INTRODUCTION

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Chapter 1

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Cladocerans which make up a considerable proportion of freshwater zooplankton constitute an important component among the microcrustacean assemblages of aquatic habitats, such as lakes, reservoirs, ponds, puddles, swamps, paddy fields, streams and rivers. They are known to be the inhabitants of both the permanent and temporary water bodies; they may be planktonic, phytophilic or benthic. A few species have been reported from some of the unique freshwater habitats like glaciated zones (Tappa, 1965), water trapped in mosses (Frey, 1980), acidic waters with pH 3.8 to 5.0 (Frey, 1982), underground water (Dumont, 1983; Dumont, 1987; Dumont and Brancelj, 1994; Dumont and Negrea, 1996), caves (Brancelj, 1990) and fast flowing rivers (Dole-Olivier *et al.* 2000).

Cladocerans exhibit wider diversity and are abundant in lentic environments than lotic environments. They are known to be more abundant in temporary water bodies than in permanent freshwater habitats (Hutchinson, 1967). Nevertheless, some species can tolerate considerable salinities (Potts and Durning, 1980; Negrea, 1983). The range of tolerance varies from nearer distilled water (Dodson, 1982) to the 3.2% salinity of oceans (Della Croce and Angelino, 1987). Members of only three genera viz. *Podon, Evadne* and *Penilia* are known to inhabit marine waters. The term "Cladocera" was derived from two Greek words, '*klados*' means branch and '*keras*' means horn, referring the two branched second antennae which are the chief locomotory structure of these animals. Most of the cladocerans move through the water with a series of hops and jumps and hence called "water fleas".

1.1 Systematic Account

The earlier classification (Calman, 1909) of branchiopod Crustacea into 4 orders viz. Anostraca, Notostraca, Conchostraca and Cladocera was a refinement of the scheme first put forward by Sars in 1867.

Fryer (1987) in his classical work, "A new classification of the Branchiopod Crustacea" considered Cladocera an artificial group comprising representatives of rather different phylogenetic origin. He classified them into 4 orders viz. Anomopoda, Ctenopoda, Onychopoda and Haplopoda. This classification has been widely accepted by taxonomists all over the world.

Fryer's (1987) classification is followed in the present study which is cited below.

Superclass Crustacea Lamarck, 1801

Class Branchiopoda Latreille, 1817

Order Anomopoda Sars, 1865

* Family Daphniidae Straus, 1820

* Family Moinidae Goulden, 1968

Family Bosminidae Baird, 1845

* Family Macrothricidae Norman and Brady, 1867

* Family Chydoridae Dybowski and Grochowski, 1894

Order Ctenopoda Sars, 1865

* Family Sididae Baird, 1850

Family Holopedidae Sars, 1865

Order Onychopoda Sars, 1865

Family Polyphemidae Baird, 1845

Family Podonidae Mordukhai- Boltovskoi, 1968

Family Cercopagidae Mordukhai-Boltovskoi, 1968

Order Haplopoda Sars, 1865

Family Leptodoridae Lilljeborg, 1861

*Species studied in the present investigation come under the family

The group 'Cladocera' thus includes 4 orders, 11 families and 80 genera comprising more than 450 species with only 2% marine representatives (Dodson and Frey, 1991; Amoros, 1996; Korovchinsky, 1996).

Martin and Cash-Clark (1995) using modern cladistic analysis studied the inter-relationships among the four orders of Cladocera and suggested that despite the large difference between the orders, they might still be monophyletic. Their theory envisages the derivation of Cladocera from a cyclestheriid-like ancestor (Olesen, 1998). Recent molecular evidence also suggests that the Cladocera is a monophyletic group (Crease and Taylor, 1998). In this system the Class Branchiopoda is divided into Subclass

Diplostraca retaining the Order status of Cladocera and further divided them into 4 suborders viz. Anomopoda, Ctenopoda, Onychopoda and Haplopoda. Subsequently, Negrea *et al.* (1999) proposed a scheme of classification of Branchiopoda giving due credit to Fryer (1987).

Cladocerans from the Indian subcontinent has been reviewed by Michael and Sharma (1988) and described 90 species (93 taxa) belonging to 37 genera. This includes 9 families namely Daphniidae Straus, 1820; Polyphemidae Baird, 1845; Sididae Baird, 1850; Leptodoridae Lilljeborg, 1861; Bosminidae Sars, 1865; Macrothricidae Norman and Brady, 1867; Moinidae Goulden, 1968; Chydoridae Stebbing, 1902 and Podonidae Mordukhai-Boltovskoi, 1968. The study was based on samples obtained from different localities in the Indian subcontinent.

In inland waters the Family Sididae was represented by 4 genera such as *Pseudosida, Sida, Latonopsis, Diaphanosoma* and Family Daphniidae by 5 genera namely *Ceriodaphnia, Daphnia, Daphniopsis, Scapholeberis* and *Simocephalus.* The Family Moinidae included 2 genera *Moina and Moinodaphnia* and Family Bosminidae included *Bosmina* and *Bosminopsis.* The Family Macrothricidae was represented by 4 genera such as *Ilyocryptus, Streblocerus, Macrothrix, Echinisca* and Family Chydoridae by 17 genera namely *Eurycercus, Pleuroxus, Alonella, Chydorus, Dunhevedia, Dadaya, Pseudochydorus, Alona, Acroperus, Camptocercus, Graptoleberis, Leydigia, Biapertura, Oxyurella, Kurzia, Euryalona* and *Indialona.* The Family Leptodoridae and Polyphemidae represented by a single Genus *Leptodora* and *Polyphemus* respectively. Subsequently, Sharma (1991) reviewed the cladoceran fauna of our country and listed 109 species.

The first study of cladocerans from Kerala is that of Michael and Hann (1979) who reported 2 species from Thiruvananthapuram. Michael and Sharma (1988) added 8 species from Thiruvananthapuram and 9 from Irinjalakuda. Raghunathan (1989a) studied the Cladocera from Wynad. Further, Babu and Nayar (2004) added 15 species from Periyar Lake. Recently, Babu and John (2007) added 1 more species from Muriyad, to the cladoceran fauna of Kerala thus raising the total number to 35.

1. 2 Habit and Habitats

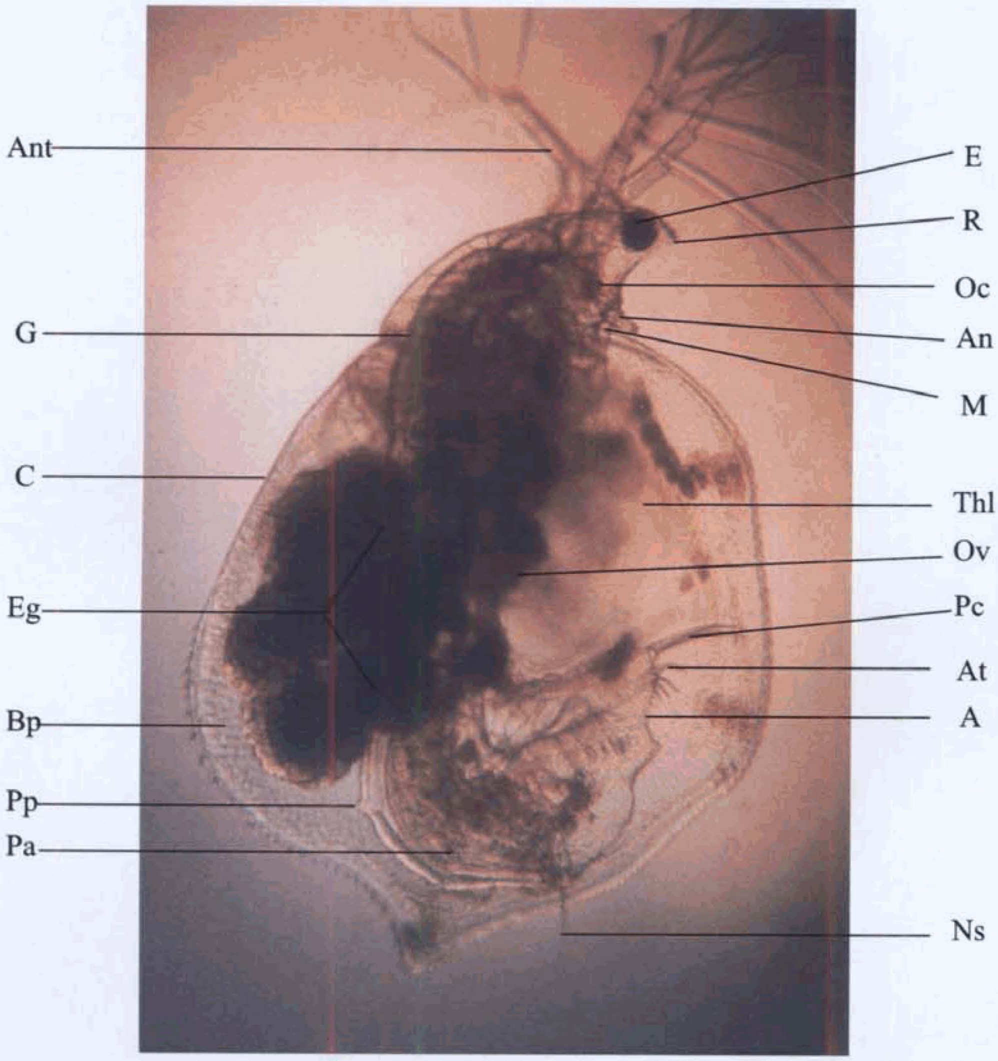
A good number of genera and species of Cladocera are encountered among the weeds in lakes, ponds, swamps and most of them are herbivores. Pennak (1978) has indicated that those found in ponds, ditches or in the weedy margins of larger water bodies are often coloured yellowish, brownish or reddish. Majority of species, are found to be living on submerged vegetation (epiphytic), organic sediments, decaying plant materials and swim only short distances. They are called "meiobenthos" by Frey (1988). Almost all members of the families Chydoridae and Macrothricidae and some members of the Sididae are benthic (Dodson and Frey, 1991). The bottom-dwelling forms may swim but more often scramble about on the bottom, pulling with their antennae and pushing with their postabdomen. However, a less number of species are truly planktonic, and appear transparent and colourless. The members belonging to Genus *Scapholeberis* are hyponeustonic forms often found associated with the surface films of water.

1. 3 General Morphology

Although no single genus or species can be considered typical of the group a generalized account of a cladoceran is given here based on Plate 1.

Plate 1

General organization of a cladoceran ***Simocephalus serrulatus*** (Koch)



Ant- Antenna	**M-** Mouth
A- Anus	**Ns-** Natatorial setae
An - Antennule	**O-** Ocellus
At- Anal teeth	**Ov-** Ovary
Bp- Brood pouch	**Pa-** Postabdomen
C- Carapace	**Pc-** Postabdominal claw
E- Eye	**Pp-** Postabdominal process
Eg- Eggs	**R-** Rostrum
G- Gut	**Thl-** Thoracic legs

The characters described include the body form and size, head morphology, nature of postabdomen; setation in antennae, antennule and shell. Vast majority of this group exhibit considerable variation in their general structural plan with an average body length often ranging from 0.2 to 3.0 mm. But the largest known species, *Leptodora kindti* attains a length upto 18.0 mm (Hutchinson, 1967).

Although, the cladoceran body is divided into distinct head, thorax, abdomen and postabdomen; the division between abdomen and postabdomen is not completely demarcated. In the great majority of the species the thoracic and abdominal regions are covered by a cuticular shell or carapace that has a general bivalved appearance but is actually a single folded piece that gapes ventrally. The carapace may vary in its shape, length, and the ventral surface architecture. In the lateral view the shell may be oval, circular, elongated or angular. There are often surface reticulations, striations, or other type of markings. Moreover the carapace margins in some forms are covered by hairs, spines or setae. The body lies free within the valves hanging from the dorsal carapace. Their internal anatomy is visible under a microscope, due to the translucent nature of the carapace.

The most conspicuous structure on the head is the large compound eye on each side, formed of a few lenses surrounding a mass of pigmented granules. A small ocellus is situated posterior to the compound eye. The compound eye together with the ocellus acts as the light sensitive organ. The presence of ocellus, its size, shape and position with reference to eye and rostrum are of taxonomical importance. Ocellus is clearly seen in family Daphniidae, Macrothricidae, and Chydoridae. But it is absent in Bosminidae and Moinidae except in *Moina oryzae* and Genus *Moinodaphnia.* The head is often bent downwards with a ventero-posterior process called the rostrum. It is well marked in most of the members of Daphniidae and Chydoridae, while it is absent in some genera of Sididae. Chydorids have small structures on or near the mid-dorsal line known as 'head pores'. These are borne on the head shield, an unpaired plate covering the frontal and lateral surfaces of head. The number and arrangement of head pores and the shape of head shield are important taxonomic features of Chydoridae (Frey, 1959).

Mouth is located near the margin separating the carapace and head. The mouth parts include a median labrum, a pair of mandibles, a pair of maxillae and a median labium which are placed near the junction of head and body. The mandibles are stout structures meant for grinding food and provided with toothed or ridged surface. Maxillae are small pointed structures used for pushing food between mandibles. The labium bears a median keel in Macrothricidae and Chydoridae, which is considered an important feature for identification of different taxa (Birge, 1918).

The head of all cladocerans bear a pair of antennules and antennae. The antennules are located ventrally near the rostrum and bears sensory setae laterally or terminally. They are large and movable in Sididae while that of Daphniidae are rudimentary and immovable. The antennules are 'cigar-shaped' and longer than head in Moinidae. In Bosminidae, they are attached to the head and are parallel to each other and curve backwardly. Macrothricidae have long and club shaped movable antennules inserted in the anterior end at the ventral side of head. In Chydoridae, they are mobile and generally do not extend beyond the tip of the rostrum. The antennules of males are generally longer than females and are important in defining the species (Frey, 1987).

The main swimming organ of Cladocera constitutes a pair of large biramus antennae that originate from the posterior margin of the head. Each consists of a stout basal segment, a segmented dorsal ramus, and a segmented ventral ramus. The two rami bear variable number of plumose setae. The number of antennary setae may be expressed by a formula; for example in *Daphnia* it is (0-0-1-3) / (1-1-3), implies that the dorsal and ventral rami have four and three segments each and again starting from the base each of the segment bears 0, 0, 1, 3 and 1, 1, 3 setae. The number of segments in each ramus, arrangement and number of setae show variation with respect to species and hence antennary setation is also an important taxonomic feature. The antennae are activated by a set of powerful muscles which originate dorsally in the 'neck' region. A strengthening ridge or fornix is seen above the base of each antenna, which is well developed in Daphniidae.

The anterior part of head in front of the eye is called vertex. The members of family Moinidae has a distinct depression just above the eye called supraocular depression. This depression is caused by the attachment of bundle of muscles to the inner surface of the flexible exoskeleton. In some cladocerans there is a depression found at the junction of head and body called cervical depression.

The thorax holds 5 or 6 pairs of thoracic legs while the abdomen is suppressed and has no legs. In family Sididae all these legs are similar, but in other families the first two pairs are more or less prehensile and may aid in clinging to the substrate. The first and second pair of legs is also used for 'filter feeding' as filter screens to keep out large particles, while the other sets of legs create a continuous flow of water. This water current oxygenates the body surface as well as brings food materials towards the mouth.

Some smaller species, especially members of the Family Chydoridae use the abdomen as a sort of foot to kick along surfaces. The postabdomen (Plate 1) is the part of the body near the end of abdomen which is bent forward so that the dorsal side is downward and ends in two terminal claws. It is used for cleaning debris from the appendages as well as for locomotion. The postabdominal claws of some cladoceran species belonging to Daphniidae and Moinidae possess a comb like structure called pecten. The claws also may bear one or two basal spines; there may be a row of anal teeth and lateral setae which are either feathered or grouped in some species. The proximal part of the postabdomen has two long abdominal natatorial setae (Plate 1). Two to three outgrowths called 'postabdominal processes' are found anterior to the natatorial setae which serves to hold the eggs or embryos in the brood pouch (Plate 1). The structure of the antennae, antennules, carapace spines and postabdomen are important features in species identification.

1. 4 Reproduction and Life cycle

Absence of any larval stage during development is a unique feature of cladocerans except *Leptodora*, in which nauplii hatch from resting eggs (Warren, 1901). The reproduction can either be totally parthenogenetic (asexual) or may be intermixed with periods of gamogenetic (sexual) reproduction. Two female morphotypes are thus recognized in the populations which include the parthenogenetic individuals and ephippial forms. Although, parthenogenesis is the predominant mode of reproduction (Shan, 1969; Hebert, 1987), they resort to sexual reproduction occasionally or seasonally. The production of males and ephippial females indicate the onset of sexual reproduction. The shift from parthenogenetic to sexual reproduction ensures their survival under unfavourable environmental conditions.

1. 4. 1 Parthenogenetic Reproduction

Parthenogenesis in Cladocera was observed by several earlier workers (Von Siebold, 1856; Lubbock, 1857; Weismann, 1886). It is the method by which cladocerans reproduce for most of the year and hence the natural populations are dominated by parthenogenetic females.

Like any other crustaceans, cladocerans also grow by moulting; in which the chitinous exoskeleton forming the carapace is removed and renewed periodically and cast off as exuvium. After a limited number of pre-adult moults, the animal attains sexual maturity with the development of ovaries. Each female carries two ovaries which lie along the entire length of thorax lateral to the intestine. The bulk of the ovary contains growing oocyte clusters; the germarium occupies a small portion at the posterior end while the remaining large portion is reserved for growth and maturation (Lumer, 1937; Ojima, 1958).

The primiparous condition is attained when the first batch of eggs are formed in the brood pouch through parthenogenesis. The mature females release eggs into the 'brood pouch', which is a space dorsal to the body in between the valves of the carapace. Embryonic development takes place within the brood pouch and the young ones are released without passing through a larval stage. Normally one clutch of eggs is released into the brood pouch during each adult instar. These eggs develop into immature young ones, without fertilization, nourished initially by egg yolk and then by the secretion from the walls of the chamber. These neonates resemble the adult form but are smaller. Just before the next moulting, these juveniles are released to the exterior by the jerking movements of the female postabdomen followed by the extrusion of another set of eggs into the brood pouch. These released juveniles then begin to feed and mature at a rapid pace to continue the parthengenetic cycle. Parthenogenesis allows for quick population growth under favourable conditions (Balcer *et al.* 1984).

1. 4. 2 Sexual Reproduction

The males are morphologically distinct from the females. The size of the body, nature of antennules and the presence of hooks in the thoracic legs make them distinct in populations. The testicles lie along both sides of the intestine and extend as far as the bend in the abdomen. In most newly hatched forms they appear as two small, solid cords consisting of relatively large, inactive spermatogonia (Taylor, 1914; Mori, 1933; Mortimer, 1936). As animals grow, the testicles enlarge and spermatogenesis begins, the maturing male germ cells are distributed along the entire length of the testicles (Zaffagnini, 1987).

Banta and Brown (1929) have suggested the effect of crowding in male production. Males appear in the population occasionally after a variable number of parthenogenetic generations (Hutchinson, 1967). Formation of male is induced by conditions like decrease in food concentration, over-crowding or due to variation in light intensity and temperature (Pennak, 1978; Dodson and Frey, 1991). Since the males appear only occasionally they are always found to be rare in natural populations and go unnoticed.

At the time of male appearance or a little later the females start producing specialized eggs. Appearance of males and mating with the females producing fertilized eggs (resting eggs) indicate the beginning of sexual cycle. The fertilized eggs are kept in the brood pouch of the female and are quite different from the parthenogenetic eggs. The resting egg is enclosed in a thick chitinous protective case called 'ephippium' which is a semi-elliptical, opaque thickening of the carapace surrounding the brood chamber.

The fertilized eggs which are enclosed inside the ephippia are called the resting eggs which undergo several cell divisions (Banta and Wood, 1939; Ojima, 1958) and further enter into a period of dormancy called 'diapause'. Schultz (1977) has described the ultrastructure of ephippium of *Daphnia* and found that it has an external and internal wall. The diapausing embryos inside the ephippia require some stimuli such as water, long or increasing day lengths, proper temperature and high oxygen concentration for initiating the development (Schwartz and Hebert, 1987). These eggs are able to retain the structural integrity under extreme conditions, because they have honey comb like structure in the ephippium made up of crystalline calcium phosphate (Kawasaki *et al.* 2004a). When the ephippial female next moults, the ephippium is shed along with the enclosed egg. These females may again produce resting eggs or resume the production of parthenogenetic eggs to continue the life cycle.

1. 5 Food and Feeding

Cladocera form a key element in the functioning of the freshwater ecosystems of the world. Despite their smaller size, they are very important ecologically not only on account of their numbers, but also as filter feeders, they consume all particles within a size range. The most important component of their diet is made up of small algae in the range of 1-25μm (Lampert, 1987). They are grazers of the ecosystem, feeding on unicellular algae as well as on protozoans, bacteria, other micro-organisms and even organic detritus.

The food uptake and utilization of *Daphnia* have been studied by Naumann (1921). The edible food particles are ground up by tiny mandibles and pushed into mouth. The interpretations of gut analysis are difficult, since the fragile forms like flagellates or ciliates may be completely destroyed by the mandibles and appear in the gut as an unidentifiable mass. Hasler (1935) for the first time studied the digestive enzymes of *Daphnia magna* and reported the presence of protenases, peptidases, amylase and lipase in the gut. The particles very resistant to digestion may be accumulating in the hindgut when all other materials are digested (Porter, 1975; Nadin-Hurley and Duncan, 1976). The undigested residue is eliminated out through the anus situated usually on the dorsal border of the postabdomen.

The cladocerans select their food based on taste and size. Porter (1977) has pointed out that cladocerans can discriminate their choice of food and can remove significant fractions of algae from a lake each day. The passive size selection has been determined at the upper end by the size of the gape between margins of carapace valves (Gliwicz and Siedlar, 1980) and at the lower end by setae spacing (DeMott, 1985). Persson (1985) pointed out that the food selection of cladocerans is generally based on a passive selection by size. However, DeMott (1986) suggested that their food selection is generally based on a combination of the taste and size of food item.

A vast majority of cladocerans obtain food by filtering water. The thoracic legs of *Daphnia,* together with the carapace, form a suction and pressure pump (Cannon, 1933). This was later confirmed by Strickler (1984). Lampert (1987) has investigated the filtering process and found that water enters the gap between carapace margins and then leaves the carapace just above the postabdomen. During this process the food particles are brought continuously into the mouth through the current of water maintained by the movements of thoracic legs.

Scourfield and Harding (1941) reported cladocerans role in removal of some harmful bacteria from water. The members belonging to Family Chydoridae, typically feed by crawling along the surfaces or through the mud, where they scrape up or filter food (Fryer, 1968). A few genera such as *Polyphemus* and *Leptodora* are predatory feeding on small crustaceans and rotifers (Pennak, 1978). Recently, Shiny *et al.* (2005) also reported that the cladoceran *Daphnia magna* is highly efficient in the removal of suspended organic matter and bacteria from waste water.

1. 6 Importance of Cladocera

The central position of Cladocera in the food web has directed the interest of many investigators to its food uptake and utilization. Their grazing contributes to the transfer of algal primary production to higher trophic levels. In other words cladocerans can make organic material available to higher trophic levels, in a larger pellet form by themselves acting as 'live feed' and there by saving the foraging energy of their predators. Thus cladocerans have become important in the aquatic ecosystems as a suitable food item for all fish larvae and a wide variety of plankton-feeding fishes.

Cladocerans have been considered an important food item of plankton-feeding fishes by earlier investigators (Herrick, 1884; Forbes, 1888; Scourfield and Harding, 1941). The importance of Cladocera as live animal food in the nursery ponds was also noticed by Alikunhi (1952) and Alikunhi *et al.* (1955). They play a crucial role in the transfer of energy from producers to secondary and tertiary consumers within the aquatic food web

(Dodson and Frey, 1991; Dumont and Negrea, 2002). Thus cladocerans contribute as the resource base for the youngest ontogenetic stages of most fish species (Fernando, 2002).

During the last three decades aquaculture has received important application in the country as a means for augmenting fish production, an enterprise for improving rural economy and an operation for productive utilization of the derelict land and water spreads. Resources of land, water and cultivable species of fish and prawn are available in different states of India. So the prime requirement of aquaculture practice is the production of appropriate nutritionally-balanced and economically viable live feed which will ensure maximum growth and survival of the cultivable fish or prawn.

Murugan (1989) has reported high levels of protein, free amino acids, fats and carbohydrates in cladocerans like *Daphnia carinata, D. longispina, D. magna* and *D. pulex*, which are considered valuable live feeds. Live feed organisms are preferred by most of the cultured larvae as they are their principal food in the natural habitat (Pandian and Marian, 1991). Cladocerans have been selected as food sources in larviculture based on availability, nutritional quality, economic feasibility, easy digestibility and their high rate of reproduction (Watanabe and Kiron, 1994). Pandey and Yeragi (2000) have also pointed out the importance of cladocerans like *Moina* and *Daphnia* as live food organisms in freshwater larviculture and ornamental fish industry. Indulkar and Belsare (2003) pointed out that live *Moina* is superior to other foods for post-larvae of *Macrobranchium rosenbergii.*

The genetic characteristics of daphniids, especially *D. magna* have been studied by Ferrari and Hebert (1982). Cladocerans are used extensively in genetic studies (Hebert, 1987; Hebert and Taylor, 1997; Crease and Taylor, 1998).

Cladocerans have also been identified as best indicator organisms for assessment of water pollution particularly nutrient linked eutrophication, resulting from pollution by untreated domestic sewage and toxicity associated with pesticides (Anderson, 1944; Makrushim, 1976; Gannon and Stemberger, 1978). Prasad (1980) showed that *Daphnia* and *Bosmina* are highly sensitive to kraft pulp mill effluents. Recently, Yogendra *et al.* (2005) suggested that *Daphnia* can serve as a good test model for biomonitoring of industrial effluents.

1. 7 Relevance of Present Investigation

The cladocerans occupy an intermediate position in the trophic levels of freshwater ecosystems as planktonic, epiphytic and benthic organisms. Their high abundance and role as transfer organisms from algae and dead organic matter to macro-invertebrates and fish often make them one of the most important organisms to influence the biological processes of freshwater ecosystems. Edmondson (1971) has pointed out that the laboratory studies of growth, instar duration, egg production and life span are valuable sources of information for a clearer understanding of secondary productivity.

Cladocerans have been used as experimental animals by several biologists in various studies pertaining to aquatic toxicology (Anderson, 1944; Makrushim, 1976; Gannon and Stemberger, 1978; Prasad, 1980 and Shiny *et al.* 2005). The small size, rapid parthenogenetic development, filter feeding habit, the capacity to survive and reproduce in different types of freshwater habitats make Cladocera an ideal organism for culture purposes; hence can be used as a model organism in basic research.

Most of the earlier studies are confined to a few species of *Daphnia* especially of the temperate regions (Koivisto, 1995; Lampert and Sommer, 1997; Alekseev and Lampert, 2001). Therefore, daphniids serve as model organisms for understanding the life history. Information on the biology of other cladocerans from tropical areas may be useful for further works in other fields like ecology, behavior and genetics.

Cladocerans are used as live food in larviculture, mainly due to their superior nutritional value and easy availability (Murugan, 1989; Pandey and Yeragi, 2000). Natural diets mainly include different species of live cladocerans. Larval survival and growth rates in many species of fishes have been shown to be the highest when they were fed with live food organisms (Indulkar and Belsare, 2003).

Cladoceran biology has not been a subject of intense study from our country especially from Kerala. Therefore, the study on the biology of cladocerans simulating natural conditions of this region makes comparison among different species more reliable. Hence the present study has focused mainly on their morphology, reproduction, growth, life cycle, embryonic development and life span of species collected from the locality. Since differences in the life histories are likely to occur, it was felt that it would be of interest to study these features. The conclusions derived from the investigation will be useful for developing better culture methods.

The biology of twelve cladoceran species collected from different freshwater habitats of Thrissur district, Kerala, has been presently studied. The species included are:

1. *Pseudosida bidentata* var. *szalayi* (Daday, 1898)

2. *Latonopsis australis* Sars, 1888

3. *Diaphanosoma sarsi* Richard, 1895

4. *Ceriodaphnia cornuta* Sars, 1885

5. *Scapholeberis kingi* Sars, 1903b

6. *Simocephalus serrulatus* (Koch, 1841)

7. *Moina brachiata* (Jurine, 1820)

8. *Moinodaphnia macleayi* (King, 1853)

9. *Ilyocryptus spinifer* Herrick, 1882

10. *Macrothrix triserialis* (Brady, 1886)

11. *Alona pulchella* King, 1853 and

12. *Oxyurella singalensis* (Daday, 1898).

It is hoped that, this attempt will be helpful in making some generalizations and to draw certain conclusions which will be useful for future investigators. The present investigation entitled ***"Studies on the biology of freshwater Cladocera: Crustacea"*** has been undertaken in order to fill the existing lacunae of our knowledge on cladoceran biology.