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First Data on Nutrition of the Ural Cave Bear *Ursus* (*Spelaearctos*) *kanivetz* Verestchagin, 1973 (Mammalia, Carnivora, Ursidae) as Based on ^{13}C and ^{15}N Isotope Analyses

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Abstract—First data on the contents of the ^{13}C and ^{15}N isotopes in collagen were obtained for 16 bones of the Ural cave bear *Ursus* (*Spelaearctos*) *kanivetz* Verestchagin, 1973 from the Tayn (Secrets) cave (55°25′ N, 57°46′ E). The bones are dated to the middle MIS 3 and belonged to males and females of about 2 years, about 3 years, and older than 4 years of age. No considerable difference in isotope signatures was observed between individuals of different ages and different genders. Cave bears were assumed to forage independently on plant food from the second year of life. The δ^{13}C and δ^{15}N values established for the Ural cave bear are close to the values reported for *U.* (*S.*) *spelaeus ingressus*.

Keywords: *Ursus kanivetz*, Ural cave bear, Pleistocene, Ural, stable isotope, ^{13}C, ^{15}N, collagen

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The ^{13}C and ^{15}N isotopes are broadly used to reconstruct both past and current environments and ecology of species. Their use is of special importance in the case of extinct species. Ample data on the ^{13}C and ^{15}N contents in bone collagen have recently been obtained for many species of the mammoth fauna [1]. Their analyses make it possible to estimate the position of a species in the trophic chain and to characterize the features of its nutrition [2]. One of the largest available datasets pertains to the large cave bear *Ursus* (*Spelaearctos*) *spelaeus* s. l. [1, 3–8]. However, samples from Western and Central Europe have been examined to collect these data. There is no data on large cave bears of Eastern Europe and the Urals. The ^{13}C and ^{15}N isotope contents in bone collagen are known only for small cave bear *U.* (*Spelaearctos*) ex gr. *savinirossicus* of the Urals [9].

According to the current morphological and molecular data, *Ursus* (*S.*) *kanivetz* Verestchagin, 1973 was the only large cave bear that inhabited the Urals in the Late Pleistocene [10, 11]. Two large cave bear species, *Ursus* (*S.*) *spelaeus* Rosenmuller, 1794 and *U.* (*S.*) *eremus* Rabeder, Hofreiter, Nagel et Withalm, 2004, inhabited Western Europe, and there were three species—*U.* (*S.*) *spelaeus* Rosenmuller, 1794; *U.* (*S.*) *eremus* Rabeder, Hofreiter, Nagel et Withalm, 2004; and *U.* (*S.*) *kanivetz* Verestchagin, 1973—in Central Europe [12].

Ural cave bear bones examined in this study originate from the Tayn (Secrets) Cave of the Central Urals (55°25′ N, 57°46′ E). The cave formed by erosion, is horizontal in structure, and has a length of 508 m [13]. The cave altitude is 230 m. There are two layers of deposits in the cave. Layer 1 consists of brown loamy sand with limestone rubble and debris and is up to 1.5 m thick. Layer 2 is greenish sandy loam and is less than 0.5 m thick. More than 16 000 large cave bear bones have been found in layer 1, including remains of embryos and various age groups from newborns to old individuals [14]. This is a typical cave bear graveyard, where bears died during winter hibernation. AMS radiocarbon dating gave the following ages for cave bear bones: 47 600 ± 900 BP, OxA-16958; 39 190 ± 360 BP, OxA-16961; 39 580 ± 360 BP, OxA-16965; 39 630 ± 360 BP, OxA-16962; 40 340 ± 370 BP, OxA-16963 [15]; and 37 190 ± 680 BP, no.? [16], which correspond to the middle marine isotope stage (MIS) 3 of the Late Pleistocene.

Six humeri and ten tibiae were taken for our analysis. The genders and ages of the respective individuals were determined from the bone size and epiphysis state (fused or not fused) [14, 17–19]. Of the humeri,

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Table 1. $\delta^{13}C$ and $\delta^{15}N$ (‰) in bone collagen of the Ural cave bear *U.* (*S.*) *kanivetz*

Gender	*n*	$\delta^{13}C$, ‰	*n*	$\delta^{15}N$, ‰
Male	10	−21.3 to −22.1	10	3.2 ± 0.1 to 5.6 ± 0.1
Female	2	−22.1 to −22.2	2	4.6 ± 0.2 to 5.4 ± 0.1
?	4	−21.4 to 22.5	4	3.0 ± 0.2 to 4.6 ± 0.02

two belonged to males of approximately two years of age; one, to an approximately three-year-old male; two, to males older than four years of age; and one, to an approximately two-year-old female. Of the tibiae, two belonged to approximately three-year-old males; three, to males older than five years of age; one, to a female older than four years of age; and four, to approximately three-year-old individuals whose gender remained undetermined. All bones were from different individuals.

The isotope compositions of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) in bone collagen were determined by isotope-ratio mass spectrometry [20] according to a standard protocol, using a DELTA V Advantage instrument (Thermo Fisher Scientific, Germany) equipped with a Flash 2000 elemental analyzer (the instruments were provided by the Tomsk Collective Access Center). VPDB was used as an international reference standard for carbon isotopes. Atmospheric N_2 gas was used as an international reference standard for nitrogen isotopes. IAEA-600 caffeine was used as international standard reference material to calibrate the working laboratory comparator gases CO_2 and N_2. The absolute measurement error was estimated in three replicate measurements and did not exceed 0.15‰ for carbon and 0.2‰ for nitrogen.

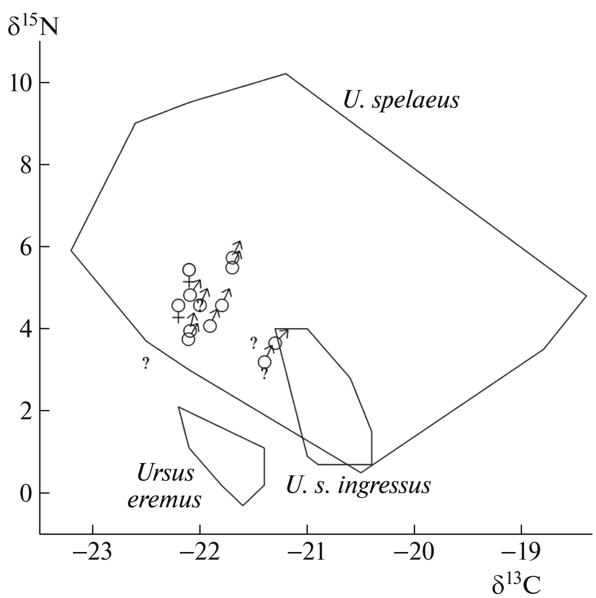

Fig. 1. Distribution of the $\delta^{13}C$ and $\delta^{15}N$ values (‰) in bone collagen of the Ural cave bear (♂, males; ♀, females; ?, gender undetermined) and the large cave bears *U. spelaeus*, *U. eremus*, and *U. s. ingressus* of Western and Central Europe.

The results of measuring $\delta^{13}C$ and $\delta^{15}N$ are summarized in Table 1. A difference between $\delta^{13}C$ values was no more than 1.2‰; a difference between $\delta^{15}N$ values was no more than 2.6‰ (Table 1). The differences were nonsignificant, and all individuals belonged to the same trophic level [2]. The conclusion was supported by the positions of points in a plot (Fig. 1).

As mentioned above, bones from individuals of different ages (two or more years old) and genders were included in the study. No considerable difference in isotope signatures was observed between individuals of different ages and different genders. The finding means that the diet did not substantially differ in Ural cave bears of two or more years of age. That is, cave bears foraged independently on plant food from the spring of the second year of life (age 1+) after the end of the second hibernation. The diet did not significantly differ between males and females.

For a comparison, distribution polygons of $\delta^{13}C$ and $\delta^{15}N$ measured in bone collagen are shown for large cave bears from Western and Central Europe [1–7] (Fig. 1). The $\delta^{13}C$ and $\delta^{15}N$ values of the Ural cave bear form a more compact cluster as compared with the data available for *U.* (*S.*) *spelaeus* and slightly fall outside of its polygon. The values are similar to those reported for its subspecies *U.* (*S.*) *spelaeus ingressus* (Fig. 1).

To summarize, our analysis of $\delta^{13}C$ and $\delta^{15}N$ in Ural cave bear bone collagen indicates that bears foraged independently starting from the early second year of life and that the diet did not differ between males and females. The Ural cave bear was similar in diet to the West European subspecies *U.* (*S.*) *spelaeus ingressus*.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interests. The authors declare that they have no conflicts of interest.

This article does not contain any experimental studies involving animals or human subjects performed by any of the authors.

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