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BATS IN THE DIET OF OWLS FROM THE RUSSIAN FAR EAST, SOUTHERN SIKHOTE ALIN

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ABSTRACT - The pellets and nesting litter of six owl species from Southern Sikhote Alin were examined for bat remains. *Bubo bubo, Asio otus, A. flammeus* and *Strix uralensis* were found to prey occasionally on bats. Remains of four bat species - *Vespertilio murinus, Murina hilgendorfi, M. ussuriensis* and *Myotis* cf. *petax* were found. Owls preyed on bats more frequently in autumn and spring, during seasonal migrations of bats and when young animals are probably more abundant.

Key worlds: Chiroptera, Strigiformes, predation, feeding habits, Russia

RIASSUNTO - ***I chirotteri nella dieta di Strigiformi dell'estrema Russia orientale, Sikhote Alin meridionale***. Le borre e i resti alimentari di nidiate di sei Strigiformi, raccolti nel Sikhote Alin meridionale, erano esaminati per la ricerca di pipistrelli. *Bubo bubo, Asio otus, A. flammeus* and *Strix uralensis* predavano occasionalmente le seguenti 4 specie: *Vespertilio murinus, Murina hilgendorfi, M. ussuriensis* e *Myotis* cf. *petax.* La predazione sui pipistrelli era più frequente durante la stagione migratoria (autunno e primavera), quando i giovani sono probabilmente più abbondanti.

Parole chiave: Chirotteri, Strigiformi, predazione, dieta, Russia

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INTRODUCTION

Bat populations of South Sikhote Alin are abundant and diverse (Rossina 2005; 2007), representing a major component of ecosystems. Being active at night, bats might be preyed by nocturnal predators (Kuzyakin 1950; Ruprecht 1990; 2005; Nowak 1994; Kowalski 1995). Owls rarely prey upon bats in the Far East of Russia. However, bats have been reported to be preyed on there by hawk owls *Ninox scutulata* (Pukinskii 2003) and Ural owls *Strix uralensis* (Shibnev 1989). As Strigiformes are particularly abundant in Southern Sikhote Alin, mainly in the Lazovsky State Nature Reserve (LSNR; Vorob'ev 1954; Belopol'skii 1955; Shokhrin 2009), we investigated the role of six owl species in the Primorskii Region - eagle owl *Bubo bubo,* fish owl *Ketupa blakistoni,* long-eared owl *Asio otus,* marsh owl *A. flammeus,* oriental scops-owl *Otus sunia* and Ural owl *S. uralensis* - as bat predators. In

addition, available data on owls preying bats are discussed.

MATERIAL AND METHODS

The material examined was collected in the LSNR and some neighbouring areas (particularly in surroundings of Lazo village and near the town of Partizansk). Some pellets were found in the Mis Hill area in the valley of the River Kievka, about 10 km east of Lazo village and on Opasniy Island (in the northern part of the Sea of Japan, next to the northern border of the LSNR).

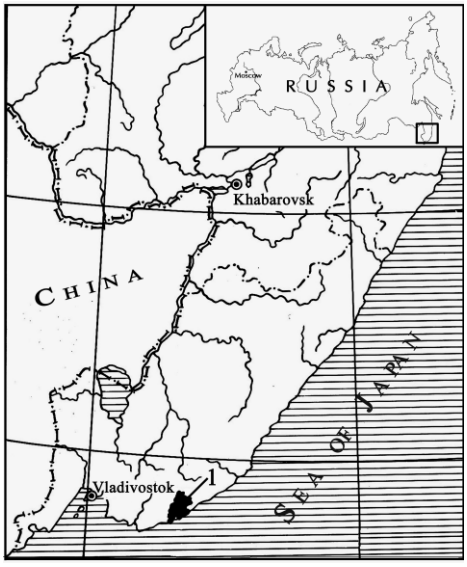

Figure 1 - Study area: Southern Sikhote Alin in the Russian Far East and Lazovsky State Nature Reserve (1).

The LSNR is located in the south-eastern part of the Primorskii Region at the foot of the Sikhote Alin range of mountains, facing the Sea of Japan (Fig. 1), and bordered by the valley of the rivers Kievka and Chernaya. The south-eastern end of the reserve stretches along the sea coast, including the small islands of Petrov and Belzov. At present the LSNR covers about 121000 ha and is surrounded by a 15000 ha wide additional protected area. The total length of the border is 240 km, of which 36 km are along the seacoast. The average altitude is 500-700 m a.s.l., with some mountain peaks reaching 1400 m (Khokhryakov and Shokhrin 2002).

Food remains of *B. bubo* were collected in April-May and October-November 2003-2006, and in June 2005 and 2007-2008 on Petrov Island. Some pellets were collected on Opasniy Island and near Partizansk in April-May 2000-2001. Food remains of *A. otus* were collected in the LSNR in May-June 2001, 2004, 2005 and 2008; those of *A. flammeus* in October 2003 and May-June 2005; those of *K. blakistoni* in April 2001, while those of *S. uralensis* were collected in April-May 2000-2006 and 2008; finally, materials from *O. sunia* were collected in May 2005 and July 2006.

In practice, complete sets of bat skeleton bones can be found in owl pellets. The phalanxes, forearms, mandibles, humeri and femurs are the most numerous and abundant remains. The pelves and scapulae are also quite common, while tibias, maxillae and cranium fragments are found only occasionally. Intact craniums of bats are rather common.

The richness of bat bones in pellets and nesting litter was expressed by the following index: $R = (N \times 100) / \Sigma n$, where N = total number of bat remains and Σn = number of pellets and nesting litters with bats. In addition, the minimum number of bat individuals (Min) was calculated based on the number of the right and left bat skeletal fragments found in each pellet or nesting litter. Seasonal variation in both the number of pellets containing bat remains and the minimum number of preyed individuals was tested by the chi-squared test (χ^2), using STATISTICA, version 6.0 (StatSoft Inc. 2001).

The feeding habits of owls were assessed by the analysis of a total of 1466 pellets, 252 leftovers and 19 nesting litters (Tab. 1).

Table 1 - Bat remains in the owl materials collected in the Southern Sikhote Alin; P: pellets with bat remains; Nl: nesting litters with bat remains; L: leftovers.

	Spring			Summer			Autumn
Strigiformes	P	Nl	L	P	Nl	L	P
Bubo bubo	79 (10)			85 (3)	2 (2)	104	53 (3)
Asio otus	512 (15)	11 (3)	69	40	1		
Strix uralensis	596 (2)	3					
Asio flammeus				55		14	7 (2)
Ketupa blakistoni	10						
Otus sunia	8			21	2	65	
Sum	1205 (27)	14 (3)	69	201 (3)	5 (2)	183	60 (5)
% bat remains	2.24	21.43	0	1.49	40	0	8.33
% bats in total food remains	2.33			1.28			8.33

RESULTS AND DISCUSSION

Bats were recorded in the food remains of four owl species: *B. bubo, A.otus, A.flammeus* and *S.uralensis*. The literature indicates that *K. blakistoni* mainly preys on fish and amphibians (Pukinskii 1977; 2003; Voronov and Zdorikov 1988), while insects and arachnids have been reported to be the main food of *O. sunia* (Pukinskii 2003; Shokhrin 2009). To our knowledge, bats have never been found in the diet of these owls. However, some bat remains were found in the pellets of pygmy owl *Glaucidium passerinum* and Tengmalm's owl *Aegolius funereus* (Shepel 1992), which are only slightly larger than *O. sunia*.

Four bat species, *i.e.* parti-coloured bat *Vespertilio murinus*, Eastern water bat *Myotis* cf. *petax*, Siberian tube-nosed bat *Murina hilgendorfi* and Ussuri tube-nosed bat *M. ussuriensis,* were found to be preyed upon.

Overall, bat remains were found in 35 pellets (2.38%) and 5 nesting litters (26.31%; Tab. 1), *i.e.* only 2.3% of the materials examined. Pellets with bat remains were more frequent in autumn ($\chi^2 = 7.59$, $P = 0.022$; Tab. 1), while the minimum number of bats recorded was the highest in spring ($\chi^2 = 72.3$, $P < 0.0001$; Tab. 2), corresponding to the periods of migration of some species of bats to and back from hibernation roosts. The highest concentration of bat bones was recorded in autumn pellets, ($R = 51.4\%$; Tab. 2), which mostly included bones of subadult bats, whilst the maximum bat species diversity in the food remains of owls was recorded in spring (Tab. 2). In summer pellets with bats were rarely found as, being mostly washed off by summer rains, they tended to disintegrate.

The eagle owl preyed on bats more frequently than other owls (Tab. 1). On the whole, 90% of pellets with bats belonged to *B. bubo* and *A. otus. B. bubo* is

Table 2 - Seasonal distribution of Chiroptera remains in pellets and nesting litter of Strigiformes in Southern Sikhote Alin; *n:* number of pellets and nesting litters with bat remains; N: total number of bat bones in pellets and nesting litters; Min: minimum number of bat individuals; R: index of richness of bat bones in pellets and nesting litters; *Bb*: *Bubo bubo*; *Ao: Asio otus; Su*: *Strix uralensis*; *Af*: *Asio flammeus.*

		Spring				Summer		Autumn		
Chiroptera		*Bb* *n=10*	*Ao* *n*=15+3	*Su* *n*=2	%	*Bb* *n*=3+2	%	*Bb* *n*=3	*Af* *n*=2	%
V. murinus	N	147	-	-	-	56	-	240	17	-
	Min	21	-	-	40.4	6	85.7	12	2	100
M. hilgendorfi	N	-	60	-	-	-	-	-	-	-
	Min	-	4	-	7.7	-	-	-	-	-
M. ussuriensis	N	-	284	85	-	-	-	-	-	-
	Min	-	18	5	44.2	-	-	-	-	-
M. cf. *petax*	N	1	-	-	-	1	-	-	-	-
	Min	1	-	-	1.9	1	14.3	-	-	-
Chiroptera indet.	N	2	1	-	-	-	-	-	-	-
	Min	2	1	-	5.8	-	-	-	-	-
R		19.33				11.4		51.4		
Location		Island Petrov	Lazo, Island Petrov	Kievka River Valley		Island Petrov, Kievka River Valley		Island Petrov		

a generalist predator (Shepel 1992). In the Primorskii Region the diet of *B. bubo* includes approximately 60 species of vertebrates: 31.1-98.0% of mammals; 2.0-68.9% of birds; 0.9-5.0% of amphibians (Tab. 3; see also Shokhrin 2005a).

Bat remains are found quite frequently in the pellets of *B. bubo* (Obuch 1989; Stubbe et al. 1989; Ruprecht 1990; 2005), and were also previously recorded in the Primorskii Region (Kolomiitsev and Poddubnaya 1985). On Petrov Island, we found two bat species to be preyed upon by this owl: *V. murinus* and *Myotis* cf. *petax* (Tab. 2). Remains of *V. murinus* were very abundant in autumn pellets (Tab. 2), which interestingly were all collected on the sea shore. Probably, the eagle-owl hunts these bats during their seasonal spring and autumn migrations along the coast. During these seasons, some eagle-owl pellets consisted solely of bat bones and hair, representing up to 7 specimens of *V. murinus* (Tab. 2). About 50% of bat bones in autumn pellets belonged to subadults, which probably are less able to escape predation.

In autumn *V. murinus* was also preyed by *A. flammeus* (Tab. 2) for which murine rodents are the main food resources in the Primorskii Region (Tab. 3; Shepel 1992; Priklonskii 1993; Shokhrin 2005a, b; 2009).

Table 3 - Diet of four owl species from Southern Sikhote Alin in 2000-2008.

Prey groups (in %)	*Bubo bubo*	*Asio otus*	*Asio flammeus*	*Strix uralensis*
Mammals:	63.7	96.2	92.9	92.7
Muroidea	53.5	93.3	90.8	84.0
Other Rodentia	3.7	0.4	0.5	3.1
Mustelidae	0.4	0.1	-	0.1
Insectivora	0.1	0.8	-	5.2
Chiroptera	5.9	1.6	1.6	0.3
Aves	34.2	2.3	5.5	5.9
Reptilia	-	0.1	-	-
Amphibia	2.2	1.0	1.6	1.3
Insect	0.1	0.4	-	0.1
Total number of specimens	763	1717	184	1983

Bats are also included in the diet of marsh owls in the Ulyanovsk Region (Zhitkov and Buturlin 1906) and in some regions of Finland (0.2% of all owl preys; Aho 1964).

S. uralensis and *A. otus* also feed mostly on murine rodents (Tab. 3; Kulaeva 1977; Lundberg 1979; Mikkola 1983; Shibnev 1989; Nechaev 1991; 2003; Shepel 1992; Pukinskii 2003; 2005; Shokhrin 2005a, b; 2009). However, these owls sometimes also hunt bats (Kulaeva 1977). Remains of *M. hilgendorfi* were found in the pellets of *S. uralensis* from Sakhalin Island (4.8% of all owl prey: Nechaev 1991). Bats were recorded in the diet of the Ural owl in the valley of the River Bikin, Primorskii Region (2.0% of owl preys; Shibnev 1989) and in some areas of Kyrgyzstan (Eremchenko and Toporova 1975). Bats occurred in the diet of *A. otus* from the Perm Region (0.19%; Shepel 1992) and Sakhalin Island (0.5%; Nechaev 1991). Remains of *Pipistrellus abramus* and *Myotis macrodactylus* were found in the pellets of the long-eared owl in Japan (Kawaguchi and Yamamota 2003; Chiba et al. 2005). We found bat remains only in spring pellets of both *A. otus* and *S. uralensis* (Tab. 2). Those of *A. otus* contained remains of *Murina hilgendorfi* and *M. ussuriensis.* To prey on ground insects (Panyutin 1974), *Murina* species mostly fly close to the earth's surface (Rossina 2007), where they may represent an easy prey for owls. Most pellets were collected in anthropogenic habitats next to Lazo village (Tab. 2) but also on the shores of Petrov Island and in the valley of the River Kievka.

The pellets of *S. uralensis* included solely bones of *M. ussuriensis.* All pellets were collected beside one nest near Mis Hill, in the valley of River Kievka. Although *M. ussuriensis* is considered rare in the Far East (Abramov et al. 2002), it was abundant in

spring pellets (Tab. 2).

CONCLUSIONS

Bats do not play a major role in the diet of owls in Southern Sikhote Alin. However in autumn and spring some bat species may form part of the owls' diet. The small number of both predator- and prey species involved probably reflects the features of owl hunting strategies and ecological and behavioural characteristics of preyed bats. Usually large and medium-sized bats living in big colonies fall victim to flying predators most frequently (Rossina et al. 2006; Shokhrin and Rossina 2008). Among them, young animals are most easily preyed upon during bat seasonal migrations.

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