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RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

Detection of feeding dietary *Rhizostoma pulmo* (Macri, 1778) in Samsun coasts of the Black Sea, Turkey

Karadeniz'in Samsun kıyılarında *Rhizostoma pulmo* (Macri, 1778) türünün beslenme rejimi tespiti

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Abstract: In this study, gastric contents of the medusa *Rhizostoma pulmo* distributed along the Samsun coast of the Black Sea were investigated between August 2008 and January 2010. Moreover, the relationship between the umbrella diameter and prey selectivity was determined. Captured *R. pulmo* individuals during the sampling period varied from 14.5 to 42.5 cm in umbrella diameter. The largest umbrella diameter was observed in October in both periods of the present study. Gastric contents of total 231 *R. pulmo* individuals have been gathered during the sampling period from all stations. 31 taxa, 10 larvae, 2 nauplii and fish and Copepod eggs from 11 phyla have been identified in the gastric contents of *R. pulmo* individuals. It has been detected that, feeding choices of *R. pulmo* individuals have differentiated and their food count has increased due to increasing umbrella diameter (according to Spearman rank correlation, r=0.70; p<0.05). According to the gastric content analyses, the feeding dietary of this species predominantly consists of copepods and dinoflagellates. It has been observed that taxa belonging to Crustaceans (59 %; Copepods 45.9 %) and Dinoflagellates (15.4 %) were densely present in the gastric contents gathered from *R. pulmo* individuals. The Phylum Ciliophora was another abundantly observed group in the gastric content of *R. pulmo*, with a 7.2 % representation rate. It was determined that jellyfish have a wide range of nutrition from phytoplankton to fish eggs. The sort of prey and amount of nutrition in stomach contents increased in parallel with the umbrella size. It is concluded that *R. pulmo* has important effects on the pelagic zone of the Black Sea ecosystem.

Keywords: *Rhizostoma pulmo, Black Sea, Samsun coasts, jellyfish, gastric content, umbrella*

Öz: Bu çalışmada Karadeniz'in Samsun kıyıları boyunca dağılan *Rhizostoma pulmo* medüzünün mide içeriği Ağustos 2008 ile Ocak 2010 arasında araştırılmıştır. Ayrıca şemsiye çapı ve av seçiciliği arasındaki ilişki belirlenmiştir. Örnekleme dönemi boyunca yakalanan *R. pulmo* bireylerinin şemsiye çapı 14,5 ila 42,5 cm arasında değişmiştir. En büyük şemsiye çapı, bu çalışmanın her iki döneminde de Ekim ayında gözlenmiştir. Örnekleme döneminde tüm istasyonlardan toplam 231 *R. pulmo* bireylerinin mide içerikleri toplanmıştır. *R. pulmo* bireylerin mide içeriğinde 31 takson, 10 larva, 2 adet nauplii ve 11 adet filumdan balık ve Copepod yumurtaları tespit edilmiştir. *R. pulmo* bireylerin beslenme tercihlerinin farklılaştığı ve artan şemsiye çapına göre besin sayısının arttığı tespit edilmiştir (Spearman rank korelasyonuna göre, r = 0,70; p <0,05). Mide içerik analizlerine göre, bu türün beslenme rejimleri ağırlıklı olarak Kopepod ve Dinoflagellatlardan oluşmaktadır. *R. pulmo* bireylerden alınan mide içeriğinde Kabuklulara (% 59; Kopepodların payı % 45,9) ve Dinoflagellatlara (% 15,4) ait taksonların yoğun olarak bulunduğu gözlenmiştir. Ciliophora filumu, *R. Pulmo* türünün mide muhtevasında,% 7,2›lik bir temsil oranı ile bol miktarda bulunan diğer bir grubu oluşturmuştur. Denizanasının, fitoplanktondan balık yumurtasına kadar geniş bir beslenme aralığına sahip olduğu belirlenmiştir. Mide içeriğindeki av türü ve besin miktarı, şemsiye büyüklüğüne paralel olarak artmıştır. *R. pulmo* türünün Karadeniz ekosisteminin pelajik bölgesi üzerinde önemli etkileri olduğu sonucuna varılmıştır.

Anahtar kelimeler: *Rhizostoma pulmo, Karadeniz, Samsun kıyıları, denizanası, mide içeriği, şemsiye*

INTRODUCTION

The Black Sea ecosystem is the youngest and dynamic ecosystem among the semi enclosed seas in the Atlantic basin (Tokarev and Shulman, 2007) and could be characterized with very low environmental capacity due to its very thin aerobic biotic layer (Proceedings of the 39th European Marine Biology Symposium, held in Genoa, Italy, 21-24 July 2004, 2007). The Black Sea, as being a semi-closed sea, gives the coast to six countries and has a popular status due to its commercial significance and economic potential. The main problems of the Black Sea such as anthropogenic pollution, eutrophication, overfishing and the presence of invasive species, and also climate change make this unique ecosystem unpredictable and unstable in the long term (Sezgin et al., 2010; Bat, 2014; Bat and Özkan, 2015; Bat, 2017).

While the Black Sea is characterized as a highly productive ecosystem at all trophic levels until the middle of 1970s, it was degraded to low diversity that was dominated by gelatinous species in 1990s (Shiganova, 1998; Bat et al., 2011). The number of gelatinous species in the Black Sea ecosystem was reported to be seven (Satılmış et al., 2006; Öztürk et al., 2011). However, recent studies indicate that this is eight (Isinibilir and Yılmaz, 2017; Isinibilir et al., 2017). *R. pulmo*, the biggest gelatinous species in the Black Sea (Golemansky, 2007), was observed at high numbers at the Northwestern Black Sea shores during late 1960s and early 1970s. Then, the population of *R. pulmo* decreased between 1973 and 1974 gradually. For the temporal and spatial records of *Rhizostoma* species, irregular distribution, gross aggregation or blooms have been observed (Lilley et al., 2009). It is widely distributed all over the world oceans, including the Northern and Southern Atlantic Ocean, the Mediterranean Sea, Aegean Sea, Sea of Marmara, the Black Sea, and the Red Sea ("Marine Species Identification Portal : *Rhizostoma pulmo*," 2011). *R. pulmo* is seen at all the coasts of the Mediterranean Sea and the Black Sea (Mariottini and Pane, 2010), whereas there are a few studies available on the distribution of *R. pulmo* at the Southern Black Sea. The deteriorating marine ecosystems, especially coastal waters, have favorable conditions for the excessive increase of jellyfish populations. Eutrophic processes depending on pollution, and rarity or absence of predator species feeding on jellyfishes make these species visible (Parsons and Lalli, 2002). Trophic process of jellyfishes is quite complex. Among pelagic consumer species, jellyfishes could change the food web completely when they reproduce excessively. The Black Sea is one of seas which exposed to the most dramatic changes in terms of jellyfish (Mutlu, 2001). The fall in the yield of anchovy in parallel with introducing of jellyfish to the ecosystem in 1980's, is one of the best examples of this problem. Thereafter, after introduction to the Black sea ecosystem of *Beroe ovata*, which is the other invasive species, this ctenophore has play an effective role in control of the *Mnemiopsis leidyi* populations (Svetlichny et al., 2004; Gordina et al., 2005; Anninsky et al., 2005; Finenko et al., 2006).

Determining of the status in food web comprehensively of *R. pulmo,* which is one of archaic and dominant species in the Black Sea, will contribute to understanding the presence state of the ecosystem as a whole, and to the efforts of future planning.

The main aim of the present study was to determine the possible effects of *R. pulmo* on pelagic community by identifying its stomach content.

In the present study nutrition regime of *R. pulmo* found at the Samsun coasts of the Black Sea was investigated.

MATERIAL AND METHODS

R. pulmo, commonly known as the barrel jellyfish, the dustbin-lid jellyfish or the frilly-mouthed jellyfish, is a scyphomedusae in the family Rhizostomatidae. The sampling of the jellyfish was carried out during cruises of a commercial vessel from August 2008 to January 2010 (excluding January, February, March, Aril, May and June 2009) from Samsun coasts of the Black Sea, Turkey (Figure 1). The samples were collected from 6 stations totally including Yeşilırmak and Kızılırmak catchments.

The samples were collected during daytime with 3 replicates of vertical and horizontal hauls by using plankton net (mesh size= 1 mm, mouth diameter =80 cm, length= 3 m). The samples were hauled from 1-25 m in depth by plankton net. After dissecting of mouth arm of collecting jellyfish by a blade, the umbrella was deposited on a flat lath and its diameter was measured. Samples were then preserved in borax-buffered formalin solution (final concentration 4%) until laboratory analysis. The temperature values of surface water at each station were measured by Sınar brand mercury thermometer.

Preparation of the Stomach Content: The stomach content was achieved by taking the fluid of stomach by an injector. For this aim, the oral arms were taken together with oral clubs around manubrium (oral cavity). Additionally, the fluid on gonads located around the stomach cavity and in oral arms was taken by the injector. Therefore it was implemented only on oral arms of individuals with a large umbrella in diameter (Hyslop, 1980). Collected gastric fluids of all medusa were transferred into 5% buffered formalin and then the remains in these fluids were examined under a NIKON model stereomicroscope and counted.

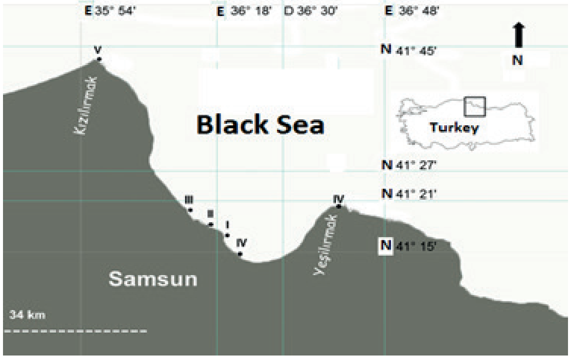

Figure 1. Location of monthly sampling stations along Samsun coasts between April 2008 and March 2010. The stations are represented with roman numbers

Statistical evaluation of morphological characters and digestive physiology data: SPSS v25 packet program was used to evaluation of morphological characters and digestive physiology data. Spearman's rank correlation and Pearson's correlation were used to compare data obtaining from *R. pulmo* samplings.

RESULTS

Hydrological results: Temperature values of all stations reached to maximum level in August. The highest sea-water temperature was determined during the sampling period was 27.1 ^{0}C in August 2009, while the lowest temperature was measured as 7.2 ^{0}C in January 2009. There was no significant differences in terms of temperature values between sampling stations with respect to months (P>0.05).

The Umbrella diameter of *Rhizostoma pulmo* by months: The umbrella diameter of 696 jellyfish trapped throughout the sampling period varied from 14.5 to 42.5 cm (Table 1 and Figure 2). The mean umbrella diameters of *R. pulmo* individuals who start appearing in the end of summer varied between months during sampling period. The mean umbrella diameters of *R. pulmo* individuals were 23 cm in August 2008, while it reached to 26 cm in October 2008. Similarly, the umbrella diameter, which averaged 21 cm in July 2009, increased to 27 cm in October 2009. The mean of umbrella diameter reached the peak level in October, and then decreased toward the winter season when they disappeared.

Table 1. The highest and lowest umbrella diameter and the weight of collected jellyfish by months

R. pulmo	The umbrella diameter (cm)			Weight (g)			The number of sampled stomach content	The number of empty stomach
	The lowest	The highest	Mean	The lowest	The highest	Mean		
Aug. ´08	14.5	29.2	22.93.1	350	2.000	1.100400	23	1
Sep. ´08	19.3	27.4	23.52.3	620	1.670	1.100300	10	0
Oct. ´08	19.7	38.6	26.14.7	710	4.370	1.600800	21	1
Nov. ´08	18.2	32.3	24.13.4	680	2.220	1.200400	15	1
Dec. ´08	18.0	29.0	23.22.9	670	2.060	1.000300	17	1
Jul. ´09	18.5	26.2	21.02.1	720	1.430	900200	21	0
Aug.´09	16.0	33.6	22.22.8	400	2.880	1.000300	23	2
Sep. ´09	19.0	37.6	25.64.5	760	3.870	1.500700	27	3
Oct. ´09	16.8	42.5	27.84.5	350	4.730	1.800800	24	0
Nov. ´09	14.9	34.6	23.93.3	380	3.010	1.200400	25	4
Dec. ´09	19.4	27.0	22.82.2	770	1.840	1.200500	17	3
Jan. ´10	21.3	31.4	25.33.4	750	2.530	1.400600	8	0

Gastric fluid results: During the study period, stomach contents of a total of 231 jellyfish were obtained. A total of 16 stomach contents couldn't be evaluated since they were empty. A total of 31 taxa belonging to 10 larvae, 2 Nauplii and fish and copepod eggs were identified in all the stomach contents of jellyfish (Table 2). The stomach content consisted of 31 taxa, larvae and eggs (Figure 3). The stomach contents were varied highly by seasons on spatial and temporal scales. Also, it was determined that the food preferences varied depending on the stomach diameter and, the number of food type increased. The total number of identified planktonic preys in the stomach of jellyfish was 30129 (Figure 4).

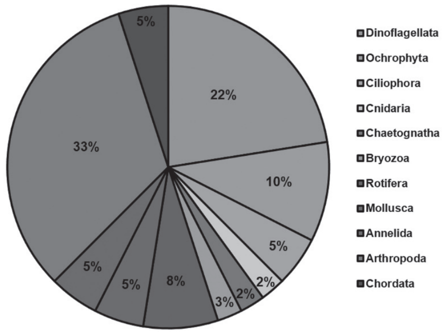

Figure 3. Percentages of Phyla identified in stomach contents of medusa

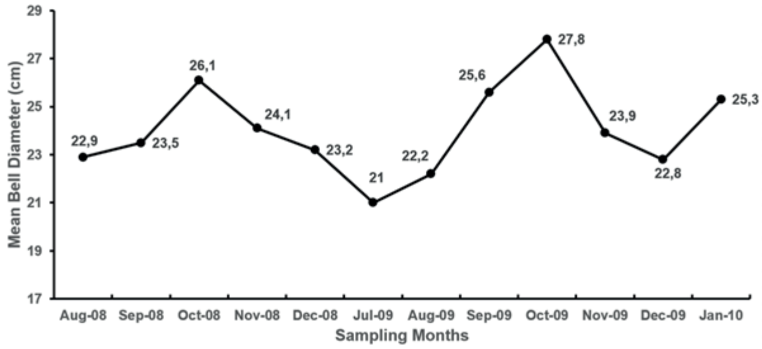

Figure 2. Mean Bell diameter frequency of captured jellyfish between August 2008 and January 2010 from Samsun coasts of the Black Sea, Turkey

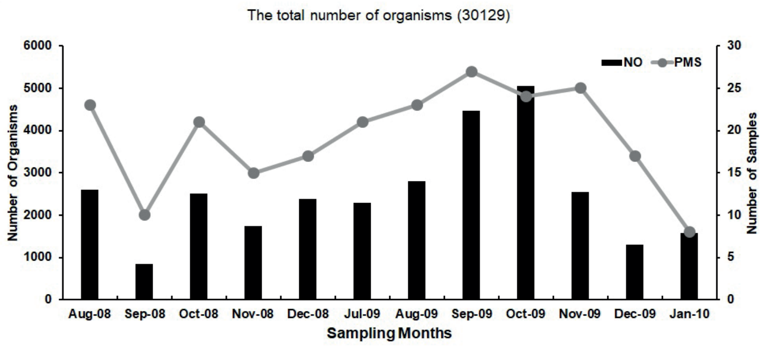

Figure 4. The total number of organisms detected in stomach contents. NO: Number of organisms, PMS: Number of medusa stomach samples

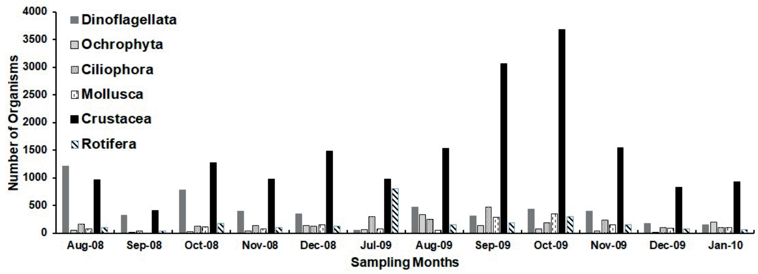

Figure 5. Monthly distribution of the most encountered food groups

Table 2. The groups determined in the stomach content of the jellyfish

Phylum: Dinoflagellata	**Phylum: Annelida**
Ceratium fusus	**Class: Polychaeta**
Ceratium tripos	Polychaete larvae
Gonyaulax sp.	Planktonic Polychaete
Neoceratium furca	**Phylum: Arthropoda**
Noctulica scintillans	**Sub phylum: Crustacea**
Prorocentrum micans	**Class: Maxillopoda**
Protoperidinium divergens	**Sub class: Copepoda**
Protoperidinium sp.	*Acartia tonsa*
Protoperidinium conicum	*Centropages ponticus*
Phylum: Ochrophyta	*Oithona brevicornis*
Achnantes sp.	Copepoda nauplii
Chaetoceros sp.	Copepodit
Conscinodiscus spp.	Copepods eggs
Pseudosolenia calcaravis	**Sub class: Thecostraca**
Phylum: Ciliophora	**Infra class: Cirripedia**
Favella spp.	Cirripedia nauplius
Tintinnopsis spp.	Cypris larvae
Phylum: Cnidaria	**Class: Malacostraca**
Actinula larvae	Shrimp larvae
Phylum: Chaetognatha	Crab zoea larvae
Sagitta sp.	**Class : Cladocera**
Phylum: Bryozoa	*Evadne spinifera*
Cyphonautes larvae	*Penilia avirostris*
Phylum: Rotifera	*Podon* sp.
Asplancha sp	**Phylum: Chordata**
Polyyartha sp.	Fish eggs
Trichocerca spp.	**Sub phylum: Tunicate**
Phylum: Mollusca	Tunicate larvae
Bivalves larvae	
Gastropod larvae	

In the analysis of stomach content, it was established that crustaceans was the most abundant group with 17.974 representative samples and 59.6% rate. The second group was dinoflagellates with a representation rate of 15.4%. *N. furca* was the most encountered species (Figure 5). *Acartia tonsa* and *Oithona brevicornis* were the most intensive species among the copepods. However, *Centropages ponticus* was the only species found in stomach of the jellyfish collected from Kızılırmak Delta (V. station).

Larvae of Bivalvia were another abundant group that was encountered throughout the study period. Shrimp larvae, tunicate and crab zoea larvae, *Oikopleura* sp., *Sagitta* sp., *Noctulica scintillans* and fish eggs were observed at a low rate. Copepod species and the individuals of *N. furca* were encountered frequently in the stomach content analysis. Copepods were mostly recorded in October, and the number of copepod individuals was 3.245 in stomach content of jellyfishes caught in October 2009.

The Relationships between the Stomach Content of *R. pulmo* and the Umbrella Diameter: The distribution of the stomach contents according to umbrella diameter was not homogenous. The total number of prey per gastric sac varied proportionally with umbrella diameter. The highest prey amount per gastric sac of jellyfish was recorded to be as 1.164 and this number was obtained from jellyfish with an umbrella diameter of 42.5 cm. This diameter was also the largest one that was observed among the sampling period. The smallest umbrella diameter found among the individuals was 16.5 cm and the total prey number in this sample was 61. Pearson Correlation showed that the relationship between the stomach content and umbrella diameter was r=0.68 and this relationship was significant statically at p<0.0001. According to this result of, there was a strong relation between umbrella diameter and the total number of the organisms found in the stomach content (Table 3 and Figure 6).

There was a strong correlation between umbrella diameter and species richness of the stomach content. Representing this relationship statistically, Spearman Rank Correlation was r=0.94, and it was significant at p<0.0001 (Table 4).

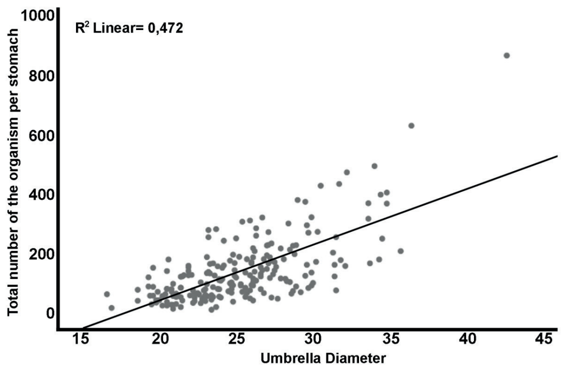

Figure 6. Relationship between umbrella diameter and total number the organisms in stomach. The regression line "fitted to" the scatterplot of values shown figure 4

Table 3. The statics relationship between umbrella diameter and the number of organisms detecting in stomach content

Correlations

		UD	TO
Umbrella Diameter	Pearson Correlation	1	.687**
	Sig. (2-tailed)		.000
	N	215	215
Total number of the organisms per stomach	Pearson Correlation	.687**	1
	Sig. (2-tailed)	.000	
	N	215	215

. Correlation is significant at the 0.01 level (2-tailed). **UD: Umbrella diameter (cm), **TO:** total number of organisms.

Table 4. The correlation between the types of groups identified in the stomach contents and the diameters of the umbrella

Correlations

			Umbrella Diameter	Species Richness
Spearman's rho	MUD	Correlation Coefficient	1.000	.946**
		Sig. (2-tailed)	.	.000
		N	19	19
	SP	Correlation Coefficient	.946**	1.000
		Sig. (2-tailed)	.000	.
		N	19	19

. Correlation is significant at the 0.01 level (2-tailed). **MUD: Mean Umbrella diameter (cm), **SP:** species richness

The species richness was 7.7 per individual having an umbrella diameter of 19 cm, while the individuals of *R. pulmo* with an umbrella diameter of 42.5 cm represented the richest group in terms of stomach content containing 28 different food groups . Although diatoms, dinoflagellates, copepods, cladocerans, rotifers and molluscs could be encountered in stomach content of the individuals with all umbrella diameters, *Oikopleura* sp. (Appendecularia) was encountered only in stomach of the specimens having a diameter ≥25 cm; *Acartia tonsa*, *Sagitta* sp. (Chaetognatha), *N. scintillans* (Dinoflagellata) and tunicate larvae were found only in stomach of the specimens having a diameter ≥26 cm; crabs and fish eggs (Chordata) were observed in diameter groups ≥27 cm whereas the shrimp larvae (Crustaceae) were found in stomach content of the jellyfish with a diameter ≥31-32 cm. *Oithona brevicornis* from Copepoda was observed in all umbrella diameters, and on the contrary *Centropages ponticus* was observed only in specimens with a diameter of 19 cm.

DISCUSSIONS AND CONCLUSIONS

The nutrition regime of *R. pulmo* is important for evaluating the effect of jellyfish on the ecosystem. Jellyfish may occupy an important trophic level in energy flow (Lilley et al., 2009). Increasing eutrophication and differentiation of nutrition levels cause increase in abundance and biomass of particularly jellyfish. A few data are available on the effect of nutrition regime of medusa on pelagic food web. The study carried out by Pérez-Ruzafa et al. (2002) on the distribution and the nutrition regime of medusa is one of the most important studies up to date. Öztürk and Topaloğlu (2011) found juvenile sardines and other fish in the stomach of medusa obtained from the Aegean Sea in 1973. According to that a total of 19 fish eggs were recorded in the stomach content of *R. pulmo* and no adult fish were found. Mayer (1910) stated that medusa cover the small animals with mucus between their oral arms and transfer the food to stomach cavity by channels of oral arms. It was observed that fish cubs with an approximate length of 4 cm were covered by mucus among the oral arms of two jellyfish at station

II in October 2008 and Station IV in December 2009, respectively and they were photographed.

Pérez-Ruzafa et al. (2002) reported in their stomach content analysis that the jellyfish fed dominantly on large diatoms (62.4%). Tintinnids were the second group in stomach contents. The other groups were veliger larvae and copepods with a representation rate of 6% and 3.8%, respectively (Pérez-Ruzafa et al., 2002). In stomach contents of jellyfish that were caught along Samsun coasts, crustaceans (59%), copepods (45.9%) and dinoflagellates (15.4%) were found to be abundant. Another frequently observed group was ciliophorans (7.2%).

Zooplankton have a vital role in network of sea (Chang et al., 2009). They are the basic consumer of primer production, and food source for organisms that are presented in higher trophic levels and having economical value (Kovalev et al., 1999). Among zooplankton, copepods are the most represented group both quantitatively and qualitatively and share an important part in holoplankton (Sever, 2009). In addition to *Acartia tonsa, Centropages ponticus* and *Oithona brevicornis,* nauplii and copepod eggs are the most abundant crustacean groups. *A. tonsa* is distributed around estuarine and coastal areas where the nutrient concentrations are high (Paffenhöfer and Stearns, 1988). Individuals of *A. tonsa* were found in stomach contents of samples obtained from station V and VI around Kızılırmak and Yeşilırmak. *Acartia* species could play a key role in the relationships of food web since they feed on ciliates and also serve as competitors to ciliates by consuming to phytoplankton (Marcus, 2004). They have a wide range of feeding regime and consume phytoplankton at first preference but in most of the studies it was reported that they also consume ciliates, dinoflagellates, rotifers, and Copepods (Gifford and Dagg, 1988; Marcus and Wilcox, 2007). *A. tonsa* which feed on organisms constituting the diet of *R. pulmo* both compete with jellyfish and serve as a nutrient for him. Another species encountered in stomach content of jellyfish was *O. brevicornis* which has been firstly recorded in Sevastopol harbor of the Northern Black Sea in 2001 (Gubanova and Altukhov, 2007). It has been estimated that this species might have come to the Sevastopol harbor by ballast water of ships (Gubanova and Altukhov, 2007; Selifonova, 2009; Zvyagintsev and Selifonova, 2010). *Oithona nana*, a settled copepod species, disappeared from the available community due to excessive grazing on plankton by *M. leidyi* which is an invasive jellyfish species and introduced to the Black Sea ecosystem after 1980's (Gubanova et al., 2014). Subsequent introduction of *B. ovata*, which is a predator of *M. leidyi* (Svetlichny et al., 2004; Anninsky et al., 2005) to the ecosystem and disappearance of *O. nana* from the community resulted in increase of *O. brevicornis*, a species which resemble *O. nana* in its ecological features (Gubanova and Altukhov, 2007). The highest abundance of *O. brevicornis* in Novorossisk harbor was observed in October 2006 (Gubanova and Altukhov, 2007; Selifonova, 2009). This result has been consistent with the data recorded in October during which the highest abundance and biomass values of jellyfish were observed. Similarly, the findings of Birinci Özdemir et al. (2018) support this. Also, the results obtained from zooplankton samplings supported this data (Üstün et al., 2018). Selifonova (2009) determined that 50% of the female individuals had egg sacs in samples of October 2006 when it was the most abundant. These findings provide opportunities to explain the causes of copepod eggs and Nauplius at the high representative level in the stomach content of jellyfish at October and November.

The eutrophication process has accelerated due to the decrease of silicon flow to the sea as a result of dams constructed on rivers which dumped into the Black Sea and the increase of nitrogen and phosphorus introduction due to anthropogenic activities (Zaitsev and Mamaev, 1995; Borysova et al., 2005; Baytut et al., 2010). Increased nitrogen (N) and decreased silicon (Si) (or both decreased) and decreased Si/N caused changes in the composition of phytoplankton species in the ecosystem. Therefore, diatoms were replaced by coccolithophores and dinoflagellates that were dominant in phytoplankton community (Humborg et al., 1997; Rabalais, 2009). The other factor which strengthened the competition success of the dinoflagellate species is that they have vertical migration ability to waters rich in nutrient values if the values decrease. Copepods prefer dinoflagellates as food rather than diatoms because they are nutritious, provide high egg production and support nest success (Kleppel et al., 1991; Vehmaa et al., 2011). During the study period, the stomach content of jellyfish was composed mostly of copepods and dinoflagellates. It was determined that dinoflagellates and zooplankton showed abundant distribution within the area where the jellyfish were recorded. The data on plankton could explain the cause of abundant presence of *N. furca* and *Ceratium* species in the stomach content of jellyfish.

Ceratium species (Dinoflagellates) could exist characteristically throughout the year. The water temperature effects the distribution and reproduction period of *Ceratium* species (Baek et al., 2008). *N. furca* was the most abundant species among Dinoflagellates. *Ceratium tripos* was the second most observed Dinoflagellate species. It was determined that the number of consumed dinoflagellate species per individuals of *R. pulmo* decreased in parallel to decreasing water temperature. The relationship between the number of dinoflagellates in the stomach content and the water temperature for the two study periods was r=0.90, p<0.05 and r=0.7, p<0.05 (Spearman Rank Correlation), respectively, and a strong positive relation was found between these two variables.

Pérez-Ruzafa et al. (2002) determined in their study that the jellyfish fed mainly on large diatoms such as *Asterionella* and *Coscinodiscus*. Diatom species determined in the present study have a widespread distribution in the world. On the contrary of the study carried out by Pérez-Ruzafa et al. (2002), which established the representation rate of diatoms as 62.4%, the percentage of diatoms in our study was as low as 3.8% along the research period. The third food group determined in the stomach content of jellyfish was composed of the members of the phylum Ciliophora (*Favella* spp. and *Tintinnopsis* spp.). In the study of Pérez-Ruzafa et al. (2002), Tintinnids were the second important food group for jellyfish.

Identifications of large diatoms and Tintinnids in the stomach content of jellyfish supported the idea that there was a moderately eutrophic food web based on large phytoplankton and an oligotrophic food web based on small particles in Mar Menor Lagoon. It was stated that the large jellyfish controlled the food web from top to bottom their feeding habits (large diatoms, Ciliates, Veliger larvae and Copepods) in Mar Menor Lagoon, and they had a direct effect on nutrient input of the lagoon by removing the large diatoms, and they could reduce the predation pressure on small phytoplankton by removing ciliates and copepods. Also, it was presumed that the jellyfish could be a control agent on the result of eutrophication process from top to bottom controlling the food web (Pérez-Ruzafa et al., 2002).

R. pulmo could digest any organism as small as enough to pass through its mouth opening (Russel, 1970). It was determined that the food groups increased proportionally with the diameter size of the umbrella. The stomach content of medusa having an umbrella diameter of ≥25 cm contained large crab larvae, tunicate larvae, fish egg, *Sagitta* sp., *N. scintillans* and *A. tonsa*, while shrimp larvae were found only in individuals with a ≥31 cm umbrella size. In the stomach content of the medusa with a 42.5 cm umbrella diameter, there were 28 different food groups, and the individual with an umbrella diameter of 30 cm had 24 food groups. The highest number of observed food groups in jellyfishes with an umbrella diameter ranging between 16 and 20 was 15. According to Spearman Rank Correlation analysis, the relation between the umbrella diameter and the number of food groups in stomach content was r=0.94. This result shows that the medusa may consume larger food by its increasing umbrella size.

Populations of jellyfishes are characterized by their abundances and high fluctuations, and constitute an important part of biomass. They are affected the equilibrium of carbon, nitrogen and phosphorus by their high biomass and the corrupted population dynamics (Pitt, Welsh, and Condon, 2009). Pérez-Ruzafa et al. (2002) reported that the species of *R. pulmo* and *Cotylorhiza tuberculata* that have wide distribution in shores of Mar Menor would provide a positive effect on improving the nutrient balance and resolving the effects of eutrophication (Kingsford et al., 2000; Perez-Ruzafa et al., 2002). *R. pulmo* and other jellyfishes distributing in the Black Sea could be contribute to resolve of high productivity depending on the excessive nutrient input and improve the marine ecosystem.

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