CHAPTER - 6

FOOD AND FEEDING

6.1. INTRODUCTION

Trophodynamics studies are undertaken to examine the tropic linkages of different feeding habits at marine and fresh water environment. It provides information in the relationship between the various producers and consumers in an ecosystem. Trophodynamics studies constitute the base for mass-balance models, which are increasingly being considered for the study and management of marine ecosystem. All living organisms depend on the energy that comes from food to perform its biological processes such as growth, development, reproduction and other metabolic function. Food is the main source of energy that plays an important role in determining the population levels, rate of growth and condition of fishes (Begum et al., 2008). The growth performance in fishes in relation to feeding is useful and the information can be successfully applied in the management and exploitation of this natural resource. It varies from individual to individual depending on their sexual maturity (Asdell, 1946). Availability of natural food has great effect on the distribution, abundance and growth of fish species. Knowledge of the food of fish and its feeding behavior helps in understanding the ecological relationship that is useful for fishery management. The food of an animal may differ at different stages of life and also vary from place to place and from season to season. It also differs according to abundance and availability of the food organisms (Gaikwad et al., 2009). The consumption of food is influenced by many environmental factors such as water temperature, food concentration, abundance of fish, size of fish and fish behaviour (Huolihan et al., 2001). The rate of feeding is vital for the spawning of the fish and directly depends upon their surrounding aquatic environment for their food requirements. Several studies on food and feeding and gastro somatic index of *P. monodon* from different part of India and abroad has been performed by several authors

(Thomas, 1972; Joubert and Davies, 1966; Dall, 1968; Marte, 1980, 1982; Tacon, 2002 and Baskar et al., 2013), but no information is available from the stock available along the West Bengal and Odisha coast in northern Bay of Bengal. The stock landed at Digha coast is from one unit stock available along the northern Bay of Bengal, for which no study has been performed till date. The present paper deals with the gastro somatic index, food and feeding intensities of *P. monodon*.

6.2. RIVEW OF LITERATURE

The shrimp nauplius is a non-feeding, planktonic stage (Rothlisberg, 1998). The three shrimp protozoea stages are non-selective filter – feeders (Rothlisberg, 1998; Narciso and Morais, 2001) that feed mostly on phytoplankton and small zooplankton like rotifers. From mysis to post larva (PL) there is a transition to active predation on larger zooplankton (Lovett and Felder, 1990). Juvenile *P. monodon* are fairly carnivorous (Tacon, 2002), feeding on seaweed, algae, crustaceans, detritus (bacterial colonies), molluscs and fish parts (Hall, 1962; FAO, 1968; Marte, 1980; Sultana, 2000). El Hag (1984) found that adults feed on crustaceans, annelids, algae and mud. Month wise feeding intensity for male and females showed that in most months, males with empty stomach were found to be dominant (Kulkarni et al., 1999). Rao (1968) stated that in fishes the occurrence of empty, one-fourth full and half-full stomachs indicated low feeding intensity during the maturation and pre-spawning period. During maturation in penaeid prawns, the major expansion of the ovary occurs in the abdominal region. Kulkarni et al. (1999) observed that in mature female prawns, the occurrence of full and three-fourth full stomachs is not impacted by the ovarian expansion as the gut of prawns is located in the cephalothorax. They stated that during maturation for deriving more energy for reproductive output, the females must feed intensively. Increasing feeding intensity with increasing maturity was observed with the presence of a larger number

of full and three-fourth full stomachs in mature females. Thus, during the breeding period, most stomachs were either full or three-fourth full.

Diurnal variation in the feeding intensity in shrimps was observed by Nandakumar and Damodaran (1998) with higher feeding intensity during nights than during the day hours. Similar observations were made by Thomas (1980) and Rao (1988). Dall (1968) reported the feeding intensity of *P. monodon* to be more in the nights. Feeding is more vigorous in mature females than in immature ones.

Hall (1962) opined that penaeidae in general are not considered as detritus feeders. Thomas (1972) studied the food and feeding habits of *P. monodon* from Korapuzha estuary. The food in order of importance was crustaceans, fishes, molluscs, polychaetes and vegetable matter. Mud and sand particles were also encountered in the gut contents. Different size groups did not exhibit appreciable variation in the nature of the food. Joubert and Davies (1966) observed the food and feeding of *P. monodon* from St. Lucia Lake waters and reported that they fed on molluscs, crustaceans, vegetable matter and polychaetes in their abundance. Marte (1980) demonstrated that *P. monodon* digests 53% of its food within 1 hour of feeding. Molluscs and polychaetes are the major natural diets of many penaeids species including *P. indicus, P. merguiensis* and *P. monodon* (Chaitiamvong, 1980; Marte, 1980; Thomas, 1972; Wassenberg and Hill, 1987). Baskar et al. (2013) examined the gastro somatic index and feeding intensity of *P. monodon* and reported it to be higher during monsoon months as compared to summer months from Mallipattinam coast in Thanjavur District, Tamil Nadu.

Marte (1982) studied the gastro somatic index (GST) of *P. monodon* and reported that feeding intensity remained high during winter months and reduced during summer months. Williams (1955) based on his studies concluded on high feeding intensity during most months of the year, except for the winter season in which maximum occurrence of empty stomachs were observed. Kuttiyama (1974), from Madras, on analyzing the stomach contents

of different size groups of *P. monodon* did not record any significant variations in the feeding intensity.

6.3. MATERIALS & METHODS:

Samples were collected randomly from the trawl landings at Digha Mohana landing centre from Bay of Bengal of West Bengal coast during January 2011to December 2013. Total length of the individual was measured to the nearest millimeter (mm) and total weight to 0.1 g. Stomachs were cut open from the individual shrimp and the contents were processed and preserved for further identification and weight. The stomachs were preserved in 5% formalin for further analysis. The feeding intensity was considered based on the stomach condition and the volume of food it contained. It was classified as full, ¾ full, ½ full, ¼ full, trace and empty as described by Pillay (1952). For assessing the feeding intensity, stomachs were grouped into actively feed (full and ¾ full stomach), moderately feed (½ full and ¼ full) and poorly feed (less than ¼ full). The feeding intensity was calculated by using the formula; Feeding intensity = number with stomach condition / total number examined x 100. Feeding analysis was performed in relation to months, sex, maturity stages and size-groups. Samples were classified into groups with 10 mm total length class interval. The stages classified (Dall et al., 1990) were 'immature', 'early maturing', 'late maturing', 'mature' and 'spent'. Gastro-Somatic Index (G.S.I) was calculated using the method of Desai (1970).

$$G.S.I. = \frac{\text{Weight of the gut contents}}{\text{Weight of the fish}} \times 100$$

Significance in G.S.I values were tested through ANOVA.

6.4. RESULTS

A total of 633 *P. monodon* were examined, comprising of 391 females and 242 males. The length ranged from 12.5 cm to 27.7 cm and weight ranged from 48 gm to 261 gm in the combined population. The length ranged from 15 cm to 23.6 cm and weight ranged from 48 g to 155 g in males and length ranged from 12.5 cm to 27.7 cm and weight ranged from 47 g to 261 g in females. The average gastro somatic index of *P. monodon* during the different months of year during January 2011 to December 2013 of males and females are presented in Table 6.1 and 6.2. In males, Ga.S.I was high in March – April and again in July, August and September. Similarly in females, the months from July to September exhibited high Ga.S.I. Ga.S.I. was significantly higher in males than females ($p<0.05$). The feeding intensity in relation to sex is shown in Table 6.3. Females exhibited significantly higher ($p<0.05$) feeding intensity than males. Almost three-fourth of the males was poorly fed, whereas in females, marginally more than half were poorly fed. The feeding intensity in relation to months is shown in Table 6.4. November – February are the months when active feeding was observed in *P. monodon*. Active feeding was significantly higher ($p<0.05$) in November – February, when compared to March, April, June, July, August and October. Highest feeding was in February and lowest feeding was in June. Moderately fed individuals were significantly higher ($p<0.05$) in February, March, April, July and September than in January and November. Poorly fed individuals were significantly higher ($p<0.05$) in January, June, July, August, October and November, when compared to February and March. The feeding intensity in relation to maturity stages of females is shown in Table 6.5. Early and late maturing females fed actively and immature females were poorly fed. Active feeding was significantly higher ($p<0.05$) in maturing females and poor feeding was significantly lower ($p<0.05$) in maturing females, in comparison to immature and spent females. The feeding intensity in relation to size is shown in Table 6.6. Active feeding was noticed from 170 - 179

mm size group. Highest feeding was observed in 230 – 239 mm group, whereas from 260 - 269 mm sizes and onwards, stomachs were empty.

6.5. DISCUSSION:

In the present study, more than half of the individuals examined were poorly fed. One third of the individuals were moderately fed and the rest actively fed. G.S.I for both males and females were higher during July to September. This could be attributed to the fact that food availability increases during the post monsoon months of July, August and September, due to increased nutrient content in the coastal waters. Also, with spawning peak between January and June, as have been stated earlier, feed intake increases in the post-breeding period. High feeding intensity in females, when compared to males is because of greater energy requirement for development of gonads for spawning. Feeding intensity was high during November – February, before the onset of spawning. The feed consumed during this period was mostly used for gonadal growth and development and very less of it was used for somatic growth. Similarly, Marte (1982) revealed that the feeding intensity remained high during winter months and reduced during summer months. Basker et al. (2013) stated that the feeding intensity was higher during monsoon months when compared to summer months. They stated that shrimps consume more feed after their breeding period. The weight of sampled individuals were highest during November – February, prior to spawning, due to the occurrence of fully matured gonads, and this could have resulted in moderate G.S.I values during this period as G.S.I. takes into consideration the weight of the individual. This explains the seasonal difference in the peak values of G.S.I. and feeding intensity. Month-wise feeding intensity for males and females shows empty stomach to be prevalent in most months. Females in advanced stage of maturity were found to feed more vigorously than the immature ones (Nandakumar and Damodaran, 1998). From the studies of Rao (1968), it is evident that during maturation and pre-spawning period in fishes and shellfishes, the females

must feed intensively in order to derive more energy for reproductive output during maturation. Similar observations were recorded in the present study, wherein early and late maturing females fed more intensely than immature and spent females. Dell (1968) reported that feeding intensity in *P. monodon* is more during the night because of their noctural behaviour. It was recorded in the present study that active feeding was observed between sizes of 170 mm and 249 mm. Smaller size shrimps and very large ones exhibited poor feeding. According to Zacharia (2003), low feeding intensity in large sized shrimps is due to physiological stress associated with spawning, this could be the reason, however further studies on impact of stress hormones in feed uptake needs to be evaluated before arriving at definitive conclusion.

Table 6.1.Gastro-somatic index of males' *P. monodon* (Mean±SE) collected from Digha coast during January 2011 to December 2013.

Month	2011	2012	2013	Mean±SE
January	1.25±0.09	1.11±0.03		1.26±0.01
February	1.27±0.13	1.69±0.20	1.32±0.17	1.37±0.17
March	1.14±0.05	1.90±0.28		1.52±0.38
April		1.75±0.20		1.75±0.20
June	1.15±0.07	0.95±0.07	1.56±0.11	1.22±0.18
July	1.75±0.04	1.67±0.39	1.71±0.12	1.71±0.02
August	1.31±0.07	1.80±0.26	1.62±0.16	1.58±0.14
September	1.66±0.23	1.82±0.20	2.94±0.21	2.14±0.40
October	1.08±0.11	1.22±0.04	1.58±0.12	1.29±0.15
November	1.11±0.12	1.66±0.26	1.19±0.03	1.32±0.17
December	1.70±0.23	1.27±0.04	1.41±0.14	1.46±0.13

Note: Data for three years are pooled and presented.

Table 6.2.Gastro-somatic index of females' *P.monodon* (Mean±SE) collected from Digha coast during January 2011 to December 2013.

Month	2011	2012	2013	Mean± SE
January	1.25±0.09	0.90±0.10		1.08±0.18
February	0.94±0.02	1.22±0.10	0.96±0.08	1.04±0.09
March	1.16±0.10	1.30±0.12		1.23±0.07
April		1.09±0.15		1.09±0.15
June	1.16±0.11	1.07±0.10	1.55±0.09	1.26±0.15
July	1.25±0.08	1.53±0.16	1.45±0.16	1.41±0.08
August	0.83±0.03	1.40±0.14	2.11±0.23	1.45±0.37
September	1.17±0.09	1.33±0.12	1.77±0.13	1.42±0.18
October	1.08±0.07	0.77±0.05	1.29±0.19	1.05±0.15
November	0.82±0.05	1.39±0.08	1.18±0.18	1.13±0.17
December	1.24±0.10	1.07±0.06	1.49±0.12	1.27±0.12

Note: Data for three years are pooled and presented.

Table 6. 3. Sex-wise feeding intensity of *P.monodon* (Mean±SE) collected from Digha coast during January 2011 to December 2013.

Sex	Total	Full	¾ full	½ full	¼ full	Trace	Empty
		Actively feed		Moderately feed		Poorly feed	
Female (number)	391	39		135		217	
Female (%)		10.0%		34.5%		55.5%	
Male (number)	242	15		48		179	
Male (%)		6.2%		19.8%		74.0%	

Note: Data for three years are pooled and presented.

Table 6.4.Month-wise feeding intensity of *P. monodon* collected from Digha coast during January 2011 to December 2013.

Month	Full	¾ full	½ full	¼ full	Trace	Empty	Total
	Actively feed		Moderately feed		Poorly feed		
January (number)	6		4		30		40
January (%)	15%		10%		75%		
February (number)	16		28		25		69
February (%)	23.20%		40.60%		36.20%		
March (number)	1		16		18		35
March (%)	2.90%		45.70%		51.40%		
April (number)	0		5		4		10
April (%)	0%		60%		40%		
June (number)	4		12		53		69
June (%)	5.80%		17.40%		76.80%		
July (number)	2		18		38		58
July (%)	3.40%		31.00%		65.50%		
August (number)	4		17		48		69
August (%)	5.80%		24.60%		69.60%		
September (number)	7		23		38		68
September (%)	10.70%		33.80%		55.90%		
October (number)	4		16		48		68
October (%)	5.90%		23.50%		70.60%		
November (number)	9		9		49		67
November (%)	13.40%		13.40%		73.10%		
December (number)	12		22		46		80
December (%)	15.00%		27.50%		57.50%		

Note: Data for three years are pooled and presented.

Table 6 .5. Maturity-wise feeding intensity of *P. monodon* collected from Digha coast during January 2011 to December 2013.

Maturity stage	Full	¾ full	½ full	¼ full	Trace	Empty	Total
	Actively feed		Moderately feed		Poorly feed		
II (number)			11		29		40
II (%)			27.5%		72.5%		
III (number)	12		23		17		52
III (%)	23.1%		44.2%		32.7%		
IV (number)	12		36		18		66
IV (%)	18.2%		54.5%		27.3%		
V (number)	16		63		154		233
V (%)	6.9%		27.0%		66.1%		
Total (number)	40		133		218		391
Total (%)	10.2%		34.0%		55.8%		

Note: Data for three years are pooled and presented

Table 6.6.Length-wise feeding intensity of *P. monodon* collected from Digha coast during January 2011 to December 2013.

Length class (mm)	Full	¾ full	½ full	¼ full	Trace	Empty	Total
	Actively feed		Moderately feed		Poorly feed		
120-129 (number)			1		3		4
120-129 (%)			25%		75%		
130-139 (number)			2		1		3
130-139 (%)			67%		33%		
140-149 (number)			2		3		5
140-149 (%)			40%		60%		
150-159 (number)			3		7		10
150-159 (%)			30%		70%		
160-169 (number)			3		21		24
160-169 (%)			12.50%		87.50%		
170-179 (number)	2		12		85		99
170-179 (%)	2%		12.10%		85.90%		
180-189 (number)	9		25		82		116
180-189 (%)	7.80%		21.60%		70.70%		
190-199 (number)	7		31		72		110
190-199 (%)	6.40%		28.20%		65.50%		
200-209 (number)	8		32		45		85
200-209 (%)	9.40%		37.60%		52.90%		
210-219 (number)	9		28		44		81
210-219 (%)	11.10%		34.60%		54.30%		
220-229 (number)	11		18		21		50
220-229 (%)	22.00%		36.00%		42.00%		
230-239 (number)	9		12		5		26
230-239 (%)	34.60%		46.20%		19.20%		
240-249 (number)	1		7		5		13
240-249 (%)	7.70%		53.80%		38.50%		
250-259 (number)			4		1		5
250-259 (%)			80%		20%		
260-269 (number)					1		1
260-269 (%)					100%		
270-279 (number)					1		1
270-279 (%)					100%		

Note: Data for three years are pooled and presented.