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Original Article

Feeding habits of striped piggy, *Pomadasys stridens* (Forsskal, 1775) (Haemulidae) in northern part of the Persian Gulf

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Abstract: Feeding habits of *Pomadasys stridens* were studied in northern part of the Persian Gulf. A total of 591 specimens were collected from the coastal water of Bushehr Province using trawl boats from May 2012 to April 2013 and diet composition, feeding intensity and season changes in diet composition were investigated. Vacuity Index was 81% during the study. RGL was 0.98±0.03 classifying this species as carnivorous to omnivorous fish. *Pomadasys stridens* had consumed 48 different food categories in 7 taxonomic classes. Crustacean, Mollusca, foraminifera, nematodes, Echinodermata, Annelida and miscellaneous were the main observed food items. There was no significant difference between males and females regarding diet composition in different months.

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Introduction

Haemulidae is one of the important tropical fishes in terms of ecology and economic point of views. This family is composed of 19 genera and 134 species (Nelson et al., 2016). Striped piggy, *Pomadasys stridens* (Forsskal, 1775), is one of the abundant haemulid fish in the Persian Gulf and Oman Sea (Valinassab et al., 2006). This species has wide distribution in the Pacific, Atlantic and Indian Ocean inhabiting reefs, shelf area, muddy, sandy bottoms and in variety of inshore habitats (Fehri-Bedoui and Gharbi, 2008). It is also important energy importer to reef communities and a major pray for many larger species such as snappers and groupers (Darcy, 1983).

Despite economic and ecological importance of *P. stridens*, there is scarcity of information on its biological aspects and feeding habits. Earlier studies were mainly focused on reproductive biology (Atiqullah Khan et al., 2013; karimi et al., 2014) and length-weight relationship (Karimi et al., 2015; Safi et al., 2014), and the only study on its feeding habits of this species was that of Safi et al. (2013) from the Karachi Coast. Therefore, many aspects of feeding characteristics and habits of this species remain unknown. In general, maintenance of ecosystem balance and design of program for ecological management depends on availability of sufficient information about biology and life history of species. Furthermore, knowledge about feeding features such as feeding habits and behavior, feeding intensity and diet composition usually provides useful tools for ecosystem management and biodiversity conservation. Hence, this study was conducted to investigate the feeding habits of *P. stridens* to provide information about some feeding parameters, including diet composition and feeding behavior of the populations inhabiting the northern part of the Persian Gulf, Bushehr coasts, for fisheries management and conservation purposes.

Materials and Methods

Specimens of *P. stridens* were caught using trawl boat, from the Bushehr Province in the northern part of the Persian Gulf (28°55´19´´N 50°59´49´´E). A total of 591 specimens were collected at monthly intervals from May 2012 to April 2013 (except September).

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Samples were immediately preserved by placing in ice box and then transported to the laboratory, total length and weight of fish were measured using biometry ruler with accuracy of 1 mm and digital balance (AND-Model FX300I) with 0.1 g precision, respectively. Gender was determined visually by macroscopic examination of the specimens' gonads.

Feeding habits: The intestine and stomachs of fish were removed and weighted in full and empty situation by digital balance with precision of 0.01 g. Then, intestine was removed and detached from other tissues gently and its length measured using biometrical ruler to the nearest 1 mm. Stomach and intestine contents were fixed in 4% formaldehyde. Food items were identified and classified to the lowest possible taxonomic levels using various identification keys (Fischer and Bianchi, 1984; Asadi and Dehghani, 1996; Carpenter et al., 1997; Jereb and Roper, 2005). For identification of food items, stereo zoom microscope was used and pray was identified by external morphological characteristics and hard parts of the body such tentacles, frustules, antenna, ornamentations, scales and etc. Some food items which were digested to the extent that was difficult to identify, were considered as unidentifiable items. Parameters which were used to evaluate the feeding habits were divided into two main categories viz. feeding intensity and food preference.

Feeding intensity: Stomachs were divided into two groups; with food (designated as "full") and without food (designated as "empty"). Fullness or emptiness of stomach was determined visually. Vacuity Index (VI) measured using following equation:

$$VI=\frac{\text{Number of empty stomachs}}{\text{Number of examined stomachs}}\times 100$$

According to VI, fish were grouped into 5 different levels from feeding intensity point of view, where 0≤VI≤20 represented for edacious, 20≤VI≤40 relatively edacious, 40≤VI≤60 moderate feeding, 60≤VI≤80 relatively abstemious and 80≤VI≤100 abstemious fish (Euzen, 1987).

Gastrosomatic Index (GaSI) and Stomach Fullness Index (SFI) were calculated by dividing total stomach weight and the weight of stomach content to fish body weight × 100, respectively (Desai, 1970).

Food preferences: As a general index, Relative Gut length (RGL) was calculated by dividing intestine length to fish length. RGL values for carnivorous and omnivorous fish species is 0.6-0.8 and 0.8-1.0, respectively and RGL value about 2.5-16.4 will represented herbivorous fish species (Kramer and Bryant, 1995).

After washing the collected food items from the stomach and intestine, they were identified and grouped into 8 different taxonomic groups (Table 1). According to Numerical Index (NI) and Frequency of Occurrence (FO) values, fish preference for diet was recognized. Equations (a) and (b) were used to measure NI and FO, respectively (Berg, 1979; Hyslop, 1980).

$$NI=\frac{\text{Number of each pry item in all full stomachs}}{\text{Total number of food items}}\times 100 \quad \text{(a)}$$

$$FO=\frac{\text{Number of stomachs containing specific prey}}{\text{Total number of full stomachs}}\times 100 \quad \text{(b)}$$

If FO is <10: prey is considered randomly ingested and not preferred food item, If 10<FO<50: food is considered second preferred item and if FO>50: the item was considered as a main preferred food of fish (Euzen, 1987).

Statistical analysis: All statistical analysis was done using SPSS (version 22). One-way ANOVA was applied to examine the differences in frequency of occurrence and numerical index and also vacuity index values between various sampling months. Where there was a significant difference (P<0.05), Duncan analysis was employed for determination of significant differences source. Sex ratio was examined by Chi-square test for determination of the significant differences between frequencies of two sexes during various sampling months.

Results

Length-frequency distribution and sex ratio: Minimum and maximum length of all samples were 11.7 and 23 cm. The females ranged 12.6-23 cm (18.55±2.2, Mean± SD) and males 11.7-22 cm (17.57±2.1). Weight ranged 27.4-144.8 g (88.92±

Table 1. Numerical index and frequency of occurrence of different food items observed in *Pomadasys stridens* stomachs.

Prey		NI%	FO%
Crustacea		39.60	84.53
Decapoda		2.01	44.48
Xanthidae	*Actaea* sp.	0.63	19.78
Ocypodidae	*Ocypode quadrata*	0.87	26,92
Portunidae	*Portunus plagicus*	0.27	10.44
Grapsidae	*Sesarma plicatum*	0.08	1.92
Calappidae	*Matuta lunaris*	0.06	2.20
Penaidae		0.11	3.85
Calanoida		1.89	6,91
Amphipoda		14.60	56.63
Gammaridae	*Orchestia* sp.	13.71	53.85
Cummacea	*Cyclaspis picta*	17.56	46.96
Ostracoda		3.54	35.64
Mollusca		34.33	82.32
Gastropoda		21.59	73.68
Actenoidae	*Pupa affinis*	0.06	1.10
Nassarididae		3.46	33.79
Xenophoridae	*Stellaria solaris*	8.62	59.34
Muricidae	*Murex scolopax*	0.02	0.55
Cerithiidae		0.59	14.01
Turritelidae		0.45	10.71
Atyidae	*Haminoea vitra*	0.47	11.54
Eulimidae	*Eulima polita*	0.35	9.89
Epitonidae	*Epitonium pallasii*	0.51	11.54
Trochidae	*Umbonium vestiarium*	1.00	21.43
Pyramidelidae	*Odostomia* sp.	0.06	2.47
Janthidelidae	*Janthina janthina*	0.64	11.26
Haminoeaidae	*Atys* sp.	2.37	25.27
	Rissoina distans	1.60	22.80
Columbelidae	*Mitrella micera*	0.09	0.82
Marginilidae	*Marginella* sp.	1.29	24.18
Bivalvia		11.96	67.68
Tellinidae	*Tellina inflate*	1.08	15.93
Veneridae	*Bassina calophyla*	0.96	18.96
Veneridae	*Callista* sp.	5.38	22.8
	Paphia sp.	2.13	25.55
Pteriidae	*Pinctada radiate*	1.01	2.47
Cardiidae	*Trachy cardium*	0.27	7.14
Solenidae	*Solen brevis*	0.09	1.65
Schaphopodae		0.78	18.78
Dentalidae	*Dentalium longitrosum*	0.08	3.02
	Dentalium octangulatum	0.70	18.41
Nematode		2.92	35.36
Foraminifera		4.30	46.96
Nubeculariidae	*Spiriloculina* sp.	3.89	46.96
Annelidae		0.48	7.46
Polychaeta			
Aciculata			
Nephtyidae	*Nephthys* sp.	0.40	6.04
Nereidae	*Platynereis cultifera*	0.04	0.55
Pectinaridae	*Pectinaria* sp.	0.04	0.82
Echinoderm		1.73	9.94
Asterozoa			
Ophiuroidea	*Ophionereis* sp.	1.73	8.25
Miscellaneous		16.58	68.51
Plant material		0.13	5.49
Echinus		13.83	44.78
Ctenoid scale		1.55	40.11
Apanthura		0.16	3.85
Gastropoda egg		0.08	3.47
Fish bone		0.09	1.92

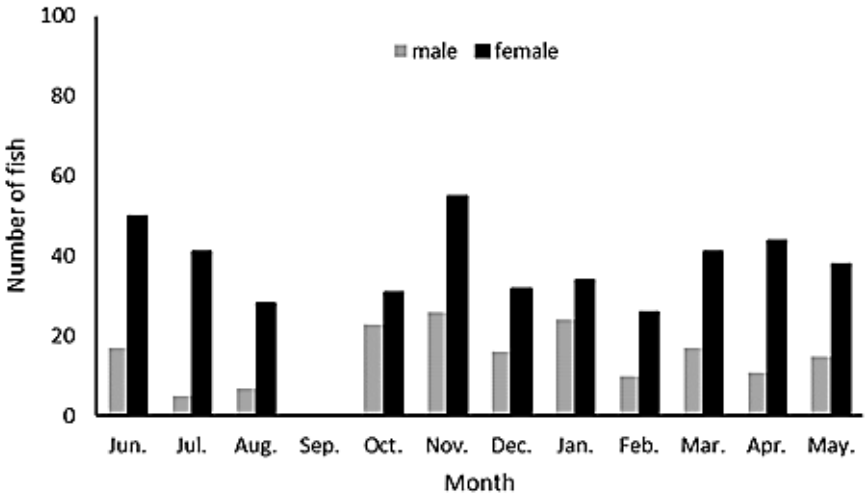

Figure 1. Female and male distribution of *Pomadasys stridens* during various sampling months.

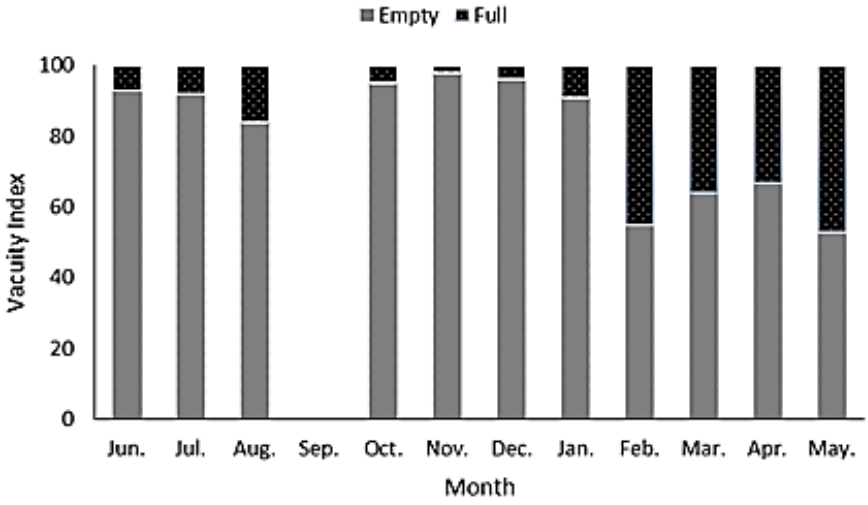

Figure 2. Monthly proportion of full and empty stomachs in sampled *Pomadasys stridens*.

26.2) and 21-124.9 g (77.41±25.9) in females and males, respectively. The females showed a slightly larger size than the males. The females were predominant sex in all sampling months. Sex ratio (male: female) ranged 11-74% and Chi-square test indicated that sex ratio values were significantly different (P<0.05) (Fig. 1). According to the overall sex ratio of the specimens 1:3.3 (male: female), the population composition is in favor of female fish.

Feeding habits: In total 591 stomachs were examined and among them, 478 were empty, and 113 full (Fig. 2). Overall vacuity index (VI) was 81% and maximum number of the empty stomachs was observed in November and December (98 and 96%) and minimum number in February and May (55 and 53%). VI value was 84 and 80% for male and females, respectively and no significant differences were observed between sexes. In the present study, VI value was 81%. According to Euzen (1987), *P. stridens* is considered as abstemious species.

Stomach fullness index (SFI) showed a significant differences between months (P<0.05) (Fig. 3a). Mean SFI increased from December and reached its maximum level in February (0.51) and May (0.52) and decreased from June, reaching its minimum level in December (0.16). GaSI showed similar trend as SFI (Fig. 4b). It maximum was observed in February (%93) and May (94%) and its minimum values were observed in November (26%) and December (23%) which was significantly different compared to other

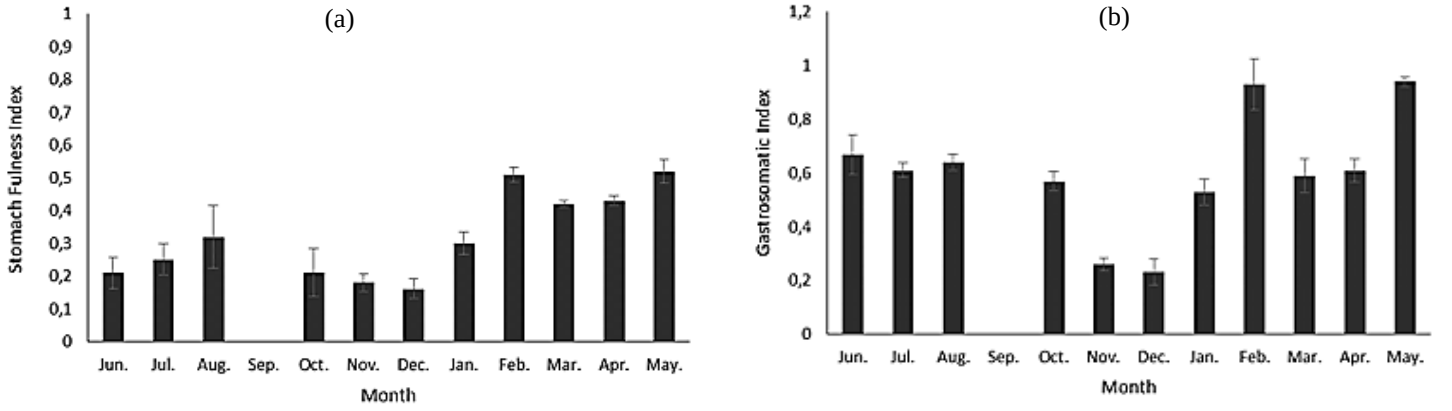

Figure 3. Mean monthly variations in (a) stomach fullness index ± SE and (b) gastrosomatic index ± SE of *Pomadasys stridens*.

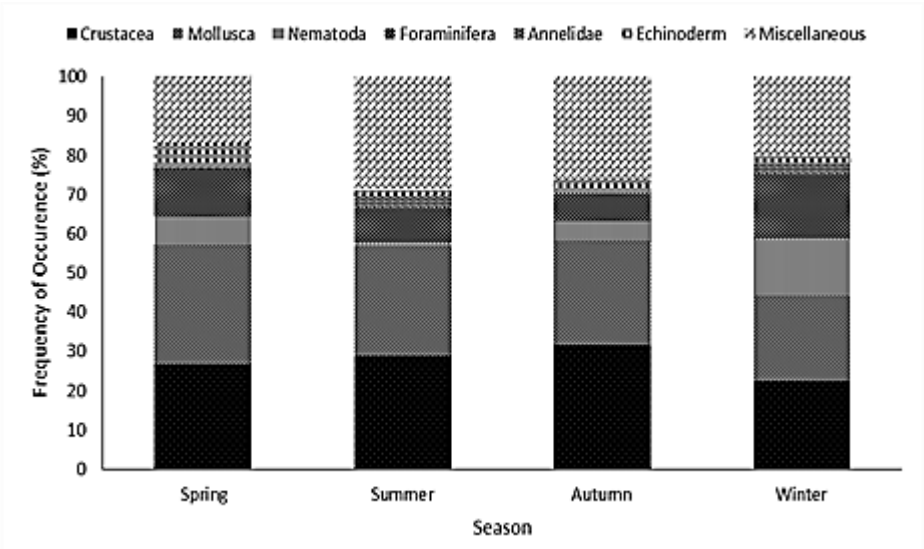

Figure 4. Seasonal variations in frequency of occurrence (%) of different food items in the diet of *Pomadasys stridens*.

months (P<0.05).

Diet composition: Based on the results, 48 categories of food items classified into 7 taxonomic classes, including Crustacean, Mollusca, Foraminifera, Nematodes, Echinodermata, Annelida and Miscellaneous. Figure 4 shows the general composition and proportion of each food items observed in the stomach and intestine of studied fish. The most abundant food items which was observed in 84.53% of gut with 39.6% numerical index (NI) value was crustacean followed by Molluscs with FO=82.32% and NI=34.33%, Miscellaneous with FO=68.51% and NI%=16.58%, Foraminifera with FO=46.96% and NI=4.3%, Nematode with FO=35.36% and NI%=2.92%, Echinodermata with FO=9.94% and NI=1.73% and Annelide was the least abundant food item with FO=7.46% and NI=0.48%. The results also showed that among Crustaean, Cummacea (FO=46.96% and NI=17.56%) and Amphipoda (FO=56.63% and NI=14.6%) and in Molluscs, Gastropoda (FO=82.32% and NI=34.33%) and Bivalvia (FO=67.68% and NI=11.96%) were most abundant food items (Table 1). Average calculated RGL value for all fish specimens was 0.98±0.03, indicating a relatively carnivorous to omnivorous feeding habits for *P. stridens*. No significant differences were found in comparing diet composition between male and female.

Discussions

There is lack of data on feeding intensity, diet composition, feeding behavior and food preference regarding the feeding habits of *P. stridens*. The present study provides the first information from the northern

part of Persian Gulf. Composition of the sampled fish was significantly in favor of females. Predominance of the females *P. stridens* has been reported for various *Pomadasys* species, such as *P. argenteus* (Kulbicki et al., 2009), *P. incises* (Pajuelo et al., 2003) and *P. kaakan* (Falahatimarvast et al., 2012). High ratio of females may be due to different survival rates of females and males (Sadovy et al., 1994), spatial segregation of size-classes in each sex (Kulbicki et al., 2009) and also sampling strategy in various depths when males and females inhabit in different depths (Falahatimarvast et al., 2012).

Considering the values of VI, SFI and GaSI in different months of sampling, the feeding intensity of *P. stridens* can be related to its reproductive cycle. Robillard et al. (2008) reported that there is an inverse relationship between spawning season and feeding intensity in fish. *Pomadasys stridens* spawns in November and December (Karimi et al., 2014), therefore by entering the fish to the last developmental stage of its maturation, the gonads especially ovaries occupy almost all abdominal cavity and therefore a limited space will be available for gastrointestinal tract. This issue is led to decrease feeding intensity by fish during this period. After spawning, a large amount of energy and nutrients is need to recruit resources for growth and preparation for next reproduction cycle (Dadzie et al., 2000). Similar feeding characteristic has been reported for *P. kaakan*, where lowest feeding intensity and highest value for VI found during spawning season i.e. spring (Valinassab et al., 2011). Whereas Safi et al. (2013) found highest feeding intensity rate of *P. stridens* in October and March, concluding that feeding intensity is higher in colder seasons, followed by a decline in warm seasons.

RGL is affected by different digestibility rate of plant, detritus and animal based diets that fish consumed as food (Pogoreutz and Ahnelt, 2014). RGL was 0.98 in *P. stridens* , hence, according to Kramer and Bryant (1995), *P. stridens* is an omnivorous fish, consuming a high protein content items as food. Furthermore, the present study revealed that the crustacean and molluscs are the preferred and dominant food items, constituting about 39.6 and 34.33%, respectively, followed by miscellaneous items (16.58%), foraminifera (4.3%), nematode (2.92%) and Annelida (0.48). Foraminifera and nematodes were secondary food preferred items preferred. Increasing the presence of the foraminifera in gut was observed in winter and spring, showing that with decreasing temperature in winter, fish prefer to stay in deeper waters. Moghaddasi et al. (2009) reported similar finding by indicating a higher intensity of foraminifera in winter diet of *P. stridens*, when they live in deep waters of the Persian Gulf and Oman Sea.

Based on our findings, the crustacean and mollusks were main food for *P. stridens* in all year round and other food taxa intensity is dependent on their availability. The amount of food digestion is dependent on the type of feed stuffs, fish species and temperature. Therefore, the digestion and absorption rate of consumed foods could be different (Bond, 1996). The presence of identifiable remains from crabs, stomatopods and gastropods in the intestine indicates a relatively slow digestion rate of items having the chitinous exoskeletons, hence, over-represented in the identified remains (Bond, 1996). Safi et al. (2013) found that semi digested items was the most dominant food items in the digestive tract and thereafter crustacean was the dominant food item followed by miscellaneous, molluscs, teleosts and Polychaeta in digestive system of *P. Stridens* as food. It seems that in both studies, crustacean was the preferred food item by fish, however, the observed differences in food preferences in both studies probably refer to geographical differences and food and prey availability (Biswas, 1993).

Conclusion

This study provided useful information about feeding habits of *P. Stridens* to better understanding of the relationship between fish species and other living organisms in the Persian Gulf. Further investigations is suggested to discover precise information about feeding behaviour and food preference by implementing digestion coefficient value for every food item consumed by *P. stridens*.

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