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On the formation of the bat fauna in the south of the Soviet Far East

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Abstract: The paper surveys the Upper Pleistocene and Holocene records of bats obtained from a fossil site, Bliznetz cave, in the south of the Soviet Far East. Ten species , viz. *Rhinolophus ferrumequinum, Myotis* aff.*formosus, M.daubentoni, M.capaccinii, M.ikonnikovi, Pipistrellus* sp., *Eptesicus nilssoni, Plecotus auritus, Murina aurata, M.leucogaster* were found. Some of them are localy extinct or do not occur in the region recently. Zoogegraphical and paleoecological aspects of these records are discussed.

INTRODUCTION

The data on fossil bats in the Soviet Far East are not numerous. There is only some information on subfossil chiropteran remains in some caves in the southern Far East (Ovodov 1974, Tiunov 1984, 1985). A more detailed information on this topic has been presented in our recent paper (Alexeeva & Tiunov 1987) devoted to the bat remains from the Bliznetz cave (Southern Primorje). That paper discussed the results obtained by studying 1184 fragments of axial crania and lower jaws taken from a well situated just behind the entrance to the cave and infilled with a soft deposits of a total thickness of about 7 m. The large thickness of deposits that accumulated under the conditions of extended continuous sedimentation enables the dynamics of a relative quantity of animals to be traced throughout a long period of time. To reconstruct a vertical profile of the distribution of fossil remains in the cave all thickness of the deposits in the well was divided into layers which were examined separately. A specific determination of fossil bats using also remains of humeri was applied. Furthermore, we used here some of our results published elsewhere on other other groups of small mammals obtained from the deposits of the Bliznetz cave. It allowed us to interpret the new data in a somewhat different way.

Material and methods

The cave is situated on the southern slope of the Lozovyj mountain ridge, the spur of the Sichote-Alin Mts., 254 kms to the north of Nakhodka. The entrance is at the altitude of 300 m above sea-level on a slope inclined at 40-50°.

The cave begins with a well, on the bottom of which we carried out excavations (Fig. 1). The sediments were taken out of the well, every 10-cm layer being treated separately. In total, 1244 fragments of chiropteran humeri were found. These fragments were examined using the key for humeral characters of recent bats, compiled by Yoon & Uchida (1983 a,b). The remains of 10 different bat species, belonging to two families, were detected.

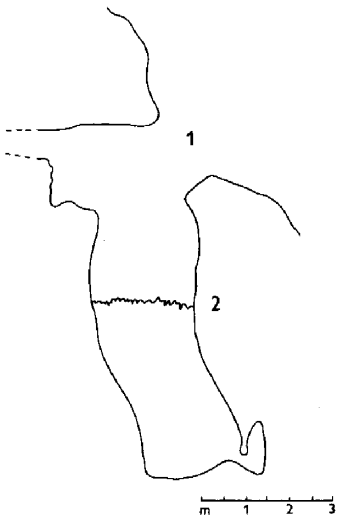

Fig. 1: A sketch map of the well in the Blizenetz cave (compiled by Ju.I.Bersenev). 1 - cave entrance, 2 - the bottom level before the beginning of our excavations.

RESULTS

Family Rhinolophidae Gray, 1825

Rhinolophus ferrumequinum Schreber, 1774

In total, 27 humeral fragments were found in depth from 6.3 to 3.2 m, with a major representation from 5.2 to 4.4 m (Fig. 2).

Family Vespertilionidae Gray, 1821

Myotis aff. *formosus* Hodgson, 1835

Three humeral fragments, found at the depths 4.2, 4.0 and 3.8, that belong to a *Myotis* species larger that any form inhabiting the Soviet Far East at present (Fig. 3). Since, in the same depths, the cranial remains of a bat close in size to *M.formosus* were found (Alexeeva & Tiunov 1987), it seems quite probable that these humeral fragments belong to one and the same species.

TABLE 1: *A comparison of humeral characters in* Hypsugo savii *and* Pipistrellus *sp. from the Blizenetz cave. Dw/Pw = ratio of distal vs. proximal epiphyses widths.*

Species	n	Length of Humerus	Dw/Pw
H.savii	7	22.2 - 24.2	0.80 - 0.89
Pipistrellus sp.	5	20.7 - 22.0	0.93

TABLE 2: *Length of humerus in recent and fossil* Murina leucogaster *and* Plecotus auritus. *Min./Max (avg.) values.*

Species	n	Length of humerus
M.leucogaster		
recent	11	23.6 - 26.0 (24.7)
fossil	53	23.2 - 27.0 (25.4)
P.auritus		
recent	11	22.4 - 25.9 (24.3)
fossil	18	22.6 - 25.9 (24.4)

Myotis daubentoni Kuhl, 1819

23 humeral fragments of this species were found in depths ranging from 5.2 to 2.6 m.

Myotis capaccinii Bonaparte, 1837

Bone remains of this species were obtained from depths of 4.9 to 1.8 m. In all, 24 fragments of humeri were found.

Myotis ikonnikovi Ognev, 1912

Information on the humeral characters of this species in missing in the key. However, *M.ikonnikovi* possesses the humeral structure characteristic of the genus, which differs well from the other species by its smaller size. 13 humeri of this species were found in the depths from 5.3 to 3.0 m.

Pipistrellus sp.

22 small-sized humeral fragments were collected in depths from 4.3 to 0.9 m. The form to which they belong differs from *Hypsugo savii,* that inhabits Primorje, in its lesser humeral length and in the greater value of the distal epiphysis width (Dw) to the proximal end width (Pw) ratio for the humerus (Table 1). The Dw/Pw ration in the form under study exceeds those for the other *Pipistrellus* spp. inhabiting the territory of Korea and Japan (Yoon & Uchida 1983b).

Eptesicus nilssoni Keyserling et Blasius, 1939

Bone remains of E.nilssoni occurred in depths from 4.3 to 1.7 m. Eighteen humeri were collected.

Plecotus auritus L., 1758

The bone remains of this species occur throughout almost all the depth range in the deposits of the well. In all, 259 humeral fragments were collected. The humeral size of the long-eared bat from the Bliznetz cave does not differ from those of the recent sample of the same species (Table 2).

Murina aurata Milne-Edwards, 1872

Only one humerus of the little tube-nosed bat was found in a depth of 2.5 m (the length of the bone was 19.7 mm).

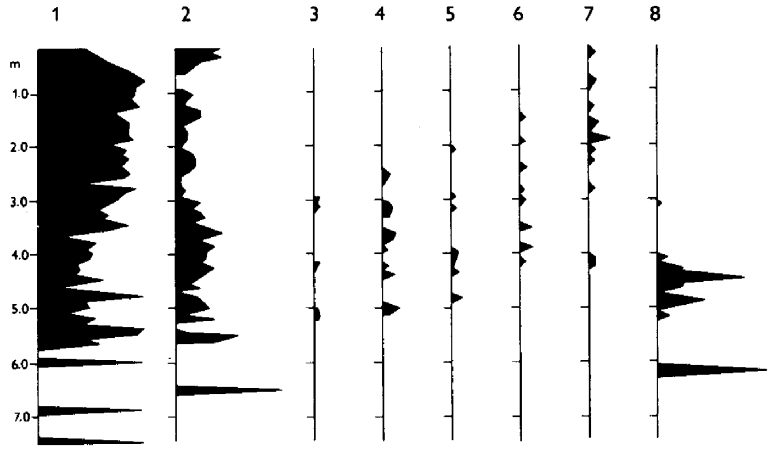

Fig. 2: The distribution of bones of different bat species over sedimentary sequence in the Bliznetz cave. Ordinate, depth of the section, in m; abscissa, bone content of most numerous bat species to total amount of bone remains ratio.
1 - *Murina leucogaster;* 2 - *Plecotus auritus;* 3 - *Myotis ikonnikovi;* 4 - *Myotis daubentoni;* 5 - *Myotis capaccinii;* 6 - *Eptesicus nilssoni;* 7 - *Pipistrellus* sp.; 8 - *Rhinolophus ferrumequinum.*

Murina leucogaster Milne-Edwards, 1872

We collected 826 humeri of the great tube-nosed bat. Their size and shape appear to be the same as in the humeri of the recent species. The bone remains of *M.leucogaster* occur throughout the whole deposits.

DISCUSSION

At present, four species of bats hibernate in the Bliznetz cave and other underground cavities located in this region: viz., *M.nattereri, M.ikonnikovi, P.auritus* and *M.leucogaster* (Tiunov 1985).

We also recorded occasional *H.savii* flying into the cave. *M.capaccinii* was obtained earlier from the Peretinskaja cave located 15 kms from the Bliznetz cave (Kuzjakin 1950). *M.daubentoni* has not been recorded in the caves of the Lozovyj ridge during hibernation but it occurs in this region in summer. Studying the cranial fragments of fossil bats we found also *M.nattereri* and *M.brandti* (Alexeeva & Tiunov 1987), both of which are met with occasionally in this region at present.

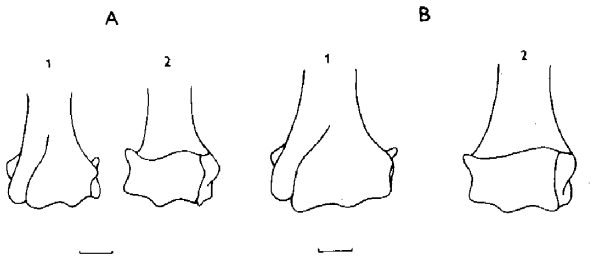

Fig. 3: The distal epiphyses of humerus in *Myotis nattereri* (A) and *Myotis* aff. *formosus* (B). 1 - caudal view, 2- frontal view.

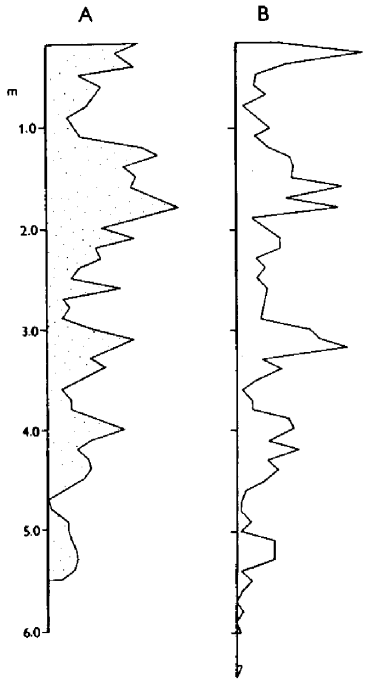

Fig. 4: The distribution of the total amount of bat bones over the sedimentary sequence in the Blizenetz cave. Ordinate, depth of the section, in m; abscissa, total amount of bat bones. 1 - number of cranial fragments and jaws, 2 - number of humeri.

Taking into account the presence of a large number of big limestone blocks in all layers of deposits, one can suppose that crumbling often occurred in the cave, the entrance opening was enlarged and the microclimate of this part of the cave did change. It is probably the cause of the absence of bats of the genus *Myotis* during hibernation in the cave now, because they prefer shelters with more humid and warmer climate.

The relatively higher percentage of the long-eared bat in the fossil sample is also connected with the peculiarities of the cave and of the burial place itself, i.e. its position close to the cave entrance which that species prefer for hibernation. At present, *P.auritus* ranks third (after the representatives of the genera *Murina* and *Myotis*) common bat species hibernating in the caves of Primorje. The same ratio was detected also in the subfossil bat remains. A high representation of *P.auritus* in our fossil record may result of the location of the burial place in vicinity of the cave entrance.

Murina leucogaster predominates now over other bat species in cave hibernacula of Southern Primorje concluding from the amount of its fossil remains, this also occurred over a considerable period of time.

The discovery of bone remains of some thermophilous species in a depth more than 4 m, but somewhat higher than the bone remains of *E.nilssoni* is more interesting, supporting a conclusion that the climate during the period under study changed considerably.

R.ferumequinum and *M.*aff.*formosus* , detected in these layers, do not occur in the territory of the Soviet Far East at present.

Unfortunately, using only our own information on the distribution of fossil bat remains, it is impossible to draw any conclusions on the age of the deposits. The more so, as the only date for bone remains (of common goral from the depth of 3 m) established with aid of a radiocarbon method (about 12 thousands years B.P.) is doubtful. If this is true, the faunal assemblages of the lower layers should be influenced by the upper Pleistocene cold snap. For lack of reliable dating of fossil record it is possible to estimate the time of accumulation of cave deposits only after a comprehensive study of all available data also on other groups of fossil vertebrates. Taking into account the peculiarities of the ecology of the species and their relative quantity it is possible to retrace the changes in landscape and climate for this region more accurately.

In order to ascertain the time of appearance of thermophilous species in the region under study it is more convenient to examine the respective faunal sequence also in respect to other groups of small mammals.

In contrast to bats which thanatocenoses correspond well to the structure of recent hibernal communities, only one species of vole does occur in the upper layers of the deposit, viz. *Microtus fortis* (Alexeeva & Golenišev 1980), i.e. the form inhabiting the environs of the cave also at present. Of shrews (Soricidae), most of the bone remains belong to the forest species, *Sorex unguiculatus* and *Sorex isodon* (Tiunov 1976).

In the lower layers in the depth of 2.6 m, most of the bone remains belong to *M.* ex.gr. *maximowiczii.* Moreover, besides this, also two other vole species do occur, viz. *M.oeconomus* (in the depths of 2.9 and 1.6 m) and *M.mongolicus* (1.8 m).In comparison with the upper layers, in the depths from 2.5 to 2.0 m the remains of the forest species of Soricidae were far fewer. Most of shrew remains found here belong to *Crocidura lasiura.* According to the data by M.V.Ochotina (1972) this species is common in open treeless landscapes. The nearest region inhabited by *M.maximoviczii* is now in the environs of Chabarovsk. The root vole, *M.oeconomus* , is also absent from the Primorje. Its nearest occurrence have been recorded in the south of the Amur administrative province. Thus, now the range boundaries of these two species are shifted to the north and north-west. It should also be pointed out that the northern bat, *E.nilssoni* , is found now only in the north of the Primorje.

Based on the recent results of the palynological studies (N.B. Verchovskaja, personal communication), the forest-steppe was a predominant type of vegetation until 1200-1000 years B.P. Only 900-800 years ago the first indications of afforestation began appearing. Thus, the upper layers of deposits, from the surface to a depth of 1.5 m seem to correspond to the second of the above-mentioned periods. It should also be noted that the upper layer to a depth of 1.0 m is dark-grey, almost black humic loam with limestone debris; it is the evidence of rapid deposit accumulation. The predominance of *C.lasiura* in the lower

layers supports a conclusion that the vegetation in this region was a steppe type during pertinent time period

The deeper layers to a depth of about 3.5 m correspond to a period of chilly climate which set in at a Postatlantic Holocene stage. The appearance of the cold-loving species in the cave area seems to be connected with these very climate changes. Hence, it is possible to assume that the findings of bone remains of thermophilous bat species, *R.ferrumequinum* and *M.*aff.*formosus*, which nearest recent occurrence is in Korea and Japan (Wallin 1969, Yoshiyuki 1989), could be attributed to the Holocene climatic optimum.

Thus, the accumulation of the whole thickness of the deposits in the cave took place during the Holocene. Anyhow, one of the authors of the present paper (E.V.Alexeeva) tends to support our earlier opinion (Alexeeva & Tiunov 1987) that the sedimentation begun already in the Upper Pleistocene. Anyhow, it seems that the recent pattern of the bat fauna in the southern Far East was achieved during the second half of the Holocene.

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