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QUANTITATIVE AND QUALITATIVE COMPOSITION OF DIET OF THE URAL OWL, *STRIX URALENSI* (STRIGIDAE, STRIGIFORMES), IN THE CENTRAL PART OF EUROPEAN RUSSIA (THE EXAMPLE OF THE REPUBLIC OF MORDOVIA)

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Quantitative and Qualitative Composition of Diet of the Ural Owl, *Strix uralensi* (Strigidae, Strigiformes), in the Central Part of European Russia (the Example of the Republic of Mordovia). Andreychev, A., Lapshin, A. — The results of the study of the Ural Owl feeding spectrum are presented. In Russia the Ural owl eats over twenty species of mammals, thirty bird species and a number of animals of other classes. The research tasks included the identification of the species of the victims of a large owl in Mordovia, their quantitative data and the characteristics of osteological material from pellets. It was found out that mammals, in particular rodents, are the basis for the Ural owl food. The Ural *Owl's diet consists mainly of* gray voles (47.7 %). On the second place there is a red vole (31.4 %). The share of mice is only 7.3 %. The predator hunts for the forest mouse most often. In pellets the mass fraction of bone remains varies in the range from 3.4 to 44.8 %. The average proportion of bone remains is, as a rule, up to 25 %, with the content of only one or two small rodents in pellets; the remains of three to six individuals — up to 45 % of the weight of dry pellet. Among all the bones of mammals, the lower jaws, femoral and tibia bones give the greatest information about the number and composition of victims of the Ural owl. In pellets the brachial and nameless bones of the victims are presented in smaller numbers.
Key words: the Ural Owls, *Strix uralensis*, diet composition, small mammals, European Russia, Mordovia.

Introduction

The long-tailed or Ural owl (*Strix uralensis* Pallas, 1771), originally a taiga species, spread widely throughout the forest zone of Northern, Central, Eastern Europe, Siberia, China, Korea and Japan (Cramp, 1985; Marcot, 1995; Kontorshikov et al., 1999). In addition, in many regions activities on attraction of the Ural owls are being carried out (Lahti, 1972; Pietiainen, 1989; Kivela, 2011). In the European part of Russia the number of publications devoted to the study of the food spectrum is small. They were held in Moscow

Region (Sharikov et al., 2009), the Urals (Karyakin, 1998) and the Altai Territory (Shcherbakov, 2012). In one of the regions of the European part of Russia, namely in Mordovia, the analysis of the food spectrum of the Ural Owl was not previously conducted. However, it was known that reports on the registration of the Ural Owl as a rare species and its absence in some areas north of the Alatyr River came from the third quarter of the 19th century in the region. In the late twentieth and early twenty-first centuries the Ural Owl becomes an ordinary sedentary species (Lapshin, Lysenkov, 1998).

The aim of our study was to identify qualitative and quantitative composition of the skeleton of different victims in the food of the Ural Owl in the Republic of Mordovia. The results of the qualitative analysis of the collected material provide new information characterizing the composition of a bird of prey diet. Quantitative representation of different skeletal elements in pellets is very important for paleozoology, as they allow counting the minimum number of victims on the osteological material. In the works of Andrews (1990), the ratio of the various elements of the skeleton of the victims is species-specific for predators, and this indicator can serve as a key factor in determining the predator species, which is extremely important for the faunistic interpretation of the results of osteological analysis (Mourer-Chauvire, 1975).

Material and methods

The materials for this article were disassembled and defined pellets, as well as bone remains from the destroyed pellets and of the Ural Owl gathered in the snowless period 2012–2015 at the nesting sites in Atyashevsky (54°39 N, 46°19 E), Ardatov (54°47 N, 46°08 E), Bolshebereznikovsky (54°04 S., 46°42 E), Oktyabrsky (54°08 N, 45°05 E) Regions in the Republic of Mordovia. The material on nutrition was collected both purposefully and during field work on the study of the Eurasian Eagle-owl food spectrum. It appeared that nesting areas of the two large owls of Mordovia largely overlap.

Field collected pellets were measured (length, width) with a caliper to within 0.1 mm. Then the pellets were dried at 60 °C for at least three days and weighed on an electronic scale laboratory OHAUS-200 up to 0.01 g for each of the areas defined by the study of variation indicators castings limits (length, width, weight) with average calculation value. Then the bone remains were separated from the fur and feathers by soaking the pelletes. The next step was drying of bone fragments. Special attention was given to skulls weighing, because the given data suggested the level of these elements damage. For calculations the following formula D = Wpel / Wbn • 100 % was used; where D — the weight fraction of bone remains in each regurgitates, Wpel — the weight of all the bones in the pellets, Wbn — the total weight of the pellets. All objects (hair, bones, feathers, skins, half-eaten carcass parts) found in the food spectrum of the Ural Owl were identified. In mammals identification classical and generally accepted manuals were used (Gromov, Erbaeva, 1995; Majakov, Shepel, 1987). Bird remains were identified to species with the aid of the scientific ornithological collection of the Museum of biology of Mordovian State University. In pellets the composition and the number of victims were carefully analyzed.

Identification of the victims species was carried out by the best preserved mostly bone remains. As models the standard skeletons of the victims were used for the determination. In the absence of a skull or its significant degree of damage, as additional elements the pelvic bone, shin, hip, etc. can be used to determine the species of a prey (Mayakov, Shepel, 1987). The number of specimens of a particular species of victim was determined by the largest number of skeleton elements of one side of bilateral symmetry (lower jaws, fragments of the skull, nameless (pelvis), femoral, tibia, humerus, ulna and radius bones, scapula). Counting only easily identifiable lower jaws or large fragments of the skull with the preserved teeth sometimes gives incorrect results in determining the number of specimens of the victims for a number of animal species.

Special attention was paid to determining the dependence of the number of food items in each pellet on the size of mammals. In total 146 pellets and a significant number of food fragments (bone remains from disintegrated pellets, fur, feathers, half-eaten parts of carcasses) from nesting sites of the Ural Owl were analyzed; over 4000 bones of vertebrates were studied. The paper puts more emphasis on the comparison and evaluation of the power spectrum of the Ural Owl in different areas. To calculate the representation of dominants in the samples the Simpson Index (D, dominance) was applied (Megarran, 1992).

Results

The results of the analysis of pellets parameters (length, width, weight) *showed no significant difference* ($p > 0.05$) between the different collection points. However, it is advisable to specify the limits of variation of pellets indicators in different regions (table 1) for future comparative work. According to the average weight index, the largest pellets are from the vicinities of vil. Nikolaevka, Oktyabrsky district of city Saransk, and the smallest — from the vicinities of vil. Nerley of Bolshebereznikovsky district. According to the results of work mammals (86.4 %) prevailed over birds (13.6 %) in pellets of the Ural owl. Among birds the size of victims ranges from the sparrow to the crow. The given

Table 1. The main parameters of pellets Ural Owl from the regions of Mordovia

Parameters	Districts												The average value for the region (146)		
	Atyashevsky (39)*			Ardatovsky (30)			Bolsheberezni-kovsky (24)			Octobersky (53)					
	Min	Max	M ± m	Min	Max	M ± m	Min	Max	M ± m	Min	Max	M ± m	Min	Max	M ±m
Length, mm	25.6	47.5	33.5 ± 1.12	32.4	52.5	38.1 ± 0.81	29.7	50.1	34.2 ± 1.26	27.1	55.3	38.5 ± 1.23	25.6	55.3	37.6 ± 1.14
Width, mm	20.2	23.8	20.5 ± 0.17	19.6	26.8	21.3 ± 0.32	19.8	25.6	20.4 ± 0.28	19.8	28.3	22.1 ± 0.34	19.6	28.3	20.7 ± 0 21
Weight, g	1.15	2.98	2.31 ± 0.18	1.02	4.37	2.54 ± 0.15	1.81	3.55	2.38 ± 0.19	1.32	4.83	2.88 ± 0.21	1.02	4.83	2.63 ± 0.19

* Sampling (number of castings).

species *Passer* sp. (Passeridae), *Fringilla coelebs* (Fringillidae), *Parus major* (Paridae), *Emberiza citronella* (Emberizidae), *Turdus philomelos* (Turdidae), *Dendrocopos major* (Picidae), *Corvus flugilegus*, *C. cornix*, *Garrulus glandarius* (Corvidae) are recorded in the diet. *Strix aluco* (Strigidae), *Accipiter gentilis* (Accipitridae) are recorded among representatives of a larger size.

As can be seen from the results of the studies (table 2), mammals form the basis for Ural owl feeding. Mammals in the spectrum of the Ural Owl diet in Mordovia are presented exclusively by representatives of rodent (Rodentia). We identified the following species of rodents: bank vole (*Clethrionomys glareolus*), common field vole (*Microtus arvalis*), root vole (*M. oeconomus*), Ural mouse (*Sylvaemus uralensis*), yellow-necked mouse (*S. flavicollis*) and striped field mouse (*Apodemus agrarius*).

The main constituents of owl's diet account for voles (47.7 %), namely, the common vole (41.8 %) and the root vole (5.9 %). Here there is similarity with the Eagle Owl (*Bubo bubo*) and Imperial Eagle (*Aquila heliaca*) (Andreychev et al., 2014, 2016 a). The second highest incidence in the food is Owl forest voles (31.4 %). The share of mice accounted for only 7.3 %. The Ural field mouse is most often hunted by a predator. Among the victims, the species of open spaces slightly prevail over forest representatives. This is due to the fact that the Ural owl for hunting prefers, first of all, glades, forest edges and edges of cuttings or burnt areas adjoining the forest (Pukinsky, 1977). The largest share of *M. arvalis* in the Ural Owl nutrition was recorded in 2014 year, when the peak of the victim population was observed. The smallest its share (25.3 %) in the diet was registered in 2012 year, when

Table 2. The range of food of the Ural Owl in central part of European Russia for the period 2012–2015

Food composition	Number of copies									
	2012		2013		2014		2015		Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Mammalia	68	74.7	92	82.9	132	95.7	76	88.4	368	86.4
Microtus arvalis s. l.	23	25.3	40	36.1	74	53.6	41	47.7	178	41.8
Microtus oeconomus	3	3.3	6	5.4	12	8.8	4	4.7	25	5.9
Clethrionomys glareolus	39	42.8	36	32.4	32	23.2	27	31.4	134	31.4
Sylvaemus uralensis	2	2.2	4	3.6	5	3.6	2	2.3	13	3.1
Sylvaemus flavicollis	–	–	3	2.7	5	3.6	–	–	8	1.9
Apodemus agrarius	1	1.1	3	2.7	4	2.9	2	2.3	10	2.3
Aves	23	25.3	19	17.1	6	4.3	10	11.6	58	13.6

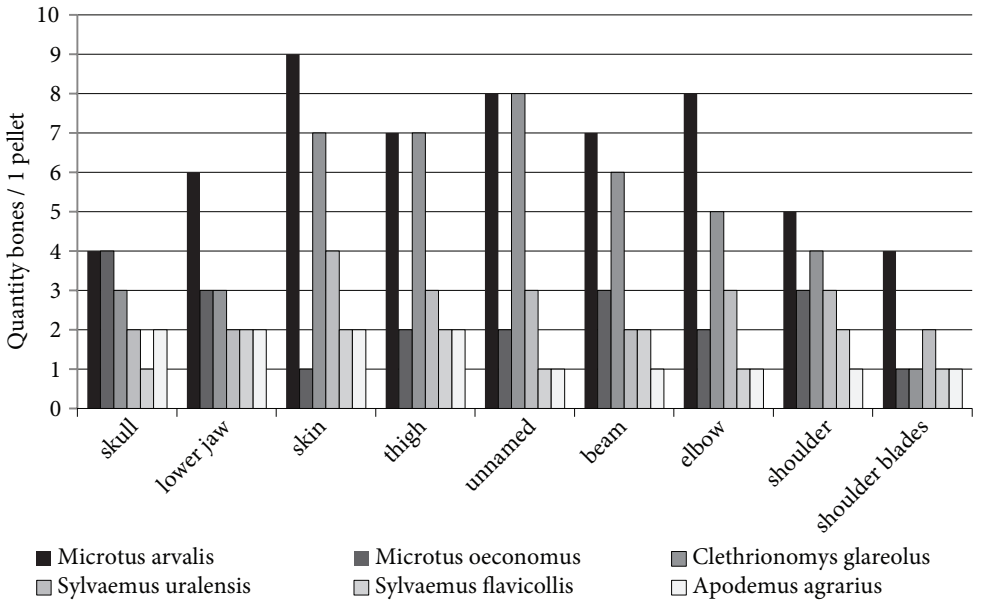

Fig. 1. The maximum number of different elements of the skeleton of rodents in pellets Ural Owl in Mordovia (n = 146 pellets)

there was compensated by eating more Owl bank vole (42.8 %). Thus, it can be stated that the range of food Ural Owl data may vary depending on the number of types of gray and red voles. However, we can accurately be called an ordinary and a red voles main prey *St. uralensis* in Mordovia. Our data are consistent with the findings of other researchers (Lundberg; 1979, Korpimaki, Sulkava 1987; Obuch et al., 2013).

The largest number of mammalian representatives of various taxa is recorded in Ardatovsky district in Mordova; the smallest one — in Octyabrsk district. Simpson's dominance index for Octyabrsky district was the highest (0.513), indicating a smaller variety of food objects. In descending order of Simpson index the remaining areas are located as follows: Atyashevsky (0.357), Bolshebereznikovsky (0.339) and Ardatovsky (0.238). The least Simpson index value for the last region confirms a significant diversity of victims of the Ural Owl.

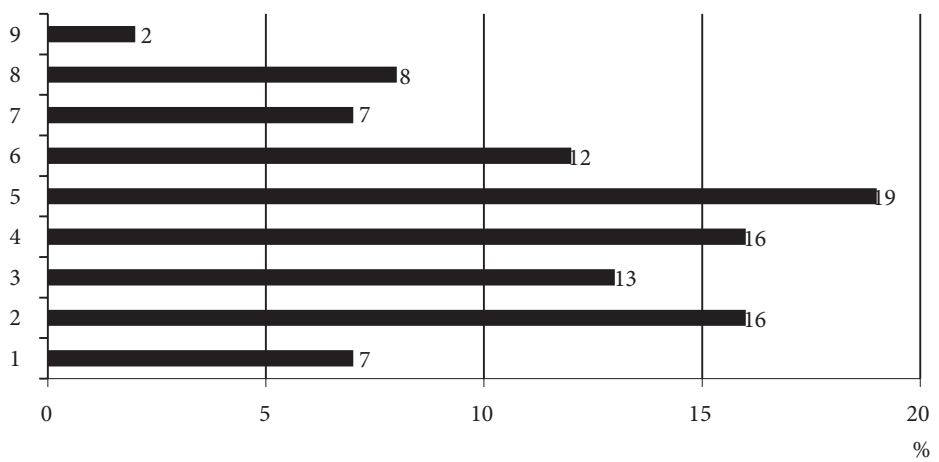

Fig. 2. The relative amount of common mammal bones in pellets Ural Owl (1— skull, 2 — lower jaw, 3— unnamed, 4 — thigh, 5 — shin, 6 — shoulder, 7 — elbow, 8 — beam, 9 — blades).

The content of bone remains in pellets is in the range of 3.4 to 44.8 % (by weight dry regurgitates) with an average share of 25.3 %. The dependence of the proportion of bone residues on the number of small victims (common and red voles) in pellets was revealed. So, if the content of only one or two individuals of small rodents in the gadget remains, the average proportion of bone residues is, as a rule, up to 25 %. Thus if pellets contain the remains of only one or two individuals of small rodents average fraction of bone residues, usually up to 25 %; the remains of three to six individuals — up to 45 % of the dry weight of the pellets. The weight proportions of bone remains increase with the content of fragments of larger victims (mice, vole-housekeeper) in the pellets. For example the proportion of root vole bones from one pellet is comparable with the share of bone remains of two individuals from another bank vole pellets; or the share of bones of four common vole in the pellets may be equal to the same index of two yellow-mice from another pellets. On average, one Ural Owl pellet contains the remains of 2.6 victims (max-6) (fig. 1). The number of different skeleton elements of the average size prays in one pellet depends on the size of the prey.

The lower jaws, femur and tibia bones (fig. 2) give the greatest information about the number and composition of owl victims among all bones of mammals. In pellets the shoulder and nameless bones of the victims are presented in a smaller amount as well as fragments of the skull, radial and ulnar bones and shoulder blades.

Discussion

The range of Ural Owl food includes more than twenty species of mammals, thirty species of birds and a number of animals of other classes (Mysterud, Hagen, 1969; Jaderholm, 1987; Brommer et al., 2003; Sidorovich et. al., 2003 a, b; Kloubec et al., 2005; Dravecky, Obuch, 2009). She, like the owl, the range of food in different regions can vary quite significantly. The basis of the food (20.0–85.8 %) are different mammals (Sharikov et al., 2009). The owl's diet, like in the eagle-owl's one, can vary quite significantly in different regions. The basis of its diet (20.0–85.8 %) is made up of various mammals (Sharikov et al., 2009). Among the owls of the *Strix* genus the Ural Owl is able to hunt the largest animals (capercaillie, black grouse, white partridge, hazel grouse, squirrel). But its main food is the muroid rodents (Pukinsky, 1977; Shokhrin, 2008; Mikkola, 1983). At one pellet, we sometimes record 4 voles at once (Pukinsky, 1977). Beetles, locusts, sparrows, frogs, lizards (Karyakin, 1998) are registered in the food spectrum among small animals. However, the proportion of insects, amphibians and reptiles is small, and apparently they are hunted only by chance.

Analysis of dietary data of the Ural Owl in Mordovia allows you to reach a consensus with respect to variation of the number of victims of predator range. The range of food owls in the region gets about 30% of the prey species selected for the predator as a whole. The received results on domination of mammals in the diet of Ural Owl will be coordinated with results of researches of other authors (Shokhrin, 2008; Lundberg, 1979; Mikkola, 1983). However, taking into account the fact that the majority of victims are on small voles and mice, include a large owl in the forest-steppe zone of Russia to the owls feed mainly on rodents. Now there are two points of view regarding the diet of owl. Some ornithologists believe that there are no food preferences in the predator's diet, and they eat the most accessible and mass food. Other researchers argue that the predator, even if it is a polyphage, still prefers prey species. The work of T. N. Dunaeva and V. V. Kucheruk are particularly indicative in this regard. They found that the brown-haired owl (*Athene noctua*) in Western Kazakhstan and the southeast of Turkmenistan neglected the numerous green toad (*Bufo viridis*), but caught the piebald shrew (*Diplomesodon pulchellum*) — a rare species for this area (Dunaeva, Kucheruk, 1938). Returning to our results on the Ural Owl, the above two postulates are natural, since under the conditions

of the forest-steppe zone, gray and forest voles preferred by predator are simultaneously mass species of the region's rodent fauna.

Diet plasticity allows *St. uralensis* to switch from Microtus species to Myodes species, and vice versa as in the case of the eagle-owl (Andreychev et al., 2014). These results are consistent with the date of other authors (Lundberg, 1979; Korpimaki, Sulkava, 1987; Obuch et al., 2013). Fluctuations the number of certain species by the year are the determining factor. It should be taken into account that the structure of open spaces populations are more stable than the forest species (Andreychev, 2016 b). In addition, we can not exclude the factor of vulnerability and visible parts of the common vole, vole and field mouse in front of the watchful eyes of the owl. In addition, in the absence of the most preferred type of prey (voles) in habitats the Ural Owl can increase the share of the birds in the diet that we recorded in 2012 year.

In contrast to the Eagle Owl, the analysis of the pellets for identification of mammals species composition of is not suitable for the Ural Owl, since it specializes only in abundant species of rodents. And the Eagle Owl by its euryphages able to eat more than half of all available types of rodents and insectivores mammals recorded in the area (Andreychev et al., 2014, 2016 b). However, it should emphasize the differences in food priorities of two big owls in the region. If the Eagle Owl prefers an ordinary vole in the diet, then for the Ural Owl, this type of prey is not of decisive importance and, in case of a decrease in its number, the owl easily switches to forest species of rodents.

Most owls illegibly ingest from the food everything that can be torn off and swallowed, including limbs, heads, stomach with inner contents, fur. This can explain the different number of elements of the skeleton of the victims in the owl's pellets. Owls often swallow the whole prey. Therefore, in regurgitated pellets, for example, there may be an even number of femurs and an odd number of tibia. Often, hedgehog needles were found in the pellets of the eagle owl in the republic. What is interesting in the diet of owl, adjacent to the eagle owls, the region has not found any evidence of eating owl urchins, no bones, no needles. This indicates a certain discrepancy between the ecological niches of large owls in Mordovia. It should be noted that the skulls of the victims are more damaged when eating by Ural Owl than Eagle owl. The reason for this, as noted above, lies in the size of the Eagle Owl, what allowed swallowing the victim without dismembering it into fragments (Pukinsky, 1977). Therefore most minor skeleton damage of small victims occurs primarily during killing preys. This fact, along with the quantitative representation of the different elements of the cranial and post-cranial skeleton, can be used as one of the defining when paleozoological studies (Mourer-Chauvire, 1975).

We support the point of view of Y. B. Pukinsky, who wrote that one could not talk about the real possibility of mass elimination of prey by a predator, since usually a pair of owls hunts not more than 6 % of rodents in their habitat (Pukinsky, 1977). In addition, in the feeding spectrum of the Ural Owl, we have not identified any species from the Red Data Book of the region, and most of them are abundant species.

Thus, summarizing some aspects of food relationships of the Ural Owl in the forest-steppe area of the republic one can say that the species has steadily entered the trophic chains, and has specific features within the region. A large variability in the choice of mass species of victims, in comparison with other studied owls in the region, distinguishes this species.

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