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*Chapter 03: Review of Literature*

## **REVIEW OF LITERATURE**

This present thesis contains an account of general biological, anatomical and biochemical parameters of both male and female species of some freshwater air-breathing fishes. On study of literature, scientific publications and available information in this field is furnished methodically. The objectives of fishery development are to improve the socio-economic condition of the fishermen through fish production between biotic and abiotic factors.

Biotic resources are also called as ecological resources which refer to all plants and animal resources in terms of individuals, species, communities, habitats and ecosystems (Gupta and Banerjee, 2012a). A freshwater is becoming scarce day by day, concerning about the water quality (Pathak and Bhatt, 1990) and (Nag and Gupta, 2014).

Analysis of plankton on seasonal basis (Gäärder and Grän, 1927)

Plankton particulars have been used as indicators of water quality. Some species flourish in highly autotrophic waters, while some others are in very organic and chemical water which was show by Coupel et al., (2015). Its appearance, disappearance, density and pattern of distribution depend upon biotic and abiotic factors. Some researchers such as Chakravarty and Srivastava (1981), Robertson and Balber (1992), Singh and Singh (1999) have the role of certain zooplankton which is significant in an aquatic ecosystem. Their seasonal abundance, bimodal population peaks, temperature, dissolved oxygen, nutrient loading of medium are stated by Khatri (1992).

The term plankton refers to those microscopic aquatic forms having no resistance of the water current and is free floating and suspended in pelagic water. Many of them carry on photosynthesis and are grazed upon by zooplankton and other aquatic organisms by Satpathy and Nair (1996). Zooplankton provides the main food items of fishes as described by Maranon

(2015). Kiran et al. (2007) made preliminary studies of the identification of zooplankton species which consisted of Rotifers 7 species, Cladoceran 4 species, Copepods 2 species, Ostracods 2 species and Protozoan 2 species. The finding expressed that Cladoceran and Copepoda densities were highest in rainy season and lowest during summer season while Ostracoda showed their maximum population during winter and rainy season. The highest species density in summer was due to the production of organic matter and decomposition by means of absence of water inflow. Kumar et al., (2006) provided information about seasonal variations of zooplankton community in freshwater reservoir at Bijapur District, Karnataka 10 species of Rotifera, 6 species of Cladocera, 5 species of Copepoda and 3 species of Ostracoda were recorded. The distribution and density of zooplankton species influenced by the physico-chemical factors of the concerned water. Islam (2007) investigated that the pond water of Rajshahi City was alkaline in nature with high bicarbonate content of 4 genera of Copepoda population was peak in summer month. Zooplankton, fish and fisheries in tropical freshwater were searched by Fernando (1994). The species richness of zooplankton was relatively low in freshwater as compared to the ocean. Freshwater have high primary productivity but low zooplankton and phytoplankton ratio. The phytoplankton is an assemblage of heterogeneous microscopic algal forms of aquatic system whose movement is more and less depending upon water current. Rajagopal et al., (2010a) compared with the physico-chemical parameters and phytoplankton species diversity of two perennial ponds in Sutter area, Tamil Nadu. The comparative study indicated that Chinnapperkovil pond was meso-autotrophic whereas Nallanchettipatti pond was oligo-autotrophic. They marked on few species like *Closterium acerosum*, *Anabaena aequalis*, *Navicula membranacea*, *Oscillatoria angusta*, *Merismopedia glauca* which were considered as pollution indicators. They stated high value of physico-chemical parameters with low phytoplankton diversity and low value of physico-chemical

parameters with high phytoplankton diversity. Multiple correlations among phosphate, silicate, DO, pH. Myxophycean and Bacillariophycean phytoplankton were significant generally in thermal condition. It was inferred through the study on plankton, ecology of some thermal springs in West Bengal, India by Jana (1973). Dash et al., (2011) is expressed that 20 physico-chemical parameters are more and less correlated with one another, created a fairly accurate idea about the quality of the ground water and recommended for treatment before drinking. Net zooplankton abundance was found to exhibit positive relationship with pH, DO combined CO<sub>2</sub>, NO<sub>3</sub> and PO<sub>4</sub>, Borah and Yadav (1996) and it is observed that some water parameters made positive correlation and some parameters made negative correlation among them in surface water samples of pond and river in Assam. They suggested that correlation study was the important method for interpretation of physico-chemical parameters and pollution level of the surface water in the parameters at the time of winter and monsoon season. Das et al., (2011) in three water ponds located at Krishnanagar City, West Bengal, India altogether 13 genera of aquatic macrophytes belonging to 10 families, 24 plant species belonging to 16 families were identified. They inferred that the physico-chemical characteristic of pond water was found to be altered due to these aquatic plants. Chatterji et al., (1992) observed that in the horse shoe crab *Tachypleus gigas*, intensity of feeding was maximum during north-east monsoon (November to January) in females and during the inter monsoon season (February to May) in males. Sarkar and Deepak (2009) did stomach content analysis of the endangered species *Notopterus chitala* which indicated that the species was predatory and carnivorous in nature. Increase in feeding intensity was observed from February to May which was reduced during June to September and coinciding with the spawning season of the species. Chacko (1945) studied the food and alimentary canal content of milkfish *Chanos chanos*. Le Cren (1951) and Sturm (1978) studied the biological aspects of *Scomberomorus maculatus* and *Perca fluviatilis*.

respectively.

Kuthalingham (1966) described in detail the food and feeding habit of *Mugil cephalus* and the mackerel *Rastrelliger kanagurta*. Bhimachar and George (1952) also conducted studies on this aspect. According to the authors, mackerel is definitely a carnivorous fish. Food and feeding habits of oil *sardines* and *Bhekki* had been studied by Menon (1948). Bachok et al., (2004) examined fish stomach from eighteen demersal and pelagic fishes from the coast of Malaysia. Serajuddin et al., (1998) investigated the seasonal changes in feeding habit. Maximum numbers of empty guts were found in adults during spawning season and in winter. Feeding intensity was studied by determining the gastrosomatic index; intensity was high in early maturity and was relatively lower in fish with ripening gonads. Suresh et al., (2006) conducted study of the food habit, length-weight relationship, stomach contents, gastrosomatic index and condition factor of *Macrognathus pанcalus*. Size of specimen was 17 cm and 30.1 gm. collected from an Ox-Bow lake situated in Ganga river basin. Feed conversion ratio, feed conversion efficiency, protein efficiency ratio, gonadosomatic index and gastrosomatic index of *Tilapia rendalli* were studied by Brown and Kangombal (2008) in a ten weeks period; the fishes were raised in three salinity levels viz; 5 ppt., 10 ppt. and 15 ppt. Rajaguru (1992) calculated the gastrosomatic index and hepatosomatic index to examine monthly variation in feeding intensity in *Cynoglossus* sp. and to correlate these variations with breeding cycles. A negative correlation between spawning activity and gastrosomatic index was noted for *Cynoglossus* sp. Hepatosomatic index value of control group was lower than other experimental groups (tannin was added at quantity 2.5 gm. per kg. feed 20 gm. per kg. feed). The gastrosomatic index and condition factor of fish showed no significance difference between the dietary treatments containing *Chilean* fish meal. Koli et al., (2012) studied the variation of *Tilapia* population in Jaisam and Lake in Udaipur taking into account of various

biological parameters like length-weight relationship, age and growth, gastrosomatic index and gonadosomatic index. In *Tilapia* having body length of 17 to 43 cm, gastrosomatic index value ranged in between 0.909 to 2.619 and gonadosomatic index value was 0.304 for male and 0.568 for female. The growth and length-weight relationship of air-breathing catfish *Heteropneustus fossilis* had been studied by Kohli and Goswami (1989). Koli et al., (2012). The growth and length-weight relationship of *Clarias gariepinus* (Bauchot et al., 1984) in Indian climatic condition had been worked out by Nath, (2012). The similar study had been conducted in *Clarias batrachus* by Goswami et al., (2010).

Harmon and Peterson (2005) investigated the changing condition factor and gonadosomatic index in *Atlantic salmon* under controlled and continuous light condition. The relation in between condition factor and gonadosomatic index suggested that *salmon* of both sexes must possess a condition factor which is greater than 1.3 in early summer for early maturation to develop. Kamanga et al., (2000) studied the effect of temperature on gonadosomatic index of *Oreochromis*, determined the seasonal changes, in gonadosomatic index of pelagic swimming white fish *Coregonus* sp. Mean gonadosomatic index increased from low values in summer to a maximum of about 24% immediately before spawning (end of November). Koca (2002) investigated the gonadosomatic index and flesh productivity of *Scorpaena* sp. Rheman et al., (2002) examined mature female specimen of *Grey mullets* for fecundity and gonadosomatic study. The mean value of fecundity was found to be 126812 nos. The fish was found to have two spawning peaks; one in December and the other in February as was indicated by the peaks of gonadosomatic index. Stoumboudi et al., (2005) assessed the yearly gonadal cycle of *Barbus longiceps* by measuring the gonadosomatic index of both the sexes as well as the spermatozoon index in the males. The fish had highest gonadosomatic index in March 6.31 for male and 1.40 for female. According to authors, the peak of the breeding season of the fish actually

represented by the highest spermatozoon index. Neat et al., (1998) studied territorial fighting in the cichlid fish *Tilapia zillii* in relation to relative body size and gonad weight. According to authors, relative gonad weight was much stronger predictor of fight outcome than the relative body size. Lal Mohan and Nanda Kumaran (1987) determined the gonadosomatic index values (4 to 20) of mature *Mugil cephalus* female of body length 44.5 to 46 cm, its minimum weight of ovary recorded as 50 gm. Weight of testis of mature *Mugil cephalus* male (35 to 38 cm) recorded as 6 to 10 gm.

In order to study the reproductive activity of *Poecilia latipinna* in Riyadh, Saudi Arabia, Al Akel et al., (2007) included parameters like gonadosomatic index, developmental stages of gonads and absolute fecundity. Recorded values of gonadosomatic index showed that the first phase of egg laying for the fish may start in June and extend till July. During December to January, there occurred a sharp decline in the gonadosomatic index values. Grnzalez and Santos (2007) studied the effect of water level fluctuation on body condition of *Geophagus* sp. in 30 sq. km reservoir. Physiological condition and gonadosomatic index of the fish were compared according to low and high water level and highest gonadal development occurred in low level water. Wang et al., (2006) tried to identify the factors influencing reproduction in the common perch and they suggested that the reproductive cycle is dependent upon annual variation in temperature and photo period. During the experiment, fishes were sampled; gonadosomatic index value was higher (3.8%) when females were exposed to small amplitude of temperature reduction and an early reduction in photo period. The method for the study of length-weight relationship in fishes was being first imitated by Le Cren (1951) and Herbert et al., (2014). The condition factor of *Heteropneustes fossilis* was studied by Bhatt and Negi (1985) and co-related this mare with feeding rhythm than with the cycle of gonadal weight. The condition of fish is subjected to a great deal of variations depending upon the various factors, nutritional and

biological cycles of the species Chatterjee et al., (2007). Hepatosomatic index associated with liver energetic reserves and metabolic activities (Pyle, 2005). Thakur (1975) studied the length-weight relationship separately for male and female during different seasons to see if there were differences separately for male and female during different seasons to see if there were differences in relationship due to sexes and seasons. Borah and Yadav (1996) worked on the biochemical and haematological response to starvation in *Heteropneustes fossilis*. The mathematical relationship between length and weight of fishes in a practical index suitable for understanding their survival, growth, maturity, reproduction and general well being (Le Cren, 1951). Length-weight relationship is important in fishery management for comparative growth studies (Moutopoulos and Stergion 2002). Borah and Yadav (1996) worked on the biochemical and haematological response to starvation in *Heteropneustes fossilis*. The muscles were taken for the estimation of biochemical aspect. Keshave et al., (2013) studied the impact of *Hildan* on total protein contents of muscles, hepatopancreas and gill of freshwater crab, *Barytelphusa guerini*, Keshave et al., (2013) studied the impact of seven on the acid and alkaline, phosphate activity of the freshwater of mussels, *Lamellidens marginalis*. A study of growth and length-weight relationship is considered as a significant aspect of aquaculture. The length-weight relationship and growth dynamics in different fishes from different environment had been reported by a large number of workers in India and abroad. The pioneer worker Le Cren (1951) studied the length-weight relationship and seasonal cycle in gonad weight and condition in perch (*Perca fluviatilis*). Hile (1936) reported the age and growth pattern of Cisco, *Leucichthys artedi* (Le Suer). Reddy and Rao (1962) studied the length-weight relationship and relative condition of *Puntius sophore* in Allahabad region. Similarly, the length-weight relationship, reproductive characters and condition of *Puntius sophore* (Ham) had been reported by Misra et al., (2012).

Beckman (1948) reported the length-weight relationship and coefficient of condition for seven different fish species from Michigan valley. A study of age and rate of growth had been conducted on *Osteobrama belangeri* (Val) and showed significant differences in relation to seasonal changes Singh et al., (2003). Similarly, the length-weight relationship and growth of IMCs had been worked out by several workers (Jhingran, 1959, 1968; Natarajan and Jhingran, (1969); Rao and Rao, 1972; Khan and Siddiqui et al., 1973; Dudley, 1974; Rao, 1979; Pandey et al., 1989, 2015; Krishna et al., (1996); Choudhuri et al., 2013; studied the growth and ponderal index of a minor carp *Puntius kolas* (Sykes). Length-weight relationship of *Glyptothorax* was studied by Subba et al., (1964) and Ghosh (2000). The length-weight relationship and relative condition index and the coefficient of correlation in between the fecundity and body weight and body length had been studied in *Tenualosa ilisha* (Hamilton-Buchanan) by Baxter (1977), De (1986) and Khan (2008) from different localities. Dobriyal and Singh (1990) reported the effect of ecological factors on the age and growth of *Barilius bendelisis* (Ham) from Indian condition. Sharma and Sharma et al., (2011) studied the condition factor of growth and its relationship with the gonadosomatic index and fecundity in freshwater mussels *Channa striata* and *Channa punctata* in the swamps of Brahmaputra river system. The age and growth of different fishes had been worked out (Jhingran, 1969; Schroeder, 1975; Thakur, 1981; Weatherley and Gill, 1987; Vadenberg et al., (1998) and Mitra, 1982; Khan (2008); Martin et al., 2007; Sivakumar et al., (2008) and Singh et al., (2013). The growth and length-weight relationship of air breathing catfish *Heteropneustus fossilis* had been studied by Kohli and Goswami (1989). Similarly, the age and growth of other channel catfishes had been reported by a number of workers from different localities and environment (Davis, 1977d; Thakur, 1981; Sivakami et al., (1986); Nath and Banerjee, 1999; Nath (2004). The growth and length- weight relationship of *Clarias gariepinus* in India, climatic condition had

been worked out by Nath (2012). Similar study had been conducted in *Clarias batrachus* by Goswami et al., (2010). The pioneer workers like Harrell et al., (1980) and Helfman et al., (2009), and Andrews et al., (1988), Foster et al., (2005); studied the age and growth of American eel *Anguilla rostrata*. Similar studies had also conducted in European eel *Anguilla anguila* by different workers (Harrell et al., 1980 and Jons et al., 2005). The condition factor (K), gonadosomatic index and fecundity of *M. cuchia* from the swamps of Assam had been studied by Kaleta et al., (1992) and Goswami et al., (2010). Muscle has high nutritional value. It is one of the most important sources of animal protein and had been widely accepted as a good sources of protein and other elements for the maintenance of healthy body (Arannilewa et al., 2005), knowledge of biochemical composition of muscle of air-breathing fishes helped in evaluating not only its nutritive value but also helped in quality assessment and optimum utilization of the natural resources (Abdullah and Lohar, 2011). Information concerning the chemical composition of freshwater fishes was useful to ecologists and environmentalists who were interested in determining the effects of changing biological and environmental conditions on the composition, survival and population change within the fish species (Kinsella et al., 1978). The main components in the edible portion of fish were water and protein. The analysis of protein of fish muscle is often referred to proximate analysis (Love, 1970). Fish (as the cold blooded) is easily influenced by the surrounding water temperature that shows the prominent effect on body temperature, growth rate, feed consumption and other metabolic function (Britz et al., 1997). Proximate composition of a number of marine, freshwater and brackish water, fish had been reported by Gopakumar (1997). Earlier report indicated that change in biochemical composition may occur as a result of gonadal maturity (Dygert, 1990). Sankar and Ramachandran (2001) had studied the biochemical composition in Indian air-breathing fishes in relation to size and season (Chandrashekhar et al., 2008). These factors may be

morphological, physiological, environmental and genetic in nature (Ali et al., 2003). Variation in the biochemical composition had been correlated with many parameters like such as the state of maturation (Bull, 1928), spawning migration (Idler and Bitner, 1960), body growth (Groves, 1970), summer storage of fat (Mackinnon, 1972) and captivity purposes (Shearer, 1994). The spawning cycle and food supply is the main factor responsible for this variation (Love, 1970). This study was undertaken to assess the chemical composition of muscle of some freshwater air-breathing fishes and their variations within season. Protein is complex organic nitrogenous substance formed from subunits called amino acids and found in the cells of all animals and plants. The chemical and physical activities in the living organisms are catalysed by enzymes, all of which are protein. Feeding habit, spawning cycle, affect the level of protein in the tissues.