MURIYAD WETLANDS: ECOLOGICAL CHANGES AND HUMAN CONSEQUENCES

Project report submitted to Kerala Research Programme on Local Development, Centre for Developmental Studies, Thiruvanandapuram

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December 2003
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Preface

Wetland forms an important ecosystem essential for existence of life on earth. Floodplains of rivers and vicinities of wetlands are considered as the cradle of human civilisation. However we treat them with indifference rather thanwith care. As urbanization increased, the wetland also started vanishing. The people who had damaged the wetlands have already begun to pay the price in terms of scarcity of water, flooding, polluting, and toppling the micro climatic pattern. This report discusses in detail about thevarious threats faced by the Muriyad wetland system, which forms part of Vembanad-Kol, a Ramsar site.

The introductory chapter gives a general description of the study area; objectives, general methodology of study, and the relevance of the investigations. Detailed methodology employed for specific area of study is explained in the beginning of each chapter. The Second chapter is a review of literature on wetland related studies. Third chapter is devoted to geo environmental appraisal and the fourth chapter describes the biological wealth of Muriyad wetlands. The impacts of the change in the socio economic perspectives of the human community on the ecology of the wetland are discussed in chapter five. The last chapter is exclusively devoted for consolidation of the outcome of the present investigations and suggestions for the conservation and management of Muriyad wetland.

Chapter 1

Status and Values of Wetlands - a Review

Wetlands are integral part of river basins or extension of sea and are considered as one of the most productive ecosystems of earth. They may include a wide range of habitat constituting about six percent of earth's surface. According to Ramsar convention wetlands are areas of marsh, fen, peat land or water bodies, whether natural or artificial, permanent or temporary, static or flowing, fresh, brackish or salt including areas of marine water, the depth of which at low tide does not exceed six meters. The characteristics of wetlands are soils that remain water logged or are submerged under water for whole or part of the year and the wetland biota depend upon and are adapted to this water logging or submergence during at least a part of their life cycle. Wetlands, as vital ecosystems, have influenced the development of human societies since historical times. Today, they provide staple food such as rice and fish for more than half of the human population.

In this context, it is relevant to determine the priceless values and the silent services rendered by the natural ecosystems to the humanity. Determination of the economic values of the wetland may also be important and useful in the context of conservation and management of the system.

International efforts for protection of wetlands emerged in the background of environmental movements. A shift from the view that 'wetlands are wastelands' and hence to be *developed,* to the growing awareness of its intrinsic values and functions has resulted in several international efforts to conserve, protect and restore wetlands in recent decades (World resources 2001). Considering the ecological values and benefits of wetlands, international scientific review boards and political leaders have promoted these benefits and called for their protection. 'Ramsar convention in 1971 and Rio summit in 1992 were the milestones in the history of conservation of the wetlands (Denny 1994). This has resulted in re-designating some of the wetlands as 'Wetlands of International Importance', 'hemispheric reserves for shore birds' or 'conservation wetlands' (Wigham et al., 1993).

A wetland is considered internationally important if it contains a representative, rare or unique example of a natural or near natural wetland type found within the appropriate biogeographic region. Other criterions are based on species, ecological communities, and water birds and fish species.

Ramsar Convention Bureau (2002) attributes ten major values for the wetland. Flood control is said to be one of the most important function and value provided by the wetlands. Several countries in the tropics as well as in the temperate regions experience

great economic loss due to flood every year. In china the 1998 flood was estimated to cost about $32 billions and 35000 human lives were lost during this flood. An analysis of the major causes of this severely damaging flood reveals that reclamation of wetlands around lakes and rivers for cultivation to feed the growing population as one among them. Another important cause is the rampant deforestation in the upper reaches of rivers augmenting heavy siltation in the lower areas, which in turn has reduced the flood absorption capacity of the wetlands. Reclamation of wetlands, destruction of a forest, or conversion of a specific land area anchors on the economic values or immediate monetary gains of the respective resource. In this context, it is relevant to determine the priceless values and the silent services rendered by the natural ecosystems like the wetland, to the humanity. Determination of the economic values of the wetland may also be important and useful in the context of conservation and management of the system.

Like most of the other natural ecosystems, wetlands are also multifunctional and the values and benefits they provide are not so obvious for a causal observer. One of the major difficulties in economic valuation of a wetland is the insufficient information available on important ecological and hydrological processes, on the basis of which such values are generated by wetlands (Barbier et al. 1997).

Troubled wetlands of India

The topography, climate and rainfall pattern of Indian subcontinent is very conducive for the development of natural wetlands. All most all seven great rivers of our country have vast floodplains and have remarkable contributions in the history of human cultural evolution. According to the latest report in the World resources (2001-2002) India has a total of 193000 hectare of area of designated Wetlands of International importance (Ramsar Sites). Altogether about nineteen wetlands are declared as Ramsar sites in the country. Expect a few, all these wetlands are facing serious threat due to anthropogenic interventions. For example, it is reported that large areas of Wular lake of Kashmir have been converted in to plantations and for paddy cultivation. This wetland is undergoing rapid siltation and the water is getting polluted day by day with domestic and industrial wastes. The loss of biodiversity and the extinction of several endemic species are well indicated. Another Ramsar site that face degradation pressure is the Loktak Lake of Manipur. The construction of Ithai barrage in 1983 has caused extinction of several native fish species (James 2002). The lake is rapidly undergoing eutrophication due to the inflow of domestic sewage and fertilizers. The pesticide run off in to the wetland is poisoning the water as well as the soil of the wetland. Over fishing, indiscriminate hunting of water birds, siltation etc. is serious threats faced by this unique wetland.

A recent symposium on 'Restoration of lakes and wetlands' organized by Indian Institute of Science, Bangalore, highlights the status of the wetlands of Karnataka State. It is reported that Karnataka has more than 2187 perennial and about 29588 seasonal tanks (Man made water impoundments). The water-spread area of these tanks is estimated to be roughly 2,90316 ha. The number of tanks in the Bangalore

metropolitan area has dwindled from 262-177 by 2000 (Sridhar et al., 2000). Another study designated to identify the qualitative and quantitative aspects of the impacts of urbanization on two natural lakes of Karnataka i.e., Rachenahalli and Amurthahalli lakes has reveled that Amruthahalli lake has attained the level of eutrophication based on the Indian standard specifications of NEERI (Rajnikanth and Ramachandra, 2000).

Investigations on the ecology of Bhoj wetland of Madhya Pradesh indicate that this man- made wetland is under severe degradation pressure. Siltation, solid waste disposal and weed infestation, dumping of agricultural waste, hospital waste disposal and idol immersion in the lake during the festival season pollutes the lake ecosystem beyond the tolerable limits of any aquatic systems (Verma et al., 2001).

In spite of the stringent laws of environmental protection, deforestation is a never-ending saga in all most all states. It is reported that about 13 Mt silt is deposited annually in the Chilka Lake degrading one of the largest natural lakes of the Indian Subcontinent (Nayar and Nayar 1997). Prompted by the quick financial gain, recently there was a great boom in the shrimp culture in our country. Various governmental and non-governmental agencies also promoted aquaculture wi th financial incentives and other technical supports. It should be noted that this proliferation of aquaculture farms has taken place at he expense of large area of coastal mangrove wetlands.

Wetlands of Kerala

The imposing presence of Western Ghats as the eastern boundary of the state of Kerala with its western slopes merging with the midland plains and the zigzag boundary of the western sea coast all provide an ideal topographic feature for the development of a myriad forms of wetlands in this small strip of land at the southern tip of Indian peninsula. Since the Western Ghats extent along the coast rising upon an average elevation of 900-1500 meters above mean sea level, the southwest monsoon winds are obstructed resulting in an annual rainfall of 2000-6000 mm. The 43 rivers that originate from the Western Ghats create and maintain almost all major wetlands of Kerala. Among the various states of the country Kerala stands first in India, in having the largest area under wetlands (Nayar and Nayar, 1997). Recently Nair and Sankar (2002) mapped the wetland systems of Kerala using IRS satellite data and reported that the state has a total of 217 wetland units of which there are only 157 units are having an area greater than 56.25ha. The total wetland area is 127930.07ha-comprising 34199.57ha of 'inland wetlands' and 93730.5 ha 'coastal wetlands.' Geomorphologically the wetlands in Kerala can be classified in to 5 major systems viz, marine, estuarine, riverine, lacustrine and palustrine. The major stakeholders of wetlands of Kerala are stated to be the fishermen, sand miners, boat operators and local self- governments (Nair and Sankar, 2002).

The majority of the wetlands of Kerala are brackish, however, there are a few fresh water wetlands also seen here. Three wetlands of Kerala, recently included in the

Ramsar site are the Vembanad–Kol, Ashtamudi and Sathankotta. Muriyad wetland is one among the eight fresh water wetlands of Kerala others being Vellyani, Sasthankiotta, Pookot, Enamackkal, Manakkodi, Eravikulam, Devikulam and Elephant lake (Nayar and Nayar 1997).

Unlike other states of our country wetlands of Karala are under extreme threat. An average Keralite prefers to live in an independent homestead rather than in a flat or in a colony. The high population density of the state, presence of fairly good proportion of middle class income groups and the boom of gulf money has all contributed for the reclamation and 'development' of wetlands for residential plots. It is reported that two -thirds of the total area of Vembanad lake has been reclaimed or converted into fields for agricultural of fishery activities (Gopalan, 1991). Reclamation of Kuttanad, another equally important wetland system of Kerala started in 1834. By the end of 1995 about 63-76% of the total area was reclaimed for other purposes (WWF. 1993).

It is reported that the estuarine stretch of the Periyar River is facing saline water intrusion at several points. The major reason for this is stated to be the diversion of water from the upper The extinction of the only fresh water crocodile, *Crocodilus porrus* is said to be the result of the destruction of the mangroves of Vembanad and adjacent areas. The construction of the Thanneermukkom barge and the subsequent obstruction of the migratory pathways is said to be one of the major reason for the disappearance of the largest fresh water prawn, *Macrobrachium* from the Vembanad backwaters Gopalan 1991).

The Kol lands

The 'Kol lands', which is spread into Thrissur and Malappuram remains as one of the major fresh water wetlands of Kerala state. This is said to be the rice granary of these districts at par with Kuttanad the 'Rice Bowl' of Kerala. Rice cultivation in Kole lands is said to have started way back in the eighteenth century. However, earliest record on rice cultivation in Trichur Kole lands dates back to 1916.

The west coast of Kerala is remarkable for the presence of a string of backwaters, estuaries, and lagoon barrier complexes. Kol lands lie between Bharathapuzha in the north and Chalakudy River in the south. It is located between 10^{o} 20' and 10^{o} 40' north latitudes and 75^{o} 58' and 76^{o} 11' east longitudes (Johnkutty and Venugopal 1993). Karuvannur and Keecheri rivers drain the Kole lands and finally discharge into the Arabian Sea. Kol lands are divided into two divisions namely the Thrissur Kole (Fig.1) and the Ponnani Kol (Fig.2). The Karuvannur River divides the Thrissur Kole land in to North and South Kole. It also acts as the flood basin for these rivers. Water level rises up to 5.5 meters during the southwest monsoon. The wetland area comes under the administration of civil authorities of Mukundapuram, Chavakkad, Thrissur and Thalappilly taluks of Thrissur district and Ponnani taluk of Malappuram district (Johnkutty and Venugopal, 1993). The

Kol land is a flat saucer shaped low-lying area, flanked by lateritic hills on the eastern and western margins.

The Kol land runs parallel to the sea and are low-lying tracts located 0.5 to 1 meter below the mean sea level. The floodwater from the rivers used to bring enormous quantities of nutrient rich alluvium, which gets deposited in the Kol lands. The cyclical nutrient recharging of the wetland during the flood season rendered the area as one of the most fertile soils of Kerala. This is indicated by the fact that 'while the average productivity of rice in the state is less than two tonnes per hectare, Kole lands yielded 4-5 tonnes of rice per hectare. Seven to eight tonnes per hectare are also not uncommon (Johnkutty and Venugopal 1993). The bumper yield under favourable condition and total loss in case of breaching of the earthen bunds made farming a gambling. Hence, these rice fields came to be called as 'Kol lands' signifying bumper crop in Malayalam.

Drainage of the area

The combined drainage area of the Keechri and Karuvanuur Rivers is 1685 km^2 with the monsoon flow of 2265 Mm^3 and total flow is 2388 Mm^3 (Anonymous, 1997). The Karuvanuur has two tributaries Manali and Kurumali. Peechi River and its tributaries feed the Manali River. Kurumali River originates at the confluence of Chemoni Puzha and Mupply Puzha. All these rivers take their origin from the Western Ghats. Formerly there were high flood in this area during the monsoon period (Johnkutty and Venugopal, 1993). However, with the completion of Chimmoni and Mupply irrigation projects it is claimed that more efficient floodwater control became possible and continuous flow is usually maintained during the summer. As the Karuvannur River flows towards west it bifurcates and one of the branches enters directly to the Chettuva estuary and the other flows towards south and joins the Manakodi estuary (Johnkutty and Venugopal, 1993). Keecheri River, which originates from the Machad hills drains the north Kole and release the water into the Enamackal estuary. The 'North Kole' stretches from Keecheri River in the north to Karuvanuur River in the south. The area extending from south bank of Karuvannur River to Vellangalur region in the south is called as 'South Kole' (Fig. 3).

A network of main and cross canals connects the different regions of the Kole to the rivers and it facilitates good drainage. Thuppan thodu and Nedum thodu are the two major drainage canals of the south Kole. The Panoli canal flows through the north and northwest of Irinjalakuda and drains into the Chemmanda Kayal. Drainage water from Karalam Kole lands flows into Karuvannur River through Nandi sluice and through M-M Canal (Muriyad – Moorkanad canal). The M.M. canal connects Muriyad wetlands to Chemmanda Kayal area and acts as a channel to drain water from the Muriyad wetlands.

From the Muriyad area Thamaravalayam canal drains into the Karuvannur River during monsoon and convey irrigation water from the river to the Kole lands during summer crop periods. The Kurumali River, the southern tributary of Karuvannur

River over flows its southern banks and the floodwaters enter into the Villichira valley (Johnkutty and Venugopal, 1993). The main exit for the water collected in the south Kole is the Enamakkal regulator and that of the North Kole the Idiyanchira regulator. These regulators also control the salt-water intrusion into the paddy fields (Johnkutty and Venugopal 1993). The water for domestic use is drawn from the rivers before they reach the wetlands. The people of Trichur Municipality and adjacent areas utilize water from the Peechi reservoir constructed across Peechi, a tributary of Manali River.

The summer irrigation needs of about 80,000 ha of Trichur Kole lands are met from three dams constructed across the tributaries of Karuvannur River i.e., Peechi in Manali river and Chimmoni and Mupply across the tributaries of Kurumali river. Water from Kurumali and Karuvannur rivers is let into the south Kole through regulators such as Manjamkuzhi, Illikal and Kottenkottuvlavu. Neeroli thodu and M-M canals act as feeders for the south Kole area.

Climate

Moderate climatic conditions are experienced in the Kole land area. The area has a recorded minimum temperature of 21^{o} C and a maximum of 38^{o} C. Air is humid (85-95% during June-September and 70% during January). As in other areas of the state, Kole lands also receive two well-defined rainy seasons, the southwest and North-west Monsoons. Johnkutty and Venugopal (1993) reported that the mean annual rainfall recorded in the Kole lands is 2757 mm out of which 67.3% is received during S-W Monsoon and 18% during N-E Monsoon. The phenomenon of depression rains which is noted during October – November is also another source of water for the Kole lands. Mean Pan evaporation in the Kole tract is 5.8 mm/day (Johnkutty and Venugopal 1993).

Geological features

It is believed that Kole lands along with the Vembanad estuarine areas have been formed by an upheaval of the shoreline subsequent to the It is believed that Kole lands along with the Vembanad estuarine areas have been formed by an upheaval of the shoreline subsequent to the regression and transgression of the coastal waters in the past (Anonym. 1997). The Kole land area is a submerged plain land representing piedmont type of deposits, silted up with alluvium brought down by Karuvannur and Keechery River. Texturally the material ranges from fine to coarse clastic particles derived from lateritic hills surrounding the area. Black carbonaceous clay with a lot of large decomposed tree trunks is often seen in the Kole indicating that fluvio-estuarine deposition process have played a major role in the formation of Kole lands. The presence of deep sand layers seen in several areas provides evidence that the area might have been under the sea in the recent geological past (Kurup, 1975). The western margin of the Kole lands has an expanse

of sedimentary rocks including sandstone and clay of Varkala formation. The coastal alluvium seen in the western extremities probably represents a sand bar extending north -south parallel to the coast. The eastern border of the Kole land is characterized by low-lying hills, which is essentially a crystalline terrain. The differential weathering of crystalline rocks such as biotite gneiss and charnockite results in heterogeneous laterite.

Soil Characters

Hameed (1975) investigated the chemical characteristics of Kole land soil and reported that the organic matter content of the soil is very high. In the surface level it varies from 2.07 - 4.16%. A lesser amount of organic matter is seen in the subsurface layer (1.37-9.70%). However, in certain parts the subsurface accumulation of peat was observed and the organic content varied between 28.91-69.91%.

Chemically the soil is acidic with P^H 2.6 to 6.3 and the P^H decreases with increasing depth. The total nutrient content of the soil throughout the Kole land is 0.14 – 0.57% Nitrogen, 0.2-0.24 % P_2O_5, and 0.09 –0.60 % of K_2O. CaO levels also are reported to be very high. Based on the textural analysis Kole land soil has been classified into clay, sandy loam, sandy clay loam, and clay loam (Sheela 1988).

Subdivisions of the of the south Kole

The major subdivisions of the south Kole are Karalam fields, Chemmada Kayal and Muriyad Kayal (Fig. 3).

The Karalam fields

It comprises about 400 ha. of land situated on the western side of the Kizhuthani-Karalam road. The western boundary of the Karalam fileds is Pullikuzhi – Thanissery road, and Southern boundary is Irinjalakuda - Kattoor road. The Karuvannur River borders the northern margin of Karalam fields.

Chemmada Kayal

Chemmada Kayal comprises a total area of 500 ha and situated 4 km north of Irinjalakuda town. The Karuvannur River, Thrissur- Kodungallur road, Kattoor-Irinjalakuda road and Kizhuthani–Karalam road mark the North, East, South and West boundaries respectively. Karalam fields have a central strip that extends from Porathissery to Karuvannur with pockets extending to either side.

The Study Area (Muriyad Kayal)

The Muriyad Kayal is situated 8 km northeast of Irinjalakuda town. NH 47 and Railway track passes along the eastern side of the area, Thrissur- Kodungallur road

on the west and Irinjalakuda-Chalakudy road on the south side (Fig. 3). The Parappukara road crosses the region almost along the middle. Kurumali-Karuvannur River is the northern boundary. The total field area is 1,215 ha. The water spread is a narrow central strip running north south from Karuvannur to Thommana. The Nedumthode (Thmaravalayam canal) running along the center of the Kayal is the major opening which functions for discharge of floodwater and letting irrigation water into the fields. M.M. canal (Muriyad - Moorkanad Canal) is the only outlet for floodwater.

Justification

The recent designation of Vembanad-Kol Wetland system as a Ramsar site has elevated the status of Kol lands. However, to the best of our knowledge no serious attempts were made in the past to study the ecology, biodivdersity, and human dependence on the wetland. A few published research reports available at present were carried out with the primary objective of evaluating the potentiality of the wetland for rice cultivation (Vide; Johnkutty and Venugopal 1993). Although there are a good number of studies on the bird fauna of Kol lands (Jayson E. A., 2002, Birds of Kole wetlands: Survey; 1992; 1993), no reliable information is available on the fish fauna or other biotic components of the wetland. Another reason for selecting Muriyad wetlands as our study area is that until recently almost the entire water logged area of the wetland was under rice cultivation. The phenomenal increase in the price of fertilizers, the non-availability of labourers and the general apathy of young people to take up farming as a way of life etc has its reflections on the perspectives of the human community that were dependent on the wetland for several decades. Thus, large areas of the wetland were reclaimed for housing plots; coconut plantation and very recently these fertile paddy fields were either sold or leased for sand mining. So far, no serious attempts were made to evaluate the long-term impacts of the change on the ecology, and food and water security of the people of the locality. Hence, we thought of addressing these problems as an urgent need of the hour. Our aim was to elucidate the present threats to the wetland and to evolve some viable strategies for its conservation and management. The following pages embody the process and results of our studies.

Objectives of the study

The major objectives of the present study was to record the ecologicl changes of the Muriyad wetlands which is located three villages of Muriyad, Porathissery, Velukkara, Parappukkara Panchayaths and part of Irinjalakkuda Municipality. Preparation of a detailed map depicting the perennially and seasonally waterlogged area of the wetland and to record the changes that have taken place during the past several decades. It is also intended to highlight the present major environmental threats and its implication on the various flora and fauna of the wetland. Recording the diversity of plants and fishes is another major objective of the present study.

The present study also aims to understatnd the impacts of the change in the socio economic perspectives of the human community on the ecology of the wetland.

General Methodology

Demarcation of micro watersheds, determination of soil and water characteristics, water fluctuation in wells of the fringe areas. Plant samples were analyzed in the laboratory for taxonomic identification. Extensive collection of fishes was done to understand the diversity in fishes. Socioeconomic survey, semi-structured interviews, and PRA techniques were employed for collection of relevant data.

Chapter 2

Geo-environmental Appraisal of Muriyad Wetlands

An environmental appraisal of any aquatic system should take in to account the geo-environmental, biological, and socio-economical variables. As far as the Muriyad wetland system is concerned, no detailed geo-environmental evaluation has yet been carried out. Periodic documentation of the changes that takes place in an area is essential for evolving better management practices, conservation policies and for framing site-specific environmental regulations for sustainable resource use.

This chapter describes the documentation and evaluation of geological aspects such as relief, slope optometry, landform, micro watershed characteristics, land use pattern, water table fluctuation, and quality and soil characteristics. The area for intensive study was determined based on the watershed boundaries of the locality. The study area falls between 10^{o} 25' 32'', 10^{o} 18' 47'' N latitude 76^{o} 17' 19", 76^{o} 12' 48"E. longitude (Fig. 4). The area is geographically distributed in Muriyad, Porathissery, Velukkara, Parappukkara Panchayaths, and part of Irinjalakkuda Minicipality. About 70000 people belonging to different occupations depend on the system directly or indirectly for meeting their various needs.

Methodology

Demarcation of micro watersheds

The area is mapped from Landsat imageries (1:250,000 scale) and aerial photo mosaics (1:50,000 scale) supplemented with topographic sheets of Survey of India (1:50,000 scale). Field checks were carried out using maps of Kerala Land Use

Board (1:10,000 scale) and appropriate corrections were made. The drainage pattern and micro watershed was traced after preparing a slope morphometric and relief map of the area. Household surveys, semi-structured interviews with inhabitants, discussion with panchayath officials and members of cooperative societies and field checking were employed for the preparation of the present land use map

The reclaimed land for settlement and agriculture, area under paddy cultivation, mixed crops and sand and clay mining pockets were represented in the land use map.

Soil characteristic study

The textural analysis of soil collected from selected areas was done using standard techniques. Soils under various micro watersheds were classified based on colour, texture, and drainage. The soil samples at a depth of 20 cm were collected from various regions such as hillocks, elevated lands, floodplains, plain lands, and waterlogged areas for textural studies.

Soil samples were collected before and after cultivation from paddy fields at 11 locations to understand the variation in chemical parameters. The chemical parameters such as P^H, conductivity, organic carbon, Phosphorus and potassium of the soil were done using appropriate methods.

Water analysis

The depth of the water table, variation in quality of water were periodically measured and analyzed. Preliminary survey conducted in this area revealed that the ecological disturbances are relatively high in the northern most part of the wetland. Hence, we have selected nine observation wells in this area to assess the quality of water and the water table fluctuation. Water samples were also collected from five observation wells in other parts of the study area. Samples were also collected from two locations in Karuvannur River and from two locations in puthen thodu. The study was conducted during months of August, December 2001 and March 2002. The various physico-chemical parameters such as pH, turbidity, conductivity, total dissolved solids, and hardness were analyzed and recorded.

The depth of water table in wells was measured by using a tape and rope. For the physical and chemical analysis, sufficient quantity of water was collected in wide-mouthed bottles of 200-300 ml capacities from the representative wells. Using appropriate instruments the analysis were done and the results were recorded and compared with the drinking water quality standards set by ISI.

Results and discussion

Micro watershed demarcation

During 1990-2001, the area received a mean rainfall of 2950mm, which is far below the mean annual rainfall obtained in the state. During the SW monsoon period, floodwater water level was up to

5.5meter. Five micro watersheds demarcated within the area are Parappukkara (MW1), Anandapuram (MW2), Pullur (MW3), Avittathur (MW4) and Thazhekkad (MW5) (Fig.5). The area under each micro watershed is presented below (Table 1 and Fig. 6).

Table 1 Area under various micro watershed

Watershed	Parappukkara (MW1)	Anadapuram (MW2)	Pullur (MW3)	Avittathur (MW4)	Thazhekkad (MW5)
Area (km^2) (Percentage)	17.75 (31)	11 (19)	11.25 (19)	5.75 (10)	12 (21)

All of the five micro watersheds together cover an area of 57.75 k m^2. Permanent water bodies are more in the MW1 and MW2. MW1 is relatively flat where as all other micro watershed area have gentle slope

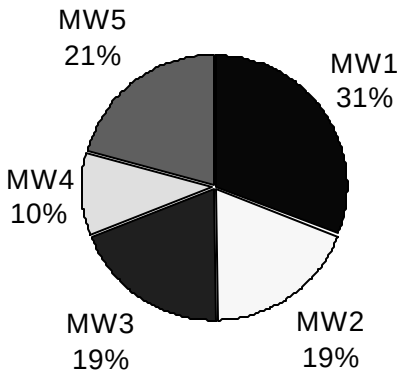


Fig. 6 Area of Micro watershed in Muriyad Wetlands

Relief

Relief in general, varies from 5 to 22 meters above the mean sea level (MSL). Highest point in Parapookkara micro water shed area is Mulungu (15m MSL), which is, located in Northeast portion of MW1. The highest point on the western flank of this micro watershed is Karuvannur Bungalow region. The highest elevated area of southern boarder of MW1 is Madayikkonam. The northern part of the area is characterized by the floodplains of the Karuvannur River. Laterite mounds with elevation 20 meters forms the eastern boarder of the Anadapuram micro watershed area. (MW2). Alathoor area is the highest elevated portion on the Southern side of this micro watershed.

Thommana has an elevation of 20 meters and which forms the highest point in the Pullur micro watershed (MW3). Lateritic mounds with a maximum elevation of 22 meters forms the southern part of Avittathoor micro watershed (MW4). The relief varies from 10 to 22 meters above mean sea level in Thazhekad micro watershed (MW5). Kaduppaserry colony, Kannikkara located at the South West and Aloor at the North East of MW 5 have an elevation ranging from 10 to 22 meters. In general, the entire region has a gentle gradient towards northwest direction.

Landforms

The landform may be classified in to four groups based on the topography
(1). Crest/mount
(2). Elevated Land
(3). Plain land
(4). Water logged area

Crest/mount: Elevation greater than 20 meters above MSL. The three hillocks in this region include Kuzhikattukonam, Taliakkonam, Manjamkuzhi. The soil type in this geomorphic unit is lateritic and gravel to coarse sand sized.

Elevated land: Altitude ranges from 5m to 20 m above MSL and includes areas near Karuvannor Bunglow. The soil is lateritic.

Plain land: Elevation ranges from 0-5m MSL. This includes Mapranam and Puthenthodu. The soil type is lateritic and coarse sandy.

Water logged area*: Low-lying region where seasonal or perennial water body is found. The soil is sandyclayey. Certain regions of the area are 0.5 to 1.5 m below MSL. Kokra Chal is the deepest part of the area. Konthilapulam, Anuruli are the other deeper areas.*

Land Use

Land use may be categorized under six broad groups: water logged area, paddy, clay and sand mining area, reclaimed area, area under mixed crops, and built up lands. The type of the land use and the area under each category (Fig. 7), within the total micro watershed area is presented in Table 2.

Table 2 Land Use Pattern and the area covered within the micro watershed areas.

Land use pattern	**Area km2**	**Percentage**
Water logged	14.96	25.90

Paddy	4.90	8.48
Clay + sand mining	1.52	2.63
Reclaimed	3.65	6.33
Mixed crops	32.54	56.35
Built up land	0.18	0.31

An area of 14.96 sq. km. (25.9 % of total area) remains water logged, which include both perennial and seasonal water bodies (Fig. 8). Out of the 13.9 % of water, logged region 7.51 sq. km area is dewatered and used for rice cultivation (Fig.9). Three-crop paddy field (Mundakan, Virippu, Puncha), two crops cultivated area (Mundakan and Puncha), and single crop cultivated area (Puncha) together covers an area of 4.9 sq. km. This forms only 8.48% of the total watershed area. Area under clay and sand mining is estimated as3.42 sq. km and forms 5.92% of the total area (Fig.10). About 3.65 sq. km areas (6.33%) have been reclaimed for cultivating other agricultural crops (coconut, tapioca, plantain, areca nut) and for other developmental activities (Fig.11).

Mixed crop area is the dominant land use type and is distributed over 32.54 sq. km. i.e., 56.35% of the study area (Fig.12). Built up land, mainly for erecting buildings is estimated as 0.18 sq. km (0.31%) (Fig.13).

Soil type

The studies reveal wide variation in the physical characteristics of soil such as colour, texture and drainage. Texture varies from clay, sand to gravel and the drainage is moderate to excellent. Soils in this area falls under four categories viz alluvium, lateritic, sandy and clay grade. The physical characteristics of each type is described in Table 3

Table 3 Classification of the soil based on texture, colour and drainage

Soil Type	**Texture**	**Drainage**	**Colour**
Alluvium	Clasts with size Sandy to clay loam	Excellent	Dark brown to black
Lateritic	Clasts with size gravel to clayey	Moderate	Red to brown

Sandy	Sand sized clastic particle	Excellent	White to light brown
Clay	Clay and silt sized particle	Moderate	Brown to black

Alluvium consists of coarse sand sized particle and clay loam. It is distributed entirely along the Karuvannur river channel. Colour is dark brown and is due to the rich humus content. It is porous permeable and the drainage is excellent.

Lateritic soil consists of particles with size varying from gravel to clay. The red brown colour is due to the iron oxide minerals like goethite and limontie.

Sandy type consists of sugar sized fine particle of uniform size and has excellent drainage. This type of soil characterizes plain lands. Clay type consists of extremely fine particles and has brown to black colour. It is porous but not much permeable and is seen mostly in the paddy fields.

Parappukkara (MW1) micro watershed area has rich potential of plastic clay; Anandapuram (MW2) area has sandy clay, red soil, as well as laterite soil. MW3,

MW4 and MW5 have a lateritic soil cover with hard lumps of iron concretions on mounts in addition to sandy clay in paddy fields.

Physicochemical characteristics

The sieve analysis of soil samples reveals wide variation in texture ranging from coarse sand to clay. Hameed (1975) reported that clay texture predominates in all most all localities of Muriyad wetland. Soils were collected from 11 locations (Fig. 4) in paddy fields spread in the five micro watershed areas. The soils of Kole area in general are acidic with pH ranging from 4.9 to 6.1. It is due to the effect of underlying peat horizon. The percent of organic carbon ranges from 0.21% to 1.11%. All the samples possess normal values of electrical conductivity. In general, content of phosphorus and potash increases after cultivation. The above observation in respect of physico-chemical characteristics of the soils reveals similarities to the soils samples found in other parts of Kole lands.

Table 4 Chemical characteristics of soil samples (after cultivation)

Location no.	pH	E.C [1] mhos/cm	Org. carbon%	P kg/ha. [2]	K kg/ha [3]
MS1	4.9	0.1	0.21	9	20
MS2	5.4	0.1	0.56	5	75
MS3	5.6	0.1	0.91	8	80
MS4	5.4	0.1	0.28	8	90
MS5	5.3	0.1	0.70	2.2	75
MS6	5.6	0.1	0.35	7	50
MS7	5.7	0.1	0.53	6	65
MS8	5.3	0.1	0.77	7	75
MS9	5.6	0.1	0.91	>34	80
MS10	5.5	0.1	0.77	18	75
MS11	5.6	0.1	1.12	5	75

1- E.C. Electrical Conductivity, 2- P. Phosphorus, 3- K. Potassium

Table 5 Chemical characteristics of soil samples (Before cultivation)

Location no.	pH	E.C [1] mhos/cm	Org. carbon%	P kg/ha. [2]	K kg/ha [3]
M1	5.1	0.1	1.11	17	300
M2	5.9	0.1	0.53	8	130
M3	5.4	0.1	0.42	9	150
M4	5.3	0.1	0.63	>34	80
M5	5.1	0.4	0.49	>34	25
M6	5.3	0.1	0.98	>34	100
M7	5.1	0.2	0.21	>34	50
M8	5.8	0.1	0.56	11	150
M9	5.7	0.1	0.98	13	150
M10	5.3	0.1	0.98	>34	180
M11	6.1	0.1	0.84	>34	150

Soil profile at clay and sand mining region in MW1

In Parapukara micro watershed area (MW1), there are discontinuous pockets of sandy deposits below the plastic clay horizon. A number of such fields are located in this area. Recently indiscriminate mining of deep sand layers is also taking place in certain pockets. Typical soil profile at Parapukkara micro watershed area (MW1) where indiscriminate sand mining take place is described below.

Location 1

Lithology	Thickness (m)
Sand + silt	0.75 m
Plastic clay	3.00m.
Peat + carbonaceous sandy clay	3.00m.

Location 2

Lithology	Thickness (m)
Sand + silt	0.25m
Plastic clay	2.00m.
Sand	1.25m
Carbonaceous sandy clay + tree trunks	2.75m

The top zone is composed of sand-silt particles and thickness varies from 0.25 m to 0.75m. Plastic clay horizon of thickness 2 to 3 meters occurs just below this zone. In certain areas, sand horizon of varying thickness from 0.6m to 1.25m is observed. Maximum thickness for this horizon is seen at Konthulapuram, Madappura and Dhanukulam areas. This horizon is horizontally impersistent. Where the sand horizon is absent plastic clay zone directly rests on peat + carbonaceous sandyclay zone.

Water quality

The seasonal fluctuation in the depth of water table in the observation wells (Fig.10) is presented in Table 6. It is observed that the drop in water table level during monsoon and dry season ranges from 1.6 to 4.8 meters. The lithology and topography controls the variation in water table level. The maximum depth of the water table is measured from Parappookkara micro watershed is 10.9 meters and in Anadapuram micro watershed area the maximum depth recorded is 11 meters and depth of 7.7 meters in Avittathoor micro water shed.

Table 6 Depth of water table from ground surface (in meters)

Well Site	August	December	February
W1	7.6	9.1	9.5
W2	1.7	3.0	4.1
W3	2.7	4.1	4.5
W4	2.8	4.2	4.4
W5	1.1	2.0	5.9

W6	6.9	8.3	9.8
W7	6.5	8.8	9.6
W8	4.2	7.6	8.1
W9	6.1	8.4	9.9
W10	6.31	9.0	10.9
W11	3.14	5.0	5.8
W12	7.1	9.75	11.0
W13	3.56	5.0	5.4
W14	5.7	7.24	7.7

P^H range of water taken from the observation wells is 5 to 7.1 (Table 7) and is within the permissible limit of potable water. The general trend is that the water becomes more acidic during the summer season.

Table 7- pH of water samples from wells

Well Site	August	December	March
W1	6.20	6.80	6.00
W2	6.12	6.98	6.50
W3	5.80	6.90	6.00
W4	5.40	6.80	5.00
W5	6.30	6.80	6.50
W6	6.60	6.90	5.00
W7	6.60	6.90	5.50
W8	6.80	6.80	6.50

W9	6.90	6.90	6.00
W10	6.80	6.30	6.00
W11	6.30	6.80	5.50
W12	7.10	6.90	5.00
W13	6.80	6.90	5.00
W14	6.50	6.90	5.50

Turbidity of water from all the wells except W6 falls within the permissible limit (0.13 to 3.61). W6 shows exceedingly high value of turbidity, which ranges from 476 NTU to 485 NTU (Table 8).

Table 8 Turbidity (in NTU) of water from observation wells

Well Site	August	December	March
W1	0.60	0.40	0.80
W2	0.50	0.40	0.51
W3	1.80	1.60	1.79
W4	1.10	1.61	1.63
W5	2.10	2.50	2.61
W6	476.00	439.00	485.00
W7	1.61	1.08	1.31
W8	1.63	2.16	2.61
W9	2.08	3.61	3.61
W10	2.61	2.51	2.68

W11	0.13	0.56	0.83
W12	0.16	2.13	2.05
W13	0.72	0.89	0.73
W14	1.50	1.81	1.71

The conductivity of water in the 14 wells shows a maximum value of 0.70 micromhos and minimum of 0.03 micromhos. There is a gradual increase in the conductivity from August to March. The values are far below the upper limit of drinking water standard (Table 9).

Table 9 Conductivity (in micromhos) of water samples from observation wells

Well Site	August	December	March
W1	0.072	0.106	0.309
W2	0.063	0.161	0.261
W3	0.029	0.151	0.268
W4	0.310	0.618	0.697
W5	0.035	0.161	0.182
W6	0.093	0.136	0.161
W7	0.045	0.269	0.308
W8	0.04	0.267	0.291
W9	0.103	0.325	0.368
W10	0.246	0.358	0.395

W11	0.117	0.208	0.235
W12	0.208	0.271	0.323
W13	0.261	0.295	0.301
W14	0.351	0.397	0.409

Hardness of water (Table 10) ranges from 13.01to 65.71mg/l (except in W6) are within the permissible limit of potable water. The hardness of W6 reaches up to 256.4 mg/l during dry season.

Table 10 Hardness (in mg/l) of water samples from observation wells

Well Site	August	December	March
W1	15.012	13.01	15.06
W2	60.04	61.04	58.03
W3	50.04	52.01	56.97
W4	60.04	62.06	65.71
W5	60.06	62.05	62.28
W6	255.48	255.51	256.38
W7	22.01	25.61	26.16
W8	35.08	35.71	36.56
W9	30.03	31.06	33.50

W10	25.03	25.52	26.86
W11	31.68	32.02	32.83
W12	16.02	17.32	18.38
W13	53.06	55.06	58.93
W14	62.09	62.08	62.81

Total dissolved solids (Table 11) ranges from 22.30mg/l to 226.10mg/l (except inW6). The TDS value of water sample from W6 exceeds the upper limit of potable water, which rises up to 956.31mg/l.

Table 11 TDS (in mg/l) of water samples from observation wells

Well Site	August	December	March
W1	51.08	56.13	65.5
W2	53.08	55.5	69.13
W3	40.13	49.15	50.26
W4	180	182.36	157.13
W5	226.1	253.3	250.3
W6	742.03	754.56	956.31
W7	22.3	23.16	29.07
W8	101.03	104.53	122.05
W9	123.5	127.48	161.01

W10	180.1	186.08	197.26
W11	172	174	178.23
W12	128.8	129.08	135.03
W13	63.8	67.08	68.69
W14	226.8	227.98	233.53

Characteristics of River water

Water samples from river do not show much variation in pH value. It ranges from 6.32 to 6.81, which is well within the permissible limit of potable water (Table 12). Conductivity of the river water shows a minimum of 0.012 to a maximum of 0.209 micromhos (Table 13). Turbidity ranges from 0.08 to 1.43 NTU (Table 14). The value of total dissolved solids ranges from 26.13 to 71.18 during monsoon period and during summer the value ranges from 32.81 to 83.71 (Table15). Hardness of water samples ranges from 16.01 to 32.61 mg/l. (Table 16). All the values are well within the permissible limit.

Table 12 P^H of river water

Sample Site	August	December	March
R1	6.8	6.2	6.9
R2	6.3	6.5	6.8
R3	6.5	6.2	6.6
R4	6.9	5.0	6.7

Table 13.Conductivity (in micromhos) water samples from river

Sample Site	August	December	March
R1	0.014	0.159	0.173
R2	0.036	0.161	0.198

R3	0.012	0.171	0.191
R4	0.016	0.169	0.209

Table14 Turbidity (in NTU) of water samples from river

Sample Site	August	December	March
R1	0.08	0.18	0.88
R2	0.41	0.31	0.50
R3	0.21	0.16	0.36
R4	1.81	1.31	1.41

Table 15 TDS (in mg/l) of water samples from river

Sample Site	August	December	March
R1	51.08	53.51	55.06
R2	26.13	26.17	32.81
R3	71.18	75.58	76.73
R4	32.13	83.5	83.71

Table 16 Hardness (in mg/ml) of water samples from rivers

Sample Site	August	December	March

R1	16.01	17.08	18.17
R2	25.61	25.71	26.19
R3	31.56	32.56	32.61
R4	22.19	24.43	24.79

Geo-environmental problems

The extent of changes that are taking place in the area is obvious even for a casual observer. Encroachment is taking place from all sides of the wetland. Even though, all sorts of conversion of wetlands is prohibited under Kerala Land Utilization Act 1967, construction of roads, mining of clay and sand, conversion of paddy fields into brick kilns, and reclamation of paddy fields are taking place at an alarming rate (Plate1). This unscientific land use (or abuse?) practices has made the geo-environment increasingly fragile. It is reported that very deep mining may lower the ground water table level and facilitate the intrusion of seawater, altering the whole ecology of the area (Muraleedharan, 2001).

Large-scale clay and sand mining is restricted at present to MW1 specifically indiscriminate sand mining is taking place in Madappura, Konthilapuram, and Nedumpal area. The depth of excavation site has reached up to a 7.5m. Recently it is observed that sand mining has also started in Madayikkonam in MW2, indicating that it can spread into other regions in the near future. Earlier manual removal of sand in a small scale was practiced in this region. However, recently sand along with water is being sucked out using high power diesel engine (Plate 2). Hence, the quantity of sand removed from the wetland has increased enormously. The lump sum amount of money offered by the sand miner to the farmer is far more attractive than the annual income from the paddy cultivation. The dwindling price of rice and increasing expenditure for farming together with the non availability of agricultural labourers force the small scale farmers to lease their land for sand mining. One or two individuals who resist such a situation and insist for keeping their farmland fail to withstand the temptation. As the level of the surrounding area lowers down the possibility of irrigating the paddy fields becomes an uphill task. Recently sand mining lobby has become so powerful and assumes the ‘status of a mafia’, intimidating those who intrude into their affairs. ‘The River bank protection and sand mining control act of 2001’ restricts illegal sand mining from the river. However, to the best of our knowledge there are no legal measures to prevent sand mining from the wetlands or dry lands of Kerala (Nair 2002). As a result, the District collector and revenue authorities are in a quandary. Despite of the awareness of the ill effects of sand mining on the ecology and environment of the area the people in authority remains as silent spectators augmenting the process with the passage of time.

Reclamation of the wetland for coconut and plantain cultivation is also not rare in this area (Plate 3). In spite of the warning from the authorities water is polluted by waste disposal, oil, and grease from the vehicles washed in the wetland. The disposal of organic waste from chicken farms and nonbiodegradable wastes like PET bottles and other plastics (Plate 4) continue to be an insurmountable problem not only in Muriyad wetlands but also in other parts of the Kol lands.

A thick sand horizon below the clay zone serves as a potential aquifer of the area and its removal will lower the water storage capacity of the wetland significantly. Recently the reclamation and conversion of paddy fields for mixed crop cultivation has been accelerated considerably. These in turn can adversely affect the ground water recharge.

Earlier the bunds were constructed using materials like earth, bamboo, trunk, and leaves of coconut and other locally available materials (c.f. Agarwal and Narain 1997). During flood time, these temporary structures were washed off permitting the deposition of fertile alluvium transported by the river. The construction permanent bunds and roads (Plate 5) have dissected water spread in to numerous smaller areas and the free flow of nutrient rich flood water from the Karuvannur River stopped completely. Moreover, the alluvial deposits brought down by the river were trapped in dams constructed in the upper reaches of the river. This prevented the annual enrichment process of the paddy fields. In addition, the bunds and dams constructed in the area for improving agricultural crops hindered the migratory activity of the fishes.

Reclamation of the water body also adversely affects the natural recharge of ground water. If this practice is continued, the fringe areas will experience water shortage in the near future itself. The conflict between the agriculturists and fishermen could have been avoided if developmental projects were carried out with proper Environmental Impact Assessment studies.

CONCLUSION

Geologically five micro watersheds viz. Parappukkara (MW1), Anadapuram (MW2), Pullur (MW3), Avittathur (MW4) and Thazhekkad (MW5) were identified within the 'Muriyad wetland system'. It forms about 57.75 km^2. In general, relief of the area varies from 5-22 m above the MSL. The region has a gentle gradient towards northwest direction. Mixed crop cultivation (56.35%) is the dominant land use of the area followed by paddy fields (21.48%). Extensive clay and sand mining is continuing in the northern most micro watershed (MW1). The chemical attributes of the soil found in this area conform to the general characteristics of soil seen in other parts of Thrissur Kole.

Chapter 3

The Biological Wealth of Muriyad Wetlands

Biological resources functions as fundamental building block for development providing the basis for local self-sufficiency. At the same time biodiversity is a global asset bringing benefits to people in all parts of the world (McNeely, 1988). Hence, efforts to maintain the diversity of biological resources are urgently required at local, national, and international levels.

Every country is said to have three forms of wealth. They are the biological, material, and cultural. The value of biological wealth is not always recognized seriously or at least taken for granted. The silent services rendered by umpteen numbers of plants and animals in supporting our life are not so tangible as the material wealth, which we transact directly. This is one of the serious errors committed by the modern man and for which we have to regret in the near future. We should remember that the vast diversity of organisms that inhabit in a particular place is the product of millions of year's evolution, which once lost cannot be revived. From the point of view of the economic value, Biological resource is a potential basis for different forms of food materials, medicines and other commercially important substances (Wilson, 1998). The 'Genes' contained in plants and animals are the functional

units that by their diversity enable the organism to adapt in the changing environment (McNeely, 1988).

The term Biological Diversity refers to the totality of genes, species, and ecosystems. If properly managed, Biodiversity can be utilized and replenished or can be conserved. The nature of management will determine the enhancement or reduction of the Biodiversity and an effective system of management will be the corner stone for sustainable development (Tiwari, 1996).

The longest definition of biological diversity is that conceived by United Nations in 1992 while preparing for the convention on biodiversity. According to this definition biological diversity means, the variety among the living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystem and the ecological complexes of which they are part (Gros, 1995), this includes diversity within species, between species and of ecosystems. In short, it is defined as the 'Totality of genes, species and ecosystems in a region'.

Our planet's greatest wealth is contained in natural forests, plains, mountains, wetlands and marine habitat (McNeely1988). Lowland tropical rain forests are the world's most species -rich terrestrial communities. Gentry and Dodson in 1987 tabulated all the vascular plant species in 0.1 ha site in a wet forest of western Ecuador. One of their samples was, at the time, by far the most species rich ever recorded. They recorded 33 ferns and fern allies, 1 gymnosperm, 77 monocotyledons and 254 dicotyledons i.e., 365 plant species in 0.1 ha of land. Over a third of the species were epiphytes. On the basis of these and other studies, it has been estimated that about two thirds of the estimated 3,00, 000 plant species in the world, occur in tropical forests (Wilson, 1998). Yet, the tropical forests occupy only 7% of the earth's surface.

Today the earth has an astonishing diversity of living organisms. Though the estimated number goes above 30 million, less than two million of these forms have been identified and described. These include 3,00,000 species of green plants and fungi, 4,809 mammals, 9,881 birds, 7,828 reptiles, 4,780 amphibians. The other vertebrate group, fishes, is excluded because data are generally poor (Myers et al, 2000).

The significance and magnitude of cataloging life on earth can be assessed from the fact that only 1.5-1.8 million species have been given scientific names against 10 million or more species wanting description. Documenting Biodiversity therefore is the prime objective at global, national, and regional levels (Vats and Singh, 2002).

India: A Country Of Mega Diversity.

It is estimated that 80% of the geographical area of India were under forest cover in BC 3000. The fact that only 8% and the area are now under forests testifies our mismanagement of the veritable storehouse of genetic diversity over the centuries. We have already lost 80% of our fresh water

wetlands and the impacts of this will definitely reach the extend plants and animals of our country (Sasidharan and Sivarajan, 1996).

India is one of the richest nations in terms of Biological Diversity. This is due to India's position in the tropical and subtropical latitudes with their variability in the environment. The Himalayan mountain chain has created a great range of environmental regimes on the northern boarder and the 'Thar' desert has created another gradient of rapid environmental change in the northwest. The islands like the Andaman-Nicobar and Lakshadweep with their own sets of endemic species also contributed to the great biological diversity of Indian subcontinent. India has therefore been christened as one of the world's top 13 mega diversity nations (Gadgil, 1997).

India supports 15,000 species of flowering plants, 5000 of them exclusive to us. She has 317 species of mammals, 38 of them exclusive to us. We have 969 species of birds, 69 of them endemic, 389 species of reptiles 156 endemic, 206 species of Amphibian, 110 are endemic. India scores relatively high in terms of frogs, salamanders and their kith and kin. This diversity of species is not evenly distributed within the country. Some parts are especially rich due to a variety of natural causes and others are less so.

India has two hotspots and these two are included under hottest-hotspots. They are the Indo-Burma (formerly Himalayan) and Western Ghats & Sri Lanka (formerly Western Ghats). Indo-Burma region harbors 7000 and Western Ghats/Sri Lanka region harbor 2180 endemic plants (Myers et al, 2000).

The Western Ghats and Sri Lanka 'hot spot' has been listed as the most densely populated with 341people/km^2. Thus the threat to Biological Diversity is real and studies have to be intensified to document the vast biological resources of India (Agoramoorthy and Hsu, 2002)

Species diversity of plants in Kerala

Kerala has been famous for her rich heritage of plant genetic resources for centuries. The various ecosystems in Kerala support rich flora and fauna. However, there is no comprehensive account that would give a realistic estimate of the number of species and their distribution in Kerala. Despite of its economic, horticultural, medicinal, industrial and ecological potentialities, our knowledge on the diversity of the lower plants like algae, fungi, lichens, mosses etc. is disappointing. No serious attempts have ever been made for understanding the taxonomy and ecology of these valuable sources (Thampi et al, 1997). From Kerala 3800 angiosperms, 4 gymnosperms, 236 pteridophytes, 350 bryophytes, 325 algae and 4800 fungi are identified so far (Puspangadhan and Nair 1997).

Recording diversity of local flora and fauna is vital for understanding the ecology of any ecosystem. Since there is no bench mark data on the flora of Muriyad wetland, it was necessary to record the floral diversity of the area.

Terrestrial plants (fringe vegetation) of Muriyad wetlands

Methods

The plant diversity of the five micro watersheds of the Muriyad wetland comprising both aquatic and terrestrial (wetland fringe) vegetation was studied (Table 17,18 and 19). Ten sampling spots (Fig. 12; Plate 6) were randomly selected about 500m from the fringes of the wetland on the basis of the vegetational diversity. Plant samples thus collected were analyzed in the laboratory for taxonomic identification.

Results and discussion

One hundred and ninety nine species of terrestrial plants belonging to 65 families are recorded from the fringes Muriyad wetlands (Table 17). 85 plant species under 33 'polypetalae' families, 71 species under 18 gamopetalae families, 33 plants species under 8 monochlamydeae families and 10 terrestrial plants from 6 monocot families. The common garden plants (Table 18) and cultivated crops (Table 19) are also recorded.

Fabaceae with its three sub-families with 21 species seems to be the family with highest species diversity. Next comes Euphorbiaceae with 15 species, Poaceae with 14 species, Acanthaceae have 12 species and so on.

Out of the 199 terrestrial plant species, 60 are herbs with five climbing herbs. 42 shrubs of which 23 are climbing, six are under trees, 59 are trees, two epiphytes and a total parasite.

The study demonstrates that Muriyad wetlands and its fringe areas harbour three threatened species of flowering plants, *Drosera burmannii, Rauwolfia serpentina* (Plate 7) and *Santalum album* (Sharma 1999). Two of them have high medicinal value.

Economic Importance

Plants like *Melastroma malabatricum, Barringtonia acutangula, Mollugo pentaphylla, and Melochia corchorifolia* have seen on the wet areas. Formerly these plant species were included under the wetland plants. However, Cook in 1996, has excluded the above-described plants from aquatic/ wetland plants and placed under terrestrial plants.

Polyalthia logifolia is an introduced plant, which is commonly planted here as an ornamental tree. The seed outgrowth of *Bixa orellana* is used for making colour dyes. The dried epicarp of *Garcinia cambogia*, is used as an ingradient in various Keralite dishes. The matchbox industry uses the wood of *Calophyllum inophyllum* and *Ailanthus malabaricum*, for making matchsticks. *Ailanthus malabaricum* has high demand in paper industries also. The durability and high finish of the timber of *Thespesia populnea*, has turned this tree a favourable alternative to costly teak and rosewood in the furniture industry. *Cieba pentandra*, is a soft wooded tree and its ingrowths of epicarp of fruit is similar to cotton wool and used by local bed making industry.

***Aegle marmelos* is a sacred plant and its leaves are used for several rituals associated with temples of Lord Siva. The nut of *Anacardium occidentale* (cashew nut) has great commercial value.**

The shoots of *Connarus monocarpus, Glyricidia sepium* and *Chromolaena odorata* are used as green manure to various crops, especially in paddy fields. *Cassia fistula*, the state tree of Kerala, is very common in the area. The flowers of the tree are used for cultural events and festivals like 'Vishu'.

The mesocarp of *Tamarindus indica*, is used as an ingredient for making culinary and its hard wood is used for various purposes. The fruits of *Syzigium cumini*, and *Carica papaya* are very nutritious. Cook in 1996, excluded the former plant from the list of wetland plants.

Morinda citrifolia, is a terrestrial plant, which is seen abundantly on the fringes of the wetlands. Local people use its wood as firewood.

Cascuta reflexa, is a total parasite of various plants. It has no true leaves and the stem itself functions as leaves. Its profuse growth affects the host and completely damages the host plant. *Lantana camara*, is an exotic plant and grown here considered as a weed.

Tectona grandis, the teak wood is one of the costly timbers of Kerala and used for furniture manufacture. *Trewia polycarpa*, has only one tree here seen on the riparian zone of Karivannur river. *Casuarina equesetifolia*, is rare in this wetland. The pole of this plant is used as a supporting stump for weak stemmed crop plants, especially to plantain. Majority of plant species listed here are also seen in similar habitats of Kerala.

Table 17 Flowering plants Class:Dicotyledons.
Sub class:Polypetalae

Sl. No	SCIENTIFIC NAME	VERNACULAR NAME	FAMILY
1	*Uvaria narum, Wall.*	ÈùáOÞÃW	Annonaceae
2	*Polyalthia logifolia,Hook.F. Thoms.*	¥øÃÎø¢	,,
3	*Cyclea peltata, (Poir) Hook.*	Îá¿ßJÞ{ß	Menispermaceae
4	*Tiliacora acuminata, Colebr.*	ÕUßAÞEßø¢	,,
5	*Nymphaea stellata, Willd.*	¦OW	Nymphaeaceae
6	*Nelumbo nucifera*	ÄÞÎø	,,
7	*Cleome viscosa,Linn.*	¦¿áÈÞùßçÕ{	Capparidaceae
8	*Cleome rutodosperma, DC.*	µÞGá¼àøµ¢	,,
9	*Bixa orellana, Linn.*	µáMÎEZ	Bixaceae
10	*Drymaria cordata, Willd.*		Caryophyllaceae
11	*Garcinia cambogia, Desr.*	µá¿Oá{ß	Guttiferae
12	*Calophyllum inophyllum, Linn.*	ÉáK	,,
13	*Sida cordifolia, Linn.*	µÞGáµáùá¢çJÞGß	Malvaceae

14	*Sida acuta, Burm.*	¦ÈµáùáçJÞGß	,,
15	*Sida rhombifolia, Linn.*	µáùáçJÞGß	,,
16	*Abutilon indicum, G.Don.*	©ù¢	,,
17	*Hibiscus vitifolius, Linn.*	µÞGáæºOøJß	,,
18	*Malvaviscus penduliflorus, DC.*	Îá{µáæºOøÄß	,,
19	*Urena lobata, Linn.*	©Äßø¢	,,
20	*Thespesia populnea, Cav.*	ÉâMøáJß	,,
21	*Melochia corchorifolia, Linn.*		Sterculiaceae
22	*Cieba pentandra(L.), Gaertn.*	ÉEßÎø¢	Bombacaceae
23	*Grewia microcos, Linn.*	æµÞçGÞX	Tilaceae
24	*Triempheta sp*		,,
25	*Hugonia mystax, Linn.*	çÎÞÄßøAHß	Linaceae
26	*Oxalis corniculata, Linn.*	Éá{ßÏ1ùßÜ	Geraniaceae
27	*Biophytum reinwardtii,*	ÎáAáxß	,,
28	*Averrhoa bilimbi, Linn.*	§øáOXÉá{ß	,,
29	*Glycosmis cochinchinensis, Pierre.*	µáxßMÞÃW	Rutaceae
30	*Aegle marmelos, Corr.*	µâÕ{¢	,,
31	*Ailanthus malabarica, DC.*	æÉøáÎø¢	Simaroubaceae
32	*Naregamia alata, W.&A.*	ÈßÜÈÞøµ¢	Meliaceae
33	*Azadirachta indica, A.Juss.*	¦øcçÕMí	,,
34	*Zizyphus oenoplea, Mill.*	Äá¿Üß	Rhamnaceae
35	*Zizyphus rugosa, Lamk.*	ÎÜLá¿Üß	,,
36	*Cissus repanda, W.&A.*	dÎá· Oá{ß	Vitaceae
37	*Cissus glauca, Rox.*		,,
38	*Cayratia carnosa, Wall.*	ÕÞÄæAÞ¿ß	,,
39	*Leea indica, (Burm.F)Menr.*	ÎÃßÉßøI	Leeaceae
40	*Cardiospermum helicacabum, L.*	©ÝßE	Sapindaceae
41	*Mangifera indica, Linn.*	ÎÞÕí	Anacardiaceae
42	*Anacardium occidentale, Linn.*	µÖáÎÞÕí	,,
43	*Odina wodier, Roxb.*	µÜÖí	,,
44	*Moringa oleifera, Lamk.*	ÎáøßB	Moringaceae
45	*Connarus monocarpus, Linn.*	µáøàW	Connaraceae
46	*Crotalaria striata, DC.*	µßÜáAÞæOGß	Fabaceae
47	*Crotalaria retusa, -*	µßÜáAÞæOGß	,,
48	*Mucuna pruriens, Linn.*	ÈÞÏíAáøÃ¢	,,
49	*Clitoria ternatia, Linn.*	Ö¢¶âÉá×íÉ¢	,,
50	*Glyricidia sepium, (Jack) Kunth.*	ÖàÎæAÞK	,,
51	*Erythrina stricta, Roxb.*	ÎáøßAí	,,
52	*Abrus precatorius, Linn.*	µáKßÎø¢	,,
53	*Centrosema pubescens, Linn.*	µÞGáÉÏV	,,
54	*Caesalpinia pulcherrima, Swartz.*	øÞ¼ÎÜïß	,,
55	*Delonix regia, Raf.*	ÉâÎø¢	,,
56	*Cassia fistula, Linn.*	µÃßæAÞK	,,
57	*Cassia occidentalis, Linn.*	æÉÞKøßÕàø¢	,,

58	*Cassia mimosoids, Linn.*		,,
59	*Cassia alata,*	Äµø	,,
60	*Bauhinia acuminata,*	ÎwÞø¢	,,
61	*Tamarindus indica, Linn.*	Éá{ß	,,
62	*Adenanthera pavonia, Linn.*	ÎFÞ¿ß	,,
63	*Mimosa pudica, Linn.*	æÄÞGÞÕÞ¿ß	,,
64	*Mimosa invisa, Mart.*	É¿ÏßF	,,
65	*Acasia intsia, W.&A.*	§F	,,
66	*Acasia auriculiformis, A.Cunn.*	¥çA×c	,,
67	*Bryophyllum pinnatum, Kurz.*	§ÜÎá{ºîß	Crassulaceae
68	*Drosera burmanii, Linn.*		Droseraceae
69	*Terminalia catappa, Linn.*	ÄÜïßçÄB	Combretaceae
70	*Calycopteris floribunda, Lamk.*	ÉáÜïÞÈß	,,
71	*Quisqualis indica, Linn.*	ÄÜµáJßÎáÜï	,,
72	*Psidium guajava, Linn.*	çÉøÎø¢	Myrtaceae
73	*Sizygium caryophyllatum, (L)Alston.*		,,
74	*Sizygium cumini, Linn.*	¾ÞÕW	,,
75	*Barringtonia acutangula, Gaertn.*	¥xáçÉÝí	Lecythedaceae
76	*Osbeckia truncata, Don.*		Melastomacae
77	*Osbeckia aspera, Blume.*		,,
78	*Melastoma malabathricum, Linn.*	µÆ{ß	,,
79	*Memecylon malabaricum, Cogn.*	µÏÞOâ	,,
80	*Rotala macranda, Koehne.*		Lythraceae
81	*Lagerstroemia indica, Linn.*	ÎÃßÎøáÄí	,,
82	*Lawsonia inermis, Linn.*	èÎÜÞFß	,,
83	*Ludwigia adscendens,*		Onagraceae
84	*Ludwigia hyssopifolia,*	µÞGáÄáO	,,
85	*Passiflora foetida, Linn.*	ÎâAGMÝ¢	Passifloraceae
86	*Carica papaya, Linn.*	ÉMÞÏ	Caricaceae
87	*Luffa aegyptiaca, Mill.*	µÞGáçµÞÕW	Cucurbitaceae
89	*Trichosanthes cucumaria,*	µÞGáÉ¿ÕÜ¢	,,
90	*Mukia maderaspatana, (L) Roemer.*	ÎáAMßøßÏX	,,
91	*Mollugo oppositifolia, Linn.*	µÏíÉXºîàø	Aizoaceae
92	*Mollugo pentaphylla, Linn.*		,,
93	*Centella asiatica, Urban.*	µá¿ÕX	Apiaceae
94	*Hydrocotyl sp.*		,,

Sub class: Gamopetalae

95	*Hedyotis brachypoda,*	ÉVM¿µÉáÜïí	Rubiaceae
96	*Mussada frondosa,*	æÕUßÜÄÞ{ß	,,
97	*Gardenia jasminoides,Ellis.*	· tøÞ¼X	,,
98	*Canthium parviflora, Bedd.*	µÞøÎáÜïí	,,

99	*Canthium rheedi,*	µÞø	,,
100	*Pavetta indica, Linn.*	ÉÞÕG	,,
101	*Ixora coccinea, Linn.*	æºJß	,,
102	*Chasalia curviflora, Thw.*	æÕUµáùßEß	,,
103	*Morinda citrifolia, Linn.*	ÎEMÞÕG	,,
104	*Vernonia cinerea, Less.*	ÉâÕÞ¢µáøßKßÜ	Asteraceae
105	*Sphaeranthus africanus, Linn.*	¥¿AÎÃßÏX	,,
106	*Eclipta alba, Hassk.*	µÏîáÃc¢	,,
107	*Tridax procumbens, Linn.*	²¿ßÏXÉºî	,,
108	*Emelia sonchifolia, DC.*	ÎáÏWæºÕß	,,
109	*Mikania cordata,*		,,
110	*Chromolaena odorata, (L) King &Robins*	æ®ÎÉºî	,,
111	*Achanthospermum hispidium, D.*	µGáæ¾øß¾ßW	,,
112	*Lobelia trigona, Roxb*		Companulaceae
113	*Sphenoclea zeylanica, Gaertn.*		,,
114	*Plumbago zeylanica, Linn.*	æÕUæµÞ¿áçÕÜß	Plumbaginaceae
115	*Chrysophyllum cainito, Linn.*		Sapotaceae
116	*Mimusops elengi, Linn.*	§ÜEß	,,
117	*Olea dioica, Roxb.*	®¿K	Oleaceae
118	*Rauwolfia serpentina, Benth.*	ØVÉ· tß	Apocynaceae
119	*Alstonia sholaris, R.Br.*	¯ÝßÜOÞÜ	,,
120	*Ervatamia divaricata, (L) Burkill.*	ÈwcÞVÕG¢	,,
121	*Tabernamontana dichotoma, Roxb.*	µáøáGâÉÞÜ	,,
122	*Ichnocarpus frutenscens, R.Br.*	ÉÞWÕîUß	,,
123	*Allamanda cathartica, Linn.*	ÎEçAÞ{Þ¢Ìß	,,
124	*Thevetia nerifolia, Juss.*	ÎEø{ß	,,
125	*Calotropis gigantea, R.Br.*		Asclepiadaceae
126	*Asclepias curassavica, Linn.*		,,
127	*Gymnema sylvestre, R.Br.*	ºAøæAÞÜïß	,,
128	*Wattakaka volubilis, (L.F) Stapf.*		,,
129	*Strychnos nux-vomica, Linn.*	µÞEßø¢	Loganiaceae
130	*Nymphoides hydrophylla, Griseb*		Menyanthaceae
131	*Nymphoides indicum, Thw.*		,,
132	*Heliotropium indicum, Linn.*	æÕÈMºî	Boraginaceae
133	*Ipomoea aqatica, Forsk.*		Convolvulaceae
134	*Ipomoea carnea, Jack.*		,,
135	*Ipomoea Pes-carpae, Sweet.*	¥¿OáÕUß	,,
136	*Ipomoea palmata, Forsk.*		,,
137	*Ipomoea paniculata, R.Br.*		,,
138	*Merremia tridentate, (L) Hallier.*	dÉØÞøßÃß	,,
139	*Quamoclit pinnata, Boj.*	¦µÞÖÎáÜï	,,
140	*Evolvulus alsenoides, Linn.*	Õß×íÃádµÞÈíÇß	,,
141	*Evolvulus numularis, Linn.*	dµß×íÃdµÞÈíÇß	,,

142	*Aniseia uniflora, Choisy.*		,,
143	*Cuscuta reflexa, Roxb.*	Îâ¿ßÜïÞÄÞ{ß	,,
144	*Solanum nigrum, Linn.*	ÎÃßÄAÞ{ß	Solanaceae
145	*Physalis minima, Linn.*	æ¾ÞGÞæ¾Þ¿ßÏX	,,
146	*Capsicum frutescens, Linn.*	Îá{µí	,,
147	*Limnophylla heterophylla, Benth.*		Scrophulariaceae
148	*Limnophylla repens, Benth.*	ÎÞBÞÈÞùß	,,
149	*Limnophylla indica,*		,,
150	*Torenia bicolor, Dalz.*	µÞAMâÕí	,,
151	*Lindernia rotundifolia,*		,,
152	*Lindernia hyssopyoides*		,,
153	*Bacopa monnieri(L), Pennel.*	dÌÙíÎß	,,
154	*Scoparia dulcis, Linn.*	µÜïâøß	,,
155	*Utricularia flexosa, Vahl.*		Lentibulariaceae
156	*Utricularia reticulata, Smith.*		,,
157	*Utricularia bifida, Linn.*		,,
158	*Sesamum radiatum, Sechum.*	µÞæGUí	Pedaliaceae
159	*Thunbergia alata, Brjer.*	ÈàÜçµÞ{Þ¢Ìß	Acanthaceae
160	*Hygrophylla schulli, Nees.*	ÕÏW°îáUß	,,
161	*Hygrophylla salicifolia, Nees.*		,,
162	*Crossandra undulaefolia, Salash.*	µÈµÞ¢Ìø¢	,,
163	*Barleria mysorensis, Roth.*	ÈàÜµÈµÞ¢Ìø¢	,,
164	*Asystasia gangetica, T.*		,,
165	*Justicia betonica, Linn.*	æÕYµáùßEß	,,
166	*Justicia jendarussa, Linn.*	ÕÞÄ¢æµÞÜïß	,,
167	*Justicia simplex,*		,,
168	*Adathoda vasica, Nees.*	¦¿çÜÞ¿µ¢	,,
169	*Rhinacanthus communis, Nees.*	ÈÞ ÎáÜï	,,
170	*Peristrophe bicalyculata, Nees.*		,,
171	*Tecoma stans,(L) H.B.R.*	æ¿çAÞÎ	Bignoniaceae
172	*Lantana camara, Linn.*	¨GÞÎßAß	Verbenaceae
173	*Phyla nodifora, Linn.*	ÈàVJßMÜß	,,
174	*Stachytarpheta indica, Vahl.*	²¿ß°îáµáJß	,,
175	*Tectona grandis, Linn.*	çÄAí	,,
176	*Clerodendron inerme, Gaertn.*		,,
177	*Clerodendron infortunatum, Linn.*	æÉøáÕÜ¢	,,
178	*Clerodendron thomsonae, Balf.*	°áÕK ¥M	,,
179	*Vitex trifolia, Linn.*	æÕUæÈÞ°îß	,,
180	*Ocimum canum, Sims.*	µÞGáÄá{Øß	Lamiaceae
181	*Ocimum sanctum, Linn.*	Äá{Øß	,,
182	*Orthosiphon stamineus, Benth.*		,,
183	*Coleus aromaticus, Benth.*	ÉÈßAâVA	,,
184	*Hyptis suaveolens, Poit.*	ÈÞxÉâæ°î¿ß	,,
185	*Anisomelus indica, R.Br.*	°¿ÏX	,,

186	*Leucas stricta, Benth.*	ÄáO	,,

Sub class:Monochlamydeae

187	*Boerhaavia diffusa, Linn.*	ÄÝáÄÞÎ	Nyctaginaceae
188	*Bougainvillaea spectabilis, Willd.*	µ¿ÜÞØáæº¿ß	,,
189	*Amaranthus spinosus, Linn.*	ÎáUXºàø	Amaranthaceae
190	*Achyranthus aspera, Linn.*	µ¿ÜÞ¿ß	,,
191	*Alternanthera sessilis, R.Br.*	æµÞÝáM	,,
192	*Aerva lanata, Juss.*	æºùâ{	,,
193	*Gomphrena globosa, Linn.*	ÕÞ¿ÞÎÜïß	,,
194	*Polygonum pulchrum*		Polygonaceae
195	*Piper longum, Linn.*	ÄßMÜß	Piperaceae
196	*Peporomia pellucida, H.B.&K.*	Î×ßJIí	,,
197	*Loranthus longiflorus,Var.falcatus,Kurz*	§JßZµHß	Loranthaceae
198	*Santalum album, Linn.*	ºwÈ¢	Santalaceae
199	*Euphorbia hirta, Linn.*	ÈßÜMÞÜ	Euphorbiceae
200	*Euphorbia antiquarum, Linn.*	ºÄáøAUß	,,
201	*Phyllanthus niruri, Linn.*	µàÝÞVæÈÜïß	,,
202	*Phyllanthus reticulatus, Poir.*	ÈàçøÞÜß	,,
203	*Glochidion zeylanicum, A.Juss.*	æÕGß	,,
204	*Aporosa lindleyana, Baill.*		,,
205	*Croton sparciflorus,*		,,
206	*Mallotus atroviriens, Muell-Arg.*	ÉáçÜïÞLß	,,
207	*Macrananga peltata, Muell-Arg.*	ÕG	,,
208	*Acalypha hipsida,*	ÉâºîÕÞÜX	,,
209	*Tragia involucrate, Linn.*	æµÞ¿ßJâÕ	,,
210	*Jatropha gossypifolia, Linn.*	µ¿ÜÞÕÃAí	,,
211	*Trewia polycarpa, Benth.*	µáOßZ	,,
212	*Breynia patens, Rolfe.*	ºáAâVÎÃß	,,
213	*Securinega virosa, (Willd) Baill.*	µÞGáÈàçøÞÜß	,,
214	*Ficus oppositifolia, Linn.*	æÄÞGß	Moraceae
215	*Ficus racamosa, Linn.*	¥Jß	,,
216	*Ficus benghalensis, Linn.*	çÉøÞW	,,
217	*Ficus religiosa, Linn.*	¥øÏÞW	,,
218	*Streblus asper, Lour.*	ÉøáÕ	,,
219	*Pouzolzia indica, Gaud.*		,,
220	*Casuarina equisetifolia, Forst.*	ºâ{Îø¢	Casuarinaceae

Class:Monocotyledons

221	*Pandanus tectorius, Soland.*	èµÄ	Pandanaceae
222	*Ananas comosus,*	¥HÞùºA	Bromeliaceae

223	*Dioscoria Sps, Linn.*	µGáµÞºîßW	Dioscoriaceae
224	*Gloriosa superba, Linn.*	çÎçLÞKß	Liliaceae
225	*Murdannia crocea subsps.ochracea*		Commelinaceae
226	*Commelina sp,*		,,
227	*Murdannia spiratum*		,,
228	*Commelina nodiflora, Roth.*		,,
229	*Cyanotis axillaris, Roem.&Sch.*		,,
230	*Cryptocoryne spiralis, Fisch.*	³ÎÈÞJÞZ	Araceae
231	*Pistia stratiotes, Linn.*	ÉÞÏW	,,
232	*Colocasia antiquorum, Schott.*	µÞGáçºOí	,,
233	*Pothos scandens, Linn.*		,,
234	*Lemna polyrrhiza, Linn.*		Lemnaceae
235	*Eriocaulon sp, Linn.*		Eriocaulaceae
236	*Limnocharis flava,*		Limnochariaceae
237	*Monocharia vaginalis,*		Potenderaceae
238	*Eichhornia crassipes, Solms.*	µá{ÕÞÝ	,,
239	*Hydrilla sp.*		Hydrocharitaceae
240	*Vallisnaria sp.*		,,
241	*Kyllinga cylindrica, Nees.*		Cyperaceae
242	*Cyperus cephalotes, Vahl.*		,,
243	*Cyperus haspan, Linn.*		,,
244	*Cyperus rotundus, Linn.*	ÎáJB	,,
245	*Cyperus tenuiculmis, Boeck.*		,,
246	*Eleocharis dulcis,*		,,
247	*Eleocharis langana,*		,,
248	*Fimbristylis miliacea, Vahl.*		,,
249	*Scirpus articulatus, Linn.*		,,
250	*Saccharum spontaneum,Linn.*	¦xáÕFß	Poaceae
251	*Ischaemum mangaluricum, Stapf.*		,,
252	*Cymbopogon flexuosus, Wats.*	§FMáÜïí	,,
253	*Digitaria ciliaris, Pers.*		,,
254	*Paspalum conjugatum, Berg.*		,,
255	*Echinochlona colona, Link*		,,
256	*Echinochlona stagina, Beauv.*		,,
257	*Saccolepis interrupta, Stapf.*		,,
258	*Isachene miliacea, Roth*		,,
259	*Cynodon dactylon, Pers.*	µùáµÉáÜïí	,,
260	*Hygrorhiza aristata, Nees*	æÉÞBMáÜïí	,,
261	*Pennisetum sp.*		,,
262	*Axonopus compressus(Swartz). P.Beauv*		,,
263	*Bambusa sp.*	Îá{	

Table 18 Common garden plants

No	Scientific name	Peculiarities
1	*Acalypha sp.*	Potted as well as on ground.
2	*Allamanda sp.*	Climber on the hedges.
3	*Allium sp.*	Potted and on ground
4	*Aloe vera.*	Potted and also in ground
5	*Angelonoia sp.*	Potted, violet flowered herb
6	*Anthurium sp.*	Various coloured inflorescences
7	*Asparagus sp.*	The evergreen plant, climber
8	*Aster sp.*	Potted , exotic
9	*Bignonia sp.*	Climber with violet coloured flowers
10	*Bulbophyllum sp.*	Epiphyte, orchid
11	*Bogainvilla sp.*	Climber on the hedges
12	*Caladium sp.*	Leaves are various colored, showy
13	*Cananga odorata*	Tree, pleasant smelling green flowers
14	*Chrysanthimum sp.*	Potted, several species, handsome
15	*Cassia biflora.*	Yellow flowered shrub
16	*Cassia fistula.*	Yellow flowered handsome tree
17	*Coleus sp.*	Plants with showy leaves
18	*Convolvulus sp.*	Climber with varied flowers
19	*Cycas revolute.*	A handsome gymnosperm
20	*Dahlia sp.*	Potted and on grounds also, flowers showy
21	*Digitalis sp.*	Red flowered potted herbs
22	*Dracaena sp.*	Plant with coloured leaves
23	*Euphorbia pulcherrima.*	Shrub with young leaves are red
24	*Ficus sp.*	In pots, grown as bonsai
25	*Gardinea jasminoides*	Under tree with white flowers.
26	*Hibiscus sp.*	Several sps, flowers are showy
27	*Hydrangea sp.*	Potted herb with commonly violet flowers
28	*Impatiens sp.*	Several varieties, herb , flowers showy
29	*Jasminum sp.*	Pleasant smelling white flowered shrubs
30	*Michelia champaka.*	Tree with good smelling yellow flowers
31	*Mussanda sp.*	Tree, with showy leaves
32	*Nerium, sp.*	Shrub with pink flowers
33	*Opuntia sp.*	Cactus, showy
34	*Portulaca sp.*	Flowers various, herbs
35	*Quamoclit sp.*	Climber with red flowers
36	*Rosa sp.*	Various varieties
37	*Spathoglotis sp.*	Orchids. Pink flowers
38	*Tagetus sp.*	Yellow flowered hansome shrubs
39	*Tecoma stans*	Exotic yellow flowered tree
40	*Vinca rosea.*	Under shrub with white and pink flowers

Table 19 Cultivated crops

No	SCIENTIFIC NAME	COMMON NAME	USAGES.
1	*Oryza sativa*	Paddy	Rice, hey etc.
2	*Cocos nucifera*	Coconut	Oil, curry flavor
3	*Areca catechu*	Areca nut	Chewing pak
4	*Musa paradisiaca*	Plantain	Vegetable, fruit
5	*Myristica fragrans*	Nut meg	As cash crop, spice
6	*Piper nigrum*	Piper	Cash crop, spice
7	*Mangifera indica*	Mango	Vegetable, fruit
8	*Anacardium occidentale*	Cashew nut	Cash crop
9	*Artocarpus heterophylla*	Jack fruit	Vegetable
10	*Artocarpus communis*	Bread fruit	Fruit
11	*Benincasa cerifera.*	White gourd	Vegetable
12	*Momordica charantia*	Bitter gourd	Vegetable
13	*Lagenaria leucantha*	Bottle gourd	Vegetable
14	*Solanum melonjena*	Brinjal	Vegetable
15	*Vigna species*	Pea	Vegetable
16	*Cucumis sativus*	Cucumber	Vegetable
17	*Moringa olefera*	Drum stick	Vegetable
18	*Hibiscus esculentis*	Ladies finger	Vegetable
19	*Coccinea indica*	Ivy gourd	Vegetable
20	*Colocasia antiquarum*	Cocoyam	Vegetable
21	*Cucurbita pepo*	Pumpkin	Vegetable
22	*Luffa acutangula*	Ribbed gourd	Vegetable
23	*Trichosanthes anguina*	Snake gourd	Vegetable
24	*Dioscorea alata*	Yam	Vegetable
25	*Amorphophallus species*	Elephant foot	Vegetable
26	*Zingiber officinalis*	Ginger	Spice
27	*Curcuma longa*	Turmeric	Spice
28	*Kaemfria galanga*	Kaccolam	Spice
29	*Ahras sapota*	Sapota	Fruit
30	*Carica papaya*	Papaya	Fruit
31	*Ananas comosus*	Pine apple	Fruit
32	*Theobroma cocao*	Coco	Fruit
33	*Amaranthus species*	Spinach	Vegetable
34	*Manihot esculenta*	Tapioca	Tuber crop,

Aquatic macrophytes

Freshwater ecosystems are an integral part of a geographical region. These systems provide habitats for many plant species, fishes, birds, insects, and other animals. Their interaction with physical factors results in a balanced ecosystem, with plants providing food and shelter for other organisms that live in

and close to the water. Thus, the plants in a water body may influence not only the aquatic system but also the surrounding areas.12% of all animal species live in freshwater ecosystems and many more species are closely associated with these ecosystems (World Resources, 2000-2001)

Aquatic plants respond strongly to the particular environmental conditions within a wetland. The chemical environment of many aquatic systems has changed at an alarming rate during the last century due to the intensified exploitation of the land for farming, urban expansion, and due to atmospheric and water pollution. Macrophytes, plants observable by the naked eyes, are an important component of aquatic ecosystems. The tolerance limit of aquatic macrophytes is linked with the chemical and physical quality of water (Heegaard et al, 2001). It is therefore, possible to quantify environmental changes of a wetland by analyzing these plants. Changes in the community composition, or in the abundance of individual species, provide valuable information on how and why an ecosystem might be changing (Scott et al., 2002). Macrophytes are also becoming increasingly valued as a means of indirectly monitoring water quality. Eutrophication, for example, can produce a progressive change in species composition resulting in the eventual loss of species diversity (Kelly and Whitton, 1998).

Macrophytes provide a refuge for small animals against predation, change the nutrient dynamics of the aquatic system, and prevent re-suspension of the sediments. Vegetated lakes usually harbour a richer community of invertebrates and fish and attract large numbers of birds than lakes without vegetation (Scheffer, 1998). Eutrophication due to anthropogenic intervention results in the decline of submerged vegetation and the domination of phytoplankton in many lakes (Korner, 2001).

The abundance of phytoplankton may be enhanced by the presence of dense beds of aquatic macrophytes. Macrophyte beds are also favorable for zooplankton development, owing to the refuge they provide against fish predation. Many studies have shown that in the presence of planktivorous fish, zooplankton abundance is much higher within the beds of macrophytes than in open water (Lauridsen et al, 1996). In fluvial lakes with a strong central current, macrophyte beds may provide zooplankton a refuge from flushing. These beds in fluvial lakes should also favour the development of phytoplankton and zooplankton by increasing the water residence time (WRT), allowing more time for populations of planktonic organisms to develop (Basu, et al., 2000). Macrophytes contribute a bulk of biomass production in floodplain wetlands. They act as substratum for periphytic growth, provide shelter to various aquatic fauna and serve as a breeding ground for associated fauna (Mitra, 1997).

Results and discussion

Thirty-five major species of aquatic macrpophytes were identified from Muriyad wetlands (Table 20). Four genera such as *Marsilea sp. Azolla sp. Ceratopteris sp*. and *Salvinia molesta* are ferns (Advanced Pteridophytes) and the rest are phanerogams.

Marsilea is a weak herb usually seen in paddy fields and irrigation ditches. It is reported to have some adverse impacts in rice fields. However, it cannot be considered as a weed

as far as the paddy fields of Muriyad wetlands are concerned. Seedlings remain submerged and adults float as an emergant plant. *Azolla* (Plate 8) was another fern represented in this wetland. It harbors a symbiotic nitrogen fixing Cyanobacteria, *Anabaena azollae*, and hence luxuriant growth of this fern can increase the fertility of paddy fields. It is calculated that *Azolla* can substitute about 25-30 kg of nitrogen/ha as applied through ammonium sulphate (Cook, 1996).

Salvinia molesta is considered as a 'worst weed' and is introduced to India from South America. This free-floating plant has become a major threat in almost all the water bodies of Kerala. Due to its rapid growth rate, it can spread over larger areas within short duration. During flood season, *Salvinia* covers almost the major part of this wetland. The usuall agricultural practices of Muriyad wetlands commenses with dewatering the fields during Sepember –October and salvinia settels down as a thick covering over the paddy field. It is not mulchable and manual removal of this weed is labour intensive causing increase in the expenditure of the paddy cultivation. Attempts to irradicate this weed using biological control measures are not fully succesfull in this area.

Nelumbo nucifera, or 'lotus' is a phanerogam usually seen in the deeper regions of this wetland. Although the flowers and buds of lotus are of great demand in the market, overgrowth of lotus can obsruct the smooth passage of country boats operated by the fishermen. The periphytonic algal growth on this plant can support several fresh water fishes. *Nymphaea stellata*, is a rooted floating macrophyte. Usually it grows both in deeper and shallow waters. It is seems that the ovules of this plant is a favorite food material for several aquatic birds.

Ludwigia hyssopifolia is a semi aquatic erect under-hrub usually seen on the fringes the paddy fields situated in the wetland. In Muriyad area it is slowly assuming the status of a weed to paddy.

***Centella asiatica* is a medicinal plant commonly seen in this wetland. The extract from the whole plant is an effective paediatric medicine and the juice of the plant is used for controlling jaundice.**

Hygrophylla spinosa and Polygonum sp. are associated plants. The former has medicinal value and used against the diseases of urino-genetal tract and for dropsy. These two plants usually invade the abandoned paddy fields and as it is difficult to remove manually and with in a short time they convert the paddy fields in to swamps.

One of the major weeds inwarding in to Muriyad wetlands is Ipomoea carnea (Plate 9). It is an exotic plant brought to India from South America as a hedge plant. Infestation *Ipomoea* is common in the major portion of micro-watershed 1 (Parappukkara micro-watershed) where large scale sand and caly mining is going on. It is a versatile plant which can grow both in aquatic and terrestrial habitats. In several localities of Muriyad wetlands *Ipomoea* provides suitable habitats for birds. Luxurient growth of *Ipomoea* in water-logged areas provides shelter and breeding ground for several species of fishes including *Channa striatus* and *Channa marulius*.

Utricularia is a submerged plant equipped with a bladder like structure to trap inseccts. Abundant growth of this can be seen during the post monsoon season. *Nymphoides indica* and *Nymphoides cristata,* are two quick growing species seen in this wetalnd. Both of them are rooted freefloating emergants. Due to the fast growth rate large scale biomass synthesis takes place during the post monsoon period. As it is a weak plant it can be very easily mulched into the soil and provide high quality organic matter to the soil.

Eichhornia crassipes or the 'water hyacinth' is also an exotic species introduced from America. It has high growth rate and clogs waterways and making fishing, boating, and almost all other water related activities impossible (Mitchel, 1976). The mats of this plant block the air-water interface and greatly diminish oxygen level leading to the degradation water quality. This in turn affects the species richness of the aquatic ecosystem. The mats also eliminate natural submerged plants by blocking sunlight.

Limnocharis flava, (L), Buch, (Plate 9) is slowly getting established as another weed, in central Kerala. In the near future, it would become one of the most serious weeds of the paddy fields. It is a handsome exotic erect herb of marshes introduced to India from America. Due to its efficient propagation by seeds, this plant is one among the three well-established weeds in Malaysia (Noda, 1979). Sown rice seedlings suffer more heavily from *Limnocharis* than the transplanted rice.

Pandanus grows on the banks of the canal and is abundant in micro-watershed 1 and 2 (Parappukkara and Anandapuram). It provides exellent habitats for several species of small mammals and reptiles. The prop roots extending in to the water body provides specific breeding ground for *Arias sp.* and fresh water prawn *Macrobachium*. Its leaves are used for making mats which is now attaining the status of an export item.

FERNS

Table 20

Sl. No	**SCIENTIFIC NAME**	**HABIT**	**FAMILY**
1	*Marsilea sp.*	Rooted floating	Marsileaceae
2	*Azolla sp.*	Free floating	Azollaceae
3	*Ceratopteris*	Rooted emergant	Ceratophyllaceae
4	*Salvinia molesta*	Free floating	Salviniaceae

Class: Dicotyledons

Sub-class: Polypetalae

Sub-class: Polypetalae

5	*Nymphaea stellata, Willd.*	Rooted floating	Nymphaeaceae
6	*Nelumbo nucifera,*	Rooted floating	,,

7	*Drymaria cordata, Willd.*	Rooted on wet areas	Caryophyllaceae
8	*Drosera burmanii, Linn.*	Rooted, rossete leaves	Droseraceae
9	*Rotala macranda, Koehne.*	Rooted emergant	Lythraceae
10	*Ludwigia adscendens,*	Rooted floating	Onagraceae
11	*Ludwigia hyssopifolia,*	Emergant, wet areas	,,

Sub-class: Gamopetalae

12	*Lobelia trigona, Roxb.*	Rooted herb, wet areas	Companulaceae
13	*Sphenoclea zeylanica, Gaertn.*	Emergant, wet areas	,,
14	*Nymphoides cristatum, Griseb*	Rooted floating	Menyanthaceae
15	*Nymphoides indicum, Thw.*	Rooted floating	,,
16	*Ipomoea aqatica, Forsk.*	Rooted floating	Convolvulaceae
17	*Ipomoea carnea, Jack.*	Emergant, shrub	,,
18	*Limnophylla heterophylla, Ben*	Rooted emergant	Scrophulariaceae
19	*Limnophylla repens, Benth.*	Rooted on wet areas	,,
20	*Limnophylla indica,*	Herb, emergant	,,
21	*Torenia bicolor, Dalz.*	Herb, wet areas	,,
22	*Lindernia rotundifolia,*	Herb, wet areas	,,
23	*Lindernia hyssopyoides*	Herb, wet areas	,,
24	*Bacopa monnieri(L), Pennel.*	Herb, wet areas	,,
25	*Utricularia flexosa, Vahl.*	Submerged, rooted	Lentibulariaceae
26	*Utricularia reticulata, Smith.*	Submerged, rooted	,,
27	*Utricularia bifida, Linn.*	Submerged, rooted	,,
28	*Hygrophylla spinosa, Nees.*	Shrub, wet areas	Acanthaceae
29	*Hygrophylla salicifolia, Nees.*	Shrub, wet areas	,,
30	*Phyla nodifora, Linn.*	Herb, wet areas	Verbenaceae

Sub-class: Monochlamydeae.

31	*Polygonum pulchrum*	Shrub, wet areas	Polygonaceae

Class: Monocotyledons

32	*Pandanus tectorius, Soland.*	Under tree, wetland fring	Pandanaceae
33	*Murdannia croceasubsps.ochra*	Herb, wet areas	Commelinaceae
34	*Commelina sp.*	Herb, wet areas	,,
35	*Murdannia spiratum*	Herb, wet areas	,,
36	*Commelina nodiflora, Roth.*	Herb, wet areas	,,
37	*Cyanotis axillaris, Roem.&Sc*	Herb, wet areas	,,
38	*Cryptocoryne spiralis, Fisch.*	Herb, irrigation channels	Araceae
39	*Pistia stratiotes, Linn.*	Free floating, ponds	,,

40	*Lemna polyrrhiza, Linn.*	Free floating paddy fields	Lemnaceae
41	*Eriocaulon sps, Linn.*	Herb, wet areas	Eriocaulaceae
42	*Limnocharis flava,*	Herb, wetlands	Limnochariaceae
43	*Monocharia vaginalis,*	Rooted, floating	Potenderaceae
44	*Eichhornia crassipes, Solms.*	Free loating, waterlogged	,,
45	*Ceratophyllum dimersum*	Rooted submerged	Ceratophyllaceae
46	*Myriphyllum sp.*	Rooted submerged	Haloragaceae
47	*Hydrilla verticillata*	Rooted submerged	Hydrocharitaceae
48	*Vallisnaria spiralis*	Rooted submerged	,,
49	*Kyllinga cylindrica, Nees.*	Rooted emergant	Cyperaceae
50	*Cyperus cephalotes, Vahl.*	Rooted, on sud vegetaion	,,
51	*Cyperus haspan, Linn.*	Rooted emergant	,,
52	*Cyperus tenuiculmis, Boeck.*	Rooted emergant	,,
53	*Eleocharis dulcis,*	Rooted emergant,	,,
54	*Eleocharis langana,*	Rooted emergant	,,
55	*Fimbristylis miliacea, Vahl.*	Rooted emergant	,,
56	*Scirpus articulatus, Linn.*	Rooted emergant	,,
57	*Saccharum spontaneum,Linn.*	Shrub, wetland fringes	Poaceae
58	*Ischaemum mangaluricum, Sta*	Rooted emergant	,,
59	*Digitaria ciliaris, Pers.*	Rooted emergant	,,
60	*Paspalum conjugatum, Berg.*	Rooted emergant	,,
61	*Echinochlona colona, Link*	Rooted emergant	,,
62	*Echinochlona stagina, Beauv.*	Rooted emergant	,,
63	*Saccolepis interrupta, Stapf.*	Emergant, aquatic	,,
64	*Isachene miliacea, Roth*	Herb, wet areas	,,
65	*Cynodon dactylon, Pers.*	Herb, wet areas	,,
66	*Hygrorhiza aristata,s Nees*	Floating herb	,,

Algal diversity

Understanding the biological diversity of microscopic life is of primary importance in aquatic ecology context of assessing water quality, habitat integrity, habitat carrying capacity, and trophic web stability. Therefore, direct microscopic observation and enumeration remain necessary to document species composition and biomass production, and is the only means to assess structural changes within the algal communities in response to environmental variations (Reynolds, 1996). The study of Algae or the science of algology forms an important part of Limnology (Biswas, 1987). The documentation of microorganism biomass in aquatic ecosystem is necessary when evaluating niche requirements, dispersion, and trophic energy flows. More than just numbers, biomass represents a measure of success of each species to reproduce and survive stressors, (e.g. predation, physical disturbances) within its niche (Gosselain et al., 2000).

The group of plants known as algae is distributed over vast areas on land, fresh and brackish water, seas, and oceans all over the globe. It covers vast ranges of organisms from the simplest protoplast, which can hardly be differentiated from bacteria to the highly evolved seaweeds. Algae exhibits elaborate morphological variation comparable to those of large trees. Alternation of generation and greatly advanced complex structures are unique in this group of organisms. The distribution of these dominantly water plants can also be compared with the distribution of higher land plants exposed, to different ranges of photic (light), climatic, and other ecological factors.

The majority of the fresh water algae is coming under Chlorophyta (green algae), Cyanophyceae (blue-green algae) and Bacillarophyceae (diatoms). Cyanobacteria and Chlorophyta comprise two composite groups of photosynthetic organisms adapted to a broad range of environmental conditions. Cyanobacteria have evolved in different types and are able to colonize very different aquatic and terrestrial systems on the earth (Salmaso, 2000). The green algae spanning a wider range of cellular organization than in any other algal 'phyta', exhibit a diverse spectrum of growth responses to critical environmental variables (Happey-Wood, 1988).

Cyanobacteria and chlorophytes represent a significant component of virtually all-photosynthetic lentic (stagnant waters) assemblages, colonizing different types of lakes over the whole trophic range. The specific composition is determined, besides the trophic status, by various lake properties (morphometry, hydrology, climate or location), which may favor distinct life strategies and plankton assemblages. Even considering a limited range of lake typology (eg. large lakes), significant differences are recognizable if the effects of latitude on phytoplankton composition and abundance are considered (Pollingher, 1990). Severe misinterpretation may arise when colonization success are deciphered taking into account only the availability of algal nutrients (Reynolds, 1988). Theoretically, the recognition of the responses of algal assemblages to different levels of available resources may be favored by considering lakes of similar characteristics, i.e., restricting the variability of physical and hydrological factors. On the other hand, the absence of a widely recognizable model that adequately fits the seasonal succession in water bodies of different trophic status reflects the different responses of the organism's life cycles to the adaptation of different morphometric, hydrologic and climate conditions. Smaller lakes are characterized by wide variability and unpredictability. Species selection is more likely to be in equilibrium in large lakes than in more unstable small lakes (Tilzer and Serruga, 1990). Thus, large water bodies may be particularly suitable in monitoring changes in algal assemblages with changing trophic status (Salmaso, 2000).

With exception of the central channel of fluvial lakes, which often has a strong current, fluvial lakes are typically wider, shallower and overall, have reduced current velocities and protracted residence times in comparison to main river channels (Allan, 1986). The resulting condition is favorable for the development of extensive beds of aquatic macrophytes outside the central canal (Hudson et al, 1996, Basu et al, 2000). Thus, presence of macrophytes favors the luxuriant gowth of periphytonic alage.

Diatoms commonly take over river plankton community with chlorophytes dominanting in summer (Reynolds, 1988). However rivers in semi-arid regions have a highly seasonal hydrological regime with turbid flows followed by pronounced periods of low-flow or impoundment of water (Fabbro, and Duivenvoorden, 2000).

The phytoplankton occurs as unicellular, colonial, or filamentous forms. Majority of them are photosynthetic and are grazed upon by zooplankton and other aquatic organisms (APHA, 1998). Fishes and oysters form one of the chief foods for human consumption. These two animals live on other smaller animals (zooplankton) and they in their turn subsist on still smaller members of algae, although larger fishes frequently devour higher representatives of algae and sometimes on floating and submerged fresh or decaying water plants (Biswas, 1987).

A number of species flourish in highly eutrophic water while others are very sensitive to organic and chemical wastes. Some species develop noxious blooms, sometimes creating offensive tastes and odors or toxic conditions resulting in animal deaths or human illness.

Because of their short life cycles, plankters respond quickly to environmental changes and have their standing crop and species composition more likely to indicate the quality of water mass in which these are found. They strongly influence certain non-biological aspects of water quality (Such as pH, colour, taste and odor) and in a very practical sense they are a part of water quality. Certain taxa often are useful in determining the origin or recent history of a given water mass. Information on plankton as indicators is interpreted best in conjunction with concurrently collected, physicochemical, and other biological data (APHA, 1998). Given the continual increase of pollution pressure on aquatic biota, it is increasingly urgent to study intact natural ecosystem prior to their disturbance (Medvedeva, 2001).

The productivity of any aquatic ecosystem is dependant on the primary producers like phytoplankton and aquatic macrophytes. Muriyad wetlands provides habitat for a good number of species of fishes and other organisms. Productivity of the fish is very intimately linked with economic stability of the human communities, who take up fishing as their primary occupation. Any prediction on the availability and sustainable utilization of the fishing resource depends on the assessment of physical and biological characteristics of the system. Hence, we thought of studying the biological characteristics of the Muriyad wetlands. About 16.195 km^2 of the area are remaining submerged for about 6 months. During the peak monsoon period, the water level may go up to 5m. Since the wetland is 1-1.5m below the mean sea level, water of 1m depth remains in the low laying areas even during the summer months.

One of the salient features of this unique wetland is that there are certain areas with a standing water body having a depth about 4m. 'Kokra chal' situated about the central part of this wetland, act as a reservoir for most of the fish species throughout the year. Water from the 'Karuvannur'river, which forms the northern boundary of this wetland flows in during the monsoon period through 'Thamaravalayam'

canal (see map). The physical ambience of the wetland provides optimum conditions for the growth of algae and thus wetland act as one of the major breeding ground for a good number of fish species.

METHODS

Using plankton net, algal samples were collected from 20 randomly selected localities. The samples were fixed in 2% formaldehyde solution and prepared temporary slides, mounted in glycerin. On the edge of the cover slips 2-3 coats of nail polish was applied to prevent damages to the slides from fungal attack. Then they were observed under microscope and diagrams were prepared using a camera Lucida. The taxonomic status of the samples was identified with the help of monographs and taxonomic publications on algae.

Results and discussion

About ninety species from twenty families of algae are identified from Muriyad wetlands. It is found that forty species observed in this wetland belongs to a single family, Desmidiaceae (Desmids), from the order conjugales of the class Chlorophyceae. The family Zygnemataceae stands next in species diversity followed by Hydrodictyaceae and Oscillatoriaceae. This indicates that Muriyad wetland supports a wide variety of algal species Diagrams 1-7 shows the camera lucida drawings of the abundant alagal species. It is pertinent to recall here that the economic importace of the majority of these species remain to be explored. These microalgae are the dominant primary pruducers of this wetland, which have significant role in the bio-productivity of this wetland ecosystem. The extra-cellular products released by these algae contributing much to the formation of a 'microbial loop' which, ultimately enhance the bio-productivity of the system.

Most abundant genera were *Staurastrum* and *Cosmarium* of Desmidiaceae, with nine spp. *Micrasterias* (seven spp.) *Closterium* (five spp.) were following *Sturastrum* and *Cosmarium.* All these species were coming under the family Desmidiaceae.

Fifty six species are unicellular and twenty are filamentous; in which sixteen are filamentous-unbranched and four are branched. Macroscopic thalloid algae such as *Chara zelanica, Nitella mirabilis* and *Hydrodictyon reticulatum* were also recorded from this wetland during the present study.

Spirulina, which is currently marketed as a protein suppliment, was also represented by 2 species *Nostoc*, also an economically valuable blue-green alga, which is noted for its nutritive value (Tseng, 2001).

During the present study a colony of *Hydrodictyon reticulatum*, commonly called as 'water net' from this wetland was recorded. There are reports from New Zealand that *Hydrodictyon* adversley affects the zooplankton and other invertebrates by blocking their food and shelter (Wells and Clayton, 2001).

In order to understand the trophic position of the algae in the food web of the water body, the gut contents of some fresh water fishes collected from the wetland was analyzed. It was found that the gut contained samples of fourteen genera of algae. They were *Oedogonium, Sphaerozosma, Sphaeroplea, Closterium, Gonatozygon, Ulothrix, Cosmarium, Micrasterias, Bulbochaete, Euastrum, Pinnularia, Pleurotaenium, Pediastrum,* and *Mougeotia*. Desmids formed the major portion of the gut content of the species of fish studied with 7 genera. *Closterium* and *Cosmarium* represented by more than two species and *Euastrum* by two species. *Oedogonium,*of the order Oedogoniales was also abundant in the gut content. The gut content analysis showed that blue-green algae were absent indicating the selectivity of feeding of the fish belonging to *Pundias sp*.

Desmids are indicator species of portability of water. Usually they flourish in slightly acidic water. The present study shows that the majority of the Desmid species were found associated with *Spirogyra* mats (Plate 8). Highest abundance of algae was observed during the month of July and August, when the floodwater settled down allowing the penetration of sunlight to the deeper layers. It is widely known that algal blooms indicate eutrophication of an aquatic system. Such blooming was seldom observed in the collection sites indicating the low nutrient loading of the water body of Muriyad wetlands.

Table 21 Classification of algal flora

Class: Chlorophyceae.

Sl.no	SCIENTIFIC NAME	ORDER	FAMILY
1	*Volvox sp.*	Volvocales	Volvocaceae
2	*Tetraspora sp.*	Volvocales	Tetrasporaceae
3	*Chlorella sp.*	Chlorococcales	Chlorellaceae
4	*Selanastrum sp.*	Chlorococcales	Selanastraceae
5	*Pediastrum simplex*	Chlorococcales	Hydrodictyaceae
6	*Pediastrum duplex*	Chlorococcales	Hydrodictyaceae
7	*Pediastrum tetras*	Chlorococcales	Hydrodictyaceae
8	*Hydrodictyon reticulatum*	Chlorococcales	Hydrodictyaceae
9	*Scenedesmus quadricauda*	Chlorococcales	Scenedesmaceae
10	*Scenedesmus dispar*	Chlorococcales	Scenedesmaceae
11	*Scenedesmus sp.*	Chlorococcales	Scenedesmaceae
12	*Coelastrum cambricum*	Chlorococcales	Coelastraceae
13	*Ulothrix zonata*	Ulotrichales	Ulotricaceae
14	*Ulothrix spp.*	Ulotrichales	Ulotricaceae
15	*Microspora sp.*	Ulotrichales	Microsporaceae
16	*Sphaeroplea sp.*	Ulotrichales	Sphaeropleaceae

17	*Cladophora sp.*	Cladophorales	Cladophoraceae
18	*Chaetophora sp.*	Chaetophorales	Chaetophoraceae
19	*Oedogonium spp.*	Oedogoniales	Oedogoniaceae
20	*Bulbochaete sp.*	Oedogoniales	Oedogoniaceae
21	*Oedocladium sp.*	Oedogoniales	Oedogoniaceae
22	*Zygnema sp.*	Conjugales	Zygnemaceae
23	*Mougeotia sp.*	Conjugales	Zygnemaceae
24	*Spirogyra spp.*	Conjugales	Zygnemaceae
25	*Staurastrum crenulatum*	Conjugales	Desmidiaceae
26	*Staurastrum muticum*	Conjugales	Desmidiaceae
27	*Staurastrum aretiscon*	Conjugales	Desmidiaceae
28	*Staurastrum pelagicum*	Conjugales	Desmidiaceae
29	*Staurastrum decieetum*	Conjugales	Desmidiaceae
30	*Staurastrum pingue*	Conjugales	Desmidiaceae
31	*Staurastrum spp.*	Conjugales	Desmidiaceae
32	*Arthrodesmus convergens*	Conjugales	Desmidiaceae
33	*Closterium kutzingi*	Conjugales	Desmidiaceae
34	*Closterium dianae*	Conjugales	Desmidiaceae
35	*Closterium closterioides*	Conjugales	Desmidiaceae
36	*Closterium spp.*	Conjugales	Desmidiaceae
37	*Cosmarium caelatum*	Conjugales	Desmidiaceae
38	*Cosmarium maryar*	Conjugales	Desmidiaceae
39	*Cosmarium quadrum*	Conjugales	Desmidiaceae
40	*Cosmarium granatum*	Conjugales	Desmidiaceae
41	*Cosmarium spp.*	Conjugales	Desmidiaceae
42	*Micrasterias foliacea*	Conjugales	Desmidiaceae
43	*Micrasterias thomasiana*	Conjugales	Desmidiaceae
45	*Micrasterias crux-melitensis*	Conjugales	Desmidiaceae
46	*Micrasterias murayi*	Conjugales	Desmidiaceae
47	*Micrasterias mahabuleswarensis*	Conjugales	Desmidiaceae
48	*Micrasterias pinnatifore*	Conjugales	Desmidiaceae
49	*Micrasterias sp.*	Conjugales	Desmidiaceae
50	*Euastrum elegans*	Conjugales	Desmidiaceae
51	*Euastrum binale*	Conjugales	Desmidiaceae
52	*Euastrum ansatum*	Conjugales	Desmidiaceae
53	*Euastrum inermis*	Conjugales	Desmidiaceae
54	*Euastrum sp.*	Conjugales	Desmidiaceae
55	*Desmidium sp.*	Conjugales	Desmidiaceae
56	*Xanthidium antilopaeum*	Conjugales	Desmidiaceae
57	*Sphaerozosma pulchrum*	Conjugales	Desmidiaceae
58	*Hyalotheca sp.*	Conjugales	Desmidiaceae
59	*Gymnozyga sp.*	Conjugales	Desmidiaceae
60	*Pleurotaenium chrenbergii*	Conjugales	Desmidiaceae

61	*Spondylosium sp.*	Conjugales	Desmidiaceae
62	*Triploceras sp.*	Conjugales	Desmidiaceae
63	*Gonatozygon kinaranii*	Conjugales	Desmidiaceae
64	*Chara zeylanica*	Charales	Charophyceae
65	*Nitella mirabilis*	Charales	Charophyceae

Class: Bacillarophyceae

.

66	*Pinnularia debesii*		Bacillarophyceae
67	*Pinnularia sp.*		Bacillarophyceae

Class: Euglenineae.

68	*Euglena sanguineas*		Euglenineae
69	*Euglena sp.*		Euglenineae

Class: Cyanophyceae.

70	*Microcystis aeruginosa*	Chroococcales	Chroococcaceae
71	*Oscillatoria amphibia*	Nostocales	Oscillatoriaceae
72	*Oscillatoria sp.*	Nostocales	Oscillatoriaceae
73	*Spirulina major*	Nostocales	Oscillatoriaceae
74	*Spirulina sp.*	Nostocales	Oscillatoriaceae
75	*Lyngbya sp.*	Nostocales	Oscillatoriaceae
76	*Nostoc sp.*	Nostocales	Nostocaceae
78	*Anabaena sp.*	Nostocales	Nostocaceae
79	*Scytonema sp.*	Nostocales	Scytonemataceae

Seasonal variation of algal flora

The seasonal distribution of algal flora of the class Chlorophyceae (Table 22) shows that ten species are seen during pre-monsoon period, three species confined to monsoon and six species seen through post- monsoon season. Fifteen species were seen in all the three seasons, 26 species were found in both pre and post-monsoon seasons. There was no species found in pre-monsoon -monsoon seasons and monsoon-post monsoon seasons

Table 22 Seasonal variation of Class Chlorophyceae

	Scientific name	***Pre monsoon***	***Monsoon***	***Post monsoon***
1	Volvox sp.	×	×	✓
2	*Tetraspora sp.*	✓	×	✓
3	Chlorella sp.	✓	×	✓
4	*Selanastrum sp.*	✓	×	×

5	*Pediastrum simplex*	✓	×	✓
6	*Pediastrum duplex*	✓	×	✓
7	*Pediastrum tetras*	✓	×	×
8	*Hydrodictyon reticulatum*	✓	×	×
9	*Scenedesmus quadricauda*	✓	✓	✓
10	*Scenedesmus dispar*	✓	✓	✓
11	*Scenedesmus sp.*	✓	×	×
12	*Coelastrum cambricum*	✓	×	×
13	*Ulothrix zonata*	✓	×	✓
14	*Ulothrix spp.*	✓	×	✓
15	*Microspora sp.*	✓	×	✓
16	*Sphaeroplea sp.*	✓	×	×
17	*Cladophora sp.*	×	×	✓
18	*Chaetophora sp.*	×	✓	×
19	*Oedogonium spp.*	✓	✓	✓
20	*Bulbochaete sp.*	✓	×	×
21	*Oedocladium sp.*	✓	×	×
22	*Zygnema sp.*	×	✓	×
23	*Mougeotia sp.*	×	✓	×
24	*Spirogyra spp.*	✓	✓	✓
25	*Staurastrum crenulatum*	✓	×	✓
26	*Staurastrum muticum*	✓	×	✓
27	*Staurastrum aretiscon*	✓	×	✓
28	*Staurastrum pelagicum*	✓	×	✓
29	*Staurastrum decieetum*	✓	×	✓
30	*Staurastrum pingue*	✓	×	✓
31	*Staurastrum spp.*	✓	×	✓
32	*Arthrodesmus convergens*	✓	×	×
33	*Closterium kutzingi*	✓	✓	✓
34	*Closterium dianae*	✓	✓	✓
35	*Closterium closterioides*	✓	×	×
36	*Closterium spp.*	✓	×	✓
37	*Cosmarium caelatum*	✓	×	✓
38	*Cosmarium maryar*	✓	×	✓
39	*Cosmarium quadrum*	✓	✓	✓
40	*Cosmarium granatum*	✓	✓	✓
41	*Cosmarium spp.*	✓	✓	✓
42	*Micrasterias foliacea*	✓	✓	✓
43	*Micrasterias thomasiana*	✓	✓	✓
45	*Micrasterias crux-melitensis*	✓	✓	✓
46	*Micrasterias murayi*	✓	✓	✓
47	*Micrasteriasmahabuleswarensis*	✓	✓	✓
48	*Micrasterias pinnatifore*	✓	×	×
49	*Micrasterias sp.*	✓	×	×

50	*Euastrum elegans*	✓	✓	✓
51	*Euastrum binale*	✓	×	✓
52	*Euastrum ansatum*	×	×	✓
53	*Euastrum inermis*	×	×	✓
54	*Euastrum sp.*	✓	×	✓
55	*Desmidium sp.*	✓	×	✓
56	*Xanthidium antilopaeum*	✓	×	✓
57	*Sphaerozosma pulchrum*	✓	×	✓
58	*Hyalotheca sp.*	✓	×	✓
59	*Gymnozyga sp.*	✓	×	✓
60	*Pleurotaenium chrenbergii*	✓	×	✓
61	*Spondylosium sp.*	✓	×	✓
62	*Triploceras sp.*	✓	×	×
63	*Gonatozygon kinaranii*	✓	×	×
64	*Chara zeylanica*	×	×	✓
65	*Nitella mirabilis*	×	×	✓

It was found that species such as Selanastrum sp, Scenedesmus sp, Sphaeroplea sp, Bulbochaete sp, Arthrodesmus convergens, Closterium closteriodes, Micrasterias pinnatifore, Micrasterias sp, Triploceras sp, and Gonatozygon kinaranii were exclusively found during the pre-monsoon season. Species such as Chaetophora sp, Zygnema sp and Mougeotia sp, were exclusively recorded during the season monsoon. Volvox sp, Cladophora sp, Euastrum ansatum, Euastrum inermis, Chara zeylanica and Nitella mirabilis were exclusively found in post monsoon season.

Algae such as *Scenedesmus quadricauda, Scenedesmus dispar, Oedogonium spp., Spirogyra spp.,Closterium kutzingi, Closterium dianae, Cosmarium quadrum, Cosmarium quadrum, Cosmarium granatum, Cosmarium spp., Micrasterias foliacea, Micrasterias thomasiana, Micrasterias crux-melitensis, Micrasterias murayi, Micrasterias mahabuleswarensis* and *Euastrum elegans* were found in all the three seasons.

Several other algae such as *Tetraspora sp., Chlorella sp., Pediastrum simplex, Pediastrum duplex,Ulothrix zonata, Ulothrix spp., Microspora sp., Staurastrum crenulatum, Staurastrum muticum, Staurastrum aretiscon, Staurastrum pelagicum, Staurastrum decieetum, Staurastrum pingue, Staurastrum spp., Closterium spp., Cosmarium caelatum, Cosmarium maryar, Euastrum binale, Euastrum sp., Desmidium sp., Xanthidium antilopaeum, Hyalotheca sp., Gymnozyga sp., Pleurotaenium chrenbergii,*and *Spondylosium sp*.were recorded during pre-monsoon as well as post-monsoon seasons.

The seasonal distribution of algal flora of the class Cyanophyceae (Table 23) shows that *Microcystis aeruginosa* was recorded only during pot-monsoon season. Species such as *Oscillatoria amphibia, Oscillatoria sp., Spirulina major, Spirulina sp, Anabaena sp.* and *Scytonema sp.* were found in both pre-monsoon and post-monsoon seasons. *Lyngbya sp*. was found in both monsoon and post-monsoon seasons.

Table 23 Seasonal variation of Class Cyanophyceae

.

	Scientific name	***Pre monsoon***	***Monsoon***	***Post monsoon***
1	*Microcystis aeruginosa*	×	×	✓
2	*Oscillatoria amphibia*	✓	×	✓
3	*Oscillatoria sp.*	✓	×	✓
4	*Spirulina major*	✓	×	✓
5	*Spirulina sp.*	✓	×	✓
6	*Lyngbya sp.*	×	✓	✓
7	*Nostoc sp.*	×	×	✓
8	*Anabaena sp.*	✓	×	✓
9	*Scytonema sp.*	✓	×	✓

Table 24 shows the monthly variation of algal species recorded from Muriyad wetland.

Table 24 Monthly variations of algal flora

No	**Scientific name**	*M	A	M	J	**J**	**A**	S	O	N	D	J	F
1	Volvox sp.	×	×	×	×	×	×	×	×	×	✓	✓	×
2	*Tetraspora sp.*	×	✓	✓	×	×	×	×	✓	✓	×	×	×
3	Chlorella sp.	✓	✓	×	×	×	×	×	×	×	✓	✓	×
4	*Selanastrum sp.*	×	✓	✓	×	×	×	×	×	×	×	×	×
5	*Pediastrum simplex*	✓	✓	✓	×	×	×	×	✓	✓	×	×	✓
6	*Pediastrum duplex*	✓	✓	✓	×	×	×	×	×	✓	✓	✓	×
7	*Pediastrum tetras*	✓	✓	✓	×	×	×	×	×	×	×	×	×
8	*Hydrodictyon reticulatum*	×	✓	✓	×	×	×	×	×	×	×	×	×
9	*Scenedesmus quadricauda*	×	✓	✓	×	×	×	✓	✓	×	×	×	×
10	*Scenedesmus dispar*	×	✓	✓	×	×	×	✓	✓	✓	×	×	×
11	*Scenedesmus sp.*	×	✓	✓	×	×	×	×	×	×	×	×	×
12	*Coelastrum cambricum*	×	✓	✓	×	×	×	×	×	×	×	×	×
13	*Ulothrix zonata*	✓	✓	✓	×	×	×	×	×	✓	✓	✓	✓
14	*Ulothrix spp.*	✓	✓	✓	×	×	×	×	×	✓	✓	✓	✓
15	*Microspora sp.*	✓	✓	×	×	×	×	×	×	×	×	✓	✓
16	*Sphaeroplea sp.*	×	✓	✓	×	×	×	×	×	×	×	×	×
17	*Cladophora sp.*	×	×	×	×	×	×	×	×	×	✓	✓	×
18	*Chaetophora sp.*	×	×	×	✓	✓	×	×	×	×	×	×	×
19	*Oedogonium spp.*	×	✓	✓	×	✓	✓	✓	✓	×	×	×	✓
20	*Bulbochaete sp.*	✓	✓	✓	×	×	×	×	×	×	×	×	×
21	*Oedocladium sp.*	×	×	✓	×	×	×	×	×	×	×	×	×
22	*Zygnema sp.*	×	×	×	✓	✓	✓	×	×	×	×	×	×
23	*Mougeotia sp.*	×	×	×	×	✓	✓	×	×	×	×	×	×
24	*Spirogyra spp.*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×
25	*Staurastrum crenulatum*	×	✓	✓	×	×	×	×	×	✓	✓	×	×
26	*Staurastrum muticum*	✓	✓	✓	×	×	×	×	×	✓	✓	×	×

27	*Staurastrum aretiscon*	✓	✓	✓	×	×	×	×	✓	✓	✓	×	×
28	*Staurastrum pelagicum*	✓	✓	✓	×	×	×	×	✓	✓	✓	×	×
29	*Staurastrum decieetum*	✓	✓	✓	×	×	×	×	✓	✓	✓	×	×
30	*Staurastrum pingue*	✓	✓	✓	×	×	×	×	✓	✓	✓	×	×
31	*Staurastrum spp.*	✓	✓	✓	×	×	×	×	×	×	✓	✓	×
32	*Arthrodesmus convergens*	×	✓	✓	×	×	×	×	×	×	×	×	×
33	*Closterium kutzingi*	×	×	✓	×	✓	✓	✓	×	✓	✓	×	×
34	*Closterium dianae*	×	×	✓	×	✓	✓	✓	✓	×	×	✓	×
35	*Closterium closterioides*	×	×	✓	×	×	×	×	×	×	×	×	×
36	*Closterium spp.*	×	×	✓	×	×	×	×	✓	✓	×	×	×
37	*Cosmarium caelatum*	×	×	✓	×	×	×	×	✓	✓	×	×	×
38	*Cosmarium maryar*	×	✓	✓	×	×	×	×	✓	✓	×	×	×
39	*Cosmarium quadrum*	×	×	✓	×	✓	×	✓	✓	×	✓	✓	×
40	*Cosmarium granatum*	×	×	✓	✓	✓	×	×	×	×	✓	✓	×
41	*Cosmarium spp.*	×	×	✓	×	✓	×	✓	×	×	✓	✓	×
42	*Micrasterias foliacea*	×	✓	✓	×	✓	✓	×	✓	✓	×	×	×
43	*Micrasterias thomasiana*	×	×	✓	×	✓	✓	×	✓	✓	✓	×	×
45	*Micrasterias crux-melitensis*	✓	✓	✓	×	✓	✓	×	✓	✓	✓	×	✓
46	*Micrasterias murayi*	×	×	×	×	✓	✓	×	×	✓	✓	✓	✓
47	*Micrasteriasmahabuleswarensis*	×	✓	✓	×	✓	✓	✓	✓	✓	×	×	×
48	*Micrasterias pinnatifore*	×	✓	✓	×	×	×	×	×	×	×	×	×
49	*Micrasterias sp.*	×	✓	✓	×	×	×	×	×	×	×	×	×
50	*Euastrum elegans*	✓	✓	✓	×	✓	✓	✓	✓	✓	×	×	✓
51	*Euastrum binale*	×	✓	✓	×	×	×	×	×	✓	✓	×	×
52	*Euastrum ansatum*	×	×	×	×	×	×	×	✓	✓	✓	✓	×
53	*Euastrum inermis*	×	×	×	×	×	×	×	×	✓	✓	✓	×
54	*Euastrum sp.*	✓	×	✓	×	×	×	×	✓	✓	×	×	✓
55	*Desmidium sp.*	✓	×	×	×	×	×	×	×	✓	✓	×	✓
56	*Xanthidium antilopaeum*	✓	×	×	×	×	×	×	✓	✓	×	×	×
57	*Sphaerozosma pulchrum*	×	✓	✓	×	×	×	×	✓	✓	×	×	×
58	*Hyalotheca sp.*	✓	×	×	×	×	×	×	✓	✓	×	×	✓
59	*Gymnozyga sp.*	×	✓	✓	×	×	×	×	✓	✓	✓	✓	×
60	*Pleurotaenium chrenbergii*	✓	×	×	×	×	×	×	✓	✓	×	×	✓
61	*Spondylosium sp.*	×	✓	✓	×	×	×	×	✓	✓	✓	×	×
62	*Triploceras sp.*	×	✓	✓	×	×	×	×	×	×	×	×	×
63	*Gonatozygon kinaranii*	✓	×	×	×	×	×	×	×	×	×	×	✓
64	*Chara zeylanica*	×	×	×	×	×	×	×	×	✓	✓	✓	×
65	*Nitella mirabilis*	×	×	×	×	×	×	×	×	✓	✓	×	×
66	*Pinnularia debesii*	✓	✓	✓	×	×	×	×	✓	✓	✓	×	×
67	*Pinnularia sp.*	✓	×	×	×	×	×	×	×	✓	✓	×	✓
68	*Euglena sanguineas*	✓	✓	×	×	×	×	×	×	×	×	×	×
69	*Euglena sp.*	✓	×	×	×	×	×	×	×	×	×	×	×
70	*Microcystis aeruginosa*	×	×	×	×	×	×	×	×	✓	✓	✓	×
71	*Oscillatoria amphibia*	×	✓	✓	×	×	×	×	×	✓	✓	×	×

72	*Oscillatoria sp.*	✓	✓	✓	×	×	×	×	×	✓	✓	✓	×
73	*Spirulina major*	×	✓	✓	×	×	×	×	×	×	×	✓	×
74	*Spirulina sp.*	×	×	✓	×	×	×	×	×	×	×	✓	×
75	*Lyngbya sp.*	×	×	×	×	✓	✓	✓	×	×	×	✓	×
76	*Nostoc sp.*	×	×	×	×	×	×	×	✓	✓	✓	×	×
78	*Anabaena sp.*	×	✓	✓	×	×	×	×	×	×	×	✓	×
79	*Scytonema sp.*	×	✓	✓	×	×	×	×	✓	✓	✓	×	×

*M to F represents Months from March 2001 to February 2002.

Zooplankton diversity

Zooplankton are the 'secondary producers' of an aquatic ecosystem. As they are responsible for energy transfer from primary producers to other higher trophic levels, they are considered as one of the most important biotic component of a natural water body. Different limnologists have already hghlighted the importance of zooplankton in the aquatic ecosystem (Hutchinson, 1957; Wetzel, 1983). The palanktonic community (both phytoplankton as well as zooplankton) is often considered as a 'microcosm' i.e., as smaller models of larger world of ecological interactions. **Rotifera**, **Cladocera** and **Copepoda** are the major components among freshwater zooplankton. A detailed knowledge about zooplankton composition and their seasonal fluctuation are essential factor for proper management of water bodies. This is true in the context of assessing the fisheries potential of any water body. The presence, persistence, and abundance of any fish species in a wetland are primarily an expression of the diversity and abundance of phytoplankton and the zooplankton. The diversity of the fish species in turn is going to determine the piscivorous avian visitors of a wetland. Thus understanding the planktonic community is essential for proper evaluation of the ecological role of a wetland.

Rotifera (Rotatoria)

Rotifera are the pseudo-coelomate, bilaterally symmetrical animals with body size from 400 µm to 0.2 mm. They are mostly considered as a separate phylum. Rotifers occur in nearly all water bodies. Majority of rotifers inhabit freshwater but some genera also are seen in brackish and marine waters. Most species are free living while some are epizootic parasites.

List of Rotifers recorded from Muriyad wetlands.

Family: Branchionidae.

1 *Brachionus calciflorus* Pallas
2 *B. caudatus* Barrois & Daday
3 *B. falcatus* (Zacharias)
4 *B. qudridentatus* Hemanm.
5 *Keratella cochlearis* (Gosse)
6 *Keratella tropica*.
7 *Plationus platulus* (Muller)
8 *Platyias quadricornis* (Ehrenberg)

Family: Euchlanidae.

1 *Euchalanis dilatata* Ehrenberg

Family: Trichotridae.

1 *Macrochetus collinsi* (Gosse)

Family: Colurellidae.

1 *Lepadella patella.*

Family: Lecanidae.

1 *Lecane bulla* (Gosse)
2 *L. inopinata* Harring & Mayers)
3 *L. lateralis* Sharma.
4 *L. ludwingii* (Eckstein)
5 *L. papuana* (Murray)
6 *L. quadridentata* (Ehrenberg)
7 *L. ungulate* (Gosse)

Family: Filinidae.

1 *Filinia opoliensis* (Zacharias)

Family: Testudinellidae

1 *Testudinella patina* (Hetmanm)

Cladocera

Cladocera are, commonly known as the "Water fleas." Mostly inhabit in freshwaters, while some of them are marine. It occurs in habitats ranging from ditches, ponds, rivers, etc. The size of these micro crustaceans are ranging from 0.2 to 5 mm. Majority of species are transparent but others found among the weeds are pigmented

List of Cladocera taxa recorded from Muriyad wetlands.

Family: Sididae.

1 *Pseudosida zalayi* (Daday)
2 *Latonopsis australis* (Sars)
3 *Diaphanosoma sarsi* Richard

Family: Daphniidae.
1 *Scapholebris kingii* Sars.
2 *Simocephalus serrulatus* (Koch)
3 *Simocephalus latirostris* Stingelin

Family: Moinidae

1 *Moina micrura* Kurz
2 *Moinodaphnia macleayi* (King)

Family: Bosminidae.

1 *Bosmina longirostris* (O.F.Muller)
2 *Bosminopsis deitersi* (Richard)

Family: Macrothricidae.

1 *Macrothrix spinosa* King
2 *Macrothrix triserialis* (Brady)
3 *Macrothrix odiosa* (Gurney)
4 *Gurnella raphalis*

Family: Ilyocryptidae

1 *Ilyocryptus spinifer* Herrick

Family: Chydoridae
Sub-family: Chydorinae

1 *Disparlona* Sp.
2 *Alonella clathratula* Sars
3 *Chydorus sphaericus* (O.F.Muller)
4 *Chydorus parvus* (Daday)
5 *Chydorus ventricosus* Daday
6 *Chydorus reticulates*
7 *Ephimeroporus barrosi* Richard
8 *Dadaya macropus* (Daday)

Sub-family: Aloninae.

1 *Alona davidi* (Daday)
2 *Alona monacantha tridentate* (Stingelin)
3 *Alona pulchella* King
4 *Alona verrucosa* (Sars)
5 *Alona affinis* (Leydig)
6 *Gratolebris testudinaria* (Fischer)
7 *Oxyurella singalensis* (Daday)
8 *Kurzia longirostris* (Daday)
9 *Euryalona orientalis* (Daday)
10 *Notalona globulosa* (Daday)

Copepoda

Copepods are very ancient arthropods. Zoogeographical data suggest that the Copepod fauna of continental waters are rich and diversified. Their habitat is ranging from small ditches to large rivers and lakes. Majorities of them are freshwater forms and some of them occur in marine waters. In freshwater numerous species are free living and some of them are parasitic or semi parasitic at their different stages of developments. Most of them are very small and the size is ranging from 0.3 mm to 5 mm. In inland waters, copepods are well known at least up to family level but numerous species remain yet to be discovered.

List of Copepod taxa recorded from Muriyad wetlands.

Order: Cyclopoida
Family: Cyclopidae.
Sub-family: Eucyclopinae.

1 *Ectocyclopes rubescens* Brady
2 *Eucyclops serrulatus* (Fischer)
3 *Tropocyclops prasinus* (Fischer)

Sub-family: Cyclopinae

1 *Mesocyclops Sp.*
2 *Mesocyclops agunus* Onabamiro
3Mesocyclops splendidus Lindberg
4 *Microcyclops varicans* Sars
5 *Thermocyclops decipiens* (Kiefer)

Order: Calanoida
Family: Diaptomidae

1 *Allodiaptomus mirabalipus* Kiefer
2 *Tropodiaptomus informis* Kiefer
3 *Heliodiaptomus cincatus* (Gurney)

Discussion

Agriculturists, bird watchers and fish biologists have earlier attempted to study several physical and biological characters of Kole lands. However, so far, no planktonic study was reported from this area and probably the present study is the first one in this direction. During the present study, 64 species of Zooplankton were identified from Muriyad wetlands. The diversity of these planktonic forms is really rich and diversified. This is indicated by the fact that eight species of Cladocera, eleven species of Copepoda and five species of Rotifera identified in this study are reported for the first time from Kerala. One species of Cladocera called *Disparlona* sp. is probably new to science. It is for the first time the species *Allodiaptomus mirabilipus* is being reported from India.

The Rotifers were one of the best-studied groups among the zooplankton from Kerala. Among the Rotifers, the genus *Lecane* was the most diversified group total seven species were reported so far. The predominance of Rotifera fauna in terms of the species number has been found to be generally characteristic of eutrophication of waters. The Muriyad wetland provides an ideal habitat for the growth of rotifers. Usually the wetland is inundated soon after the harvesting season and the decaying hey and other aquatic vegetations provides a very good nutrient medium for the growth of unicellular algae and protozoan. These microorganisms are the favorite food material for the rotifers. Some of the zooplankton reported in the present study is cosmopolitan in distribution while majority of them are endemic to tropical waters. The copepods seen in this area are the least diversified group.

The occurrence of 64 species of Zooplankton fauna based on a few random collections indicates the species richness of zooplankton fauna of the wetland. A more extensive study based on periodic collection will definitely reveal more species from this area. To the best of our knowledge, so far no attempts were made to assess the contribution of planktonic forms in the productivity of the wetlands. Hence, further investigations are

required to understand the trophic structure of wetland and the habitat utilization by various fish and aquatic bird fauna.

The species Diversity of Fish Fauna of Muriyad Wetlands

Wetlands are the natural wealth of the human race. One of the major values of wetland as identified by the Ramsar Convention for wetlands is that they support wide varieties of organisms. In this sense, wetlands are often referred to as ' the heavens of biodiversity' or the 'biological super markets' (Mitsch and Gosselink 1993).

Scientific information regarding the flora and fauna of the Muriyad wetlands is far from complete. Even though, the bird fauna of Kole lands is well documented (Birds of Kole Wetlands, 1992; 1993) no information is available on the diversity of fish fauna of this vast wetland. There are a few studies on the fishes of Karivannur River. Kadhar (1993) reported 23 species of fresh water fishes from the Karivannur river and he enlisted three species of fishes viz. *Putius vittatus, Chela labuca and Nandus nandus* from 'the Muriyad lake'. Inasu (1991) studied the fish fauna of Trissur district. However, no specific information is available regarding the distribution or the species composition of the fishes of the Kole lands. The present report is based on one-year collection of fish from the Muriyad wetlands.

Materials and Methods

A preliminary survey was conducted covering the entire area of Muriyad wetland and five collection sites namely; Kanakkankadav, Kokkarachal, Mutrathikkara, Nedumpal and Parapukkara were identified based on the availability of fishes. For the detailed study of the species diversity of fishes of the wetland extensive collection was done from five selected sites through regular fortnightly visits. Fishes were collected either personally or with the help of fishermen using indigenous fishing methods.

The information on the occurrence, abundance, previous history and economic value of the fishes were gathered from the local fishermen as well as from other available literature. All specimen collected were preserved in 10% formaldehyde and brought to the laboratory for further studies. Using standard taxonomic keys viz. Fishes of India (Day 1889); Inland fishes of India (Vol. I & II) Talwar and Jhingran (1991), and The fresh water fishes of the Indian region (Jayram 1999), identified the species status of the collected fish. By comparing the research reports (Published and unpublished) on the fish fauna of Thrissur region, specifically that of Karivannur River, the present status, and trend of species composition of Muriyad wetland were determined.

Results and Discussion

Results are given in Table 25. In the present study, about 28 species of fishes belonging to 21 genera were identified from the wetland. Khadar (1993) reported

only three species of fishes from the 'Muriyad Kayal'. However, he has extensively surveyed the fish fauna of the Karivannur River and reported about 23 species of fishes belonging to 15 genera. Since Muriyad wetland is situated in the flood plains of the Karivannur, river similarity in the species diversity of wetland fishes with that of the species of fishes from the River is not very surprising. This preliminary study indicates the rich diversity of fish species of Muriyad wetland. The contribution of the wetland in supporting the economically valuable fishes of the area is yet to be studied.

One significant feature observed in the present study is the absence of *Wallago attu* and *Clarias batraches* in the present collections. Information regarding the earlier species diversity and abundance of fishes of the wetland collected from the traditional fishermen of the area reveals that *Wallago attu* and *Clarias batraches* were abundant during yester years. It is said that Wallago of about six feet in length was common in certain parts (Kokrachal area) of the wetland. A sudden decline in the availability of two economically important species requires detailed investigation and urgent attention from the part of investigators as well as from the local authorities. It is relevant to note that both these species are bottom feeders and hence accumulation of aquatic pollutants like pesticides in the bottom sediments affecting the normal physiology of the fish species cannot be ruled out. It is well documented that sub-lethal level of pesticides can interfere with several vital behavioural patterns of fishes and thus lower the chances of reproduction or abundance of a species (Pathiratne and George, 1998; Smitha, 2002).

Another interesting phenomenon noted in the present study is that Muriyad wetland provides habitat for two important migratory fishes from the estuaries. *Caranx carangus* (Bloch) and *Lutjanus argentimaculatus* (Forsskal) are known to be residents of estuaries, which are available in plenty during the post monsoon periods. However, whether the migration of the fishes is for spawning purpose or for feeding is not clear. The present study is not exhaustive; hence, further detailed investigations are needed for understanding the number of migratory species and resident species that utilize the wetland. Some economically important species are shown in plates 10 and 11.

Table 25. Species of Fishes recorded from Muriyad Wetlands

Family: Anguillidae

1.*Anguilla bicolor* (McClelland)

Family: Cyprinidae

Sub-family: *Cyprininae*

1. *Puntius chola (Hamilton)*
2. *P.vittatus* (Day)
3. *P. parrah* (Day)
4. *P. filamentosus* (Valenciennes)
5. *P.sarana* (Hamilton-Buchanan)

Sub-family: Rasborinae

1. *Rasbora daniconius*
2. *Danio aequipinnatus* (McClelland)
3. *Esomus danricus* (Hamilton).

Family: Bagridae

1. *Mystus malabaricus* (Jerdon)
2. *Mystus oculatus* (Valenciennes)

Family: Belonidae

1.*Xenentodon cancila* (Hamilton)

Family: Hemiramphidae

1. *Hyporhamphus limbatus* (Valenciennes)

Family: Aplocheilidae

1. *Aplocheilus dayi* (Hamilton)

Family: Ambassidae

1. *Parrambassis thomassi* (Day)

Family: Carangidae

1.Caranx carangus* (Bloch)

Family: Lutjanidae

1. *Lutjanus argentimaculatus** (Forsskal)

*Visitors from estuaries

Family: Nandidae

Sub-family: Nandinae

1. *Nandus nandus* (Hamilton)

Family: Cichlidae

1. *Etroplus maculatus* (Bloch)
2. *Etroplus suratensis* (Bloch)

Family: Gobiidae

Sub-family: *Gobiinae*

1.*Glossogobius giuris* (Hamilton)

Family: Bagridae

1. *Horabagrus brachysoma* (Gunter)

Family: Anabantidae

1. *Anabas testudineus* (Bloch)

Family: Channidae

1. *Channa striatus* (Bloch)
2. *Channa maurulis* (Hmailton-Buhanan)

Family: Mastacembelidae

1. *Mastacembelus armatus* (Lacepede)
2. *Macrognathus guntheri* (Day)

Family: Tetraodontidae

1. *Tetradon travancoricus* (Hora & Nair)

Table 26. Species of Fishes recorded in the present work and previous report from Karivannur River by Khadar (1993).

Sl. No.	Name of the fish	Present work	Abdul Khadar
1	*Anguilla bicolor*	+	_
2	*Puntius chola*	+	+
3	*P.vittatus*	+	+
4	*P. parrah*	+	_
5	*P. filamentosus*	+	+
6	*P. amphibius*	_	+
7	*P. sarana*	+	+.
8	Rasbora daniconius	+	+
9	*Danio aequipinnatus*	+	_
10	*Esomus danricus*	+	+
11	*Chela labuca*	_	+
12	*Mystus vitatus*	_	+
13	*Mystus malabaricus*	+	+
14	*Mystus oculatus*	+	+
15	*Xenentodon cancila*	+	_
16	*Hyporhamphus limbatus*	+	_
17	*Aplocheilus dayi*	+	_
18	*A. lineatus*	_	+
19	*Parrambassis thomassi*	+	_
20	*Caranx carangus**	+	_
21	*Lutjanus argentimaculatus**	+	_
22	*Nandus nandus*	+	+
23	*Etroplus maculatus*	+	_
24	*Etroplus suratensis*	+	_
25	*Glossogobius giuris*	+	+

26	*Horabagrus brachysoma*	+	+
27	*Wallago attu*	_	+
28	*Heteropenustus fossilis*	_	+
29	*Anabas testudineus*	+	+
30	Macropodus cupanus	_	+
31	*Channa striatus* (Bloch)	+	+
32	*Channa maurulis*	+	+
33	*Mastacembelus armatus*	+	_
34	*Macrognathus guntheri*	+	+
35	*Tetradon travancoricus*	+	_

*Visitors from estuaries

Chapter 4

Impacts of change in social perspectives on the ecology of Muriyad wetlands

Human dimension of the ecosystem changes: A Theoretical frame work

All most all-major biomes of the world have experienced drastic changes due to the geological processes or climatic changes. Land subsidence, upheaval of the earth's crust and changes in the weather pattern had radically changed the face of the earth intermittently for the past several million years. However, the recent changes that we observe in the environment are strikingly the result of human interference with the functioning of the natural world. Moreover, the pace of the change is so fast that it has become increasingly difficult for all living organisms to cope up with such unprecedented

changes. Species extinction is a part of the history of life but the root cause of modern extinctions is habitat loss and pollution of the life supporting systems namely the air, water, and the soil. This is the manifestation of a remarkable change in values given to the natural resources. As Solecki (2001) has stated 'profound changes in the twentieth century shaped and re-shaped the architecture of markets and the states responsible for resources use and pressures through which environmental change is initiated. Gradual and abrupt political shifts between and with in the states and an unprecedented shift in the mobility and power of capital in the world market further help to drive the changes'.

Several theories are put forward to explain the human dimension of the ecosystem changes. The major focus of all these arguments is change in the paradigm of the society and the sociopolitical ambience in which a specific natural resource is utilized (Johnston et al., 1995). The most prevalent view is that environmental impact will be the product of local population, affluence, and technology (Kasperson et al., 1995). It is now an accepted fact that events that occur in the local level are dictated by decisions and episodes that takes place in far off places. Any alteration in the pattern of land use change can fundamentally modify the input of energy, water, and nutrients and thus affect the natural processes of an ecosystem (Adger and Brown, 1994). As the wetlands are among one of the most fragile ecosystems evolved out of the delicate balance between a water body and the land surrounding it, any change in the land use can alter several vital functions of the wetland. The major human intervention into the wetlands from time immemorial is its conversion into agricultural lands. Agricultural expansion in the wetlands profoundly affects the flow of water, energy and materials and lead to substantial indirect environmental effects even beyond the limits of the converted land (Douglas, 1994).

In order to understand the social dynamics behind the ecological changes of the Muriyad wetlands the socio-economic and demographic features of the community that directly come in contact with the ecosystem is necessary. Muriyad wetlands remain spread into six panchayaths, viz. Vallachira, Muriyad, Porathissery, Aloor, Parappukkara, Velookkara and one municipal area viz. Irinjalakuda. According to the recent census, the total number of people living in the five micro-watersheds is 70,000 and the number of households in the area is about 17,000.

Methodology

A sample of 870 households was randomly selected. Socioeconomic survey, semi-structured interviews, and PRA techniques were employed for collection of relevant data. Preparation of historical time line, lively hood analysis, and group discussions with different occupational groups were some of the other methods of data collection. Opinions of small groups and individuals were verified by triangulation.

Historical sketches of farming in Muriyad wetland

Historical records as available in the form of title deeds indicate that paddy cultivation was practiced some 216 years back. The elders who participated this study were able to recollect the events only from 1940's onwards. The major rice varieties cultivated at that time were *'karutha cheera, chempavu, chuvanna cheera'* etc. Only single crop of rice cultivation was done at that time. These cultivars were tall and they have to cut the tip of the plant two to three times. One significant observation of people was that the pest attack was not so common at that time. The best-known pest was 'karumkutty puzhu' that were destroyed by women labourers by beating with a broom. Yield per hectare was comparatively low i.e., for one bushel of rice seed; about 20 bushels of grains were obtained. Agriculture was mainly depended on monsoon rains and natural weather patterns. Water wheels operated by foot were used for dewatering and irrigating the paddy fields. In 1952, for a day's labour a male could earn 12 *anas* (16 *anas* make one Rupee at that time), while a woman labourer got only six *anas.*

Before the introduction of land reform bill, rich land lords owned the major portions of the Muriyad wetlands. They were forced to give up large portions of their land holdings when the bill was enacted as law. By 1958, diesel and kerosene water pumps became available and the rich landlords of the area began to use it for dewatering the fields as well as for irrigation. Electric water pumps were introduced in Muriyad wetlands by 1960's. Throughout these periods, only one crop of rice cultivation was carried out here. The bunds of 'Thamaravalayam' were completed by this time. This bund prevented the drainage of water from the paddy fields during the cultivation period and prevented water from outside entering the fields at the time of dewatering.

In Kole lands dewatering was done by erecting temporary bunds built using locally available materials like branches of trees, coconut trunks and mud or soil brought to the locality from far away places in country crafts. During flood season fertile alluvium brought down from the mountain ranges through the river settled down in the paddy fields enriching natural fertility of the soil to a great, extend.

Sweeping changes in the agricultural practices of Muriyad wetlands came around 1970's when high yielding varieties of rice were introduced along with packages of chemical fertilizers. By 1975, tillers and tractors came into use for ploughing the fields and the first model was Izaki-Japan.

Permanent bund construction started in the year 1979 in this area with a view to convert single crop fields to double and triple cropping fields. However, the cries-cross bund construction in the wetland interfered with transport of alluvium in to paddy field and obstructed the migratory pathways of fish.

In 1980's agriculture, using chemical fertilizers boosted the production in the whole area. However, the yield and income from agriculture decreased slowly. The major reason for this was the sudden increase in pest infestation. Subsequently the farmers were forced to use more and more pesticides. In spite of the downward trend in the rice yield, large rice mill owners from Kalady and Kottayam used to collect paddy from households of Muriyad area.

By the year 1990, overuse of chemical fertilizer reduced the natural fertility of the soil of the wetland. Urea, magnesium sulphate, and factomphose were the major chemical fertilizers used in this area. Brown hopper infestation increased with the increase in the use of urea.

In 1998, 40 kg urea, Magnesium sulphate, and Factumphose have to be applied for a single crop. Usually pesticide is sprayed eight times during a single cropping season. The most serious problem as far as the farmers are concerned is the non-availability of agricultural labourers (Plate 12). At present labourers come from Palakkad district and even from Tamil Nadu. 1/8 of the yield goes to the labourers. The wage for a male is Rs.150 and for woman Rs. 75.

Karate, Metacid, Nemacron, Nuvan, Hinosan and Sevin etc is some of the commonly used pesticides in Muriyad wetlands (Plate 12). It is stated that the expenditure for rice cultivation per hectare is about Rs. 8000 and the income is only Rs. 3000. The farmers continue agriculture because they wanted to keep alive the tradition of their family and it is not possible for them to some other job at present.

There are some isolated cases where some individuals continue rice cultivation as a profitable venture. In such cases, generally the land holding is more than two ha.

Kol land development and bund construction

Construction of permanent bund

Leaders like N. I. Devassikutty and K. P Prabhakaran initiated the idea for the construction for permanent bunds in Kole lands. Considering the public demand the then agricultural minister Mr. Govindankutty Nair sanctioned this project. Only the farmer's demands were taken in to consideration during the implementation of the project. However, at present proposals for the cultivation of rice and fish are being considered.

The original estimate for the construction of bunds in Kole lands was Rs.29 crores. The revised budget NABARD estimates about 53.74 crores and 33.78 crores have already spend for this project. It is estimated that the present yield of rice is 5.9 tone/ha.

About Rs. 8 crores were already written off up to this time by KLDC. Every year a large amount of money is being, spend by KLDC for repairing the bunds and for weed removal from the paddy fields. When the rampant snad and clay mining that takes place in Muriyad wetland was brought to the notice, they said that KLDC is not an authority to handle such issues.

The fishermen community of Muriyad area

A community of fishermen was living around the wetland for the past several decades totally depended on the fishes of Muriyad wetland (Plate13). The history of 'Padanna

Kanakkan' community of Anurali dates back before 1923 when three families from 'Peya', a village of Kannur district, migrated to the suburbs of Irinjalakuda. They settled down north, east, and southern parts of Muriyad wetlands, as they were fishermen. Most of the elders of the present community remember the great flood of 1923. They still recalled that during the flood, their canoes were anchored to a big tree and the women and children were sheltered in Pullur L. P School.

The fishing season starts by Jan-Feb (Dhanu) and lasts for 6 months during which they would get large quantity of fishes. One of the major species of fish available at that time was *Wallago attu*, a cat fish belonging to the family *Siluridae*. Fish weighing about 12 kg was available in plenty at that time. Krishnankutty Karthavu, Chethalans, Kuruppathukar etc were the landowners of that time. The landlords allowed the members of this community to capture the fish under one condition that ¾ of the total catch should be given to the land owner.

In 1938, the fishermen obtained the right for fishing in Kokra chaal, one of the deepest areas of the wetland, by paying Rs. 85 in an auction. In the year 1940, there was an epidemic of smallpox in this area. At that time, there were no effective remedies for this disease. Small pox patients were housed in a thatched shed and food and water were provided from outside till the death of the person.

Fishing was the major occupation of this community. The men flock was engaged in fishing and the women flock was fish vendors. A meager price of one or two chilly (chillykkasu) was the maximum price per 1 kg of fish at that time. During the monsoon, when fishing activity was not possible, they resorted for cutting trees from the forest. During this period, the women flock was engaged in coir yarn making.

In 1950s, 'Moothuru' was one of the leading landlords of the area and he settled the internal problems of the fishermen community. It was said that the name 'Muriyad' evolved from the family name of 'Moothuru'. During this period, the 'Arattu' (ritualistic bathing of idols) of 'Nambiankavu' was held in Muryad wetlands.

The economic status of the people of the wetland community was very low even from the very beginning. At that time, each family had only a single net for fishing. In 1966, the fishermen cooperative society was registered under the name the 'Pullur Pattikajathy Cooperative Society'. By 1966-68, the right of the community for fishing in 'Kokra chaal' was almost established and they started remitting 'kisth' (tax) to the panchayath. In 'Muriyad' region the embankment for the irrigation canal was initiated by K.L.D.C (Kerala Land Development Corporation, under Govt. of Kerala) by the year 1975. Loans for purchasing dugout canoes were sanctioned under IRDP (Integrated Rural Development Programme, an agency under Govt. of Kerala) in the year 1985. A portion of the loan was given to the owners as subsidy. While the total cost for a canoe was only Rs 10000, those who failed to pay the loan amount within the stipulated time have to remit Rs. 25000.

One of the events that shattered the livelihood of the people of this community was

the spread of the epizootic ulcerative syndrome (a fish disease), during the year 1992. Almost all the economically valuable fishes like *Clarias, Ophiocephalus* and different varieties of carps were severely affected by this disease. According to the fishermen, over usage of chemical pesticides in paddy fields and unexpected change in the climate were the major reasons for this serious fish disease, which had thrown the community out of gear. Now the younger generation of the community has abandoned fishing as their major occupation and turned to other sectors like masonary, auto driving etc. As far as the 'Padanna' community is concerned, the year 1992 has another importantance, as the temporary office building of their cooperative society was replaced by a pucka building constructed by Trissur Nirmithi Kendram with the financial aid from the state govt.

By 1994, the construction the embankment of the canals was almost completed. They opined that even though the construction of the permanent bunds was beneficial to the agricultural sector, it was a curse to the fishermen community. The canals blocked the migratory pathways of a good number of species of fishes, which utilize the habitat for breeding and feeding. After the implimentation of 'the peoples planne campaign in 1998, the usual financial assistance provided by the Fisheries Dept. for purchasing cycle and nets were abruptly withdrawn.

Eventhough several species of fishes disappeared form the wetland, one of the positive trends noted in 2000 was the return of Clarias and Opheocephalus populations back to the Muriyad wetlands.

The community noted that there is an increased presence of Cormorants and other migratory birds in the wetland. Since these birds feed on fingerlings and even the adults of several species of fishes, it results in a heavy loss of fishes of the wetland. Another factor that contributed the decimation of fish population is the increased usage of chemical pesticides in the paddy fields.

At present majority of women are occasionally employed in a cashew factory at Pullur, a near by area. A few of the women flock are engaged in making bead chains (beads of sandal wood and other plastic materials) usually worn by Sabarimala pilgrims.

When asked about the fishery potential of the area they said that there is no decrease in fish population of the wetland, however the phenomenal increase in the people from outside for capturing fishes is an important reason for the decrease of income from fishing for the traditional fishermen of this area. Yet, the members of the community continue their traditional occupation using the crafts and gears available to them (Plate 14). Due to these problems, the community is facing a very serious financial crisis at present.

Puthenthodu area of Porathissery village also harbours another group of fishermen belonging to the same community of Padanna Kanakkans.

They formed fishermen cooperative society in the year 1933. At that time, the community had 23 canoes. They used three different types of nets namely, *vayambuvala, muppirivala,* and *kannanvala*. Muppirivala was used for capturing lager fishes like Wallago and kannanvala for catching average sized barbs. The fishermen themselves made the nets. It is a conical net and the narrow portion '*veesuvala'* (cast net) starts with 125 meshes. The width of the net increases towards the other end and comes about 2000 meshes at the broder end. The size of the mesh also increases from the narrow end to the broder end. For the past 20 years, the fishermen purchase the nets from the market and single net coasts nearly Rs. 2000.

The fish was sold under the supervision of the Panchayath authorities, for which a commission of three paise per rupee was given to them. Out of the balance amount, ¼ was given to the society and rest was divided among the fishermen.

The society flourished from its inception till 1987, and it had 18 new canoes and handsome amount of money in the bank as deposit. Then in 1987 some government officials suggested that if the name of the fishermen cooperative society is changed in to the scheduled caste cooperative society, it would be possible to channelize more funds from the govt. Accordingly they renamed the society into 'Pattikajathi Sahakarana Sangham' (Scheduled caste cooperative society) in 1987. Even after the re-naming, the contribution to the society was only from the Padanna community but its control was taken over by other scheduled cast people. However, the activities of the society came to a stand still within a short time, and canoes, which were the major assets of the community, were not maintained properly. Slowly it got damaged and now lay abandoned on the banks of the river. The society is not functioning properly at present.

At present only, very few people are engaged in fishing activity. They earn a very meager amount of Rs. 50-100 after the toil for day and night. *Wallago* and Thooly like fishes were availabe in plenty in the yester years. However, the availability of these economically important fish declined drastically. During October- November, esturine migratory fishes like *Caranx carangus* (Bloch) and *Lutjanus argentimaculatus* (Forsskal) are available at present.

Livelihood analysis

At present, the means of income generation of the fishermen community are agriculture, employment on the basis of daily wage, business, traditional jobs, animal husbandry etc. The percentage of expenditure for food, dress materials, health care, festivities, and miscellaneous items were recorded (Fig. 14). Their annual income ranges from Rs. 7600 to 20500 while the expenditure is between Rs.15500 to 57000. It is pertinent to recall here that as the income increases the expenditure also shoots up beyond the income limit putting them in the debt trap.

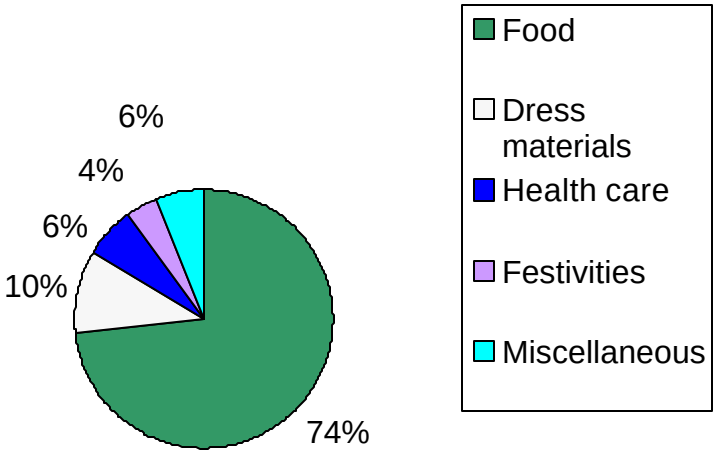


Fig. 14. Livelihood analysis

Source and availability of drinking water

As usually found in several villages of Kerala, most of the households in the area (74.71%) use water from their own wells (Fig. 15). However, drinking water is available throughout the year only for 57.24% of the households; others experience scarcity of water during the summer months.

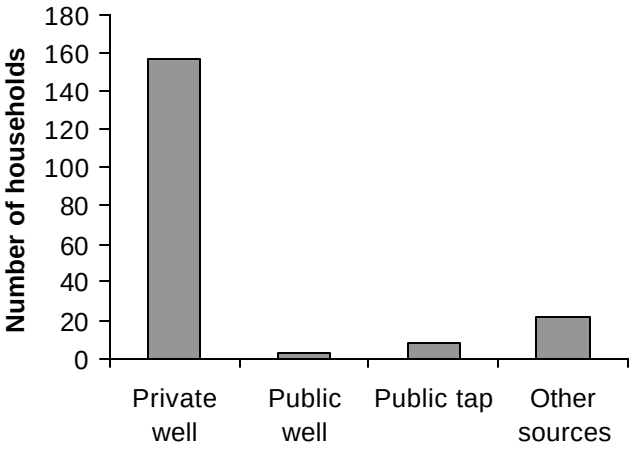
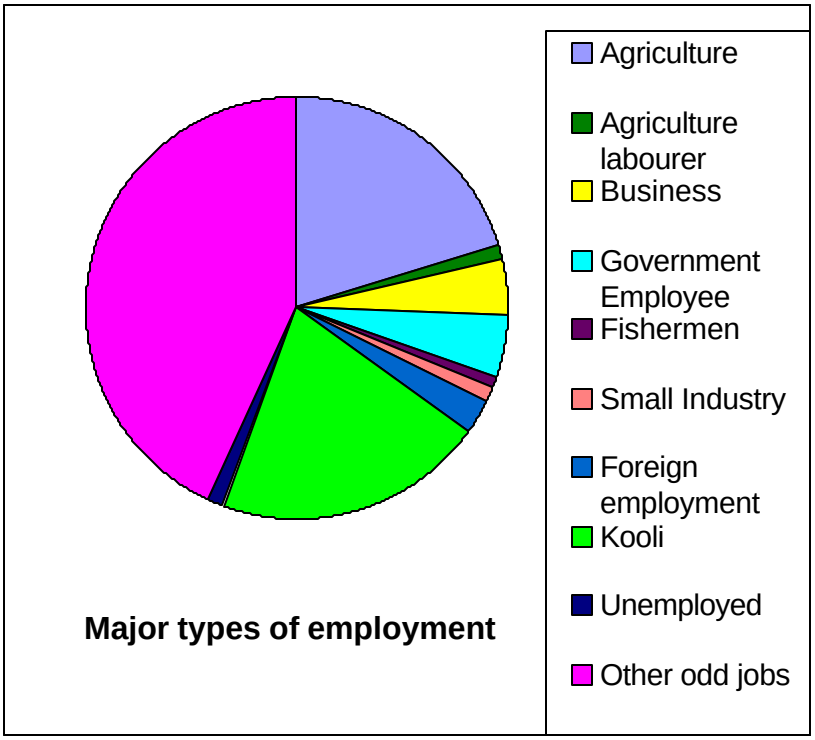


Fig. 15 Drinking water source (farmers)

Occupation

Agricultural practices show a declining trend with 40.11% of household leaving their land fallow. Small size of the land (45.86%) holding, high labour charges, lack of finance, non-availability of labourers, non profitable nature of agriculture etc. are said to be the major problems faced by the farmers. 43.68% of the people procure their living through several odd jobs like toddy tapping, sand mining and other agriculture related works (Fig. 16).



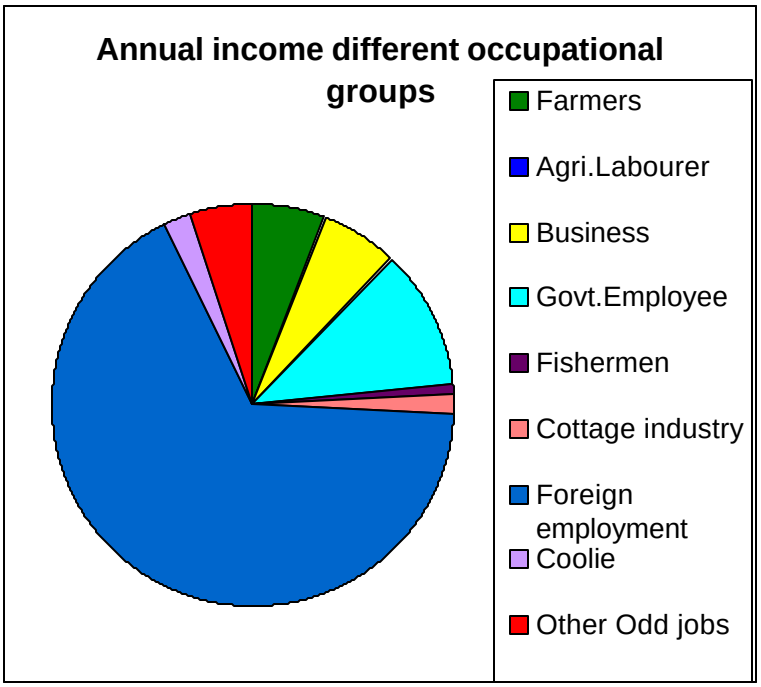


Fig. 16. Employment and annual income of the community

Pattern of land holdings

Among the households under study, 12% are landless. 38. 46 % own up to 10 cents of land. Average size of the land holding is 27.56 cents (Table 26).

Table 26 Size of land holdings

SL.NO.	*Land holding (in cents)*	*Number of households*	*Percentage*
1	*1-10*	*320*	*38.46*
2	*11-25*	*218*	*25.41*
3	*26-50*	*122*	*14.22*
4	*51-100*	*105*	*12.24*
5	*101-500*	*74*	*8.62*
6	*Above 500*	*9*	*1.05*
	Total	*858*	*100*

Changes in agriculture

Climate changes, scarcity of water, non- availability of labourers etc. are said to be the major causes for the changes in agricultural practices. Changes in the quality of drinking water and incidence of several health problems among the members of the community are also reported.

Conclusion

One of the significant changes observed in the social status of the people of the this area is that only 19.19% of the house holds are taking agriculture as their major occupation. The majority of the population is marginal farmers with less than 50 cents of land. With an increase in the expenditure for agriculture and declining income, it is quite natural that agriculture land is either left without farming or given up for other purposes, which brings more money to the landowner. Clay mining and sand mining intruded into the area due to the change in the socio-economic perception of the community. It is to be noted that a large chunk of the households (43.68%) sustains their life by any odd jobs that are available to them. As several people engaged in sand mining and clay mining expressed they are engaging in such an activity knowing that it is going to destroy the land and water of the whole area. While the contractors are getting high profit out of this illegal activity, the labourers are getting only a merger amount just to sustain their life. The general living standard of the people of the locality has increased as indicated by the type of houses, and the modern amenities they have in their households.

Chapter 5

Conclusions

The present study unequivocally shows that irreversible changes are taking place in several parts of the Muriyad wetland. Rampant clay mining for the past several decades has already altered the northern parts of the wetland. At present, the most serious threat faced by the Muriyad wetland is the indiscriminate sand mining that takes place in different parts of the wetland. The recent boom in sand mining from paddy fields is primarily triggered by the stringent directives given by the high Court regulating extraction of sand from the various rivers of Kerala. Even though the 'Sand extraction control act of 2002' prohibits uncontrolled sand mining from the rivers, the very same act is silent on sand mining from paddy fields (Nair, 2002). The unprecedented rise in the cost of rice cultivation also augmented the present wave of conversion of paddy fields for several purposed other than rice cultivation. Reclamation of the wetland as housing plots and for coconut and plantain cultivation is not rare in several areas. Existing land use laws prohibits conversion or use of paddy fields for any purpose other than rice

cultivation. In spite of all these well-intentioned legislations, natural resources like paddy fields and wetlands are disappearing very fast.

Construction of roads, permanent bunds, and other structures like motor sheds, embankments etc. alters the natural hydrological regime and in turn affects the fauna and flora associated with the wetland. It is claimed that the construction of permanent bund has considerably augmented the rice production in the Kole land area (Ashok, 2001). This is because there was a quantum jump in rice production from just 3-7 tons/ha during 1965-1970 to 5-9 tons/ha in 1999-2000 periods. This may be true when we take the rice production in the whole area of kole lands. However, the adverse impacts of bund construction and other developmental activities on the ecology of the wetland and the economic loss in terms of reduction in its natural values and functions are not taken into consideration. For example, the impact of the obstruction of free flow of flood water during monsoon preiod and the alteration in the hydrological dynamics, on the biota, specifically the fish population is neither studied nor accounted. As far as Muriyad wetland is concerned, bund construction failed to achieve the dream of two crops in a year (Ashok 2001). Here even after completion of permanent bunds the majority of the area is still under a single crop of rice cultivation. Ironically, mundakan, puncha, and viripu cultivation is practiced in certain areas of myriad wetland where the permanent bunds have not yet reached. More over at present more and more farmers leave their fields uncultivated because of sociological and economic reasons.

In spite of the warning from the authorities water is polluted by waste disposal, oil, and grease from the vehicles washed in the wetland. The disposal of organic waste from chicken farms and nonbiodegradable wastes like PET bottles and other plastics continue to be an insurmountable problem not only in Muriyad wetlands but also in other parts of the kole lands. Even though the direct dependence of the human community on the wetland has decreased drastically as indicated by the reduction in the number of people taking up rice cultivation as their primary occupation, all most all the members of the human community that live around the wetland depend on it indirectly. Acting as the receptacle for the floodwater the wetland protects the dry land from inundation. It is also the source of water for irrigation in the coconut and other plantations on the banks of the wetland. The extensive sand beds of the wetland are the reservoir for ground water and acts as the aquifers in recharging the ground water resources.

Perhaps the ecological changes of the wetland directly affect the fish fauna of the area. The present study, even though not exhaustive, indicates that various estuarine fish species migrate into the wetland regularly indicating the importance of the wetland in supporting fishery wealth of the state. Yet, we do not know how the habitat is utilized by different fish species. The algal and vegetational diversity of the wetland is also rich and diverse indicating the need for its conservation. Presence of at least two threatened species like *Rauwlfia and Drosera,* is an indication that more of such medcinally important or threatened species can be found out if an extensive servey is conducted in this area.

It is pertinent to note that the total faunal characteristics of the wetland are not seriously studied so far. As the present report indicates the presence of forty-two species of Zooplankton from a very narrow stretch of the wetland area indicates the richness and productivity of the wetland. In conclusion, the present study urges us to take necessary steps to conserve the wetland at least in the present state for the multitude of benefits it provides for the human community present and future. As the Vembanad-kol wetlands of Kerala have been recently designated as Ramsar site along with the Astamudi and Sasthankota lakes (The Hindu, Tuesday, 19th November 2002), it is the duty of the State as well as the National authorities to protect and conserve the wetland as a common heritage of humanity.

Suggestions

1. New legislation should be enacted in restricting or controlling the sand mining practices from paddy fields.
2. The present laws prohibiting clay mining beyond the sand horizon should be strictly enforced.
3. Already excavated areas should be reverted to paddy fields or converted in to integrated fish farming sites.
4. In MW4 experienced scarcity of water for irrigation during summer season. Instead of extending the permanent bund to that area the existing pond should be restored and the water from it may be used for irrigation.
5. Further construction of roads and bunds should be avoided.
6. To facilitate the migration of fish species from the estuary as well as to the river, wider corridor should be provided in the area where the bund is obstructs free flowof water. 'Kokra chaal' should be demarcated as a fish species conservation plot.
7. In order to reduce the pesticide load to the wetland alternative strategies like biological control and integrated pest management system should be popularized among the farmers.
8. The prospects of integrating pisciculture along with paddy cultivation should be explored.
9. The due consideration should be given to fishermen community in planning any further developmental activity in the wetlands.
10. Micro watershed standard should be taken as the basic unit for implementation of any developmental projects.
11. Similar studies are to be extended to other areas of kole lands

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