

PRELIMINARY STUDY ON THE DIET OF JUVENILE SWORDFISH (*XIPHIAS GLADIUS*) IN THE AEGEAN SEA

Tevfik Ceyhan¹, Okan Akyol

SUMMARY

Stomach contents of 28 juvenile swordfish specimens from the middle Aegean Sea of Turkey were analyzed. Major prey categories in stomachs were 88.7% teleosts, %10.7 cephalopods and %7.4 crustaceans. A total of 336 prey items of which 298 fish, 36 cephalopods and 2 crustaceans were identified. Anchovy was the most frequent (%F=70.4), abundant prey (%N=66.7) and the highest index of relative importance (IRI= 7237.1) whereas, sardine had the highest percentage by weight (%W=41.1). Other fish species were Cepola macrophthalma, Merluccius merluccius, Scomber japonicus and Sardinella aurita. The secondary food preference group was cephalopoda, especially Loligo vulgaris. This squid species was the third option in terms of index of relative importance (IRI=67.7). Crustaceans were low values for all indices.

RÉSUMÉ

Les contenus stomacaux de 28 spécimens de juvéniles d'espada provenant du centre de la mer Égée de la Turquie ont été analysés. Les principales catégories de proies présentes dans les estomacs étaient les téléostéens (88,7%), les céphalopodes (10,7%) et les crustacés (7,4%). 336 restes de proie ont été identifiés, à savoir 298 poissons, 36 céphalopodes et 2 crustacés. L'anchois était la proie la plus fréquente (%F=70,4) et la plus abondante (%N=66,7). Cette espèce présentait l'indice d'importance relative le plus élevé (IRI= 7237,1) alors que la sardine affichait le pourcentage le plus élevé en poids (%W=41,1). Les autres espèces de poissons étaient Cepola macrophthalma, Merluccius merluccius, Scomber japonicus et Sardinella aurita. Le groupe de préférence alimentaire secondaire était composé de céphalopodes, et plus particulièrement de Loligo vulgaris. Cette espèce de calmar se situait en troisième position en termes d'indice d'importance relative (IRI=67,7). Les crustacés présentaient de faibles valeurs pour tous les indices.

RESUMEN

Se analizaron los contenidos estomacales de 28 ejemplares de pez espada juvenil del mar Egeo central de Turquía. Las principales categorías de presas en los estómagos correspondían a teleosteos (88,7%), cefalópodos (10,7%) y crustáceos (7,4%). Se identificaron en total 336 presas, de las que 298 eran peces, 36 cefalópodos y 2 crustáceos. La anchoa era la presa más frecuente (%F=70,4) y abundante (%N=66,7) y con el mayor índice de importancia relativa (IRI=7237,1) mientras que la sardina representaba el mayor porcentaje en peso (%W=41,1). Otras especies de peces presentes eran Cepola macrophthalma, Merluccius merluccius, Scomber japonicus y Sardinella aurita. El segundo grupo de preferencia alimentaria eran los cefalópodos, especialmente Loligo vulgaris. Esta especie de calamar era la tercera opción en términos de índice de importancia relativa (IRI=67,7). Los crustáceos tenían los valores más bajos para todos los índices.

KEYWORDS

Swordfish, Xiphias gladius, juvenile, diet, Aegean Sea

¹ Ege University Faculty of Fisheries, 35100 Bornova, Izmir, Turkey; E-mail:tevfik.ceyhan@ege.edu.tr

1. Introduction

Swordfish (*Xiphias gladius*) is a large pelagic, oceanodromous species of high commercial value that is heavily exploited in the Atlantic Ocean and the Mediterranean Sea. It migrates toward temperate or cold waters in the summer and back to warm waters in the fall at a depth range of 0–800 m (Tserpes et al., 2003; Froese and Pauly, 2016). Swordfish lives solitary or in small groups and feeds on small schooling fish and squids; it uses its bill to slash into a school of fish to stun its prey, and also probably uses the bill to dig into the substrate to disclose benthic organisms (Golani et al., 2006).

There are only a few studies on feeding habits of swordfish in the Mediterranean Sea. Bello (1991) studied the role of Cephalopods in the diet of the swordfish (n=38), collected from south Adriatic Sea, north Ionian Sea and Gulf of Taranto from 1984 to 1986. Orsi Relini et al. (1995) also studied the feeding of swordfish (n=126) in the western Ligurian Sea. Peristeraki and Tserpes (2001) analyzed the stomach content of 69 swordfish from the southern Aegean Sea. Salman (2004) documented the role of Cephalopods in the diet of swordfish (n=108) in the southern Aegean Sea during 1999-2000. This once, Peristeraki et al. (2005) analyzed the cephalopod beaks found in the stomach of 69 swordfish from the southern Aegean Sea.

The main goal of the present study is to identify the stomach content of juvenile swordfish obtained from the middle part of the Turkish Aegean Sea.

2. Material and Methods

Juvenile swordfish specimens were sampled from commercial purse seiners and pelagic longliners off Özdere, Uzunada, Karaburun, along the coasts of Izmir, middle Aegean Sea during September (n=2), October (n=9), March (n=1), November (n=1) 2008 and January (n=2), October (n=6), November (n=7) 2009.

Lower jaw fork length (LJFL) to the nearest cm and whole body weight to the nearest g was recorded for fresh fish. Stomachs were removed immediately from all fish and preserved in 4% formaldehyde for later analysis. In the laboratory, prey were identified to the lowest possible taxonomic level, counted and weighed to the nearest 0.1 g for fish after removal of surface water using blotting paper. Preys were counted and weighed to the nearest 0.1 g.

The importance of the different prey types was evaluated calculating the frequency of occurrence (%F = number of stomachs containing prey i/total number of stomachs containing prey × 100), percentage abundance (%N = number of prey i/total number of prey × 100) and percentage weight (%W = weight of prey i/total weight of all prey × 100) (Hyslop, 1980). The index of relative importance (IRI) combines the above three quantities into a single numerical index: $IRI = [F\% \times (W\% + N\%)]$ and was used to assess the importance of various food items in the diet (Caragitsou and Papaconstantinou, 1988).

3. Results and Discussion

Twenty-eight juvenile swordfish were ranged from 62 to 113 cm LJFL (mean: 74.7 cm ± 2.2) and from 1440 to 5300 g (mean: 3126 g ± 163.6). There was only one empty stomach (3.6%) and the others had full (50%) and ½ full (46.4%) stomachs.

The analyses of stomach contents seem that a total of 336 prey items of which 298 fish (including fish bone and fish flesh), 36 cephalopods (including some hard parts, e.g. cuttle bone and beaks) and 2 crustaceans were identified. Major prey categories in stomachs were 88.7% teleosts, %10.7 cephalopods and %7.4 crustaceans. The preliminary results of the stomach content analysis revealed that juvenile swordfish feed mostly on fish, especially anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*). Anchovy was the most frequent (%F=70.4), abundant prey (%N=66.7) and the highest index of relative importance (IRI= 7237.1) whereas, sardine had the highest percentage by weight (%W=41.1). Other fish species were *Cepola macrophthalma*, *Merluccius merluccius*, *Scomber japonicus* and *Sardinella aurita* (Table 1). The secondary food preference group was Cephalopoda, especially *Loligo vulgaris*. This squid species was the third option in terms of index of relative importance (IRI=67.7). Crustaceans were low values for all indices.

Bello (1991) reported that the major of prey remains consisted primarily of cephalopods and secondarily of teleosts in the Italian waters. Orsi Relini et al. (1995) recorded that the stomach content analysis of swordfish in the Ligurian Sea consisted of 67.8% cephalopods, 30.7% fish and 1.5% crustaceans. Ommastrephidae family (IRI=2087.8) from cephalopoda was the first preference food for swordfish, following Paralepididae (teleostei, IRI=936.9), Cranchiidae (cephalopoda, IRI=622.4) according to index of relative importance. Peristeraki and Tserpes (2001) declared that the food of swordfish consisted of fish (51.9%) and cephalopods (48.1%). Besides, *Todarodes sagittatus* was the most abundant species among the 9 cephalopod taxa (Peristaraki et al., 2005). Salman (2004) also recorded that the *Sepietta oweniana* was the first food item in the stomach contents of swordfish in the southern Aegean Sea, following *Todarodes sagittatus*, *Loligo vulgaris*, *Ommastrephes bartramii* as well as *Engraulis encrasicolus* and *Sardina pilchardus* were the main food items for fish species according to both percentage frequency occurrence (%FO) and percentage composition by number (%N).

In the present study, it seems that the food preference of juvenile swordfish is different as primarily fish contrarily cephalopods were the first preference in the other studies, mentioned above [except Salman (2004) but cephalopod ratio was higher than this study]. Peristeraki et al. (2005) already stated that the larger swordfish were more likely to feed on cephalopods. This argument explains that the cephalopods why does the secondary and a little preference of juvenile swordfish. However, anchovy and sardine are abundant fish species along the coasts of Aegean Sea, whereas cephalopods are not plentiful in the area. We think that the juvenile swordfish exist close to the shore and they show opportunistic feeding behavior. On the other hand, existing plenty of anchovy and sardine in the stomach contents might also be explained with the purse-seine catch, targeted anchovy and sardine. In the Turkish Aegean Sea, purse-seiners usually use a strong source of light in order to aggregate the fish schools for easy to catch them. Additionally, *Cepola macrophthalmia* is reported for the first time from the content of swordfish stomach in the Aegean Sea.

Acknowledgements

This study was funded by Turkish Scientific and Technological Research Council (TUBITAK Project No.108O210).

References

- Akyol, O. and Ceyhan, T. 2011. The Turkish Swordfish Fishery. Collect. Vol. Sci. Pap. ICCAT, 66(4): 1471-1479.
- Bello, G. 1991. Role of Cephalopods in the diet of the swordfish, *Xiphias gladius*, from the eastern Mediterranean Sea. Bulletin of Marine Science, 49: 312-324.
- Caragitsou, E. and Papaconstantinou, C. 1988. Feeding habits of red pandora (*Pagellus erythrinus*) off the western coast of Greece. Journal of Applied Ichthyology, 4: 14-22.
- Froese, R. and Pauly, D. eds. 2016. FishBase. World Wide Web electronic publication. www.fishbase.org. version (01/2016).
- Golani, D., Öztürk, B. and Başusta, N. 2006. The fishes of the eastern Mediterranean. Turkish Marine Research Foundation, Publication No. 24, Istanbul, Turkey.
- Hyslop, E.J. 1980. Stomach contents analysis: a review of methods and their application. Journal of Fish Biology 17, 411-429.
- Orsi Relini, L., Garibaldi, F., Cima, C. and Palandri, G. 1995. Feeding of the swordfish, the bluefin and other pelagic nekton in the western Ligurian Sea. Col.Vol.Sci.Pap. ICCAT, 44: 283-286.
- Peristeraki, P. and Tserpes, G. 2001. Feeding habits of swordfish (*Xiphias gladius* L.,1758) in the S. Aegean Sea. In: 10th Hellenic Congress of Greek Ichthyologists. Channia, 18-20 October. pp. 1-4.
- Peristeraki, P., Tserpes, G. and Lefkaditou, E. 2005. What cephalopod remains from *Xiphias gladius* stomachs can imply about predator-prey interactions in the Mediterranean Sea? Journal of Fish Biology, 67: 549-554.
- Salman, A. 2004. The role of Cephalopods in the diet of swordfish (*Xiphias gladius* Linnaeus, 1758) in the Aegean Sea (Eastern Mediterranean). Bulletin of Marine Science, 74: 21-29.
- Tserpes, G., Peristeraki, P. and Di Natale, A. 2003. Swordfish abundance trends in the Mediterranean. CIESM Workshop Monographs No.22.Mediterranean Biological Time Series- Split, 11-14 June, pp.101-108.

Table 1. Percentage frequency of occurrence (%F), percentage abundance (%N), percentage by weight (%W) and index of relative importance (IRI) for prey types of juvenile *Xiphias gladius* in the Aegean Sea.

Prey items	%F	%N	%W	IRI
Teleostei				
<i>Engraulis encrasicolus</i>	70.4	66.7	36.1	7237.1
<i>Sardina pilchardus</i>	63.0	16.7	41.1	3641.4
<i>Cepola macrophthalma</i>	3.7	0.3	0.6	3.3
<i>Merluccius merluccius</i>	3.7	1.8	3.8	20.7
<i>Scomber japonicus</i>	3.7	0.6	3.2	14.1
<i>Sardinella aurita</i>	7.4	0.6	1.8	17.8
Fish bone	11.1	1.2	0.3	16.7
Unidentified fish	11.1	0.9	1.7	28.9
Cephalopoda				
<i>Loligo vulgaris</i>	11.1	0.9	5.2	67.7
<i>Eledone moschata</i>	3.7	0.3	3.2	13.0
<i>Alloteuthis media</i>	3.7	0.3	0.2	1.9
<i>Sepietta</i> spp.	3.7	6.5	2.1	31.8
Octopus' beak	14.8	2.4	0.0	35.5
Cuttle bone	3.7	0.3	0.0	1.1
Crustacea				
<i>Parapenaeus longirostris</i>	3.7	0.3	0.2	1.9
<i>Penaeus</i> spp.	3.7	0.3	0.0	1.1
No. of stomach	28			
No. of empty stomach	1			
% of empty stomach	3,6			