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Stomach contents and length-weight relationship of the white-spotted rabbitfish *Siganus canaliculatus* (Park, 1797) from the Arabian Sea coast of Oman

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Abstract

The white-spotted rabbitfish *Siganus canaliculatus* feeds mainly on seaweeds and seagrass during most part of the year in the Omani waters. The presence of benthic invertebrates like polychaetes, small shrimps and bivalves in large sized fish appears to be accidental inclusions. Majority of mature fish occurred with empty stomach or with little food during spawning season. The monthly hepato-somatic index ranged from 1.1 to 1.73 in males and 1.06 to 1.8 in females and the values were generally higher prior to spawning months. The length-weight relationships of males and females differed significantly ($p < 0.05$) and can be expressed as log W = -4.0395 + 2.6736 log L for males and log W = -4.3544 + 2.8048 log L for females.

Keywords: *Siganus canaliculatus*, food and feeding, hepato-somatic index, length- weight relationship

Introduction

The family Siganidae popularly called rabbitfishes are small to moderate-sized, commercially important fishes distributed throughout the Indo-Pacific region (Randall, 1995). Several species of siganids are considered as excellent candidates for mariculture (Lam, 1974; Randall *et al*., 1997). Among the *Siganus* spp. of Oman, the white-spotted rabbitfish, *S. canaliculatus* (Park, 1797) is dominant in the landings both from the Arabian Sea and the Gulf of Oman. The estimated landings of *S. canaliculatus* from the Arabian Sea coast of Oman for the years 2005-06 and 2006-07 stood at 571 t and 443 t respectively (GoSO, 2007; MSFC, unpublished data). In spite of its commercial and culturable importance, no information is available on the biological characteristics of *S. canaliculatus* from the Omani waters.

Knowledge on food and feeding is essential to attempt culture possibilities of *S. canaliculatus* in Oman. Similarly, study on the length-weight relationship helps to determine the mathematical relationships between the two variables so that if one is known the other can be computed and to calculate the variation from the expected weight for the length of the individual or groups of fish (Le Cren, 1951). Further, the estimation of a and b parameters of length-weight relationship is important for stock assessment (Vivekanandan, 2005). The present paper deals with the stomach content analysis, hepato-somatic index (HSI) and length-weight relationship of *S. canaliculatus* from the Arabian Sea coast of Oman.

Material and Methods

A total of 895 specimens collected at random on monthly basis between April 2005 and March 2007 from different artisanal gears such as gillnets of different mesh sizes, traps and beach seines operated in the coastal waters of the Arabian Sea between Laqbi and Salalah (Fig. 1) were analysed in the laboratory for gut contents. The size of fish in the commercial catches ranged between 15 and 38 cm of total length (TL).

After washing, the TL of each fish was measured to the nearest 1 mm using a fish measuring board and the total wet weight (TW) was recorded to the nearest 1 g using an electronic balance. Then the fish was cut open sex and maturity stage were recorded. The liver was removed and weighed to the nearest 0.001 g using an electronic balance. Stomachs were preserved in 5% neutral formalin for subsequent analyses.

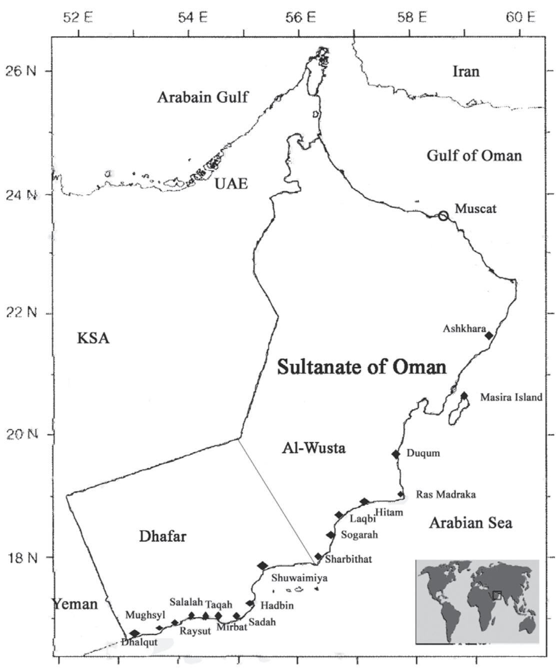

Fig. 1. Map showing the Arabian Sea and Gulf of Oman coasts of Oman

The food items found in the gut were identified up to group level. When the food was in an advanced state of digestion, it was recorded as semidigested matter. For the seasonal variation of food items, points (volumetric) method (Hynes, 1950) was used. Feeding intensity of fish in relation to months, maturity stages and size of fish was observed between September 2005 and September 2006. Based on the fullness, the stomachs were grouped into actively fed (full and 3/4 full stomach), moderately fed (1/2 full stomach), poorly fed (1/4 full stomach) and empty. Feeding intensity was determined in relation to different stages of maturity of *S. canaliculatus* such as I-Immature; II-Maturing 1; III-Maturing 2; IV-Mature; V-Ripe/Running and VI-Spent based on macroscopic appearance and microscopic structure of ova in different stages of maturity of females and on the macroscopic appearance of the testes in males (Al-Marzouqi *et al.*, 2009).

To understand the nutritional state of the fish, the monthly hepato-somatic index (HSI) was determined (Busacker *et al.,* 1990) using the formula,

$$HSI = HW/TW \times 100$$

where HW is liver weight (g) and TW, is total weight (g).

For estimation of length-weight relationship, a total of 648 specimens comprising 346 males and 302 females were measured for their TL to the nearest mm and weighed to the nearest g. The general equation, Y = a+bX was used separately for male and female by taking logarithm on both the sides Y = log W and X = log L.

The coefficient of determination (R^2) was estimated to know the strength and pattern of association between the two variables. Analysis of covariance (ANCOVA) (Snedecor and Cochran, 1967) was employed to test the significant difference if any, in the relationships between males and females at 5% level.

Results and Discussion

***Food composition*:** The food mainly consisted of plants namely the seaweeds (green and brown algae) and to some extent the seagrass. There was not much variation in the food composition during 2005-06 and 2006-07 (Fig. 2) except the presence of zoobenthos like polychaete worms, small crustaceans (shrimps, crabs) and bivalves (about 4.7%) during 2005-06. The contribution of semidigested matter was high (49.7%) during 2005-06 than during 2006-07 (26.7%). The presence of considerable quantites of semidigested matter might be due to the rapid digestion that takes place in the tropical waters as the metabolic rate is high (Kalita and Jayabalan, 2000).

Monthly variation in the composition of diet: Among the identifiable food items, the seaweeds were dominant in the gut of *S. canaliculatus* during most part of the year (Fig. 3). During 2005-06, the percentage contribution of benthic algae was higher than 50% to the total volume of food items during April-May and February. Seagrass was found in

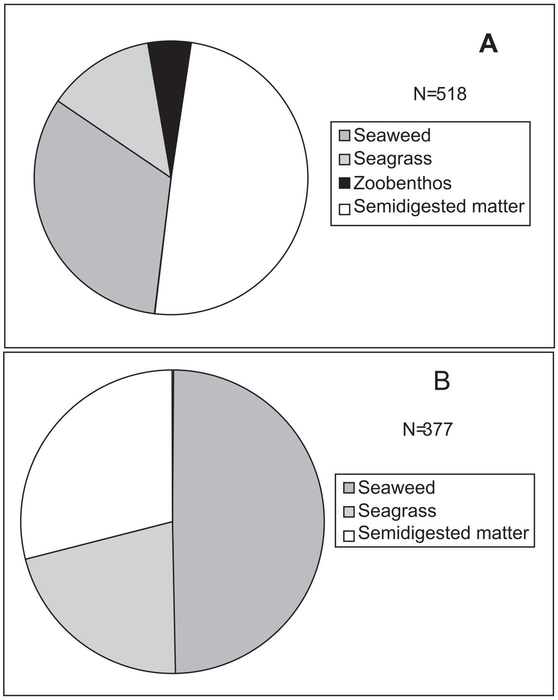

Fig. 2. Composition of food items of *S. canaliculatus* (A) 2005-06, (B) 2006-07

moderate percentages during May-June and July and its contribution ranged from 0 to 35.3%. The benthic invertebrates occurred only during January 2006 with 47.1%. The contribution of semidigested matter ranged between 10.4% and 95.5% during 2005-06. During 2006-07, the seaweeds were dominant in the gut during all the months.

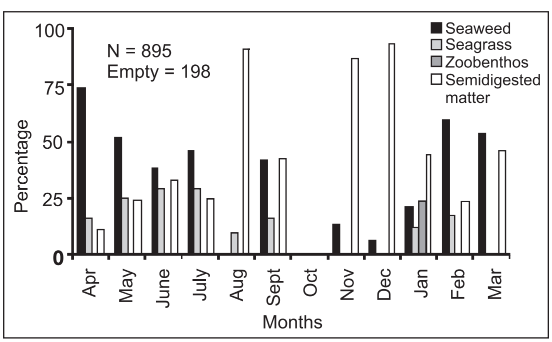

Fig. 3. Monthly variation in the composition of food items in *S. canaliculatus* during 2005-06 and 2006-07 (pooled)

Food composition in relation to size of fish: The percentage composition of food items found in different size groups of *S. canaliculatus* pooled for 2005-06 and 2006-07 showed that the volume of seaweeds increased from 15.4% in 17-18 cm fish to 54.7% in 25-26 cm size group (Fig. 4). While the share of seagrass was moderate, benthic invertebrates were found in larger size groups between 26-27 cm and 33-34 cm. Semidigested food was found in all the size groups.

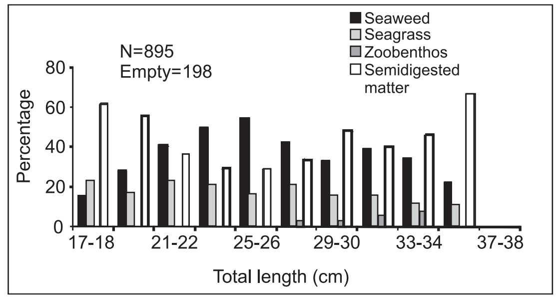

Fig. 4. Food items in the gut of various size groups of *S. canaliculatus* during 2005-06 and 2006-07 (pooled)

While the functional morphology of the gut of *S. canaliculatus* is suited for herbivorous feeding, laboratory studies indicated the macroalgae and seagrass as the main food preferred by the fish (Westernhagen, 1974; Bryan, 1975; Lundberg and Lipkin, 1979). The present study also indicates that *S. canaliculatus* feeds mainly on seaweeds and seagrass during most part of the year in the Omani waters and the presence of benthic invertebrates like polychaetes, small shrimps and bivalves in large-sized fish of 27-28 cm to 33-34 cm might be of accidental ingestion as indicated in *S. canaliculatus* in the Philippine waters (Westernhagen, 1973). However, *S. canaliculatus* fed on pellet diet grew faster in culture systems (Bwathondi, 1982) and on detritus of terrestrial origin, fish carrion, bivalves, amphipods and larval decapods, polychaetes and barnacles in the estuaries of Hong Kong (Wu, 1984).

Feeding intensity in relation to months: Active feeding was recorded during September 2005 (67.9%) and February (58.3%), April (67.5%), August (68.3%) and September (72.5%) 2006 (Fig. 5). While moderate feeding was observed during January 2006, June-August (> 30.0%), poor feeding was recorded in more than 20% of fish during November 2005-January 2006. Higher percentages of empty stomachs were encountered during all the months of the study with the highest (64.3%) during November 2005 followed by July 2006 (52.5%).

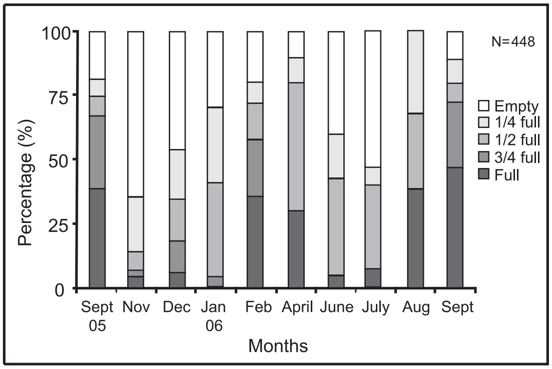

Fig. 5. Feeding intensity in *S. canaliculatus* during different months

Feeding intensity in relation to maturity stages: Generally, active feeding was observed in higher number of individuals in immature, maturing, and spent conditions of both males and females (Fig. 6). Moderate feeding was also seen in lower stages. Poor feeding was common in mature males and females. In the present study, though fishes with empty stomachs were recorded in different maturity stages of males and females, higher percentages of empty stomachs were recorded in mature males (50%) and females (58.3%). Fishes with empty stomach and poor feeding activity are common in several species of tropical fishes (Kagwade, 1972; Sreenivasan, 1974; Kalita and Jayabalan, 2000; Zacharia, 2003).

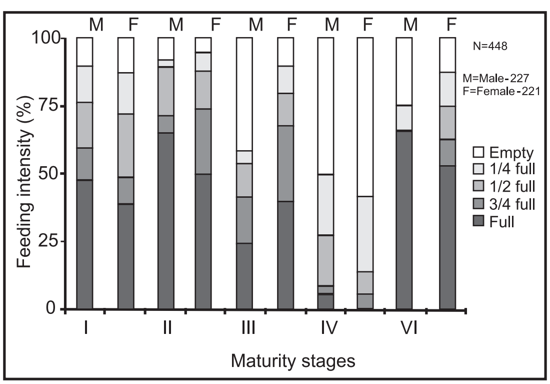

Fig. 6. Feeding intensity in relation to different maturity stages of *S. canaliculatus*

The spawning of *S. canaliculatus* in the Arabian Sea coast of Oman takes place between November and February and during June-July. During spawning months, majority of mature fish occurred with empty stomachs or with ¼ full stomachs. This may be due to the calorific value of food consumed (Longhurst, 1957) or faster rate of digestion (Qasim, 1972).

Feeding intensity in relation to size of fish: Observation on feeding intensity in relation to size of *S. canaliculatus* clearly indicated that as the fish grows in size, active feeding declined (Fig. 7). The fishes in 17-18 cm size group feed actively. The percentages of empty stomach increased from 0% (17-18 cm) to 77.8% (37-38 cm) as the size group of fish increased. Moderate and poor feeding was observed in all the size groups at varying percentages. Low feeding intensity in large-sized fish may be due to physiological stress associated with spawning (Zacharia, 2003).

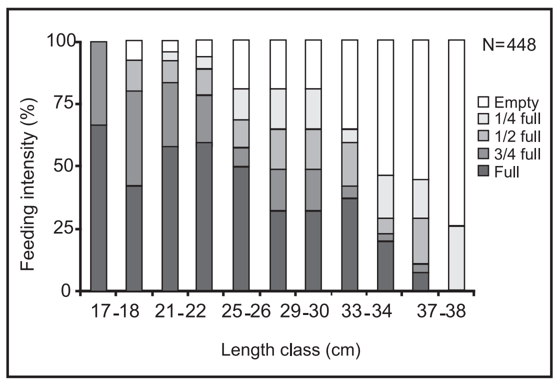

Fig. 7. Feeding intensity in different size groups of *S. canaliculatus*

Hepato-somatic Index (HSI): The average monthly hepato-somatic indices for the years 2005-06 and 2006-07 showed an irregular trend in males and females (Fig. 8). In males the HSI values ranged between 1.1 (November) and 1.7 (September) and in females the corresponding values were 1.06 (November) and 1.8 (May). Besides storing energy in the muscle, the fish accumulates in the liver during periods of high energy intake and the relative size of liver can be correlated with the nutritional state of the fish and also with the growth rate (Busacker *et al*., 1990). Considering the spawning season of *S. canaliculatus* in the Omani waters, the drop in monthly HSI during June-July coincided with the minor spawning activity. However, prior to peak spawning season (November-February), the HSI dropped to the lowest in November in both males and females and abruptly increased in females than in males in subsequent months.

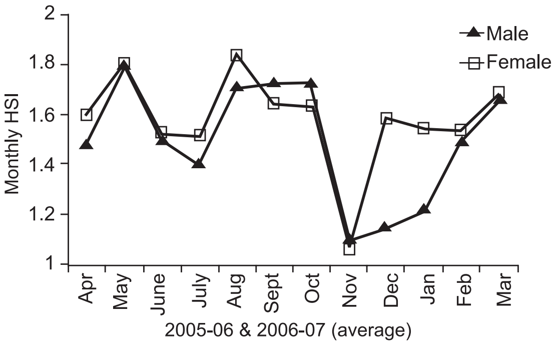

Fig. 8. Monthly hepato-somatic index in *S. canaliculatu*

Length-weight relationship: The linear regression equations for length and weight of males and females can be expressed as follows:

Male : log W = -4.0395 + 2.6736 log L (r^2 = 0.9447)

Female: log W = -4.3544 + 2.8048 log L (r^2 = 0.9544)

The relationships show that the females are slightly heavier than the males of the same length. The regression equations derived for males and females when tested for equality through ANCOVA test (Table 1) showed the slopes to differ significantly between the sexes ($p < 0.01$); however, the elevations did not differ at 5% level ($p > 0.05$).

The b value in length-weight relationship in an ideal fish will be equal to 3 (Allen, 1938). Significant variation from the isometric growth is not always common in fishes (Beverton and Holt, 1957). Similar significant difference between the length - weight relationship of males and females was found for *S. canaliculatus* from the Arabian Gulf (Al-Ghais, 1993). However, no significant difference was observed between the length-weight relationships of males and females of *S. canaliculatus* from Indian waters by Jayasankar (1990). The observation in the present study that the females were slightly heavier than males of same length is in agreement with the earlier study by Al-Ghais (1993).

Table 1. Comparison of length-weight relationships between sexes

						Deviations from regression				
Source	d.f.	ssx	ssy	ssxy	Reg.coef	d.f.	S.S.	M.S	F	Prob
Within										
Males	345	7.712801	58.36023	20.62105	2.673613931	344	3.227501	0.009382		
Females	301	6.567479	54.13166	18.42023	2.804764208	300	2.467256	0.008224		
						644	5.694757	0.008843		
		Difference between slopes				1	0.061012	0.061012	6.837052	0.009137237
Between B										
W+B	647	14.33529	113.1207	39.22726		646	5.778711			
		Between adjusted means				1	0.022942	0.022942	2.570923	0.109333773

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