CHAPTER II

HISTORICAL RESUME
Though the importance of studies on seasonal fluctuations of abiotic and biotic factors in fresh waters of India has been dealt with by different workers, the investigations conducted so far in this line are more or less of preliminary nature only. Pruthi (1933) and Sewell (1934) studied the bionomics of fresh water micrometazoans of a tank within the Indian museum compound Calcutta. They also studied some physico-chemical characteristics of the tank water and the organisms at an interval of one month. But their study was purely qualitative as no details of quantitative variations of the organisms were given. A comparative abundance of planktonic organisms in a garden pond at Madras was examined by Ganapati (1943) who expressed the density of the organisms by symbols only. Chacko and Krishnamurthy (1954) made observations on ecology of three fish ponds in Madras. Alikunhi et al. (1955) while considering the relationship of the abundance of plankton with survival and growth of fish fry in a nursery pond, made a few observations on the fluctuation of the density of the plankton. These authors listed the major groups of plankton and estimated their fluctuations in terms of volume, number and dry weight for a period of two months only. Other workers in the field who made ecological studies limited to a particular season of the year include Moitra and Bhattacharya (1955). Such studies made at a particular part of the year assume little significance as most of the micrometazoans are plastic and
vary to a large extent with the changes in the environmental conditions. Extensive studies were made for a period of complete one year by Das and Srivastava (1959). These authors reported a bimodal pattern of plankton production in certain fresh water ponds of Uttar Pradesh. They noted an inverse relationship between phytoplankton and zooplankton. Sreenivasan et al. (1964) made some observations on the limnology of Bhawaniisagar reservoir in Madras. These authors emphasized mainly on the hydrological parameters. Their work was not on seasonal variation in plankton, but they listed some plankton organisms occurring in different months of the year (1961-62). George (1966) made a comparative study of plankton ecology in five fish tanks in Delhi giving the seasonal abundance of the major groups of zoo - and phytoplankton and variation in the physico-chemical characteristics of water. Sehgal (1967) made some observations on copepods occurring in fresh water ponds of Orissa. Michael (1968) studied the seasonal trends in physico-chemical factors and plankton of a fresh water fish pond. The author also studied their role in fish culture. In course of his two years study, he made successful attempt to record a detailed seasonal qualitative and quantitative variations of different plankton. Vasisht and Dhir (1970) made a detailed study of the seasonal distribution of
zooplankton in four tanks of a fish farm in Chandigarh for a period of one year (July 1969-June 1970). They studied the relative abundance of individual plankton and reported bimodal pattern of fluctuation of crustaceans and rotifers. Munawar (1970) worked on some limnological aspects of fresh water ponds in Hyderabad. Saha et al. (1971) selected a perennial fresh water pond in Cuttack, Orissa for studies related to seasonal and diurnal variations of physico-chemical and biological conditions in the pond. These authors gave a detailed account of diurnal variation of different groups of phytoplankton and zooplankton and physico-chemical characteristics of water. Seenaya (1973) made observations on the ecology of zooplankton and bacteria in some fresh water ponds in Hyderabad. Vasisht and Sharma (1975) made a study of the ecology of a typical urban pond in Ambala (Haryana) in order to explore the effect of certain physico-chemical and biological factors on the relative abundance of plankton. These authors concluded that low temperature and low turbidity were more conducive to the development of plankton in general and pH was found to be a controlling factor for the abundance of certain rotifers. They observed that phytoplankton and zooplankton peaks were closely linked together. Zutshi (1976) made some remarks on phytoplankton productivity, algal dynamics and trophic status of lake Mergozzo (Northern Italy).
Khan and Siddique (1977) while studying seasonal changes in the limnology of a perennial fish pond in Aligarh also made a brief report on the seasonal distribution of main groups of phyto and zooplankton in the pond. Singh and Sahai (1978) studied the seasonal fluctuations of zooplankton population in relation to certain physico-chemical factors for a period of two years in Jalwania pond, Gorakhpur. These authors reported only group wise count of zooplankton. Cynthea (1980) made some ecological investigations on phytoplankton of two small lakes situated at Hyderabad. Sullivan and Carpenter (1982) evaluated fourteen trophic state indices for phytoplankton of lakes and reservoirs. The author correlated the total chlorophyll to the phytoplankton and observed three chlorophyll maxima, corresponding to three peaks of phytoplankton, one each in summer, monsoon and winter. Trivedy et al. (1985) studied the chemistry and phytoplankton of few fresh water bodies in Kolhapur with special reference to human activity. These authors opined that increasing human population caused eutrophication of lakes in Kolhapur. Singhal et al. (1985) made some observations on the relationships among physical, chemical and plankton characteristics of unregulated rural ponds in Haryana. Noor-ul-Haque et al. (1988) made some observations on the impact of some ecological parameters on rotifer population in
a tropical pereneal pond in Aligarh. They found a significant negative relationship between total rotifers and total alkalinity and concluded that disappearance of certain rotifers was due to low dissolved oxygen and increased free carbon-dioxide at low temperature. Srivastava (1988) determined the different factors affecting the population of plankton in a tropical pond in Allahabad. Tripathi et al. (1989) observed the effect of mahua oil cake on water quality and biota of fish ponds in Bhubaneshwar. An observation on seasonal variation of rotifers in Tawa reservoir in Hoshangabad (India) was made by Singhal et al. (1989). Singh (1990) studied the seasonal fluctuations of phytoplankton of Mcpherson lake in Allahabad. The abiotic factors and their effects on biotic factors has been studied in two ponds of Jammu by Kant and Raina (1990). Sivaswamy and Prasad (1990) studied the physico-chemical properties and their effects on the phytoplankton population along the sea coast in Madras. Shardendu and Ambasht (1990) studied the seasonal variations of the physico-chemical properties in a pond located centrally in Varanasi. Belsare et al. (1990) made some limnological studies on Bhopal lakes and observed seasonal changes in abiotic factors.

The study of food and feeding habits of both freshwater and marine fishes has attracted the attention of
investigators since early times. Though considerable work has been done on the biology of the marine and estuarine fishes, work available on fresh water fishes is fragmentary in nature. Among the earliest workers in India, the contribution of Neill (1938), Job (1940) and Bapat and Lal (1950) on the feeding habits of fishes are of special interest. Neill (1938) studied the food and feeding habits of brown trout (Salmo trutta) in relation to its organic environment. Job (1940) explained the nutrition of perches of Madras coast while Bapat and Lal (1950) made an account of the food of some young clupeids. Hynes (1950) described the food of the fresh water stickle back Gasterosteus aculeatus and Pygostomus pungilues with review of methods used in study of food of fishes. Bhimachar and George (1952) reported the food and feeding of the Indian mackerel, Rastrelliger kanagurta. Frost (1954), studied the food of pike Esox lucius, a fresh water fish. Malhotra (1967) studied the feeding habit and maturation in Schizothorax niger and Botia birdi. Agrawal and Tyagi (1969) studied the food and feeding habits of some fresh water teleosts of district Muzaffarnagar. Frantz and Almo (1970) described the food of lake trout. Jyoti and Malhotra (1975) reported the seasonal variations in feeding of Nemacheilus kashmiriensis, while Mathavan et al. (1976) described the importance of animal and plant food for Tilapia mossambica.
Rita and Nair (1979) worked out the food and feeding habits and gastric digestion in *Nemacheilus triangularis*. Ramanathan and Natarajan (1980) made a comparative study of food and feeding habits of *Psettodes erumei* and *Pseudorhombus arrius*. Sashikala Devi (1981) reported the feeding habits in relation to buccopharynx, olfactoreceptors and gustatory receptors of a few teleosts. Mustafa et al. (1982) reported the seasonal patterns of feeding of *Colisa fasciata*. Amita and Saxena (1982) described the seasonal variations in food and feeding habit of the fish in relation to the reproductive cycle of female *Channa punctatus*. Arunachalam et al. (1985) studied the sublethal effects of carbaryl on food utilization in *Channa punctatus*. Trino and Fortes (1989) reported the food preference of wild milk fish (*Chanos chanos*) juveniles. These authors have attempted to correlate the food preference of the juveniles with habitat and food availability. Vincent et al. (1989) studied the effect of selected steroid hormones on food utilization in the freshwater fish *Channa punctatus*. A glance at the above literature shows that very little information is available on the seasonal variations of the food and feeding habits of *Channa punctatus*.

Determination of maturity of ovary, size, number and colour of ova forms an essential part of fish biology. Considerable literature exists regarding the morphology of
Earlier authors (Brock, 1878; Calderwood, 1891) confined their study to general structure of the ovary. Wallace (1903) made some observations on the ovarian ova and follicles in certain teleostean and elasmobranch fishes. Wheeler (1924) observed the growth of the eggs in Pleuronectes limanda. Hisaw and Albert (1947) studied the reproduction of the spiny dog fish, Squalus acanthus. Ghosh and Kar (1952) reported the seasonal variations in the gonads of Heteropneustes fossilis while Gokhale (1957) observed the seasonal histological changes in the gonads of Gadus merlangus and G. esmarkii. Satyanesan (1960) described the cyclic changes in the gonads of Mystus seenghala and Barbus stigma, correlating these changes with pituitary. Qayyum and Qasim (1964) made some observations on breeding of Ophiocephalus punctatus. These authors concluded that this fish has only one breeding season from June to October in North India. A comprehensive study of the seasonal cycle of gonads of some teleost fishes was made by Rastogi (1966). Goedmakers and Verboom (1974) studied the maturation and fecundity of pike. The maturity and fecundity of Labeo calbasu of Loni reservoir were studied by Pathak and Jhingran (1977). Magnin et al. (1978) worked out the growth and reproduction of lake trout. Reddy (1979) made a descriptive study of the maturity and spawning in Channa punctatus in Andhra Pradesh. Rishi and
Kaul (1982) observed the fecundity of Mystus tengra. Detailed study of the reproductive biology of some major carps was conducted by Selwaraj et al. (1989) in a reservoir in Tamil Nadu. These authors reported that gonads reach only certain stages of maturation and then undergo resorption before attaining ripe condition.

Heavy metals in the environment have become an important topic of concern not only for scientists and engineers in the field of water and air quality, but also the general public. There are numerous sources of domestic and industrial effluents, leading to heavy metal enrichment of water, vegetation and fish.

Abdullah and Royale (1972, 1974) have reported the presence of Cu, Zn, Mn, Fe, Cd, and Ni in water of Wales rivers and lakes. Husan and Pande (1982) estimated the heavy metals in Ramtek water works, Nagpur. These authors estimated the concentration of metals like Cd, Cr, Cu, Fe, Mn, and Zn, over a period of three years in this water body. Mohan and Chaudhary (1989) determined trace metals Zn, Cu, Pb and Cd in a few wells of Jojhri river belt, Jodhpur. Joseph (1989) made a comparative study of heavy metals pollution in fish of some estuaries in Madras region.
Varadarajan et al. (1982) reported the concentration of Cu, Cd, Ni, Pb and Zn in marine plankton, invertebrates and vertebrates. Ajmal et al. (1985) have also reported high concentration of these metals in fish of Yamuna river. A review of contaminated food and uptake of heavy metals by fish was reported by Dallinger et al. (1987). Timmermans et al. (1989) observed some trace metals in 15 species of freshwater macro-invertebrates from littoral zones of two Maarsseveen lakes in Netherlands. Khan et al. (1989) reported comparative bioaccumulation of Hg, Cd, Cu and Zn in two populations of grass shrimp, Palaemontes pugio collected from contaminated estuaries in New Jersey (U.S.A.). Das and Kaviraj (1990) studied the accumulation of cadmium in fish Heteropneustes fossilis and also observed changes in haematological parameters.

The biochemical composition of different tissues of fishes was reported by several workers. Saha and Guha (1939) studied the nutritive value of Bengal fish. Qayyum and Qasim (1964) studied some biochemical aspects in Ophiocephalus punctatus. Jafri and Khawaja (1968) reported seasonal changes in biochemical composition of Ophiocephalus punctatus. These authors noted that moisture content in muscle, liver and ovary varied inversely with the fat. Chaturvedi et al. (1976) studied the biochemical composition of some tissues in
Heteropneustes fossilis. Joshi et al. (1979) examined the biochemical composition of muscles and gonads of Heteropneustes fossilis. Dabrowski (1982) reported seasonal changes in the chemical composition of fish body and nutritional value of the muscle of the pollan (Coregonus pollan). Gupta and Joshi (1986) reported the chemical constituents of gonads of Clarias batrachus. These authors found a significantly higher level of glucose and glycogen in large sized fish in comparison to small sized ones during spawning period. Belsare and Belsare (1990) reported increase in lipid content in muscle and liver of some major carps, after feeding with high fat and algae diet. These authors reported a significant increase in lipid content after these carps fed on high fat diet. Singh and Nauriyal (1990) made a comparative study of some biochemical constituents in the reproductive cycle of two teleost fishes, Schizothorax richardsoni and Glyptothorax pectinopterus.

Though zinc is essential to animals in their various metabolic activities, it is toxic and even lethal if absorbed in surplus amounts thereby causing massive fish kills and other important members of aquatic biota.

The classical method for determining the toxicity of a metal towards an aquatic organism involves the LC 50 test.
Toxicity experiments with zinc were carried out by many workers. Lloyd (1960) has studied the acute toxicity of zinc on Salmo gairdneri. LC 50 value for 48 hr was 4.0 mg/l. Sastry and Subhadra (1982) found the LC 50 value for 96 hr in Heteropneustes fossilis as 40 mg Zn/l.

Chronic effects of toxicity of zinc on fish have been studied by many workers. Goodman (1951) made an observation on rainbow trout exposed to zinc and noted vertebral damage. The toxicity of zinc sulphate to rainbow trout was investigated by Lloyd (1960). The author opined that zinc sulphate was less toxic to rainbow trout in hard water than in soft water and cause of death of fish in solutions of zinc sulphate was not the precipitation of mucus on the gills but probably the damage to gill epithelium. Resistance to toxic effects of zinc sulphate on zebra fish, Brachydania rerio at different stages of life history was studied by Skidmore (1965,66). Grande (1967) determined the effects of copper and zinc on Salmonid fishes. Skidmore (1970) examined toxic effects of zinc sulphate in rainbow trout with special reference to the gills. Lewis and Lewis (1971) observed the effect of zinc and copper on the osmolality of blood serum of channel cat fish, Ictalurus punctatus and gold fish. Vertebral fractures and the development of internal haemorrhage in minnow, Phoxinus phoxinus, exposed to toxic concentration of zinc was reported.
by Bengtsson (1974). Chapman (1978) observed the effects of continuous zinc exposure on sockeye salmon during adult to smolt fresh water residency. Shaffi (1979) studied the effect of zinc intoxication on fresh water fishes. The author used different concentrations of zinc sulphate on serum glucose and lactate levels in nine nutritionally important species of fish from a tropical environment. He found a direct relationship between the depletion of energy reserve and accumulation of glucose and lactate in serum which was highest in the major carp, followed by snake-head and cat fish. Jeng and Sun (1981) observed the effects of dietary zinc levels on zinc concentration in tissues of common carp. The ionic balance in flounder (*Platichthys flesus* L.) after a sublethal concentration of 5-500 ug cd/1 was studied by Larsson et al. (1981). These authors suggested that ionic disturbances might be associated with cadmium induced pathological changes in ion regulating tissues. Khangarot (1982 a) studied the acute toxicity of zinc to a freshwater teleost *Channa punctatus*.

Sastry and Subhadra (1982) made an extensive study of the toxicity of cadmium and zinc to *Heteropneustes fossilis*. Goel and Gupta (1985) noted haemato biochemical characteristics of *Heteropneustes fossilis* under the stress of zinc. They reported a decrease in serum protein and elevation
in serum cholesterol, pigment, triglycerides and urea. Influence on the toxicity and accumulation of zinc in the fresh water fish, *Lepidocephalichthyes quntea* was studied by Bengeri and Patil (1980). Kaur and Bajwa (1987) noticed the effect of zinc and cadmium on early stages of common carp, *Cyprinus carpio*. The authors reported that survival of eggs and larvae decreased with increasing concentrations of metals. Shankar and Verma (1989) observed the toxicity of vanadium in *Notopterus notopterus* exposed to sublethal concentrations of 14.0, 7.0 and 4.66 mg/l of sodium vanadate.

Little information is available on histopathological changes in fishes induced by zinc sulphate in different tissues. Crandall and Goodnight (1963) observed histopathological changes in gills, liver and kidney of common guppy, *Lebistes reticulatus* exposed to sublethal concentration of zinc. Skidmore (1970) reported the damage of gills of rainbow trout exposed to zinc sulphate. The observations of Burton et al. (1972) on rainbow trout, *Salmo gairdneri* exposed to zinc reveal damage of gills, liver and kidney. They also suggested that acceleration of zinc uptake with temperature may result from gradual damage to gill tissue which causes tissue hypoxia. Sastry and Gupta (1978) studied the effects of lead nitrate on the digestive system of *Channa punctatus*, after 120 days of exposure to a sublethal concentration (6.6
mg/l) of lead nitrate and observed considerable degenerative changes in the histological structure of liver, intestine and pyloric caeca. Khangarot (1982 b) noticed the histopathological changes in branchial apparatus of Puntius sophore, subjected to toxic effects of zinc. Sastry and subhadra (1982), studied the histopathological changes caused by 4.0 mg/l of zinc sulphate in some tissues of Heteropneustes fossilis.