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Diet composition of the Morocco dentex: *Dentex maroccanus* Valenciennes, 1830 (Teleostei: Sparidae) in the central Turkish Aegean Sea

by

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Abstract

This study examined the stomach contents of 230 individuals out of 439 samples obtained from commercial fishermen between January 2013 and March 2014 from a trawler using trawl bags with a full cod-end mesh size of 44 mm.

It was found that 216 samples were full and the stomach fullness index was estimated at 93.9%. The varying diet composition of the species was determined by estimating the percentage numerical composition (N%), frequency of occurrence (F%), gravimetric composition (W%) and the index of relative importance (IRI%). Diversity (Shannon index), richness (Margalef index) and similarity (Bray-Curtis index) of the catches in different seasons were calculated using the Biodiversity Professional (Version 2) software.

Three major groups were identified in the catches: Crustacea, Mollusca and Teleostei. At least 17 different prey groups were identified. With regard to the diversity of consumed prey, the winter (1.204), autumn (1.079) and spring (1.000) seasons were characterized by a medium level of diversity, summer (0.699) – by a low level of diversity. However, the richness of prey does not show seasonal differences. As indicated by the Bray-Curtis index, the highest similarity between the prey groups was observed between the autumn and winter seasons, at 81.61%.

Key words: Morocco dentex, *Dentex maroccanus*, diet composition, Izmir Bay, Aegean Sea

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Introduction

The Morocco dentex, *Dentex maroccanus* Valenciennes, 1830, is an important demersal commercial sparid species occurring throughout the Mediterranean (but absent in the Adriatic), at depths ranging from 20 to 500 m, especially in areas featuring gravel or rubble beds. The ecology of the Morocco dentex suggests that this species prefers deep waters and higher salinity. The species also occurs in the southern and eastern Mediterranean (Maravelias et al. 2007) and the Atlantic (from the Bay of Biscay to the Gulf of Guinea) (Froese & Pauly 2014). In the Aegean Sea, the sparids are generally caught by trawls, demersal longlines and trammel nets (Gül et al. 2014).

Studies concerning the biological characteristics of *Dentex maroccanus* have been carried out by – in chronological order – Nguyen & Wojciechowski (1972), Mennes (1985), Bauchot & Hureau (1986), Lamrini & Bouymajjane (2002), Chemmam-Abdelkader et al. (2004), Karakulak et al. (2006), İşmen et al. (2007), Maravelias et al. (2007), Antonucci et al. (2009), Ceyhan et al. (2009), Aura et al. (2013), Mohdeb & Kara (2014), Gül et al. (2014). The only study concerning the diet regime of *Dentex maroccanus* was carried out on the north-western shores of Africa in 1973 (Nguyen & Wojciechowski 1972).

A detailed literature review shows that there is lack of research on the feeding regime of species distributed across the Mediterranean and Aegean Sea shores of Turkey. The presented study investigated the diet composition of the Morocco dentex along the Mediterranean and Aegean coast of Turkey. The purpose of this study was to identify the most important food groups for the Morocco dentex and to understand the seasonal selection of prey groups so that this information is available for comparisons with studies from other nearby or remote areas. We believe that the results of this study can be applied to the management of marine stocks in the investigated Mediterranean region for both the target species and other species competing for food in the same habitat.

Materials and Methods

Dentex maroccanus specimens, with the total lengths ranging from 8.1 to 22.1 cm, were collected from commercial fishermen, who generally use trawl nets (full cod-end mesh size 44 mm; hull length 17-22 m, 240-400 HP) from the Izmir Bay in the Turkish Aegean Sea, and who cover significant fishing grounds in the central part of the sea, between January 2013 and March 2014. As a result of the dissection of 439 individual fishes obtained during the study, 230 stomach samples (macroscopically examined and found to be full) were preserved for future examination.

The mean total length (cm) and the number of individuals (N) examined separately in autumn, winter, spring and summer were as follows: 14.32 cm – 47, 12.49 cm – 78, 13.29 cm – 50 and 12.46 cm – 55, respectively.

The fish were dissected immediately after collection. Their stomachs were removed and stored in formalin (10%) until the contents could be analyzed. The stomach contents were homogenized in petri dishes and then examined using an SZX7 Olympus stereo microscope at 0.8 to 5.6× (zoom) and 10× resolution. Prey items were identified to the nearest possible taxon.

Once counted, individuals of the same species were weighed together (wet weight to the nearest ±0.0001 g) after excess moisture was removed by blotting the prey items on the tissue paper. The following indices were used to quantify the importance of different prey items in the diet of *D. maroccanus*:

1. the percentage frequency of occurrence (F%) = the number of stomachs in which a food item was found, divided by the total number of non-empty stomachs, multiplied by 100 (for each prey group computed separately).

2. the percentage numerical abundance (N%) = the number of each prey item in all non-empty stomachs, divided by the total number of food items in all stomachs, multiplied by 100.

3. the percentage gravimetric composition (W%) = wet weight of each prey item, divided by the total weight of stomach contents, multiplied by 100 (Hyslop 1980).

The main food items were identified using the index of relative importance (IRI) of Pinkas et al. (1971):

$$IRI = F\% \times (N\% + W\%)$$

the index was expressed as follows:

$$IRI\% = (IRI/\sum IRI) \times 100$$

The percentage of empty stomachs to the total number of examined stomachs was expressed as the vacuity index (VI), where VI% = 100 × (the number of empty stomachs/the number of examined stomachs).

The Biodiversity Professional (Version 2) software was used to determine the seasonal diversity of consumed catches (Shannon index), the richness (Margalef index) and similarity (Bray-Curtis). In the assessment of the Shannon index results, the following ranges were applied: 0-1 = a low level of diversity, 1-3 = a medium level of diversity and 3-5 = a high level of diversity (Washington 1984).

Results

During the study period, a total of 230 specimens of the Morocco dentex were examined, and it was found that 216 stomachs of that total number were full. Whereas the stomach fullness index was estimated at 93.9%; the highest seasonal stomach fullness index was determined in the winter – 96.2%. This was followed by the autumn (95.7%), spring (92.0%) and summer (90.9%), respectively.

Following the examination of the contents of full stomachs, it was found that the species feeds mainly on three major prey groups: Crustacea, Mollusca and Teleostei (Table 1). As evidenced by the frequency of occurrence, numerical composition, gravimetric composition and the index of relative importance, Crustacea was determined as the most important prey group. Mollusca were the second prey group in terms of the numerical amount and frequency of occurrence, whereas Teleostei were the second group in terms of the weight method (Fig. 1).

According to the detailed stomach content analysis, the species feeds on 17 different prey groups. Of these prey groups, the ones represented by an IRI value

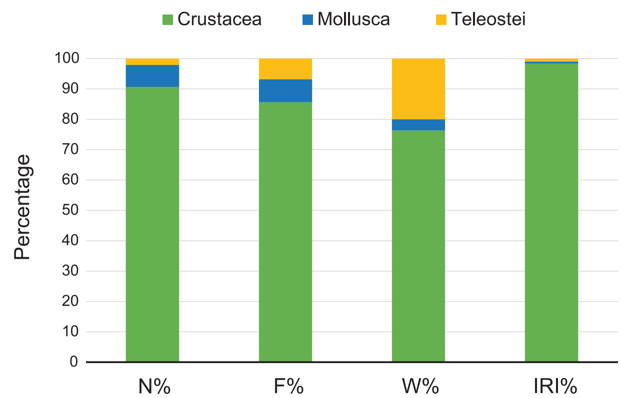

Figure 1

Percentage numerical composition (N%), frequency of occurrence (F%), percentage gravimetric composition (W%) and the percentage index of relative importance (IRI%) of the main prey groups for *Dentex maroccanus*

Table 1

Seasonal diet composition of *Dentex maroccanus* (N% – percentage numerical composition, F% – frequency of occurrence, W% – percentage gravimetric composition and IRI% – percentage index of relative importance).

	Winter December, February				Autumn September, October				Spring March, April				Summer June, August			
Prey groups	N%	F%	W%	IRI%	N%	F%	W%	IRI%	N%	F%	W%	IRI%	N%	F%	W%	IRI%
Crustacea																
Amphipoda	19.30	29.33	0.14	7.63	16.67	40.00	0.45	8.86	8.33	8.70	0.89	0.92	5.88	10.00	0.27	0.84
Brachyura	5.61	21.33	22.29	7.96	8.89	40.00	17.08	13.44	6.25	8.70	23.46	2.96	-	-	-	-
Decapod crustaceans	28.77	81.33	31.91	66.00	27.78	86.67	14.91	47.86	47.92	82.61	46.72	89.65	47.06	80.00	6.47	58.38
Isopoda	7.72	20.00	1.30	2.41	11.11	33.33	0.91	5.18	2.08	4.35	3.55	0.28	-	-	-	-
Mysidacea	21.40	42.67	2.24	13.49	22.22	53.33	1.13	16.11	10.42	13.04	1.63	1.80	29.41	30.00	1.20	12.52
Ostrocoda	1.40	5.33	0.32	0.12	1.11	13.33	12.23	2.30	2.08	4.35	0.36	0.12	-	-	-	-
Copepoda																
Candacia longimana	0.35	1.33	0.08	0.01	1.11	6.67	0.12	0.11	-	-	-	-	-	-	-	-
Euchaeta marina	0.35	1.33	0.52	0.02	-	-	-	-	-	-	-	-	-	-	-	-
Aetideus armatus	0.70	2.67	0.61	0.05	-	-	-	-	-	-	-	-	-	-	-	-
Corycaeus spp.	0.35	1.33	20.80	0.38	1.11	6.67	31.88	2.84	-	-	-	-	-	-	-	-
Calanoida	2.46	8.00	0.66	0.33	2.22	13.33	0.29	0.43	2.08	4.35	0.64	0.14	-	-	-	-
Parazitic copepoda	0.35	1.33	0.39	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Harpacticoida	1.75	6.67	0.20	0.17	-	-	-	-	-	-	-	-	-	-	-	-
Mollusca																
Pteropoda	6.32	1.33	0.30	0.12	3.33	6.67	0.91	0.37	-	-	-	-	-	-	-	-
Gastropoda	-	-	-	-	-	-	-	-	14.58	8.70	14.84	2.93	5.88	10.00	6.17	1.64
Bivalvia	2.11	8.00	0.77	0.31	2.22	13.33	2.26	0.77	2.08	4.35	2.35	0.22	-	-	-	-
Teleostei	1.05	4.00	17.44	0.99	2.22	6.67	17.83	1.73	4.17	8.70	5.56	0.97	11.76	20.00	85.88	26.62

equal to or greater than 1% are decapod crustaceans (IRI% = 71.5), Mysidacea (IRI% = 9.8), Brachyura (IRI% = 7.8), Amphipoda (IRI% = 5.7), Isopoda (IRI% = 2.1) and Teleostei (IRI% = 1.8). Other prey groups are represented by IRI values below 1% (Fig. 2).

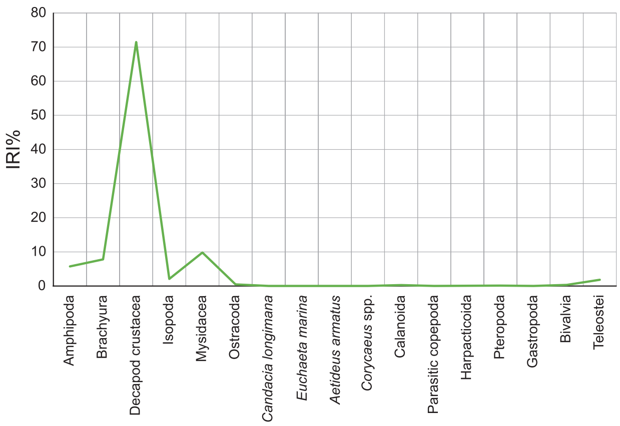

Figure 2

Percentage index of relative importance (IRI%) of prey groups for *Dentex maroccanus*

In terms of N%, F% and W% values, decapod crustaceans proved to be the most abundant. In terms of the W% value, this prey group was followed by Brachyura, Teleostei and others. In terms of the F% value, it was followed by Mysidacea, Amphipoda, Brachyura, Isopoda and other prey groups (Fig. 3).

When seasonal consumed prey group diversity (Shannon index, Shannon H_{max} Log Base 10) based on IRI% values was taken into consideration, it was found that winter (1.204), autumn (1.079) and spring (1.000) seasons were characterized by a medium level of diversity, while the summer season (0.699) – by a low level of diversity. On the other hand, the richness of the prey group consumed by this species was the same for all seasons (Margalef index, Margalef M Base 10 = 8). Therefore, it can be concluded that the prey group richness does not differ in respect of the seasons. According to the Bray-Curtis clustering analysis, the similarity between the top and the bottom prey groups was 81.6% in the winter and autumn seasons and 55.3% in the autumn and spring seasons. There were two different groups at the 75% similarity threshold. While autumn, winter and spring seasons constituted a group on one side, the summer season constituted a group on the other side (see Fig. 4).

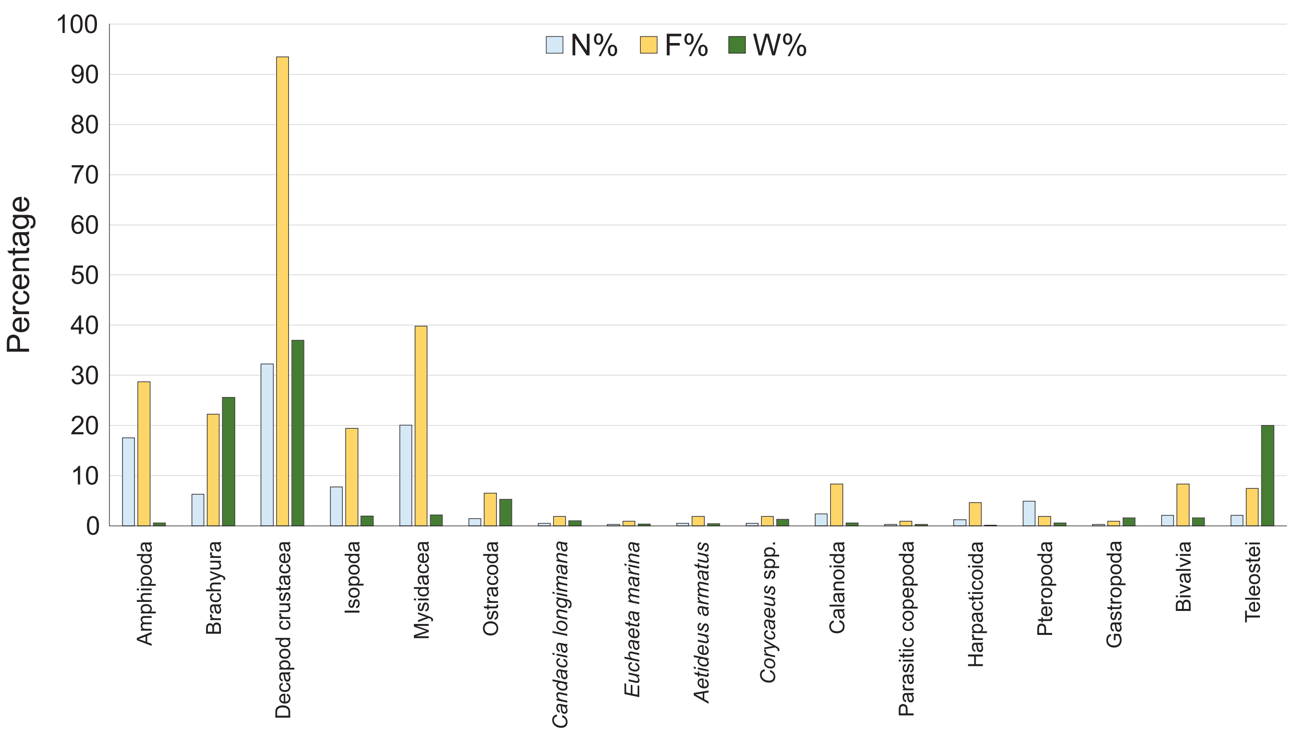

Figure 3

Diet composition of *Dentex maroccanus* (N% – percentage numerical composition, F% – frequency of occurrence and W% – percentage gravimetric composition)

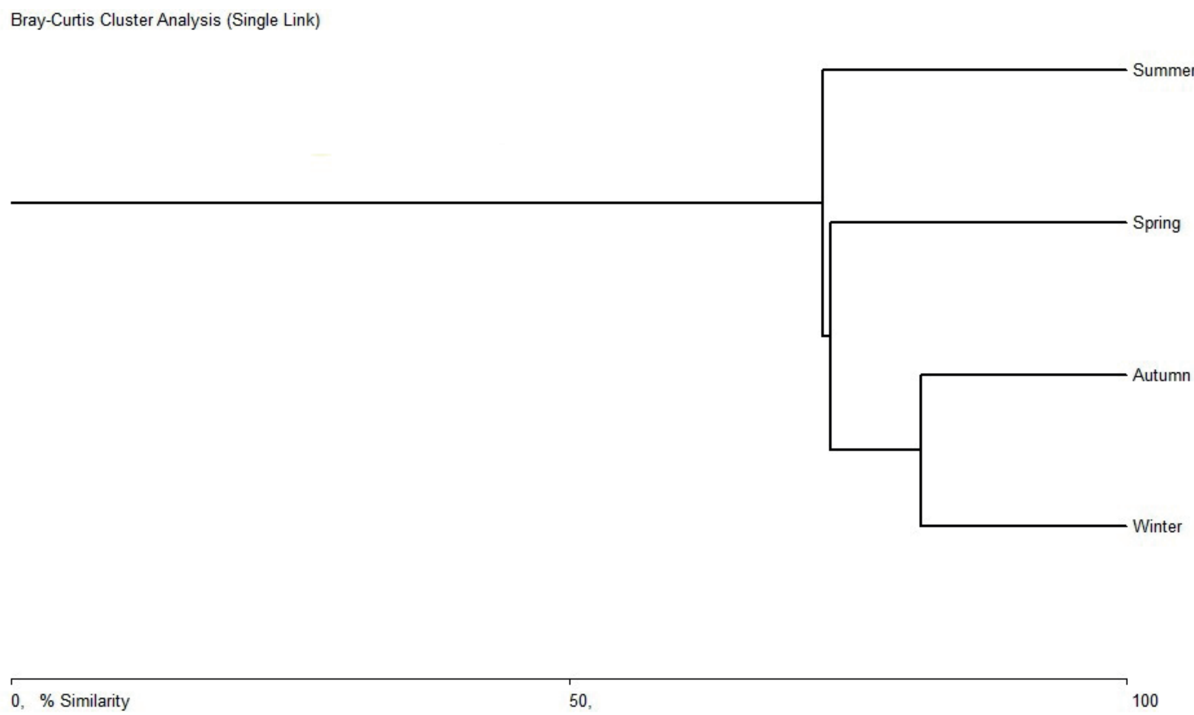

Figure 4

Dendrogram of the cluster analysis showing the diet similarity (IRI%) in relation to seasons, using the Bray-Curtis index

Discussion

Feeding occurs daily for most fish and may be the most frequent voluntary activity (Bond 1996). It is generally stated that the feeding intensity in fish decreases during the spawning season (Nikolsky 1976). Our findings were consistent with this statement. The Morocco dentex spawns in the spring and summer months in the Mediterranean (Bauchot & Hureau 1986). In line with this, we observed the largest number of empty stomachs in the summer.

In another detailed study of the diet composition of this species, the stomach contents of 1281 samples from 4 different stations were examined, and the empty stomach rate was determined to be 60% (Nguyen & Wojciechowski 1972). The findings of that research suggested that the species has a lower stomach fullness rate on the Senegal shelf. A larger number of fish samples might have resulted in a higher empty stomach rate. Moreover, it is believed that the poorer Atlantic waters, in comparison with the Aegean Sea, would result in higher empty stomach rates for this species.

In the study conducted on the Senegal shelf during the winter season only, which displays a significant similarity with this study, and based on the diet composition analysis, four major prey groups were found in the stomach content of the species: Crustacea, Teleostei, Polychaeta and Mollusca (Nguyen & Wojciechowski 1972). Of the groups caught, only the Polychaeta group was not found in our study. However, it was reported in other studies in relatively insignificant amounts compared to other taxa and determined by the weight method. This may be due to the smaller population in our study. However, Polychaeta were found and reported in the diet composition of a number of fish species in recent decades along the Aegean Sea shores of Turkey (Sever et al. 2005; Sever et al. 2006; Sever et al. 2009; Bayhan et al. 2009; Bayhan & Sever 2009 and Bayhan et. al. 2013).

According to all index values used in this study, the primary prey group was Crustacea. Similarly, in terms of weight, Crustacea (especially Paguridae, Galatheidae, Brachyura and Cirripedia) accounted for 60% of all prey. Our findings showed that fish is the second prey group, accounting for 20% of the total prey weight. In addition, other similar studies have reported that this group was followed by other prey groups, such as Polychaeta, Gastropoda, Mysidacea and Amphipoda (Nguyen & Wojciechowski 1972). A review of the existing literature has shown that *Dentex maroccanus* feeds mainly on crustaceans and fish, but also on mollusks (Bauchot & Hureau 1986).

Body shape is clearly an important part of the mechanism for bringing the predator close enough to the prey or food item for it to be consumed (Horn

& Ferry-Graham 2006). Also in many fish species, morphological similarity can be considered as a proxy for similarities in the habitat use. The Sparidae family includes species that are recognized for common morphological features such as the structure and positioning of the fins and for specialized dentition. *Dentex maroccanus* has been classified as a low-predator (Antonucci et al. 2009). Sparidae have jaws with bluntly-rounded, posterior molars and enlarged front teeth. These are carnivorous feeding on crustaceans, mollusks and small fish (Orrell 2000). The results from our study clearly show that *Dentex maroccanus* is a carnivorous species, which is consistent with earlier findings (Nguyen & Wojciechowski 1972; Bauchot & Hureau 1986; Orrell 2000). The benthic invertebrate fauna provides a significant portion of the food for carnivorous fish. For the most part, organisms such as aquatic insects (including larvae and pupae, small crustaceans, mollusks and worms) constitute the main food source for most of the fish (Bond 1996). Therefore, the scarcity and/or abundance of the benthic invertebrate fauna will directly affect the diet composition and the growth of the species on the Aegean Sea coasts. Therefore, trophic levels are currently used for the development of ecosystem-originated fishery management strategies. The long-term changes in fish stocks over the years and intervals between low and high stock regimes can be defined according to the trophic controls that are formed upward from the bottom of the food chain and downward from the top of the food chain (Daskalov 2002; Daskalov et al. 2007).

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References

Antonucci, F., Costa, C., Aguzzi, J. & Cataudella, S. (2009). Ecomorphology of Morpho-Functional Relationships in the Family of Sparidae: A Quantitative Statistic Approach. *Journal of Morphology* 270: 843-855. DOI: 10.1002/jmor.10725.

Aura, C.M., Anam, R.O., Musa, S. & Kiman, E. (2013). Length-Weight Relationship and Condition Factor (K constant) of *Dentex maroccanus*, Valenciennes 1830 (Family Sparidae) at Malindi, Kenya. *Western Indian Ocean J. Mar. Sci.* 12(1): 79-83.

Bauchot, M.L. & Hureau, J.C. (1986). Sparidae. In P.J.P. Whitehead, M.L. Bauchot, J.C. Hureau, J. Nielsen & E. Tortonese (Eds.), *Fishes of the north-eastern Atlantic and the Mediterranean* (pp. 883-907). Paris.

Bayhan, B. & Sever, T.M. (2009). Food and feeding habits of the Atlantic Horse Mackerel, *Trachurus truchurus*, from the Aegean Sea. *Zool. Middle East* 46: 47-54. DOI: 10.1080/09397140.2009.10638327.

Bayhan, B., Sever, T.M. & Taskavak, E. (2009). Age and feeding habits of Atlantic spotted flounder *Citharus linguatula* (Linnaeus, 1758) (Pisces: Pleuronectiformes) from central Aegean Sea of Turkey. *North-West. J. Zool.* 5(2): 330-337.

Bayhan, B., Sever, T.M. & Kara, A. (2013). Diet composition of the Mediterranean horse mackerel, *Trachurus mediterraneus* (Steindachner, 1868) (Osteichthyes: Carangidae), from the Aegean Sea. *Belg. J. Zool.* 143(1): 15-22.

Bond, C.E. (1996). *Biology of fishes*. 2nd edition, Saunders College Pub., 576 pp.

Ceyhan, T., Akyol, O. & Erdem, M. (2009). Length-weight relationships of fishes from Gökova Bay, Turkey (Aegean Sea). *Turk. J. Zool.* 33: 69-72.

Chemmam-Abdelkader, B., Kraiem, M.M. & El Abed, A. (2004). Etude de l'age et de la croissance de deux especes de dentes (*Dentex dentex* et *Dentex maroccanus*) des cotes Tunisiennes. *Bull. Inst. Natn. Scien. Tech. Mer de Salammbô.* 31: 43-51.

Daskalov, G.M. (2002). Overfishing drives a trophic cascade in the Black Sea. *Mar. Ecol. Prog. Ser.* 225: 53-63. DOI: 10.3354/meps225053.

Daskalov, G.M., Grishin, A.N., Rodionov, S. & Mihneva, V. (2007). Trophic cascades triggered by overfishing reveal possible mechanisms of ecosystem regime shifts. *Proceedings of the National Academy of Sciences of the United States of America* 104(25): 10518-10523. DOI: 10.1073/pnas.0701100104.

Froese, R. & Pauly, D. (2014). FishBase. World Wide Web electronic publication. Available at: http://www.fishbase.org.(accessed on 15 April 2015).

Gül, G., İşmen, A. & Arslan, M. (2014). Age, Growth, and Reproduction of *Dentex maroccanus* (Actinopterygii: Perciformes: Sparidae) in the Saros Bay (North Aegean Sea). *Acta Ichthyol. Piscat.* 44(4): 295-300. DOI: 10.3750/aip2014.44.4.03.

Horn, M.H. & Ferry-Graham, L.A. (2006). Feeding Mechanisms and Trophic Interactions. In L.G. Allen, D.J. Pondella II & M.H. Horn (Eds.), *The Ecology of Marine Fishes: California and Adjacent Waters* (pp. 660). Los Angeles, California, DOI: 10.1525/california/9780520246539.003.0014.

Hyslop, E.J. (1980). Stomach content analysis: a review of methods and their applications. *J. Fish Biol.* 17(4): 411-429. DOI: 10.1111/j.1095-8649.1980.tb02775.x.

Ismen, A., Özen, O., Altinağaç, U., Özekinci, U. & Ayaz, A. (2007). Weight-length relationships of 63 fish species in Saros Bay, Turkey. *J. Appl. Ichthyol.* 23(6): 707-708. DOI: 10.1111/j.1439-0426.2007.00872.x.

Karakulak, F.S., Erk, H. & Bilgin, B. (2006). Length-weight relationships for 47 coastal fish species from the northern Aegean Sea, Turkey. *J. Appl. Ichthyol.* 22(4): 274-278. DOI: 10.1111/j.1439-0426.2006.00736.x.

Lamrini, A. & Bouymajjane, A. (2002). Biologie de *Dentex maroccanus* (Valenciennes, 1830) dans la région de Safi. *Actes Inst. Agron. Vet (Maroc).* 22(1): 11-18.

Maravelias, C.D., Tsitsika, E.V. & Papaconstantinou, C. (2007). Evidence of Morocco dentex (*Dentex maroccanus*) distribution in the NE Mediterranean and relationships with environmental factors determined by Generalized Additive Modelling. *Fisheries Oceanography,* 16(3): 294-302. DOI: 10.1111/j.1365-2419.2007.00421.x.

Mennes, F. (1985). Multispecies assessment of fish stocks off the Western Sahara region with emphasis on the family Sparidae. *Fishbyte* 3(3): 5-10.

Mohdeb, R. & Kara, M.H. (2013). Dimorphisme sexuel et croissance de dente´ de Maroc *Dentex maroccanus* (Valenciennes, 1830) des coˆtes d'El Kala en Est Alge´rien. Rapport de la Commission Internationale pour l'Exploration Scientifique de la Me´diterrane´e 40: 453.

Nguyen, X.L. & Wojciechowski, J. (1972). Comparative biology of fish from genus Dentex (sparidae) of north-west African coast. *Acta Ichthyol. Piscat.* 2(2): 77-79.

Nikolsky, G.V. (1976). *The ecology of fishes*. Academic Press, London. 352 pp.

Orrell, T.M. (2000). *A molecular phylogeny of the Sparidae (Perciformes: Percoidei).* Dissertation, College of William and Mary, Williamsburgs, VA. Doctor of Philosophy, 291 pp.

Pinkas, L., Oliphant, S.L. & Iverson, K. (1971). Food habits of albacore, bluefin tuna and bonito in California waters. *Fish. Bull.* 152: 1-105.

Sever, T.M., Bayhan, B. & Taskavak, E. (2005). A Preliminary Study on the Feeding Regime of European Pilchard (*Sardina pilchardus* Walbaum 1792) in Izmir Bay, Turkey, Eastern Aegean Sea NAGA, *WorldFish Center Quarterly* 28(3-4): 41-48.

Sever, T.M.; Bayhan, B.; Bilge, G., Taskavak, E. (2009). Diet composition of *Belone belone* (Linnaeus, 1761) (Pisces: Belonidae) in the Aegean Sea. *J. Appl. Ichthyol.* 25: 702-706. DOI: 10.1111/j.1439-0426.2009.01368.x.

Sever, T.M., Bayhan, B., Bilecenoğlu, M. & Mavili, S. (2006). Diet composition of the juvenile chub mackerel (*Scomber japonicus*) in the Aegean. Sea (Izmir Bay, Turkey). *J. Appl. Ichthyol.* 22: 145-148. DOI: 10.1111/j.1439-0426.2006.00705.x.

Washington, H.G. (1984). Diversity, biotic and similarity indices, a review with special reference to aquatic ecosystems. *Water Res.* 18: 653-694. DOI: 10.1016/0043-1354(84)90164-7.