Diet of the common cuttlefish *Sepia officinalis* (Linnaeus, 1758) (Cephalopoda: Sepiidae) in the Southern Moroccan Atlantic waters, Cap Boujdour, Cap Blanc

[1]Fatima Mzaki, [2]Khalid Manchih, [2]Hounaida F. Idrissi, [2]Abdellatif Boumaaz, [3]Asia B. Haddouch, [1]Ouadiaa Tazi

[1] Laboratory of Immunology and Biodiversity, Department of Biology, Faculty of Sciences, University Hassan II Casablanca, Casablanca, Morocco; [2] Fisheries Department, National Fisheries Research Institute (INRH), Casablanca, Morocco; [3] Quality and Safety Department of Marine Environment, National Fisheries Research Institute (INRH), Casablanca, Morocco. Corresponding author: F. Mzaki, fatima.mzaki@gmail.com

Abstract. The diet of the cuttlefish *Sepia officinalis* was studied for the first time in the Southern Moroccan Atlantic waters during an annual cycle between September 2013 and October 2014. Samples were collected from bottom trawl surveys and commercial artisan catches taken between cap Boujdour to cap Blanc (26°N-21°N latitude). A total of 479 individuals (252 male and 227 female), ranging between 4 and 40 cm DML and of total weight (W) ranging between 18 and 4,750 g are studied. A qualitative and quantitative analysis was realized according to sex, size and sampling season. The stomach contents were analyzed using five indices: frequency of occurrence (F%), percentage by number (Cn%), percentage by weight (Cp%), Index of Relative Importance (IRI %) and Feeding Coefficient (Q). Trophic activity was assessed using the stomach vacuity coefficient (V%). A MANOVA test was used to compare the quantitative composition of the diet according to seasons, size and sexes. According to the results of the index of relative importance (IRI%) of the stomach contents (which takes into account weight, number and frequency of occurrence), fish and crustaceans are the most consumed prey category representing respectively 51.36% and 42.56% and are considered as a principally prey of *S. officinalis*. Cephalopods occurring in 13.78% of non-empty stomachs, accounting for 7.71 % of preys in number and 18.79% in weight are considered as a secondary prey for *S. officinalis*. The evolution of the vacuity coefficient shows that this index varies according to the sexual cycle and season. Significant seasonal variations in the diet were observed. It is proposed that seasonal differences in diet composition are caused by spatial and temporal variations in abundance and distribution of some of the major prey species. No significant differences in the diet between males and females were found. Differences in food composition between jveniles and adult individuals appeared to be influenced by the *S. officinalis* size and the reproduction period. In specimens with dorsal mantle lengths up to 15 cm crustaceans dominated, occurring in 54.63% of examined stomachs and made up (57.27%) of (IRI%). Important prey categories of the adults (≥15 cm DML) were fish with (IRI%= 54.49%), followed by crustaceans (IRI%=37.86%) and cephalopods (IRI%=5.73%). The variations of *S.officinalis* diet in the studied area indicate an opportunistic character of this predator as cited in many studies in other regions of the world.
Key Words: feeding intensity, prey, MANOVA, stomach content.

Introduction. The study of the dietary habits of marine fish based on stomach content analysis has become a widely used method in fish ecology (Hyslop 1980; Ahlbeck et al 2012). Food and feeding habits are important biological factors used to describe the life history of fishes like growth, reproduction, maturation, spawning, habitat use and migratory movements (Rosecchi & Nouaze 1987). The description of the diets of marine species provides the basis for understanding many important ecological components including the feeding patterns, quantitative assessment of food habits (Chipps & Garvey 2006). This can give information about the position of species in the ecosystem and its possible dependence on other species. In recent years, the study of species diets in the marine ecosystem has received increased attention in determination of trophic interactions in marine food webs with development of multispecies models for fisheries management (Christensen & Walters 2004; Gasalla et al 2010).

Cephalopods species play an overall role of trophic structure of the world's marine ecosystems. Like fish, they are a very important part of the ocean biomass and their position in the food chain means that they are both important predators and preys (Lipinski 1992; Piatkowski et al 2001). Therefore, cephalopods are recognized to be important food resources for higher trophic levels such as mammals and birds and as predatory consumers of finfish and other invertebrates (Boletzky & Hanlon 1983). Cephalopods are characterized by a plastic life cycle with a recognized capacity to adapt to different ecosystems due to a short life span and a rapid growth (Lourenço et al 2012). In fact, cephalopods have a high and fast food conversion rate; according to Lee (1994) their growth rates ranging from 3 to 15% of body weight per day during their life cycle. All cephalopods are carnivorous, opportunistic and dynamic predators (Lee et al 1998), most of them exhibit a preference for live natural foods (Domingues et al 2003). In addition, cephalopods metabolism is essentially carnivorous and very different compared to that of fish and crustaceans (Lee 1994; Forsythe & Van Heukelem 1987).

The common cuttlefish *Sepia officinalis* (Linnaeus, 1758) is a cephalopod species belonging to the family Sepiidae. It is a neritic and demersal species, occurring predominantly on sandy grounds from the coastline to depths of 150-200 m. *S. officinalis* is an oceanic species broadly distributed throughout the Mediterranean Sea and the Eastern Atlantic, in an area stretching from the southern Norway and northern England to the northwestern coast of Africa. The species also found in Madeira and in the Canary Islands (FAO 2000).

Southern Morocco's Atlantic area situated along the northwest African coast approximately between 21N° and 26N° is considered one of the richest fishing grounds in the world. This area is characterized by the great extension of continental shelf and magnitude of the permanent upwelling caused by the almost constant Northeast trade wind and Canary current (Benazzouz et al 2014; Moujane & Mordane 2014). This is the cause of an extremely high productivity and holds one of the richest fishing grounds in the world.

The fishery sector is playing an increasingly important role in the Moroccan waters. Cephalopods are important fisheries resource in the Southern Moroccan Atlantic. In fact, cephalopods species ("common octopus" *Octopus vulgaris*, "common cuttlefish" *S. officinalis* and "common squid" *Loligo vulgaris*) occupy an important socio-economical and ecological role in this area because of their abundance and high commercial value (INRH 2014). Therefore, *S. officinalis* represent 35.75% of total cephalopods landings in Morocco with a value exceeding 537 Million MAD (Anonym 2014). In order to assess the status of this specie fishery resource, reliable informations related to the reproduction, growth and diet must be well known. These biological informations will contribute to develop a management plan of the Moroccan cuttlefish fishery.

The biology of the cuttlefish in Moroccan waters has not been studied comprehensively and the information of its diet patterns is largely unknown. The previous studies of the diet of *S. officinalis* in its natural habitat are those in other areas by Najai & Ktari (1979) in Gulf of Tunis, Castro & Guerra (1990, 1989) in Ria de vigo NW Spain, Blanc et al (1998) in Moribihan Bay (France), Pinczon du Sel et al (2000) in Bay of Biscay (France), Alves et al (2006) in south coast of Portugal, Neves et al 2009 in the Sado estuary (Portugal), Evans (2012) in English channel and Akesse et al (2016) in Cote d'Ivoire.

The main objective of this study is to characterize for the first time the diet of *S. officinalis* in the Southern Moroccan Atlantic waters between Cap Boujdour and Cap Blanc, according to sexes, size and season.

Material and Method

Fish sampling. The samples was obtained from the National Fisheries Research Institute's vessel, R/V CHARIF AL IDRISSI during the cephalopods bottom trawl surveys carried out on September 2013, April 2014 and October 2014 in the southern Moroccan Atlantic area between Cap Boujdour (26°N) and Cap Blanc (20°50'N) (Figure 1). The main objectives of these surveys are to measure temporal variation in cephalopod stock size, population abundance indices and biomass, with other biological characteristics of the stock under management regulation. The trawling stations are determined according to a stratified-random sampling design and adjusted regarding the nature of the grounds and the depth. The details of the survey design are described by (Faraj 2009). Additionally, biological samples from the commercial landings of the artisanal fishery were collected in the port of Dakhla and the Lassarga fishing village respectively. The individuals were frozen onboard to -20°C for later analysis in the laboratory.

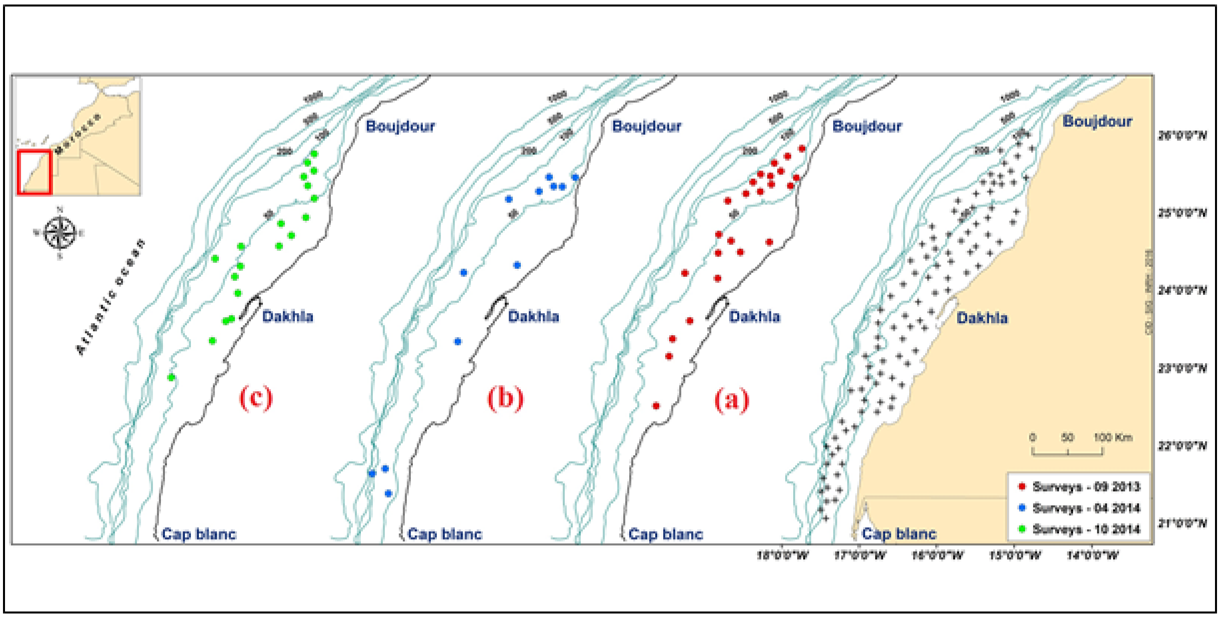

Figure 1. Map of the study area Southern Moroccan Atlantic showing the distribution of sampling stations in each bottom trawl survey (a): September 2013; (b): April 2014; (c): October 2014.

Stomach content analysis. In the laboratory, for each of 479 *S. officinalis* sampled, the total weight (W) in grams, Dorsal Mantle Length (DML) (cm) and sexes were recorded. Maturity stages were assigned according to Richard (1971). The stomach was removed from each specimen, weighed and preserved in a 70° alcohol solution. In order to compare the diet of *S. officinalis* of various size, the individuals were classified into two size groups, juveniles (DML < 15 cm) and adults (DML ≥ 15 cm), on the basis of the length at first maturity (LM 50). The total DML 50 in this study is 15.45 cm, was determined by plotting graph between dorsal mantle length class and percentage frequency of mature cuttlefish. To determine seasonal variations in the diet, the monthly samples were grouped together by seasons: winter comprising December-February; spring, March-May; summer, June- August and autumn, September- November.

The stomach contents were examined counted and weighed at 0.001 g precision (after blotting on tissue paper to remove excess moisture). Prey items were identified to the lowest possible taxonomic level (family, specie), under a binocular microscope, using reference guides and taxonomic keys. Fishes were identified from their otoliths and other hard structures such as scales, eyes and bones. Crustaceans were recognizable from their eyes, antennae, legs and various other fragments of carapace. Cephalopods components were identified from beaks, pieces of arms and suckers. Polychaetes were identified using body fragments with multiple appendages. The preys digested beyond visual recognition were classed as undetermined preys.

There are several qualitative and quantitative methods used to describe food habits and feeding pattern of fishes. In the present study, the contribution and the relative importance of each prey item (i) to the diet of *S. officinalis* was estimated using numerous indexes (Hyslop 1980):

Vacuity coefficient (V%) = percent number of empty stomachs

Percent frequency of occurrence (F%) = (number of stomachs containing prey item i / total number of non-empty stomachs) x 100

Percentage by number (Cn%) = (number of individuals of prey item i/total number of all prey items) x 100

Percentage by weight (Cp%) = (weight of prey item i/total weight of all prey items) x 100

The hierarchization of food items was established using the index of relative importance (IRI) of Pinkas et al (1971):

$$IRI = (Cn + Cp) \times F$$

The IRI index was again converted to % of the total IRI as IRI %=(IRI/ ∑IRI) x 100

Feeding Coefficient (Q) = Cn% x Cp% (Hureau 1970), which characterizes the relative importance of the different preys in a diet. Using this coefficient, preys were separated into three categories (Q>200 = principal prey), (20<Q<200 = secondary prey), (Q<20 = accessory prey).

Statistical analysis*.* A MANOVA non-parametric analysis was used to compare feeding activity. A three factor was used to test the null hypothesis that there were no differences in the diet between sexes, size and seasons. Prey items were merged into major taxonomic groups (Fishes, Crustacea, Cephalopoda, Polychaeta and Bivalvia) to avoid problems with low expected frequencies. The statistical significance of the MANOVA can be determined in a variety of ways. We used the most widely used statistic test, Wilks' Lambda (L) (although alternative test statistics (e.g Pillai's trace) gave similar results). When the MANOVA were statistically significant, subsequent univariate ANOVAs were performed to elucidate which responses contributed to the significant multivariate response. Prior to analyses of data by ANOVA and MANOVA, all elemental data were examined for normality and homogeneity of variances using Shapiro-Wilk normality tests ($\alpha = 0.05$). The statistical analyses were carried out using the computer program R version 3.1.3. Non-identified food items were excluded from the analysis.

Results. The biological sample consist of 479 *S. officinalis* observed dorsal mantle lengths (DML) ranged from 4 to 40 cm (15.79±5.99 cm) and body weight (W) ranged from 18 to 4,750 g (571.69±596.56 g). The mean DML of female *S. officinalis* was 16.3 cm (range 5.3–39.7 cm, n = 227), and that of males was 15.8 cm (range 4.9–40 cm, n = 252) (Figure 2). The juveniles-adults Dorsal Mantle Length (DML) frequency distributions are shown in Figure 3.

Feeding intensity. The feeding activity, as indicated by the percent of empty stomachs, a stomach was considered empty if there was no weighable material. Out of 479 stomachs examined, 196 were empty (V% = 40.92%). The vacuity index did not reveal any significant differences over the year (X^2test = 1.32, d.f. = 3, p>0.05), and accounted for 42% in summer, 38% in autumn, 27% in winter and 45% in spring.

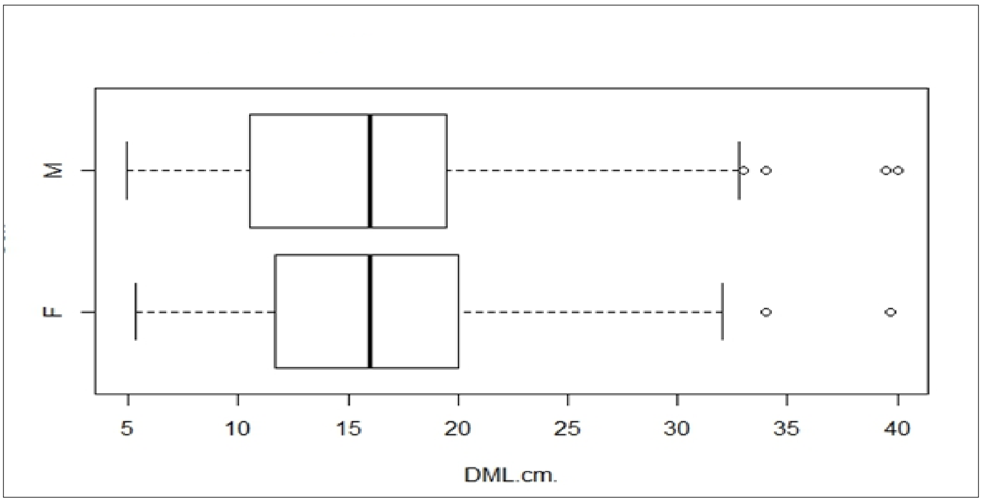

Figure 2. Males and females dorsal mantle length (DML) distribution of *Sepia officinalis* caught in the southern Moroccan Atlantic.

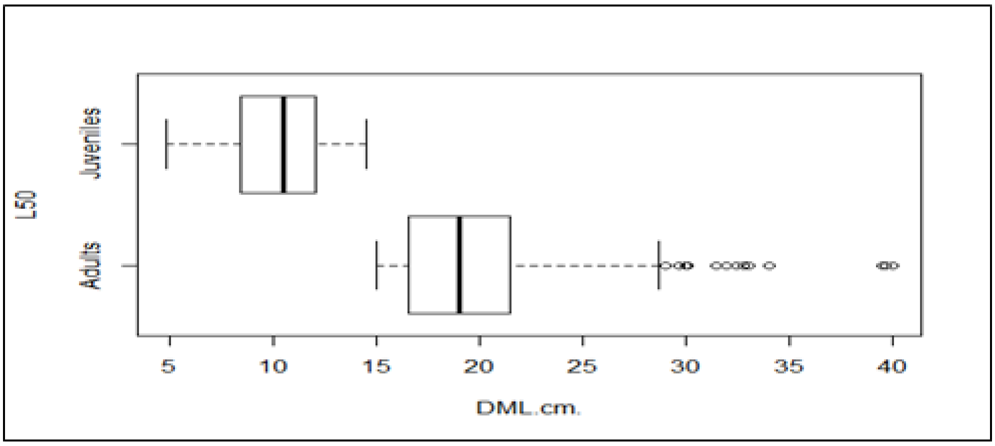

Figure 3. Juveniles (DML<15 cm) and Adults (DML≥15cm) dorsal mantle length frequency distribution of *Sepia officinalis* caught in the southern Moroccan Atlantic.

The Table 1 shows the tendency of the seasonal V% vary according to the sexes. There were no seasonal significant differences in the vacuity index (V%) between females and males (X^2test, d.f. = 3, P>0.05). However, the proportion of empty stomachs computed by juveniles (DML<150 mm) and adults (DML≥150 mm) showed significant seasonal variations in autumn, winter and summer season (X^2test, d.f. = 3, p<0.0001) (Table 2). The V% values recorded in juveniles showed the highest proportion of empty stomachs than that of adults with a maximum in spring (V% = 50.8%), while the lowest V% values was observed in the adults in the winter season (0%).

Table 1

Seasonal variations of the vacuity index in males and females of *Sepia officinalis*

	Males	*Females*	X^2
Autumn	41.40	33.30	0.11
Winter	33.30	20.00	1.73
Spring	48.50	41.10	0.01
Summer	38.90	46.40	2.16
X^2	1.87	2.15	4.01

Table 2

Seasonal variations of the vacuity index (V%) in juveniles and adults of *Sepia officinalis*

	Juveniles (LDM<150 mm)	*Adults (LDM≥150 mm)*	X^2	*Test*
Autumn	28.9	39.5	5.65	***
Winter	33.3	0	25.66	***
Sring	50.8	34.7	0.29	NS
Summer	40	43.6	2.55	*
X^2	14.85	19.29	34.14	

Significance codes: * p<0.1; *** p<0.01, NS (non significant): p>0.05.

General composition of S. officinalis diet. The Table 3 shows the relative importance of the main prey groups identified in the stomachs of *S. officinalis*. The various food items recorded from the stomach of *S. officinalis* during the study period are presented in Table 4. Examination of stomach contents revealed a large variety of food items that could be assorted into nine taxonomic groups namely: Fishes, Crustacea, Cephalopoda, Bivalvia, Gastropoda, Polychaeta, Anthozoa, Echinodermata and algae. The stomach content data (Table 4) reveals that the most commonly occurring general prey category was fish (F% = 52.30%) followed by Crustacea (F% = 49.82%) and cephalopods (F% = 13.78). Polychaeta, Bivalvia and Gastropoda share the lower level of food composition with (F% = 5.3%), (F% = 9.89) and (F% = 2.47%) respectively. Stomach contents weight in terms of taxonomic composition was dominated by fishes (Cp% = 48.58%). The most important fish prey families were: Sparidae, Gobiidae, Soleidae, Trachinidae, Bothidae and Clupeidae made up almost 33.40% of the total estimated prey weight. Crustaceans the second category in weight food items (CP% = 25.53%) followed by cephalopods (Cp% = 18.79%). Small weight of bivalves, Polychaetes and Gastropods were also recorded, in 2.91%, 3.83% and 0.59% of stomachs, respectively. The percentage by number of prey was dominated by Crustacea, accounting for (Cn% = 45.26%) of the total number of prey items. Fishes were the second most important group comprised (Cn% = 32.80%) in number of prey ingested. The maximum number of fish and crustacean prey species found in a single stomach varied from one to 13. Overall, portunidae and sparidae was the most important crustacean and fish prey family, representing 27.67% and 15.90% of the total number of prey, respectively. The prey items belonging to the group: Cephalopoda, Bivalvia, Polychaeta and Gastropoda showed a lower percentage by number (Cn%). Cannibalism of *S. officinalis* was important in frequency (3.18%) weight (8.67%) but is represented only (1.78%) in number.

Table 3

Feeding coefficient (Q) for the identified items by sexes, size and season, (analysis in five main groups of preys)

Prey taxa	*Sexes*		*Size*		*Season*			
	Males	*Females*	*Adults*	*Juveniles*	*Autumn*	*Winter*	*Spring*	*Summer*
Fishes	Principal	Principal	Principal	Principal	Principal	Principal	Principal	Principal
Crustacea	Principal	Principal	Principal	Principal	Principal	Secondary	Principal	Principal
Cephalopoda	Principal	Principal	Secondary	Secondary	Secondary	Principal	Secondary	Principal
Bivalvia	Secondary	accessory	Secondary	Secondary	accessory	-	accessory	Principal
Polychaeta	Accessory	Secondary	accessory	accessory	Secondary	accessory	accessory	accessory

Table 4

Composition of the diet of *Sepia officinalis* of the Southern Moroccan Atlantic coast and percentages of the corresponding food indices

Prey taxa	*F%*	*Cn%*	*Cp%*	*Prey taxa*	*F%*	*Cn%*	*Cp%*
ALGAE	0.35	0.20	0.01	Calliostomatidae			
Cladostephaceae				Turritellidae			
ANTHOZOA	0.71	0.59	0.13	**FISHES**	52.30	32.81	48.58
Homathiidae				Bothidae	2.12	1.38	1.85
BIVALVIA	9.89	5.93	2.91	Carangidae	0.71	0.40	1.56
Cardiidae	2.47	1.58	1.39	Centracanthidae	0.71	0.40	0.82
Acanthocardia tuberculata				Clupeidae	2.47	1.58	3.23
Cerastoderma edule				*Sardina pilchardus*			
Tellinidae	4.95	2.96	0.95	Congridae	1.06	0.79	2.20
Tellina pulchella				Engraulidae	0.71	0.40	0.16
Tellina sp				Gadidae	0.35	0.20	0.25
Veneridae	2.47	1.38	0.57	Gobiidae	9.89	6.72	5.34
CEPHALOPODA	13.78	7.71	18.79	*Deltentosteus quadrimaculatus*			
Loliginidae	2.83	1.58	2.62	*Gobius cruentatus*			
Loligo vulgaris				*Gobius sp*			
Octopodidae	2.83	1.58	5.18	*Lesueurigobius sp*			
Octopus vulgaris				*Ophidion barbatum*			
Ommastrephidae	1.06	0.59	0.49	Haemulidae	0.35	0.20	0.12
Sepiidae	3.18	1.78	8.67	Labridae	0.35	0.20	0.28
Sepia elegans				Mullidae	0.71	0.40	0.43
Sepia officinalis				Ophidiidae	0.35	0.20	0.22
Sepia orbignyana				Scombridae	0.35	0.20	0.54
Sepia sp				Soleidae	4.59	2.96	2.35
Sepiolidae	2.12	1.19	1.57	*Dicologlossa cuneata*			
Sepietta oweniana				*Michrochirus sp*			
Sepiola rondeleti				*Microchirus azevia*			
Sepiola sp				*Microchirus ocellatus*			
unidentified	1.77	0.99	0.28	*Solea solea*			
CRUSTACEA	49.82	45.26	25.53	*Solea sp*			
Alpheidae	0.71	0.59	0.31	Sparidae	15.90	9.88	18.71
Amphipoda	1.06	0.59	0.16	*Boops boops*			
Inachidae	0.35	0.20	0.80	*Dentex dentex*			
Majidae	0.71	0.40	0.38	*Dentex gibbosus*			
Nephropidae	0.35	0.20	0.06	*Dentex maroccanus*			
no.ident shrimps	0.71	0.40	0.11	*Dentex sp*			
Pasiphaeidae	0.71	0.40	0.27	*Diplodus sp*			
Penaeidae	0.71	1.78	0.46	*Diplodus vulgaris*			
Portunidae	26.15	27.67	19.62	*Pagellus acarne*			
Liocarcinus corrugatus				*Pagellus erythrinus*			
Liocarcinus depurator				*Pagellus sp*			
Liocarcinus sp				*Pagrus pagrus*			
Thalamita poissonii				*Sparus aurata*			
Nematocarcinidae	0.35	0.20	0.07	Trachinidae	2.12	1.38	1.93
Solenoceridae	0.35	0.20	0.08	*Echiichthys vipera*			
Squillidae	2.83	2.17	0.81	*Trachinus sp*			
Squilla mantis				no.ident telestei	9.19	5.34	8.58
Isopoda	0.35	0.20	0.04	Triglidae	0.35	0.20	0.01
Mysidacea	0.35	0.20	0.02	**POLYCHAETA**	5.30	4.35	3.38
Decapoda				Nereidae	1.41	0.99	0.57
ECHINODERMATA	0.35	0.20	0.09	Oweniidae	2.12	1.78	1.77
GASTROPODA	2.47	2.96	0.59	unidentified	1.77	1.58	1.05

Frequency of occurrence (F%), percentage by number (Cn%), percentage by weight (Cp%).

Seasonal variations in the diet of S. officinalis. Differences between seasons in the diet of S. officinalis were detected (Table 5). Seasonal variation of the diet of *S. officinalis* was examined on dietary data stratified into seasons. The percentage composition of different food items are given in Table 6 (a) and Table 6 (b) respectively. The dietary indices, for the identified items, showed that fishes and crustaceans were the most important type of prey based on the frequency of occurrence and percentage by number. The number composition of the diet was more diversified in spring, and almost exclusively composed of crustaceans in autumn (Cn% = 54.64%) and of fishes in winter (Cn% = 60%). Bivalvia, fishes, crustaceans and cephalopods, were important prey in summer, representing 28.07%, 31.58%, 21.05% and 14.04% of the percentage by number (Cn%) of prey, respectively. Polychaetes were poorly present in the diet during spring and autumn. In contrast, the diet composition by mass evolved from a quasi-exclusive fish diet dominated by Sparidae family in autumn and spring to a more diversified one in summer.

The proportion of crustaceans increased from Cp% = 5.69% in winter to Cp% = 24.89% in spring and then reached its maximum in early autumn (Cp% = 27.24%). The crustacean preys consisting mainly of Portunidae. The importance of cephalopods increased substantially during winter (Cp% = 64.81%) when they formed the most important part of the diet. Finally, bivalves appeared in late spring and reached their maximum in summer (Cp% = 12.59%). Polychaetes did not show any marked variation.

During the study, the feeding coefficient Q calculated for each prey showed that the *S. officinalis* feed principally on fishes and crustaceans over the autumn and spring and feeding on fishes and cephalopods in the winter. Fishes, crustaceans, cephalopods and bivalves were the principally prey in summer. The cephalopods constituted secondary prey in spring and autumn. However, the crustaceans were the secondary prey in winter. Polychaetes, constituted a secondary prey in autumn and an accessory prey in all the year, whereas all the other taxa were accessory prey (Table 3).

Based on the IRI values, there was a strong seasonal effect on the diet composition of *S. officinalis*. Therefore, there was a highly significant difference in seasonal variation of the diet during the period of study (MANOVA, F_3 = 1.906, P = 0.006) (Table 5). In addition, there was a significant difference in seasonal variation of crustaceans (ANOVA, F_3 = 4.3735, P = 0.0049) and bivalves (ANOVA, F_3 = 5.4113, P = 0.0012). However, there was no significant difference in seasonal variation of fishes, cephalopods, gastropods, echinoderms and polychaetes (ANOVA, F_3 = 0.2951, P = 0.8289), (ANOVA, F_3 = 0.9865, P = 0.3995), (ANOVA, F_3 = 0.4028, P = 0.7511) (ANOVA, F_3 = 0.3898, P = 0.7605), (ANOVA, F_3 = 1.5875, P = 0.1926) respectively.

Table 5

Multivariate analysis of variance (MANOVA) results for all variables tested (season, sexes, size)

Variable	*Test de Pillai*			*Test de Hotelling-Lawley*			*Test de Roy*			*Test de Wilks*		
	P-Value	F	Test	P-Value	F	Test	P-Value	F	Test	P-Value	F	Test
Season	0.006	1.887	**	0.005	1.922	**	0.001	3.505	***	0.006	1.906	**
Sexes	0.394	1.057	NS	0.394	1.057	NS	0.394	1.057	NS	0.394	1.057	NS
Size	0.013	2.459	*	0.013	2.459	*	0.013	2.459	*	0.013	2.459	*

Significant result. '***' p<0.001; '**' p< 0.01; '*' p< 0.05; NS (no significant): p>0.05

Table 6 (a)

Prey identified in the stomach contents of *Sepia officinalis* in relation to season

Prey taxa	*Autumn*					*Winter*				
	Cn%	*Cp%*	*F%*	*IRI%*	*Q*	*Cn%*	*Cp%*	*F%*	*IRI%*	*Q*
Algae	0.34	0.02	0.76	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Anthozoa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bivalvia	3.44	1.97	6.87	0.39	6.77	0.00	0.00	0.00	0.00	0.00
Cephalopoda	5.50	14.7	12.2	2.58	81.27	10.0	64.8	12.5	11.6	648.10
Loliginidae	1.37	2.27	3.05	0.42	3.13	0.00	0.00	0.00	0.00	0.00
Octopodidae	1.03	6.80	2.29	0.67	7.01	10.0	64.8	12.5	23.6	648.10
Ommastrephidae	0.34	0.41	0.76	0.02	0.14	0.00	0.00	0.00	0.00	0.00
Sepiidae	0.69	4.56	1.53	0.30	3.14	0.00	0.00	0.00	0.00	0.00
Sepiolidae	1.03	0.51	2.29	0.13	0.52	0.00	0.00	0.00	0.00	0.00
Unidentified	1.03	0.22	2.29	0.11	0.23	0.00	0.00	0.00	0.00	0.00
Crustaceans	54.6	27.2	64.1	54.66	1488.4	20.0	5.69	12.5	3.99	113.70
Alpheidae	0.34	0.22	0.76	0.02	0.08	0.00	0.00	0.00	0.00	0.00
Amphipoda	0.69	0.70	1.53	0.08	0.48	0.00	0.00	0.00	0.00	0.00
Brachyura	14.0	3.16	22.9	14.71	44.52	0.00	0.00	0.00	0.00	0.00
Inachidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Isopoda	0.34	0.17	0.76	0.01	0.06	0.00	0.00	0.00	0.00	0.00
Majidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mysidacea	0.34	0.05	0.76	0.01	0.02	0.00	0.00	0.00	0.00	0.00
Nephropidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No.ident shrimps	0.34	0.08	0.76	0.01	0.03	0.00	0.00	0.00	0.00	0.00
Pasiphaeidae	0.34	0.35	0.76	0.02	0.12	0.00	0.00	0.00	0.00	0.00
Penaeidae	3.09	0.94	1.53	0.23	2.92	0.00	0.00	0.00	0.00	0.00
Portunidae	32.3	20.5	29.0	57.14	664.83	20.0	5.69	12.5	8.13	113.70
Nematocarcinidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solenoceridae	0.34	0.17	0.76	0.01	0.06	0.00	0.00	0.00	0.00	0.00
Squillidae	2.41	0.82	4.58	0.55	1.98	0.00	0.00	0.00	0.00	0.00
Echinodermata	0.34	0.18	0.76	0.00	0.06	0.00	0.00	0.00	0.00	0.00
Gastropoda	4.47	1.20	4.58	0.21	5.36	0.00	0.00	0.00	0.00	0.00
Fishes	26.1	50.4	51.9	41.36	1316.8	60.0	28.8	75.0	82.7	1729.3
Bothidae	0.34	0.21	0.76	0.02	0.07	10.0	4.95	12.5	4.73	49.46
Carangidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Centracanthidae	0.69	1.70	1.53	0.14	1.17	0.00	0.00	0.00	0.00	0.00
Clupeidae	0.34	0.10	0.76	0.01	0.04	0.00	0.00	0.00	0.00	0.00
Congridae	1.37	4.55	2.29	0.51	6.25	0.00	0.00	0.00	0.00	0.00
Engraulidae	0.34	0.12	0.76	0.01	0.04	0.00	0.00	0.00	0.00	0.00
gadidae	0.34	0.52	0.76	0.02	0.18	0.00	0.00	0.00	0.00	0.00
gobiidae	5.50	7.49	11.4	5.54	41.16	20.0	12.0	25.0	20.2	239.91
Haemulidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Labridae	0.34	0.59	0.76	0.03	0.20	0.00	0.00	0.00	0.00	0.00
Mullidae	0.34	0.52	0.76	0.02	0.18	0.00	0.00	0.00	0.00	0.00
No.ident telestei	4.47	13.4	9.16	6.12	60.16	30.0	11.8	37.5	39.7	356.45
Ophidiidae	0.34	0.45	0.76	0.02	0.16	0.00	0.00	0.00	0.00	0.00
Scombridae	0.34	1.11	0.76	0.04	0.38	0.00	0.00	0.00	0.00	0.00
Soleidae	2.06	1.59	3.82	0.52	3.29	0.00	0.00	0.00	0.00	0.00
Sparidae	7.22	14.3	13.7	11.02	103.25	<0.0	<0.0	<0.0	<0.0	<0.01
Trachinidae	1.72	3.67	3.05	0.61	6.31	0.00	0.00	0.00	0.00	0.00
Triglidae	0.34	0.02	0.76	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Polychaeta	5.15	4.19	7.63	0.74	21.58	10.0	0.68	12.5	1.66	6.82
Nereidae	1.03	0.96	2.29	0.17	0.99	0.00	0.00	0.00	0.00	0.00
Oweniidae	1.72	1.18	2.29	0.25	2.03	10.0	0.68	12.5	3.38	6.82
Unidentified	2.41	2.05	3.05	0.51	4.92	0.00	0.00	0.00	0.00	0.00

Frequency of occurrence (F %), percentage by number (Cn %), percentage by weight (Cp %), percent index of relative importance (%IRI) and feeding coefficient Q.

Table 6 (b)

Prey identified in the stomach contents of *Sepia officinalis* in relation to season

Pray taxa	*Spring*					*Summer*				
	Cn%	*Cp%*	*F%*	*IRI%*	*Q*	*Cn%*	*Cp%*	*F%*	*IRI%*	*Q*
Algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anthozoa	2.00	0.33	1.87	0.05	0.67	0.00	0.00	0.00	0.00	0.00
Bivalvia	2.67	1.47	3.74	0.18	3.91	28.0	12.5	40.5	26.1	353.43
Cephalopoda	9.33	19.0	13.0	4.36	178.09	14.0	27.1	21.6	14.1	381.03
Loliginidae	1.33	1.01	1.87	0.14	1.35	3.51	10.2	5.41	6.44	35.84
Octopodidae	2.00	1.38	2.80	0.31	2.76	1.75	1.00	2.70	0.65	1.76
Ommastrephidae	0.67	0.48	0.93	0.04	0.32	1.75	0.91	2.70	0.63	1.60
Sepiidae	3.33	14.7	4.67	2.77	49.15	3.51	6.65	5.41	4.77	23.32
Sepiolidae	1.33	1.06	1.87	0.15	1.41	1.75	8.28	2.70	2.36	14.53
Unidentified	0.67	0.41	0.93	0.03	0.27	1.75	0.09	2.70	0.43	0.16
Crustaceans	38.6	24.8	43.9	32.7	962.36	21.0	24.3	27.0	19.4	511.94
Alpheidae	1.33	0.51	0.93	0.06	0.69	0.00	0.00	0.00	0.00	0.00
Amphipoda	0.67	0.36	0.93	0.03	0.24	0.00	0.00	0.00	0.00	0.00
Brachyura	4.67	1.50	6.54	1.32	6.98	5.26	2.09	8.11	5.18	11.02
Inachidae	0.00	0.00	0.00	0.00	0.00	1.75	7.28	2.70	2.12	12.78
Isopoda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Majidae	0.00	0.00	0.00	0.00	0.00	3.51	3.46	5.41	3.27	12.14
Mysidacea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nephropidae	0.67	0.15	0.93	0.03	0.10	0.00	0.00	0.00	0.00	0.00
No.ident shrimps	0.67	0.18	0.93	0.03	0.12	0.00	0.00	0.00	0.00	0.00
Pasiphaeidae	0.67	0.26	0.93	0.03	0.17	0.00	0.00	0.00	0.00	0.00
Penaeidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portunidae	26.6	20.6	29.9	46.4	551.57	10.5	11.4	10.8	20.6	120.85
Nematocarcinidae	0.67	0.18	0.93	0.03	0.12	0.00	0.00	0.00	0.00	0.00
Solenoceridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squillidae	2.67	1.06	1.87	0.23	2.83	0.00	0.00	0.00	0.00	0.00
Echinodermata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gastropoda	1.33	0.03	0.93	0.01	0.03	0.00	0.00	0.00	0.00	0.00
Fishes	44.0	51.1	56.0	62.5	2251.0	31.5	34.4	37.8	39.6	1089.0
Bothidae	3.33	4.26	3.74	0.93	14.20	0.00	0.00	0.00	0.00	0.00
Carangidae	1.33	4.02	1.87	0.33	5.36	0.00	0.00	0.00	0.00	0.00
Centracanthidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clupeidae	2.00	1.65	2.80	0.34	3.31	7.02	23.0	8.11	21.1	161.83
Congridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Engraulidae	0.00	0.00	0.00	0.00	0.00	1.75	0.91	2.70	0.63	1.60
Gadidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gobiidae	6.00	2.44	5.61	1.55	14.65	12.2	5.10	13.5	20.3	62.61
Haemulidae	0.67	0.30	0.93	0.03	0.20	0.00	0.00	0.00	0.00	0.00
Labridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mullidae	0.67	0.46	0.93	0.03	0.31	0.00	0.00	0.00	0.00	0.00
No.ident telestei	5.33	3.56	7.48	2.18	18.98	5.26	4.32	8.11	6.75	22.76
Ophidiidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scombridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soleidae	4.00	3.74	5.61	1.42	14.97	5.26	1.09	5.41	2.98	5.75
Sparidae	19.3	30.3	25.2	41.1	586.40	0.00	<0.0	<0.0	<0.0	<0.01
Trachinidae	1.33	0.39	1.87	0.11	0.51	0.00	0.00	0.00	0.00	0.00
Triglidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polychaeta	2.00	3.04	1.87	0.11	6.09	5.26	1.46	5.41	0.58	7.67
Nereidae	0.00	0.00	0.00	0.00	0.00	3.51	0.91	2.70	1.04	3.19
Oweniidae	2.00	3.04	1.87	0.31	6.09	0.00	0.00	0.00	0.00	0.00
Unidentified	0.00	0.00	0.00	0.00	0.00	1.75	0.55	2.70	0.54	0.96

Frequency of occurrence (F %), percentage by number (Cn %), percentage by weight (Cp %), percent index of relative importance (%IRI) and feeding coefficient Q.

Variation in the diet composition of males and females. The food of males and females were analyzed separately to find out the differences, if any.

The percentage composition of different food items of males and females are given in Table 7.

Table 7

Prey identified in the stomach contents of *Sepia officinalis* in relation to sexes

Prey taxa	*Males*					*Females*				
	F%	*Cn%*	*Cp%*	*IRI%*	*Q*	*F%*	*Cn%*	*CP%*	*IRI%*	*Q*
Algae	0.00	0.00	0.00	0.00	0.00	0.71	0.38	0.02	0.00	0.01
Anthozoa	0.70	0.82	0.18	0.01	0.15	0.71	0.38	0.07	0.00	0.02
Bivalvia	12.6	7.76	3.09	1.75	23.96	7.09	4.18	2.69	0.55	11.25
Cardiidae	1.41	0.82	0.83	0.11	0.68	3.55	2.28	2.04	0.57	4.66
Tellinidae	7.75	4.90	1.50	2.34	7.33	2.13	1.14	0.30	0.11	0.34
Veneridae	3.52	2.04	0.76	0.47	1.56	1.42	0.76	0.34	0.06	0.26
Cephalopoda	19.0	11.0	24.6	8.63	271.81	8.51	4.56	11.6	1.55	53.09
Loliginidae	3.52	2.04	3.20	0.87	6.54	2.13	1.14	1.92	0.24	2.19
Octopodidae	3.52	2.04	6.58	1.43	13.42	2.13	1.14	3.31	0.35	3.77
Ommastrephidae	1.41	0.82	0.53	0.09	0.43	0.71	0.38	0.44	0.02	0.17
Sepiidae	4.93	2.86	11.9	3.44	34.02	1.42	0.76	4.84	0.30	3.68
Sepiolidae	2.82	1.63	2.10	0.50	3.42	1.42	0.76	0.94	0.09	0.71
Unidentified	2.82	1.63	0.35	0.26	0.57	0.71	0.38	0.19	0.02	0.07
Crustaceans	49.3	40.4	23.0	39.7	929.32	50.3	50.1	28.7	44.7	1442.0
Alpheidae	0.00	0.00	0.00	0.00	0.00	1.42	1.14	0.67	0.10	0.77
Amphipoda	1.41	1.22	0.89	0.14	1.09	0.71	0.00	0.00	0.00	0.00
Brachyura	11.9	8.98	1.76	6.07	15.77	16.3	11.0	3.03	8.59	33.40
Inachidae	0.70	0.41	1.48	0.06	0.60	0.00	0.00	0.00	0.00	0.00
Isopoda	0.70	0.41	0.15	0.02	0.06	0.00	0.00	0.00	0.00	0.00
Majidae	1.41	0.82	0.70	0.10	0.57	0.00	0.00	0.00	0.00	0.00
Mysidacea	0.70	0.41	0.04	0.01	0.02	0.00	0.00	0.00	0.00	0.00
Nephropidae	0.00	0.00	0.00	0.00	0.00	0.71	0.38	0.13	0.01	0.05
No.ident shrimps	1.41	0.82	0.20	0.07	0.16	0.00	0.00	0.00	0.00	0.00
Pasiphaeidae	1.41	0.82	0.50	0.09	0.41	0.00	0.00	0.00	0.00	0.00
Penaeidae	0.70	1.63	0.39	0.07	0.63	0.71	1.90	0.54	0.06	1.02
Portunidae	25.3	22.8	16.4	47.0	376.34	26.9	32.7	22.7	56.0	744.85
Nematocarcinidae	0.70	0.41	0.13	0.02	0.05	0.00	0.00	0.00	0.00	0.00
Solenoceridae	0.70	0.41	0.15	0.02	0.06	0.00	0.00	0.00	0.00	0.00
Squillidae	2.11	1.22	0.16	0.14	0.19	3.55	3.04	1.58	0.61	4.82
Echinodermata	0.00	0.00	0.00	0.00	0.00	0.71	0.38	0.19	0.00	0.07
Gastropoda	2.82	4.90	0.83	0.21	4.07	2.13	1.14	0.31	0.03	0.35
Fishes	50.0	31.0	46.4	49.2	1440.0	54.6	34.2	51.1	52.4	1749.4
Bothidae	2.11	1.22	0.95	0.22	1.17	2.13	1.52	2.90	0.35	4.41
Carangidae	0.00	0.00	0.00	0.00	0.00	1.42	0.76	3.41	0.22	2.59
Centracanthidae	0.70	0.41	0.04	0.01	0.02	0.71	0.38	1.75	0.06	0.66
Clupeidae	2.11	1.22	0.84	0.21	1.03	2.84	1.90	6.04	0.84	11.49
Congridae	0.70	0.82	0.55	0.05	0.45	1.42	0.76	4.15	0.26	3.15
Engraulidae	1.41	0.82	0.30	0.07	0.24	0.00	0.00	0.00	0.00	0.00
Gobiidae	11.2	6.94	8.22	8.06	57.02	8.51	6.46	1.94	2.68	12.57
Haemulidae	0.00	0.00	0.00	0.00	0.00	0.71	0.38	0.26	0.02	0.10
Labridae	0.00	0.00	0.00	0.00	0.00	0.71	0.38	0.62	0.03	0.23
Mullidae	0.00	0.00	0.00	0.00	0.00	1.42	0.76	0.94	0.09	0.71
No.ident telestei	11.9	7.35	13.5	11.8	99.74	6.38	3.42	2.68	1.46	9.18
Ophidiidae	0.00	0.00	0.00	0.00	0.00	0.71	0.38	0.48	0.02	0.18
Scombridae	0.00	0.00	0.00	0.00	0.00	0.71	0.38	1.17	0.04	0.44
Soleidae	4.93	3.27	3.56	1.59	11.63	4.26	2.66	0.91	0.57	2.42
Sparidae	12.6	7.76	15.2	13.7	118.39	19.1	11.7	22.7	24.8	268.57
Trachinidae	1.41	0.82	2.65	0.23	2.17	2.84	1.90	1.07	0.32	2.03
Triglidae	0.00	0.00	0.00	0.00	0.00	0.71	0.38	0.03	0.01	0.01
Polychaeta	4.93	4.08	1.81	0.37	7.38	5.67	4.56	5.24	0.63	23.91
Nereidae	2.11	1.63	0.49	0.21	0.81	0.71	0.38	0.65	0.03	0.25
Oweniidae	0.70	0.41	0.02	0.01	0.01	3.55	3.04	3.83	0.91	11.64
Unidentified	2.11	2.04	1.29	0.33	2.64	1.42	1.14	0.76	0.10	0.87

Frequency of occurrence (F %), percentage by number (Cn %), percentage by weight (Cp %), percent index of relative importance (%IRI) and feeding coefficient Q.

The study revealed that the food preferences of males and females were similar with variations in the magnitude of different food items consumed. Therefore, no differences were found between the diets of males and females of *S. officinalis* (MANOVA, F_1 = 1.057, P = 0.394) (Table 5). The feeding coefficient Q calculated for each prey showed that males and females cuttlefish feed principally on fishes, crustaceans and cephalopods (Table 3). For both sexes, the three diet indexes F% and Cp% and the IRI (Table 7) showed that fish were more than 50% of the ingested preys and constituted the most dominant and important food source. Fishes did not show any significant difference for either sexes (ANOVA, F_1 = 0.0288, P = 0.8653). Crustaceans occupy second position in prey group for both sexes and also not show any significant difference for either sexes (ANOVA, F_1 = 1.4891, P = 0.2234). However, this prey group had the highest contribution in percentage by number representing Cn% = 40.41% for males and Cn% = 50.19% for females. Comparing crustaceans' species in the stomachs between the two sexes, it seems that crustaceans species identified in males were more diverse than in females. Crustaceans were followed by cephalopods. The preference for cephalopods was found to be important in males than in females. The Cn%, F%, CP% and IRI% were slightly higher for males than for females. Ingestion of cephalopods showed a sexual significant variation (ANOVA, F_1 = 3.9245, P = 0.0485). Bivalves, constituted secondary prey in males and an accessory prey in females. However, Polychaetes were an accessory prey in males and a secondary prey in females (Table 3).

Feeding habits in relation to size. High significant differences were recorded in the IRI of prey groups based on all sizes (DML) of *S. officinalis* (MANOVA, F_1 = 3.7011, P = 0.0004). Therefore, arid in order to simplify the presentation of the results and the comparisons, the results were presented into two size groups, juveniles (DM L< 15 cm) and adults (DML ≥ 15 cm). Results for the more important species prey of juveniles and adults are tabulated in Table 8. There was a significant difference in diet of adults and juveniles (MANOVA, F_1 = 2.4591, P = 0.013) (Table 5). Dietary comparisons of the different groups of prey as a function of the size revealed that the juveniles showed a poorly diversified diet, consisted of a "small" prey sizes. However, the adult diet was more diversified and contained greater prey richness than juveniles.

The highest feeding preference in frequency of occurrence (F%) in adults was fishes with (54.29%) followed by crustaceans whit (F% = 47.43%) (Table 8). Fishes had the highest contribution by weight (Cp% = 51.65%) in the stomach contents followed once again by crustaceans (Table 8). Based in percentage by number, crustaceans were the main preys in adult whit Cn% = 44.93% followed by fishes (Table 8). According to the IRI and the feeding coefficient Q, fishes and crustaceans were the principally prey of adults. Cephalopods and bivalves constituted secondary prey. However Polychaetes were an accessory prey (Table 3). There was significant difference in variation of fishes (ANOVA, F_1 = 6.597, P = 0.01073). However, there was no significant difference in variation of Cephalopods, bivalves and Polychaetes (ANOVA, F_1 = 2.547, P = 0.1116) (ANOVA, F_1 = 0.3224, P = 0.5706) (ANOVA, F_1 = 2.0824, P = 0.1501). The feeding habits changed as size decreased <15 cm. Therefore, in juveniles, the dietary indices, indicated that crustaceans were the most important type of prey based on the F%, Cn%, Cp% and IRI, showed a low significant variation (ANOVA, F_1 = 3.2684, P = 0.0717). Crustaceans were followed by fishes and both, constituted a principally prey (Table 3). Cephalopods made up 6.21% of Cn%, 12.34% of Cp%, and 1.94% of IRI. No differences were found in the cephalopods, bivalves and Polychaetes between juveniles and adults. Comparison between the diet of adults and juveniles showed that the adults were represented more active feeding behavior that of the juveniles noted from the presence of highest number of full stomachs. Empty stomachs denote that the diet of juveniles comprises of tiny organisms which were digested quickly. It was confirmed that the main food item in the juveniles was found to be crustaceans constituted mainly by shrimps, amphipoda and isopoda.

Table 8

Prey identified in the stomach contents of *Sepia officinalis* in relation to size

Prey taxa	Juveniles					Adults				
	F%	*Cn%*	*Cp%*	*IRI%*	*Q*	*F%*	*Cn%*	*Cp%*	*%IRI*	*Q*
Algae	0.00	0.00	0.00	0.00	0.00	0.57	0.29	0.01	0.00	0.00
Anthozoa	1.85	1.86	0.70	0.05	1.30	0.00	0.00	0.00	0.00	0.00
Bivalvia	9.26	6.83	3.27	1.06	22.31	10.2	5.51	2.82	1.04	15.56
Cardiidae	0.00	0.00	0.00	0.00	0.00	4.00	2.32	1.71	0.66	3.95
Tellinidae	6.48	4.97	2.13	2.02	10.60	4.00	2.03	0.68	0.44	1.37
Veneridae	2.78	1.86	1.13	0.37	2.11	2.29	1.16	0.44	0.15	0.51
Cephalopoda	9.26	6.21	12.3	1.94	76.63	16.5	8.41	20.1	5.73	169.34
Loliginidae	0.93	0.62	0.64	0.05	0.40	4.00	2.03	3.07	0.83	6.22
Octopodidae	1.85	1.24	6.93	0.66	8.61	3.43	1.74	4.65	0.90	8.09
Ommastrephidae	0.93	0.62	0.54	0.05	0.33	1.14	0.58	0.47	0.05	0.28
Sepiidae	1.85	1.24	1.00	0.18	1.25	4.00	2.03	10.4	2.04	21.15
Sepiolidae	2.78	1.86	2.36	0.52	4.40	1.71	0.87	1.38	0.16	1.20
Unidentified	0.93	0.62	0.86	0.06	0.53	2.29	1.16	0.14	0.12	0.17
Crustaceans	54.6	47.2	45.6	57.2	2156.0	47.4	44.9	21.0	37.8	945.21
Alpheidae	0.00	0.00	0.00	0.00	0.00	1.14	0.87	0.38	0.06	0.33
Amphipoda	2.78	1.86	2.58	0.54	4.80	0.00	0.00	0.00	0.00	0.00
Brachyura	12.0	8.07	4.37	6.58	35.26	15.4	11.0	1.88	8.14	20.66
Inachidae	0.00	0.00	0.00	0.00	0.00	0.57	0.29	0.98	0.03	0.29
Isopoda	0.93	0.62	0.43	0.04	0.27	0.00	0.00	0.00	0.00	0.00
Majidae	0.93	0.62	0.97	0.06	0.60	0.57	0.29	0.25	0.01	0.07
Mysidacea	0.93	0.62	0.12	0.03	0.07	0.00	0.00	0.00	0.00	0.00
Nephropidae	0.93	0.62	0.32	0.04	0.20	0.00	0.00	0.00	0.00	0.00
No.ident shrimps	0.93	0.62	0.38	0.04	0.23	0.57	0.29	0.05	0.01	0.01
Pasiphaeidae	1.85	1.24	1.45	0.22	1.80	0.00	0.00	0.00	0.00	0.00
Penaeidae	1.85	5.59	2.45	0.65	13.69	0.00	0.00	0.00	0.00	0.00
Portunidae	25.0	21.7	29.1	55.9	634.53	27.4	31.0	17.1	54.0	530.65
Nematocarcinidae	0.93	0.62	0.38	0.04	0.23	0.00	0.00	0.00	0.00	0.00
Solenoceridae	0.93	0.62	0.43	0.04	0.27	0.00	0.00	0.00	0.00	0.00
Squillidae	4.63	4.35	2.62	1.42	11.40	1.71	1.16	0.40	0.11	0.46
Echinodermata	0.00	0.00	0.00	0.00	0.00	0.57	0.29	0.11	0.00	0.03
Gastropoda	0.00	0.00	0.00	0.00	0.00	4.00	4.35	0.73	0.25	3.15
Fishes	49.0	36.0	35.1	39.4	1266.6	54.2	31.3	51.6	54.4	1616.7
Bothidae	1.85	1.24	0.88	0.17	1.09	2.29	1.45	2.07	0.33	3.00
Carangidae	0.93	0.62	1.24	0.08	0.77	0.57	0.29	1.63	0.04	0.47
Centracanthidae	0.93	0.62	0.11	0.03	0.07	0.57	0.29	0.98	0.03	0.29
Clupeidae	2.78	1.86	3.28	0.63	6.11	2.29	1.45	3.22	0.44	4.66
Congridae	0.00	0.00	0.00	0.00	0.00	1.71	1.16	2.70	0.27	3.14
Engraulidae	0.00	0.00	0.00	0.00	0.00	1.14	0.58	0.20	0.04	0.11
Gadidae	0.00	0.00	0.00	0.00	0.00	0.57	0.29	0.31	0.01	0.09
Gobiidae	10.1	9.94	4.97	6.67	49.43	9.71	5.22	5.43	4.23	28.31
Haemulidae	0.93	0.62	0.63	0.05	0.39	0.00	0.00	0.00	0.00	0.00
Labridae	0.00	0.00	0.00	0.00	0.00	0.57	0.29	0.35	0.01	0.10
Mullidae	0.93	0.62	0.97	0.06	0.60	0.57	0.29	0.31	0.01	0.09
No.ident telestei	8.33	5.59	3.73	3.41	20.84	9.71	5.22	9.69	5.93	50.57
Ophidiidae	0.93	0.62	1.18	0.07	0.73	0.00	0.00	0.00	0.00	0.00
Scombridae	0.00	0.00	0.00	0.00	0.00	0.57	0.29	0.66	0.02	0.19
Soleidae	2.78	1.86	2.99	0.59	5.57	5.71	3.48	2.20	1.33	7.65
Sparidae	16.6	11.1	13.3	17.9	148.75	15.4	9.28	19.9	18.4	185.05
Trachinidae	1.85	1.24	1.88	0.25	2.34	2.29	1.45	1.94	0.32	2.81
Polychaeta	3.70	3.11	2.86	0.25	8.89	6.29	4.93	3.50	0.64	17.25
Nereidae	1.85	1.86	2.14	0.33	3.98	1.14	0.58	0.21	0.04	0.12
Oweniidae	1.85	1.24	0.73	0.16	0.90	2.29	2.03	2.00	0.38	4.07
Unidentified	0.00	0.00	0.00	0.00	0.00	2.86	2.32	1.29	0.42	2.99

Frequency of occurrence (F %), percentage by number (Cn %), percentage by weight (Cp %), percent index of relative importance (%IRI) and feeding coefficient Q.

Discussion. This work provided the first quantitative and qualitative analysis of the food of *S. officinalis* in the southern Moroccan Atlantic waters. Information on the feeding habits of cuttlefish has been given by several authors in various areas. However there is no information for this specie in our study area. In this paper, aggregate information on the feeding habits of the *S. officinalis* of the southern Moroccan water is given for the first time.

The present study showed that *S. officinalis* living in the Southern Moroccan Atlantic feeds on diverse range of prey including fishes, teleosts, crustaceans, crabs, cephalopods, polychaetes, bivalves, gastropods and algae debris. This diverse diet is consistent with previous reports of *S. officinalis* diet from Atlantic waters and other locations (Najai & Ktari 1979; Guerra 1985; Castro & Guerra 1990; Castro & Guerra 1989; Pinczon du Sel & Daguzan 1997; Blanc et al 1998; Alves et al 2006; Neves et al 2009; Pinczon du Sel et al 2000; Evans 2012; Akesse et al 2016). Species composition within these prey groups depends upon the respective species composition and availability in each ecosystem.

In terms of diet composition, fish and crustaceans were the dominant prey in the diet of *S. officinalis* in this study. This feeding was also reported by several authors in analogous studies investigating the diet of *S. officinalis* such as Najai & Ktari (1979), Guerra (1985), Castro & Guerra (1990), Blanc et al (1998), Pinczon du Sel et al (2000), Alves et al (2006), Evans (2012) and Akesse et al (2016). However, the frequency of occurrence of fish is (F% = 52.3%) was higher than other studies such as by Najai & Ktari (1979), Castro & Guerra (1990), Alves et al (2006) and Evans (2012). The amount of crustaceans observed (F% = 49.8%) is lower than other studies such as Najai & Ktari (1979), Castro & Guerra (1990) and Alves et al (2006). This is probably a result of the opportunistic predator character of cephalopods (Nixon 1985). The opportunistic behavior could also be the origin of the differences in diet detected in this study, since these differences were probably a consequence of unequal availability of prey. This differences can be also seen as resulting from the sampling method used (bottom trawl) (Pinczon du Sel & Daguzan 1997). Or, probably a consequences of habitat differences, predator size and the number of analyzed stomachs (Castro & Guerra 1990; Pinczon du Sel et al 2000).

The large number of fish families (17) consumed by the *S. officinalis* in this study can be explained by the presence of permanent upwelling, it appear to provide ideal conditions for the development of phytoplankton and zooplankton, these organisms form the base of the marine food chain and food sources for sea's species. This explains the abundant distribution of fishes and the high biological diversity present in this area. (Zizah et al 2012; Benazzouz et al 2014; El Arraj et al 2015; Hariss et al 2016). Two of the fishes found most frequently in *S. officinalis* in the majority of stomachs are Sparidae and Clupeidae, which were the abundant fish species in this area.

Cannibalism in *S. officinalis* has been reported by Najai & Ktari (1979), Guerra (1985), Le Mao (1985), Castro & Guerra (1989, 1990) and Pinczon du Sel et al (2000). Cannibalism has been reported for many cephalopod groups (Ibanez & Friedemann 2010) and as pointed out by Castro & Guerra (1990) cannibalism seems to be just incidental. In the present study, the frequency of occurrence of both cannibalism and other cephalopod items in the diet appears to be higher than others studies, probably because cephalopods are more abundant in this area.

Polychaetes and Bivalves prey reached relatively low values of frequency of occurrence and number. The presence of Polychaetes in the diet of this species was reported by several authors. However, Bivalves not considered as prey items for this species by Castro & Guerra (1990), Pinczon du Sel et al (2000) and Akesse et al (2016). Also, Gastropods are shown by Najai & Ktari (1979) and Neves et al (2009). Other prey, such as Anthozoa, Echinodermata were in minor importance. Copepods, ostracods, nemertean worms, are shown to be part of the diet of *S. officinalis* in study by Najai & Ktari (1979); however none were found in this study. There were also no Foraminifera recorded by Najai & Ktari (1979), Pinczon du Sel & Daguzan (1997) and Neves et al (2009).

Feeding intensity is negatively related to the percentage of empty stomachs. The low feeding intensity observed in this study may be a result of the feeding behavior of *S. officinalis* at the moment of capture. In this study the *S. officinalis* was captured during the day. However, it is known that *S. officinalis* are most active generally at night; in darkness, the density of the cuttlebone decreases and the *S. officinalis* becomes more buoyant (Denton & Gilpin-Brown 1961). This could mean that during the night the *S. officinalis* acquires a larger movement capacity and a higher rate of success in capturing prey. The low feeding intensity also due to a rapid digestion of prey due to a high content of total digestive enzymes in different organs of *S. officinalis* and also dependent on time which has elapsed between capture and the last feeding period (Boucaud-Camou & Boucher-Rodoni 1983; Mancuso et al 2014).

The high vacuity index values reveal low feeding intensity. In both sexes, a high vacuity index values are recorded during autumn and spring. This could be explained by reproduction and gonad maturation period (Wahbi et al 2015). In fact, the *S. officinalis* in the southern morocco have two spawning season a principal one in April (autumn) and a secondary one in September (spring) (Personal result). According to Richard (1971), adults in reproduction period stopping feeding because their gonads compress the digestive system. Similarly, Alves et al (2006) and Akesse et al (2016) also noted lower feeding intensity of *S. officinalis* in reproduction period.

Higher feeding intensity in winter is reflecting a trophic activity significantly greater during this season. Therefore, adults had a higher feeding intensity than juveniles, as they need to consume more energy for the maturation of their gonads and return energy invested in the reproduction during the spawning season. However, the high vacuity index in summer may be related to the lower availability of prey or to the environmental factors (e.g. temperature, salinity).

Seasonal variation was one of the important sources of variation in diet composition of *S. officinalis*. In our study, the results on seasonal variation suggest very pronounced shifts in diet from season to season. This variation in the diet might be expected to follow variation in the availability of preferred prey. Fishes dominated the diet composition throughout the year, particularly in winter. The higher importance of fishes in the winter diet could relate to the lower availability of crustaceans. Increased crustaceans consumption during autumn coincides with the period of the new recruits of many decapods species. The relatively high proportion of cannibalism in diet during autumn and spring can be explained by the high abundance of cephalopods, as a result of application a biological rest period of cephalopods species in this area. The dietary differences observed for the summer individuals may be due to seasonal changes in the area; declines in the availability of common prey could lead *S. officinalis* to switch to other prey species- prey sizes. It could also be associated with low food availability, which occurred during warm-water periods in summer, when biological productivity and standing fish biomass in the region are known to be lower. Few studies have elaborated the seasonal variation of the *S. officinalis* diet. Alves et al (2006) showed small differences in *S. officinalis* diet and explain this by the influence by the *S. officinalis* size and reproduction period. However Castro & Guerra (1990) showed no seasonal significant difference.

Overall, males and females fed on similar prey items and no significant differences were found between sexes. In terms of diet overlap, males and females appear to use the habitat in the same way, with no apparent difference in diet. These results agree with those obtained by several authors, Guerra (1985), Castro & Guerra (1990), Alves at al (2006) and Neves et al (2009), who also reported no significant differences between sexes concerning the feeding habit.

The diet of juveniles was less diversified that than adults. This is a common feature of cephalopods (Boucaud-Camou & Boucher-Rodoni 1983). The diet of the young cuttlefish is essentially based on crustaceans mainly *Liocarcinus sp.* that are probably easier to catch than the larger crabs, there was also reported in Morbihan bay (France) by Blanc et al (1998). The preponderance of crustaceans in juveniles was reported in nature by several authors (Najai & Ktari 1979; Le Mao 1985; Castro & Guerra 1990; Pinczon du Sel & Daguzan 1997; Pinczon du Sel et al 2000; Alves et al 2006; Evans

2012; Akesse et al 2016) and that can be explain by the fact that benthic crustaceans might be easier to catch. This field data is supported also by laboratory studies; several authors have indicated that for *S. officinalis*, crustaceans are the optimal food for development and growth (Koueta & Boucaud-Camou 1999; Domingues et al 2003; Domingues et al 2004). The juvenile's diet is also dominated by small organisms, such as amphipoda, isopoda and mysidacea; this is also reported by Guerra et al (1988) and Blanc & Daguzan (2000).

In adults, fishes are the most important prey item. The diets of *S. officinalis* between juveniles and adults show a transition from crustacean dominance to fish dominance. This variation indicates a relationship between diets and predator size; as *S. officinalis* grow, their food preferences also change, and fish and larger crabs became the most important prey. This feeding behavior between adults and juveniles is also reported in other studies (Alves et al 2006; Neves et al 2009). This shift can also be associated whit large energy demands during the sexual maturation process (Castro & Guerra 1990). Quite reasonably, there are increased nutritional requirements and optimizing energy may be achieved by selecting fatty fish such as (Sparidae and Clupeidae), but also by selecting larger fish, because these generally contain more energy per item. The quality of the food source has also been shown to influence growth rates of *S. officinalis* (Forsythe & Van Heukelem 1987). Moreover, in adults, the larger size, the big beaks and the strong arms which makes them stronger, could allow the capture and ingestion of bigger and harder prey.

Cannibalism related to the size seems to be a common behavior of cephalopods and it may be attributed to a strategy that favors energy transfer from smaller to larger specimens (Ibanez & Friedemann 2010).

Comparing the *S. officinalis* with other cephalopods in the Moroccan coast, the most abundant predator with the most similar average body size is *Octopus vulgaris*. Few studies have been carried out on the diet of common octopus in the Moroccan Atlantic. In general, his diet is dominated also by crustaceans, mollusks and fishes. Diets of *S. officinalis* and *O. vulgaris* are seen to follow a similar pattern, which is consistent with both types of predators exploiting the same locally abundant resources.

Conclusions. In conclusion, in the southern Moroccan Atlantic *S. officinalis* is a carnivorous opportunistic predator. This species feeds on local fish, crustaceans, cephalopod fauna and benthic organisms such as Polychaetes and bivalves. Prey were typical of benthic and benthopelagic habitats. The diet of males and females did not differ; however, differences between juveniles and adults and seasonal variations in diet were recorded and were shown to be influenced by the *S. officinalis* size, the reproduction period and possibly by the abundance of prey. The data from this study support the view that *S. officinalis* feed opportunistically on those species most abundant locally and change their diet according to fluctuations in the abundance and availability of prey. Our results also show that *S. officinalis* occupy a high range of trophic levels and exploit a large diversity of trophic resources, reflecting the versatility of their feeding behavior and dietary habits.

Acknowledgements. We are grateful for logistical support from the National Fisheries Research Institute (INRH). The authors wish to thank Mr. Abdellatif Boumaaz for assistance with the biological sampling. Thanks also to Mrs Asia Ben haddouch and Dr. Hounaida Farah Idrissi for expert assistance in laboratory operations. We would like also to acknowledge Mr. Ben Mhamed Adbelouahed and Mr. Kalmouni Abdlkarim for database assistance.

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Received: 22 September 2017. Accepted: 20 December 2017. Published online: 29 December 2017.
Authors:
Fatima Mzaki, University Hassan II Casablanca, Faculty of Sciences, Department of Biology, Laboratory of Immunology and Biodiversity, Morocco, Casablanca, Ain Chock, Maârif, Km 8, Route d'El Jadida, BP 5366, e-mail: fatima.mzaki@gmail.com
Khalid Manchih, National Fisheries Research Institute (INRH), Fisheries Department, Morocco, Casablanca, 20050, Bd Sidi Abderrahman, Ain Diab, e-mail: manchih@hotmail.com
Hounaida Farah Idrissi, National Fisheries Research Institute (INRH), Fisheries Department, Morocco, Casablanca, 20050, Bd Sidi Abderrahman, Ain Diab, e-mail: idrissi.farah.h@gmail.com
Abdellatif Boumaaz, National Fisheries Research Institute (INRH), Fisheries Department, Morocco, Casablanca, 20050, Bd Sidi Abderrahman, Ain Diab, e-mail: abdboumaaz@gmail.com
Asia Ben Haddouch, Quality and Safety Department of Marine Environment, National Fisheries Research Institute (INRH), Bd Sidi Abderrahman, Ain Diab, 20050 Casablanca, Morocco, e-mail: benhaddouch asia@gmail.com
Ouadiaa Tazi, University Hassan II Casablanca, Faculty of Sciences, Department of Biology, Laboratory of Immunology and Biodiversity, Morocco, Casablanca, Ain Chock, Maârif, Km 8, Route d'El Jadida, BP 5366, e-mail: taziouadia@gmail.com

How to cite this article:
Mzaki F., Manchih K., Idrissi H. F., Boumaaz A., Haddouch A. B., Tazi Q., 2017 Diet of the common cuttlefish *Sepia officinalis* (Linnaeus, 1758) (Cephalopoda: Sepiidae) in the Southern Moroccan Atlantic waters, Cap Boujdour, Cap Blanc. AACL Bioflux 10(6):1692-1710.