Evaluation of some feeding indices *of Pomadasys kaakan* in the Northern Persian Gulf

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Received: September 2010 Accepted: March 2011

Abstract

In this paper the Vacuity Index (VI), Fullness Index (FI) and Food Preference Index (FPI) for the stomach contents of *Pomadasys kaakan* were evaluated to assess the quantity and kind of food which this fish consumes in the Persian Gulf. A total of 227 specimens were collected from fishing trawlers or landings from November 2005 to September 2006. 24.7% of stomachs were full, 11.9% were semi-full and 63.4% were empty. The seasonal average of VI was 77.4, 44.6, 80.0 and 54.0 % for autumn, winter, spring and summer, respectively. The overall FI was 36.6 with seasonal averages of 22.6, 55.4, 20.0 and 46.0 in autumn, winter, spring and summer, respectively. The main stomach contents were crustaceans (esp. crab & shrimp), fish, mollusks (bivalves, gastropods and cuttlefish), stomatopoda, brittle stars, *Lingula* sp. and sea weeds. The estimated FPIs for crustaceans were 77.7, fish 32.1, mollusks 28.6 and echinoderms 18.8 %. Overall, the results show that this fish is a relatively frugal species which consumes crustaceans as main food and has adopted itself with ecological changes of the Persian Gulf.

Keywords: *Pomadasys kaakan*, Feeding, Food Preference, Vacuity and Fullness Indices, Persian Gulf

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Introduction

The Persian Gulf is a semi-closed water body connected to the Gulf of Oman through the Strait of Hormuz. The maximum width of the Persian Gulf is 640 km and its average depth is 35m (Reynolds, 1993). Less saline (and less dense) water enters at the Strait of Hormuz at the surface and more saline (and denser) water leaves the area at the bottom (Sheppard et al., 1992).

Next to oil, fisheries are the second most important natural resource, and the most important renewable natural resource in the study area (Carpenter et al., 1997).The waters of the Persian Gulf and the Gulf of Oman are environmentally unique with an unusual faunal assemblage (Carpenter et al., 1997). There are numerous commercially exploited fish species which include the javelin grunt (*Pomadasys kaakan,* family: Haemulidae). This species is caught by a range of gears including bottom trawl, gillnet and trap (Adjir, 2005).

The javelin grunt inhabits coastal waters to 75 m depth, in rocky areas, coral reefs and in muddy substrates. In addition to the Persian Gulf and the Gulf of Oman, this species is found in the neritic zones of the Indian Ocean and adjoining waters including the west coast of Africa, the Red Sea, the Gulf of Aden, and Sri Lanka. It is also distributed in the northern areas of Australia to the southern parts of Taiwan. It has been reported to reach a maximum length of up to 80 cm (Al-Abdessalam, 1995) and specimens up to 41 cm are commonly caught in the fisheries.

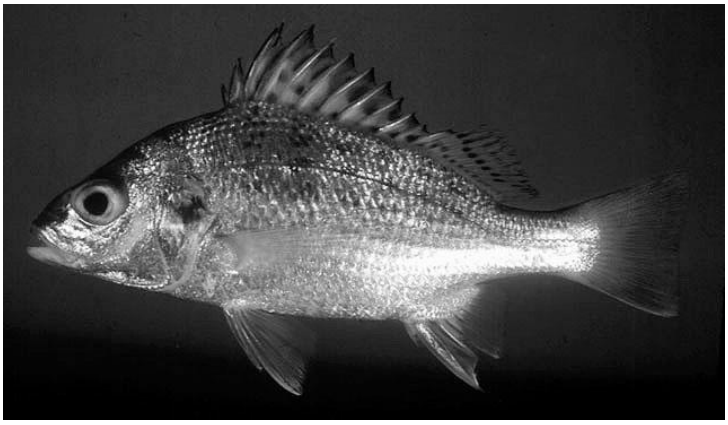

Figure1: Javelin grunt, *Pomadasys kaakan* (from Randall, 1997 available at www.fishbase.com)

There are few published studies on feeding of this species in the study area however Talebzadeh et al. (1992) and Pour-Reza (1997) have assessed the feeding habits of *P. kaakan* in the Persian Gulf and the Gulf of Oman. They reported that this species is an active predator, feeding generally on small fishes, crustaceans and polychaeta (Fischer and Bianchi, 1984). Pour-Reza (1997) reported that *P. kaakan* feeds on a wide variety of fish species inhabiting coral reefs.

This study conducted qualitative and quantitative analysis of stomach

contents to determine the seasonal prey composition and feeding intensity of *P. kaakan* in the Persian Gulf and the Gulf of Oman.

Materials and methods

The study was conducted in three sampling areas of Hormuzgan province in southern Iran (Fig. 2). The study area extends 68476 km^2 between latitudes 25º23'N and 28º57'N and longitudes 52º41'E and 58º00'E. Depths ranged from 10 to 50 m in the Persian Gulf and 10 to 100 m in the deeper waters of the Gulf of Oman. The total area was stratified into 7 strata (A to G), of which 5 strata belong to the Persian Gulf (A to E) and 2 strata were for the Gulf of Oman (F & G). Each stratum was classified into 4 substrata (depth layers) of 10-20, 20-30, 30-50 and 50-100 m. Samples were collected between October 2005 and September 2006 from the three indicated sampling areas in Figure 2. Samples were obtained from each area twice per season from commercial trawlers active in the area. Samples were taken at pre-selected random fishing stations. The seasons corresponded to the quarters of the year i.e. winter is January to March.

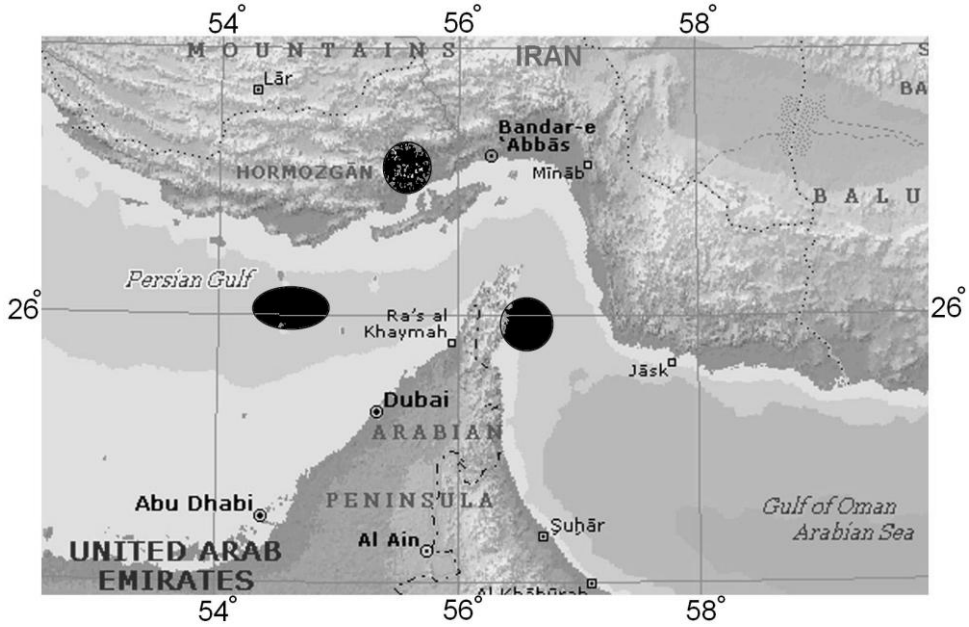

Figure 2: Map of the study area in the coastal waters of Hormuzgan province-northern Persian Gulf (Derived from Iran National Geography Center, the circles showing the sampling regions)

The specimens collected at sea were subsequently analyzed in the laboratory. The intact specimens were measured for total length (mm) and body weight (g). An abdominal cut was made to determine the sex of the specimen and to exit the digestive tract. The stomach and intestine were weighted and then emptied and the stomach contents were preserved in 10% formaldehyde solution for further microscopic examination and identification of prey items. Stomach contents were identified in two stages and first they were sorted to higher taxa (*e.g.* bivalvia, gastropoda, fishes, crabs, shrimps, etc). Further identification within each taxonomic group was done following appropriate taxonomic identification guides (Fischer and Bianchi, 1984; Jones, 1986; Asadi and Dehghani, 1996; Randall,

1997; Carpenter et al., 1997; Sadeghi, 2003; Jereb and Roper, 2005). Identified prey items were weighed to 0.01g precision.

Two feeding indices, VI and FPI, were calculated for each seasonal sample as well as the overall (annual) index. The VI reflects the frequency of feeding, i.e. the fraction of the population having food in the digestive tract and is defined as (Euzen, 1987):

$$VI = \frac{E_S \times 100}{T_S}$$

Where,

E_S = number of empty stomach samples

T_S = Total number of stomach samples.

The intensity of feeding as indicated by the VI is interpreted as:

- Edacious species $0 \le VI < 20$
- Relatively edacious species $20 \le \mathrm{VI} < 40$
- Moderate feeder $40 \le \mathrm{VI} < 60$
- Relatively abstemious $60 \le \mathrm{VI} < 80$
- Abstemious $80 \le \mathrm{VI} < 100$

Seasonal and sex based differences in VI were tested pairwise using two-sample T-tests of proportion (Euzen, 1987) at p=0.05.

Also the diet using a Food Prevalence Index defined (Euzen, 1987); who called it "Food Preference Index" was calculated as:

$$FP_j = \frac{NS_j \times 100}{Ns}$$

Where,

NS_j = total number of individual prey of species *j* in all samples (stomach and intestine)

Ns = Total number of samples containing food.

If $FP_j < 10$ then species *j* is considered to be negligible in the diet. For FP_j between 10 and 50, species *j* is considered a minor prey species and if $FP_j > 50$ then species *j* is a main diet item.

Results

A total of 227 specimens of javelin grunt (*P. kaakan*) were collected from the 3 sampling areas. There were 144 empty stomachs (VI = 63.4%) in total (Table 1). VI was higher in spring and autumn and there was no significant seasonal difference between them (P≥0.05). VI was lower in the summer and winter and again there was no significant difference between those seasons (P≥0.05). The differences between the high VI seasons (spring and autumn) and the low VI seasons (summer and winter) were highly significant. Comparison of VI between males and females showed no significant difference over the entire year (P≥0.05). The females showed the same pattern of seasonal differences as the overall dataset. On the other hand, the seasonal pattern for males was relatively weak with only one pairwise difference (winter-spring) being significant.

Table 1: Seasonal sample numbers (N) and Vacuity Index (VI) in *P. kaakan* overall and partitioned by sex in the northern Persian Gulf (2005-06)

Season	N (total)	Vacuity Index	Male		Female	
			N	VI (%)	N	VI (%)
Spring	50	80.0	26	76.9	23	82.6
Summer	50	54.1	15	60.0	35	51.4
Autumn	62	77.4	25	64.0	37	86.5
Winter	65	44.6	32	40.6	30	46.7
Total	227	63.4	98	59.2	125	66.4

Crabs, specifically *Portunus pelagicus*, are the only diet item for which the FP index exceeded the threshold (>50) to be considered a main diet item. It was important in the diet year-round being the highest or second highest FP in all seasons. Minor diet groups were stomatopoda, bony fishes, ophiuroidea and bivalvia with FP = 25.0, 25.0, 18.8 and 17.0%, respectively. FP for all other groups was less than 10 making negligible contributions to the diet (Table 2).

Table 2: Food Prevalence Index of *P. kaakan* in the northern Persian Gulf (2005-2006)

	Spring N=13	Summer n=43	Autumn n=17	Winter n=39	Whole year n=112
Food type					
Sea weeds				5.1	1.8
Bivalvia	23.1	14.0	23.5	15.4	17.0
Bony fishes(other)	30.8	27.9	5.9	28.2	25.0
Cephalopod(other)		2.3			0.9
Copepods				2.6	0.9
Crab(other)		2.3	11.8	12.8	7.1
Dentalium				2.6	0.9
Echinodermata			11.8		1.8
Eelfish larvae				2.6	0.9
Fish larvae		2.3		5.1	2.7
Gastropoda	15.4		23.5	7.7	8.0
Jellyfish				2.6	0.9
Leiognathidae	15.4				1.8
Lingula		9.3		2.6	4.5
Metapenaeus affinis		4.7	11.8	7.7	6.3
Mullidae	7.7		5.9		1.8
Octopus aegina		2.3	5.9	5.1	3.6
Ophiuroidea	69.2		41.2	12.8	18.8
Other worms		2.3			0.9
Polychaete				5.1	1.8
Portunus pelagicus	61.5	37.2	35.3	69.2	50.9
Sardine	7.7				0.9
Sea cucumber				2.6	0.9
Sea rabbit				2.6	0.9
Shrimp larvae		58.1		7.7	25.0
Cornetfish			5.9		0.9
Uroteuthis duvauceli	7.7			2.6	1.8
Zooplanktons				5.1	1.8

Table3: Food Prevalence (FP) Index for different types of the Consumed food by *P. kaakan* in the northern Persian Gulf (2005-2006)

	Spring N=13	Summer n=43	Autumn n=17	Winter n=39	Whole year n=112
Food type					
Branchiopoda		9.3		2.6	4.5
Crustacean	61.5	88.4	52.9	82.1	77.7
Echinodermata	69.2		41.2	12.8	18.8
Fishes	46.2	30.2	17.6	35.9	32.1
Jelly fish				2.6	0.9
Mollusca	38.5	16.3	47.1	30.8	28.6
Sea cucumber				2.6	0.9
Sea weeds				5.1	1.8
Zooplanktons				5.1	1.8

Discussion

Understanding fish nutrition habits requires extensive field and laboratory studies to infer the main sources of nutrition for a species. Even then, feeding studies can identify the prevalence of food items but it is not possible to assess the diet preferences of fish without detailed complementary studies to estimate the range and abundance of potential food items available in their natural environment (Biswass, 1993). It is clear that food habits such as frequency of feeding or size and species of prey, are constrained by the evolutionary history leading to the species body shape and digestive system (Nikolsky, 1963).

In this study, *P. kaakan* was shown to be a relatively abstemious feeder from the overall estimate of VI of 63.4%. This is consistent with results from Talebzadeh et al., (1992) who estimated annual VI to be 77% i.e. also in the relatively abstemious range. Seasonal patterns in this study were also consistent with Talebzadeh et al., (1992) with moderate feeding in winter and summer and dropping to relatively abstemious in spring and autumn, simultaneous with the spawning season (Valinassab et al., 2007).

The javelin grunt is a carnivorous fish (Fischer and Bianchi, 1984; Allen, 1985) capable of rapid digestion which may contribute to the high values estimated for VI. The speed of digestion also makes detailed taxonomic identification less achievable. In this study, sample collection was carried out during daylight hours only. If *P. kaakan* feeds more heavily at night, the daytime sampling may have resulted in many stomach contents being highly digested or stomachs being empty. Further study to determine the diurnal pattern of feeding would clarify this issue. Polovina and Ralston (1987) reported that there is an inverse relationship between spawning and feeding in fish. During spawning season, the gonads especially ovaries, grow substantially larger, generally filling the body cavity and also transferring energy content of body to gonads. This displaces and limits the size of the digestive tract in turn limiting fish feeding (Dadzie et al., 2000). The spawning season of *P.kaakan* was reported to be in the spring (Valinassab et al., 2007) with the peak of

reproduction consequently corresponding to the lowest feeding rate i.e. peak values for VI.

Our results indicate that crustaceans, entirely *P. pelagicus*, are the single major food group and minor groups include fish, mollusks and echinoderms. Other groups observed in the diet data are considered negligible. Other studies (Fischer and Bianchi, 1984; Niameimandi, 1990; Talebzadeh et al., 1992) have consistently identified crustaceans and fish as important food groups. Fischer and Bianchi (1984) also included polychaetes in *P. kaakan* diet. Niameimandi (1990) separated the crustacean component of the diet into crab in the winter and shrimp in the summer. Unlike the present study, these other studies reported the amount of echinoderms such as ophiuroidea as no more than negligible in the diet (Fischer and Bianchi, 1984). The amount of food digestion is dependent on the type of feeding agent, fish species, temperature and the rate of swallowed food is different (Bond, 1979). The presence of identifiable remains from crabs, stomatopods and gastropods in the intestine indicates a less complete digestion of them in comparison with food items which were observed in the stomach only. This suggests that the chitinous exoskeletons of crustaceans persist longer in the digestive tract and consequently may be over-represented in the identified remains (Bond, 1979).

Both the size of individual prey items and the total volume consumed increases with predator growth (Rajauru, 1992; Wootton, 1995) and energy efficiency of predation is improved by taking the largest prey size possible. The predominance of relatively large prey (Portunid crabs) in the diet coupled with fast digestion suggests that the amount of food consumption by *P. kaakan* is relatively high despite the apparent low feeding rate indicated by the high values of VI.

Acknowledgments

We would like to acknowledge Paul Fanning for his precious comments and for reviewing the manuscript. A sincere thanks to reviewers of the manuscript for making this a serious work to provide more valuable publication. The authors would also like to express their special thanks to captain and personnel of R/V Ferdows-1 for all their helps in collecting the samples. We would like to express sincere appreciation to the Iranian Fisheries Research Organization for supporting this study.

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