



FEEDING HABITS OF THE *SEPIA ORBIGNYANA* (FÉRUSSAC IN D'ORBIGNY, 1826) FROM AIN EL-GHAZALA LAGOON, EASTERN LIBYA

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Abstract: The feeding habits of 117 specimens of *Sepia orbignyana* (family: Sepiidae), inhabiting Ain El-Ghazala lagoon on the Mediterranean coast, were studied monthly from November 2012 to October 2013. The annual diet composition, monthly variations in the diet composition, the variations of diet with length and the intensity of feeding were studied. *Sepia orbignyana* feed on a wide variety of prey types: Crustaceans (19.9%), Digestive food (16.5%), Seagrasses (16.2%), Foraminifera (11.1%), Sediments (10.8%), Fish parts (10.1%), Mollusca (5.7%), Polychaetes (5.5%) and Echinoderms (4.2%). The Crustaceans, Digestive food, Seagrasses, Foraminifera, Sediments and Fish part were the major food item all year round and it was found in all length groups. In the present study the Crustaceans, Foraminifera, Sediments, Fish parts and Echinoderms increased as the size increased, while Digestive food, Seagrasses, Mollusca and Polychaetes decreased as the fish size increased. The feeding intensity was quite high during the summer and autumn.

Keywords: Feeding habits, *Sepia orbignyana*, Ain El-Ghazala lagoon, Eastern Coast, Mediterranean Sea, Libya

INTRODUCTION

Family Sepiidae live in all the oceans and seas of the world, and occur in all depths especially in the Mediterranean Sea. The genus *Sepia* includes approximately 100 species (Lu et al, 1992). Family Sepiidae are significant commercial value to artisanal and industrial fisheries in the Mediterranean Sea (ICES, 2010). Sepiidae inhabit the continental shelf and upper slope to a maximum depth of approximately 1000 m. The members of family are primarily bottom dwellers over a range of habitats, including rocky, sandy and muddy substrates, sea grass, seaweed and coral reefs, some species migrate seasonally in response to temperature changes and aggregate usually in shallow water at spawning time (Boletzky, 1983). *S. orbignyana* is a nekton-benthic species occurring predominantly on sandy and muddy bottoms from the coastline (2-3m depth) to approximately 200 depth, with the greatest abundance in the upper 100m. Furthermore, it is relatively tolerant to variations in salinity. Animal have been observed in coastal lagoon at a salinity of 27‰ in the eastern Mediterranean Sea (Akyol et al., 2011). This is the first study so far to investigate the feeding habits of *S. orbignyana* (family Sepiidae) in Libyan eastern coast. The trophic structure of *S. orbignyana* position in the Libyan eastern coast is poorly understood. The purpose of the present study is to provide information about the trophic relationships between *S. orbignyana* with other invertebrates and fishes in this area. Therefore, the aim is to obtain fuller understanding of the dynamic of this regional ecosystem. The results of

feeding habits of *S. orbignyana* may have direct implications for aquaculture.

MATERIAL AND METHODS

Monthly samples of *S. orbignyana* were collected during the period from November 2012 to October 2013 by using gill and trammel nets from artisanal fishing in Ain El-Ghazala lagoon on the Mediterranean (Fig. 1). A total of 117 specimens of *S. orbignyana* were sampled for studying the feeding habits. Annual diet composition, seasonal variations of diet, variations of diet with lengths and feeding intensity were estimated in this study. Specimens were collected as fresh and immediately kept in ice containers to slow the digestion process of bacteria. Total length was measured to the nearest 0.1 cm by digital caliper and weights were measured with electronic balance. Each individual was dissected and the alimentary tract removed and preserved in 10% formalin for further analysis. The degree of fullness of the stomach was assessed by visual estimation and classified as empty, trace, quarter full, half full, three quarters full and completely full respectively as described in Pillay (1952). The gut content was examined under binocular microscope and all food items were identified to their groups. A list of general diet composition was made. Food analysis was made by points of assessment (Hyslop, 1980 & Hynes, 1985).

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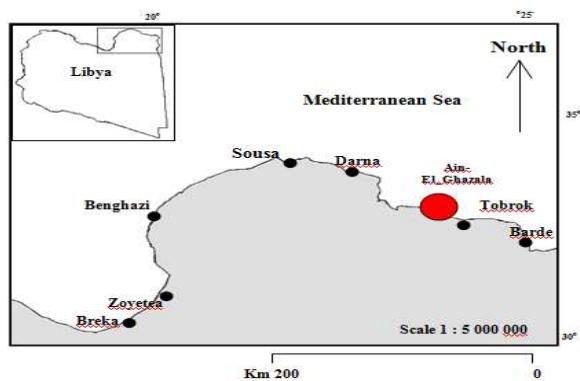


Figure 1: Map of Ain El-Ghazala lagoon, on the Mediterranean Sea, Libya

Statistical analysis

The results were statistically analysis subjected to the further statistical treatment according to Godfriaux (1969), in order to give more precise information about food and feeding habits of *S. orbignyana*. All data were tested for normality using a Kolmogorov–Smirnov test. One-way ANOVAs was used to the differences in diet composition among seasons and feeding habits in relation to body size.

RESULTS

Annual Diet Composition

The diet of *S. orbignyana* is mainly opportunistic and carnivorous such as Crustaceans, Foraminifera, Echinoderms, Mollusca, fish, Polychaetes, Seagrasses and Sediments. The stomach content data (Fig. 2) reveals Crustaceans (19.9%) as higher composition which represented in small prawns and crabs. It also showed a high percentage of Digestive food (16.5%) along with Seagrasses at (16.2%), *Cymodacea nodosa* and *Posidonia oceanic* formed the main constituent of Seagrasses in *S. orbignyana* diet. Foraminifers were, however, less significant and accounted for (11.1%) of the total percentage of food items. Moreover, there were considerable quantities of Sediments (sand) occurred in 10.8% of the stomach content, while fish parts including fish scales and bones composed (10.1%) of food. Molluscs, Polychaetes and Echinoderms share the lower level of food composition with (5.7%), (5.5%) and (4.2%) respectively.

Variations in diet composition

Study species feed on a wide range of diet such as Crustaceans, Foraminifera, Echinoderms, Mollusca, Fish, Polychaetes, Seagrasses and Sediments, and this food item were available in all year round during the study. However, the major constituents of food item throughout the period of study were crustaceans, digestive food, seagrasses, foraminifera, sediments and fish parts, and it also was found in all length groups (Table 1).

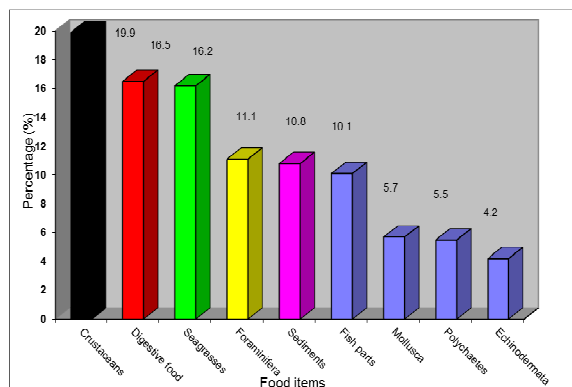


Figure 2: The diet composition of *Sepia orbignyana* from Ain El-Ghazalaha lagoon during the period from November 2012 till October 2013

There was a highly significant difference in seasonal variation of seagrasses during the period of study (ANOVA, $F_{3,113} = 6.05$, $P = 0.001$). In addition, there was a significant difference in seasonal variation of mollusca (ANOVA, $F_{3,113} = 2.96$, $P = 0.035$). However, there was no significant difference in seasonal variation of crustaceans, digestive food, foraminifera, sediments, fish parts, echinoderms and polychaetes (ANOVA, $F_{3,113} = 2.28$, $P = 0.083$), (ANOVA, $F_{3,113} = 0.11$, $P = 0.955$), (ANOVA, $F_{3,113} = 1.32$, $P = 0.271$), (ANOVA, $F_{3,113} = 2.35$, $P = 0.076$), (ANOVA, $F_{3,113} = 0.06$, $P = 0.980$), (ANOVA, $F_{3,113} = 0.11$, $P = 0.956$), (ANOVA, $F_{3,113} = 0.24$, $P = 0.867$) respectively. Table (2) shows the seasonal variations in diet composition for 117 specimens of *S. orbignyana* in Ain El-Ghazala lagoon during the period of study, in autumn the species fed predominantly on crustaceans (17.9%), seagrasses (17.9%) and sediments (14.2%). During winter, it mainly ingested on two food items which are crustaceans (18.8%) and foraminifers (16.7%). Furthermore, *S. orbignyana* preferred crustaceans (22.5%) and seagrasses (17.0%) in spring, also seagrasses (21.7%) and crustaceans (21.4%) in summer.

Table 1: Monthly variations in diet composition for 117 individuals of *Sepia orbignyana* from Ain El-Gazalaha lagoon during the period

Months	No.	Food items								
		Crustaceans	Digestive food	Seagrasses	Foraminifera	Sediments	Fish parts	Mollusca	Polychaetes	Echinodermata
Nov. (2012)	2	12.5	A	12.5	12.5	25.0	12.5	12.5	12.5	A
Dec.	2	25.0	A	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Jan. (2013)	4	18.8	18.8	12.5	12.5	12.5	12.5	A	12.5	A
Feb.	4	12.5	18.8	A	25.0	12.5	6.3	12.5	6.3	6.3
Mar.	B	B	B	B	B	B	B	B	B	B
Apr.	11	22.7	9.1	15.9	11.4	9.1	13.6	9.1	2.3	6.8
May	18	22.2	18.1	18.1	9.7	9.7	8.3	6.9	5.6	1.4
Jun.	15	21.7	13.3	20.0	8.3	8.3	13.3	3.3	5.0	6.7
Jul.	20	20.0	20.0	22.5	7.5	6.3	8.8	6.3	6.3	2.5
Aug.	20	22.5	16.3	22.5	11.3	5.0	12.5	A	5.0	5.0
Sep.	20	16.3	17.5	16.3	11.3	17.5	11.3	A	5.0	5.0
Oct.	1	25.0	50.0	25.0	A	A	0.0	A	A	A
Total	117	219.1	181.7	177.7	121.9	118.4	111.6	63.1	60.3	46.1
%		19.9	16.5	16.2	11.1	10.8	10.1	5.7	5.5	4.2

Remarks: Data expressed as percentage, (A) No food in month occurred, (B) No specimens in month occurred.

Table 2: Seasonally variations in diet composition for 117 individuals of *Sepia orbignyana* from Ain El-Gazalaha lagoon during the period from November 2012 till October 2013

Seasons	No.	Crustaceans	Digestive food	Seagrasses	Foraminifera	Sediments	Fish parts	Mollusca	Polychaetes	Echinodermata
Autumn	23	17.9	22.5	17.9	7.9	14.2	7.9	4.2	5.8	1.7
Winter	10	18.8	12.5	8.3	16.7	12.5	10.4	8.3	6.3	6.3
Spring	29	22.5	13.6	17.0	10.5	9.4	11.0	8.0	3.9	4.1
Summer	55	21.4	16.5	21.7	9.0	6.5	11.5	3.2	5.4	4.7

Remarks: Data expressed as percentage

Feeding habit in relation to size

The specimens ranged from the size 8.3-14.4 cm in length and 37.54-286.24 gm in weight. The total length of *S. orbignyana* population classified into 5 classes ranged from 8.33cm to 14.44cm with 1.22cm interval (Table 3). There was a difference in Prey size between large and small individuals of *S. orbignyana*, large sized individuals had ingested the large size prey, whereas the small sized ingested the small size prey.

Crustaceans, Digestive food, Seagrasses, Foraminifera, Sediments and Fish parts were found in all length groups of *S. orbignyana*. There was a significant variation of Crustaceans in food item among length groups (ANOVA, $F_{4,112} = 3.45$, $P = 0.011$). There was also high significant variation of Sediments in food item among length groups (ANOVA, $F_{4,112} = 4.28$, $P = 0.003$). However, there were no significant differences in the variation of Digestive food, Seagrasses, Foraminifera, Fish parts, Echinoderms, Mollusca and Polychaetes among length groups of individuals (ANOVA, $F_{4,112} = 0.30$, $P = 0.876$), (ANOVA, $F_{4,112} = 1.50$, $P = 0.208$), (ANOVA, $F_{4,112} = 0.52$, $P = 0.724$), (ANOVA, $F_{4,112} = 0.70$, $P = 0.591$), (ANOVA, $F_{4,112} = 0.24$, $P = 0.915$), (ANOVA, $F_{4,112} = 0.83$, $P = 0.509$), (ANOVA, $F_{4,112} = 40$, $P = 0.807$) respectively. In the present study

(Table 3) the Crustaceans, Foraminifera, Sediments, Fish parts and Echinoderms raised in food item as the size of individual increased. While, Digestive food, Seagrasses, Mollusca and Polychaetes decreased in diet as the individual size increased. The feeding intensity was relatively high during the summer and autumn. Crustaceans were found in all length groups of *S. orbignyana*, which increased from 23.2% in size class (8.30- 9.52cm) to 34.4% in size class (13.22-14.44cm). Conversely, Digestive food decreased from 18.6% in size class (8.30- 9.52cm) to 14.1% in size class (13.22- 14.44cm). Similarly, Seagrasses reduced from 20.3% in size class (8.30-9.52cm) to 11.9% in size class (13.22- 14.44cm). However, Foraminifera ingested in size class (8.30- 9.52cm) by 8.7%, but increased in the following length groups and recorded the highest value with 15.1% in size class (13.22-14.44cm). Furthermore, Sediments increased from 6.1% in size class (8.30- 9.52cm) to 11.9% in size class (13.22- 14.44cm), Fish parts also increased from 8.0% in size class (8.30- 9.52cm) to 12.7% in size class (13.22- 14.44cm). Finally, Mollusca, Polychaetes and Echinodermata were completely absent in the largest specimens in size class (13.22- 14.44cm).

Table 3: The diet composition of different size classes for *Sepia orbignyana* from Ain El-Gazalaha lagoon during the period from November 2012 till October 2013

Size groups (cm)	Food items										
	Average	No.	Crustaceans	Digestive food	Seagrasses	Foraminifera	Sediments	Fish parts	Mollusca	Polychaetes	Echinodermata
8.30 - 9.52	9.03	28	23.2	18.6	20.3	8.7	6.1	8.0	5.3	6.1	3.6
9.53 - 10.75	10.24	18	23.7	17.1	13.3	11.1	5.6	11.1	5.6	6.9	5.6
10.76 - 11.98	11.38	28	23.9	16.1	13.1	13.2	9.5	11.2	4.1	4.5	4.5
11.99 - 13.21	12.62	28	24.1	15.1	12.2	13.7	11.7	12.5	2.7	3.6	4.5
13.22 - 14.44	13.82	15	34.4	14.1	11.9	15.1	11.9	12.7	C	C	C

Remarks: Data expressed as percentage, (C) = No food in class occurred

Feeding intensity:

The degree of fullness of stomachs was recorded and divided into six categories: completely full, almost full, half full, quarter full and empty or with traces. Specimens with full, almost full and half full stomach were considered to have actively fed, whereas others with quarter full and traces or empty as poorly fed. Individuals with stomach half full, almost full and full of food ranked b% constituted (42.7%) of all stomachs examined, while those with stomach that were empty

or with traces of food and quarter full ranked a% represented (57.3%) of the total individuals (Table 4). It was noticed that the feeding activities of *S. orbignyana* individuals varied among seasons. A high feeding intensity occurred throughout autumn (65.0%) and summer (46.1%). However, the minimal rate of feeding intensity was recorded in winter (25.0%) and spring (30.6%) (Table 5).

Table 4: Monthly variations in the intensity of feeding of *Sepia orbignyana* from Ain El-Gazalaha lagoon during the period from November 2012 till October 2013

Months	No.	The degree of distension of the stomach							
		Empty	Trace	1/4	a%	1/2	3/4	Full	b%
Nov. (2012)	2	A	A	50.0	50.0	A	50.0	A	50.0
Dec.	2	A	100.0	A	100.0	A	A	A	A
Jan. (2013)	4	A	50.0	25.0	75.0	A	A	25.0	25.0
Feb.	4	A	50.0	A	50.0	A	25.0	25.0	50.0
Mar.	B	B	B	B	B	B	B	B	B
Apr.	11	A	63.6	36.4	100.0	A	A	A	A
May	18	A	27.8	11.1	38.9	A	27.8	33.3	61.1
Jun.	15	A	46.7	20.0	66.7	A	20.0	13.3	33.3
Jul.	20	A	35.0	10.0	45.0	A	25.0	30.0	55.0
Aug.	20	A	35.0	15.0	50.0	A	25.0	25.0	50.0
Sep.	20	A	35.0	20.0	55.0	A	45.0	A	45.0
Oct.	1	A	A	A	A	A	100.0	A	100.0
Average					57.3				42.7

Remarks: Data expressed as percentage (A) = No food in month occurred (B) No specimens in month occurred.

Table 5: Seasonally variations in the intensity of feeding of *Sepia orbignyana* from Ain El-Gazalaha lagoon during the period from November 2012 till October 2013

Seasons	No.	The degree of distension of the stomach							
		Empty	Trace	1/4	a%	1/2	3/4	Full	b%
Autumn	23	D	11.7	23.3	35.0	D	65.0	D	65.0
Winter	10	D	66.7	8.3	75.0	D	8.3	16.7	25.0
Spring	29	D	45.7	23.7	69.4	D	13.9	16.7	30.6
Summer	55	D	38.9	15.0	53.9	D	23.3	22.8	46.1

Remarks: Data expressed as percentage, (D) No food in season occurred.

DISCUSSION

The aim of this study was to investigate the trophic relationships between *S. orbignyana* with other invertebrates and fishes in Libyan eastern coast. The food and feeding habits of different species of cuttlefishes have been studied by many authors (Castro and Guerra, 1990; Hanlon and Messenger, 1996; Blanc et al., 1999; Pinczon du sel et al., 2000 and Perrin, 2004). *S. orbignyana* is a neritic, demersal species occurring predominantly on sandy and muddy bottoms. It often occurs from the coastline (2-3 m

depth) to a possible maximum depth of 200 m, but primarily in the upper 100 m (Mangold-Wirz, 1963).

In the current study, *S. orbignyana* were found to consume a wide range of food items such as Crustaceans, Digestive food, Seagrasses, Foraminifera, Sediments, Fish parts, Mollusca, Polychaetes and Echinoderms, this is in full consistency with Pinczon du Sel et al., (2000) who studied the feeding habits of *S. orbignyana* in Northern Bay of Biscay (France).

S. orbignyana captures preys using feeding tentacles, which have the ability to reach the prey in less than milliseconds. For example, prawns are injected with paralyzing saliva and bitten within six seconds of capture; crabs are also paralyzed in about ten seconds (Hanlon and Messenger, 1996).

It was also shown that the Crustaceans, Digestive food, Seagrasses, Foraminifera, Sediments and Fish parts were the major food item all year round, and found in all length groups. Comparable results of the diet composition have been obtained for the same species in south Brittany (Blanc et al., 1999).

It was demonstrated that the number and the size of prey taxa increased with size of *S. orbignyana*, since larger animals can consume a wide range of prey sizes than small individuals. These findings match those for a study on a related species *S. officinalis* (Blanc and Daguzan, 2000). Further, the Crustaceans, Foraminifera, Sediments, Fish parts and Echinoderms increased as the size increased, while Digestive food, Seagrasses, Mollusca and Polychaetes decreased as the fish size increased. This finding mirrors a previous study that has shown the same in *S. orbignyana* in south Brittany (Blanc et al., 1999).

The monthly variation in the condition factor of animal is affected by the feeding activities which may show their reflection on the body condition (Boletzky, 1979). This phenomenon appears to be correct for the species in the present work. The highest condition factor values (K_f and K_c) were recorded in summer and autumn (Blanc et al., 1999). These results correspond with the degree of stomach fullness. This supports observation described in the English Channel (Boucaud and Boismery, 1991), in NW Spain (Castro and Guerra, 1989) and recently the study area but for *S. officinalis* (Abdalrazig, 2013).

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