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Evaluation of feeding indices of cobia *Rachycentron canadum* (Linnaeus. 1766) from northwest coast of India

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Original Article

Abstract

Cobia *Rachycentron canadum* (Linnaeus. 1766) is an esteemed table fish occurring along both east and west coast of India. Feeding indices of the species inhabiting waters of the northwest coast of Indian EEZ was studied to understand the variation of its feeding intensity based on season, sex and life history changes. Monthly variation of stomach condition of cobia male, female, pooled and size wise were analyzed. In general, 56% of fishes were found in either actively fed or moderately fed state. Except during April and July they were found in actively fed condition. Analysis of occurrence of empty stomach in different length classes of fishes revealed that the percentage of occurrence of empty stomachs decreased with the fish growth. Month- wise Mean Index of Feeding intensity (MIF) and Index of Fullness (IF) values showed that cobia fed well during post monsoon periods but poor feeding activity was noticed in July. Gastrosomatic index for male, female and pooled samples of matched with the MIF and IF values. The results indicated a seasonal variation in feeding intensity of cobia. On an average, feeding intensity during July was low.

Keywords: *Cobia, feeding intensity, gastrosomatic index, seasonality of feeding.*

Introduction

Knowledge on the food, feeding habits and trophic inter-relationships of fishes is essential to understand the life history of fish including growth, breeding and migration (Bal and Rao, 1984). This will also help to understand the predicted changes on ecosystem due to natural or anthropogenic interventions. Cobia *Rachycentron canadum* (Linnaeus, 1766) is an esteemed table fish occurring both along east and west coast of India. Moreover, Cobia is considered as a potential species for mariculture.

Priliminary information on food and feeding habits of cobia occurring in Aransas Bay was provided by Miles (1949). Other studies on food and feeding habits of cobia are that of Knapp (1949, 1951), Joseph *et al.* (1964), Richards (1967), Takamatsu (1967), Sonnier *et al.* (1976), Darracott (1977), Randall (1985), Dity and Shaw (1992), Smith (1995), Franks *et al.* (1996), Meyer and Franks (1996), Somvanshi *et al.* (2000), Arendt *et al.* (2001), Chou *et al.* (2004), Ganga *et al.* (2012) and Rohith and Bhat (2012). All these studies provided information on the preferential diet of the cobia inhabiting in different water bodies round the world.

Knowledge on feeding intensity is essential to understand the interrelationship of the fish in the ecosystem and the effects of environmental changes on the feeding pattern of the fish. Moreover, information on feeding intensity is essential in managing the organism in the culture system. The

information on the feeding intensity of cobia and difference in their feeding intensity due to seasonal variation, sex, and size are scanty. Hence, an attempt was made to study the feeding intensity and its variation according to the changes in season, sex and size of *R. canadum* inhabiting along the northwest coast of Indian EEZ.

Material and methods

Samples of cobia, *R. canadum* collected from the vessel *M.V. Matsya Nireekshani*, belonging to the Fishery Survey of India, Mumbai and samples from landing centers viz. Sassoon dock and new ferry wharf at Mumbai for a period of two years from January 2008 to December 2009 were used for this study. Length, weight, sex, stomach fullness and length of alimentary canal of specimens were recorded before dissecting the stomach (Philip, 1994). The stomachs were visually classified as gorged, full, ¾ full, ½ full, ¼ full, traces and empty based on the degree of fullness and the amount of food contained in them (Philip,1994). The stomachs were dissected out following standard procedures and analysed in fresh condition. Three hundred and thirty-one guts were examined for the study, which includes 158 male, 127 female and 46 juveniles (sex not identified). Major gut contents of Cobia were identified up to species/genus/ group level to understand the diversity of its gut content.

The average intensity of feeding was evaluated by points method (Pillai, 1952). Points were assigned as 10, 9, 7.5, 5.0, 2.5, 1.0 and 0 for gorged, full, ¾ full, ½ full, ¼ full, trace and empty stomachs, respectively. Feeding intensity was assessed following two methods ie. Mean Index of Feeding intensity (MIF) and Index of Fullness (IF). Month-wise Mean Index of Feeding Intensity (MIF) was calculated by taking average value of points allocated to the fullness of stomachs of each month's sample (Robotham,1977). Index of fullness (IF) or Degree of satiation values were calculated following Shorygin, 1952.

Month-wise average values of MIF and IF were assessed separately for male, female, and pooled to understand seasonal variation in feeding intensity and also to assess sex wise variation. Feeding intensity in different length groups were also assessed for understanding the changes in feeding behavior of the fishes in different life stages. Month-wise and lengthwise occurrences of empty stomachs were assessed separately for male, female and pooled data to understand the feeding absenteeism in the fish. The Gastrosomatic Index (GSI) is another method used to estimate the feeding intensity of fish. GSI values were calculated following Desai, 1970.

Gastrosomatic index values of male, female and pooled were calculated on month-wise and length group basis. Values thus obtained were compared with the relative condition factor values recorded during the month for the particular size group/ sex of fish..

Results and discussion

Feeding intensity

Major gut contents of cobia were fishes, crabs, squilla, penaeid shrimps, non penaeid shrimps, squids, cuttlefishes, octopus, other mollusc, digested matter and others (Table 1). As shown in Table, cobia feed on variety of prey items available in the ecosystem. Results of the studies carried out on the composition of gut content indicate that cobia is an opportunistic feeder (Somvanshi *et al*., 2000; Ganga *et al*., 2012; Rohith and Bhat, 2012).

Table 1. Constituents of gut contents of Cobia, *Rachycentron canadum*

S. No	Major group	Major constituents Group/ Genus/species level
1	Fish	*Tetradontids, Rastrelliger kanagurta, Leiognathids, Nemipterus spp., Decapterus spp., Eel, Therapon jarbua, Acropoma sp., Other carangids, Elasmobranchs, Saurida spp., Priacanthus spp., Cynoglossuss spp., Sphyraena spp., Stolephorus spp., Megalaspis cordyla, Platycephalus spp., Harpodon nehereus, Sardinella spp., Trichiurus sp., Epinephelus diacanthus, Sciaenids, Ambassis spp., Alectis spp. and Others*
2	Crab	*Portunus sanguinolentus, Portunus pelagicus, Charybdis feriatus and Charybdis smithii*
3	Squilla	*Oratosquilla nepa*
4	Shrimp penaeid	*Fenneropenaeus indicus, Penaeus monodon, Penaeus merguiensis, Metapenaeus dobsoni, Metapenaeus monoceros, Metapenaeus affinis, Solenocera crassicornis and Solenocera choprai*
5	Shrimp non penaeid	*Nematopalaemon tenuipes, Exhippolysmata ensirostris, Acetes indicus, Acetes johni, Acetes sibogae and Acetes erythraeus*
6	Squid	*Loligo duvaucelli, Doryteuthis sibogae and Loliolus investigatoris*
7	Cuttle fish	*Sepia pharaonis, Sepia aculeata, Sepia elleptica and Sepiella inermis*
8	Octopus	*Cistopus indicus*
9	Other Mollusca	Not identified
10	Digested matter	Not identified
11	Others	Not identified

The intensity of feeding and month-wise, sex-wise and size wise variation on the intensity were analysed. Results of month-wise analysis of feeding intensity of Cobia is presented as Table 2. As it is evident from Table 2, Cobia actively fed during post monsoon period with a peak during December and the percentages of actively fed fishes were low during July and September. As far as share of empty stomachs is concerned maximum percentage was recorded during

Table. 2. Month-wise Feeding intensity in percentage of *Rachycentron canadum* (pooled)

Month		Poor feeding		Moderate feeding	Active feeding			Number of Observations
	Empty	Trace	1/4th Full	1/2 full	3/4 full	Full	Gorged	
Jan	3.33	23.33	10.00	33.33	3.33	23.33	0.00	30.00
Feb	10.81	6.76	21.62	14.86	18.92	25.68	1.35	74.00
Mar	46.43	3.57	14.29	3.57	0.00	32.14	0.00	28.00
April	18.75	31.25	15.63	9.38	12.50	12.50	0.00	32.00
May	6.67	26.67	0.00	33.33	0.00	20.00	13.33	15.00
June	12.90	9.68	6.45	38.71	3.23	29.03	0.00	31.00
July	8.33	16.67	16.67	41.67	8.33	8.33	0.00	12.00
August	26.19	4.76	19.05	16.67	7.14	23.81	2.38	42.00
Sept	71.43	0.00	0.00	7.14	0.00	21.43	0.00	14.00
Oct	0.00	0.00	25.00	16.67	33.33	25.00	0.00	12.00
Nov	15.00	20.00	25.00	10.00	5.00	20.00	5.00	20.00
Dec	4.76	4.76	4.76	4.76	14.29	66.67	0.00	21.00
Total	17.82	11.78	14.80	18.43	9.67	25.98	1.51	331.00

September and March. In general, 56% of fishes were found in either actively fed or moderately fed state.

Analysis of month-wise percentage of occurrence of stomach condition of male and female Cobia in different degree of fullness and feeding condition showed that except during April and July, male Cobia fed very actively. On an average, 56% of female and 52 % male Cobia was found either active or moderately fed.

Variation in the feeding intensity based on length of *R. canadum* was analysed and results are presented in Table.3. Feeding intensity invariably increases in proportion to length. This clears that the percentage of occurrence of empty stomach showed a decreasing trend when the fish grow. Except at the mid length of 135 cm, empty stomachs were absent in the case large sized Cobia. In general 55% of juveniles and 57% adults were found either in active or moderately fed condition.

Mean Index of Feeding intensity (MIF) and Index of Fullness (IF)

Month-wise Mean Index of Feeding intensity (MIF) and Index of Fullness (IF) values for male, female and pooled data are furnished in Table 4. As showed in Table. 4, these fishes were well fed during most of the months. In the case of male, low feeding intensity was recorded during April and July.

Likewise, females were recorded as poorly fed during March, April and July. Values estimated for the pooled data also supports the above view. Similar trend was observed in the case of MIF and IF values of all three categories, with some exception during certain months. In general, Cobia fed well during post monsoon periods and poor feeding activity was noticed during the month of July.

Variation in the Feeding intensity was analysed by comparing the MIF and IF values of juvenile and adults. The result is illustrated as Fig. 1. As exemplified in Fig.1 MIF and IF values of juveniles were 4.62 and 3.96 respectively against 7.79 and 5.26 recorded for adults. This indicates that adults are

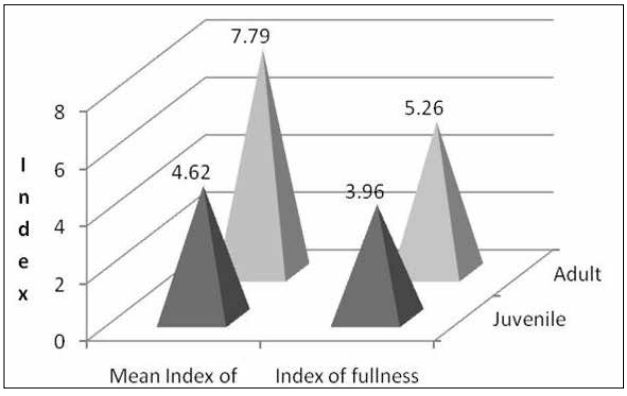

Fig. 1. Mean index of fullness and index of fullness of adult and Juvenile Cobia *Rachycentron canadum* (pooled).

Table 3. Length-wise variation of feeding intensity in percentage of *Rachycentron canadum* (pooled)

Mid length of Length class (cm)	Poor feeding			Moderate feeding		Active feeding		Number of Observations
	Empty	Trace	1/4th Full	1/2 full	3/4 full	full	Gorged	
25	32.61	17.39	17.39	13.04	4.35	15.22	0.00	46.00
35	21.88	12.50	14.06	18.75	9.38	20.31	3.13	64.00
45	15.38	14.29	10.99	19.78	14.29	24.18	1.10	91.00
55	11.90	4.76	9.52	21.43	7.14	45.24	0.00	42.00
65	13.79	17.24	10.34	10.34	10.34	37.93	0.00	29.00
75	13.64	4.55	18.18	22.73	9.09	27.27	4.55	22.00
Juveniles	19.12	13.24	12.24	17.65	9.93	26.47	1.10	294
85	15.38	7.69	30.77	7.69	0.00	30.77	7.69	13.00
95	14.29	0.00	57.14	14.29	14.29	0.00	0.00	7.00
105	0.00	0.00	33.33	50.00	16.67	0.00	0.00	6.00
115	0.00	0.00	0.00	0.00	50.00	50.00	0.00	2.00
125	0.00	0.00	0.00	0.00	0.00	100.00	0.00	2.00
135	20.00	0.00	20.00	60.00	0.00	0.00	0.00	5.00
145	0.00	50.00	0.00	0.00	0.00	50.00	0.00	2.00
Adults	11.86	5.08	25.42	22.03	8.47	24.73	3.39	37
Total	17.82	11.78	14.80	18.43	9.67	25.98	1.51	331

Table 4. Month-wise mean Intensity of Feeding and Index of fullness of *Rachycentron canadum*

Month	Male		Female		Pooled	
	Mean Index of fullness	Index of fullness	Mean Index of fullness	Index of fullness	Mean Index of fullness	Index of fullness
Jan	5.81	3.52	4.33	1.74	4.86	2.74
Feb	5.93	5.63	6.02	5.57	5.87	6.04
Mar	7.34	6.03	5.08	2.05	6.36	4.41
Apr	2.46	2.08	2.75	1.88	3.79	3.15
May	5.68	3.44	3.88	4.55	4.44	3.75
June	6.24	4.19	4.87	9.37	5.69	6.30
July	4.13	1.79	4.88	1.69	4.38	1.81
Aug	5.83	6.05	5.29	3.67	5.76	4.63
Sept	9.00	1.08	7.00	7.41	7.00	5.78
Oct	5.75	7.51	7.75	5.47	6.47	6.90
Nov	6.05	5.78	3.90	8.25	4.81	5.53
Dec	8.66	3.18	4.33	1.74	7.8	4.94
Average	6.07	4.19	5.01	4.45	5.60	4.66

more active in feeding than juveniles. Higher efficiency in the predatory behavior of adult cobia may be the reason for these differences in feeding intensity of different life stages of cobia.

Gastrosomatic Index (GSI)

Month-wise Gastrosomatic index values for male, female and pooled are furnished in Fig.2. Male were found feed better than female as the GSI values of male were on higher side. This indicates the active feeding nature of male. In general, GSI value for the months of January, March and July were on the lower side, which manifest the very low feeding intensity during the above period.

Length-wise Gastrosomatic index (GSI) values were compared with the Relative Condition Factor (Kn) values recorded for

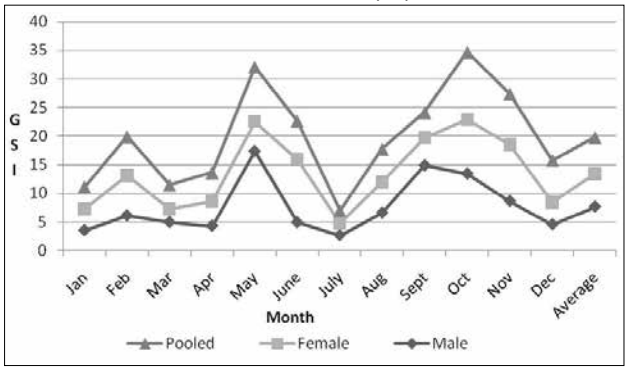

Fig. 2. Month-wise gastrosomatic Index (GSI) values of *Rachycentron canadum*.

the length group (Fig.3). GSI value was maximum in smaller size group (21-30), from there it showed a decreasing trend up to the length class 61-70. After the size group 60-70 the GSI value showed an increasing trend. Interestingly, both male and female cobia reaches the sizes at first maturity when they are in the size group of 61-70 (Sajeevan, 2011). Hence the fluctuation in the GSI pattern can be considered as an indication of a major change in the life history pattern of the fish. The GSI values of mature size class were almost

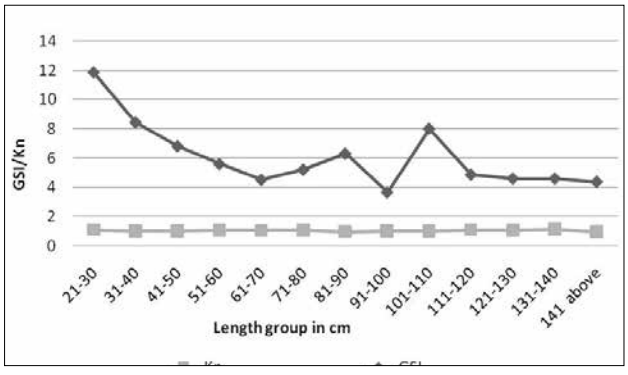

Fig. 3. Length- wise gastrosomatic Index (GSI) and Relative Condition Factor (Kn) of *Rachycentron canadum* (pooled).

similar with some fluctuation in certain size groups. The Kn values were almost equal to one with slight variation in some length group. This indicates that the fish is in good condition throughout their life history. As the variation in the Kn values were minute, changes in the life history pattern was not clear as appeared in the case of GSI pattern.

Seasonal variation in feeding habits and feeding intensity was noticed during the study. On an average, feeding intensity was low during July. Reduction in water temperature due to southwest monsoon, peak-spawning activity and less availability of prey items during the month can be attributed for this low feeding intensity. Hassler and Rainville (1975) observed reduced feeding activity at a water temperature below 18^0C. Results of the present study support this hypothesis as the low feeding intensity coincide with the peak monsoon season (July) and low sea water temperature. Moreover, peak spawning activity of cobia takes place during July-August and November-January (Sajeevan, 2011). Less intake of feed during the peak spawning may be the reason for low feeding intensity during July. Results of Richard (1977) support this view as the results of the study inferred that cobia may cease feeding during spawning.

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