A Preliminary Study on the Feeding Regime of European Pilchard (*Sardina pilchardus* Walbaum1792) in Izmir Bay, Turkey, Eastern Aegean Sea

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Abstract

The gut contents of *Sardina pilchardus* specimens captured in Izmir Bay were examined in order to determine their feeding regimes. Of the 365 stomachs examined, 321 (87.95%) contained food and 44 (12.05%) were empty. Analysis of gut contents verified that *S. pilchardus* feeds on zooplankton. The most important group in the diet of *S. pilchardus* was copepods (79.79%). Decapod crustacean larvae (8.17%) and bivalves (3.18%) were second and third, respectively, in order of importance. The application of analysis of variance to monthly data of numerical percentage, weight percentage, frequency of occurrence and index of relative importance indicated that there was no significant difference between months. *Oncaea media* was the most dominant species for six months of the year. *Euterpina acutifrons, Centropages typicus, Calanoida, Oncaea* sp. and *Corycaeus* sp. were the most dominant for March, April, May, September, October and December.

Introduction

The European pilchard, *Sardina pilchardus* (Walbaum, 1792), is a species found in several regions of the Atlantic and Mediterranean. It is a key staple along the areas from the Canary Islands to the Adriatic and Aegean coasts. *S. pilchardus* is most prolific in the water bodies of the Turkish seas, except for the Black Sea. The most important fish that are the mainstay of the Turkish fisheries are the anchovy (*Engraulis encrasicolus* Linnaeus, 1758), European pilchard or sardine (*S. pilchardus* Walbaum, 1792), horse mackerel (*Trachurus trachurus* Linneaus, 1758 and *T. mediterraneus* Steindachner, 1868) and chub-mackerel (*Scomber japonicus* Houttuyn, 1782).

With an estimated yearly catch of 22 000 t/year, *S. pilchardus* is of great economic importance to Turkish fisheries and ranks third as the primary food source after anchovy and gray mullet. Of this yearly catch, 3 351 t of this species are netted annually from the Aegean Sea (Anon 1999a). The most important regions are the Edremit and Izmir bays on the Turkish coast in Aegean Sea (Cihangir and Tirasin 1990). The presence of permanent populations in Izmir Bay (Mater 1979) has increased the importance of these fisheries.

The European pilchard, a pelagic species living at depths of 25-55 m during daylight and 15-35 m by nightfall, feeds exclusively on a diet of crustaceans and larger organisms of the plankton (Whitehead 1984). According to Massuti (1955), sardines obtain their nourishment by filtering seawater through their mouths and consuming all organisms small enough to be absorbed as food. Muzinic (1955) claimed that *S. pilchardus* consume their food by selection. Vucetic (1955) stated that feeding of *S. pilchardus* is rhythmic and they consume nothing between 2000 hrs and 0400 hrs, whereas Larraneta (1959) claimed that feeding goes on through the night.

The annual yield and economic importance of *S. pilchardus* to Turkish fisheries has prompted researchers to study the habits and lifecycle of this species [Geldiay (1969), Özelsel (1982), Aksiray (1987), and Akyol et al. (1996) on the general characteristics and biology of the sardine; Demir (1957), Mater (1977, 1979), Mater and Bayhan (1999), Cihangir (1990, 1991), and Cihangir and Tirasin (1990) on breeding biology; Artuz (1957) and Ozcan (1975) on fisheries and stock assessment]. However, information on the feeding regimen of *S. pilchardus* off the Turkish coast is scarce and incomplete. The objective of this study was to determine the feeding habit of *S. pilchardus* captured in Izmir Bay.

Materials and Methods

The specimens were collected on a monthly basis from commercial catches (70% purse net fishing and 30% beach seine) at various sites in Izmir Bay between Karaburun and Foça (Figure1) from January 1997 to December 1997. All samples were either preserved in 10% formaldehyde after capture or immediately frozen to stop enzymatic activity in the digestive tract. The specimens were then weighed to the nearest gram and fork length was measured to the nearest 0.1 cm in the laboratory. Their sex was not taken

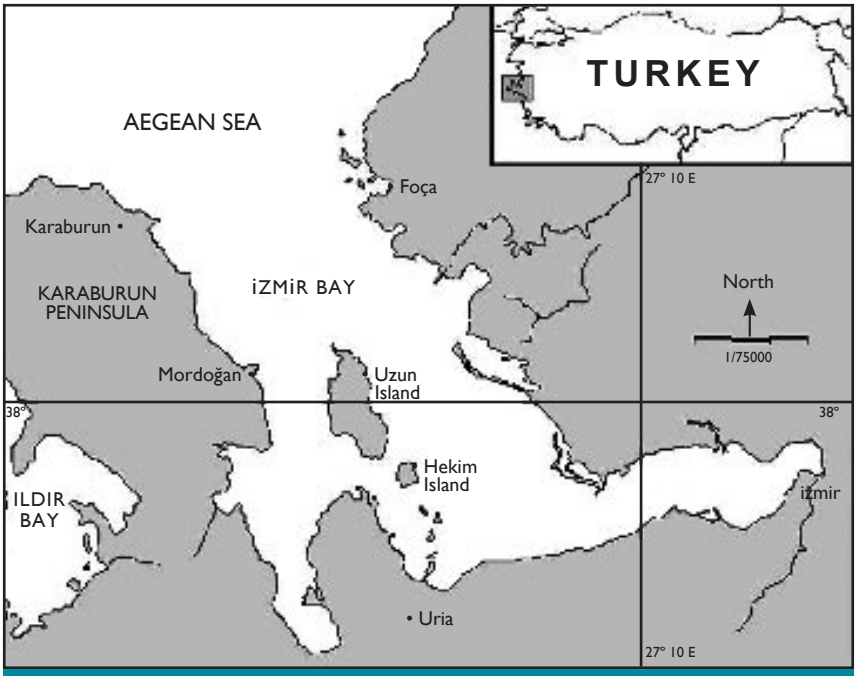

Figure 1. Map showing the location of the sampling area.

into consideration and the fishes were dissected following the techniques of Hyslop (1980) and Amezaga-Herran (1988). Empty and full stomachs of the specimens were determined. Stomach contents, recovered and homogenized in petri dishes, were examined using a stereoscopic microscope at 1-6.3x (zoom) and 10x resolution. The food items were identified to the lowest possible taxonomic level. Then they were counted under a stereoscopic microscope by immersing the food items in distilled water in a back-lit petri dish and weighed to the nearest 0.0001 g. The copepods, the most important group, were identified to the species level.

For a quantitative description of the diet as given by Pinkas et al. (1971), Berg (1979) and Hyslop (1980), results for each prey species or group were expressed as frequency of occurrence (%F), relative weight of total stomach content (%W), relative number of total stomach content (%N) and Index of Relative Importance [IRI = F (N+W)]. In order to determine similarities and differences between months, analysis of variance (ANOVA) was applied to the raw numerical and weight values.

Results and Discussion

A total of 365 stomachs were analyzed. The fork lengths of the fish examined ranged between 9.6-14.9 cm. No mode was established for the length-frequency distribution. This is an expected result as the specimens were obtained from commercial catches (following the national legislation on mesh sizes used for fishing). Thus, the size and sex of the fish were not considered in this study. Of 365 stomachs, 321 (87.95%) contained food and 44 (12.05%) were empty. The months having the highest percentage of stomach fullness (96.67%) were April, June and December. August had the highest variety of foods, when 14 food groups were determined.

By analyzing the full stomachs, the authors verified that *S. pilchardus* feeds exclusively on zooplankton. According to frequency of occurrence (95.95) and numerical (79.79) and weight (54.63) percentages, the dominant group was copepods (Table 1). This result coincides with the data on zooplankton given by various researchers for Izmir Bay. It has been reported that the zooplankton population of Izmir Bay is primarily composed of various species of copepoda and cladocera (Anon 1999b). It was also determined that copepods form the most common food sources for *S. pilchardus* throughout the year (Table 2). In terms of number and weight percentages (Table 1), the important groups were decapod crustacean larvae (8.17 and 16.80%, respectively) and bivalves (3.18 and 8.07% respectively). In respect to frequency of occurrence, decapod crustacean larvae (16.17%) were in third sequence, while bivalves (21.92%) were second (Table 1).

According to the index of relative importance (IRI), copepods (12 896.96) were followed by decapod crustacean larvae (474.53) and bivalves (280.45). It appeared that copepods were the most dominant group throughout the year (Table 1). The applications of analysis of variance to the monthly data of numerical values ($F=0.438$, $P= 0.933$) and weight values ($F=0.891$, $P= 0.554$) indicated that there were no significant differences between months (Figure 2 A and B). Analysis of variance of weight values (step-wise) differed April from January, May and October (Figure 2 A).

Among copepods, *O. media* was the most important species in respect to the numerical index (16.49%) and frequency of occurrence (61.99%), while *Oithona nana* (22.38%) and *Isias clavipes* (14.28%) had the highest values of weight percentages (Table 1). The dominant species found in the environment through the year were *Acartia clausi, A. latisetosa, Paracalanus parvus, Oithona plumifera, Centropages kröyeri* and *Temora stylifera* (Anon 1999b), whereas, *Oncaea* was the most common species found in the stomach contents. It might be expected that the dominant species in the environment would also be the dominant one in the feed of European pilchards. However, similar studies conducted by Demirhindi (1961) for the Marmara region produced very different results. According to the results given by the researcher, *Rhizosolenia* sp. (76.2%) and *Chaetoceros decipiens* (20.3%) were

Table 1. Overall diet composition of the *Sardina pilchardus* specimens examined, Izmir Bay, January-December 1997.
F% = Frequency of occurrence; N% = Numerical percentage; W% = Weight percentage; IRI = Index of relative importance.

Prey Item	F%	N%	W%	IRI	Prey Item	F%	N%	W%	IRI
Thaliacea	0.62	0.07	0.33	0.25	*Oncaea conifera*	0.31	0.02	0.07	0.03
Pteropoda	0.62	1.41	2.02	2.14	*Oncaea spp.*	47.66	12.87	0.28	626.96
Appendicularia	0.31	0.02	0.04	0.02	*Lubbockia squillimana*	0.31	0.02	0.12	0.04
Polychaeta	0.31	0.02	0.06	0.03	*Sapphirina sp.*	0.62	0.04	0.12	0.09
Cladocera	6.54	1.10	1.20	20.29	*Copilia sp.*	1.87	0.02	0.14	0.30
Copepoda	95.95	79.79	54.63	12896.86	*Corycaeus clausi*	4.36	0.49	0.09	2.53
Calanoida	34.27	4.43	0.28	161.42	*Corycaeus limbatus*	2.49	0.24	0.14	0.93
Nannocalanus minor	8.10	0.87	1.89	22.34	*Corycaeus typicus*	16.82	2.12	0.19	38.71
Calanus spp.	1.25	0.13	0.18	0.38	*Corycaeus flaccus*	0.94	0.07	0.70	0.72
Paracalanus parvus	2.49	0.16	0.03	0.47	*Corycaeus giesbrechti*	2.49	0.09	0.41	1.25
Paracalanus nanus	0.94	0.05	0.75	0.75	*Corycaeus latus*	0.62	0.04	0.07	0.06
Paracalanus sp.	0.62	0.04	0.07	0.07	*Corycaeus ovalis*	0.31	0.02	0.06	0.02
Calocalanus pavo	0.94	0.05	0.08	0.13	*Corycaeus brehmi*	2.80	0.20	0.02	0.62
Ischnocalanus plumulosus	0.62	0.05	0.31	0.22	*Corycaeus spp.*	21.50	2.75	0.13	61.95
Clausocalanus arcuicomis	1.25	0.15	0.05	0.25	*Farranula rostrata*	18.69	2.95	0.09	56.70
Clausocalanus furcatus	1.87	0.11	0.08	0.35	*Harpacticoida*	6.54	1.05	0.67	11.26
Clausocalanus sp.	4.98	0.45	0.59	5.22	*Microsetella rosea*	0.31	0.02	0.01	0.008
Euchaeta marina	0.31	0.02	0.42	0.14	*Microsetella norvegica*	4.05	0.29	0.04	1.33
Temora stylifera	24.30	6.80	0.93	187.77	*Microsetella sp.*	0.94	0.05	0.06	0.11
Pleuromamma abdominalis	0.31	0.02	0.04	0.02	*Euterpina acutifrons*	37.70	9.78	0.90	402.75
Pleuromamma sp.	0.31	0.02	0.06	0.02	*Clytemnestra scutellata*	0.31	0.02	0.08	0.03
Centropages typicus	13.71	4.88	1.18	83.03	*Clytemnestra rostrata*	0.31	0.02	0.02	0.01
Centropages kröyeri	2.80	0.22	0.75	2.72	*Clytemnestra sp.*	0.31	0.02	0.16	0.06
Centropages sp.	0.31	0.02	0.02	0.01	*Copepod nauplius*	0.62	0.04	0.04	0.05
Isias clavipes	10.90	1.81	14.28	175.45	*Cirripedia*	3.74	0.22	0.34	2.09
Candacia armata	3.12	0.34	0.96	4.07	*Cypris larvae*	4.98	0.81	1.48	11.44
Candacia aethiopica	0.31	0.02	0.02	0.01	*Ostracoda*	1.56	0.13	0.38	0.79
Candacia simplex	0.94	0.07	0.49	0.52	*Mysidacea*	6.54	0.78	2.39	20.69
Candacia spp.	8.41	0.87	0.83	14.28	*Isopoda*	6.23	0.78	6.04	42.48
Labidocera wollastoni	3.12	0.33	0.40	2.27	*Amphipoda*	0.31	0.02	0.14	0.05
Acartia clausi	11.84	1.19	1.39	30.63	*Dec. Crust. Egg*	2.49	0.20	0.53	1.82
Acartia latisetosa	0.62	0.04	0.08	0.07	*Dec. Crust. larvae*	19.00	8.17	16.80	474.53
Acartia sp.	0.62	0.04	0.07	0.07	*Natantia*	0.31	0.02	0.29	0.10
Cyclopoida	0.62	0.04	0.04	0.05	*Reptantia*	0.62	0.05	0.04	0.06
Oithona nana	10.28	4.97	22.38	281.22	*Euphausiacea*	0.62	0.04	0.03	0.04
Oithona plumifera	1.25	0.07	0.04	0.13	*Brachyura larvae*	3.43	0.47	2.55	10.35
Oithona sp.	4.67	0.02	0.04	0.29	*Stomatopoda*	0.94	0.05	0.41	0.43
Oncaea venusta	2.49	0.22	0.93	2.87	*Gastropoda*	10.59	1.72	1.23	31.24
Oncaea mediterranea	25.86	1.63	0.08	44.14	*Bivalvia*	24.92	3.18	8.07	280.45
Oncaea media	61.99	16.49	0.28	1039.40	*Fish egg*	5.92	0.96	0.20	6.87

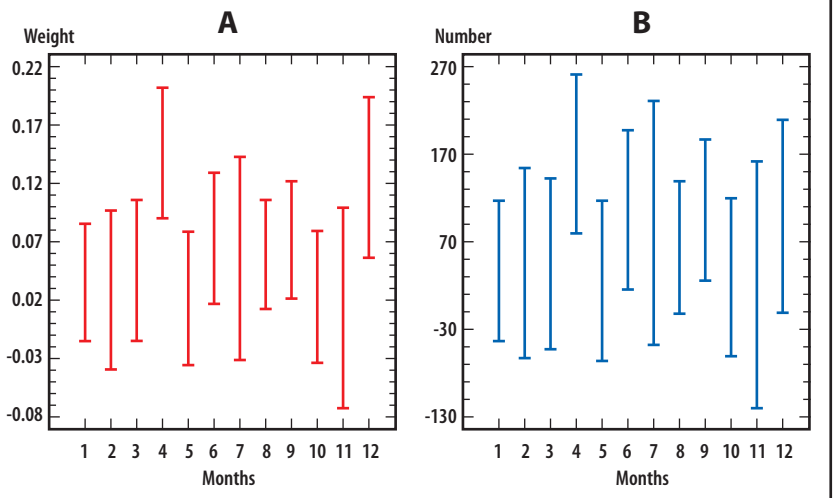

Figure 2. Results of variance analysis subjected to monthly weight (A) and numerical (B) values of the *Sardina pilchardus* specimens examined.

the most commonly encountered species in the environment, whereas, the frequency of occurrence of *Rhizosolenia* sp. in the stomach contents was only 0.2%. *C. decipiens* was not consumed by *S. pilchardus* (Demirhindi 1961). In spite of the lack of *Oncaea* in the environment, Demirhindi (1961) found the frequency of occurrence as 3.8% for this species in the stomach contents of 152 *S. pilchardus* specimens. This study assumed that the reason for a greater abundance of *Oncaea* in the stomach contents than in the environment might be their slow motion. However, this assumption could not be supported. In order to determine incidental or selective feeding, we must know the availability of each prey in the environment. If samples of plankton

Table 2. Diet composition by month of the *Sardina pilchardus* specimens examined, Izmir Bay, January-December 1997.

	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prey items	F%	F%	F%	F%	F%	F%	F%	F%	F%	F%	F%	F%
Thaliacea	0.00	0.00	0.00	3.45	0.00	0.00	0.00	3.57	0.00	0.00	0.00	0.00
Pteropoda	3.57	0.00	0.00	0.00	0.00	0.00	0.00	3.57	0.00	0.00	0.00	0.00
Appendicularia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00
Polychaeta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.57	0.00	0.00	0.00	0.00
Cladocera	7.14	4.00	0.00	0.00	16.67	6.90	0.00	7.14	29.63	3.33	4.55	0.00
Copepoda	100	96.00	92.59	100	91.67	100	91.30	96.43	100	93.33	95.46	93.10
Cirripedia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.71	18.52	13.33	0.00	0.00
Cypris larva	0.00	0.00	3.70	0.00	29.17	13.79	0.00	0.00	0.00	13.33	0.00	0.00
Ostracoda	7.14	0.00	0.00	0.00	0.00	0.00	0.00	3.57	7.41	0.00	0.00	0.00
Mysidacea	0.00	8.00	0.00	0.00	0.00	0.00	0.00	35.71	0.00	0.00	0.00	31.03
Isopoda	17.86	0.00	0.00	10.35	0.00	0.00	0.00	14.29	0.00	0.00	0.00	27.59
Amphipoda	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec. Crust. Egg	3.57	8.00	7.41	0.00	0.00	6.90	0.00	3.57	0.00	0.00	0.00	0.00
Dec. crust. larvae	42.86	0.00	0.00	86.21	4.17	0.00	4.35	14.29	0.00	6.67	4.55	51.72
Natantia	0.00	0.00	0.00	0.00	0.00	3.45	0.00	0.00	0.00	0.00	0.00	0.00
Reptantia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.41	0.00	0.00	0.00
Euphausiacea	0.00	4.00	00.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00
Brachyura larvae	0.00	0.00	11.11	3.45	0.00	0.00	0.00	25.00	0.00	0.00	0.00	0.00
Stomatopoda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.71	0.00	0.00	0.00	0.00
Gastropoda	0.00	0.00	11.11	86.21	8.33	0.00	0.00	0.00	3.70	3.33	0.00	6.90
Bivalvia	0.00	0.00	85.19	10.35	25.00	48.28	17.39	14.29	65.96	30.00	0.00	0.00
Fish egg	3.57	0.00	0.00	0.00	20.83	44.83	0.00	00.00	0.00	0.00	0.00	0.00
Overall stomachs	31	30	30	30	30	30	30	30	30	34	30	30
Stomachs including food	28	25	27	29	24	29	23	28	27	30	22	29

Table 3. Diet composition by month (for only copepod species) of the *Sardina pilchardus* specimens examined, Izmir Bay, January-December 1997.

	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Copepoda Species Observed	F%	F%	F%	F%	F%	F%	F%	F%	F%	F%	F%	F%
Calanoida	35.71	33.33	36.00	17.24	59.09	44.83	19.05	18.52	62.96	3.57	14.29	81.48
Nannocalanus minor	46.43	8.33	0.00	13.79	0.00	0.00	4.76	18.52	0.00	0.00	0.00	3.70
Calanus spp.	7.14	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00	3.70
Paracalanus parvus	3.57	0.00	4.00	6.90	0.00	0.00	0.00	0.00	0.00	10.71	4.76	0.00
Paracalanus nanus	0.00	0.00	0.00	10.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paracalanus sp.	0.00	8.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calocalanus pavo	3.57	0.00	0.00	3.45	0.00	0.00	0.00	3.70	0.00	0.00	0.00	0.00
Ischnocalanus plumulosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.41	0.00	0.00	0.00	0.00
Clausocalanus arcuicornis	0.00	12.50	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clausocalanus furcatus	0.00	0.00	4.00	6.90	0.00	0.00	0.00	7.41	0.00	0.00	0.00	3.70
Clausocalanus sp.	10.71	4.17	0.00	34.48	0.00	0.00	0.00	0.00	3.70	3.57	0.00	0.00
Euchaeta marina	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Temora stylifera	50.00	4.17	0.00	79.31	0.00	6.90	0.00	59.26	22.22	7.14	4.76	48.15
Pleuromamma abdominalis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00
Pleuromamma sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70
Centropages typicus	0.00	8.33	4.00	89.66	9.09	3.45	0.00	25.93	7.41	0.00	4.76	7.41
Centropages kröyeri	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.82	18.52	0.00	0.00	0.00
Centropages sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00
Isias clavipes	0.00	4.17	8.00	79.31	9.09	3.45	0.00	18.52	7.41	0.00	0.00	0.00
Candacia armata	7.14	4.17	4.00	3.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.52
Candacia aethiopica	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Candacia simplex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00	7.41
Candacia spp.	35.71	12.50	0.00	6.90	0.00	0.00	0.00	3.70	0.00	3.57	0.00	37.04
Labidocera wollastoni	0.00	0.00	0.00	34.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acartia clausi	0.00	0.00	12.00	20.69	36.36	27.59	4.76	3.70	22.22	14.29	4.76	0.00
Acartia latisetosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.41	0.00	0.00	0.00
Acartia sp.	0.00	0.00	0.00	0.00	4.55	0.00	0.00	0.00	0.00	0.00	0.00	3.70
Cyclopoida	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70
Oithona nana	0.00	0.00	4.00	0.00	9.09	3.45	0.00	0.00	59.26	39.29	9.52	0.00
Oithona plumifera	0.00	0.00	0.00	0.00	4.55	0.00	0.00	7.41	0.00	0.00	4.76	0.00
Oithona sp.	0.00	0.00	56.00	0.00	0.00	3.45	0.00	0.00	0.00	0.00	0.00	0.00
Oncaea venusta	0.00	8.33	0.00	0.00	0.00	0.00	0.00	18.52	0.00	0.00	0.00	3.70
Oncaea mediterranea	35.71	29.17	4.00	13.79	0.00	24.14	0.00	29.63	18.52	0.00	0.00	11.11
Oncaea media	64.29	66.67	40.00	72.41	45.56	96.55	80.95	62.96	74.07	25.00	100	37.04
Oncaea conifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.57	0.00	0.00
Oncaea spp.	14.29	41.67	0.00	58.62	50.00	86.21	66.67	62.96	85.19	50.00	9.52	59.26
Lubbockia squillimana	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sapphirina sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.41	0.00	0.00	0.00	0.00
Copilia sp.	3.57	0.00	0.00	17.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

continued >

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	Months											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Copepoda Species Observed	**F%**	**F%**	**F%**	**F%**	**F%**	**F%**	**F%**	**F%**	**F%**	**F%**	**F%**	**F%**
Corycaeus clausi	25.00	4.17	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00	18.52
Corycaeus limbatus	0.00	0.00	0.00	0.00	0.00	13.79	0.00	11.11	0.00	0.00	0.00	3.70
Corycaeus typicus	53.57	16.67	8.00	48.28	0.00	3.45	4.76	14.82	7.41	3.57	4.76	33.33
Corycaeus flaccus	3.57	4.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70
Corycaeus giesbrechti	14.29	4.17	4.00	6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corycaeus latus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.41	0.00	0.00	0.00	0.00
Corycaeus ovalis	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corycaeus brehmi	3.57	0.00	0.00	20.69	0.00	0.00	0.00	7.41	0.00	0.00	0.00	0.00
Corycaeus spp.	28.57	29.17	40.00	0.00	9.09	17.24	0.00	29.63	11.11	0.00	4.76	92.59
Farranula rostrata	50.00	33.33	8.00	55.17	4.55	6.90	4.76	18.52	0.00	0.00	9.52	33.33
Harpacticoida	0.00	0.00	4.00	0.00	0.00	41.38	0.00	7.41	14.82	3.57	0.00	3.70
Microsetella rosea	0.00	4.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Microsetella norvegica	3.57	0.00	8.00	0.00	0.00	0.00	0.00	7.41	18.52	0.00	9.52	3.70
Microsetella sp.	0.00	0.00	4.00	3.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70
Euterpina acutifrons	25.00	8.33	64.00	34.48	45.56	75.86	28.57	25.93	88.89	35.71	19.05	11.11
Clytemnestra scutellata	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clytemnestra rostrata	0.00	0.00	0.00	0.00	0.00	3.45	0.00	0.00	0.00	0.00	0.00	0.00
Clytemnestra sp.	0.00	0.00	0.00	3.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Copepod nauplius	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.14	0.00	0.00
Overall stomachs	31	30	30	30	30	30	30	30	30	34	30	30
Stomachs including copepoda	28	24	25	29	22	29	21	27	27	28	21	27

Table 4. Stomach contents of sardines in different localities given by various researchers.

Authors	**Localities**	**Species considered**	**Groups determined**
Fleury, 1950	Gascogne Bay	Sardine sp.	Copepoda, Cirripedae, Amphipoda, etc.
Moravic, 1959	Adriatic	*Clupea finta*	Fish, Crustacea, etc.
Demirhindi, 1961	Marmara Sea	*Sardina pilchardus*	Copepoda, Lamellibranchiata post larvae, Cladocera, etc.
Flinkman et al., 1991	Finland Bay	*Clupea harengus*	Copepoda, Amphipoda, etc.
Flinkman et al., 1992	Finland Bay	*Clupea harengus*	Neritic copepods, Cladocera, etc.
Molina & Manrique, 1994	California Bay	*Sardinops sagax caeruleus*	Calanoid copepods, Coscinodiscus sp., etc.
Covay et al., 1994	North coast of Spain	*Sardina pilchardus* (larvae)	Development stages of copepods (eggs, nauplii and copepodites), Gastropod larvae, etc.
This study	Izmir Bay	*Sardina pilchardus*	Copepoda, Decapod crustacean larvae, Bivalvia, etc.

had been collected while capturing the sardines, it may have produced different results. Table 3 shows that *O. media* is the most dominant species consumed for six months of the year. *Euterpina acutifrons* (64%), *Centropages typicus* (89.66%), *Calanoida* (59.09%), *Euterpina acutifrons* (88.89%), *Oncaea* sp. (50%) and *Corycaeus* sp. (92.59%) are the most dominant during March, April, May, September, October and December, respectively.

Previous studies on *S. pilchardus* and other confamilial species given in Table 4 indicated that the copepods have constituted the most important nourishment. Our results for the *S. pilchardus* of Izmir Bay coincide with the results given by various researchers in Table 4. Similarly, Svetovidov (1963) stated that young *S. pilchardus* in coastal regions fed on crustaceans (Copepoda, Brachyura) as well as phytoplankton.

As a result, feeding of *S. pilchardus* on specific plankton is confirmed here. The copepod species, the de facto food source that influence feeding habits of European pilchard from Izmir Bay are determined in point of numerical percentage, weight percentage, frequency of occurrence, and index of relative importance. However, incidental or selective feeding of *S. pilchardus* could not be ascertained in this study. Parallel studies accomplished in similar time (i.e., sampling *S. pilchardus* for stomach contents and sampling plankton from the environment) may determine whether the fish consume them incidentally or selectively.

Acknowledgement

We would like to thank Dr. Mary Labropoulou (National Center for Marine Research, Athens, Greece), for improving the scientific scope of the study and critical comments on an earlier manuscript of this paper.

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