Chapter-1

Introduction

1.1 Freshwater ecosystem

Freshwater ecosystems are taxonomically diverse and resourceful systems in which living organisms interact, modify the habitat, and also play a significant role in the preservation of aquatic ecosystems as well. On earth, life originated from water, and many organisms occupied aquatic ecosystems (Trivedi and Goel 1984). Water is a vital element for the survival of life on our planet from which the entire framework of life is built up. It covers about significant part of the earth's surface (Mishra et al. 2001). Approximately 97% of the total water exists in oceanic form. The remaining 3% is distributed in rivers, lakes, underground water, and water vapor, of which 0.62% is only freshwater available for living organisms. Conventional freshwater ecosystems as rivers, ponds, etc., are water sources and have more importance to man and other organisms. The most common and stable habitats in the biosphere are freshwater ecosystems with physical, chemical, and biological characteristics shaped by local surroundings and physiographic factors (Khan et al. 1998). Aquatic ecosystems are responsible for maintaining nutrient cycling, upholding water quality, and maintaining the continuity of food chains (Radhika et al. 2004). Rivers are an essential part of the earth's water cycle; they play an efficient and prominent role in the earth's topography by carrying vast quantities of water to support life on earth. Rivers differ through cyclic and seasonal progression and their size, length, characteristics of flow, geology of gradients, salt concentration, turbidity, etc. There is another characteristic difference in the degree to which they have suffered degradation through pollution. Limnological works in freshwater bodies in rivers, ponds, and lakes in India date back from 1890 onwards. Significant work was carried out by many workers (Turner 1892; Chacko and Ganapathi 1949; Krishnamurthy 1954; Desikachary 1959; Suxena and Venkareswarlu 1966, 1968; Kamat 1968;

Chadha and Pandey; 1977, 1978; Sarode and Kamat 1978; Iyengar and Desikachari 1981; Pandey and Pandey 1982; Hosmani and Bharati 1983; Ramesh et al. 1990; Murugesan et al. 2003).

Kerala is the land of rivers. In general, the state's topography controls the length and size of rivers. Periyar, Pamba, Bharathapuzha, and Chaliyar are considered as the significant rivers of Kerala. These rivers jointly are more than one hundred and sixty kilometers long and drain about 35% of the state's total area and carry about 45% of the entire surface water (Nair et al. 1975). Out of the 44 rivers of Kerala, three viz., Kabani, Bhavani, and the Pambar flow eastwards; all other rivers flow westwards. In India, several workers have contributed towards studies in Limnology. Chacko and Ganapati (1949) studied the hydrobiology of the Adayar River. Some significant contributions have been made by (Chakraborty et al. 2010; Hynes 1978; Sullivan 1975; Sharma 2010; Singh and Saha 1982b; Nautival and Lal 1984). The extensive ecological degradation and biodiversity loss in riverine ecosystems because of overexploitation of rivers raised broad spread concern for conservation and restoration of healthy river ecosystems throughout the world (Allan and Flecker 1993). The current river management and development policies resulted in groundwater depletion, declines in water quality and availability, saltwater intrusion into the river, and a host of other ecological, social, and economic problems. Therefore, immediate means for conservation of freshwater resources, thus assume paramount importance. The first step towards achieving these goals is to have a thorough knowledge on the ecological status of the aquatic ecosystem, composition, and distribution of the species inhabiting there, and of the factors that influence and regulate the life activities of these organisms. Biodiversity is crucial to the functioning of ecosystems. Each species has unique role in an ecosystem, and they depend on

others for food, shelter, or other resources. The loss of a single species, have deep effect on the whole ecosystem. Monitoring and quantifying of the loss of biodiversity is the essential subject of ecological research and of conservation biology. Hydrological conditions of freshwater ecosystem can directly modify the physicochemical environment, in turn, have a direct impact on the biotic response.

Phytoplankton are the most beautiful and valuable components of aquatic ecosystem. They are indispensable regulators of water quality and quantity. The undisturbed and stable ecosystems have large number of species equal dominance. If the conditions changed, only some species can tolerate, while the rest will decrease due to stress. Fresh water biodiversity constitutes the study of freshwater, its inhabitants and their interaction with their environment. Algae are extensive and diverse, simple to multicellular, and phototrophic. Size of algae varies from simple unicellular to multicellular forms, solitary or colonial organisms represented by some of the shared pond scums which may or may not be motile and are entirely invisible as individuals to the naked eye, exhibit a wide range of simple cell division to complex sexual reproduction. The phytoplankton contributes more than half of total primary production at the base of the food chain worldwide (Guschina and Harwood 2009), play a vital role in maintaining the steadiness of abiotic and biotic components aquatic ecosystem. Classification of algae is based on their pigmentation, nature of food reserves, the fine structure of plastids, chemical disposition of the cell wall, and the number, position, and fine structural details of flagella in the motile stages (Krishnamurthy 2000). Freshwater algae are of various taxonomic groups such as diatoms (Bacillariophyceae), green algae (Chlorophyceae), blue green algae (Cyanophyceae), dinoflagellates (Dinophyceae), brown algae (Phaeophyceae), and red algae (Rhodophyceae) because of their characteristic adaptations to specific

habitats in environments. Algae are the most diverse and are environmental assets that help to port organisms and generate oxygen into the environment utilized by organisms in all trophic levels (Bergman and Bump 2015). In freshwater ecosystems, microalgae are taxonomically diverse, very resourceful, and play an important role in worldwide ecology. Algae lodge a unique position among the primary producers. In addition to being an essential link in the food chain and food organizers, algae are also indicators of the trophic status and health of the water body. Algal assays are incredibly suitable for analyzing various ecological problems and the assessment of environmental qualities. The algal study opens the possibility of fruitful combinations of physical, chemical, and biological measurements resulting in the relevant information.

The chemical analysis provides information on the concentration of the substances present. The nature of water depends on its physical, chemical, and biological characteristics. Physical parameters include colour, odor, temperature, turbidity, etc. Chemical qualities with the presence of organic and inorganic substances in solution and these are suspended or dispersed in water. Biological characteristics include organisms present in water. The analysis of natural materials and chemical elements of water forms a valued method of water quality assessment. The term water quality is causally related to water pollution. The quality of water bodies can be determined from the analysis of Physico chemical parameters, which have an essential role in determining the distribution of aquatic organisms. In the aquatic ecosystem, water forms one of the leading media in which most chemical compounds or salts ionize readily. Some salts were naturally present in water which serve as nutrients for the growth and function of aquatic organisms. In sometimes, such nutrients enhance phytoplankton growth, while some of them are limiting factors

of development. Water pollution is a critical threat faced by man today due to rapid urbanization, industrialization, agriculture, mining, and technological development. Since water can act as a universal solvent capable of dissolving or carrying a variety of toxic chemicals, several rivers and water bodies are utilized to dispose of sewage and industrial effluents. Nitrogen and phosphorus form the essential nutrients for algae growth and are known to interfere with water quality (Reddy and Kumar 2001).

The ability of algae to tolerate polluted and unpolluted water bodies has been considered valuable bioindicators in water bodies. Microalgae can have an essential role in solving environmental problems (Kurano and Miyachi 2004) have massive industrial and economic values (Rai et al. 2000), as valuable sources for pharmaceuticals, health foods, carotenoids (Lui et al. 2000), restriction endonucleases (Saravanan et al. 2003) and in the bioremediation of industrial effluent (Muthukumaran et al. 2005; Kamaleswari and Sivasubramanian 2011). Algae as biological indicators of water pollution (Palmer 1969; Prasad and Singh 1982), a source of food for larger aquatic animals. They are used to human beings being the source of food especially rich in vitamins. Many are essential sources of iodine, potassium, and other minerals (Krishnamurthy 2000). Algae also show extraordinary potential to absorb metal ions from an aqueous solution and valuable for wastewater treatment (Mehta and Gaur 2005).

The three basic requirements for living organisms on earth are air, water, and soil. In the past, these features were pure, undisturbed, uncontaminated, and most suitable for living organisms. Still, the situation is just the reverse because rapid industrialization and technology also lead to severe environmental, ecological imbalance, making it disastrous for humankind. The primary source of environmental

pollution has been man's misbehavior with nature and ego that he is the master of nature. These unwanted situations are created by man and other active biotas on the earth (Mathur and Pathak 1990). Several studies prove that human interruption has caused a global increase in river input of geochemical constituents, incredibly nutrient elements leading to imposed eutrophication in many coastal areas. Raising engineering structures like dams, spillways, etc., are also accountable for alterations in river environments. The framework is being complicated further by the massive discharge of toxic contaminants from different sources. The degradation of water bodies in the earth due to domestic, industrial effluents, agricultural run-off water, and discarding solid wastes into nature (Behura 1989; Ghosh 1989). These factors lead to a luxuriant growth of organisms, mainly the algae, in the water bodies (Hynes 1978; Varshney 1991). Enrichment of organic or inorganic fertilizers either naturally or by anthropogenic activity leading to the growth of algal bloom in the freshwater ecosystem, which results from the deterioration of water quality and eutrophication. The situation is not as different in Kerala river systems, especially in the Bharathapuzha and Bhavani rivers. Discharge of pollutants from urban, agricultural and industrial sources, indiscriminate mining of construction grade materials like sand from instream and floodplain areas, damming of rivers, etc., have adversely affected the nature of these river systems. These incidences are due to human imposed stresses in these ecosystems, which perceptibly need immediate attention and corrective measures based on careful observations and studies. The present study is an effort to report certain aspects of physico chemical parameters and algal diversity of rivers Bharathapuzha and Bhavani flowing through Palakkad, Malappuram, and Thrissur districts of Kerala.

Algae play a crucial role in the freshwater ecosystem as primary producers to increase soil fertility, bioindicators, and secondary productivity. Thus, it is essential to study the algal community in fluctuating physicochemical scenario of water bodies to conserve and manage the ecosystem. Decline in biodiversity greater in freshwater ecosystem than in the terrestrial ecosystem. So, it is particularly important to study biodiversity of algal flora. The study includes a systematic analysis of algal diversity in the present study area and the water quality of these river systems. The scientific species level identity would enrich the algal diversity list in Kerala. An attempt has also been made to evaluate the pollution status of the site. The study covers the spatiotemporal variation of the above parameters and identified the most influencing parameters in months. Different groups of algae give a clear concept about the ecological parameters like pH, temperature, TDS, EC and Dissolved oxygen, etc. The differences in the use of water are also responsible for environmental variations in the algal community. 75% of the population in Palakkad district depends on surface water resources for their various needs, mainly from Bharathapuzha and its tributaries. So, the assurance of water quality should be healthy. Certain areas in the eastern part of Palakkad district showing some water quality deterioration where fluoride and mercury content is slightly high. This also leads to acute changes in the physiology of water and biodiversity. A perusal of the existing literature reveals that very few investigations related to algal biodiversity had been done on rivers in the Palakkad district. There was a lack of accurate data on the Palakkad district's freshwater algal biodiversity, especially regarding the data on the lower plant groups. Practically no evident work has been done on the taxonomy, distribution, species diversity and composition, seasonal and spatial variation of freshwater algae from rivers in Palakkad district, and hence the present work is undertaken. The species composition,

distribution, and comparison of algal flora would give more information regarding the species richness of Kerala.

1.2 Objectives

1. To gather data regarding the diversity of freshwater algae in the rivers of Palakkad district up to the species level.

2. To compare the seasonal and spatial distribution of algae from the study area.

3. To compare Physicochemical aspects of water concerning algal diversity.

4. To compare the pollution status of rivers based on water quality index and algal diversity.

5. To quantify the diversity of habitat using diversity Indices.