CHAPTER V

STUDIES ON MORPHOLOGICAL INDEX OF FISHES IN RETTING AND NON-RETTING AREAS

5.1 Introduction

Effects of pollutants on ecosystems and communities originate in effects on individual organisms and ultimately, all effects of pollutants are the result of the interaction between a foreign chemical and one or several biomolecules in an individual. This interaction may lead to a disturbance in the cell function, which in turn, may be important enough to alter the function of the organ (Hogstrand, 2000). The response of biomarkers can be regarded as biological or biochemical effects after a certain toxicant exposure, which makes them theoretically useful as indicators of both exposure and effects. The most compelling reason for using biomarkers is that they can give information on biological effects to pollutants rather than a mere quantification of their environmental levels (van der Oost *et al.*, 2003).

One of the important morphological index of the fish is the condition factor. Condition factor (CF) is the measure of the fitness of the fish. The CF is based on the body weight and length and allows to comparison to be made between populations living under different conditions (Heath, 1995). The physiological indicator may be affected if food is limited or if food consumption of the fish is impaired due to other stress factors (van der Oost *et al.*, 2003). The CF is a useful tool in monitoring the nutritional health status of fish populations over long experimental period (Hoque *et al.*, 1998). The present study on the fish diversity and abundance showed that the fish *Oreochromis mossambicus* is one of the most abundant species in the Kadinamkulam estuary during all three seasons of the study period and therefore this species was selected for the detailed study on the changes in the morphological index of the fishes in retting and non retting areas.

5.2 Review of Literature

The size-weight relationship has been used in fishery analyses for several purposes: to convert one variable to another, to estimate the expected weight for a certain size, or to detect ontogenetic morphological changes related to maturation of crustaceans and fishes (Pinheiro and Fransozo, 1993). According to Le Cren (1951), evaluation of the condition factor can provide important information about the "well-being" of a species, indicating its recent feeding conditions (fat content) and degree of adjustment to the environment. Vazzoler (1996) termed this parameter the "isometric condition factor" (or Fulton's condition factor). The condition factor can vary with gonadal development and time of year, and also among different populations. In Fisheries Science, the condition factor is used in order to compare the "condition", "fatness" or wellbeing of fish. And it is based on the hypothesis that heavier fish of a particular length are in a better physiological condition (Bagenal, 1978). Condition factor is also a useful index for the monitoring of feeding intensity, age, and growth rates in fish, it is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem in which fish live (Oni *et al.,* 1983).

Fish condition, defined as the robustness or wellbeing of an individual fish (Bulow *et al.,* 1981; Blackwell *et al.,* 2000), is an essential component of fishery biology used to assess the general health of populations (Gulland, 1983; Sparre *et al.,* 1989). Condition can vary dramatically both within and among populations; and it is therefore critical to identify environmental predictors of this variation to optimize fishery production. Two types of condition indices are generally used by fisheries scientists as surrogates of fish health and growth (Wootton, 1990; Pauly, 1993; Petrakis and Stergiou, 1995; Binohlan and Pauly, 1998). The first are somatic indices such as calorific and proximate (e.g. lipid content) indices (Brown and Murphy, 1991), and liver, fat, and gonado-somatic indices (Adams *et al.,* 1982). The second groups are length-weight based indices such as Fulton's condition factor (Ricker, 1975), relative condition factor (Le Cren, 1951), and relative weight (Wege and Anderson, 1978). Length-weight based condition indices are the most frequently applied because the data are relatively easy, efficient, and cost-effective to collect. Length-weight relationships have thus been used extensively in fisheries biology to convert growth in length to growth in weight equations for use in stock assessments (Oscoz *et al.*, 2005) and to provide an index of condition (Bolger and Connolly, 1989).

Weight–length relationships are used for estimating the weight corresponding to a given length, and condition factors are used for comparing the condition, fatness, or well-being (Tesch, 1968) of fish, based on the assumption that heavier fish of a given length are in better condition. Both concepts have been used in fisheries research since the beginning of the 20th century. The temporal and seasonal fluctuations of the condition factor are influenced by endogenous parameters (e.g., nutritional aspects, sex, and the state of gonadal maturation) or exogenous parameters (environmental factors) affecting a population (Rodriguez, 1987). Relationships between fish condition and population structure, fecundity, life history adaptations, environmental conditions, and/or management actions have been studied for a variety of fish species in temperate regions (Brown and Murphy, 1991; Blackwell *et al.*, 2000).

Studies in tropical fisheries are far less prevalent, but there is a growing body of literature on the condition of tilapia fishes in the larger tropical freshwater lakes and reservoirs that suggest great variation in tilapia condition within and among systems (Welcomme, 1970; Fryer and Iles, 1972; Siddique, 1977; Lowe-McConnell, 1982). The WT/CW relationship and the condition factor have been evaluated for the crabs *Callinectes bocourti*, by Costa *et al.* (1980), *Callinectes danae*, by Branco and Thives (1991) and Branco *et al.* (1993), *Arenaeus cribrarius*, by Pinheiro and Fransozo (1993), *Hepatus pudibundus*, by Mantelatto and Fransozo (1993), *Portunus spinimanus*, by Santos *et al.* (1995) and *Dilocarcinus pagei,* by Pinheiro and Taddei (2005). The value of condition factor (K) is influenced by age of fish, sex, season, stage of maturation, fullness of gut, type of food consumed, amount of fat reserve and degree of muscular development. With females, the K value will decrease rapidly when the eggs are shed Golani (1990).

5.3 Materials and Methods

Oreochromis mossambicus (Peters) belong to the family Cichlidae (Plate.3) was selected for the present study. This species with common name 'tilapia' naturally occurs along the eastern coast of Africa, in the lower Zambezi and its tributaries, eastward-flowing rivers and coastal lagoons southward to the Bushman's River, near Port Elizabeth, South Africa (ISSG, 2006). Now this fish is widely distributed in the back waters, rivers and fresh water ponds of Kerala. In general, *Oreochromis mossambicus* are omnivorous; feeding on whatever is available, although they seem to show some preference for detritus and plant matter. Over their natural range, *Oreochromis mossambicus* appears to be primarily detritivorous, with diatoms playing an important role in their nutrition (Trewevas, 1983). Feeding on filamentous algae, phytoplankton, zooplankton, vascular plant fragments, insects, crustaceans and small fish has also been reported (De Silva *et al.,* 1984). *Oreochromis mossambicus* opportunistically feeding on other fish are common (Bruton and Boltt 1975), it is a mouth brooder. Males construct nests in areas of sparse to moderately dense vegetation. Females mouth brood the young. There have been a few reports of male's mouth brooding young (Arthington and Milton, 1986). Maturation appears to usually occur between 150 and 160 mm in females and between 170 and 180 mm for males. Eggs are fertilized within the nests and then carried off to deeper waters for maturation by the female. Incubation ranges from 20-22 days, and maturation of ova takes two weeks. Fry are released in shallow waters by females once they have reached a length of 9-10 mm. Release of fry appears to also be associated with cues relating to rainfall. Males grow faster and become larger than females (Bruton and Allanson, 1974). Like most cichlids, optimal growth occurs near 30°C (Price *et al.,* 1985). However, growth rates vary depending on food availability and habitat quality.

Plate 3: *Oreochromis mossambicus* (Peters)

Genus	: Oreochromis
Tribe	: Tilapiini
Sub Family	: Pseudocrenilabrinae
Family	: Cichlidae
Suborder	: Labroidei
Order	: Perciformes
Class	: Actinopterygii
Phylum	: Chordata
Kingdom	: Animalia

Oreochromis mossambicus occur in freshwater and estuaries along the coast, tolerating a broad range of salinities (Trewevas, 1983). However, they prefer estuarine waters; Dial and Wainright (1983) reported successful spawning in seawater under artificial conditions. It may be able to spawn in salinities of up to 30 ppt and survive in salinities of up to 40 ppt (Courtney *et al.,* 1974), and it can survive temperatures less than 15°C but prefers warmer temperatures (above 22°C). It can also tolerate temperatures up to 42°C (Skelton, 1993). These fishes cannot survive in water where the temperature falls below 11°C, for long periods of time. It also has a tolerance for high ammonia and low oxygen concentrations (Nussey, 1994).

The present study was conducted in Kadinamkulam estuary where the coconut husk retting process is immense. The retting of husk presents unique and extremely serious problems along the Kadinamkulam estuary, changing the hydro-ecology of the water body. Traditional conventional method of retting has adverse impacts on this ecosystem, including fauna, flora and human beings. Lack of dissolved oxygen, very high biological oxygen demand (BOD), chloride, hardness, nutrients, low pH, and foul smell of hydrogen sulphide are the characteristic features of coconut husk retting yards.

Soaking of large quantities of coconut husks and prolonged periods of retting in the estuarine basins have converted vast areas of the estuaries into virtual cesspools of foul smelling stagnant waters. Earlier, this estuary was the major sauce of fishery resource for the local people. Due to the extensive use of these estuaries for coconut husk retting the fishery resource were expansively degraded and the invasive tolerant species like *Tilapia*, *Claries* were introduced here and flourished in these tainted water bodies. They can survive and breed in unhygienic and polluted conditions, can endure wide range of salinity and low oxygen concentrations. Because of the above reasons the abundant fish species, *Oreochromis mossambicus* (Peters) in Kadinamkulam estuary was selected for the study.

Oreochromis mossambicus (Peters) were collected from the four stations (retting and non-retting sites) of the Kadinumkulam estuary during pre monsoon, monsoon and post monsoon seasons during the period 2004-2005. Female fishes of three different body length groups were selected for the present study. The body weight and body length were noted in the collection site itself. The length was measured using standard centimeter scale, it is measured from the tip of the snout to the rear edge of the fork at the tail fin and weighed on a precision balance to the nearest 0.01 g (WT = wet weight). The three groups (G_1, G_2 and G_3) of fishes (n = 6) were collected from each stations with an average length between 8-9 cm (G_1) 7-8 cm (G_2) and 6-7 cm (G_3). The Fulton's Condition Factor (K) (Fulton, 1904) was calculated using the formula.

$$K = \frac{W}{L^3} \times 100$$

where 'K' is the Fulton's condition factor, W = whole body wet weight in grams and L^3= length in cm; the factor 100 is used to bring close to unity.

5.4 Results and Discussion

The condition factor allows comparisons to be made between fish populations living under different conditions. The changes in Fulton's condition factor (FCF) in the fishes in coconut husk retting and non retting zones during different seasons are given in Table 17-19.

The seasonal variations of Fulton's condition factor ranges from a minimum of 20.47 (SII) and maximum of 21.77 (SIV) in G_1 group, from 28.99 (SI) to 30.44 (SIV) in G_2 group and from 31.63 (S I) to 36.56 (SIV) in pre monsoon season and in monsoon season it varies from 20.13 (SII) to 21.32 (SIV) in G_1 group, from 26.44 (SI) to 29.91 (SIV) in G_2 group and in G_3 group it varies between 30.89 (SI) to 35.37 (SIV) respectively. In post monsoon season CF varies between 20.37 (S I) to 21.42 (SIV) in G_1 group, from 27.86 (SII) to 28.77 (SIV) in

G_2 group and in G_3 group it ranges from 35.15 (SII) to 36.28 (SIV) respectively. From the above study there is a clear disparity in FCF in fishes that found in retting areas and the fishes found in non retting areas of Kadinamkulam estuary in all three seasons. The retting of coconut husk and associated deleterious changes influence the food habit and biomass of fishes in retting areas of Kadinamkulam estuary with respect to the non retting areas. The Fulton's condition factor of fishes in retting areas was less than that of the fishes in non-retting areas. A decrease in condition factor can be considered as a reflection of depletion of energy reserves. The maximum values for FCF of fishes were noticed in Perumathura (Station IV) and this area is free from pollution compared to the retting areas. The FCF is relatively insensitive to short term environmental stress but may be useful in monitoring the nutritional and health status of fish populations (Hoque, 1998). Previous studies showed that the body weight loss in fishes of retting areas was probably associated with the susceptibility of hydrogen sulphide (Vander Oost *et al.*, 2003). Studies by Richard *et al.* (2006) also showed that better the condition of the fish, the higher the value of Fulton's condition factor.

Therefore the results obtained in the present study revealed that Fulton's condition factor is a sensitive indicator of aquatic pollutant toxicity (stress) in fishes.

Table 17 Fulton's Condition Factor (FCF) in Pre monsoon season
(Values in Average)

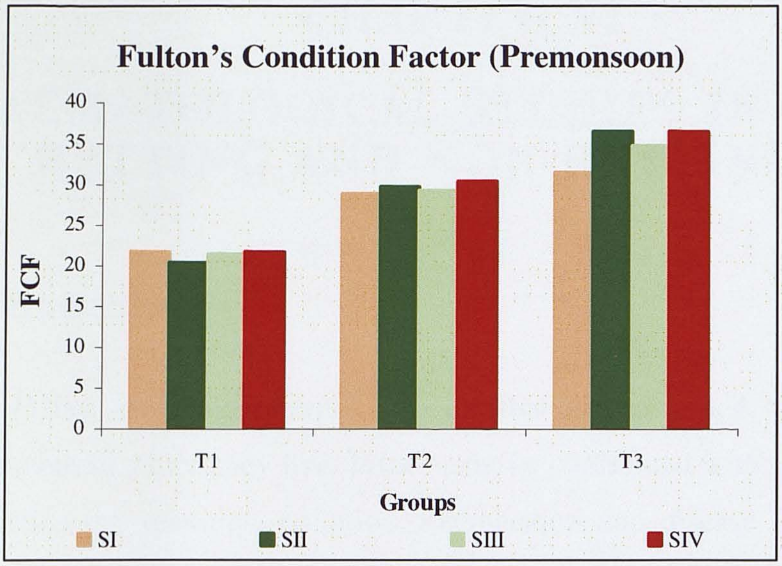
Stations	SI			SII			SIII			SIV		
	L (cm)	W (gm)	CF	L (cm)	W (gm)	CF	L (cm)	W (gm)	CF	L (cm)	W (gm)	CF
Groups (n= 6)	8.24	121.46	21.71	8.4	121.35	20.47	8.3	122.73	21.46	8.3	124.48	21.77
	7.34	112.77	28.99	7.28	114.78	29.75	7.28	113.20	29.33	7.32	119.41	30.44
	6.50	86.87	31.63	6.32	92.25	36.54	6.38	90.07	34.68	6.34	93.17	36.56

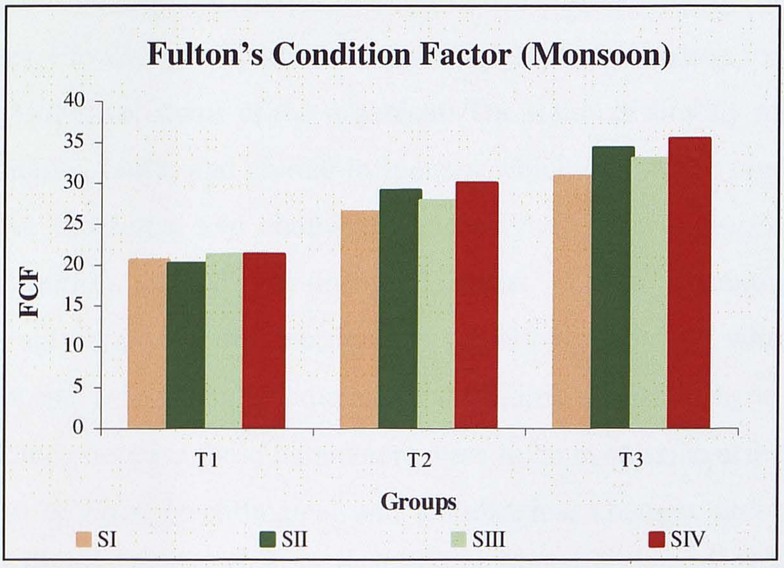
Table 18 Fulton's Condition Factor (FCF) in Monsoon season
(Values in Average)

Stations	SI			SII			SIII			SIV		
	L (cm)	W (gm)	CF	L (cm)	W (gm)	CF	L (cm)	W (gm)	CF	L (cm)	W (gm)	CF
Groups (n= 6)	8.48	126.08	20.67	8.52	124.52	20.13	8.3	121.73	21.28	8.4	126.39	21.32
	7.62	116.98	26.44	7.24	110.89	29.21	7.38	111.92	27.84	7.36	119.25	29.91
	6.58	88.022	30.89	6.46	92.58	34.34	6.5	90.79	33.06	6.44	94.49	35.37

Table 19 Fulton's Condition Factor (FCF) in Post monsoon season
(Values in Average)

Stations	SI			SII			SIII			SIV		
	L (cm)	W (gm)	CF	L (cm)	W (gm)	CF	L (cm)	W (gm)	CF	L (cm)	W (gm)	CF
Groups (n= 6)	8.54	126.97	20.37	8.42	123.97	20.76	8.42	124.53	20.86	8.44	128.83	21.42
	7.42	115.94	28.38	7.46	115.68	27.86	7.36	114.29	28.66	7.46	119.47	28.77
	6.26	87.84	35.8	6.36	90.44	35.15	6.26	88.84	36.21	6.36	93.292	36.28





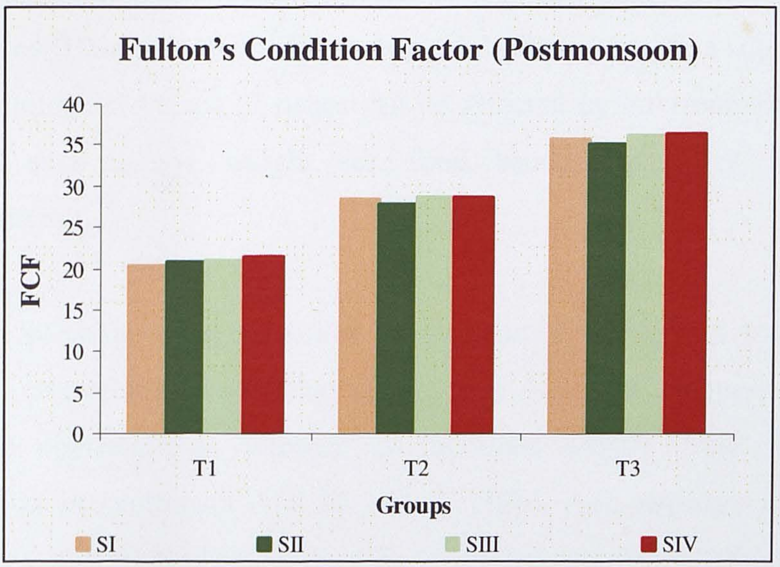


Figure 7. Fulton's Condition Factor of *Oreochromis mossambicus* in three different seasons