood decay fungi. With regard to the susceptibility of host tissue, the amount and type of lignin and the presence of accessory compounds are

also known to influence fungal activity (Rayner and Boddy, 1988). So the density and occurrence of polypores on different host species have been quantified. The highest number of individuals and occurrence of polypores was recorded from *Terminalia paniculata* followed by *Xylia xylocarpa* and *Terminalia elliptica* (Fig. 8 & 9). *Terminalia paniculata* harboured 44 per cent of total polypores individuals in the study area, *Xylia xylocarpa* and *Terminalia elliptica* provided substrate for 14.50 per cent and 10.50 per cent of total polypores individuals reported from the sanctuary. It was also observed among the host families that highest number of polypores individuals was recorded on Combretaceae followed by Mimosoideae and Euphorbiaceae (Fig. 10). Combretaceae hosts 58 per cent of total individuals, while Mimosoideae and Euphorbiaceae hosts 17 per cent and 8 per cent respectively.

The reason could be that coarse woody debris of Combretaceae, Mimosoideae and Euphorbiaceae trees were likely to be abundant on the forest floors; because of these families have high population densities in the sanctuary (Jayanarayanan, 2001). Moreover, the trees in these families like *Terminalia paniculata, Terminalia elliptica, Xylia xylocarpa* were moderately heavy to heavy (Anoop, 2005) and the specific gravity for *Terminalia Paniculata* and *Xylia xylocarpa* was from 0.61 to 0.74 respectively (Bhat *et al.*, 1990). The tree species that has specific gravity more than 0.80 showed some kind of resistance towards decaying fungi (Takahashi and Kishima, 1973).

Host density in the Moist Deciduous Forest was found to be determinant in the diversity of polypores. A significant positive relationship between the polypore fungal diversity and density of host tree species has been observed (Fig. 12). *Terminalia paniculata* with more number of logs supported highest number of polypores species and the similar pattern was observed in other host species that the number of polypores on host increases linearly with increase in number of logs. Notably, in the diversity of polypore fungal communities in tropical forests of Panama, each of many species infected a given host species in a density

dependent manner and host species with higher density supported greater fungal diversity (Gilbert *et al.*, 2002).

5.3.1. Host preference and specificity of polypores

The distribution and ecological impacts of plant-associated fungi is determined in large part by their degree of specificity for particular host species or environmental conditions (Gilbert *et al.*, 2008). Here, a total of 12 polypores species showed a possible preference for a tree host as defined by having more than 50 per cent of their occurrences on a single tree species (Table 15). In the host specificity regression analysis, three polypore species were deviated from the regression line. The three species were *Polyporus virgatus*, *Fuscoporia senex* and *Fulvifomes nilgheriensis*. Among these *Polyporus virgatus* was observed twice, a number of occurrences that allow for the conclusion about the host specificity. Thus only two species out of 20 polypore species (i.e 10 %) with three or more occurrences can be considered as host specialists. Host specialists *Fuscoporia senex* and *Fulvifomes nilgheriensis* preferred *Xylia xylocarpa* (Mimosoideae). This tree species was one of the most common species in the study site. The specialist polypores species sampled in the Moist Deciduous forests are specialists for tree species of that forest type, at the same time these species were described in the literature as being from evergreen, semi-evergreen and plantations (Leelavathy and Ganesh, 2000; Mohanan, 2011). Within the local community context, there is strong support for specialization for trees of that particular forest type and a strong pattern of host preference was not seen in the high-diversity tropical forests but was very strong in the low-diversity temperate forests (Gilbert and Sousa, 2002). Remarkably similar patterns of host specialization in tropical forest as a function of local host density and polypores have been observed (Linbald, 2000) and host specificity of *Phellinus* species belonging to Hymenochaetaceae was also observed from the tropical forests of Brazil (Drechsler-Santos *et al.*, 2010).

5.4 Substrate features and polypore assemblage

5.4.1 Substrate diameter and its influence on polypores distribution

Availability of logs with a wide range of different characteristics is the most important factor in species richness of polypores (Kuffer and Senn-Irlet, 2005). Hence, the relationship between log diameter and distribution of polypores based on the no. of individuals has been studied. Out of total individuals, 2861 (56 %) individuals occurred on substrates in the two smallest diameter classes (11- < 20 cm and 21- < 30 cm), while out of the total individuals 305 (6%) individuals occurred on substrates in the largest diameter class (51- < 60 cm and 61cm & above). Three polypore species (*Daedalea flavida, Fomitopsis feei* and *Microporellus obovatus*) made up more than two-third of individuals on substrates in the small diameter class. The reason could be the large diameter substrates decay at a slower rate and persist for longer as well decayed substrates; they have been shown to serve as an important refuge for fungal species that require woody debris in advanced decay (Heilmann-Clausen and Christensen, 2004).

Noteworthy that in hardwood zone of North America Brazee *et al.* (2014) found similar pattern of diversity for polypores in different diameter classes. The results of the study revealed that, in total, 1,061 out of 1,882 (56 %) of all observations occurred on substrates in the two smallest diameter classes (1 to <10 cm), while 152 out of 1,882 (8 %) occurred on substrates in the largest diameter class (>40 cm) and also showed that smaller diameter substrates (<20 cm) supported increased fungal species richness compared to larger diameter classes (>20 cm). Small diameter substrates have a higher surface to volume ratio for colonization (Norden *et al.*, 2004), hence results of the present study highlighted that small diameter class substrates are also important in maintaining species richness of polypore fungal community.

On average, a more competition free substrate, which could favour the establishment of the common pioneer species (Berglund *et al.*, 2011). Therefore, the diameter class range and preference of polypores has been recorded based on

the number of occurrences (Table 18). The occurrences of polypores showed an interesting pattern of distribution. Species like *Daedalea flavida Fomitopsis feei* and *Earliella scabrosa* have wide range of diameter class, while species like *Hexagonia tenuis* and *Microporus xanthopus* have only very narrow range of diameter class. Similarly wide range diameter class and preference for a particular diameter class was observed for wood-inhabiting aphyllophorales fungi in a cool temperate area of Japan (Yamashita *et al.*, 2010).

A total of seven polypores species showed a possible preference for a diameter class as defined by having more than 50 per cent of their occurrences on a single diameter class (Table 19). *Hexagonia tenuis* , *Microporus xanthopus* and *Microporus affinis* showed preference for very small diameter class (0- < 10 cm). Species like *Fulvifomes nilgheriensis*, *Fuscoporia gilva* and *Phellinus dependens* preferred 31- < 40 cm diameter substrates. The species preferred for 31- < 40 cm diameter class were perennials with woody and hard fruitbodies. Notably in lowland rainforests in Malaysia, *Microporus xanthopus* are mostly restricted to <10 cm diameter class, whereas *Phellinus lamaensis*, and perennials occur mostly on larger substrates (Hattori and Lee 2003; Yamashita *et al.*, 2009) and these species are considered as important decomposers of coarse woody debris in that forest type.

5.4.2 Substrate type and its influence on polypores distribution

In trees, the central core of dead heartwood is protected from the decay fungi by the outer living sapwood and the bark. As the tree grows, chances for the infection also increase, the rate of healing of wounds becomes slow, the relative proportion of heartwood increases with a consequent decrease in the resistance to decay and if the heartwood becomes exposed due to injuries, decay may establish in the heartwood as heart rot which becomes progressive (Mohanan, 1994). Some wood decay fungi are saprotrophic in nutrition and attack on fallen logs, branches or twigs (Toupin *et al.*, 2008). Pathogenic wood decay fungi are sometimes placed in convenient categories and that can decay heartwood in living trees despite tree

produce protective chemicals and low oxygen conditions (Highley and Kirk, 1979).

In order to understand the distribution of polypores on different substrate type were studied by dividing the substrates into four types (Table 20). Out of the total individuals, 49 per cent were found in trunk (2480 individuals), 29 per cent were in branch/twig (1469 individuals) and 20 per cent in snag (1012 individuals). The living trees supported only 2 per cent of total individuals (113 individuals). The high density species like *Fomitopsis feei, Dadalea flavida* and *Trametes cotonea* made up more than half of their total individuals in trunk and species like *Microporus affinis, Microporus xanthopus, Polyporus grammocephalus* and *Hexagonia tenuis* made up more than half of the their total individuals in branches/ twigs. Likewise, higher richness of fungal species was found in the branches and logs of hardwood zone of North America (Brazee *et al.*, 2014).

Although *Fomitopsis feei*, a brown rot fungus showed high preference for snag (dead standing trees) and hymenochaetaceae members like *Phellinus dependens* and *Fulvifomes nilgheriensis* was observed in the living trees; no other species were observed in the living tree during the entire study period and these living trees were belonged to *Xylia xylocarpa.* Besides, white rot fungi with annual habit like *Daedalea flavida, Trametes cotonea, Microporus affinis, Microporus xanthopus, polyporus grammocephalus* and *Hexagonia tenuis* have wide spread occurrence in trunk (fallen log) and branches/twigs. Mohanan (1994) reported that *Microporus affinis and M. xanthopus* were common in the forest stands of Kerala, which caused mainly white-rot of branches and twigs and brown fungi including *Fomitopsis* spp. have wide spread occurrence. It was also discussed that despite the diversity of the microbes associated with heart rot of living trees, the degradation of the cell wall components is still ascribable to hymenomycetes. Hence the present study agrees with the findings of previous studies in the forests of Kerala.

5.4.3 Substrate decay class and its influence on polypores distribution

Wood inhabiting fungi succeed each other according to a regular order and that they differ from each other in their association with microclimatic regimes in their strategies in resource capture, in their competition ability during the wood decomposition and their species associates (Renvall, 1995). In order to understand the succession pattern of polypores and decomposition stages of wood along seasons in tropical forests, a correspondence analysis has been done. The correspondence analysis for pre-monsoon season indicated during this season the species distribution was related with the decay class 1, 2 and 3 while in monsoon and post monsoon seasons, decay class 4 plays a significant role in the distribution of polypores (Fig. 16, 17 & 18).

During pre-monsoon season, species like *Microporus affinis*, *Microporus xanthopus* and *Melanoporia nigra* have a strong affinity towards decay class 3 and *Phellinus spp.* and *Trametes spp.* showed affinity for decay 1 and 2 respectively. Also species like *Nigroporus vinosus* was found in late decay stages (decay class 3). In this study, *Phellinus dependens, Fulvifomes nilgheriensis, Fuscoporia spp.* and *Trametes spp.* were the dominant species, comprising more than 70 per cent of the fruitbodies encountered and decay class 1 and 2 are the advanced decay class. It was widely accepted that dominant species, and in particular their functional traits, are most important in determining current magnitude, rate and direction of ecosystem processes, whereas subordinate and rare species play a minor role in present ecosystem dynamics (Walker *et al.*, 1999; Díaz & Cabido, 2001). However, Yamashitha *et al.* (2010) revealed that in cool temperate regions of Japan some polypores species occurs mainly in the early decay stages of decomposition whereas others form fruiting bodies in later stages of decomposition.

The decomposition of wood materials on the forest floor proceeds through sequential colonization by fungal species with different decay types and their interspecific interactions, which leads to a fungal succession during

decomposition (Rayner and Boddy, 1988). Apart from the pre monsoon season, during monsoon season and post monsoon, the newly germinated white rot species like *Earliella scabrosa, Trametes cingulata, Ganoderma lucidum, Microporellus obovatus, Coriolopsis telfarii* and C. *sanguinaria* were showed high association with decay class 2. Fukasawa *et al.* (2009) suggested that white-rot basidiomycetes, play a central role in the simultaneous decomposition of acid-unhydrolyzable residue (AUR) and holocellulose in the first phase of decomposition. In early stages of decay (decay class 2), *Fomitopsis feei* (brown rot fungi), *Microporellus obovatus* and *Trametes hirsuta* have high similarity between each other. Among these species *Fomitiopsis feei* showed high abundance in the monsoon and post monsoon season. The reason could be that inter-specific mycelial interactions among brown rot fungi and white rot fungi resulted in either deadlock or replacement of one fungus by the other and some brown rot fungi are capable of invading and occupying domains within white rot fungal communities in decaying wood (Owens *et al.*, 1994).

Species with annual, small sized fruitbodies like *Microporus affinis, Microprus xanthopus, Polyporus grammocephalus, Hexagonia tenuis, Polyporus arcularius* have a close association and highly associated with decay class 3, where there is less energy available. It was also observed that during all seasons, species belonging to genera such as, *Phellinus, Fulvifomes, Fomitopsis, Ganoderma* and *Fuscoporia* with long lived fruitbodies are more abundant in decay class 1 and decay class 2 (i.e. less decayed wood samples), which would typically hold more available energy. These results support the idea of an energy driven control of fruit body production for some species (Schmit, 2005). Although, sporophore production, particularly regarding species with short lived sporophores, may also be triggered by other factors, such as shifts in temperature and humidity as well as interspecific interactions (Moore *et al.*, 2008).

Microporus xanthopus has shown a sign of decay class shift, during pre-monsoon season as it is associated with decay class 3 only and during monsoon and post monsoon season, it showed a shift towards decay class 2 and equally

distributed in decay class 2 and 3. This reflects a species turnover towards a community that depends upon a pre-modified wood environment as well as the presence of senescing mycelia (Kubartova *et al.*, 2012). Other polypores species *Daedalea flavida* was found in decay class 1 to decay class 4 supports the view that once a primary species is established in a fallen trunk, it may persist in the community for a long time (Vetrovsky *et al.*, 2011). Thus, they can be considered as stress-selected species that move towards competitive-selected life histories as the substrate proceeds to higher decay classes.

5.5 Ecological strategies of polypores

Cooke and Rayner (1984) proposed the following primary strategies in wood decaying fungi based on the behavioural attributes: a) Ruderal strategies (R-selected fungi) b) Stress-tolerant strategies (S- selected fungi) c) Combative strategies (C-selected fungi). Ruderal species are short-lived, capable only of utilizing easily assimilable resources, rapid and sometimes total commitment to reproduction. Stress-tolerant species persist as long as the stress condition maintained, subject to replacement if stress condition is alleviated, not generally of rapid growth, spore germination or reproduction rates and good enzymatic competence. Combative species are persistent, long lived, capable of defending captured, with or without rapid growth and spore germination, slow or intermittent reproduction and good enzymatic competence.

Short lived polypores species with fleshy fruitbodies like *Polyporus grammocephalus, Polyporus virgatus, Polyporus arcularius, Microporellus obovatus and Earliella scabrosa,* showed typically fast reproduction and rapid growth during favourable conditions (high abundance during monsoon and post monsoon season) and competition-free substrate (decay class 3 and 4). In temperate forests, Boddy and Heilmann-Clausen (2008) explained the ecological strategy of *Phelbia radiata,* a polypore fungus and found that the mycelium extends rapidly, utilize simple organic compounds and does not respond

aggressively to other fungi. It was explained R-selected characteristics are favoured in the relative absence of stress in uncrowded environments resulting from disturbances; which includes the ability to reproduce rapidly, effective dispersal, narrow enzymatic ability, hence, utilization of simple easily available substrates.

Species like *Daedalea flavida, Microporus xanthopus, Microporus affinis, Hexagonia tenuis, Melanoporia nigra* and *Nigroporus vinosus* with persistent and moderately hard fruit bodies and found in all seasons. These species have intermediate value of abundance throughout all the seasons, which indicated the moderate level of growth and germination during the entire life cycle. In case of species like *Nigroporus vinosus* and *Microporus xanthopus* get subjected to replacement during monsoon and post monsoon season, which showed these species have the capacity to sense the easily assimilable organic substrates. Species like *Daedalea flavida* was found in all stages of decay and indicated that it is a primary species with stress tolerance. *Microporus xanthopus, Microporus affinis, Hexagonia tenuis, Melanoporia nigra* spend their life in small diameter class substrates and substrate type such as branches and twigs, which were with low nutrient availability. S-selected fungi are successful in situations where assimilable organic nutrients are freely available but where other environmental factors like temperature, relative humidity, water availability are inimical to fungal development (Cooke and Rayner, 1984).

Long-lived, woody and corky fruitbodied species like *Phellinus dependens, Fulvifomes nilgheriensis, Fuscoporia gilva, Fuscoporia senex, Ganoderma lucidum, Fomitopsis feei, Trametes cotonea and Trametes hirsuta* were the C-selected polypores in the study site. Among these *Fulvifomes nilgheriensis* and *Fuscoporia senex* showed preference for host tree species, found abundant in early decay stages (decay class 1 and 2), preferred wide range of diameter class substrates and rapid growth and spore germination during the monsoon and post monsoon season. In Norway spruce forests, Ottosson (2013) found that Long-lived polypores such as *Heterobasidion parviporum* and *Phellinus nigrolimitatus*

were encountered in the majority of the studied logs where they typically dominated the inner parts. It was discussed that, the behavioural pattern of these species reflects a competitive life-strategy (C-selected) where one species may dominate a large part of the inner wood column in a log. Also (Ovaskainen *et al.*, 2010), suggested that the coexistence of the species might be explained by niche partitioning by excluding each other from their occupied domain, and, thus, being C-selected species.

SUMMARY

6. SUMMARY

The objective of the study was to understand the diversity, distribution and host preference of polypores in the moist deciduous forests of Peechi-Vazhani Wildlife Sanctuary in three different seasons. Three sites were randomly selected in the moist deciduous forests of the sanctuary and the details like species composition, host attached, substrate features like diameter, type and decay class were enumerated during all the three seasons. The results obtained from the study are summarized below:

1) Altogether thirty six polypores species were encountered in the study area out of which *Pycnoporus cinnabarinus* and *Datronia mollis* are first reports from South India.
2) Out of the total species reported, white rotters comprised of 94.44 per cent and brown rotters were 5.56 per cent only.
3) *Fomitopsis feei* with higher abundance values dominated the moist deciduous forests during monsoon season (17.72) and post monsoon season (13.79). During pre-monsoon season, *Daedalea flavida* was the dominant species with abundance value 10.93. *Fomitopsis feei* and *Daedalea flavida* were predominant during all the seasons due to their high ecological amplitude.
4) The present study of polypores during different seasons showed significant differences in species composition and fungal community structure. It was observed that the distribution of *Daedalea flavida* was more related to pre-monsoon season and that of *Fomitopsis feei* was highly related to monsoon and post monsoon seasons.
5) The species composition and community structure of polypores during pre-monsoon was significantly different from monsoon and post monsoon seasons, the reason for the difference can thus be attributed the fluctuations in the climatic factors. So it is considered that rainfall,

temperature and relative humidity are the main determinants for the species composition and community structure.

6) The structural analysis of polypores during different seasons revealed that brown rot fungus *Fomitopsis feei* and white rot fungi namely *Daedalea flavida, Trametes cotonea, Microporellus obovatus, Fuscoporia gilva, Earliella scabrosa* and *Microporus xanthopus* were dominating the moist deciduous forests of Peechi-Vazhani Wildlife Sanctuary.
7) Fungal diversity studies revealed that species richness was higher during monsoon season compared to pre-monsoon and post monsoon seasons. Comparing the three seasons, it was found that Simpsons' diversity index (species richness) for monsoon season was 0.90 while it was 0.88 for pre-monsoon and post monsoon seasons.
8) Shannon-Wiener index was highest for both monsoon and post monsoon seasons compared to pre-monsoon season.
9) Sorensen similarity index worked out in the study during different seasons showed that similarity index between pre-monsoon and post monsoon was low compared to the same between pre-monsoon and monsoon.
10) Polypore-host association revealed that a total of 48 tree species belonging to 28 families were identified from the study area and out of this, 17 were recognized as host species and 31 were non-host species.
11) Out of the 28 families, host species were comprised of 10 families. Euphorbiaceae and Combretaceae contributed four species each and they represented the major host families.
12) The highest number of basidiocarps and highest number of occurrences were recorded from *Terminalia paniculata* and Combretaceae family.
13) A total number of 144 logs of different size belonging to 17 host species were recorded. Out of this, highest numbers of logs were recorded from *Terminalia paniculata*. The regression graph revealed that diversity of

polypores has increased linearly with the availability of more logs of a host i.e. density of host.

14) *Terminalia paniculata* was highly preferred by the polypores. *Fulvifomes nilgheriensis* and *Fuscoporia senex* were considered as host specific and found only in *Xylia xylocarpa.*

15) The maximum species density has been recorded in host trees having 21-< 30 cm diameter class. Species like *Fomitopsis feei, Daedalea flavida* and *Microporellus obovatus* contributed maximum number of individuals in this diameter class.

16) Species like *Daedalea flavida, Earliella scabrosa* and *Fomitopsis feei* have been attached to wide range of diameter classes, while species like *Hexagonia tenuis* and *Microporus xanthopus* have only very narrow range of diameter classes.

17) *Hexagonia tenuis, Microporus xanthopus* and *Microporus affinis* showed preference for 0- < 10 cm diameter class while *Trametes hirsuta* preferred 21- < 30 cm diameter class. Species like *Fulvifomes nilgheriensis, Fuscoporia gilva* and *Phellinus dependens* preferred 31- < 40 cm diameter substrates.

18) Among the substrate types, maximum number of individuals was observed in trunk whereas living trees supported only very few polypores individuals (113). The species observed in the living trees were *Phellinus dependens* and *Fulvifomes nilgheriensis.*

19) During pre-monsoon season, *Microporus affinis, M. Xanthopus* and *Melanoporia nigra* have a strong association with decay class 3 and during monsoon and post monsoon season newly present species like *Earliella scabrosa, Trametes cingulata, Ganoderma lucidum* and *Microporellus obovatus* were found to have strong association with decay class 2.

20) Decay class association of *Phellinus dependens, Fulvifomes nilgheriensis, Fuscoporia spp.* has remained unchanged during all the

three seasons and these species were more associated with decay class 1. *Microporus xanthopus* has shown its liability to decay class shift.

21) Polypores species like *Polyporus grammocephalus, Polyporus virgatus, Polyporus arcularis, Microporellus obovatus, Earliella scabrosa, Coriolopsis telfarii* and *Coriolopsis sanguinaria* were identified as ruderal species or R-selected species.

22) *Daedalea flavida, Microporus xanthopus, Microporus affinis, Hexagonia tenuis, Melanoporia nigra* and *Nigroporus vinosus* were the Stress tolerant or S- selected species.

23) Species like *Phellinus dependens, Fulvifomes nilgheriensis, Fuscoporia gilva, Fuscoporia senex, Ganoderma lucidum, Fomitopsis feei, Trametes cotonea and Trametes hirsuta* were recognized as combative species or C-selected species.

REFERENCES

REFERENCES

Andrew, E. E., Kinge, T. R., Tabil, E. M., Thiobal, N., and Mih, A.M. 2013. Diversity and distribution of macrofungi (mushrooms) in the Mount Cameroon Region. *J. Ecol. Nat. Environ.* 5(10): 318-334.

Anoop, E. V. 2005. Anatomical key for the identification of important timbers of Kerala. Kerala Agricultural University, Thrissur. 226p.

Aragon, J. M. D., Bonet, J. A., Fischer, C. R., and Colinas, C. 2007. Productivity of ectomycorrhizal and selected edible saprotrophic fungi in pine forests of the pre-Pyrenees mountains, Spain: Predictive equations for forest management of mycological resources. *Forest Ecol. Manag.* 252: 239–256.

Arnolds, E. 1981. Ecology and coenology of microfungi in grasslands and moist heathlands in Drenthe, The Netherlands. Part 1. Introduction and synecology. *Bibliogr. Syst. Mycol.* 83: 1–410.

Asiegbu, F. O., Nahalkova, J., and Li, G. 2005. Pathogen-inducible cDNAs from the interaction of the root rot fungus *Heterobasidion annosum* with Scots pine (*Pinus sylvestris* L.). *Plant Sci.* 268: 365–372.

Bader, P., Jansson, S., and Jonsson, B. G. 1995. Wood-inhabiting fungi and substratum decline in selectively logged boreal spruce forest. *Biol. Conserv.* 72: 355–362.

Bagchee, K. 1953. A new and noteworth disease of Gamhar *(Gmelina arborea* Linn.) due to *Poria rhizomorpha* sp. nov. *Indian For.* 79 (1): 17-24.

Bagchee, K. 1954. The fungal disease of Sal *(Shorea robusta* Gaertn. f. & Fils.), Part II, secondary parasites of Sal. Indian For. Rec. 1 (8): 97-184.

Bagchee, K. 1958. The fungal diseases of Sal *(Shorea robusta* Gaertn. f. & Fils.) V. The heart rot of Sal caused by *Trametes incerta* (Currey) Cokke. *Indian For. Rec.* 2(4): 61-69.

Bagchee, K. 1961. The fungal diseases of Sal *(Shorea robusta* Gaertn. f. & Fils.), IV. *Fames caryophylii* (Rae.) Bres. A destructuve heart rot of Sal. *Indian For. Rec.* 2(3): 25-28.

Bagchee, K., and Bakshi, B. K. 1950. Some fungi as wound parasities of India trees. *Indian For.* 76: 244-253.

Bagchee, K., and Bakshi, B. K. 1951. *Poria monticola* Murr. on Chir (*Pinus longifolia* Roxb.) in India. *Nature* 167 (4255): 824.

Bakshi, B. K. 1955. Diseases and decays of conifers in the Himalayas. *Indian For.* 81 (12): 779-797.

Bakshi, B. K. 1956. Occurrence of *Polyporus squamosus* (Hund.) Fr. in India. *Indian Phytopath.* 9: 191-194.

Bakshi, B. K. 1957a. Diseases of Khair (*Acacia catechu* Willd.) and their prevention. *Indian For.* 83: 41-46.

Bakshi, B. K. 1957b. Heart rots in relation to management of Sal. *Indian Phytopath* 83: 651-661.

Bakshi, B. K. 1965. Four *Fomes* as unrecorded tree parasites in India.Forest Bulletin No.244, Forest Research Institute, Dehradun. pp.4

Bakshi, B. K. 1971. Indian Polyporaceae (on trees and timber). ICAR, New Delhi, 246p.

Bakshi, B. K., and Sujan, S. 1970. Heart rot in trees. *Int. Rer. For. Res.* 3: 197-251.

Bakshi, B. K., and Balwant, S. 1961. Heart rot and decay due to *Polyporus palustris. Indian For.* 87: 116-118.

Bakshi, B. K., and Boyce, J. S. 1959. *Polyporus shorea* (root rot) on Sal. *Indian For.* 85:656-658.

Bakshi, B. K., Sujan, S., and Ujagar, S. 1966. A new root rot disease complex in *teak. Indian For.* 92 (9): 566-569.

Bakshi, B. K., Sen, M., and Balwant, S. 1970. Cultural diagnosis of Indian Polyporaceae- II. Genera *Fomes* and *Trametes. Indian For. Rec.* 2 (10): 245-476.

Bakshi, B. K., Sehgal, H.S., and Balwant, S. 1969. Cultural diagnosis of Indian Polyporaceae-1. Genus Polyporus. *Indian For. Rec.* 2 (9): 205-244.

Baltazar, J. M., Trierveiler-Pereira, L., and Loguercio-Leite, C. 2009a. A checklist of xylophilous basidiomycetes (Basidiomycota) in mangroves. *Mycotaxon* 107:221–224.

Baltazar, J. M., Trierveiler-Pereira, L., Loguercio-Leite, C., and Ryvarden, L. 2009b. Santa Catarina Island mangroves 3: a new species of *Fuscoporia*. *Mycologia*. 101:859–863.

Balwant, S. 1961. Occurrence of *Trametes ravida* (Fr.) Pilat in India. *Indian For.* 87:429-430.

Balwant, S. 1966a. Timber decay due to five species of *Fomes* as new records. *Indian For.* 92: 653-655.

Balwant, S. 1966b. Studies on Indian *Poria II*. Diagnosis of five species as new record. *Indian For.* 92: 680-683.

Balwant, S., and Bakshi, B. K. 1961. New records of *Fomes* from India. *Indian For.* 87: 302-303.

Banerjee, S. N., and Bakshi, B. K. 1945. Studies in the Biology of wood rooting fungi of Bengal. *J. Indian Bot. Soc.* 24: 73-93.

Banerjee, S. N., and Chakravarthy, M. 1945. On the biology of *Polyporus agaricus* Berk. Proc. 32nd Indian Science Congress, Nagpur. p.69.

Banerjee, S. N., and Ghosh, T. 1945. On the collection of Hymenomycetous fungi from the Sikkim-Himalayas. Proc. 32nd Indian Science Congress, Nagpur. p.69.

Banerjee, S. N., and Chatterjee, S. B. 1945a. Some observations on the identity of *Amaurodema rugosum* Nees., a rare species in Bengal. Proc. 32nd Indian Science Congress, Nagpur p.68.

Banerjee, S. N., and Chatterjee, S. B. 1945b. A note on the hyphal systems of the sporophores of *Amaurodema rugosum* Nees. Proc. 32nd Indian Science Congress, Nagpur. p.68.

Banerjee, S. N., and Chatterjee, S. B. 1945c. Studies on "white rot" and "brown rot". Proc. 32nd Indian Science Congress, Nagpur. p.68.

Banerjee, S. N., and Ghosh, T. 1942. Preliminary report on the occurrence of higher fungi on bamboos in and about Calcutta. *Sci. Cult.* 8 (4): 194.

Banerjee, S. N., and Sinha, A. K. 1955. A simple method for producing typical sporophores of *Polystictus sanguineus* (L.) Mey. *Sci. Cult.* 20: 612-613.

Banerjee, S. N. 1946. Some higher fungi of Sikkim-Himalayas. *Sci. Cult.* 11: 444-445.

Becker, G. 1956. Observations surl'écologie des champignons supérieurs. *Ann. Sci. Univ.* 7: 15–128.

Berglund, H., Jönsson, M., Penttilä, R., and Vanha-Majamaa, I. 2011. The effects of burning and dead-wood creation on the diversity of pioneer wood-inhabiting fungi in managed boreal spruce forests. *Forest Ecol. Manag.* 261: 1293–1305.

Berkeley, M. J. 1839. Description of exotic fungi in the collection of Sir W. J. Hooker, from memoirs and notes of J. F. Klotzsch, with additions and corrections. *Ann. Nat. Hist.* 3: 375-401.

Berkeley, M. J. 1847. Decades of fungi XV-XIX. Ceylon Fungi No.183. Land. *J. Bot.* 6: 312-326.

Berkeley, M. J. 1850. Decades of fungi XXV-XXX.Sikkim-Hirnalayan fungi. *Hook. J. Bot.* 2:42-51.

Berkeley, M. J. 1851. Decades of fungi XXXI-XXXVI. Sikkim-Himalayan fungi collected by Dr. Hooker. *Hook. J. Bot.* 3:4-21, 39-49, 77-84, 167-172,200-206.

Berkeley, M. J. 1854. Decades of fungi XLI-L. Indian fungi. *J. Bot.* 6: 129-143, 161-174, 204-212, 225-35.

Berkeley, M. J. 1855. Fungi, in Hooker, W. J. (Eds.) Botany of the Antartic Voyage II. Flora Nova-Zealandia 2. London. p.555.

Berkeley, M. J. 1866. Fungi of the plains of India. Intellectual Observer 12:18-21. *Bharati Annals* 14(2): 20-29.

Berkeley, M. J. 1872. Australian fungi received principally from Baron F. Von Mueller and Dr. R. Schomburk. *J. Linn. Soc. Bot.* 13:155-177.

Bhat, K. M., Bhat, K. V., and Dhamodaran, T. K. 1990. Wood specific gravity in stem and branches of eleven timbers from Kerala. *Indian For.*116 (7): 541-546.

Bhosale, S., Ranadive, K., Bapat, G., Garad, S., Deshpande, G., and Vaidya, J. 2010. Taxonomy and Diversity of *Ganoderma* from the Western parts of Maharashtra, India. *Mycosphere* 1(3): 249–262.

Bielenin, A., Jeffers, S.N., Wilcox, W. F., and Jones, A. L. 1988. Separation by protein electrophoresis of six species of *Phytophthora* associated with deciduous fruit crops. *Phytopathology* 78 (11): 1402-1408.

Bieri, Ch., Lussi, S., Senn-Irlet, B., and Hegg, O. 1992. Zur Synökologie der Makromyzeten in wichtigen Waldgesellschaften des Berner Mittellandes, Schweiz. *Mycol. Helv.* 5: 99-127.

Binder, M., and Hibbert, D. S. 2002. Higher-level phylogenetic relationships of Homobasidiomycetes (mushroom-forming fungi) inferred from four rONA regions. *Mol. Phylogenet. Eval.*22:76-90.

Binder, M., Larsson, K. H., and Matheny, P. B. 2010. Amylocorticiales ord. nov. and Jaapiales ord. nov.: Early diverging clades of Agaricomycetidae dominated by corticioid forms. *Mycologia.* 102: 865–880.

Boddy, L., and Heilmann-Clausen, J. 2008. Basidiomycete community development in temperate angiosperm wood. In: Boddy L., Frankland J.C., Van West P. (Eds.). Ecology of Saprotrophic Basidiomycetes. Elsevier Academic Press. pp. 211–237.

Bondertzeva, A. S., and Singer, R. 1941. On the taxonomy of the Polyporaceae. *Ann. Mycol.,* 39: 43-65.

Bondertzeva, M. A. 1961. A critical review of the most recent classifications of the family of the Polyporaceae. *Botanicheskii Zhurnal,* 46:587-593.

Bose, S. R. 1919-1928.1. Description of fungi in Bengal. *Proc. Indian Assoc. Cult. Sci.* 4:119-114; II. *Proc. Sci. Convention Indian Assoc. Cult. Sci.* For the year 1918: 136-143, III. Fungi of Bengal. Polyporaceae of Bengal Part III, *Bull. Carmichael Med. Coil.* Belgachia 1:1-5; IV. Polyporaceae of Bengal Part IV, *Bull. Carmichael Med. Coil.* 2: 1-5; V. *Bull. Carmichael Med. Coil.* 3: 20-25; VI. Part VI, *Proc. Sci. Convention, Indian Assoc. Cult. Sci.* for the year1919; VII. *Proc. Sci. Convention, Indian Assoc. Cult.*

Sci. For the year 1920-21; 27-36; VIII. *J. Dept Sci.* Calutta Univ. 9: 27-34; IX. *J. Dept Sci.* 9: 35-44.

Bose, S. R. 1922b. Geographical distribution of the Bengal species of Polyporaceae with a short history of them in Bengal. *J. Indian Bot. Soc.* 3: 19-21.

Bose, S. R. 1929a. Revival of an old fruitbody of *Hexagonia discopda* Pat. & Har., and its successful spore culture from its fresh spore-discharge. *Ann. Mycol.* 27: 321-323.

Bose, S. R. 1929b. Artificial culture of *Ganoderma lucidum* (Leyss) Fr. From spore to spore. Proc. 15th Indian Science Congress. Madras. p.229.

Bose, S. R. 1935. The distribution of polypores at high altitudes. *Ann. Mycol.* 33: 3-4.

Bose S. R. 1937a. Polyporaceae from Lokra Hills (Assam). *Ann. Mycol.* 35: 119-137.

Bose S. R. 1937b. A fringe within the pore-tubes of *Daedalea flavida* Lev. Proc. 24th Indian Science Congress. Hyderabad. p.259.

Bose S. R. 1939. An abnormal sterile form of *Polystictus sanguineus* Linn. Proc. 26th Indian Science Congress. Lahore. p.116.

Bose S. R. 1944. Importance of anatomy in systematics of Polyporaceae. *J. Indian Bot. Soc.* 23: 153-157.

Bose, S. R. 1946. Polyporaceae of Bengal XI. *J. Dep. Sci. Calcutta Uni.* 2: 53-87.

Bourdot, H., and Galzin, A. 1928. *Hymenomycetes de France,* Paris. 358p.

Brazee, N. J., Lindner, D. L., D'Amato, A. W., Fraver, S., Forrester, J. A., and Mladenoff, D. J. 2014. Disturbance and diversity of wood-inhabiting fungi: effects of canopy gaps and downed woody debris. *Biodivers Conserv.* 23: 2155–2172.

Bujakiwicz, A. 1969. Udzial grzybow wyzszych w lasach Xegowych i olesach puszczy bukowej pod Szczecinem. - *Badan. Fizjograf. nad Polska Zachodnia,* 23: 61–96.

Butler, E. J., and Bisby, G. R. 1931. The Fungi of India. Imp. Coun. of Agr. Res. India, Calcutta, *Sci. Monogr.* 1: 237pp.

Carlos, A. L., Straatsma, G., Franco-Molano, A.E., and Boekhout, T. 2012. Macrofungal diversity in Colombian Amazon forests varies with regions and regimes of disturbance. *Biodivers. Conserv.* 21(9): 2221-2243.

Cohen, R., Persky, L., and Hadar, Y. 2002. Biotechnological applications and potential of wood-degrading mushrooms of the genus *Pleurotus*. *Appl. Microbiol. Biotechnol.* 58: 582–594.

Cooke, C. R., and A. D. M. Rayner. 1984. Ecology of saprotrophic fungi. Longman, London. 414p.

Cooke, M. C. 1876. Some Indian fungi. *Grevillea* 4: 114-118.

Cooke, M. C. 1881. Some Exotic fungi. *Grevillea* 9: 97-101.

Cooke, M. C. 1891a. Additions to *Daedalea*. *Grevillea* 19: 91-93.

Cooke, M. C. 1891b. *Trametes* and its allies. *Grevillea* 19: 91-93.

Cooke, M. C. 1891c. *Favolus* and *Laschia*. *Grevillea* 19: 105.

Corner, E. J. H. 1932. The fruit body of *Polystictus xanthopus* Fr. *Ann. Bot.* 46: 71-111.

Corner, E. J. H. 1953. The construction of polypores. Introduction: *Polyporus sulphureus, P. squamosus, P. betulinus and Polystictus microcyctus. Phytomorphology* 3: 152-167.

Cui, B. K., Zhao, C. L., and Dai, Y. C. 2011. *Melanoderma microcarpum* gen. et sp. nov. (*Basidiomycota*) from China. *Mycotaxon* 116: 295–302.

Cunningham, G. H. 1965. Polyporaceae of New Zealand. *N. Z. Dep. Sci. Industr. Res.Bull.* 164: 1-304.

Curtis, J. T., and McIntosh, R. P. 1950. The interrelations of certain analytical and synthetic phytosociological characters. *Ecology* 31: 434-455.

Dai, Y. C., Vainio, E . Hantula, J., Niemela, T., and Korhonen, K. 2003. Investigations on *Heterobasidion annosum* in central and eastern Asia

with the aid of mating tests and DNA fingerprinting. *For. Path.* 33: 269-286.

De, A. B. 1977. Infertility of *Polyporus grammocephalus* Berk. *Curr. Sci.* 46: 58-59.

De, A. B. 1981. Taxonomy of *Polyporus osterijormis* in relation to its morphologhical and cultural characters. *Can. J. Bot.* 59: 1297-1300.

De, A. B., and Roy, A. 1978. Typical sporophore production of *Polyporus tricholoma* Mont. in culture. *Curr. Sci.* 47: 472-473.

De, A. B., and Roy, A. 1980. Studies on Indian Polyporaceae-VII. Morphological and cultural characters of *Polyporus hirsutus* Wulf. ex. Fr. *Indian J. Mycol. Res.* 18: 25-32.

De, A. B., and Roy, A. 1981. Studies on Indian Polypores-IV. Morphological and cultural characters of *Polyporus grammocephalus. Mycologia.* 73: 150-156.

De, A. B. 2011. Evolution in taxonomic studies in Polypores. *J. Mycopathol. Res.* 49 (1): 1-8.

Díaz, S., and Cabido, M. 2001. Vive la différence: plant functional diversity matters to ecosystem processes. *Trends Ecol. Evol.* 16: 646–55.

Donk, M. A. 1933. Revision der niederlandi Schen Homobsidiomycetae-Aphyllophoraceae II.Meded. *Bot. Mus. Herb. Univ. Utrecht.* 9: 1-278.

Donk, M. A. 1948. Notes on Malaysian fungi. I. *Bull. Bot. Gat. d.Buitenz.* 3, 17: 473-482.

Donk, M. A. 1964. A conspectus of the families of Aphyllophorales. *Persoonia.* 3(2): 199-324.

Drechsler-Santos, E. R., Santos, P. J. P., Gibertoni, T. B., and Cavalcanti, M. A. Q. 2010. Ecological aspects of Hymenochaetaceae in an area of Caatinga (semi-arid) in Northeast Brazil. *Fungal Diver.* 42: 71-78.

Ellenberg, H,. and Klötzli, F. 1972. Waldgesellschaften und Waldstandorte der Schweiz. Mitt. Schweiz. *Anst. Forstl.Versuchswes.* 48: 388-930.

Ferrer, A., and Gilbert, G. S. 2003. Effect of tree host species on fungal community composition in a tropical rain forest in Panama. *Diver. Distri.* 9: 455-468.

Florence, E. J. M., and Yesodharan, K. 2000. Macrofungal flora of Peechi-Vazhani Wildlife Sanctuary. Research Report 191. Kerala Forest Research Institute, Peechi, Kerala, India. 43p.

Fries, E. M. 1821. Systema Mycologicum, Lundae. *Ernesti mauritii.* 1: 1- 520.

Fries, E. M. 1825. Systema orbis vegetabilis- I. *Plantae Homonemeae.* 37p.

Fries, E. M. 1874. Hymenomycetes Europaei. *Unsaliae.* 755p.

Fukasawa, Y., Osono, T., and Takeda, H. 2009. Dynamics of physicochemical properties and occurrence of fungal fruit bodies during decomposition of coarse woody debris of *Fagus crenata*. *J. For. Res.* 14:20–29.

Gams, W., and Julich, W. 1984. Taxonomy and phylogeny of fungi. *Progress in Botany* 46, Springer Verlag, Berlin Heidelberg, pp. 274-296.

Gibertoni, T. B. 2008. Polyporoid fungi (*Agaricomycetes*, *Basidiomycota*) in the Estação Científica Ferreira Penna (State of Pará, Brazilian Amazonia): diversity and ecological aspects. *Sci. Acta.* 2: 70-74.

Gilbert, G. S., and Sousa, W.P. 2002. Host specialization among wood-decay polypore fungi in a Caribbean mangrove forest. *Biotropica.* 34:396–404.

Gilbert, G. S., Ferrer, A., and Carranza, J. 2002. Polypore fungal diversity and host density in a moist tropical forest. *Biodivers. Conserv.* 11:947–957.

Gilbert, G. S., Gorospea, J., and Ryvarden, L. 2008. Host and habitat preferences of polypore fungi in Micronesian tropical flooded forests. *Mycol. Res.* 112: 674 – 680.

Gilbertson, R. L. 1980. Wood-rotting fungi of North America. *Mycologia* 72: 149.

Gilbertson, R. L., and Ryvarden, L. 1986. North American polypores 1. Oslo: Fungiflora. 433p.

Gilbertson, R. L., and Ryvarden, L. 1987. North American polypores 2. Oslo: Fungiflora. 449p.

Gillet, C. C. 1878. Les champignos (Fungi, Hymenomycetes) qui croissant en France, Paris. 134p.

Hattori, T. 2005. Diversity of wood-inhabiting polypores in temperate forests with different vegetation types in Japan. *Fungal Divers.* 18:73–88.

Hattori, T., and Lee, S. S. 2003. Community structure of wood-decaying Basidiomycetes in Pasoh. In: Okuda T, Manokaran N, Matsumoto Y, Niiyama K, Thomas SC, Ashton PS (Eds.) Pasoh: Ecology of a lowland rain forest in southeast Asia. Springer, Tokyo. pp.161-170.

Hattori, T., Yamashita, S., and Lee, S. S. 2012. Diversity and conservation of wood-inhabiting polypores and other aphyllophoraceous fungi in Malaysia. *Biodivers. Conserv.* 21:2375–2396.

Hawker, L. E. 1965. Environmental influence on reproduction. In: Ainsworth, G. C., and Sussman, A. S. (Eds.), The Fungi- an advanced treatise. Vol. II. Academic press. London. pp. 436-465.

Heim, R. 1969. Champignons d'Europe. N. Boubeé and Cie, Paris. pp.681.

Hennings, P. 1900. Fungi Indiae Orientalis. *Hedwigia* 39:150-153.

Hennings, P. 1901. Fungi Indiae Orientalis II, Cl. W. Gollana. *Hedwigia* 40: 323-345.

Hibbett, D. S., Binder, M., and Bischoff, J. F. 2007. A higher-level phylogenetic classification of the fungi. *Mycol. Res.* 111: 509–547.

Highley, T. L., and Kirk, T. K. 1979: Mechanisms of wood decay and the unique features of heartrots. Phytopathology 69 (10): 1151- 1157.

Hutton, R. S., and Rasmussen, R. A. 1970. Microbiological and chemical observations in a tropical rain forest. In: Odum H.T & R.F. Pigeon (Eds.). A tropical rain forest: a study of irradiation and ecology at El verde, Puerto Rico. U.S. Atomic Energy Commission. pp.43-56.

Imazeki, R. 1943. Genera of Polyporaceae of Nippon. *Bull. Tokyo. Sci. Mus.* 6: 1-111.

Imazeki, R., and Toki, S. 1954. Higher fungi of Asakawa Experiment Forest. *Bull. Govt. For. Exp. Sta.*, 67: 19-71.

Imrose, N. E., Gopakumar, S., and Florence, E. J. M. 2005. Polypores on some selected tree species of Kerala: Identification and wood decay characteristics studies. *J. Timber Dev. Assoc. of India.* 51(3 &4): 79-86.

Ingold, C. T. 1965. Spore release. In: Ainsworth, G. C., and Sussman, A. S. (Eds.), The Fungi- an advanced treatise. Vol. II. Academic press. London. pp. 679-707.

Jayanarayanan, T. 2001. Forest Degradation in Kerala: Causes and Consequences: a Case Study of Peechi-Vazhani Area. Discussion paper no. 27. Centre for Development Studies, Thiruvananthapuram, India. pp.115.

Jonsson, M., Edman, M., and Jonsson, B.G. 2008. Colonization and extinction patterns of wood-decaying fungi in a boreal *Picea abies* forest. *J. Ecol.* 96: 1065–1075.

Junninen, K., and Komonen, A. 2011. Conservation ecology of boreal polypores: A review. *Biol. Conserv.* 144: 11–20.

Junninen, K., Penttilä, R., and Martikainen, P. 2007. Fallen retention aspen trees on clearcuts can be important habitats for red-listed polypores: a case study in Finland. *Biodivers. Conserv.* 16: 475–490.

Juutilainen, K., Halme, P., Kotiranta, H. and Monkkonen, M. 2011. Size matters in studies of dead wood and wood-inhabiting fungi. *Fungal Ecol.* 4:342–349.

Kammerer, A., Besl, H., and Bresinsky, A. 1985. Omphalotaceae tam. Nov. und Paxillaceae, ein chemo taxonomischer vergleich zweier Pilzfamilien der Boletales. *Pl. Syst. Envoi,* 150: 101-117.

Karim, M., Kavosil, M.R., and Hajizadeh, G. 2013. Macrofungal Communities in Hyrcanian Forests, North of Iran: Relationships with Season and Forest Types . *Ecol. Bal.* 5(1): 87-96.

Karsten, P. A. 1881. Enumeratio Boletinearum et Polyporearum Fennicarum, Systemate novo Dispositarum. *Rev. Mycol.* 3: 16-23.

Kauserud, H., Heegaard, E., Halvorsen,R., Boddy, L., Høiland, K., and Stenseth, N.C. 2011. Mushroom's spore size and time of fruiting are strongly related: is moisture important? *Biol. Lett.* 7(2): 273–276.

Klotzsch, J. F. 1832. Mycologische Berichtingungen. *Linnaea* 7: 193-204.

Klotzsch, J. F. 1833. Fungi exoticie collectionibus britannorum. *Linnaea* 7:478-490.

Kriesel, H. 1969. Grundzuge eines naturlichen systems der Pilze. *J. Cramer.Jena.* pp. 245.

Kruys, N., Fries, C., Jonsson, B.G., Lamas, T., and Stahl, G. 1999. Wood-inhabiting cryptogams on dead Norway spruce (*Picea abies*) in managed Swedish boreal forests. *Can. J. For. Res.* 29: 178–186.

Kubartova, A., Ottosson, E., Dahlberg, A., and Stenlid, J. 2012. Patterns of fungal communities among and within decaying logs, revealed by 454 sequencing. *Mol. Ecol.* 21(18): 4514–4532.

Kuffer, N., and Senn-Irlet, B. 2005. Influence of forest management on the species-richness and composition of wood-inhabiting basidiomycetes in Swiss forests. *Biodivers. Conserv.* 14:2419–2435.

Kuffer, N., Gillet, F., Senn-Irlet, B., Aragno, M., and Job, D. 2008. Ecological determinants of fungal diversity on dead wood in European forests. *Fungal Divers.* 30: 83- 95.

Leelavathy, K. M., and Ganesh, P. N. 2000. Polypores of Kerala. Daya Publishing House, Delhi. pp.165.

Lindblad, I. 1998. Wood-inhabiting fungi on fallen logs of Norway spruce: relations to forest management and substrate quality. *Nord. J. Bot.* 18: 243–255.

Lindblad, I. 2000. Host specificity of some wood-inhabiting fungi in a tropid forest. *Mycologia* 92: 399-405.

Lloyd, C. G. 1898-1925. Mycological Writings Vol.1. *Cincinnati*, Chio.

Locquin, M. 1957. *Bull. Jard. Bot. Brux.* 27:560-562. Quoted from Singer, 1975.

Lodge, D. J. 1997. Factors related to diversity of decomposer fungi in tropical forests. *Biodiv. Conserv.* 6: 681-688.

Lodge, D. J., Ammiranti, J. F., O'dell, T. E., and Mueller, G. M. 2004. Collecting and Describing Macrofungi. In: Biodiversity of Fungi: Inventory and

Monitoring Methods (eds GM Mueller, GF Bills, MS Foster). Elsevier Academic Press, USA, pp.128–158.

Lodge, D. J., and Cantrell, S. 1995. Fungal communities in wet tropical forest: variation in time and space. *Can. J. Bot.* 73(1): 1391–1398.

Magurran, A. E., 1988. Ecological Diversity and its Measurement. Princeton University Press, Princeton, NJ. 45p.

Massee, G. 1901. Fungi Exotici 3. *Kew Bull.* 1901: 150-169.

Massee, G. 1906. Fungi Exotici 4. *Kew Bull.* 1906: 91-94.

Massee, G. 1908. Fungi Exotici 8. *Kew Bull.* 1908: 216-219.

Massee, G. 1910. Fungi Exotici. *Kew Bull.* 1910: 249-253.

Mehus, H. 1986. Fruit body production of macrofungi in some North Norwegian forest types. *Nor. J. Bot.* 6(5): 679–702.

Mohanan, C. 1994. Decay of standing trees in natural forests. KFRI Handbook No. 97. Kerala Forest Research Institute, Peechi, Kerala, India. 34p.

Mohanan, C. 2011. Macrofungi of Kerala. KFRI Handbook No. 27. Kerala Forest Research Institute, Peechi, Kerala, India. 597p.

Moore, A., Gange, E,. Gange., and Boddy, L. 2008. Ecology of Saprotrophic Basidiomycetes Fruit bodies: their production and development in relation to environment. *Elsevier.* 79–102.

Murrill, W. A. 1907. Some Philippine Polyporaceae. *Bull. Torrey Bot. Club* 34 (9): 465-481.

Murrill, W. A. 1908. Polyporaceae. *North Am. flora* 9 (2): 73-131.

Natrajan, K., and Kolandavelu, K. 1985.Resupinate Aphyllophorales from South India I. *Kavaka* 13(2): 71–76.

Niemela, T. 2005. Polypores – lignicolous fungi (in Finnish with a summary in English). *Norrlinia* 13: 1–320.

Nobles, M. K. 1958. Cultural characters as a guide to the taxonomy and phylogeny of the Polyporaceae. *Can. J. Bot.* 36: 883-926.

Nobles, M. K. 1964. Identification of cultures of wood-inhabiting Hymenomycetes. *Can. J. Bot.*, 43: 1097- 1139.

Nobles, M. K. 1971. Cultural characters as, a guide to the taxonomy of the Polyporaceae. In R.H.Peterson (Eds.), Evolution in the higher Basidiomycetes, The University of Tennessee Press, Knoxville. pp. 169-192

Nogueira-Melo, G.S Parreira Santos, P.J., and Tatiana Baptista Gibertoni, T.B. 2014. The community structure of macroscopic basidiomycetes (Fungi) in Brazilian mangroves influenced by temporal and spatial variations. *Rev. Biol. Trop.* 62 (4): 1587-1595.

Norden, B., Ryberg, M., Götmark, F., and Olausson, B. 2004. Relative importance of coarse and fine woody debris for the diversity of wood-inhabiting fungi in temperate broadleaf forests. *Biol. Conserv.* 117:1-10.

Ottosson, E. 2013. Succession of wood-inhabiting fungal communities :diversity and species interactions during the decomposition of norway spruce. PhD. Thesis, Swedish University of Agricultural Sciences, Uppsala. 265p.

Ovaskainen, O., Hottola, J., and Siitonen, J. 2010. Modeling species co-occurrence by multivariate logistic regression generates new hypotheses on fungal interactions. *Ecology* 91(9):2514–2521.

Overeem, C. V., and Weese, J. 1924. Icones Fungorum Malayens,Vienna. Quoted from Singer, 1975.

Owens, E. M., Reddy, C. A., and Grethlein, H. E. 1994. Outcome of interspecific interactions among brown-rot and white-rot wood decay fungi. Federation of European Microbiological Societies 1:19-24.

Papa, G., and Polini, V. 1987. Caratterizzazzione elettroforetica di Tuberales e Hymenogastrales dopo conglomento su estratti proteici. *Mycol. Ital.* 3: 177-182.

Park, D. 1968. The ecology of terrestrial fungi. In: Ainsworth, G. C., and Sussman, A. S. (Eds.), The Fungi- an advanced treatise. Vol. III. Academic press. London. pp. 5-39.

Patouillard, N. 1890. Sur laplace du genre *Favolus* dons la classification. *Bull. Sco. Mycol. Fr.* 6:19-21.

Patouillard, N. 1900. *Essai taxonomique sur les families et les generas des Hymenomycetes*. Lons-le-Saunier. 184p.

Peace, T. R. 1962. Pathology of trees and shrubs with special reference to Britain. Clarendon Press, Oxford. 753p.

Pegler, D. N. 1973a. Poroid families of the Aphyllophorales. In Ainsworth, G.C., Sparrow, F.K & Sussman, A.S. (Eds.). The Fungi An advanced Treatise. Vol. IVB. Academic press. London. pp.397-420.

Pegler, D. N. 1973b.The Polypores. Supplement *Bull. Brit. Mycol. Soc.* 7 (1):1-43.

Pharo, E. J., Beattie, A. J., and Binns, D. 1999. Vascular plant diversity as a surrogate for bryophyte and lichen diversity. *Conserv. Biol.* 13: 282–292.

Pilat, A. 1936-1942. Polyporaceae. In C. Kavina and A. Pilat's *Atlas desv champignos de Europe., Ser B, Fasc.* 1-48, pp.1-624.

Pradhan, P., Duttaa, A. K., Roy, A., Basu, S. K., and Acharyaa, K. 2013. Macrofungal diversity and habitat specificity: a case study. *Biodivers.* 14 (3): 147 -161.

Puri, Y. N. 1956. Studies on Indian *Poria. J. Ind. Bot. Soc.* 35: 277-283.

Pyle, C., and Brown, M. M. 1998. A rapid system of decay classification for hardwood logs of the eastern deciduous forest floor. *J. Torr. Bot. Soci.* 125(3): 237-245.

Quelet, L. 1886. *Enchiridion tungorum,* Lutetia. 160p.

Ranadive, K. R., Joshi, T., Khare, H., Jagtap, N. V., Jite, P. K., Ranade, V. D., and Vaidya, J. 2012. Host Distribution of *Phellinus* from India. *Indian J. For.* 35 (1): 67–72.

Ranadive, K. R., Vaidya, J. G., Jite, P. K., Ranade, V. D., Bhoslae, S. R., Rabba, A. S., Hakimi, M., Deshpande, G. S., Rathod, M. M., Forutan, A., Kaur, M., Naik-Vaidya, C. D., Bapat, G. S., and Lamrood, P. 2011. Checklist of Aphyllophorales from the Western Ghats of Maharashtra State, India. *Mycosphere* 2 (2): 91–114.

Rangaswami, G., Seshadn, V. S., and Lucy Channamma, K. A. 1970. Fungi of South India. Univ Agric. Sci. Bangalore. 193p.

Rattan, S. S. 1977. Resupinate Aphyllophorales of North Western Himalaya. *Bibliotheca Mycologica* 60: 1 – 427.

Rayner, A. D. M., and Boddy, L. 1988. Fungal Decomposition of Wood, its Biology and Ecology. Chichester, UK: John Wiley & Sons Ltd. 602p.

Rea, C. 1922. *British Basidiomycetae.* Cambridge Univeristy Press. 799p.

Reid, D. A., Thind, K. S., and Chatrath, M. S. 1959. The *Polyporaceae* of Mussoorie hills: Indian IV. *Trans. Br. Mycol. Soc.* 42 (1): 40-44.

Renvall, P. 1995. Community structure and dynamics of wood-rotting fungi on decomposing conifer trunks in northern Finland. *Karstenia* 35: 1–51.

Richardson, M. J. 1970. Studies of Russula emetica and other agarics in a Scots pine plantation. *Trans. Br. Mycol. Soc.* 55: 217–229.

Rostamian, M., and Kavosi, M. R. 2013.The effect of trees diameter on establishment, diversity and richness of Bracket fungi in Golestan province forest, North of Iran. *J. Biodiver. Ecol. Sci.* 3 (2): 99-105.

Roy, A. 1968a. Anatomy of India Polyporaceae-I. *Trametes cingulata* Berk. and *T. persooni* Fr. *Bull. Bot. Soc.* 22: 45-54.

Roy, A. 1968b. Anatomy of India Polyporaceae- II. *Daedalea flavida* Lev. and *D. microzona* Lev. *Bull. Bot. Soc.* 22: 131-134.

Roy, A. 1969. Anatomy of Indian Polyporaceae-III. *Polyporus adustus* Willd. ex Fr. and *P. osteriformis* Berk. *Bull. Bot. Soc.* 23:205-211

Roy, A. 1971. Anatomy of India Polyporaceae- V. *Polyporus anthelminticus* Berk. *Visva Bharati ann.* 14(2): 20-29.

Roy, A. 1972. Some microstructures in relation to *Polyporaceae. Mycol. Appl.* 48: 111-119.

Roy, A. 1975. Anatomy of Indian Polyporaceae- VI. *Hexagonia discopoda* and *H. sulcata. Bull. Bot. soc. Bengal.* 29: 57-64.

Roy, A. 1976. Structures of zones in fruiting bodies of Polyporaceae. *Nova Hedwigia* 27: 801-804.

Roy, A., and De, A. B. 1977. A record of *Polyporus trocholoma* Mont. From India. *Trans. Brit. Mycol. Soc.* 68:442-444.

Roy, A., and De, A. B. 1979. Studies on Indian polypores- I. Morphological and cultural characters of *Polyporus anthelminticus. Bull. Bot. Soc.* 33:105-114.

Roy, A., and De, A. B. 1980. Studies on Indian polypores-III. Morphological and cultural characters of *Trametes floccosa. Norw. J. Bot.* 27: 297-300.

Roy, A. 1981a. Studies on Indian polypores- VI. Morphological and cultural characters of *Irpex flavus* Klotzsch. *Nova Hedwig.* 34: 259-263.

Roy, A. 1981b. Studies on Indian polypores- VIII. Morphological and cultural characters of *Ganoderma colossum* (Fr.) Torrend. *Nova Hedwigia* 35:749-754.

Roy, A., and De, A. B. 1996. Polyporaceae of India. Int. Book Dist. Dehra Dun, pp. 309.

Ryti, R. T. 1992. Effect of the focal taxon on the selection of nature reserves. *Ecol. Appl.* 2: 404–410.

Ryvarden, L., and Jonansen, I. 1980. A preliminary polypore flora of E. Africa. Fungiflora, Oslo, Norway. 636p.

Ryvarden, L., and Gilbertson, R. L. 1993. European polypores Part 1. *Syn. Fung.* 6:1-387.

Ryvarden, L., and Gilbertson, R. L. 1994. European polypores Part 2. *Syn. Fung.* 7:388-743.

Saetersdal, M., Gjerde, I., Blom, H. H., Ihlen, P.G., Myrseth, E.W., Pommeresche, R., Skartveit, J., Solhoy, T., and Aas, O. 2004. Vascular plants as a surrogate species group in complementary site selection for bryophytes, macrolichens, spiders, carabids, staphylinids, snails, and wood living polypore fungi in a northern forest. *Biol. Conserv.* 115:21–31.

Schmit, J. P. 2005. Species richness of tropical wood-inhabiting macrofungi provides support for species-energy theory. *Mycologia* 97:751-761.

Sehgal, P.M., Mukerjee, S. K., and Balwant, S. 1961. Short note on the fungus flora of Nicobar Islands. *Indian For.* 87: 766-767.

Sehgal, P.M., Sen, M., and Bakshi, B. K. 1966. Temperature relationships of Indian polypores. *Indian For. Rec.* 2(7): 131-137.

Shannon, C. E., and Weiner, W. 1962. The Mathematical theory of communication. University of Illinois Press, Urbana, U.S.A. 117 p.

Sharma, J. R. 1995. Hymenochaetaceae of India. Calcutta, India. Botanical Survey of India. 219p.

Sharma, J.R. 2000.Genera of Indian Polypores. Botanical Survey of India, Calcutta. 188p.

Sharma, J.R. 2006. Wood rotting fungi of Temperate Himalaya. In: Mukerji, K. G and Manoharachary, C (Eds), Current concepts in Botany, IK International Publishing House Pvt. Ltd., New Delhi. pp. 101–120.

Simpson, E. H. 1949. Measurement of diversity. *Nature* 163:688.

Singer, R. 1962. Agaricales in Moderm Taxonomy 2nd Ed. J. Cramer, Germany. 915p.

Sorenson, T. 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content and its application to analyses of the vegetation on Danish commons. *Biol. Skr.* 5: 1-34.

Strasburger, E., Noll, F., Schenck, H., Schimper, A. F. W., Sitte, P., Ziegler, H., Ehrendorfer, F., and Bresinsky, A. 1991. Lehrbuch der Botanik. Gustav Fischer, Stuttgart. *J. Plant Nutr. Soil Sci.* 155 (3): 253.

Sujan, S., Balwant, S., and Bakshi, B. K. 1961. Fungus flora of South Andamans. *Indian For.* 87: 248-250.

Sundaramani, S., and Madurajan, D. 1925. Some Polyporaceae of Madras Presidency. Madras Agricultural Department. Year Book ,1924. pp. 69-75.

Swapna., Syed, A., and Krishnappa, M. 2008. Diversity of macrofungi in semi-evergreen and moist deciduous forest of Shimoga District-Karnataka, India. *J. Mycol. Plant Pathol.* 38 (1):21-26.

Takahashi, M., and Kishima, T. 1973. Decay resistance of sixty-five Southeast Asian timber specimens in accelerated laboratory tests. *Southeast Asian Stud.* 10:525–541.

Theissen, E. 1911. Fungi aliquot Bombayenses Rev. Ed. Blatter Collecti. *Ann. Mycol.* 9: 153-159.

Thind, K. S., and Chatrath, M. S. 1957. Polyporaceae of Mussoorie Hills. II. *Res.Bull. Punjab. Univ.* 25:431-442.

Thind, K. S., Bindra, P. S., and Chatrath, M. S. 1957. The Polyporaceae of Musssorie Hills - III. *Indian Phytopath.* 12:471-483.

Thind, K. S., and Chatrath, M. S. 1960. Polyporaceae of Mussoorie Hills I. *Indian Phytopath.* 23:76-89.

Thind, K. S., Rattan, S. S., and Dhanda, R. S. 1970. The Polyporaceae of India - VI. *Indian Phytopath.*. 21:109-17.

Thind, K. S., and Rattan, S. S. 1971a. The Polyporaceae of India- V. *Indian Phytopath.* 24: 50-57.

Thind, K. S., and Rattan, S. S. 1971b. The Polyporaceae of India -VII. *Indian Phytopath.* 24:290-294.

Thind, K. S., and Rattan, S. S. 1971c. The Polyporaceae of India- VIII. *Res. Bull. Punjab Univ.* 22: 27-34.

Thind, K. S., and Dhanda, R. S. 1978. The Polporaceae of India- XL. *Indian Phytopath.* 31:463-472.

Thind, K. S., and Dhanda, R. S. 1979a. The Polyporaceae of India- IX. Eight species of Poria new to India. *Kavaka* 7:51-58.

Thind, K. S., and Dhanda, R. S. 1979b. The Polyporaceae of India - XII. The genus *Albatrellus. Indian Phytopath.* 32: 55-60.

Thind, K. S., and Dhanda, R. S. 1980. The Polyporaceae of India - X. *Kavaka* 8:59-67.

Toljander, Y. K., Lindahl, B. D., Holmer, L., and Högberg, N. O. S. 2006. Environmental fluctuations facilitate species co-existence and increase decomposition in communities of wood decay fungi. *Oecologia* 148:625–631.

Toupin, R., Filip, G., Erkert, T., and Barger, M. 2008. Field Guide for Danger Tree Identification and Response. R6-NR-FP-PR- 01-08. Washington, DC: U.S. Forest Service. 64p.

Urcelay, C., and Robledo, G. 2009. Positive relationship between wood size and basidiocarp production of polypore fungi in *Alnus acuminata* forest. *Fungal Ecol.* 2: 135-139.

Van der Westhuizen, G. C. A. 1963. The cultural characters, structure of the fruit body and type of interfertility of *Cerrena unicolor* (Bull, ex Fr.) Murr. *Can. J. Bot.* 41: 1487- 1499.

Van der Westhuizen, G. C. A. 1971. Cultural characters and carpophore construction of some poroid Hymenomycetes. *Bothalia* 10: 137-327.

Vetrovsky, T., Vorisková, J., Snajdr, J., Gabriel, J., and Baldrian, P. 2011. Ecology of coarse wood decomposition by the saprotrophic fungus *Fomes fomentarius*. *Biodegradation* 22(4):709–718.

Vishal, R. K., Mane, S. K., and Khilare, C. J. 2012. Host specificity of some wood rotting fungi in Western Ghats of Maharastra, India. *Bio Front.* 5 (2): 217-223.

Walker, B., Kinzig, A., and Langridge, J. 1999. Plant attribute diversity, resilience, and ecosystem function: the nature and significance of dominant and minor species. *Ecosystems* 2: 95-113.

Worrall, J. W., Anagnost, S. E., and Zabel, R. A. 1997. Comparison of wood decay among diverse lignicolous fungi. *Mycologia* 89: 199-219.

Yamashita, S., Hattori, T., and Abe, H. 2010. Host preference and species richness of wood inhabiting aphyllophoraceous fungi in a cool temperate area of Japan. *Mycologia* 102:11-19.

Yamashita, S., Hattori, T., Ohkubo, T., and Nakashizuka, T. 2009. Spatial distribution of the basidiocarps of aphyllophoraceous fungi in a tropical rainforest on Borneo Island, Malaysia. *Mycol. Res.* 113:1200–1207.

Zhou, L., and Dai, Y. 2012. Recognizing ecological patterns of wood-decaying polypores on gymnosperm and angiosperm trees in northeast China. *Fungal Ecol.* 5: 230 - 235

Zhou, L., Hao, Z., Wang, Z., Wang, B., and Dai, Y. 2011. Comparison of ecological patterns of polypores in three forest zones in China. *Mycology* 4 (2): 260–275.

APPENDICES

Appendix 1. Catalogue number of polypore specimens collected from the Peechi-Vazhani Wildlife Sanctuary

Sl.No	Species Name	Catalogue No.
1	*Coriolopsis sanguinaria*	MIA 1/29-10-2014
2	*Coriolopsis telfarii*	MIA 2/ 30-10-2014
3	*Daedalea flavida*	MIA 7,30,33,40,43,46/22-4-2012
4	*Daedalea flavida*	MIA 21/ 8-9-2014
5	*Daedalea flavida*	MIA 19/ 8-9-2014
6	*Daedalea flavida*	MIA 9/ 9-9-2014
7	*Daedalea flavida*	MIA 14/ 9-9-2014
8	*Daedalea flavida*	MIA 7/ 9-9-2014
9	*Daedalea flavida*	MIA 9/ 10-9-2014
10	*Daedalea flavida*	MIA 10/10-9-2014
11	*Daedalea flavida*	MIA 4/10-9-2014
12	*Daedalea flavida*	MIA 6/ 10-9-2014
13	*Daedalea flavida*	MIA 7/ 29-10-2014
14	*Daedalea flavida*	MIA 8/ 29-10-2014
15	*Daedalea flavida*	MIA 9/ 29-10-2014
16	*Daedalea flavida*	MIA 6/1-11-2014
17	*Earliella scabarosa*	MIA 4/25-5-2014
20	*Earliella scabarosa*	MIA 3/ 29-10-2014
21	*Earliella scabarosa*	MIA 4/ 29-10-2014
22	*Earliella scabarosa*	MIA 1/ 30-10-2014
23	*Earliella scabrosa*	MIA 13/13-3-2014
24	*Earliella scabrosa*	MIA 14/ 8-9-2014
25	*Earliella scabrosa*	MIA 8/8-9-2014
26	*Earliella scabrosa*	MIA 13/ 8-9-2014
27	*Earliella scabrosa*	MIA 5/ 8-9-2014
28	*Fomes psuedosenex*	MIA 1/1-11-2014
29	*Fomes psuedosenex*	MIA 13/22-4-2012
30	*Fomes psuedosenex*	MIA 13/22-4-2012
31	*Fomitopsis feei*	MIA 16/22-4-2012
32	*Fomitopsis feei*	MIA 3/ 9-9-2014
33	*Fomitopsis feei*	MIA 1/ 10-9-2014
34	*Fomitopsis feei*	MIA 11/ 10-9-2014
35	*Fomitopsis feei*	MIA 7/1-11-2014
36	*Fomitopsis feei*	MIA 2/ 10-9-2014
37	*Fulvifomes nilgheriensis*	MIA 9,36/22-4-2012
38	*Fuscoporia gilva*	MIA 31,32/22-4-2012
39	*Fuscoporia gilva*	MIA 18/8-9-2014
40	*Fuscoporia gilva*	MIA 17/ 8-9-2014
41	*Fuscoporia gilva*	MIA 13/9-9-2014
42	*Fuscoporia gilva*	MIA 10/ 9-9-2014

43	*Fuscoporia gilva*	MIA 10/ 9-9-2014
44	*Fuscoporia gilva*	MIA 4/ 9-9-2014
45	*Fuscoporia gilva*	MIA 5/1-11-2014
46	*Fuscoporia senex*	MIA 10/ 13-3-2014
47	*Ganoderma australe*	MIA 4/ 3-8-2014
48	*Ganoderma lucidum*	MIA 5/3-8-2014
49	*Ganoderma lucidum*	MIA 1/ 8-9-2014
50	*Ganoderma lucidum*	MIA 19/ 9-9-2014
51	*Hexagonia tenius*	MIA 51/22-04-2012
52	*Hexagonia tenuis*	MIA 1/ 25-5-2014
53	*Hexagonia tenuis*	MIA 6/ 30-10-2014
54	*Inonotus luteoumbrinus*	MIA 3/1-11-2014
55	*Melanoporia nigra*	MIA 11/ 13-3-2014
56	*Melanoporia nigra*	MIA 20/ 9-9-2014
57	*Melanoporia nigra*	MIA 21/ 9-9-2014
58	*Melanoporia nigra*	MIA 3/ 10-9-2014
59	*Melanoporia nigra*	MIA 4/1-11-2014
60	*Microporellus obovatus*	MIA 23/ 8-9-2014
61	*Microporellus obovatus*	MIA 17/ 9-9-2014
62	*Microporus affinis*	MIA 34,44,45/22-4-2012
63	*Microporus affinis*	MIA 9/ 13-3-2014
64	*Microporus xanthopus*	MIA 50,20,29/22-4-2012
65	*Microporus xanthopus*	MIA 18/9-9-2014
66	*Microporus xanthopus*	MIA 5/ 29-10-2014
67	*Oxyporus mollissimus*	MIA 2/ 25-5-2014
68	*Phellinus fastuosus*	MIA 22/ 8-9-2014
69	*Phellinus punctatus*	MIA 15/8-9-2014
70	*Phellinus dependens*	MIA 1,2,15/22-4-2012
71	*Phellinus fastuosus*	MIA 7/ 10-9-2014
72	*Phellinus fastuosus*	MIA 5/ 10-9-2014
73	*Phellinus fastuosus*	MIA 10,25/22-4-2012
74	*Phellinus fastuosus*	MIA 10,25/22-4-2012
75	*Phellinus fastuous*	MIA 11/ 29-10-2014
76	*Phellinus ferrugineo-velutinus*	MIA 11/ 9-9-2014
77	*Phellinus gilvoides*	MIA 1/3-8-2014
78	*Phellinus gilvoides*	MIA 6/ 3-8-2014
79	*Polyporus arcularius*	MIA 19/22-04-2012
80	*Polyporus arcularius*	MIA 3, 13/3/2014
81	*Polyporus dictyopus*	MIA 4,5/22-4-2012
82	*Polyporus grammocephalus*	MIA 8/ 13-3-2014
83	*Polyporus grammocephalus*	MIA 5/25-5-2014
84	*Polyporus grammocephalus*	MIA 2/3-8-2014

85	*Polyporus grammocephalus*	MIA 10/ 8-9-2014
86	*Polyporus grammocephalus*	MIA 20/ 8-9-2014
87	*Polyporus grammocephalus*	MIA 8/ 9-9-2014
88	*Polyporus grammocephalus*	MIA 12/ 9-9-2014
89	*Polyporus grammocephalus*	MIA 12/ 10-9-2014
90	*Polyporus virgatus*	MIA 6/ 25-5-2014
91	*Pycnoporus cinnabarinus*	MIA 3/ 22-4-2012
92	*Rigidoporus lineatus*	MIA 3/3-8-2014
93	*Rigidoporus lineatus*	MIA 12/ 8-9-2014
94	*Trametes cingulata*	MIA 2/29-10-2014
95	*Trametes cingulata*	MIA 6/ 29-10-2014
96	*Trametes cotenea*	MIA 5/ 13-3-2014
97	*Trametes cotonea*	MIA 21,23,24,41,,42,47/22-4-2012
98	*Trametes cotonea*	MIA 10/ 29-10-2014
99	*Trametes cotonea*	MIA 3/ 30-10-2014
100	*Trametes hirsuta*	MIA 12/ 13-3-2014
101	*Trametes hirsuta*	MIA 6/ 13-3-2014
102	*Trametes hirsuta*	MIA 7/ 13-3-2014
103	*Trametes hirsuta*	MIA 2/ 13-3-2014
104	*Trametes hirsuta*	MIA 4/ 8-9-2014
105	*Trametes lactinea*	MIA 22,23,21/22-4-2012
106	*Trametes lactinea*	MIA 4/ 30-10-2014
107	*Trametes marianna*	MIA 3/ 25-5-2014

Appendix 2. Key to the polypore species collected from Peechi-Vazhani Wildlife Sanctuary

KEY TO FAMILIES OF POLYPORES
(Partly adapted from Leelavathy and Ganesh, 2000)

1. Spores with double wall, exosporium hyaline, thin, membraneous covering an ornamented, thick brownish endosporium; spores round, truncate.....GANODERMATACEAE
1'. Spores with simple wall, smooth or ornamented, hyaline or brownish..... 2

2. Hyphal system monomitic; cystidia present.....3
2'. Hyphal system dimitic or trimitic, cystidia present or absent.....4

3. Fruitbody brownish; xanthochroric; generative hyphae with simple septa, rarely clamped; hyaline if dimitic, dark brown if monomitic; setae brownish, present or absent..... HYMENOCHAETACEAE
3'. Fruitbody white, cream, red, brown or black; generative hyphae simple-septate or with clamps, usually not xanthochoric, if xanthochoric generative hyphae clamped; hyaline if monomitic; setae absent.....5

4. Individual pileus effused-reflexed, zonation not prominent, context stratified, pores split .....SCHIZOPHORACEAE

4'. Individual pileus flabelliform with brown concentric zones, context uniform, hymenophore poroid.....MERIPILACEAE

5. Context light shaded, corky, dimitic, normally ungulate with a crust, never stipitate.....FOMITOPSIDACEAE
5'. Context thin, whitish or coloured, coriaceous, dimitic to trimitic, stipitate or sessile.....POLYPORACEAE

FOMITOPSIDACEAE Julich
Biblthca Mycol. 85:367, 1981

Fruitbody with round pores, context with a distinct crust at least at the base, woody hard..... *FOMITOPSIS* P. Karst. (*F. feei*)
Fruitbody lamellate to daedaloid, if poroid with large pores, >2mm in diam..... *DAEDALEA* Pers. (*D. flavida*)

GANODERMATACEAE Karst.
Rev. Mycol. 3: 17, 1881.

1. Sporophore stipitate; upper surface laccate, reddish brown to yellowish..... *G. lucidum*
1'. Sporophore sessile; upper surface not laccate and shiny, Brownish, powdery..... *G. applanatum*

HYMENOCHAETACEAE Donk
Bull. Bot. Gard. Buitenz. 3 (17): 474, 1948.

1. Hyphal system monomitic..... *INONOTUS* Karst. (*I. luteoumbrinus*)
1'. Hyphal system dimitic 2

2. Fruitbody resupinate to effused, hymenial layer of honey-comb type, a dense palisade of basidia and paraphyses associated with setae..... *FUSCOPORIA* Murr.

2'. Fruitbody imbricate; context dimitic, firm, corky to woody; tubes frequently stratified; setae present or absent; 4

3. Fruitbody greyish brown to black; Basidiospores brownish yellow..... *FULVIFOMES* Murr. (*F. nilgheriensis*)
3'. Fruitbody cinnabar-coloured; Basidiospores hyaline to yellowish ..... *PHELLINUS* Quel.

FUSCOPORIA Murr.
N. Am. Fl. 9: 3, 1907

1. Pileal surface radially wrinkled ..... *F. gilva*
1'. Pileal surface concentrically sulcate ..... *F. senex*

PHELLINUS Quel.
Elench. Fung. P. 172, 1886

1. Tramal setae or hymenial setae present 2
1'. Tramal setae and hymenial setae absent 3

2. Fruitbody resupinte; pores 9-10 per mm..... *P. ferrugineo-velutinus*
2'. Fruitbody imbricate; pores 6-8 per mm ..... *P. dependens*

3. Fruitbody resupinate ..... *P. punctatus*
3'. Fruitbody imbricate 4

4. Pores 6-8 per mm; dissepiments 70- 90 um thick..... *P. f astuosus*
4'. Pores 7-10 per mm; dissepiments 100-120 um thick..... *P. gilvoides*

MERIPILACEAE Julich
Biblthca Mycol. 85: 378, 1981

One species collected during the study. *Rigidoporus lineatus* (Pers.) Ryvarden

POLYPORACEAE Corda
Icon. Fung. 3: 49, 1839

1. Fruitbody stipitate..... 2
1'. Fruitbody sessile, effused-reflexed.....6

2. Spores elliptical; corolloid elements present in hymenium ..... *MICROPORUS* P. Beauv.
2'. Spores globose to sub-globose, corolloid elements nil ..... *MICROPORELLUS* Murr. (*M.obovatus*)
3. Hyphal system di, trimitic, darker in KOH.....8
3'. Hyphal system di, trimitic, darker in KOH .....*POLYPORUS* S. Str. Fr.

4. Pores hexagonal..... *HEXAGONIA* Fr. (*H. tenuis*)
4'. Pores round, rarely daedaloid.....5

5. Context coloured, poriod 6
5'. Context white or cream, poriod, sometimes daedaloid.....9

6. Fruitbody effused-reflexed, never imbricate ..... *MELANOPORIA* Murr. (*M. nigra*)
6'. Fruitbody imbricate, attached with a broad base 7

7. Context dark grey to black, Hyphal system dimitic ..... *NIGROPORUS* Murr. (*N. vinosus*)
7'. Context Reddish to orange, hyphal system trimitic ..... *PYCNOPORUS* P. Karst. (*P. cinnabarinus*)
8. Context dimitic, cystidioles absent ..... *FOMES* (Fr.) Fr. (*F. psuedosenex*)
8' Context trimitic, cystidioles frequently present..... *CORIOLOPSIS* Murr.

9. Sporophore dark at the base, reddish elsewhere, pileate .....*EARLIELLA* Murr. (*E. scabrosa*)
9'.Sporophore creamish, thin, effused to reflexed.....10

10. Sporophore reddish towards reflexed basal region;
pores daedaloid in older regions ..... *DATRONIA* Donk (*D. mollis*)

10'. Sporophore creamish throughout; poroid ..... *TRAMETES* Fr.

CORIOLOPSIS Murr.
Bull. Torrey. Bot. Club 32: 358, 1905

1. Pileus surface glabrous; pores 6-8 per mm;
dissepiments upto 50 µm thick..... *C.sanguinaria*

1'. Pileus surface hirsute to scrupose; pores less than 5 per mm;
dissepiments more than 50 µm thick..... *C. telfarii*

MICROPORUS Beauv. ex Kuntze emend Pat.
Rev. Gen. Pl. 3: 494, 1898

1. Stipe central to slightly excentric, yellow to yellowish brown;
sporophores infundibuliform; pileus surface blabrous;
spores 5-6.75 x 1.75-2.25µm..... *M. xanthopus*

1'. Stipe lateral, blackish brown; sporophores flabelliform to spathulate;
pileus surface velutinate while young, seldom glabrous
when old; spores 3.5-4 x 1.5-2 µm ..... *M. affinis*

POLYPORUS S. Str. Fr.
Syst. Mycol. 1: 341, 1821

1. Stipe central to excentric .... *P. arcularius*
1'. Stipe distinctly lateral 2
1. Pileus surface dark coloured; spores 3-5 per mm..... 3
2'. Pileus surface whitish; pores 7-8 per mm..... *P. dictyopus*
3. Pileus surface dark brown to black when old;
margin thick rounded..... *P. virgatus*
3'. Pileus surface reddish yellow; margin thin
and pointed..... *P.grammocephalus*

TRAMETES Fr.
Fl. Scan. P. 339, 1835.

1. Pileus surface velutinate, hirsute, or strigose.....2
1'. Pileus surface glabrous..... 4

2. Pileus surface finely tomentose, glabrescent when mature, white to cream-coloured..... *T. cotonea*
2'. Pileus surface adpressed-velutinate to strigose or agglutinated..... 3
3. Pileus surface milky white azonate or faintly zonate..... *T. lactinea*
3'. Pileus surface pale grey to brownish, deeply zonate..... *T. hirsuta*
4. Pileus surface partly dark brown to soot brown; stipe rudimentary or converging; pores 5-6 per mm..... *T. cingulata*
4'. Pileus surface yellowish , sessile; pores 6-8 per mm..... *T. marianna*

SCHIZOPHORACEAE Julich
Biblthca Mycol. 85: 378, 1981

One species collected during the study: *Oxyporus mollismus* (Pat.) D. A.Reid

DIVERSITY AND DISTRIBUTION OF POLYPORES IN THE MOIST DECIDUOUS FORESTS OF PEECHI-VAZHANI WILDLIFE SANCTUARY, KERALA.

By

MUHAMMED IQBAL, A.
(2011 – 17 – 110)

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE IN FORESTRY

Faculty of Forestry
Kerala Agricultural University

DEPARTMENT OF FOREST MANAGEMENT AND UTILIZATION
COLLEGE OF FORESTRY VELLANIKKARA, THRISSUR- 680656
KERALA, INDIA

2015

ABSTRACT

The study entitled "Diversity and distribution of polypores in the moist deciduous forests of Peechi-Vazhani Wildlife Sanctuary, Kerala" was carried out with the objectives to find out the diversity, distribution and host preference of polypores in the moist deciduous forests of Peechi-Vazhani Wildlife Sanctuary during three different seasons. An attempt has also been made to find out the effect of substrate features like diameter, type and decay class on the diversity and abundance of polypores. Three fixed size permanent sample plots of 100 m×100 m were established in three different locations and these permanent plots were enumerated during three different seasons to collect information on influence of seasonal fluctuation in fruitbody production and details on substratum. Apart from the plot based sampling, opportunistic sampling method was also adopted to maximize the documentation of polypore fungal diversity and distribution.

A total of thirty six species were recorded from the sanctuary and among this *Pycnoporus cinnabarinus* and *Datronia mollis* were the first report from South India. Out of this, white rot fungi contributed 94.44 per cent and 5.56 per cent were brown rot fungi. The density and frequency of occurrence have been varied significantly during different seasons and the community structure and species composition during monsoon and post monsoon season were distinct from pre-monsoon season. However, fungal diversity analysis showed that species richness was higher during monsoon season and revealed the influence of seasonal variation on fungal diversity. The high species similarity was observed between monsoon and post monsoon season compared to pre-monsoon and monsoon. A total of 17 host tree species were identified in ten different families and *Terminalia paniculata* was found to be highly preferred by polypores. Polypores like *Fulvifomes nilgheriensis* and *Fuscoporia senex* were found to be host specific and were found only on *Xylia xylocarpa.* The maximum fungal density has been recorded in host trees with 21-<30 cm diameter class. Among the substrate types, maximum number of individuals was observed on trunk and living trees supported only very few polypores. The newly emerged species during monsoon season showed more association with decay class 2 and the decay class association of some species remained unchanged during all the seasons. The conceptual framework on primary ecological strategy revealed that polypores exhibits ruderal, combative and stress tolerant behaviours. The present study concluded that the diversity and distribution of polypores are determined by seasonal fluctuations and substrate features.