2. Review of Literature

2.1 International Status:

Kofoid and Campbell, (1929) were first men to detail explain the large number of planktonic protozoan ciliate diversity, especially marine tropical ecosystem. His monograph includes more than 97 species from tintinnids in the earlier days, from simple light microscope. The tintinnid ciliate codonellidae with lorica usually bowl-shaped, never with a narrow oral aperture, distinct aboral end closed or rarely with an irregular aperture were firstly explained. *Tintinnopsis beroidea* is an abundant neritic species very difficult to differentiate with other species in the marine system. Many species of some genus are either neritic or brackish-water inhabitants. Further he described *Codonella* differ from other species, with less regular pattern of the secondary structure wall and in the lack of nuchal groove or an inner nuchal shelf. *Stenosemella* sp. is very rare species, recorded from the pelagial of temperate, subtropical, and tropical neritic waters. The cytological features were unknown. These species are now redescribed by protargol impregnation staining.

Jones, (1974) was classified the taxonomy on the bases of internal structure of protozoan ciliates from both fresh water and marine water basins. In 1954 the society of protozoologists established a committee on taxonomy and taxonomic problems to prepare a revised scheme of classification of the protozoa. It included a number of radical changes, including the merging of the sarcodines and the flagellates into a single subphylum, under the sarcomastigophora.

There are two major points declared. Firstly the opalinids were removed from the ciliates and placed in separate super class of the subphylum Sarcomastigophora. Under the ciliophora subphylum there are four subclasses classified such as holotricha, peritrichia, suctoria and spirotrichia. The spirotrichia is somatic ciliature often reduced. Buccal ciliature well developed. Adoral Zone of Membranelles (AZM) was winding clockwise to the cytostome, often large sized. It includes six orders such as:
1. Heterotrichida have somatic ciliature uniformly present, often very large in structure.
2. Oligotrichida have somatic ciliature sparse. AZM is large, often extended round apical end of the body.
3. Tintinnida have loricate but ‘motile’ and large membranelles. They are typically marine, pelagic in nature.
4. Endodiniomorphida have ciliature lacking. Membranelles restricted to small dress. Pellicle stiff and ornamented.
5. Odontostomatida have ciliature sparse, oral ciliature of eight membranelles. Small, laterally compressed.
6. Hypotrichida have ciliature specially modified as cirri, AZM prominent and dorso-ventrally flattened.

Robert, (1978) was created a special monograph on fresh water invertebrates of the United States. He emphasized that the ciliate have four subclasses classified such as holotricha, peritrichia, suctoria and spirotrichia. In spirotrichia ciliation is sparse, cirri, buccal ciliation conspicuous with AZM. Further he has classified microplanktonic forms of zoomastigophorea into eight orders. For example, with three flagella, two of which are trailing, free-swimming or attached and estuarine habitat (*Macromastix* sp.).

Hall, (1964) has classified ancient forms of microplanktonic communities of protozoans from marine environments. In his book “Protozoa-The simplest of all animals” have numbers of illustrated micro-photographs were presented. He stated that the microzooplanktonic protozoan have eight orders.

One of the order foraminiferida have ‘test’. Usually calcareous, sometimes siliceous, foreign particles cemented together to form loria in certain genera. Reticulopodia may extend from major opening (aperture) of the test, or from both aperture and smaller openings like perforate tests. Syngamy known in certain genera showed alternation of mature test with one to many chambers. Radiolarian have porous central capsule and separated from outer to inner cytoplasm containing nuclei in certain genera, no skeletal elements, and some genera have siliceous skeleton Ex. *Eucyrtidium*
sp. In *Acantharia* sp. skeleton containing strontium sulfate, radially arranged spines penetrating perforated capsule, spines emerge in equatorial group and two groups half way between equator and poles representative genus *Acanthometra*.

Dolan *et al.*, (2006) has compared the taxonomically with morphological biodiversity of tintinnids (Planktonic ciliates) from New Caledonia. He classified 26 groups of tintinnids from marine habitat. Tintinnids species identifications were made at ×400 and mostly on the basis of descriptions by Kofoid and Campbell (1929) literature. Taxonomic diversity was estimated from each sample under the Shannon-Wiener Index and calculated species richness. Morphological diversity was estimated by placing species into ‘size’ classes of Lorica Oral Diameter (LOD). From the result microplanktonic forms of tintinnids and its abundance from the lagoon was similar to that of other systems. Taxonomically, the assemblage did not appear to be a predictable assemblage, simply from the location of New Caledonia. Species of tropical or warm-water genera were not dominant, but species is cosmopolitan or neritic genera. *Tintinnopsis* and *Eutintinnus* species dominated from the near shore and mid lagoon stations, respectively. However, metrics of morphological diversity based on LOD were correlated with metrics of taxonomic diversity. Because LOD is related to the size of prey exploited in tintinnids in the lagoon reflects a trophic diversity.

Turley *et al.*, (1986) suggested that, relationship between the *Uronema*, and the slower moving *Euplotes* have more ‘persistent’ strategy, which under the conditions of some experiment favours a stable equilibrium with its food supply. Grazing activities of these two ciliates have an important influence on abundance and size-class structure of their bacterial prey. In the presence of both *Uronema* and *Euplotes*, in same habitat, there is some evidence of an initial removal of large rods and squat rod bacteria, followed by removal of the smaller cocci before the initial population of bacteria is consumed. This is followed by the appearance of a secondary bacterial assemblage, which associated only with the development of the grazing ciliates and is dominated by small thin rods. Hence, as much as ‘73% to 81% of the carbon ingested’ by microzooplanktonic forms with the bacterial food is dissipated through respiration and excretion.
Novarino et al., (2001) given the details of loricate mixotrophic nanoflagellates from the plankton simple of the Western Mediterranean Sea. He used transmission and scanning electron microscopy for internal observation. It includes taxa are conspecific with Ollicola vangoorii. By contrast Ollicola pascheri is best maintained as a separate species and retained in the genus. From the ultrastructural viewpoint, the basic architecture of the lorica is ‘fibrillar ribbon coiled’ around the cell and eventually hardened as a result of inorganic mineralization from the environment. The cell apex is modified as newly documented apical cytostome. Hence the presence of an external lorica increases the probability of intercepting prey, ready to be ingested by the cell, in the apical cytostome.

Wickham et al., (2000) have developed new technique for enumeration of microzooplanktonic forms includes benthic ciliates under the laboratory condition. Earlier technique was combined two basic steps. Identify and count pelagic ciliates and benthic flagellates.

This method is centrifugation to separate ciliates from sediment, and the quantitative protargol stain silver- staining technique to stain the cilia and nuclei of ciliates which, after centrifugation are concentrated on cellulose nitrate filters. This is suitable for studying both the natural distribution and diversity of protozoa, microcrustaceans and all benthic forms and their response to experimental works. Glutaraldehyde was used as a fixative because ‘percoll’ forms a gel; too dense to pass through a filter at a pH less than 4.5 such as acidic fixatives Bouin’s or Lugol’s staining. Protargol is a silver proteinate stain, which stains cilia as well as internal structures such as microtubule, extrusomes and nuclei. This stain was subsequently fixed with ‘sodium thiosulfate’ and the cells were dehydrated with an alcohol series. He also investigated predator- prey interations at both a broad and fine taxonomic scale.

Paffenhofner, (1979) investigated the laboratory culture of marine microzooplankton and its contribution to the studies of ‘marine planktonic food webs’. He differentiates the various types of zooplankton cultivation techniques under the three categories: maintenance, rearing and culturing. Planktonic foraminifera and
radiolarian have apparently not yet been cultured in the laboratory. Microflagellates such as *Isochrysis galbana* appeared to be adequate food for tintinnid ciliates in the laboratory condition and subsequently various species of tintininds have been cultured on such type of diets. *Tintinnopsis* sp. multiplied at 10°C in a defined seawater substitute medium feeding on a mixture of bacteria-free cultures. *Favella campanula* and *Tintinnopsis tubulosa* uses the same phytoflagellates as food with the addition of the dinoflagellates. In this study, it was found that *F. campanula* in culture exhibited an abnormal morphology. For example, the lorica structure was modified in *in-vitro* condition; the length of lorica was 132µm in cultured animals, as compared with 197 µm and 212 µm for animals from surface and below surface plankton samples.

Hence, decline in tintinnid culture, was due to the failure of conjugation. Another tintinnid, *Stenosemella nivalis* was cultured at 18° to 20°C in screw-cap tubes with *Monochrysis* sp. Maximum ciliate densities approached to 50 animals. He found that ‘high food concentration lead to a reduced ciliate density’. In contrast to the neritic tintininds that have proved amenable to laboratory culture a species of pelagic hymenostome ciliate of the genus *Uronema*. Further he emphasized that *Tintinnopsis*, where the importance of high temperature survivor. This protozoan cannot feed effectively on free bacteria in the sea. Few planktonic rotifers are found in marine waters, most forms being found near shore or in ‘brackish’ water originating from euryhaline freshwater species. Rotifers have been used extensively to provide a food source for fish larval rearing but the species used are not “strictly planktonic” The rotifer *Brachionus plicatilis* was cultured at 21 to 25°C in large volume, 464 liter containers using actively growing *Dunaliella* sp. as food. High food concentrations of about 10^6 cells ml^{-1} seemed to be the key factor in maintaining a constant high yield of rotifers. Aeration, 14hrs illumination per day, and sufficient nutrients to ensure growth of *Dunaliella* were needed. He has maintained a high production rate of individuals. It is necessary to optimize amitotic (parthenogenetic) reproduction.

Stoecker *et al.*, (1994) have estimated the abundance of microplankton with several commonly used fixative samples from the north Atlantic and subarctic Pacific oceans. Buffered formaldehyde has the advantage that it allows epifluorescence
microscopy observation. ‘10% lugol’s solution’ more useful than 2% formaldehyde. He observed very practically under the viable techniques. Bouin’s solution yield cell counts are usually similar to those with 10% acid Lugol’s solution, but with ‘less shrinkage’. Further he has compared the effects of various fixatives and cell number in natural microplankton assemblages.

It is difficult to compare fixation losses for individual species or to compare changes in cell volume in natural assemblages, experiments on fixation and preservation of laboratory cultures. It represents the Oligotrichida (Strombidium), the Choreotrichida (Strobilidium) non-loricate and loricate Favella, were performed. Several months later, 100ml sub-samples were concentrated by sedimentation using ‘Utermohl Chambers’ and examined with an inverted microscope. All aloricate ciliates in the settling chambers were enumerated at ×200 magnification. The large mixotroph Laboea strobila was enumerated separately from other cone-shaped ciliates. For Strombidium capitatum and Favella sp. cell volumes with 10% acid lugol’s solution were significantly lower than with 5% acid Lugol’s solution. For all three species, cell volume with 2%, 5% and 10% acid lugol’s solution was significantly lower than with 2% buffered formaldehyde. Hence, ‘5 % to 10% Bouin’s solution’ were significantly higher count of microzooplanktonic forms in the sample than those preserved with 10% acid lugol’s solution.

Johansson and Jonsson, (1997) studied the behavior of Euplotes sp. He observed the movement for gathering the prey in critical condition. Further, the ability of a marine benthic ciliates Euplotes sp. to found patches of food exploit them and leave for new patches were learned in both still water and flume flow. The ciliates efficiently accumulated in patches of food independent of flow. Euplotes sp. walked on surfaces with bundles of cilia, cirri and when swimming they moved in a helix direction. Also, he has conducted a small scale experiment in still water to observe if Euplotes sp. was attracted to patches of food and to test for discrimination of prey species. Three prey species: the microalgae Rhodomonas baltica, Isocrysis galbana and Chaetoceros calcitrans were compared with a control patch without food. Each treatment was replicated in three times. The analysis of the swimming activity and the
observations of *Eulplotes* sp. in flowing water indicated that this ciliate can use the
flow to find patchily distributed resources.

Faure-Fremiet, (1951) found that many new marine sands ciliates and
psammophilous ciliates from the tidal zone of different beachers in Brittany. He
emphasizes that the cosmopolitan distribution of the marine littoral protozoan species
and inter-granular spaces acts as a selective factor in the distribution of the interstitial
ciliates. Hence, these two categories of ciliate species ‘dwell in the damp sand’ of
marine beaches. Some of these seem to be so closely adapted to ‘interstitial conditions’
that they do not live outside. Some others enter the sand readily and can live in it as
well as anywhere else along the seashore, where they are ordinarily widespread. With
regard to the size of the interstitial sand spaces, which are roughly proportional to the
size of the grains. The sand-dwelling ciliates can be divided into two ecological classes.
In coarse sands, with diameter of the grains above 0.4mm, the meso-poral infusorians
fauna includes a few species of sand-living and many occasional sand-dwelling forms
were present. In fine sands, with diameter of 0.3 to 0.7mm the micro-poral infusorians
fauna is composed of true sand-living ciliate species. In addition, some typical
interstitial species, widespread in fine and coarse sands, are called euryporal.
Comparison of the ciliate interstitial fauna observed in Brittany and Cape Cod beaches
showed that interstitial species are cosmopolitan, and that the distinguishing
characteristics of meso-poral and micro-poral fauna have been generalized by
ecological succession.

Broglio *et al.*, (2001) analysis the swimming behavior of *Strombilidium spiralis*
and *Metacylis* sp. under the laboratory condition. He reports the behavior of *S.spiralis*
was characterized by ‘slow upward and downward’ swimming interrupted by sudden
jumps. But, *Metacylis* sp. (Tintinnina) showed a swimming pattern typical for many
tintinnids, with steep helical trajectories and ‘without jumps’. When *Acartia clausi*
(Copepods) was incubated with 1:1 mixture of both ciliate species showed a higher
predation rate on *Metacylis* sp. It exhibits a 2 fold difference in ingestion rate between
the ciliate species. *S. spiralis* escaped the attacking predator with rapid jumps, while
*Metacylis* sp. lacked any effective behavioral response to the approaching predator.
Alekperov et al., (2006) described the morphological characters of two new strains of ciliates from the Caspian Sea. After Kahl, 1932 description, *Strombidium nabranicum* and *Euplotes khazarica* first was reported by this man. *S.nabranicum* size is 60-80µm, after fixation up 65µm, and acontractile nature. Somatic ciliature consisting of 18-20 dikinetid rows. Body surface covered by multiple silver line system. There are 15 anterial collar and 14 ventral adoral membranelles. He stated that these species differ from all the remaining species of the genus by its unusual multiple silver line system. *E. khazarica* size is 40-55µm, after fixation upto 35µm. Body oval, flattened dorsoventrally. AZM contains 45 elements and occupies the left margin of the ventral side. There are 11 fronto terminal cirri, near two of them which locate upper and 5 transversal cirri. There is small unciliated argentophilic plate present. Four caudal cirri andventral argyrom fine with small argyroconts with polygonal shapes. On the dorsal side, there are five ribs with 5 dorsal kinetics with 18-19 cilia. Endoplasm is clear and uncolored. Macronucleus C-like with small structure. A spherical micronucleus is also observed. *E.khazarica* sp. described above differs from other representatives of this genus by its maximal number of frontoventral cirri-11 and minimal number of dorsal cilia rows. From *E. trisulcatus* view, (Khal,1932) *E.khazarica* is differs in body shape, with a much longer dorsal zone of membranelles, smaller on two numbers of dorsal rows and other type dargyrom.

Wang et al., (2005) studied the effect of spatial constraints on the mobility of six species of marine protozoa. Microfluidic devices were created with small channels similar in size to pore spaces in soil or sediment systems. Individuals from each species of protozoa were tested. They able to rapidly discover and move within the channels. The time required for locating the channel entrance from the source well increased with protozoan size and decreased with channel height.

Protozoa of every species were able to pass constrictions with dimension equal to or smaller than the individual’s unconstrained cross-sectional area. Channel geometry was also an important factor affecting protozoan mobility. *Euplotes plicatum*, *E.vannus* and *Keronopsis* sp. are hypotrichs ciliates. These are commonly found in
polluted environments. Bacterial predators such as *E.vannus* are especially well suited to the micro-fluidic devices. He provided that channel structures ‘strongly affect’ the movement of protozoa. Protozoan behaviors at the pore scale including location of channel openings and navigation along narrow passages are reported for the first time. He found that quantitative measurements of the motility of protozoa in narrow channels. The empirical results and qualitative observations obtained in this study will be helpful in understanding the behavior of protozoa and physical limitations on grazing by protozoa on bacteria in porous media.

Ricci *et al.*, (1982 &1989) compared the specific adaptation to different substrates of microhabitats. He conducted experiments based on two different species belonging to the order of Hypotrichida. These species were chosen for two reasons. They have been kept in cultures at this lab for many years and considered ecologically quite similar in “thigmotactic”, they differ in a number of morphological, physiological features and related to their microhabitats. When conjugating *Oxytricha bifaria* forms a kind of pair in which the partners, ‘fused side by side’, maintain a functional ventral surface roughly twice as large as that of a single cell. A strong specific adaptation of this species to flat substrates might represent the evolutionary element accounting for such an apparently double paradox. The conjugating partners of *E. crassus* on the contrary, fuse part of their ventral surfaces, uniting two by two according to a spatial pattern that is more convenient than that of *O.bifaria* for that exchange of the pronuclei.

The mating area of *O.bifaria* represents an area of the substrate where most complementary cells congregate to interact with each other, according to the series of clear, successive steps of the visible reaction. It leads to the “pair formation” and also a ‘peculiar dance’, frequently mediating their re-encounter. But *E. crassus* mating cloud represents cell-cell interactions between complementary cells occurred. The different behavior of single and paired cells of *O.bifaria* when moving on sand granules with average dimensions of 100-200µm. It bends dorsally and creep from one grain to the next easily, but *E. crassus* passes from one grain to another by not easily. The partner creeping actively on the substrate and he observed that the *E.crassus* partner as the swimming entity of the pair.
Christoffersen et al., (1990) observe in detailed the microzooplankton ingestion rate such as nauplii forms, rotifers and ciliates in the eutrophic system. He reported that larger than 50µm ciliates ingested low amounts of bacteria and removed 10-16% of bacterial carbon and ciliates smaller than 50µm removed 19-39% of bacterial production, than heterotrophic nanoflagellates in a eutrophic lake during a bloom of cyanobacteria. Hence protozoan ciliates are an important link between bacteria and higher trophic level. He stated that larger crustaceans species to decrease in numbers during severe blooms of cyanobacteria and are replaced by smaller species, which are able to feed on pico-and nanoplankton. Bacteria, flagellates and small ciliates were considered as significant components of aquatic water food webs. These microheterotrophic organisms feed on bacterioplankton and form “microbial loop’ to the traditional grazer food chain.

Chao et al., (2006) recorded 964 soil ciliate species from five continents- Africa, Asia, Australia, European and South America. Accurate point estimation is not feasible due to several under sampling the statistical model enables us to obtain a minimum regional diversity and global species diversity.

Soil ciliate distributions between continent pairs are analyzed by adjusted abundance-based similarity indices. The analysis of distribution, similarity or dissimilarity indices provided quantitative measures by comparing species composition in two or more habitats. A variety of similarity indices such as ‘Jaccard and Sorensen’ used. They framed the following properties:
1. Species abundances are incorporated and community-level indices
2. Under sampling bias can be largely removed and indices are less sensitive to sample size.
3. Sampling errors can be assessed to construct confidence intervals.

Felip et al., (1999) monitored Oligotrichs an average of 43% of total ciliate biomass dominated in the ciliate community; other groups (Gymnostomatida and Prostomatida) constituted a sizeable proportion in the Estany Redo, Pyrenees. He
included Colpodea, Prostomatida, Gymnostomatida, Hymenostomata, Oligotrichida, Suctoria and Non-identified ciliates.

Gifford, (1985) developed culture medium for marine microplanktonic forms such as oligorichs. Successful laboratory culture was done by the function of appropriate phytoplankton food and the chemical composition. The genera Strombidium and Strombidinopsis are a pre-requisite for making measurements of physiological rates under controlled conditions. Such physiological rates and functions for the microzooplankton are not well known. The important oligotrich cultures were handled and disturbed as little as possible. Cultures were examined under the dissecting microscope and food was added as necessary and typically at 4 to 7 days intervals. Cultures were maintained in the medium and fed a mixture of the 2 phytoplankton strains which resulted in maximum growth rates during the isolation procedure. Debris was removed from the bottom of the culture vessels and from the surface of the medium with a pasteur pipette, as necessary.

To cultures transfer, a portion of the culture volume was poured gently into another vessel, and both vessels were brought to full volume by addition of medium. Subsamples of successful cultures were collected on weekly basis and the ciliates enumerated.

Agatha, (2004) selected and discussed more than 23 characters through Hennig’s method with computer programs of cladistic approach. Five characters from morphology of oral apparaturs, eight characters from somatic ciliature, four from special organelles and six characters from ontogenetic particulars. Several new features were included into the analyses of the cladogram match other morphological trees in the monophyly of oligotrichaea, halteria and choreotrichida. He suggested that cladistic approaches have paraphyly of the family Strombidiidae, due to the scarce knowledge. A revised classification of the oligorichea is suggested. It includes all sufficiently known families and genera. Further, cladograms inferred from gene sequence data. The Oligotrichia comprise at least 19 sufficiently known genera with about 180 species, while gene sequences are available from about twenty Choreotrichida and ten
Oligotrichida species from the genera of *Strombidium*, *Laboea*, *Novistrombidium* and *Spirostrombidium*. Due to under sampling and unequal sampling, the gene trees are not comparable with the morphology based cladistic approach at familial and generic level. All molecular trees differ from the morphological cladograms in the position of the halteriids. They consistently revealed that *Halteria grandinella* not as an early branch of the Stichotrichs, but within this taxon as sister group to *Oxytricha granulifera*.

Song *et al.*, (2002) investigated and redescribed the morphology and infraciliature of four marine hypotrichous ciliates. *Bakuella agamalievi*, *Pseudokeronopsis flavicans*, *Holosticha heterofoissneri* and *Cyrtohymena marina* collected from the coastal water of Qingdao, China.

*Pseudokeronopsis flavicans* is characterized by yellow-coloured, flexible body, *in-vivo* × 200-300, 40-55µm that is slender ribbon-shape with a narrowed caudal portion, a bicorona comprising 5-9 pairs of frontal cirri, one buccal, 2 fontoterminal and 3-6 transverse cirri. Mid-ventral rows consisting of about 25-40 pairs of cirri which terminate caudally about 15µm above the inconspicuous transverse cirri, 46-66 adoral membranelles on average, 52 left and 60 right marginal cirri, 3-4 dorsal kineties, numerous macro nuclear segments, colorless, sub-pellicular blood-cell shape, granules distributed over whole cell and bright yellow-brownish cortical granules grouped around cilia or cirri. One contractile vacuole lying in anterior 2/5 of body. The diagnosis for *Bakuella agamalievi* is ×100-150, 30-50 µm *in-vivo* with elongated body shape about 30 adoral membranelles, on average 33 left and 43 right marginal cirri, 4-7 fronto-terminal, 4 frontal, one buccal and 4-7 transverse cirri. *Holosticha heterofoissneri* is slender, fusiform body, 14-21 macronuclear segments forming an elongate U-shape, single and post-equatorial contractile vacuole. Finally, *Cyrtohymena marina* is also characterized. The body is elongate oval to long elliptical shape, ×100-150, 30-50µm *in-vivo*, one pre-equatorially positioned contractile vacuole, and 32-42 AZM.
Hu & Song, (2000 & 2001) studied by using protargol impregnation staining for live observation. *Pseudokeronopsis pararubra* and *Amphisiella annulata* collected from the coastal waters of Tsingtao, China. *Pseudokeronopsis pararubra* is reddish in colour and 64-92 AZM. The *Amphisiella annulata* with some marine congener has been provided in this study. The amphisiellid have median cirral rows were distinctly present.

Xu *et al.*, (2006) was studied the morphology and infraciliature of two marine Oligotrich ciliates, such as *Spirostrombidium agathae* and *S.schizostomum* were isolated from the litteral zone of coastal waters near Qingdao, China. The new species *S.agathae* is distinguished from its congener by the following combination of characters. It is small size, distribution of extrusomes, presence of two prolonged thigmotactic membranelles, number of anterior and ventral membranelles and number of dikinetids in girdle and ventral kineties. The ciliary pattern of *Strombidium schizostomum*, which has been not reported.

Curds, (1975) written a special monograph under the title of “A guide to the species of the genus *Euplotes* (Hypotrichida, Ciliatea). He has described all the species of Order: Euplotida. Further, he explained the taxonomical details, general features and infraciliature of *Euplotes* species. *Euplotes* are very frequently observed in both marine and freshwater samples. It is an often used for the protozoologist to make specific identifications. *Euplotes* identification is very difficult due to two major factors. 1, Known to vary within clonal cultures. 2, Confusion in the literature for identification. *Euplotes* species as a strict taxonomic character and known to be ‘euryhaline nature’. Dorsal and ventral ridges are sometime value for species determination particularly when comparing modern preparations with early descriptions, where ridges were often clearly figured. He suggested that the use of nigrosin and formalin method might help create a union of old and new species within the genus.

Horsman, (1985) stated in his book under the title of “The seafarer’s guide to Marine life” most microzooplankton can swim, but they are too small to move ‘against currents’.
Their swimming ability enables them to travel up and down in the water and also migrating from deep water to the surface and back each day. Vertical migration travel may vary in different species. He reported as smaller microcrustaceans travel between 30 and 150 meters from the surface.

Mohoney, (1965) emphasized the soil extract cultures and methods for examining protozoan groups. He includes many algae and some protozoa grown under the soil extract cultures the detritus which can be a disadvantage in some case of soil pluswater cultures. The basic medium is prepared as following the ingrediants. Put some good garden soil. Heat in a steamer for 3hrs, allow the soil to settle and then filter through muslin cloth. Add a little preservative. This stock solution can be kept for several months. Further recommended, to make the medium, use 10 percent of the extract in glass distilled or deionized water put it into culture vessels and autoclave. It is best to make a number of stock soil extracts of different pH values and from soils of different organic contents. He suggested that these are then mixed in various proportions with standard procedures. The pH is measured the day after the medium has been made up. 1, Soil extract 10%, 2, KNO₃ -0.02%, 3K₂HPO₄ -0.002%, 4, MgSO₄ 7H₂O-0.002% with 0.1 % of beef extract.

Grell, (1973) has classified the hypotrichs into three groups. 1,keronopsis, 2,urostyla and 3,stylonychia. Further he has re-described Keroplosisssp. have two ventral of cirri, Urostyla have number of ventral rows of cirri and Stylonychiaasp. have cirri in groups, with bristle-like terminal cirri. In Oligotricha body ciliation is reduced or absent. AZM are present in the anterior region. Ex.strombidium is without equatorial wreath of bristles.

Barnes, (1982) classified and re-described the subclass of ciliates. Spirotricha, which includes some familiar forms such as Stentor, Halteria, Spirostomum and Euplotes are typically suspension feeders also. They usually possess a highly developed adoral zone of many membranelles. In Stentor, the adoral zone wings around the apical pole of the body similar to the buccal ciliature of the Euplotes. The loricate marine
ciliates of the order tintintinida have a crown of pectinate or feathery membranelles with peculiar organelles, called as Tentaculoids, where interspread among them.

Jomas, (1997) has classified the phylum zoomastigophora in very convenient manner. Three orders of flagellate members are frequently found in the marine plankton community. In protozoan systematic, choanoflagellidea (with collared cells) contains almost invariably colorless species. Cell shape is oval with a single flagellum encircled at the base and a collar composed by fine pseudopodia. The cell covered by lorica. It composed of silica rods, costal strips and taxonomy is based almost solely on the lorica morphology. The loricate species are usually identified from the dimensions and construction of the loricas and most relevant method is to study dry mounts in the light microscope. Kinetoplastida cells showed pyriform and some species are exceedingly flattened. Flagella are very heterodynamic nature. Often zooflagellate species are coastal and littoral areas. The apparent lack of species identified in offshore waters probably reflects inadequate preservation methods. He reports on the Ebridea cells naked with two flagella and an internal siliceous skeleton.

Wood, (1972) observed many characteristic features of planktonic ciliates and coral associated ciliates from the sediments. Planktonic ciliates confined to holozoic nutrition and require other organisms.

The Tintinoidea are characterized by being encased in a sheath or lorica, the front end of which is always open, and out of which the cilia are extruded. In sediment associated ciliates, usually abundant in grains on the lorica. With the sediments, where some species graze on the surface plants, micro-organisms including bacteria, while others, example Euplotes, live in an anaerobic environments, feeding on bacteria and colourless flagellates. He suggested that Euplotes grown on synthetic cultures of Desulphovibrio at a redox potential of -270mV in a medium with no organic constituents other than the bacteria and their products of metabolism. The ecological importance of the ciliates in these environments in ‘Clearing Polluted Waters’. He found that Colpidium and Paramecium devoured polluting bacteria, but tended to die out on a strictly bacterial diet. In Sarcodina, the two important groups in this class are
the Foraminifera and the Radiolaria, having calcareous and siliceous tests or skeletons present. These organisms occur in the plankton community, where they are very numerous in specific environmental conditions. In shallow waters, the tests sink to the bottom, forming ‘oozes’, often composed of one genus or species, Example *Globigerina ooe*. The ocean floor is covered with foraminiferal oozes may be gauged by a glance at navigational charts, where they are distinguished by the letters. These ooze consolidate to form limestones, cherts, or jaspers, so that the rhizopod section of the Sarcodina are of great geological significance. Naked sarcodina are also to be found in the microzooplankton community quite numerous. Planktonic foraminifera are only now receiving the attention they deserve. He concluded that foraminifera are usually present but sparsely distributed in coral seas. Microzooplanktons are also quite frequently attached to algae including the ‘kelps’. The vast concentrations of foraminifera and radiolarian in sediments and sedimentary rocks would not seem to be reproducible at the present time. The nutrition of these organisms is holozoic, and they ingest particulate matter including diatoms.

Also, he has found apparently living foraminifera in some sediments taken during the galathea expedition from a depth of 7,400m in the Weber Deep, suggested that they may be ‘autochthonous’ on the surface of even the deepest sediments.

Austin, (1988) has classified the epipelagic microzooplankton from the marine habitat. In photic zone, Radiolarida and Foraminiferida were predominantly present in spring of the year. He also reported that ciliates are especially common in shallow benthic habitats and marine sands. But amoebae are quite rare in such environments.

Lawal-Are *et al.*, (2010) recorded and re-described the microcrustacean forms such as juvenile stages of nauplii were dominated in the Lagos, Nigeria. The arthropods which were the most abundant accounted for 1,465 individuals which gave 59.31% of the total individuals. The Chordates recorded 5 (0.20%), the Cnidarians recorded 70 (2.83%), the Chaetognatha recorded 20 (0.81%). The juvenile stages comprised the Barnacle nauplii, Copepod naupliii, Fig egg and Fish larva which made up 36.84% of the total individuals recorded.
Graneli & Johansson, (2003) studied the growth and feeding response of the ciliate *Euplotes affinis* when exposed to algal cultures of *Prymnesium parvum* and *Rhodomonas baltica* as monocultures or as mixtures. The response of *E. affinis* to different mixtures of *Prymnesium parvum* and *Rhodomonas baltica* were studied in multiwells. *E. affinis* strains were incubated together with *R. baltica*. In order to test the differences in indirect growth response of *E. affinis* related to nutrient conditions of the water. From this result, he concluded that ciliates (*E. affinis*) grew well when fed only *Rhodomonas baltica* but avoided grazing on monocultures of *P. parvum*, regardless of algal concentration.

Ashraf et al., (2010) observed that, there was no selective mortality in ciliates of particular Hypotrichs at any stage in Rotifers (*Brachionus calyciflorus*) batch culture. Nevertheless both ciliates and rotifers were dead at 0.2ppm. Rotifers and ciliates are microzooplanktonic forms, but the “compete” for feed with rotifers. Halotricha and hypotricha ciliates such as *Uronema* sp. and *Euplotes* sp. are not desired in intensive cultures. The appearance of these organisms is generally due to sub-optimal rearing conditions. Ciliates produce metabolic wastes which increase the NO$_2$–N level in the water and cause a decrease in the pH.

Lie et al., (1997) found that microzooplanktonic forms like *Brachionus plicatilis*; transferred to the microalgae tank *Isochrysis galbana* feeding had a positive effect on nutritional value rather than baker’s yeast. Because, such species produced lipid-soluble vitamins. Most of the minerals and trace elements were unaffected by the transfer to *I. galbana*, but, Fe, Mn, As and Cd increased, Cu and Ni decreased, whereas the effect on Cr and Mo were uncertain. Lysine, Serine and Proline, all amino acid levels seemed to be unaffected by the transfer to *I. galbana*.

Bernard & Rassoulzadegan, (1990) has observed the special vacuole contents of the oligotrichous ciliates such as *Strombidium sulcatum* fed 12 different types of food. He determined the turnover time of food vacuoles as a function of ‘prey quality and size’. The grazing ratesand filtration, also volume specific clearance as a function of
prey quality and size. His finding indicated that shortest feeding turnover time for 2.5 μm prey (*Nannochloris* sp.).

Gast & Horstmann (1983) found that hypotrich ciliates when fed *Dunaliella tertiolecta* excreted more ammonia $0.41 \times 10^{-5}$ in the culture medium rather than *Vibrio* sp. When bacteria (*Vibrio* sp.) were offered as food a small NH$_4$ peak was observed after 9.5 hrs. The interaction between ciliates and bacteria appears complicated.

Burkill *et al.*, (1987) has investigated the microzooplankton grazing activity from the Celtic Sea. He used a dilution technique to high performance liquid chromatographic (HPLC) analysis in phytoplankton. Water samples were obtained either from the sub-surface or from thermocline region. Samples were prefiltered through 200μm gauze to remove macroplankton and made up to 1 litre volumes in triplicate in a dilution series. Samples for pigment analysis and counts were taken before and after incubation from each grazing bottle. Microscopic counts of microzooplankton and phytoplankton were made from samples preserved with glutaraldehyde or lugol’s iodine fixative in settled volumes of between 40 and 100ml by inverted-phase contrast microscopy. The microzooplankton found in the experimental samples was comprised ciliates, choanoflagellates and aloricate colourless flagellates. The ciliates were primary naked oligotrichs (species of *Strombidium, lohmanniella*) although a few tintinnids (*Eutintinus* sp.) were found. These protozoans were more common in the autumn than summer experiments and were present in higher numbers in-shore than offshore. He also found that tintinid may graze particles between 1 and 30μm and in phycobilis-protein analysis report that significant rates of microzooplankton grazing on cyanobacteria.

Capriulo *et al.*, (1988) found that marine ciliates fed large prey-chain forming diatoms than small nano-sized prey. But *Strombidium* sp. with protruding ingested cells at particular times larger than the ciliate predator.

Jonsson, (1986) found that oligorichous ciliates fed in the ‘size range’ of autotrophic and heterotrophic microflagellates. *Strombidium vestitum* 2.1μm,
Strombidium reticulatum 7.9µm and Lohmanniella spiralis has fed 9.7 sized preys ingested, but that they were incapable of effective ingestion of bacterioplankton.

Gransden and Lewitus, (2003) have observed the ciliate growth and grazing parameters on cryptophyte monocultures. Pfiesteria piscicida was significantly higher with Euplotes woodruffi than E.vannus. This study examined the grazing properties of two benthic ciliates (Euplotes vannus and E.woodruffi) on Pfiesteria piscicida and Cryptoperidiniopsis sp. another heterotrophic dinoflagellates that morphological resembles and often co-occurs with Pfiesteria spp. He reports on E.woodruffi are found in a number of aquatic environments including salt marshes, marine surface, benthic habitats, and estuarine rocky shore and bottom waters.

Guella et al., (1996) discovered the Euplotin-C compound from marine hypotrichs. The most abundant of terpenoids of the marine ciliate morpho-species Euplotes crassus was found in salt marshes. It undergoes degradation by hydrolysis of the acetate group. These processes may be assumed to mimic inactivation of the euplotins in the sea water. He also used degradation of stronger base and acidic medium for analysis of such compound.

Dini et al., (1993) suggested that Euplotes crassus have important structural and functional roles in the marine littoral ecosystem. The remarkable ability of the bulk of E. crassus populations directly with changing environmental conditions by homeostatic properties. It plays a role in determining the higher ecological valence of this morphospecies. He reported that a novel factor, effective in biologically ‘active terpenes’ occurring in the E.crassus. Eupotins producers are resistant, non-producers are sensitive.

This strain responsible for the high reactivity of the euplotins, leading to efficient ‘cell-to-cell contact inhibition’ and quick loss of information through the medium due to rapid euplotin degradation.
Savoia et al., (2004) discovered that Euplotes crassus produce exclusive terpenoids. They assessed against the protozoa Leishmania major, Leishmania infantum, the fungus Candida albicans, nine strains of gram-positive and gram-negative microorganisms. An activity of Euplotin-C against Leishmania sp. was measured by LD50 value 4.6-8.1µl/ml. While, the effect was less evident on Candida sp. and nearly absent on bacteria. This study provided the details for other similar natural products from other species.

Bourne et al., (2008) has isolated new ciliate groups from brown band disease of corals from the marine system. He identified a new species belonging to the class oligohymenophorea, subclass scuticociliatia. This protozoan microzooplanktonic sediment groups presence of large numbers of intracellular dinoflagellates. The structural features characterized by uniform ciliature except for three distinct cilia in the caudal region. Ciliates collected from coral specimens were processed for microscopic analysis by fixation in Bouin’s solution and stored in the dark room at 4°C or kept at -80°C until DNA was extracted. High densities of intracellular zooxanthellae were observed within all ciliates. The length of the ciliate ranged from 200 to 400µm, while the width ranged from 20 to 50µm. He used conserved eukaryotic primers (18S- 6-CIL-V) for sequencing. The nucleotide sequence data have been submitted to the Gen Bank nucleotide sequence database and got accession number for this study.

Rochelle, (2004) developed molecular protocols for detection of protozoa in the environmental water samples. Giardia duodenalis and Cryptosporidium parvum have been the causative agents of many water borne disease outbreaks with hundreds of thousands of illnesses and some deaths, attributed to their presence in drinking water. C. parvum is particularly systematic for water utilities because it is common in surface waters (rivers and lakes) and the oocyst stage of the parasite, which is found in environmental waters is resistant to ‘chlorine disinfection’, at the concentrations typically applied during drinking water treatment. Acanthamoeba sp. is common in marine environments as well as air, dust, plumbing and ventilation systems associated with human habitation. They are opportunistic pathogens that cause chronic nervous system disease in immune compromised individuals, pneumonitis and keratitis. The
most frequently used filters such as nominal porosity polypropylene yarn filters for large volumes, 1µm absolute porosity high volume samples for 10 to 200 liters were used. Following filtration, cysts and oocysts are recovered from ‘Envirochek’ filters by vigorous agitation in an elution buffer. Genotyping has also been applied in non-outbreak situation. In this study using RFLP analysis of a variety of specific amplification, 33% if C. parvum-positive human samples were genotype 1 and 67% were genotype 2 was observed. This genetic variation between isolates within a species can be displayed by restriction fragment length polymorphism (RFLP) analysis of amplification immediately following PCR.

Snoeyenbos-West et al., (2004) analysed small subunit ribosomal DNA sequences to evaluate both the monophyly of the ciliate class phyllopharyngea and relationship among subclasses.

The classification based on morphology and ultrastructure. It divides the phyllopharyngea into four subclasses, the phyllopharyngia, chonotrichia, rhynchodia and suctoria. He re-described the phylogeny Cho notrichia: Isochona sp. provides strong support for the monophyly of the phyllopharyngia 1 and showed that the cho notrichia emerge from the ‘within’ the phyllopharyngia. Phylogenetic analysis of group I introns suggested that a complex evolutionary history involving either multiple loses or gains of introns within endogenously budding Suctoria.

Modeo et al., (2006) has re-described the ciliate Chattonidium setense combining morphological observations with behavioral notes and molecular data. Ultra structural analysis revealed that remarkable similarities between Chattonidium and representative members of the class Heterotrichia in cortical structure and cytoplasmic organization. Relatedness verified by 18S rRNA genes from Chattonidium and from one Condylostoma species were sequenced. The presence of the aboral cavity complex, a unique feature never described in other ciliates. He has used to collect the strains in twice during sampling in ‘tidal pool’. The 18S rDNA amplification and sequencing were followed. DNA extraction, only five starved individuals were picked up with a micropipette and repeatedly washed in sterilized 33ppt sea water to completely remove
food contaminants. His technical procedure was practically very useful for sequence analysis.

Paiva et al., (2009) suggested the reconsideration of both Convergent and Evolution of Urostylids & Uroleptids (CEUU) and position of ‘Halteria among flexible-body Oxytrichids’. The polyphyly of Oxytricha was not rejected. Stichotrich ciliates have some remarkable contradictions of morphology based classification such as CEUU and Halteria paradox.

He has hypothesized the internal phylogeny of 18S rDNA from 53 morphological species of stichotrichs and their relationship with Hypotrichia and Oligotrichia using parsimony and neighbor joining methods, including new data from Pseudo-uroleptus caudatus and Strongylidium pseudocrassum.

Florian and Klein, (1996) found that two apparent micro-nuclear precursors exist for EFA1. The macro nuclear genome of Euplotes crassus contains two different genes. One of these gene is not processed into a macro-nuclear gene and has accumulated C-T transitions in a limited section of the coding region. The true EFA1 precursors harbors. The novel type of internal sequence comparative sequence analysis of the two micro nuclear EFA1 genes have shown that they are ‘very similar’.

Chen et al., (2002 & 2003) studied the Uronychia morpho-species under the protargol impregnation staining. U.transfuga is differ from others, because large cells size, more macro nuclear segments etc. By contrast, U.setigera and U.binucleata are very similar and difficult to separate based only on their morphologies. Random Amplified Polymorphic DNA (RAPD) was used to confirm the division between them. Using 4 different random primers, the RAPD finger printing revealed 3 distinct patterns. According to their molecular analyses the ‘Uronychia-populations comprised at 3- taxa morpho species’. Moreover the morphological similar U.setigera and U. binucleata could be separated. Further, he investigated and sequenced the hypotrichous ciliates, Aspidisca steini and Euplotes vannus. The genera forms a
monophyletic clade groups. Euplotid clade at a long level with strong boot strap was supported in both distance matrix and maximum parsimony tree construction method.

Protozoologists classified as *Euplotes* and its relatives with other ‘highly developed’ ciliates under the hypotrichs family. Based upon ultra-structural characteristics of the dikinetid, euplotids come under the subclass of Nassophorea. He emphasized on the contrary, *Euplotidium* species, placed in the family Gastrocirripidae, and might be more closely related to *Uronychia-Disphrys* than to the *Aspidisca-Euplotes* group.

Song *et al.*, (2004) has re-described the *Uronychia* and related *Euplotids* based on 18SrRNA gene sequence analysis. He compared the traditional Order Euplotida might comprised 3 paraphyletic groups. 1, Euplotids with a 5 cirral anlagen, 2, Gastrocirrhids and 3, Discocephalids which is convergent lineagase.

### 2.2 National Status:

Thirunavukkarasu *et al.*, (2009) has developed new technique to culture the Seabass using microzooplanktonic rotifers in the coastal water system. Seabass is protandrous hermaphrodite fish. They are males during early stage of its life cycle and become females in later period. Reproductive system is very much complicated in hermaphrodite fishes since they go through different phases hormone secretion which is responsible for gonadal development. Planktonic rotifers (*Brachionus plicatilis*) are given as feed to the fish larvae forms on 3rd day it self. Rotifer is maintained in the larval rearing tanks at concentration at the rate 5 nos./ml initially. From 4th day to 15th day the rotifer concentration is increased to 10-20 nos./ml gradually. He used every day after water exchange, the food concentration in the tank should be assessed and fresh rotifers should be added to the required concentration. In the early stages (3-5 days) the larvae may not be in a position to ingest the large sized rotifers. Hence, after collecting the rotifers from the tanks, small sized rotifer less than 1500µm should be sieved using suitable mesh size bolting cloth nets. From 6th day assorted size rotifer can be given as feed. The rotifers can be enriched with special enrichment media. Further he has
emphasized that *Moina* sp. as a Cladoceran can also be fed to the seabass larvae after hatchling days.

Ambasankar *et al.*, (2009) studied the nutritional requirement of larvae of Seaboss. Seabass have a body mass less than few milligrams are not very much understood. Based on the composition of the yolk the larvae withstand for long days. It is assumed that the nutritional requirements of larvae were higher than those of the ‘juveniles’. The nutritional requirement is not similar for larvae and juveniles. Indeed, a dietary formulation sustaining good growth in juveniles induces poor results in larval growth and survival.

He examined the requirements for protein in *Lates calcarifer* diets. He suggested a relatively high protein requirement, consistent with carnivorous and piscivorous nature of the fish. Seabass being highly carnivorous showed a dietary requirement of 45-55% protein. Experiments conducted in CIBA in Chennai, with different level protein feeds on the young-ones of Seabass showed a protein requirement of 43% for this fish. The requirements for methionine, lysine and arginine have also been determined to be about 2.2%, 4.9% and 3.8% of dietary protein respectively. Seabass have no specific requirement for dietary carbohydrates. Research findings inferred that carbohydrate as gelatinized bread flour had some capacity to provide dietary energy to *Lates calcarifer* than marine microzooplanktonic forms like rotifer species.

Sekar *et al.*, (2009) measured the different parameters of Thoothukudi coastal areas, under the influences of industrial pollution. Dissolved Oxygen (DO) concentration was varied from 1.00 to 4.910ml/L. The DO minimum was recorded during November 2007 and the maximum was recorded during January 2008. The levels of DO recorded in this study, where compared with the work and carried out by Rajasegar *et al.*, (2004). It clearly indicates that the water at Tuticorin areas are polluted by the effluent discharge from the surrounding Industries. Ammonia concentration was varied from 0.700 µmol/L to 38.409 µmol/L. The high values of ammonia observed in all the stations except station Tuticorin-TPS may be attributed to the new type raw
sewage and effluents entering here. Low concentration of inorganic phosphate was observed during the post-monsoon seasons may be due to the decreased land drainage and sewage disposal.

Vengadeshaperumal et al., (2010) to develop new procedures for culture of marine larval forms based on Chlorella sp. Nannochloropsis salina and Isochrysis galbana. Microplanktonic nauplii density was maintained 24.123org./l from the 2 months culture period, whereas copepods 10.564org./l. The report of biochemical constituents like protein 63.85%, lipid 16.92%, and carbohydrates 10.56% in Acartia southwelli species, whereas, in Acartia centrura species protein is 63.98%, lipid 17.06% and carbohydrates 10.48%. The A.southwelli and A.centrura were found to be a rich source of polyunsaturated fatty acids (PUFA). From the analysis copepod nauplii have been shown to be a highly advantageous food source for very ‘first larval fish’ and hence the culture copepods and harvest their nauplii essential. When larval ornamentals fish first begin to feed, the larvae are small and consumption of a suitable food is critical for healthy development. He also emphasized, the haptophyte, Isochrysis sp. is a suitable food for ‘all naupliar stages’ and small copepodid stages, which is rich in the highly unsaturated fatty acid that has been proven beneficial to the growth, development and survival of marine fish larvae.

Chattopadhyay and Barik, (2009) recorded few microzooplanktonic forms of protozoan and rotifers from a tropical freshwater lake. In rotifer groups, Branchionus angularis were observed in 44.4%. Simultaneously, Keratella tropica were predominantly presented in this area. The relative abundance was maximum 2.2% for Physarum polycephalum and minimum 0.5% for Didinium nasatum in protozoa, maximum 7.6% for Keratella tropica. Simpson’s diversity indices were used for measurement of valves, such as high scores 0.0925-0.961 for site 1 and 0.905-0.0968 for site 2.

Kumari et al., (1993) has reported the survey of microzooplanktonic community of larval forms like fish eggs and larvae of fish from the oil field of Bombay. They estimated the biochemical constituents as percentage of dry weight were protein 50.1%,

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carbohydrate 2.6% and lipid 23.8% from the marine oil field. This is the first report in India from oil field microzooplanktonic community. Carbohydrate value fluctuated marginally between groups except for the relatively high value 4.84% recorded in crab eggs. Maximum percentage contribution of decapods with dominance of Acetes sp. of larvae at stations 3 probably resulted in the highest value of protein at this station. The difference in various biochemical components between shelled organisms, gelatinous organisms, other crustaceans, fish eggs and larvae were found significant level.

Krishnamoorthy et al., (1999) studied the Meroplankton groups from the Gulf of Mannar areas. They have selected two in-shore stations, Mandapam and Kudankulam along the east-coast of India. Few microcrustacean forms were recorded. Such as Veliger larvae of Molluscs, fish larvae and eggs. They have recorded few species microzooplanktonic larval forms from the Gulf of Mannar. They encountered highest species diversity in Mandapam areas. Dominance index (79.3>74.6>71.6) was found maximum at station 2 followed by station 1 and station 3 denoted protective nature of coral bed for these young ones at Gulf of Mannar and Palk Bay. Nauplius, Veliger larvae of Gastropods and Bivalves and fish larvae were recorded in pre-monsoon at station 1 in September, 1994. Nutrients such as nitrate, phosphate and silicate showed negative relationship with richness and dominance.

Mishra and Panigrahya (1999) quantified the diversity of protozoan tintinnids from the Bahnda estuary, Orissa, East coast of India. About 23 species of 12 genera were encountered. Tintinopsis and Favella were dominant groups. Population of tintinnids ranged from 650-16,500 organisms m$^{-3}$. Some physico-chemical character like salinity ‘highly’ influenced the diversity of population. The data of diversity of tintinnids were obtained from Shannon-Wiener diversity index.

Godhantaraman and Krishnamurthy, (1997) have conducted many experiments on feeding activity of rotifers and estimated tintinnid diversity. When prey size decrease in the rotifers, ingestion rates were increased. Tintinnids were fed only nanophytoplankters of cell width less than 30µm, but rotifers preferred to take ‘cyanobacterial strains’ rather than microalgae forms. Brachionus plicatilis and
Keratella sp. were ingested the *Phormidium fragile* strain. Hence, tintinnids the lorical diameter plays an important role in the selection of prey species. Further he has estimated the production rates of tintinnids in tropical estuarine and mangrove waters of Parangipettai, southeast coast of India. Totally 47 species from 14 genera were identified. *Codonellopsis, Stenosemella, Favella and Eutintinnus* most abundant in this water. The trophodynamic role of tintinnids was assessed by estimating their grazing impact as daily removal of phytoplankton biomass. In summer, high concentration of food supply available. Hence, tintinnids play an important role to transfer the production of pico-and nanoplankton to meso-and macrometazoan predators. Finally, he reported the qualitatively and quantitative analyzed the microzooplankton commonly across a brackish-water lagoonal system from Japan. He studied eight stations in Lake-Shinji-Ohashi, river-lake Nakaumi brackish-water system of Japan. Naked ciliates 39.6% followed tintinnids 30.3%, Copepods (nauplii) 24.6% and rotifer 5.5%. Naked ciliates occurred overwhelmingly in Lake Shinji where salinity is lower than Lake Nakaumi. In these area, nearly 49 species of microzooplanktonic tintinnids were identified. Tintinnids species were associated with species-specific temperature, salinity and tolerance. But microzooplankton biomass remained moderate than mesozooplankton.

Reddy *et al.*, (2011) studied the 24 group of zooplankton from the coastal waters of Adubidri, Karnataka. In this analysis, copepods formed the dominant groups. The ‘columnar’ waters were collected at each station by using bongo net with 200µm mesh size. The samples were fixed in 4% formalin on board in the vessel and later preserved in 2% formalin. Salinity ranged from minimum of 31.3 ppt to a maximum of 35% ppt. Tintinnids were the single major group recorded under protozoa. The number of tintinnids varied from 725/m³ to 121750m³, copepod eggs that seen in ‘bunch’ constituted a major groups among microzooplankon. The group larvae comprised of mainly larvae of copepods barnacles, echinoderms, bivalves, polychaetes, decapods and fish. Higher numerical abundance of fish larvae was recorded in this study.

Rao *et al.*, (2002) estimated the total protein, carbohydrate and lipid of zooplankton biomass, from Visakhapatnam harbor water. In microzooplanktonic part, tintinnids and decapods formed dominant groups of total planktonic forms. Protein
formed the major component, varied from 233.6 to 563 mg $g^{-1}$, Lipid varied from 61.2 to 181mg $g^{-1}$ and carbohydrates ranged from 65.5 to 127mg $g^{-1}$. Higher values were recorded only high salinity areas, during the pre-monsoon and post monsoon periods.

Chandrasekaran et al., (2008) investigated the bio invasion species of Rhodophyta: Solieriaeae, Kappaphycus alvarezii on the corals and coral associated organisms. Bio invasive species are the greatest and significant threat to marine biodiversity especially marine ciliates and marine derived bio resources. Kappaphycus sp. was introduced into the coastal ecosystem for commercial production of carrageenan. The Gulf of Mannar is rich in diversity of corals especially in three genera viz, Acropora, Montipora and Porites.

This study clearly indicated that very specifically invaded the Acopora sp. and ‘associated microplanktonic forms’. Kurusadai Island, Mandapam and Kellakkarai abundant variety of Acropora present. He emphasized that, if loss this variety due to bio invasion, certain microzooplankton forms also destroyed in these areas. His finding disagree with earlier arguments and assumptions that the algae being as coral- friendly as well as suitable for commercial cultivation under wild in the Gulf of Mannar.

Jyothibabu et al., (2003) has studied the biomass production of microzooplankton at five oceanic stations from the Bay of Bengal and Andaman Sea. Throughout the study protozoans dominated the microzooplankton community about 88%. Tintinnids 36 species belonging to 24 genera were recorded. Most of the genera showed their presence within the 150m water column. Salpingella and Salpingacantha were restricted to 75-100m. He emphasized that, dinoflagellates are considered as an important component of microzooplankton community based on the current understands of the ‘mode of nutrition of this group’ where only six species are proved. Micro metazoans (larval stages of metazoans) and other minor taxa of protozoans were identified up to the group level. Protozoans consisted mainly of ciliates, heterotrophic flagellates (few dinoflagellates), acantharians, radiolarians and foraminiferan. Micro metazoans included nauplii and other copepodide stages of copepods and other metazoan larval forms. He reported among ciliates, tintinnids comprisemainly
represented by *Eutintinus fraknoi*, *Undella* sp. *Rhabdonella*, *Salpingella*, *Dictyocysta*, *Protorhabdonella*, *Salpingacantha*, *Amphorella*, *Steenstrupiella*, *Epiilocyli*, and *Petalotricha* sp. The total absence of five genera of tintinnids viz, *Favella*, *Helicostomella*, *Metacylis*, *Steenosemella* and *Tintinnopsis*, which were reported from coastal waters ascertained their ‘neritic water’ preference.

Sithik *et al.*, (2009) investigated the physio-chemical parameters of two holy places such as Agnitheertham and Kothandaramar kovil from the Gulf of Mannar, areas. Generally higher values of Dissolved Oxygen (DO) were recorded during the months of April, June and October due to phytoplankton photosynthesis, which act as a major factor and higher solubility of oxygen in the ‘lower surface waters’. The nitrite concentration was higher than the nitrate, it was higher during April, which was due to seasonal floods increased phytoplankton excretion, other microplanktonic wastes, oxidization of ammonia and bacterial decomposition of ‘planktonic’ detritus to environment.

Karuppanapandian *et al.*, (2007) studied the physico-chemical properties from the coral reefs areas of Gulf of Mannar regions. Gulf of Mannar corals growth highly disturbed by human activities, due to oil pollution, waste discharge from processing units and discharge of domestic household wastes from the nearby Mandapam town. The high BOD load of sewage can produce high algal biomass in 10-12 days period and the conversion coefficient would be 0.95. For example, 1 Kg of BOD can produce 950g of algae. The algae would ‘prevent the sunlight’ entering the sea, which will automatically affect the growth of coral reefs and associated organisms. The higher BOD values indicated entry of organic waste in the sea. It is an alarming condition in near future and hence prevention in needed to disposing waste into the sea. Regression analysis showed that a significant positive correlation between temperature and pH, temperature and BOD and temperature and Total Organic Carbon (TOC). From this analysis, severe in the sewage disposal site affected, not only the quality of seawater but also the flora and fauna of this area. He stressed that, conserves the coral reefs, because essentially an important microzooplanktonic forms depends on coral reefs for nutrition of microbial loop system succession.
Pradhan *et al.*, (2009) proved that the addition of phosphates and silicates to the coastal water due to modernization activities were observed from the mouth of the Devi estuary in Orissa, during the winter season in 2006-07. The multivariate statistics and principal component analysis applied to the datasets, indicated that three factors each during the summer and winter seasons influencing the water to the extent of 77 and 80% respectively. The three principal components explain 79.74% of the total variance during the winter season. Principal components-1 accounts for 38.26% of the total variance, which is due to ‘strong positive’ load of phosphate phosphorus (0.941), silicates (0.848) and temperature (0.806) and a strong negative load of salinity (-0.809), with significant positive correlations of temperature with phosphate phosphorus (r-0.79) and silicates (r=0.67) and their negative correlations with salinity. He suggests that the phosphate and silicate content increases in low-salinity water, which is riverine-source water coming from the hinterlands. From his analysis, freshwater discharge through the river and rivulets includes additions of PO$_4$–P and SiO$_4$–Si to the coastal water and is marked during both the seasons. Whereas, the addition of nitrogenous products NO$_3$–N and NO$_2$–N were from anthropogenic sources such as fertilizer output, as an effect of industrialization in the northern region of the Devi estuary.

Sridhar *et al.*, (2008) found that the increased in nutrients levels in the coral reef waters would affect the coral skeleton formation and causes the micro and macro-algal blooming. The above process would affect the coral reefs by decreasing the light availability to the Zooxanthellae and certain ‘important microbes’. Temperature would directly affected the corals and associated microzooplanktonic forms. Coral reefs ecosystem of Munaikadu and Devipattinum were selected for the study based on the dominant ecosystem prevalent in these sites.

Goes *et al.*, (1999) studied the rhythmicity of food intake by microzooplanktonic forms of Cladocera (*Evadne* sp.) and Copepoda (*Acrocalanus* sp.). His findings, prolonged periods of starvation, certain species of microzooplankton exhibited a clear tendency to reingest ‘their own fecal pellets’. Samples for this study
were collected from the Mandovi estuary, Goa, India, using a Heron-Tranter plankton net. Microcinematographic techniques clearly demonstrated that this rhythmicity in microzooplankton was not an experimental artifact. It was shown that planktonic forms had a tendency to alternate brief bouts of feeding or swimming with breaks or swimming activities ceased. A feature of considerable interest that observed in the evacuation experiments, the increase in the gut pigment levels towards the end of two hours starvation period. However, fecal pellets produced by microcrustaceans are recognized as the most important factor which flux of carbon out of the ecosystem is achieved.

Ramaiah and Nair, (1993) emphasized the importance of monitoring chaetognath populations in the marine environment subjected to anthropogenic influences. In their study, *Sagitta robusta* was found to occur only as a minor component of the chaetognath population, as already reported. However, its total absence in all the interior station during monsoon period, that it is a ‘Stenohaline’ species changed. Occurrence of *S. bedoti, S.oceania* throughout the period of study in large numbers can be suggestive of their tolerance and adaptation to the ‘deteriorating water quality’ in the region. It can be concluded that a decline in the species diversity of chaetognaths and other microzooplanktonic forms in general over the past few years indicates the deteriorating water quality. The existing species appear to have adapted themselves well to the prevailing conditions, and it’s reflected by an increase in their population density when compared with the earlier reports. Finally he suggested that, the continuous monitoring of this system becomes imperative in the environmental impact assessment studies.