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Food and Feeding Habits of Two-Bar Seabream, *Acanthopagrus bifasciatus* (Forsskål, 1775) from Southern Red Sea, Egypt

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ABSTRACT

The food and feeding habits of the two-bar seabream, *Acanthopagrus bifasciatus* fishes from Southern Red Sea, Egypt were studied to know its feeding behavior in relation to sex, length and season as well as its preference for food items. Fish samples were collected monthly covering a period of 12 months from January 2015 to December 2015 and a total of 227 fish stomachs were examined for this study. The results indicated that *Acanthopagrus bifasciatus* fish feed on a variety of food materials mainly Mollusks (gastropods, bivalves and chitons), crustaceans (hermit crabs, crabs and eggs of hermit crab), fish scales, cnidarians (soft coral), Echinodermata as well as food remains. The variety of food substances in the stomach of *Acanthopagrus bifasciatus* shows that the species is a carnivorous**.** The feeding intensity showed its highest value during spring (76.74%) followed by winter (73.58%), while the lowest value was recorded during summer (57.14%). *Acanthopagrus bifasciatus* shifted their fullness index as they grow in length where the lowest value of this index was recorded for a length group 17–25 cm TL and the highest value was recorded for a length group 36–45 cm TL. The feeding habits of *Acanthopagrus bifasciatus* showed no significant difference between males and females and both sexes have the same diet composition with nearly the same concentration and distribution except for bivalves which were recorded only in the stomachs of female.

INTRODUCTION

Seabreams (Sparidae) are common coastal fish species inhabiting tropical and temperate waters throughout the world. Up to date, 117 of 15 genera have been ascribed to this family (Chiba *et al.*, 2009; Iwatsuki and Heemstra, 2011 a,b). Seabreams represent one of the most important fish families in the Red Sea. Its

members are carnivorous, marine, brackish, reef-associated and inhabit shallow coastal waters (Sommer *et al.*, 1996; Riede, 2004). The two-bar seabream, *Acanthopagrus bifasciatus* (Forsskål 1775) is a popular food sparid fish and has a great importance in the Red Sea area. It is marine, brackish and reef-associated in shallow coastal waters from 2 to 20 m depth (Grandcourt *et al.,* 2004; Cheung *et al.,* 2013). It is distributed in western Indian Ocean and Red Sea, Persian Gulf, off southern Oman; presumably along the whole southern coast of the Arabian Peninsula, also Iran to Pakistan (Iwatsuki and Heemstra, 2011a).

Study of the food and feeding habits of fish helps to know the distribution of a fish population and such knowledge is highly essential for successful management of a fishery. The knowledge of food and feeding habits helps to select such species of fish for culture and produce an optimum yield by utilizing all the available potential food of the water bodies without any competition (Manon and Hossain, 2011). Moreover, the recent development in modeling of marine ecosystems (Christensen and Pauly, 1993; Walters *et al.,* 1997) requires information mainly on the diet composition and food consumption rates besides, biomass and mortality estimates of organisms. Hence, the study of stomach contents of fish becomes pertinent to understand the marine food chain and the predator-prey relationship.

Various investigations have been conducted into the food and feeding habits of fish with the aim of determining their dietary requirements (Hyslop, 1980) and form the basis for the development of successful capture and culture fisheries, world-wide (Adebisi, 1981; Blay and Eyeson, 1982). According to Ndome and Victor (2002), the correct usage of fish species for fish culture, ornamental purpose and larval control requires fundamental information on the feeding ecology of the fish.

Though, *A. bifasciatus* is a commercially important species and intensively fished in Red Sea, no detailed study has been carried out on the seasonal variation of food items and feeding intensity of this species. Thus, in the present study an assessment of the general food composition، seasonal variation of food items and feeding intensity of *A. bifasciatus* from the Egyptian Red Sea was investigated to develop a database for trophic modeling of Egyptian Red Sea fishes.

MATRIALS AND METHODS

Sampling:

Samples of *Acanthopagrus bifasciatus* were collected from Southern Red Sea, Egypt from January 2015 to December 2015. Fishes were sorted according to sex and length; they were divided into four length groups (17 –25 cm, 26 – 35 cm, 36 - 45 cm and 46–55 cm). The stomachs were preserved in 4% formalin solution for later examination.

Identification of stomach contents:

Each stomach was dissected and the contents were examined under a monocular microscope. The food materials were identified and weighted in an electronic balance. The methods of Hynes (1950) and Pillay (1952) were followed for quantitative estimation of food items.

Feeding intensity:

The feeding intensity in different months was studied by the degree of fullness of the stomach in relation to the fish size. The fullness of the stomachs was classified as Full, ¾ full, ½ full, ¼ full and empty. The full and ¾ full stomachs were considered to have been feeding actively. It was based on the percentages of Vacuity index (VI) (Empty stomachs) and fullness index (The percentage of stomachs containing foods) in relation to the total number of examined stomachs.

Feeding activity:

The feeding activity of *A. bifasciatus* was studied using the following indices:

1- Occurrence index (OI): The percentage of stomachs having a specific food item to the total food items found in the examined stomachs.
2- Weight index (WI): The percentage of the weight of a specific food item to the total weight of stomachs containing food.
3- Numerical index (NI): The numerical percentage of a specific food item to the total number of food items in stomachs containing food.
4- Modified food index (MFI): The following formula of modified food index (MFI) was used (Rodrigues, 1997):

$$MFI = \sqrt{W\% \frac{(O\% + N\%)}{2}}$$

Where O%, occurrence percentage; N%, numerical percentage; W%, weight percentage. Note: The sum of the total different values of (MFI) for different food items does not equal 100% but each value can be taken as a separate indicator for preferable food items.

RESULTS

Feeding intensity:

The feeding intensity of *A. bifasciatus* according to season and fish length is shown in Figs. 1 and 2. Out of 227 stomachs examined, 71 stomachs were empty (31.28 % of the total stomachs). The percentage of vacuity index varied with season and fish length. The highest values of vacuity index (VI) were recorded during summer and autumn (42.85% and 31.25%, respectively) and the lowest values were detected during winter and spring (26.41% and 23.25%, respectively). The length group of 17–25 cm TL had the highest vacuity VI (81.25%) and the length group of 36–45 cm TL had the lowest one (19.32%). The fullness index which is a real indicator for feeding intensity exhibited the highest values during spring and winter (76.74% and 73.58%, respectively), while the lowest values were during summer and autumn (57.14% and 68.75%, respectively). The highest fullness index was recorded in the length group 36–45 cm TL (80.68%) and the lowest one was recorded in the length group 17–25 cm TL (18.75%).

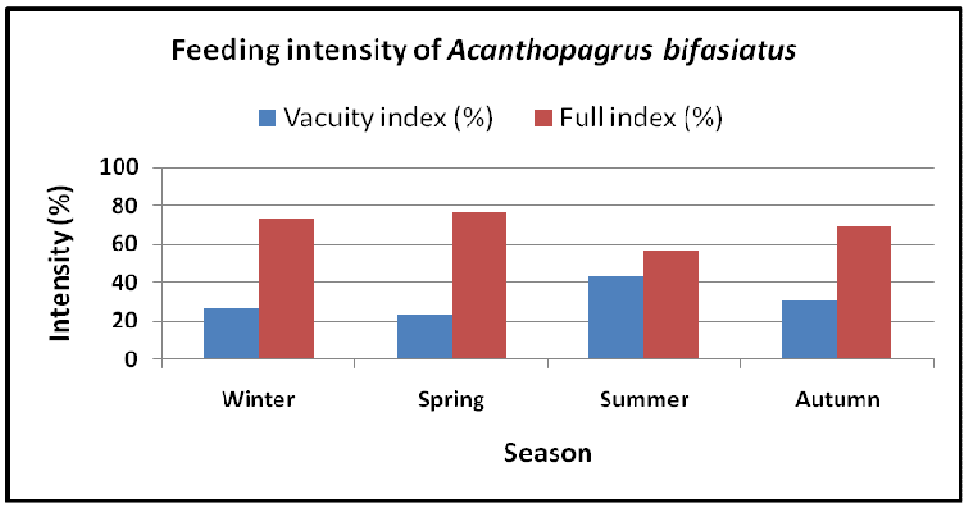

Fig. (1): Seasonal variations in feeding intensity of *A. bifasciatus* from Southern Red Sea, Egypt

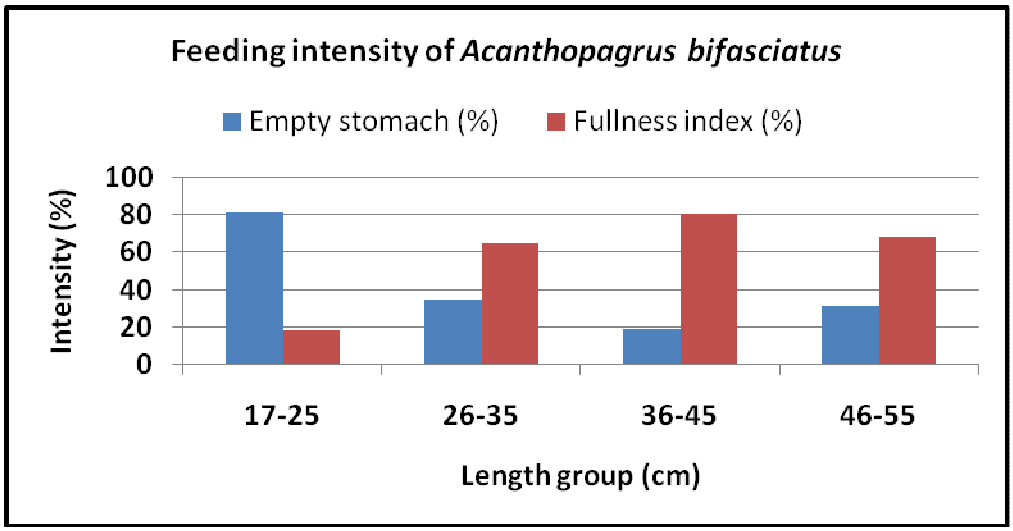

Fig. (2): Length group variations in feeding intensity for *A. bifasciatus* from Southern Red Sea, Egypt.

Food composition:

- **General food items:**

Out of 227 examined stomachs, 156 stomachs were found to contain food items. The quantitative composition of food components for *A. bifasciatus* is presented in Table 1. There were 9 prey taxa belonging to five general categories (mollusks, crustaceans, fish scales, cnidarians and Echinodermata). Digested food was also recorded. As presented in Table 1, mollusks are the most important food items in the diet of *A. bifasciatus* which are followed by crustaceans. By number, weight and occurrence, mollusks constituted 50.88%, 21.80% and 95.51% of the total food items, respectively. Mollusks were represented by gastropods, bivalves and chitons. Gastropods were the main mollusks food items followed by bivalves then chitons which were the lowest mollusks' food items. Crustaceans were the second class in the total food items as expressed by number, weight and occurrence as 20.72%, 10.35% and 68.59%, respectively. This category included Paguroidea (hermit crabs), crabs and eggs of the hermit crab. Paguroidea (hermit crabs) are the most dominant crustaceans. The third category was fish scales constituting 4.90%, 0.32% and 15.38% for number, weight and occurrence respectively. The fourth category was the cnidarians (soft corals) constituting 1.52%, 0.54% and 4.49% for number, weight and occurrence respectively. The fifth category was Echinodermata constituting 2.07%, 0.24% and 6.41% for number, weight and occurrence respectively. The other category of the total food items is the food remains within the stomach content. This category constituted 0.40% and 3.85% for weight and occurrence respectively; it was simply the remains of unidentified organisms.

According to the modified food index (MFI), Mollusks were the preferable food item which formed about 39.66% followed by crustaceans (19.04%), fish scales (1.80%), cnidarians (1.27%), Echinodermata (1.01%) and food remains contributed 1.00% (Fig. 3 and Table 1).

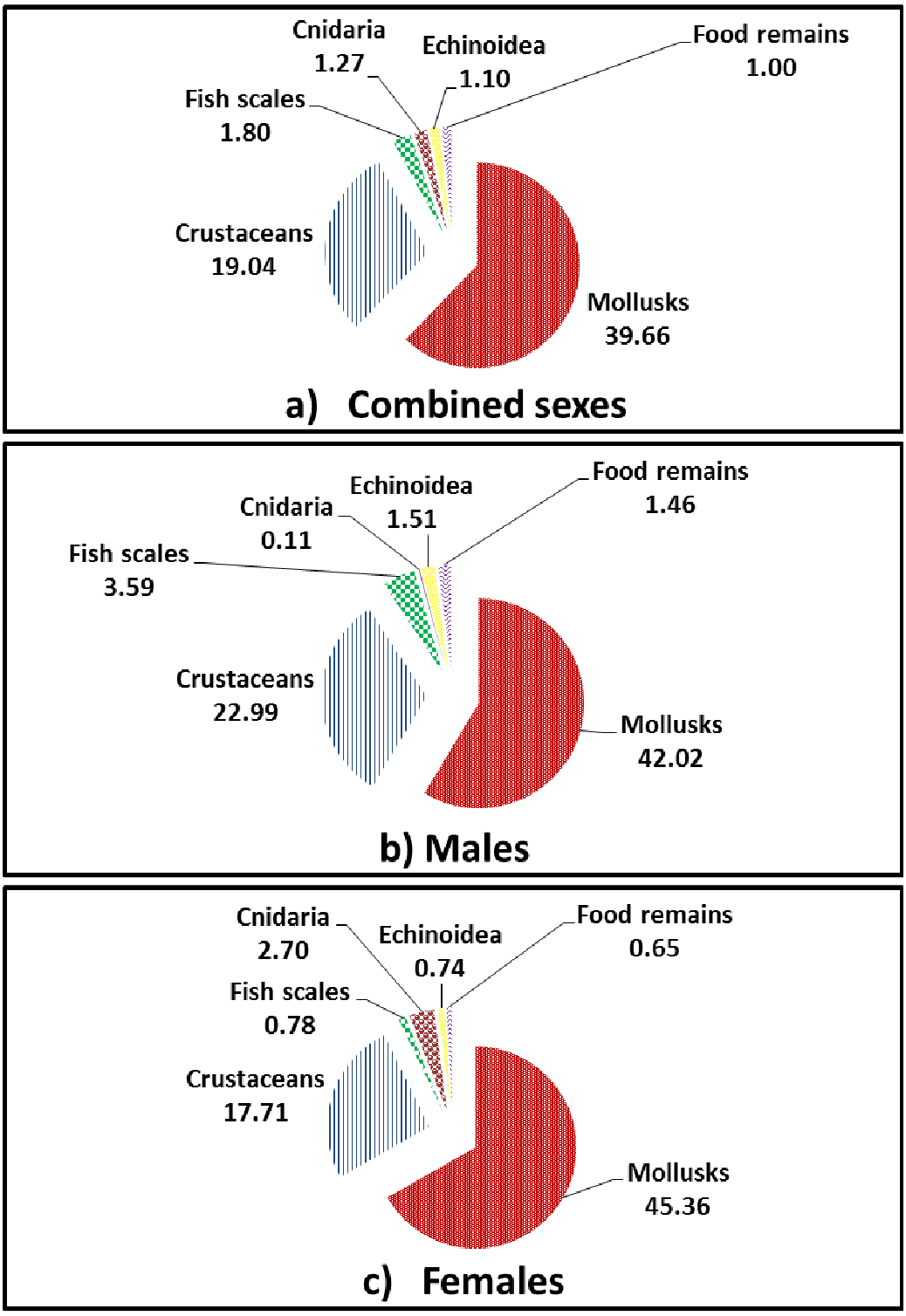

Fig. (3): Variations in modified food index (MFI) for combined sexes, males and females of *A. bifasciatus* from Southern Red Sea, Egypt.

Table (1): General food items of combined sexes, males and females of *A. bifasciatus* fishes from Southern Red Sea, Egypt.

Food items	Combined sexes				Males				Females			
	N%	W%	O%	MFI	N%	W%	O%	MFI	N%	W%	O%	MFI
Mollusks	50.88	21.80	95.51	39.66	60.78	23.82	89.36	42.02	66.90	26.75	93.55	45.36
Gastropods	48.16	18.53	83.33	34.90	59.98	23.46	81.91	40.80	60.53	20.44	85.48	38.63
Bivalves	2.12	2.77	7.05	3.57	0.00	0.00	0.00	0.00	5.82	5.62	6.45	5.87
Chitons	0.61	0.50	5.13	1.20	0.80	0.36	7.45	1.22	0.55	0.69	1.61	0.87
Crustaceans	20.72	10.35	68.59	19.04	26.57	16.10	69.15	22.99	22.71	8.31	67.74	17.71
Hermit crabs	15.51	5.33	60.26	14.22	22.28	7.71	63.83	18.21	15.65	5.26	54.84	13.62
Crabs	1.67	4.84	5.13	4.06	1.91	8.38	3.19	4.62	1.52	3.04	8.06	3.81
Eggs of hermit crab	3.54	0.17	3.21	0.77	2.39	0.01	2.13	0.15	5.54	0.01	4.84	0.27
Fish scales	4.90	0.32	15.38	1.80	8.99	1.03	15.96	3.59	4.16	0.07	14.52	0.78
Cnidaria	1.52	0.54	4.49	1.27	0.08	0.02	1.06	0.11	4.02	1.06	9.68	2.70
Echinoidea	2.07	0.24	6.41	1.01	2.94	0.44	7.45	1.51	1.25	0.18	4.84	0.74
Food remains	1.11	0.40	3.85	1.00	1.75	0.71	4.26	1.46	0.55	0.22	3.23	0.65
Total No. items	1979				1257				722			
Total weight items	1145.07 (g)				579.45 (g)				565.62 (g)			
Total No. of stomachs	156				94				62			

N% is a numerical index; W% is the weight index; O% is the occurrence index and MFI is the modified food index.

- **Feeding variations according to sex:**

Variations in feeding habits for males and females are shown in Table 1 and Fig. 3. In the males and females, mollusks were the most important category of food items and occupied 89.36% and 93.55% of occurrence, respectively. This category included gastropods, bivalves and chitons. Gastropods represented the most important food items in males and females. Bivalves were not observed among the food items in the examined stomachs of males. The second category was crustaceans (69.15% and 67.74% of occurrence for male and female respectively); it included hermit crabs, crabs and eggs of hermit crabs. The third category was fish scales which occupied 15.95% and 14.52% (for males and females, respectively) of the total food items and other categories occupied small percentages.

- **Variations in feeding habits according to fish length:**

As previously mentioned the collected specimens of *A. bifasciatus* were divided into four length groups: 17–25 cm, 26–35 cm, 36–45 cm and 46–55 cm total length. As presented in Table 2 and Fig. 4, in all length groups the mollusks represented the main food item. The diet of fishes, for all length groups, constituted of gastropods followed by bivalves and finally chitons. Bivalves disappeared in the length groups (17–25 cm and 26-35 cm). Crustaceans came next in importance; hermit crabs constituted the main food item in the examined stomachs. Crabs were recorded in the stomachs of fish length larger than 26 cm and disappeared in length groups from 17 to 25 cm. other categories were less important for *A. bifasciatus* and they were recorded only in the stomachs of fishes larger than 26 cm and completely disappeared in the stomachs less than 26 cm.

Table (2): General food items of *A. bifasciatus* fishes in different length groups from Southern Red Sea, Egypt.

Food items	17 - 25 cm				26 - 35 cm				36 - 45 cm				46 – 55 cm			
	N%	W%	O%	MFI	N%	W%	O%	MFI	N%	W%	O%	MFI	N%	W%	O%	MFI
Mollusks	82.61	47.36	100.00	73.97	61.22	23.64	74.42	39.54	69.57	18.30	95.77	38.43	52.31	18.76	89.74	36.00
Gastropods	80.43	43.75	100.00	62.83	60.30	23.30	65.12	38.22	68.55	16.52	91.55	36.36	42.36	14.48	76.92	29.38
Bivalves	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	1.07	1.41	0.92	9.49	4.12	7.69	5.95
Chitons	2.17	3.61	66.67	11.14	0.93	0.34	9.30	1.31	0.85	0.71	2.82	1.14	0.46	0.16	5.13	0.67
Crustaceans	4.35	14.90	100.00	27.89	19.85	9.19	69.77	20.29	22.91	6.07	71.83	15.59	35.65	11.59	53.92	17.17
Hermit crabs	4.35	14.90	100.00	27.89	18.55	8.74	67.44	19.38	22.39	3.97	67.61	13.36	18.52	4.72	43.59	12.10
Crabs	0.00	0.00	0.00	0.00	1.30	0.45	2.33	0.91	0.51	2.10	4.23	2.23	0.93	6.85	5.20	4.58
Eggs of hermit crab	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.20	0.02	5.13	0.49
Fish scales	21.74	2.40	66.67	10.31	11.32	1.76	30.23	6.05	3.93	0.06	11.27	0.69	1.85	0.00	5.13	0.12
Cnidaria	0.00	0.00	0.00	0.00	0.74	0.29	2.33	0.67	0.68	0.28	4.23	0.83	5.09	0.65	7.69	2.03
Echinoidea	0.00	0.00	0.00	0.00	5.01	0.54	4.65	1.62	0.85	0.14	1.41	0.40	2.08	0.16	1.30	0.53
Food remains	0.00	0.00	0.00	0.00	0.19	0.43	2.33	0.73	1.37	0.22	2.82	0.68	2.78	0.54	10.26	1.88
Total number items	46				539				585				432			
Total weight items	4.16 (g)				171.67 (g)				582.94 (g)				619.25 (g)			
Total number of stomachs	3				43				71				39			
N% is a numerical index; W% is the weight index; O% is the occurrence index and MFI is the modified food index.																

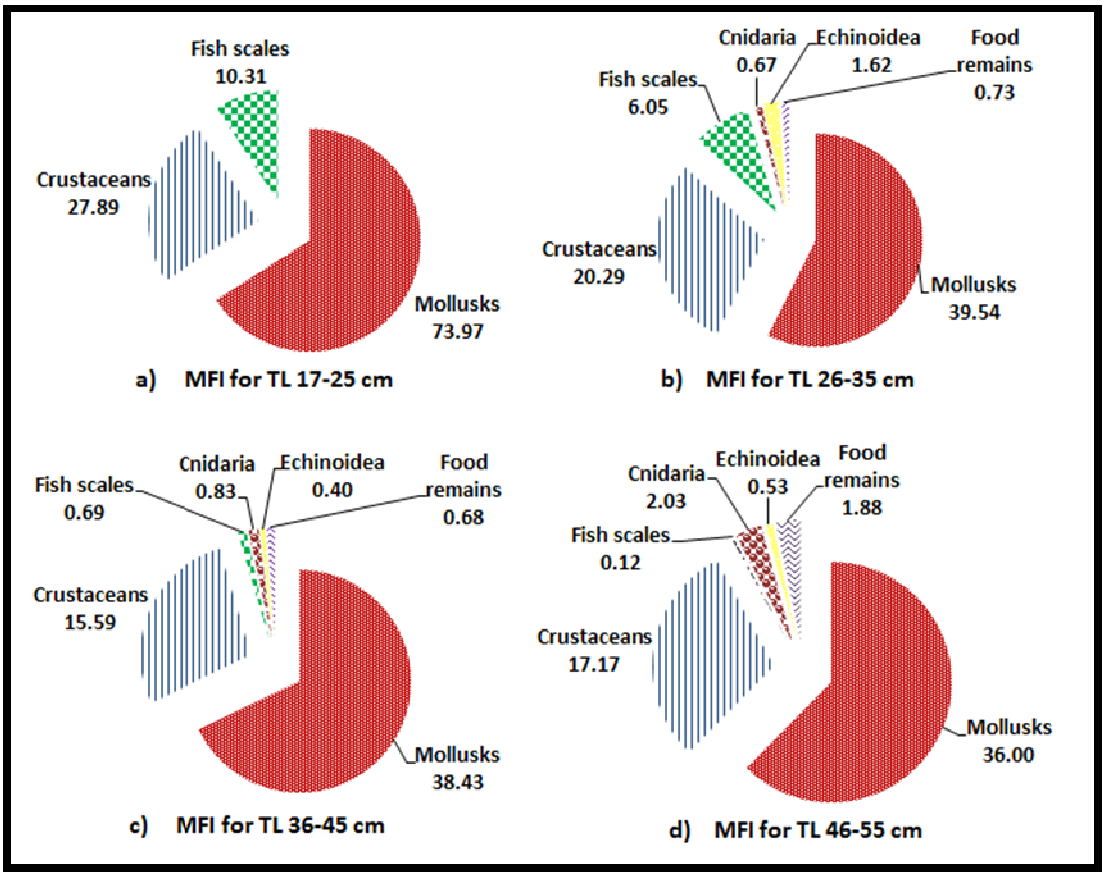

Fig. (4): Variations in Modified food index (MFI) for food items of different length groups of *A. bifasciatus* from Southern Red Sea, Egypt.

- **Seasonal variations of the different food items:**

Modified food index is shown in Fig. 5 and Table 3. Mollusks had high values of modified food index (MFI) during summer (44.19) and low values during winter and spring (37.66 and 36.66, respectively). Gastropods were the preferable mollusks' food items during all seasons followed by chitons. Bivalves were completely absent during winter. Crustaceans showed high modified food indices during spring (21.94), and low ones during summer (9.33). Fish scales showed high modified food indices during winter (2.95), and low ones during autumn (0.48). Soft coral reefs (cnidarians) were absent during winter and have high value during autumn (3.08). Echinodermata was completely absent during winter and summer and modified food index was 1.44 and 1.63 for spring and autumn respectively. Food remains were absent during autumn and forming high values during winter (2.63).

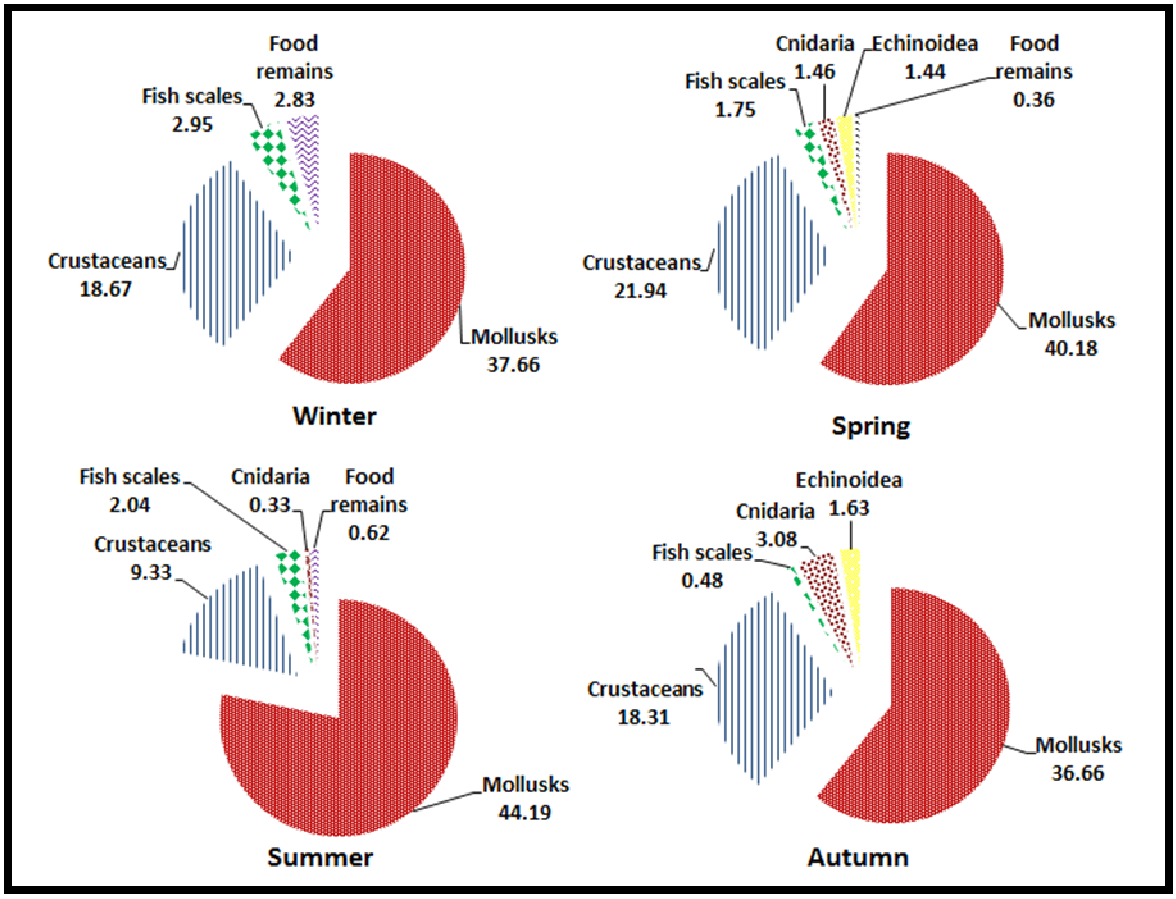

Fig. (5): Seasonal variations in modified food index (MFI) for food items of *A. bifasciatus* from Southern Red Sea, Egypt.

Table (3): Seasonal variations in general food items of *A. bifasciatus* fishes from Southern Red Sea, Egypt.

Food items	Winter				Spring				Summer				Autumn			
	N%	W%	O%	MFI	N%	W%	O%	MFI	N%	W%	O%	MFI	N%	W%	O%	MFI
Mollusks	57.35	19.62	87.18	37.66	55.34	24.41	86.36	40.18	65.27	27.32	81.25	44.19	75.14	16.68	100.00	36.66
Gastropods	58.01	20.55	81.63	37.88	52.43	20.08	83.33	36.92	64.85	25.25	75.00	42.02	65.54	11.85	86.36	30.00
Bivalves	0.00	0.00	0.00	0.00	2.67	4.23	1.52	2.98	0.21	2.01	3.13	1.83	8.47	4.64	4.55	5.50
Chitons	1.76	2.21	7.69	3.23	0.24	0.10	1.52	0.29	0.21	0.07	3.13	0.34	1.13	0.18	13.64	1.16
Crustaceans	27.94	8.52	53.85	18.67	32.52	11.93	85.03	21.94	25.94	2.78	43.75	9.33	10.17	16.20	50.00	18.31
Hermit crabs	27.94	8.52	53.85	18.67	24.27	5.65	77.27	16.94	16.11	2.50	37.50	8.19	9.89	6.58	45.45	13.49
Crabs	0.00	0.00	0.00	0.00	0.97	6.26	6.06	4.69	1.46	0.25	3.13	0.76	0.28	9.62	4.55	4.82
Eggs of hermit crab	0.00	0.00	0.00	0.00	7.28	0.02	1.69	0.31	8.37	0.03	3.13	0.38	0.00	0.00	0.00	0.00
Fish scales	9.41	0.88	10.26	2.95	5.10	0.33	13.64	1.75	8.37	0.23	28.13	2.04	1.13	0.04	9.09	0.48
Cnidaria	0.00	0.00	0.00	0.00	1.94	0.86	3.03	1.46	0.21	0.06	3.13	0.33	5.93	1.27	9.09	3.08
Echinoidea	0.00	0.00	0.00	0.00	3.40	0.64	3.03	1.44	0.00	0.00	0.00	0.00	7.63	0.32	9.09	1.63
Food remains	3.82	1.78	5.13	2.83	1.46	0.04	6.06	0.36	0.21	0.23	3.13	0.62	0.00	0.00	0.00	0.00
Total number items	340				412				478				354			
Total weight items	212.44 (g)				283.87 (g)				311.67 (g)				290.88 (g)			
Total number of stomachs	39				66				20				22			

N% is a numerical index; W% is the weight index; O% is the occurrence index and MFI is the modified food index.

DISCUSSION

The food and feeding habits of sparid fishes have been studied by some authors (Harvath *et al*., 1990; Buxton and Clarke, 1992; Abdel-Rahman and Abdel-Barr, 2003 and Osman and Mahmoud, 2009). The variety of food substances in the stomach of *A. bifasciatus* shows that the species is a carnivore; feeding on all types of mollusks and crustaceans. These findings agree with the results of Souissi *et al.* (2014).

According to Sakamoto (1982), the vacuity index (VI) or empty stomachs' ratio, is an inverse indication of feeding intensity which vary according to variations in the abundance of fish, spawning time and seasonal changes in water temperature and food item. Moreover, during spawning time fish need more energy input in order to meet the reproduction requirements (Froese and Pauly, 2000). This finding agrees with the present results, where the high percentage of fullness index was recorded during spawning season (winter and spring) which may be due to the need of energy for spawning. The highest value was recorded for the length group 36 – 45 cm, and this result may be attributed to the high abundance of the length group 36 – 45 cm.

Feeding activity and feeding intensity depend (in most cases) on the sex and length of fish (Owolabi, 2007). According to the present results, the feeding habits of *A. bifasciatus* showed no significant difference between males and females and both sexes have the same diet composition with nearly the same concentration and distribution except for bivalves which were recorded only in the stomachs of female.

According to the variation in length, the selected fish shifted their diet composition as they grow, which may be an adaptation to reduce intra-specific competition among different size groups (Guruge, 2002). Many authors (e.g. Mehanna, 1996; Piet, 1998; Jennings *et al.,* 2001; Hanson and Chouinard, 2002; Nakamura *et al.*, 2003) reported that there may be important changes of diet with size, many species switching from smaller, easier to access prey, to larger prey or to prey more difficult to catch or extract but of higher nutritive value.

Fishes have the capability to adjust its diet according to the seasonal abundance of the food item (Nieland, 1982). In the present study, *A. bifasciatus* preferred gastropods and hermit crabs during all seasons. There are few studies relating the diet of large carnivorous reef fish with food availability in the tropics (Harmelin- Vivien 1981; Parrish *et al.* 1985).

CONCLUSION

The ability of *Acanthopagrus bifasciatus* to feed on a number of different trophic levels coupled with the potential for fast growth makes this species a promising candidate for commercial culture. As the species is widely used as human food throughout the area in which it occurs, it could easily be incorporated into locally operated polyculture systems.

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ARABIC SUMMARY

عادات الغذاء والتغذية لأسماك أبوكحلة من جنوب البحر الاحمر ، مصر

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تم دراسة عادات الغذاء و التغذية لأسماك ابوكحلة من البحر الأحمر بمصر لمعرفة سلوكه الغذائي فيما يتعلق بالجنس والطول والموسم وكذلك تفضيله للمواد الغذائية. وأظهرت النتائج أن سمكة أبو كحلة تتغذى على مجموعة متنوعة من المواد الغذائية مثل الرخويات (الرخويات، ثنائي المصراع وكيتون)، القشريات (سرطان البحر الناسك، سرطان البحر وبيض سرطان البحرالناسك)، قشور الأسماك، الشعاب المرجانية الناعمة، شوكيات الجلد وكذلك بقايا الغذاء. وأظهرت شدة التغذية ان أعلى قيمة لها خلال فصل الربيع (٧٦.٧٤٪) يليها الشتاء (٧٣.٥٨٪) بينما سجلت أدنى قيمة خلال الصيف (٥٧.١٤٪). تم تحديد مؤشر امتلاء أسماك ابوكحلة كدليل لأنها تنمو في الطول حيث تم تسجيل أدنى قيمة لهذا المؤشر لمجموعة طول ١٧-٢٥ سم من الطول الكلي وأعلى قيمة سجلت لمجموعة طول ٣٦-٤٥ سم من الطول الكلي. ولأن هذا النوع يستخدم على نطاق واسع كغذاء في جميع أنحاء المنطقة التي يتواجد فيها، فإنه يمكن بسهولة إدراجه في نظم الاستزراع السمكي.