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Diet Composition of the Barn Owl *Tyto alba* (Scopoli, 1769) (Strigiformes: Tytonidae) in the Kızılırmak Delta, Turkey

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Abstract: The diet of the barn owl *Tyto alba* was studied at the Kızılırmak Delta (Northern Turkey) between May 2014 and May 2015. A total of 436 pellets were analysed and 1118 prey remains (mammals, birds, amphibians and insects) were encountered. Participation of animal species in the diet was assessed on the basis of their frequency (F%) and biomass (B%). Nine mammal taxa (3 of Eulipotyphla, 1 of Chiroptera and 5 of Rodentia) were found in the diet composition. Mammals (F=96.8%, B=95.65%) were more frequent in the diet content than other groups (F=<4%, B=<5%). White-toothed shrews *Crocidura* spp. were the most frequent prey (annual F=64%, B=34.9%). Voles *Microtus* spp. (F= 18.3%, B=28.76%) were more abundant in summer. Rats *Rattus* spp. were only found in autumn (F=0.5%, B=6.03%) and winter (F=0.5%, B=4.59%). The distribution of preys in the content of the barn owl diet did not vary seasonally ($p>0.05$). Both prey diversity and evenness were low.

Key words: Barn owl, dietary diversity, Northern Anatolia, pellets.

Introduction

Owls regurgitate the undigested parts of their preys such as fur, bones and feathers in the form of a compressed pellet (Taylor 1994). Since the skulls and mandibles, which can stay intact in the pellet, are used for identification of small mammals at the species level, they reveal significant information about the composition of small mammal within preying areas of owls and their diet preferences (Niethammer 1989, Bego 2003, Goutner & Alivizatos 2003, Yalden 2009). In addition, analysis of owl pellets has advantages since it reveals rare mammal species, which are difficult to be sampled with traditional capture methods, or species which cannot be identified by using small mammal traps (Teta et al. 2010).

The wide geographical distribution of barn owls and the fact that their pellets can easily be found are among the reasons why this species is frequently involved in pellet analysis (Contoli 1980). The barn owl is a native species, which is widely distributed and possible to be found locally almost at all low-altitude habitats in Turkey (Kirwan et al. 2008). There are no previous studies on the seasonal changes in the diet composition of the barn owl. The objective of this study is to reveal the diet composition of barn owls in the eastern part of the Kızılırmak Delta, to find out the rate of mammals in the composition of prey and to study the seasonal changes in diet.

Materials and Methods

Research Area

This study was carried out in the Kızılırmak Delta (41°38'N, 36°04'E) within the borders of the city of Samsun, Northern Turkey. Kızılırmak Delta is the largest wetland area at the Black Sea coast of Turkey, covering a territorry of 56,000 ha and is very well protected inside of its natural boundries (Barış et al. 2010). Its parts have different protection status, including natural site area, wildlife development area and has been designated as a Ramsar site (Yeniyurt & Hemmami 2011). The annual average temperature is 13.5°C. The coldest month is January, with av. 5.7°C, while the hottest month is August, with av. 22.7°C. Annual total rainfall is 793.4 mm; the highest month-

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ly rainfall is in November with 100.3 mm, while the lowest rainfall is in June with 28.5 mm (Bahadır & Özlü 2014). The area contains various types of habitats, such as freshwater lakes and lakes with low salinity, dry and floodplain meadows, reedbeds, mud flats, dunes, cultivated areas, forests and floodplain forests (Eken et al. 2006, Barış et al. 2010).

Research method and data analysis

Food remains (421 intact and 15 destroyed pellets) were collected from four localities in ten-day intervals between May 2014 and May 2015. One of the locations is a breeding site, others are roosting places. Small mammal identification was made according to Krystufek & Vohralik (2001, 2005, 2009). Bird identification followed Svensson (1992) and Brown et al. (2003). At the same time, the data from the Cernek Bird Ringing Station (Samsun, Turkey) was used to identify one of the bird remains which was ringed. Average weights of birds were taken from online-database (http://genomics.senescence.info/species/). Amphibian remains (parasphenoid bone) were determined according to Yalden (2009), while biomass (B) was determined following Gryz & Krauze–Gryz (2015). The identification of insect taxa was made according to Chinery (1993).

Minimum numbers of individuals (MNI) were estimated using skulls and mandible bones of tetrapodan preys. Average weights of mammals were found according to Krystufek & Vohralik (2001, 2005, 2009). For all pellets, seasonal biomass and frequency analysis of mammal, bird, amphibian and insect taxa was made and average annual and seasonal prey numbers were calculated per pellet. The seasonal frequency and biomass of Eulipotyphla/Rodentia (e / r) within the diet were determined. The following indices were calculated: Shannon – Wiener Index (H'=-$\sum$pi*ln*(pi), where pi was the proportion of species *i* in the entire sample; Krebs 1994), which showed the species richness in the diet and the individual numbers between taxa; Evenness Index (J' = H'/logS; S number of species in the pellets, J'= 0 – individuals not equally distributed, 1 – individuals equally distributed), which showed the distribution of individuals within the diet.

Results

Nine mammal species (three of Eulipotyphla, one of Chiroptera and five of Rodentia), eight bird species (Passeriformes), four insect families (two of the Coleoptera and two of the Orthoptera) and one amphibian (*Rana* spp.) taxa were found within the 436 pellets of the barn owl (Table 1). The proportion of mammals in the diet was quite high (F=96.8%). The rate of bird, insect and amphibian taxa were quite low (total F=3.2%). Reptiles were lacking completely. White-toothed shrews *Crocidura* spp. were the main prey of the barn owl in the research area (F=64%, B=34.9%) and they dominated in frequency and biomass in all seasons (Table 1). They were followed by mice *Mus* spp. (F=19.0%, B=18.25%) and voles *Microtus* spp. (F=9.9%, B=22.01%). Although the water vole *Arvicola amphibius* was in low rate (F=1.4–2.9%) within the diet composition for all season, its biomass proportion was high (B=11.67–19.94%). *Rattus* spp. were found in the diet composition in autumn (F=0.5%, B=6.03%) and winter (F=0.5%, B=4.59%). The Etruscan shrew *Suncus etruscus* and *Pipistrellus* sp. were rare in the diet (F=<1%) (Table 1).

While low-weight Eulipotyphla (weight between 1.9 and 12.8 g) formed a significant part of the diet of the barn owl (F=64.6%) and dominated in Eulipotyphla / Rodentia (e / r) proportion, the proportion of rodents was dominant in terms of biomass (Table 1, Fig. 1). The average prey frequency per pellet was lowest in winter (F=2.04%) and highest in autumn (F=2.93%).

Bird, amphibian and insect taxa were also found in the diet of the barn owl in all seasons except summer. While the bird amount in the diet composition differed across seasons, the annual frequency (F=2.1%) was consistently quite low (Table 1). Insect and amphibian taxa were rare found in the diet (F=<2%).

The highest Shannon–Wiener Index (H') was calculated in spring (H'=1.24) and its annual value was 1.07. Evenness Index (J') value was 0.32 annually and the highest seasonal value (0.58) was measured in winter (Table 1).

Discussion

The Kızılırmak Delta has high biodiversity due to its various habitat types and its geographical position (Barış et al. 2010). For this reasons, it is a suitable habitat for Eulipotyphla and Rodentia. Our results show that there are a large variety of taxa in the barn owl diet such as bats, eulipotyphlans, rodents, birds, amphibians and insects.

In many studies, the main prey of barn owls is reported as *Microtus* spp. (Taylor 1994). However, Bontzorlos et al. (2009) have found that the main nutritional source in Crete and the Mitrikou Lake, where there are no *Microtus* species, consisted of *Crocidura* spp., similarly to present results. Furthermore, the barn owl can be the main

Table 1. Seasonal and annual diet composition of barn owls in the Kızılırmak Delta, Number of prey (MNI), Frequency (F%), Biomass (B%), Shannon – Wiener Index (H'), Evenness Index (J') and statistical analyses.

Prey taxa	Mean body weight (g)	MNI	Spring		Summer		Autumn		Winter		Annual	
			F%	B%	F%	B%	F%	B%	F%	B%	F%	B%
Crocidura suaveolens	9.3	670	54.2	32.55	53.6	26.28	64.6	37.5	55.7	26.52	59.9	32.47
Crocidura leucodon	12.8	11	-	-	-	-	1.5	1.23	1.0	0.62	1.0	0.73
Crocidura sp.	9.3	35	6.3	3.76	5.5	0.4	1.9	1.09	2.4	1.13	3.1	1.70
Suncus etruscus	1.9	7	-	-	0.6	0.35	0.9	0.10	0.5	0.05	0.6	0.07
Mus macedonicus	16.4	82	9.0	9.57	5.0	4.32	6.9	7.0	9.5	7.99	7.3	7.01
Mus domesticus	22.7	4	2.1	3.06	0.6	0.35	-	-	-	-	0.4	0.47
Mus sp.	16.4	126	8.3	8.83	13.3	19.5	11.3	11.55	11.4	9.59	11.3	10.77
Microtus levis	38.4	97	6.3	15.51	17.7	26.01	6.5	15.57	8.6	16.85	8.7	19.41
Microtus sp.	38.4	13	2.1	5.17	0.6	2.75	0.5	1.23	2.9	5.62	1.2	2.6
Arvicola amphibius	130	24	1.4	11.67	2.8	19.94	1.9	15.25	2.9	19.01	2.1	16.26
Rattus sp.	188.4	4	-	-	-	-	0.5	6.03	0.5	4.59	0.4	3.93
Pipistrellus sp.	5	9	0.7	0.22	0.6	0.11	1.2	0.37	-	-	0.8	0.23
Mammals - total		1082	90.3	90.34	100	100	97.7	96.91	95.2	91.97	96.8	**95.65**
Motacilla sp.	16.63	2	0.7	0.75	-	-	0.2	0.18	-	-	0.2	0.17
Motacillidae	18.23	1	0.7	0.82	-	-	-	-	-	-	0.1	0.1
Erithacus rubecula	17.60	1	-	-	-	-	0.2	0.19	-	-	0.1	0.09
Turdus iliacus/philomelos	60.40	1	-	-	-	-	0.2	0.64	-	-	0.1	0.31
Sylvia sp.	16.30	1	0.7	0.73	-	-	-	-	-	-	0.1	0.08
Sylvia communis	17.70	1	-	-	-	-	0.2	0.19	-	-	0.1	0.09
Sturnus vulgaris	75.0	4	0.7	3.37	-	-	0.2	0.80	1.0	3.66	0.4	1.56
Emberiza sp.	31.07	2	0.7	1.39	-	-	-	-	0.5	0.76	0.2	0.32
Fringillia coelebs	21.0	2	-	-	-	-	-	-	1.0	1.02	0.2	0.22
Passer sp.	24.75	6	-	-	-	-	0.5	0.79	1.4	1.81	0.5	0.77
Passer hispaniolensis	24.75	1	-	-	-	-	0.2	0.26	-	-	0.1	0.13
Fringillidae	21.0	2	0.7	1.39	-	-	-	-	0.5	0.76	0.2	0.32
Birds - total		24	**4.2**	**8.45**	**-**	**-**	**1.7**	**3.05**	**4.3**	**8.0**	**2.1**	**4.18**
Amphibia - total	20	**1**	**0.7**	**0.9**	**-**	**-**	**-**	**-**	**-**	-	**0.1**	**0.10**
Acrididae	1	1	-	-	-	-	0.2	0.01	-	-	0.1	0.01
Gryllotalpidae	1	6	2.8	0.18	-	-	0.2	0.01	0.5	0.02	0.5	0.03
Scarabaeidae	1	2	1.4	0.09	-	-	-	-	-	-	0.2	0.01
Hydrophilidae	1	2	0.7	0.04	-	-	0.2	0.01	-	-	0.2	0.01
INSECTA total		11	4.9	0.31	-	-	0.6	0.03	0.5	0.02	1.0	0.06
Total		1118										
Total pellet number			68	-	66	-	199	-	103	-	436	-
Prey number and biomass per pellet			2.12	37.6	2.74	71.59	2.93	47.11	2.04	39.84	2.56	44.0
Index e / r			2.07	0.67	1.5	0.37	2.5	0.71	1.67	0.44	2.07	0.58
H'			1.24	-	0.99	-	0.95	-	1.12	-	1.07	-
J'			0.42	-	0.43	-	0.45	-	0.58	-	0.32	-

Kruskall-Wallis: $p>0.05$, for frequency and biomass in seasonal samples

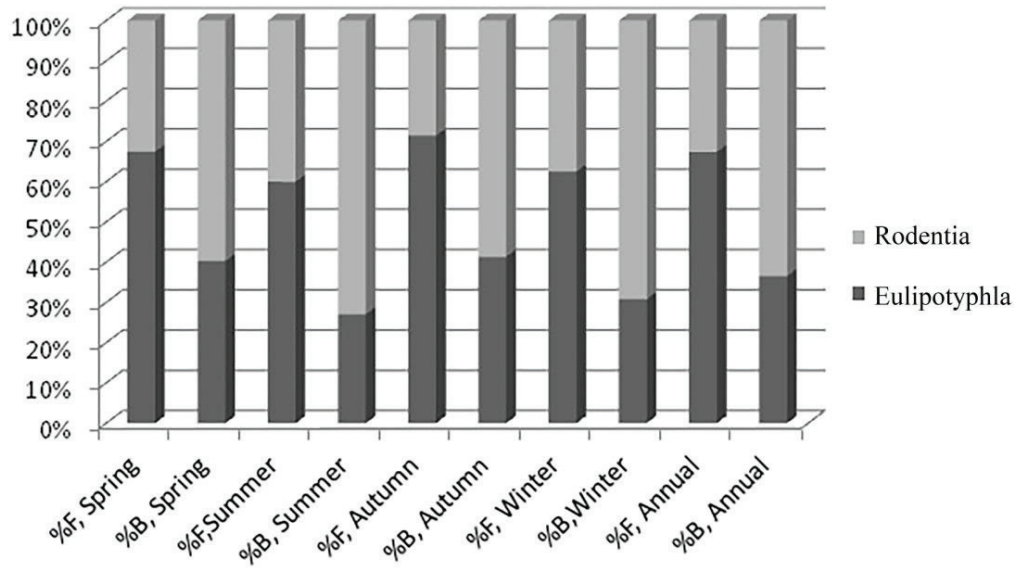

Fig. 1. Seasonal Eulipotyphla / Rodentia (e / r) frequency (F%) and biomass (B%) changes

predator of shrews (Korpimaki & Norrdahl 1989). Especially in southern Europe, small-sized species such as *Suncus etruscus* or *Crocidura suaveolens* are common in the diet of the barn owl (Roulin 2004, Popov et al. 2004).

Barn owl can change the main prey in habitats where *Microtus* spp. population is low (Bontzorlos et al. 2009). *Microtus* spp. and *Crocidura* spp. often dominate the diet of barn owl (Milchev et al. 2006), while *Mus* spp. can replace *Microtus* spp. and *Crocidura* spp. in inland places with dry and hot Mediterranean climate (Miltschev et al. 2004, Milchev et al. 2006). In previous studies conducted on southern and eastern coast of Turkey, where Mediterranean climate dominates, *Mus* spp. was the main nutritional source of barn owl (Table 2). In this study, the proportion of *Mus* spp. (F = 19%) was the second highest in the diet composition, following *Crocidura* spp.

Microtus levis is generally spread in swamps and wet areas with dense vegetation (Krystufek & Vohralik 2005). Since the breeding activity of *M. levis* is between April and May (Steiner & Vauk 1966), *M. levis* intensity in the research area may have increased in the summer. As a result of the increase in *M. levis* proportion within the diet, e / r proportion was the lowest (F%=1.5, B%=0.37) in summer.

Rattus sp. samples were found in autumn and winter. Owing to the lack of urban areas, the amount of *Rattus* sp. (F=0.4%, B=3.93%) might be low in the diet composition (Becker 1978). If urban territories are included in the research area, *Rattus* spp. proportion can be higher, e.g. F=11% and B=55.5% (Bontzorlos et al. 2005) or F=11.32% (Maurizio 1999). Adverse weather conditions during autmn and winter can result in unfavorable hunting conditions for the barn owl (Roulin 1996, Bontzorlos et al. 2009). Therefore, the preference of large prey items, such as rats (weight ranging 100-498 g, see Krystufek & Vohralik 2009) to increase the preying success of the barn owl has advantages in terms of energy input – output (Bontzorlos et al. 2009, Paspali et al. 2013). Barn owls can prey on bats from perching places in summer or during hibernation (Sommer et al. 2009). In this study, bats were not seen in pellets collected in winter whereas they were found in the samples collected in other seasons, thogh with low rates (F=<2%). In general, the rate of bats is quite low in barn owl diet composition (Nowsad & Salata-Pilacinska 1987, Kasprzyk et al. 2004, Roulin & Christe 2013, present study), while it is rarely in high levels, e.g. F=54.2% (Bauer 1956) or F=26.6% (Sommer et al. 2009). In addition, according to Alcover et al. (1998), the density of small mammals on islands is lower and, therefore, the rate of bats in diet of barn owls is higher there (Roolin & Christe 2013).

The rate of *Suncus etruscus* in the diet of the barn owl is lower in our results than in studies performed in the Western and Southern Anatolia regions where the climate is drier than in the Kızılırmak Delta (Table 2). In various studies conducted in the Mediterranean region, the rate of *Suncus etruscus* in the diet is usually higher (Niethammer 1989, Temme 2000, Popov et al. 2004, Obuch & Benda 2009). However, in this study, *S. etruscus* was found with low frequency (F=0.5-0.9%, B=0.05-0.35%). These results confirm earlier findings that the rate of

Table 2. Mammals (%) in the diet of the barn owl (*Tyto alba*) in Turkey

Prey	Southern Anatolia		Western Anatolia		Central Anatolia	Northern Anatolia
	Samandağ, Hatay (Hoppe 1986)	Deveciuşağı, Adana (Obuch & Benda 2009)	Bafasee (Kasparek 1988)	İzmir and Aydın (Niethammer 1989)	Kilbasan, Karaman (Nedyalkov & Boev 2016)	Kızılırmak Delta, Samsun (Present study)
Mammals	F%	F%	F%	F%	F%	F%
Crocidura suaveolens	23.6	10.45	28.0	21.03	15.6	59.9
Crocidura leucodon	-	0.5	0.7	-	-	1.0
Crocidura sp.	-	-	-	-	-	3.1
Suncus etruscus	-	6.47	4.0	4.8	3.1	0.6
Microtus levis	-	-	-	-	18.8	8.7
Microtus arvalis	-	-	-	2.2	-	-
Microtus guentheri	-	27.36	-	-	3.1	-
Mictorus sp.	-	-	-	-	-	1.2
Cricetulus migratorius	2.8	-	0.2	0.08	12.5	-
Mesocricetus brandti	-	-	-	-	3.1	-
Myomimus roachi	-	-	0.2	-	-	-
Arvicola amphibius	-	-	-	-	-	2.1
Meriones tristrami	-	5.97	-	-	3.1	-
Mus domesticus	42.2	-	58.6	-	-	0.4
Mus macedonicus	-	-	-	-	37.5	7.3
Mus sp.	-	46.77	-	67.4	-	11.3
Apodemus mystacinus	-	-	0.2	4.48	-	-
Apodemus sp.	-	-	4.1	-	-	-
Rattus rattus	0.9	-	-	-	-	-
Rattus sp.	-	-	-	-	-	0.4
Pipistrellus sp.	-	-	-	-	-	0.8

S. etruscus in the diet of the barn owl is positively correlated with temperature (Popov et al. 2004).

In our study, e / r value changes seasonally between F=1.5 and 2.5. This ratio in the diet of barn owls could be lower in areas where agricultural lands are dense (Bego 2003, Paspali et al. 2013). On the other had, the low H' index could be explained with higher rate of *Crocidura* in the diet composition.

While birds were not recorded in the diet composition in summer, they were found in low rate in other seasons (Table 1). Bird frequency was higher in winter and spring. Since some bird species perch in groups in winter (Sage 1962), they can be an easy prey for barn owls (Bontzorlos et al. 2005). The rate of insect taxa (F=1%) was the lowest in winter and highest in spring.

As conclusion, a significant part of the diet of barn owls consisted of small mammals. Other preys (Aves, Amphibia, Insecta) were recorded in very low numbers. A great number of studies on the diet composition of barn owls (Castaneda-Alvarez et al. 2004, Bontzorlos et al. 2005, Tores et al. 2005, Milchev et al. 2006, Leonardi & Dell'Arte 2006, Sommer et al. 2009, Bernard et al. 2010, Paspali et al. 2013, Rolin & Christe 2013, Milchev 2015, present study) show that the diet can vary depending on the research area, season, breeding - non-breeding status, hunting intensity in the area and the variety of habitats.

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