

Feeding habits of garfish, *Belone belone euxini* Günther, 1866 in autumn and winter in Turkey's south-east coast of the Black Sea

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Abstract

Feeding habits of garfish, Belone belone euxini Günther, 1866 in autumn and winter in Turkey's south-east coast of the Black Sea.— We studied the stomach content of *Belone belone* in the south-east Black Sea during autumn and winter months in 2010–2011. The most frequent feeding items in the diet were insects in autumn and fish in winter. Other items in the diet were mollusks, crustaceans and isopods. Flying ants were mostly consumed by male garfish, particularly the smaller fish, in autumn.

Key words: Garfish, *Belone belone euxini*, Feeding habits, Black Sea, Flying ants

Resumen

Hábitos alimentarios de la aguja, Belone belone euxini Günther, 1866 en otoño e invierno en la costa suroriental del Mar Negro, en Turquía.— En el estudio se examinó el contenido estomacal de *Belone belone* en la costa suroriental del Mar Negro durante los meses de otoño e invierno de 2010 y 2011. Las hormigas voladoras constituyeron la presa más frecuente de la dieta en otoño, mientras que en invierno fueron los peces. Otras presas que aparecen en la dieta son moluscos, crustáceos e isópodos. Las hormigas voladoras son consumidas básicamente por los machos, en especial por los más pequeños, durante el otoño.

Palabras clave: Aguja, *Belone belone euxini*, Hábitos alimentarios, Mar Negro, Hormigas voladoras

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Introduction

Garfish, *Belone belone* (Family Belonidae), are a commercially important pelagic species in Turkey, with landings amounting to 314.2 tones (t) in 2015. They are caught mostly along the Black Sea (139.1 t per year) and Marmara (134.7 t per year) (TUIK, 2015).

Garfish is a pelagic species that moves to warmer coastal areas in summer months to spawn before returning to the deeper, open sea (Dorman, 1989; Zorica & Cikes Kec, 2012). The species matures to about 38 cm total length (TL) (Samsun et al., 2006). Young specimens are most common near the *Cystoseira* and *Zostera* belts (Radu et al., 1999). Garfish tend to leap and skitter at the surface (Collette, 2003). They are carnivorous, feeding primarily on small fishes which they catch sideways in their beaks (Collette, 2003). They can move for a considerable length of time at high speeds, exploring a large area in search of prey (Pavlov & Kasumyan, 2002).

Studies on the dietary patterns of garfish (*Belone belone*) are scarce: Dorman, 1988 (Irish waters), Sever et al., 2009 (Aegean Sea) and Zorica & Cikes Kec 2012 (Adriatic Sea). This is the first study on the feeding habits of this species in the Black Sea region of Turkey. The objective of the paper was to study the dietary composition of *Belone belone* in autumn and winter by analyzing stomach contents.

Material and methods

Garfish were obtained from commercial catches during autumn and winter months 2010–2011 in the Trabzon region of the south east Black Sea. The samples were collected from artisanal fishermen using garfish trammel nets. We collected specimens in autumn (October–November 2011) and winter (December 2010–January 2011). Total length (TL) measured to the nearest cm and total weight (TW) were recorded for each fish. Stomach contents were removed and frozen at -18°C . We were unable to identify food items from stomach contents to the lowest possible taxa due to the high degree of digestion of prey.

Data analysis was carried using the index of relative importance (IRI) (Pinkas et al., 1971):

$$\text{IRI} = \text{O}\% (\text{N}\% + \text{W}\%)$$

where O% is frequency of occurrence of each item, N% is the percentage of total number of food items, and W% is the percentage of total weight of stomach contents (wet weight) calculated for each food category. IRIs were standardized to 100% by calculating the percentage of total IRI contributed by each prey type (IRI %) (Hyslop, 1980). The sample was split into two groups according to size: small fish (≤ 38 cm TL) and large fish (≥ 38 cm TL). We compared stomach contents of similar size classes between sexes (to avoid the effect of size on sex).

Schoener's diet overlap index (Schoener, 1970) was used to measure diet overlap between size, sex and season. Schoener's index values above 0.6 are usually considered to indicate significant overlap.

Results

We collected 533 specimens in autumn (October–November 2011) and 146 specimens in winter (December 2010–January 2011). The total sample size consisted of 679 specimens (405 females and 272 males). Total length (cm) ranged from 15 to 49.5 cm and total weight ranged from 70.0 and 120.0 g. The sample was composed of 39% males and 61% females. The sex ratio (F:M) was significantly different from 1:1 ($P < 0.01$; $\chi^2 = 26.173$; $\text{SD} = 1$).

Only 2% of the individuals analyzed had empty stomachs. The total number of prey was 2,785. The maximum number of prey per stomach was 200 and the mean number of prey per stomach was 21.28 ± 3.34 .

Table 1 shows the food composition of *B. belone euxini* in autumn and winter. We identified nine types of prey, most of them at family, genus or species level. The most frequent feeding items were insects in autumn and fish in winter. Less frequent items were mollusks, crustaceans, isopods, and unidentifiable matter. The index of relative importance showed that the diet of *B. belone euxini* in autumn was dominated by flying ants belonging to the Formicidae Family (Subfamily Myrmicinae; genus *Pheidole* Westwood) of insects (IRI% = 59.74). In autumn, the mean number of flying ants per stomach was 74.2. The maximum number of flying ants in a stomach was 200. Anchovy, *Engraulis encrasicolus* (IRI% = 28.25), was also an important prey in the diet in autumn. Garfish also fed on smaller garfish (table 1). In winter the preferred food item was fish (anchovy and unidentified fish) ($P < 0.05$). Shrimp larvae, isopods and copepods were found only in winter. Garfish also ate the young of their own species in winter (table 1). The small-size group (≤ 38 cm) consumed mainly flying ants while the large-size group (> 38 cm) consumed mainly fish ($P < 0.05$). Small garfish consumed copepods, but this was not an important prey. Female and male diets differed significantly ($P < 0.05$) (table 1). Females (35.6 ± 3.9 cm) were significantly larger than males (31.6 ± 10.8 cm) ($P < 0.05$). In both same size groups, males consumed more flying ants than females (table 1).

The highest value of diet overlap was 0.71 between females and males, and the lowest was 0.28 between autumn and winter. This index was 0.55 between small- and large-sized groups.

Discussion

The dietary pattern of the garfish, *B. belone*, varies depending on geographic location. The most important prey in the Middle Eastern Adriatic Sea are copepods (Sever et al. 2009 in Aegean Sea; Zorica & Cikes Kec., 2012) while in Irish waters the most common food items are crab larvae, and clupeids (mainly juveniles) (Dorman, 1988). In the Black Sea, garfish feed on small fishes, particularly clupeids and anchovy (*Engraulis* sp.) (Collette & Parin, 1986; Dorman, 1988; Sever et al., 2009). Although in the present study we found that garfish feed mainly on flying ants in autumn, fish (particularly clupeids and anchovy) constitute its

Table 1. Diet composition of garfish, *B. belone euxini*, from southeastern Black Sea in autumn and winter: %N. Percentage by number; %W. Percentage by weight; %O. Percentage frequency of occurrence; %IRI. Percentage index of relative importance: W. Winter; A. Autumn; F. Female; M. Male.

Tabla 1. Composición de la alimentación de la aguja, *B. belone euxini*, en la costa suroriental del Mar Negro en otoño e invierno: %N. Porcentaje por número; %W. Porcentaje por peso; %O. Porcentaje de la frecuencia de presencia; %IRI. Porcentaje del índice de importancia relativa: W. Invierno; A. Otoño; F. Hembra; M. Macho.

Prey	Composition				% IRI					
					Length (cm)		Season		Sex	
	%N	%W	%O	%IRI	≤ 38	> 38	W	A	F	M
Flying ant	90.8	11.7	28.5	59.7	69.0	23.0	4.1	61.7	47.8	73.4
Anchovy	1.5	54.1	24.8	28.3	20.8	55.9	18.7	27.7	38.0	14.9
Red mullet	0.1	5.8	2.9	0.4	0.4	0.3	0.1	0.4	0.9	0.0
Young garfish	< 0.1	0.3	0.7	0.0	< 0.1	0.0	0.0	< 0.1	0.0	< 0.1
Unidentified fish	0.8	19.2	16.8	6.9	5.1	14.0	39.4	5.2	6.1	9.1
Isopoda	< 0.1	0.0	0.7	< 0.1	< 0.1	0.0	0.4	0.0	< 0.1	0.0
Copepod	0.1	< 0.1	0.7	< 0.1	< 0.1	0.0	0.8	0.0	0.0	< 0.1
Shrimp larvae	1.9	1.7	1.5	0.1	< 0.1	0.0	28.6	0.0	0.0	0.6
Gastropod larvae	1.2	0.8	0.7	< 0.1	0.2	0.0	8.1	0.0	0.1	0.0
Unidentified tissues	3.5	6.4	22.6	4.6	4.4	6.9	0.0	5.1	7.1	2.1

main food item in the other seasons —as indicated by our data and other works performed in the region (Yüce, 1975; Colette & Parin, 1986; Dorman, 1988). In Turkey's south east coast of the Black Sea, 78% of total marine fish production is anchovy and sprat of small pelagic fish (TUIK, 2015). Therefore, although ants are important in autumn, two small pelagic fish (anchovy and sprat) are the basis of the garfish diet (if we consider the whole year) due to their high abundance in this region.

Our study also confirms the observations of Sever et al. (2009) and Dorman (1988) that garfish display cannibalism of smaller specimens.

Although Zorica & Cikes Kec (2012) reported that the composition of the garfish diet was not size related, we found differences in the present study related to size. We observed that fish prey (IRI%) made up 20.84% of the diet for garfish ≤ 38 cm TL but 55.88% for garfish > 38 cm TL. As Samsun et al. (2006) found that females reached 50% sexual maturity at 38.8 cm length, the differences in diet in these size groups (< 38 cm vs. > 38 cm) could be related to maturity. Similarly to our study, Dorman (1988) found size-related differences in the diet of garfish in Irish waters: garfish of < 70 cm preyed on insects more often than fish, although all sizes fed predominantly on crustaceans.

Sever et al. (2009) also found that members of the Formicidae Family were an important prey. They

reported an index of relative importance of 308 (1.2%), 2,385 (17.2%) and 3,176 (32.5%) in March, April and August respectively (the %IRI was calculated by ourselves). However, we observed flying ants in the diet of garfish in October. This difference may be due to the availability of different insect species. Dorman (1988) stated that garfish in Irish waters fed on different orders of insects (Hemiptera, Diptera, Coleoptera and Hymenoptera), captured in summer (June–September), but the proportion of insects in the diet in these fish in Irish waters was lower than that in our study in the Black Sea.

Ants are abundant and dominant members of almost every terrestrial ecosystem. Nuptial flight of ants is a common phenomenon, usually occurring in summer or autumn, depending on the species (Dunn et al., 2007). Different ant species have different requirements concerning the weather to begin the nuptial flight. Nene et al. (2016) found that nuptial flights occurred during the raining season and on days with high relative humidity and less sunshine. The climate of the Black Sea coastal region has high humidity and rain falls throughout the year, mostly in autumn and winter. In rainy conditions, the flying ants may reach the coast in rainy weather, with large clouds and wind, and they may drown at sea. Garfish likely eat any masses of dead ants floating on the surface of the sea. In other seas and oceans flying ants are often seen in summer and autumn during

the nuptial flights (Dunn et al., 2007) but information about distribution and the timing of nuptial flights of this ant species in the Black Sea is lacking.

This is the first study to investigate the dietary pattern of garfish along the Turkish coast of the Black Sea but further research is needed to understand more about the trophic relationship between insects and garfish in this region.

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