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Feeding habits of the common sole, *Solea vulgaris* (Quensel, 1806), from Mediterranean Sea, Port Said, Egypt

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ABSTABCT

A total of 550 specimens of *Solea vulgaris* were collected from monthly catches by trawling net operating on the Port Said Coast on the Mediterranean Sea from January to December 200٦. The annual diet composition, monthly variations in the diet composition and the variations of diet with length and the intensity of feeding were studied. *Solea vulgaris* feed on a wide variety of prey types, polychaetes**,** copepods, algae, seagrasses, mollusks and amphipods with frequent quantities of sediments. Polychaetes, copepods were the major food items all year round. Polychaetes and copepods were found in all length groups of *Solea vulgaris*. They decreased as the size of fish increased, whereas seagrasses and algae increased as the size increased. The diet composition of *Solea vulgaris* is indicative of a general feeding strategy. The feeding activities were quite high during spring and autumn seasons.

Keywords: Feeding habits, *Solea vulgaris*, Egyptian Mediterranean Sea.

INTRODUCTION

Flatfishes constitute 520 extant species of a successful group of marine temperate shallow water fishes. They are mostly important predators in benthic communities (Nelson, 1976). Feeding habits studies of flatfishes have been created all over the world; in New Zealand waters (Livingston, 1987); Bering Sea and Gulf of Alaska (Livingston, 1993; Yang, 1995). Pacific, Kamchatkan Peninsula (Orlov, 1997), Baltic Sea (Aarnio *et al*., 1996), North Sea (Kaiser and Ramsay, 1997) and Canadian/American Atlantic waters (Methven, 1999).

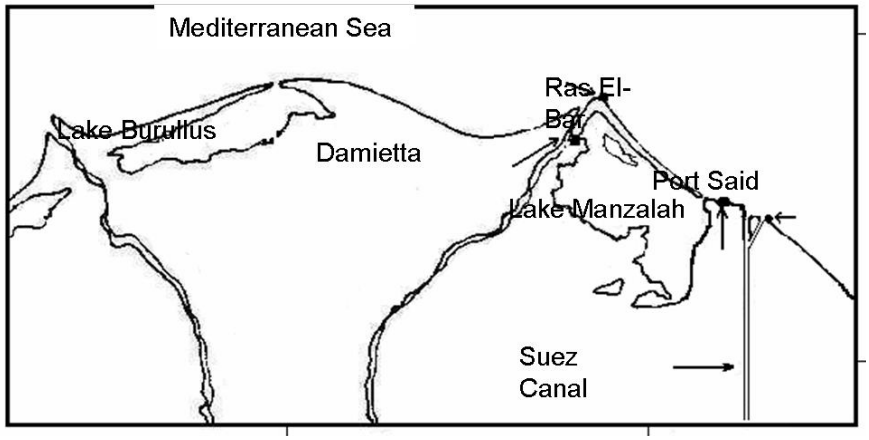
In the Gulf of Alaska, Livingston (1993) and Yang (1995) concluded that flatfish primarily consume benthic invertebrates, with some larger, wider-gaped species being almost entirely piscivorous. Flatfish tend to be among different feeding groups; fish-feeders, crustaceans-feeders, Polychaeta / Mollusca-feeders, thereby minimizing competition for food (De Groot, 1971; Lande, 1973; Stickney *et al*., 1974; Kravitz *et al*., 1977; Pearcy & Hancock 1978; Steinarsson, 1979).

Recently in the area of study, Port-Said, Sharaf *et al*. (2007) studied the feeding habits of *Solea aegyptiaca* and they stated that this species feeds mainly on polychaetes, and copepods. They added that they feed on algae and seagrassess, Mollusca and amphipods and frequent quantities of sediments.

Solea vulgaris position in the trophic structure of the Egyptian Mediterranean Sea, Port Said is poorly understood, and so, the aim of the current study is to define the trophic relationships between *Solea vulgaris* with other invertebrates and fishes in this area, for understanding the dynamics of this regional ecosystem. Besides, results from feeding habits of *Solea vulgaris* may have direct implications for aquaculture.

MATERIALS AND METHODS

The stomachs of 550 specimens of *Solea vulgaris* were examined to study their feeding habits from January to December 2006 as a commercial catch (trawl nets) from Port Said Fishing Harbour (Map.1).



Map 1. Showing the trawling area between Port Said Fishing Harbor to Ras El-Bar

Annual diet composition, seasonal variations of diet, variations of diet with length and feeding intensity of this species were estimated in the current study. For each fish specimen, total length was measured to the nearest 0.1 cm. Each fish was dissected and the alimentary tract removed by cutting at the point where the stomach entered the abdominal cavity and immediately before the anus. The degree of fullness of the stomach was assessed by visual estimation and classification as empty, trace, quarter full, half full, three quarter full and completely full respectively as described by Pilly (1952). Then the stomach was cut, opened longitudinally, and its contents were scraped off and transferred into a small Petri dish containing a small amount of water. Food items were sorted out under a binocular microscope. They were identified down to their groups. A list of general diet composition was made. Food analysis was made by points of assessment (Hynes, 1950; Hyslop,1980) then the results were subjected to further statistical evaluation according to Godfriaux (1969), in order to give more precise information about food and feeding habits of *S. vulgaris*.

RESULTS

Annual diet composition

There were great variations in of food items (Fig. 1). However, polychaetes supplemented by copepods formed the major food groups for *Solea vulgaris*. Polychaetes made up 40.7 % by volume composition of the bulk of the diet, whereas benthic copepods constituted 18.8% of all food items consumed, coming in the second position of importance and were represented by calanoids and harpacticoids.

The other food items contained algae that constituted 11.7%**;** including green and blue green algae**,** followed by seagrasses **(**10.1%**),** Sediments **(**9.7%) and Mollusca (6.1%) which was represented mainly by bivalves and gastropods. The minor food item included amphipods (2.8 %).

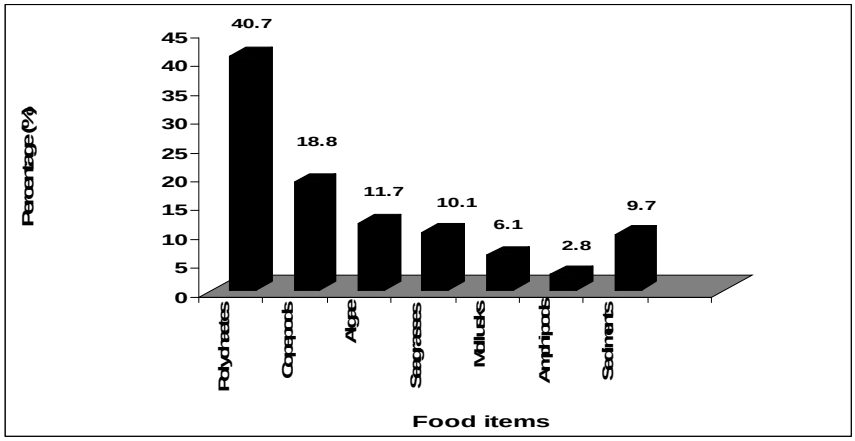


Fig. (1) : The diet composition of *Solea vulgaris* from Port Said coast during 2006

Monthly variation in diet composition

The monthly variations in food items are illustrated in Table (1). Food items occurred in all year round of the study. Polychaetes and copepods constituted the major food items in most months, from January till June where its contribution ranged from 46.4% in June to 93.6% in March and from September (51%) till October (62.1%).

In July, August and December, the major food items were polychaetes, copepods combined with Mollusca and ranged from 51.2% in December to 64.5% in August.

Algae and seagrasses occurred in all year round. They attained the maximum value in December being 36.3% and 22.2 respectively, whereas the minimum value was recorded in March 2.3% and 1.6 respectively.

Mollusca and Amphipods occurred in the period from May to October and ranged from 0.5 in October to 33.8% in August, whereas amphipods occurred from May till November and ranged between 0.9 in November and 9.9 in June.

Sediments were frequently taken with the food items, representing 0.8% in January and increased in the following months to maximum value in August (20.9%) and then decreased in the next months then increased again in November (11.3%) and 12.5% in December by volume composition.

Table (1): Monthly variations in diet composition of *Solea vulgaris* from Port Said coast during 2006

		Food items						
Months	No.	Polychaetes	Copepods	Algae	Seagrasses	Mollusks	Amphipods	Sediments
Jan.	22	39.2	20.6	18.8	20.7	A	A	0.8
Feb.	23	51.8	21.7	10.6	14.5	A	A	1.5
Mar.	49	68.2	25.4	2.3	1.6	A	A	2.6
Apr.	57	69.5	17.5	3.9	2.8	A	A	6.3
May	66	60.6	11.1	7.4	4.7	3.2	6.9	6.2
Jun.	33	33.2	13.2	12.1	3.1	11.5	9.9	17.1
Jul.	41	19.7	15.4	11.2	7.2	22.4	6.2	17.8
Aug.	44	11.3	19.4	1.4	9.1	33.8	4.1	20.9
Sep.	59	47.3	23.7	4.8	9.7	0.9	3.1	10.6
Oct.	68	41.9	20.2	14.4	10.1	0.5	2.2	10.8
Nov.	70	34.9	19.6	18.2	15.2	A	0.9	11.3
Dec.	18	11.1	17.9	36.3	22.2	A	A	12.5

Remarks : Data expressed as percentage **A = No food in class occurred**

Feeding habits in relation to fish size

The variations of food items with length are illustrated in Table (2). Within the length groups study in the common solea population it could be classified into twelve classes ranging from 11.5 to 23.4 cm with 1 cm interval. Prey size differed between large size fishes which ingested large-size prey, whereas the small sized fishes ingested small size prey.

Polychaetes and copepods were found in all length groups of *Solea vulgaris*. They decreased as the size increased, where polychaetes decreased from 74.9 % in size class (11.5 – 12.4 cm) to 9.4% in older fishes (22.5 – 23.4 cm), similar trend was observed in copepods which were decreased from 25.2 % in small fish (11.5 – 12.4 cm) to 16.1% in size class (22.5 – 23.4 cm) by volume composition.

Table (2): The diet composition of different size classes (cm) of *Solea vulgaris* from Port Said coast during 2006.

		Food items						
Size range	**No.**	**Polychaetes**	**Copepods**	**Algae**	**Seagrasses**	**Mollusks**	**Amphipods**	**Sediments**
11.5 - 12.4	**9**	74.9	25.2	A	A	A	A	A
12.5 - 13.4	**13**	68.2	16.4	A	A	3.1	12.4	A
13.5 - 14.4	**26**	62.3	20.9	A	A	6.3	7.1	3.3
14.5 - 15.4	**38**	59.2	20.2	A	A	7.2	5.9	7.6
15.5 - 16.4	**52**	49.6	19.9	0.9	3.3	14.3	4.1	7.9
16.5 - 17.4	**97**	42.9	19.1	1.6	5.1	20.5	3.2	7.5
17.5 - 18.4	**103**	41.8	18.2	2.2	6.8	8.2	1.2	21.7
18.5 - 19.4	**63**	36.6	18.1	6.2	11.8	6.3	A	20.9
19.5 - 20.4	**60**	22.2	17.9	26.2	14.1	4.1	A	15.6
20.5 - 21.4	**47**	11.6	17.2	32.1	16.7	3.2	A	19.3
21.5 - 22.4	**26**	10.6	16.8	34.5	29.6	A	A	8.5
22.5 - 23.4	**16**	9.4	16.1	36.2	33.8	A	A	4.5

Remarks : Data expressed as percentage **A = No food in class occurred**

Seagrasses and algae food items increased as the size range increased. Algae and Seagrasses were ingested by size range from 15.5 to 23.4 cm long. Mollusks occurred in fish size range from 12.5 to 21.4 cm long, varying from 6.3% in size class (12.5 – 13.4 cm) to 3.2% in size class (20.5 -21.4) by volume composition.

Amphipods occurred in size range from 12.5 to 18.4cm long varying from 12.4% to 1.2% by volume composition, while sediments were frequent in all size range except from 11.5 to 13.4 cm long.

Feeding intensity

Generally, the intensity of feeding in *Solea vulgaris* clearly indicates a low rate of feeding activity (Table 3). Fishes with stomach half full, almost full and full of food constituted 47.6% of all analyzed individuals, whereas those with stomachs that were empty or with traces of food represented 52.4% of the total specimens. The feeding activities were quite high during spring (86.6%) and autumn (67.9%). There are minimal rate of feeding intensity in winter season, where the stomachs were empty, trace and quarter full, ranged from 75.05% to 78.45% in January. Then the maximum feeding intensity was attained in spring, where the half full, almost full and full ranged from 78.1% to 91.65.

Table (3): Monthly variations in the intensity of feeding of *Solea vulgaris* from Port Said coast during 2006.

		The degree of distension of the stomach							
Months	**No.**	**Empty**	**Trace**	**1/4**	**%**	**1/2**	**3/4**	**Full**	**%**
Jan.	22	52.3	22.9	3.2	78.4	A	5.3	16.3	21.6
Feb.	23	60.3	12.2	3.0	75.5	2.5	3.6	18.4	24.5
Mar.	49	A	10.0	A	10.0	70.5	14.3	5.2	90.0
Apr.	57	A	8.4	A	8.4	71.6	11.5	8.5	91.6
May	66	10.2	11.7	A	21.9	44.5	18.9	14.7	78.1
Jun.	33	52.7	27.5	2.1	82.3	6.9	6.9	3.9	17.7
Jul.	41	59.6	15.7	11.2	86.5	5.1	4.9	3.5	13.5
Aug.	44	78.2	7.3	7.3	92.8	3.1	1.9	2.2	7.2
Sep.	59	A	39.9	A	39.9	32.8	11.5	15.8	60.1
Oct.	68	1.1	3.6	25.0	29.7	36.8	17.3	16.2	70.3
Nov.	70	12.2	14.6	A	26.8	38.3	17.6	17.3	73.2
Dec.	18	40.3	23.0	13.1	76.4	11.5	10.8	1.3	23.6

Remarks : Data expressed as percentage **A = No food in class occurred**

DISCUSSION

Flatfishes as polychaetes-feeders have asymmetrical jaws (Aarino *et.al*., 1996; Methven, 1999), and characterized by small stomach, long intestine and lack gill rakers and pyloric ceaca (Rajagurura, 1992).

In the current study, *Solea vulgaris* fed on a broad spectrum of food items; it fed predominantly on polychaetes (40.7%) supplemented by copepods (18.8%). Algae constituted 11.7%, whereas seagrassess represented 10.1%. Mollusca and amphipods were of minor food items, constituting 6.1% and 2.8% by volume composition. There was a frequent amount of sediments (9.7%). Some stomachs were full of polychaetes or polychaetes supplemented by copepods, which might indicate either a great availability of these food items or a patchy distribution of them. This is in agreement with Molinero *et al.* (1991) and Cabral (2000) who studied the main food items of *Solea solea* and *S. senegalensis* and concluded that this species has a broad spectrum of food items but both species feed mainly on polychaetes. On the other hand, *Sá et al*. (2003) studied the main food items of *Solea vulgaris* in Portugal and stated that there was a very limited food spectrum (polychaetes and tanaidacea) of this species.

In the present study, sediments constituted 9.7% by volume composition of the main food bulk and this result is in agreement with Rajaguru (1992) who studied the Malabar sole *(Cynoglossus lida)* and concluded that ingestion of sediment was probably ingested accidental with the bottom polychaetes and other fauna.

Generally, the food extent demands and ability for food acquisition increase with fish development (Honda, 1984). Pearcy and Hancock (1978) studied the feeding habits of dover sole, *Microstomus pacificus*; rex sole, *Glyptocephalus zachirus* and slender sole, *lyopsetta exilis* and they concluded that the number and the size prey taxa increased with size of the flat fish, due to the ability of larger fishes to consume a wide range of prey sizes than smaller fishes.

In the present work, the size range of (11.5-12.4cm) for *Solea vulgaris* consumed two food items, whereas larger size range (20.5-21.4 cm), the fish consumed five food items. Moreover, the ratio of volume composition of polychaetes and copepods decreased as the fish size increased, whereas the ratio of volume composition of algae and seagrasses increased as the fish size increased.

In the current study, the feeding intensity of *Solea vulgaris* clearly indicates a low rate of feeding activity. This in agreement with De Groot (1971) who studied the feeding habits *S. vulgaris* and found that this species has a characteristics digestive tract and rapid digestive process; that it feeds on small quantities of prey very often. Also, Lagardere (1987) suggested that a high evacuation rate between the stomach and intestine, and lack of digestion in the stomach indicated low rate of feeding intensity. This high evacuation also was found in *Solea sengalensis* and *S. solea* (Molinero *et al*., 1991 ; Cabral, 2000).

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Fig. (1) : The diet compositio n of Solea vulgaris

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