INTRODUCTION
General Introduction

Water is the most versatile inorganic liquid, which sustains life in this planet. Life began in water – researchers on evolutionary chemistry during the last few decades have proved this more or less conclusively. And life is sustained by water – no research is needed to prove it. We won’t last, neither will this world if there is to be no water. Town, cities... entire civilizations have grown where water was available. Water has therefore been the focus, the pivot around which human destinies have taken shape. And water has been reckoned as life giver, sometimes even worshiped, by most of the civilizations. In our own trinity, water features as one of the three pillars of existence. From the very beginning to the very end, our lives flow along with the serene water bodies around us.

Of the total available water in natural aquatic resources of which around 98 per cent is salt water, which is found in oceans, inland seas, and deep underground basins. The remaining 2 per cent is available as fresh water of which 77.2 per cent is permanently frozen, 22.4 percent as ground water and soil moisture, about 0.35 percent is present in lakes and wetlands, and less than 0.01 percent in rivers, ponds, pools. Thus the amount of available fresh water is very little to which we depend for all our livelihood purposes. Moreover, the distribution of available freshwater in our Earth is uneven. This coupled with all our abuses of water as a result of population explosion and industrialisation makes water crises a reality. Water is the one of the most threatened natural resources all over the world in the present day. About 4 per cent of the world population uses as much as 400 litre of water per day, while two-thirds of the population uses less than 50 litres per day. In some cases it is even in lower range, i.e.
less than 20 litre per day (Rajvidya and Markendaya, 1998). Recently in 1999, UN estimated that some 1.2 billion people in developing countries lacked access to safe drinking water, another 2.9 billion lacked adequate sanitation, 4 million children died each year from water related diseases (Simonvic, 2000). India loses every year about 4 lakh children less than five years of age mainly due to diarrhea (Panda, 2003).

If water is sacred, if water is precious, the wetlands, which hold water must be equally sacred, must zealously guarded as one would guard treasure troves. Development of any nation is linked with harvesting of its available water resources through proper scientific conservation and management techniques to meet water demands in domestic, industrial and agricultural sectors. But strangely – and sadly we have treated wetlands with indifference rather than care, cruelty rather than affection, contempt rather than respect. More ‘developed’ and ‘advanced’ an area more ‘pathetic’ is the condition of its wetlands. In cities, which are the epitomes of ‘development’ wetlands have either been dead and buried or tottering on the brink. The abandoned and neglected water resources, indiscriminate and excessive exploitation of the available ones, coupled with pollution cause acute scarcity and depletion of our freshwater resources with respect to quality and quantity. Mishandling of nature’s bounties can’t go without backlashes. It might take time for the backlashes to become strong enough to sting but when the sting begins it keeps on increasing with frightening severity in the form of shortage of water, flooding (when it rains), pollution, a ravaged microclimate, disappearing flora and fauna and finally imbalanced ecosystem. Therefore, judicious management of these precious resources is inevitable, which requires multidisciplinary approach to evolve strategies for the abatement of pollution and its sustainable existence.
Kerala Scenario

The Kerala State comprises a narrow strip of land with an area of 38,863 sq. km extending between North latitude 8°17'30" and 12°27'4" and East longitude 74°51'57" and 77°24'47" and its population as per 2001 census is over 32 million – making it one of the most densely populated regions of the world. The Western Ghats with the magnificent array of sky-scrapping peaks on the east and the Arabian Sea washing its shore on the west are the natural boundaries of the State, providing its distinctive features. Dakshin Kannada, Kodagu and Mysore districts of Karnataka bound its northern and northeastern political borders, while Tamil Nadu districts of Nilgiri, Coimbatore, Madurai, Ramanathapuram, Thirunelveli and Kanyakumari define its eastern and southeastern boundaries.

The state is mainly comprised of crystalline rocks such as charnockites, khondalites, gneisses, and Dharwar schists of precambian age. The charnockites are found in all districts, khondolites and gneisses are concentrated in the southern part of the state and Dharwar schists and gneisses are prevalent in the northern part of the state only. Pegmatite and quartz veins cut across all the rock formations all over the state.

There are forty-four rivers, of lengths, exceeding 15 km flowing in Kerala State. Out of these forty-one originates from the Western Ghats and flows towards West to join Arabian Sea, while three of these originate from the Western Ghats with in Kerala State and join the Bay of Bengal. The freshwater sources of Kerala consist of these forty-four rivers, 10 freshwater lakes, countless number of village ponds, household ponds and temple tanks (Nasar, 1980). The territory of Kerala falls with in the realm of tropical climate. Kerala experiences two monsoons namely the South West (June –
September) and the North East (October – December) seasons. Locally these are known as “Edavapathi” and “Thulavarsham” respectively.

The beautiful Neyyar that originates in Agasthyarkudam, the second highest peak in Kerala supports one of the State's famous tourist's attractions, the Neyyar Wildlife Sanctuary. The Neyyar Dam, constructed across the river is an enchanting place with a reservoir and facilitates for boating. The beautiful Adiyan Para waterfall is in the Kumblangodu village of Nilambur Taluk in North Kerala with dense forest surrounding. On its journey from the Western Ghats to the Vembanad Lake, the Pampa gives birth to the beautiful Perunthenaruvi waterfall. The Chinnar, a tributary of river Amaravathi originates in the high ranges. A major portion of the river flows through the Chinnar forest in the rain shadow region of the Anamudi Hills. Chinnar River gives birth to the famous Thoovanam waterfall.

The Periyar is Kerala's longest river and is known as the 'Ganges' of Kerala, originates in the Sivagiri Hills and flows into the Vembanad Lake. The wealth of the river is tapped not only for fishing but also for irrigation and power generation. Originating in the Anamalai region of Tamil Nadu the Chalakudy River merges with the Periyar at Puthenvelikara village in Ernakulam district and flows into the Vembanad Lake. Athirapally and Vazhachall, two famous picturesque waterfalls are part of this river.

Originating from the Kulathupuzha Hills in the Western Ghats, the Kallada River traverses through the virgin forests before merging with the Ashtamudi Lake. From it forms the breathtaking Palaruvi waterfall that falls from a height of 300 ft. The historical 400 ft. long hanging bridge at Punalur and Thenmala dam are across this
River. The *Meenachil Ar* originates in the Western Ghats flows through Kottayam district, nourishing the farming heartland of Kerala’s plantations sector, before merging with the *Vembanad Lake*.

**Natural Lakes**

The major lakes are *Sasthamkotta Lake* (North East of Kollam), *Periyar Lake* (East of Alleppy) and *Pookot Lake* (Wyanad district) in addition there are a number of man-made lakes, which has come up as a consequence of bunding the rivers for hydroelectric, irrigation or multipurpose projects. These lakes especially *Pookot Lake* is a part of a highly scenic environment, endowed with natural beauty. The lake basin and the adjoining areas where once covered with dense forests, which harbored a unique assemblage of flora and fauna. A, once serene freshwater lake is apparently losing its innate nature due to anthropogenic activities such as extensive deforestation, agro-based industries and intensive agricultural activities. As a preliminary step towards the conservation of this attractive freshwater lake, extensive studies have been carried out on the limnological status of the lake (Nirmala and Nair, 1990). Therefore, studies of the freshwater bodies from the hydrological and biological point of view have become the need of the hour.

Kerala is the wettest regions of the world after Brazil with an average annual rainfall of 2615mm. But liberally, as it is sprayed with water by the South West and North East monsoons, the region swings between states of embarrassment of richness to painful shortage. A lot comes down to its lap, all on a sudden overflowing it. But within a few months most of it drains off in to the sea via Kerala’s 44 rivers. Then
follow the months of shortage of water and the gradually increasing pollution of what is available in its rivers, ponds and lakes

Rocks, the primary construction material is available across the length and breadth of Kerala State is mainly two types; Granite and Laterite. Granite is extracted mainly through controlled blasting, whereas Laterite is extracted with the help of cutting machines. After extraction of rocks for several years, quarrying operation is stopped due to various reasons. Public agitation against quarrying due to threat to life and properties of nearby people, considerably low income to the owner through leasing of the land for mining, non-remuneration for the operators of the quarry, closing of the access for vehicular traffic to the quarry due to fragmentation of the land are few reasons for stopping the operations of quarries. Extraction of granites and laterite below the earth surface, results in the formation of large deep depressions. During rainy season, water enters by showering and by flowing from the catchment area to the depression making it a pool. There are rock natural pools formed by landslides or erosion of soil.

Though the owners of the quarries are private individuals the pattern of use of water stored in the quarries are mainly of three types. They are: (1) private use in which the water in the quarry is exclusively used by the owner for domestic purpose, irrigation and pisciculture, often these quarries are protected by proper fencing. (2) semi private use in which the owner uses water stored in the quarry for domestic, irrigation and pisciculture, whereas the neighbours depend on the quarry water mainly for domestic purposes only; (3) public use with no restriction on the user (Abdulla et al., 2004)
Different methods resorted to maintain the quality water in the quarry are:

1. Maintenance of the low embankment provided around the quarry for operational purposes ensuring that rainwater and clean sub-surface water alone enter the quarry.

2. Drawing water and using it outside as in the case of wells;

3. Dilution and overflow during rainy season;

4. Providing outlet for partial drainage from the pool just before monsoon, and

5. By introducing aquatic organisms mainly by sucker variety of fishes (Abdulla et al., 2004).

Types and Classification of Waterbodies

Depending on the depth and surface area, freshwater bodies are divided into lakes, ponds and swamps. Muttkowsky (1918) formulated a set of criteria that would make a lake to include only those waterbodies, which are deep enough to stratify thermally, thus eliminating all the ponds, large and small. Carpenter (1928) held that the true difference between a lake and a pond was one of depth and not area. Welch (1952) employed the term pond for that class of very small shallow waterbodies characterized by quite water and occurrence of higher aquatic plants. He referred all larger waterbodies as lakes.

Lakes have been variously classified on the basis of a number of criteria, viz. thermal behavior (Muttkowski, 1918, later modified by Whipple, 1927; Hutchinson and Loffler, 1956; Hutchinson, 1957a; Andreolicarlo and Rascio, 1975), on thermal and oxygen relation in summer (Thienemann, 1954), oxygen conditions (Ruttner, 1963), trophic state (Thienemann, 1954), trophic state plus presence or absence of calcium,
nitrogen, phosphorus and humus (Zafar 1959a), geomorphological inception (Hutchinson 1957a).

Zafar (1959a) recognized the arbitrary descriptive nature of the earlier classification and attempted to evolve a system of naming the lakes more or less on the same lines as the conventional binomial system of Linnaeus. The name as a whole consists of three components, the first indicating the physico-chemical nature of the water, the second the climatic zone and the third the productivity in general. For this purpose he took advantage of the expression of volume development and used the terminology of latitudinal zonation of Harvey (1934) and Good’s (1953) altitudinal zones in lake typology. He recognised five types of lakes in the tropics, four types in sub-tropics, three types in temperate regions and two types in the arctics on the basis of latitudinal and altitudinal zonation and six types of lake basins on the basis of volume development.

Studies on freshwater bodies of India extend back to the later half of the 19th century and were initially in the nature of mentioning species list and the description of taxa knew to the then Indian sub-continent (Michael, 1980). According to Iyengar (1939) the temporary rainwater pools fall into two categories viz. 1) rainwater pools, which dry up after a very short time; 2) small pools or ponds, which dry up during hot season. These are now designated as astatic ponds (Rajendran, 1981). Ganapathi (1960) classified the inland freshwater bodies of India on the basis of location and time duration of the water body. Philippose (1960) classified them on the basis of total alkalinity. According to Sreenivasan (1979), temple tanks constitute a very peculiar ecosystem in India. Most of these are hyper-trophic, though they are not
directly polluted by sewage. A dense bloom of blue green algae, especially Microcystis aeruginosa, characterizes them. Fort-moats, which are polluted by sewage, almost resemble the temple tanks and are hyper-trophic. They produce large quantities of fish. According to Gulathi and Schulz (1980) the number of lakes and reservoirs in India is very low considering the size of the country. The number of ponds and tanks is undoubtedly larger than those of lakes and reservoirs. So also studies on smaller waterbodies are far more when compared to those on lakes and reservoirs. Rock pools form another peculiar type of ecosystem. Their irregular morphometry, very low surface area to depth ratio and they are being closed systems, pose interesting problems (Sreenivasan, 1981).

The Indian sub-continent enjoys a great variety of topographical and climatic conditions and as a result of this the freshwater algae are rich both in variety and abundance. These freshwater habitats ranging from the large deep perennial lakes to the small shallow astatic ponds and pools are dispersed all over the country. The Indian freshwater system offers a variety of habitats providing subtropical to fully tropical conditions for rich phytoplankton association.

Though inland waters of the world constitute below 2 per cent of the Earth's surface and less than 1 per cent of the hydrosphere, they have been the objects of detailed study from time immemorial. Forel is hailed as the originator of Limnology on account of his extensive studies on the Swiss lakes. Modern freshwater biology perhaps had its origin around 1845 in the studies of Johannes Muller and his students. In 1887, Victor Henson coined the term Plankton to designate the heterogeneous
assemblage of the minute organisms. And it is he, who for the first time showed that the fine miller's net could be used to collect the plankton (Welch, 1952).

Since the earlier days very impressive progress has been made in the field of freshwater biology. The comprehensive books on limnology by Welch (1952), Hutchinson (1957a, 1957b, 1967, 1975), Ruttner (1963) and Wetzel (1975) are very valuable sources of literature. In the following pages an attempt is made to summarize the most important works on the world's lentic systems.

Limnological observations on the arctic waters are limited on account of the difficulties rendered by the arctic climate. The very few studies available are observations performed during summer months. The arctic waters are characterized by freezing temperatures in most part of the year and very low temperature even during summer months, low nutrients and low phytoplankton productivity. A large number of lakes are found in the northern hemisphere (Wetzel, 1975). The larger waterbodies such as Great Lakes of America, Canadian Shield Lakes and the Lakes of the English Lake District have been studied in greater details when compared to the smaller waterbodies.

In European countries several studies have been conducted regarding the hydrography. Galicka and Penczak (1989) have investigated the nutrient loadings of the Sulejow reservoir and Kajak (1990) studied the ecology of a lowland Zegrzynski reservoir near Warsow. Other important works are those of Vaconcelus (1990) on the physico-chemical properties of a recently commissioned reservoir Azibo in Portugal, Kamarianos et al., 1993 on the influence of hydrobiological regime on the plankton population in Kerkini reservoir of North Greece and Thebault and Selencen (1993) on
the behavior of a mesotrophic reservoir in France in terms of its biological and hydrodynamic properties. Water qualities of six Czech reservoirs were studied by Matulova (1990) and he reported the influence of atmospheric input, watershed and pH on the nitrogen-phosphorus relationship in mountain lakes in Czech Republic.

Several studies where conducted on the hydrography of lakes and reservoirs in North America. Lean (1987) studied the nutrient status of Lake Ontario in Canada as part of the Lake Ontario Nutrient Assessment Study (LONAS). The phosphorus dynamics of a north temperate reservoir of Wisconsin have been reviewed by James et al., (1990). Sterner (1990) studied the morphometry of twenty lakes in Minnesta, USA and suggested that small basins are more productive than large ones for both, energy related and nutrient related reasons. Brookes and Edgington (1994) studied the biogeochemical processes that influence nutrient flux between the sediments and water in Lake Michigan.

South American reservoir and lakes were also studied by several workers. In Australia the nutrient levels and other water quality parameters of Dumaresq reservoir, a small monomictic upland lake in New South Wales was studied by Bavens (1990).

Osborne et al., 1987 studied the effect of seasonal water changes in chemical limnology of Lake Murray, Papua New Guinea. Several studies were conducted on the hydrography of lakes and reservoirs of Asia. Some important works in South East Asia are those of Frey (1969) on Lake Lanao, Philippines and of Green et al., 1976 on the stratification in Lake Ranu, Lamongan, Indonesia.
Ali and Amin (1985) elucidated the physico-chemical limnology of Missriot Dam in Pakistan and discussed the factors that influence the eutrophic process. Chandrasoma et al., (1986) observed the limnological features in connection with fish production in Udawalawe reservoir of Sri Lanka.

Iyengar (1939) highlighted the algal problems peculiar to the tropics with special reference to those of India, while comparing the tropical and temperate climates. Thinemann (1954) concluded that the impact of environmental factors was much weaker in water than on land. He further reported that tropical waters are characterized by greater phytoplankton biomass, phytoplankton productivity and higher rates of bacterial decomposition in the bottom sediments, which are all attributed to the low angles of incident radiation, longer day lengths, greater intensity of illumination and uniform high temperature.

The studies on water quality of lakes in Kashmir has been carried out by Zutshi et al., 1980; Zutshi and Vass, 1982; Mir and Kachroo, 1982. In Madhya Pradesh, Adholia et al. (1991) studied on the abundance, distribution and total population of phytoplankton in relation with limno-chemical parameters of Manasasarowar reservoir in Bhopal. Rao and Chaudary (1990) studied some aspects of phytoplankton dynamics in relation to hydrographical parameters and explained their relation with status of primary production in Gandhisagar reservoir. Joshi et al. (1987) studied the nutrient status of Sagar Lake. In Uttar Pradesh, diurnal variation in physico-chemical factors of Rihand reservoir was studied by Singh et al., 1980, Singh, 1983 investigated the water quality of Dah Lake; Srivastava et al., 1999 have studied the G.B Pant Sagar reservoir in the South Muzafpur district of eastern Uttar Pradesh in


In Karnataka, Bharati and Core (1975) made limnological studies in ponds and lakes Dharwar. Hegde (1985) compared the biomass of plankton in four water bodies of Dharwar. Gaddad and Nimbargi (1983) mainly dealt with sewage pollution aspects of Jagath tank Gulberga. Rao (1985) observed the hydrobiological conditions of tank near Bangalore and opined that soil quality affects the nature of primary productivity of water body. Ayyapan and Gupta (1985) while studying a perennial pond at coastal Karnataka traced out a significant correlation between physical and chemical


The wave of interest in limnological studies in other states of India had resulted in certain attempts elucidating the hydrobiology of certain reservoirs, lakes and ponds in Kerala also. The important studies are those of Nair and Prabhoo (1980) who investigated the various physicochemical factors that affected primary production in the Neyyar reservoir, of Joseph (1985) and Abdul Aziz (1989) on the physicochemical features of Vellayani freshwater lake, of Gopinathan (1985) on the limnology of Aruvikkara reservoir, of Khatri (1985) on the nutrient status of Idukki

As opined by Srinivasan (1972a), rock pools are peculiar types of ecosystems. Their irregular morphometry, very low surface area to depth ratio and they are being closed systems pose interesting problems. In Kerala, rock pools are not taken previously to investigate in detail to study the algal flora, density, diversity, seasonal succession and variation with reference to physical and chemical parameters. Keeping this paucity in
mind, the present work is undertaken. We undertook hydrographical study of a temple pond and a rock pool in 2000, which revealed the results that rock pools are highly suited for harboring rich algal flora and they undergo seasonal fluctuation in response to the seasonal fluctuations of physico-chemical parameters. Further, looking at the ongoing national water crises there are experts who insist that small tanks make more sense, they are cheaper, more amenable to local control and cause far less ecological damage. This concept takes us to the traditional water harvesting systems present in every village in Kerala. No scientific study has hitherto undertaken to pave the way to utilize rock pools available in interior villages as rainwater harvesting basins and distributing sources. Nowadays a number of blue green and green algae are found to be useful in the dietary sense and as biofertilizers. An attempt also is made to bring economically important algae in auxenic cultures and study their responses to varying physicochemical factors, which help us to understand the eco-physiological responses of these organisms in the natural environment. The photosynthetic efficiency and their seasonal variations in response to the biological and physicochemical parameters also studied. Many workers (Walsh and Merril, 1984) have emphasized the use of algae as indicators of water quality and pollution load. Bioremediation by growing tolerant algae in polluted waters is a new trend that is to be unraveled.

**Objectives of the present study**

1. Inventorization of the major rock pools of Kottarakara Taluk, Kollam District, Southern Kerala.

2. To study the physico-chemical parameters and correlate with the seasonal variations of algae.
3. To study the standing crop of the components in terms of chlorophyll.

4. To study the primary productivity of the pools and their seasonal variations in response to physico-chemical and biological parameters.

5. To assess the trophic status of the ponds and identify the algal indicators, which are tolerant and sensitive.

6. To understand the eco-physiological responses of certain selected algae to varying concentrations of chemical factors in laboratory.

7. To suggest methods to conserve pools as basins for rainwater harvest and sources of distribution of drinking water.

**Study Area**

Kerala consists of 14 districts and Kollam is the one located at the southern part. Kollam district is located between 76°44'25" - 76°51'37" East longitude and 8°58'53" - 8°51'20" North latitude. Geomorphologically Kollam district exhibits an undulating terrain with plain areas with laterised hillocks and valleys. The geological formation can be divided into four units, viz. 1) crystalline rocks of Archean group; 2) laterite; 3) a narrow belt of Warakkall beds of the tertiary age, and 4) the western most coastal belt of recent to sub-recent deposits. The important economic materials found here are clays, glass sand, black sand and building stones. Good quality of china clay is found in many parts of the area beneath the laterite cover.

The district has a healthy climate generally free from extreme hot and cold conditions. A good annual rainfall, a warm humidity or atmosphere and a more or less uniform temperature through the year are the some of the important characteristic features of
the climate of the study area. The area enjoys four seasons: a) the dry winter from December to February; b) the hot summer from March to May; c) the South West monsoon from June to September, and d) the North East monsoon from October to November. The average rainfall is computed to be about 2534 mm. The air is characterized by high humidity throughout the year ranging from 87 per cent in the morning to 60 per cent in the evening. The monsoon months are characterized by the presence of heavy clouds. Sky is clear during summer season. The winds are moderate to strong in monsoon months and in other months it will be light to moderate. The temperature of the district ranges from 36.1°C to 20.3°C.

Kollam district abounds in rock pools. They are rock basins filled with water. Generally they are formed by quarrying or by the erosional forces of nature. The rock pools confirm the third order as per Whipple’s (1927) classification of lakes and the third class lakes of Hutchinson’s (1957) classification.

The rock pools may occur in plains in level with the surroundings or may be located on the boulders jutting above the ground level. They may occur on rocky terrains of the hills and hillocks also. Most of the rock pools are open on all sides. Some are over shadowed on one or more sides by rocks jutting above the ground level. Some of them are called cave pools being exposed to very little light. The rock basin may be conical, shallow or highly irregular. The sides of the basin may be steep or shallow, smooth or rough with irregular projections. Depending on the age of the pool, the bottom is rocky with detritus, whose depth depends on the age and trophic status.

Nature of the catchment area decides the hydrochemistry of the water body, which in turn decides the flora and fauna sustained in them (Mariamuthu and Krishnamurthy,
<table>
<thead>
<tr>
<th>Pool Name</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
<th>IX</th>
<th>X</th>
<th>XI</th>
</tr>
</thead>
<tbody>
<tr>
<td>U₁: Andoor*</td>
<td>OP; Q; P</td>
<td>Det. M</td>
<td>93</td>
<td>3.2</td>
<td>22.0 - 30.0</td>
<td>0 - (-)5</td>
<td>6.92 - 10.5</td>
<td>0.0 - 11.0</td>
<td>0.41 - 3.7</td>
<td>Nil</td>
<td>Micro. Bl.</td>
</tr>
<tr>
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<td>OP; N; P</td>
<td>M</td>
<td>35</td>
<td>1.8</td>
<td>22.0 - 29.0</td>
<td>(-)2 - (-)7.5</td>
<td>8.2 - 10.0</td>
<td>2.5 - 5.7</td>
<td>0.6 - 6.5</td>
<td>Nil</td>
<td>No Bl.</td>
</tr>
<tr>
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<td>OP; Q; Pl. L. M</td>
<td>42</td>
<td>2.1</td>
<td>24.0 - 30.0</td>
<td>(-)2 - (-)6</td>
<td>8.2 - 10.0</td>
<td>4.0 - 6.5</td>
<td>0.6 - 5.5</td>
<td>Nil</td>
<td>No Bl.</td>
<td></td>
</tr>
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<td>V₁: Kottappara*</td>
<td>OP; Q; SP</td>
<td>Pl. L. M</td>
<td>20.8</td>
<td>1.4</td>
<td>22.5 - 33.0</td>
<td>(+)1.5 - (-)5</td>
<td>7.0 - 9.4</td>
<td>0.8 - 9.9</td>
<td>0.2 - 0.9</td>
<td>Subm.</td>
<td>No Bl.</td>
</tr>
<tr>
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<td>OP; Q; P</td>
<td>M</td>
<td>10.0</td>
<td>1.4</td>
<td>22.0 - 35.0</td>
<td>(+)1 - (-)7.0</td>
<td>8.5 - 10.0</td>
<td>4.0 - 6.5</td>
<td>0.5 - 3.5</td>
<td>Amph.</td>
<td>No Bl.</td>
</tr>
<tr>
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<td>OP; Q; Det</td>
<td>Det M</td>
<td>140</td>
<td>2.0</td>
<td>22.5 - 33.0</td>
<td>(-)1 - (-)7.0</td>
<td>8.5 - 10.0</td>
<td>5.0 - 8.0</td>
<td>0.7 - 6.9</td>
<td>Fltg. &amp; Subm.</td>
<td>No Bl.</td>
</tr>
<tr>
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<td>M</td>
<td>15.0</td>
<td>1.5</td>
<td>22.5 - 31.0</td>
<td>(-)2 - (-)6.3</td>
<td>7.5 - 8.5</td>
<td>5.0 - 7.0</td>
<td>0.4 - 7.5</td>
<td>Fltg.</td>
<td>No Bl. BG Dom.</td>
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<tr>
<td>E₂: Kayila</td>
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<td>Pl. L. M</td>
<td>35</td>
<td>2.0</td>
<td>24.5 - 32.0</td>
<td>(-)1 - (-)7.5</td>
<td>8.2 - 10.0</td>
<td>4.0 - 6.5</td>
<td>0.6 - 2.7</td>
<td>Subm.</td>
<td>No Bl. BG Dom.</td>
</tr>
<tr>
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<td>2.5</td>
<td>21.5 - 33.0</td>
<td>0 - (-)12.5</td>
<td>7.0 - 10.0</td>
<td>3.5 - 5.5</td>
<td>0.2 - 3.5</td>
<td>Fltg. Lemna</td>
<td>Micro. Bl. BG Dom.</td>
</tr>
</tbody>
</table>

Abbreviations:

I to XI = Different Aspects

I = Nature of the Pool;
OP = Open
N = Natural;
P = Permanent
Q = Formed by quarrying
SP = Semi Permanent

II = Bottom nature;
Det = Detritus;
Pl. L = Plant Litter
M = Muddy

III = Surface area in m²
IV = Depth in m
V = Range of variations in water temperature °C
VI = Range by which water temperature exceeded Atmospheric temperature (+) or was lower than atmospheric temperature (-)
VII = pH
VIII = Dissolved Oxygen as mg/L
IX = Salinity °/oo
X = Macrophytic vegetation
Subm. = submerged;
Ftg = Floating;
Amph = Amphibious
XI = Phytoplankton.
Micro = Microcystis
BG = Blue Green Algae;
Bl = Bloom;
BG Dom = Blue Green Dominant ;

* Pools studied in detail
1995). In case of rock basins of plains, which are in level with the surrounding ground level there are chances for inflow through drainage from catchment areas and also outflow from the basin when it is full. In such cases when the catchment area is soil covered, nutrients may be added allochthonously to the basin. Same is the true for the rock pools located on slopes of hills. Surface runoff from the slopes enters the basin and when the basin is full the excess water flows out on the other side. In this case if the slope above contains soil, nutrients may be leached into the basin. If the slope is steeper rainwater runs down fast having no time to dissolve and carry nutrients down. If the slope is gentle the rainwater is takes time to reach the basin down and may dissolve and carry some nutrients from the soil on the way. The water in most of the pools has a distinctly alkaline pH during most part of the year, one or two pools on occasions registering a low pH. Rooted submerged, rooted amphibious and free floating macrophytes are present in some of the pools besides the phytoplankton and zooplankton. Many pools are devoid of macrophytes. Permanent blooms of blue green algae, especially *Microcystis aeruginosa*, characterize some.

The general morphometric, chemical and biological characters of the pools deeply surveyed and studied in three adjacent panchayats – Ummannoor, Elamadu and Veliyam of Kottarakara Taluk, Kollam district are given in Table 1. Study of two of these (Pool U\textsubscript{1} and V\textsubscript{1}) is dealt with in detail (Fig. 1 and 2 and Plate 1).

**Description of Pool U\textsubscript{1} and Pool V\textsubscript{1}**

Ummannoor and Veliyam panchayats are enriched with numerous rock quarries formed by controlled blasting of granite rocks, which later transformed into water
Fig. 1 Location map of the study area
Fig. 2. Study area showing pool locations
filled pools. Out of the three pools studied from Ummannoor panchayat pool U₁ at Andoor and of the three pools studied from Veliyam panchayat at Kottappara pool V₁ are selected for detailed study.

**Pool U₁**

The area around the pool U₁ is made up of granite and laterites with in which all the other rock types are strewn over the xenolethic patches. Pink and grey granites are also common. The pool has rock jutting above the ground on two sides and an outlet meant for irrigation purpose. On the eastern side of the pool, it has an inlet through which water enters. On the southern and northern sides the pool has soil bed. The rain fed pool is partially loaded by inflow of village sewage and also subjected to human and other disturbances as it is used for washing livestock and to soak coconut leaves. It is an open pool and is exposed to direct sunlight at all times of the day. In the year 1998, two school children of neighborhood drowned and died in this pool.

The morphometric data are given in Table 2 and the bathymetric map is given in Fig. 3. Since the volume development value was more nearly with unity it confirms to the ‘γ’ type basin (Zafar, 1959a). This pool did not dry up in any part of the year and supported a permanent bloom of *Microcystis aeruginosa*. Surface, middle and bottom waters were collected for analysis on all occasions.

**Pool V₁**

Pool V₁ and V₂ are located side by side. Pool V₁ is a smaller pool compared to pool U₁. This is also an open pool receiving direct sunlight during most part of the day.
<table>
<thead>
<tr>
<th>Morphometric parameters</th>
<th>Pool U₁</th>
<th>Pool V₁</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Depth (Zm)</td>
<td>3.2 m</td>
<td>1.5 m</td>
</tr>
<tr>
<td>Length (l)</td>
<td>15.75 m</td>
<td>8.8 m</td>
</tr>
<tr>
<td>Breadth at the broadest point (bₓ)</td>
<td>7.25 m</td>
<td>2.6 m</td>
</tr>
<tr>
<td>Maximum Depth</td>
<td>3.2 m</td>
<td>1.5 m</td>
</tr>
<tr>
<td>Mean Depth ((\bar{Z} = \frac{V}{A}))</td>
<td>6.7 m</td>
<td>0.463 m</td>
</tr>
<tr>
<td>Area (A)</td>
<td>93.0 m²</td>
<td>20.8 m²</td>
</tr>
<tr>
<td>Volume (V)</td>
<td>645.0 m³</td>
<td>9.0 m³</td>
</tr>
<tr>
<td>Shoreline (L)</td>
<td>43.5 m</td>
<td>21.25 m</td>
</tr>
<tr>
<td>Development of Shoreline (D_L)</td>
<td>1.15</td>
<td>1.16</td>
</tr>
<tr>
<td>Development of Volume (D_V)</td>
<td>1.03</td>
<td>2.04</td>
</tr>
</tbody>
</table>
Fig: 3 BATHYMETRIC MAPS OF THE POOLS

SCALE: 1M

CONTOUR INTERVAL = 20CM
Access is only on two sides being enclosed by projection of rocks. Contrary to the pool U1, this pool did not support a phytoplankton bloom at any part of the study. Aquatic macrophytes like *Salvinia molesta*, and *Eichhornia crassipes* are found floating. This pool is temporary unlike the other pool drying during summer.

The morphometric data are given in Table 2 and the bathymetric map in Fig.3. Since the volume development was far from unity, the basin can be described as ‘λ’ type (Zafar, 1959a). The depth and volume of water in this pool showed a greater degree of fluctuation. Surface and bottom waters were sampled for analysis on all occasions.

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