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First Data on Non-occlusal Surface Incisor Microwear of Cave Bears from the Urals

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Abstract—The microwear of the non-occlusal surface of incisors (I1, I2) of the small cave bear (*Ursus* ex gr. *savini-rossicus*) and Ural cave bear (*Ursus kanivetz*) from the Pleistocene of the Middle and South Urals is analyzed and compared. Qualitative characteristics of incisor microwear have been shown to be different in these species. In the small cave bear, coarser lesions on the non-occlusal surface of the incisors are observed. Considering the specificity of microwear of non-occlusal tooth surfaces, the data obtained suggest differences in trophic specialization of the species. studied

Keywords: *Ursus savini*, *Ursus rossicus*, *Ursus kanivetz*, small cave bear, Ural cave bear, Pleistocene, lower incisor, Ural, microwear

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INTRODUCTION

According to modern morphological and molecular data, two species of cave bear occurred in the Urals in the Late Pleistocene [1, 2]. These were the large, or Ural, cave bear (*Ursus kanivetz* Verestchagin, 1973) and the small, or Russian, cave bear (*U. rossicus* Borissiak, 1930). Currently, the small cave bear group needs revision [2]. In this paper, we assign the small cave bear to the *savini-rossicus* group (*U.* ex gr. *savini-rossicus*).

The small cave bear, compared to the large cave bear, is a poorly understood species. There are very few studies on the features of the ecology of the small cave bear [3–6], and studies of its diet are extremely rare [7]. One of the methods for studying the nutritional characteristics of mammals is the analysis of traces of microwear on teeth. At present, on the basis of the analysis of teeth microwear, the diet of representatives of various orders of mammals has been reconstructed [8–12]. Of particular interest in this area is the analysis of microwear of non-occlusal surfaces of teeth. Studies on microwear of the buccal and labial surfaces of primate teeth have shown the importance of this approach not only for clarifying the composition of the diet, but also for reconstructing feeding behavior [7, 13–15]. The food preferences of several bear species have also been studied using the tooth microwear analysis method [7, 10, 12, 16]. However, few data on micro-damage and wear of the incisors of cave bears are available in the literature.

The purpose of this study was to assess the qualitative and quantitative characteristics of microwear of the labial surfaces of incisors in small and large cave bears from the Urals. We chose the upper first (I1) and second (I2) incisors for the analysis of microtraces. In an isolated state, it is quite difficult to distinguish the first from the second incisor in cave bears. These teeth erupt at the same time and are eroded synchronously, hence we will further consider these incisors together. Incisors with an average level of wear were selected, when the dentin of the upper part of the crown is exposed quite strongly, but the tooth is worn down by no more than a third. Ten upper incisors (I1-2) belonging to the small cave bear and originating from the Late Pleistocene locality of Imanay Cave were studied. The incisors of a large cave bear ($n = 11$ specimens) come from the Tayn ($n = 2$), Ignatievskaya ($n = 3$), Zapovednaya ($n = 3$), and Asha 1 ($n = 3$) caves. The Tayn Cave is located in the Middle Urals, the rest of the caves are in the South Urals. On the basis of radiocarbon dates and biostratigraphic data, all sites with cave bear remains are dated to the beginning and middle (marine isotope stage (MIS 5–MIS 3)) of the Late Pleistocene [2].

METHODS

Microwear was analyzed on the labial surface of the incisors in micrographs obtained at a magnification of ×30 using a TESCAN VEGA3 scanning electron

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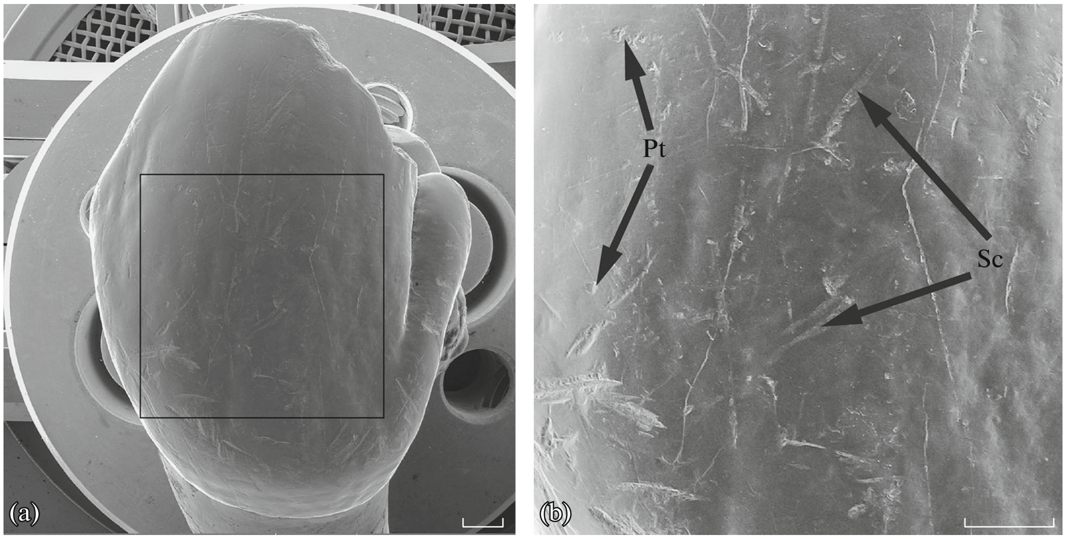

Fig. 1. (a) General view and location of the examined area on the labial surface of the incisor (for example, *U.* ex gr. *savini-rossicus*). (b) Pits (Pt) and scratches (Sc) on the examined area. Scale, 1 mm.

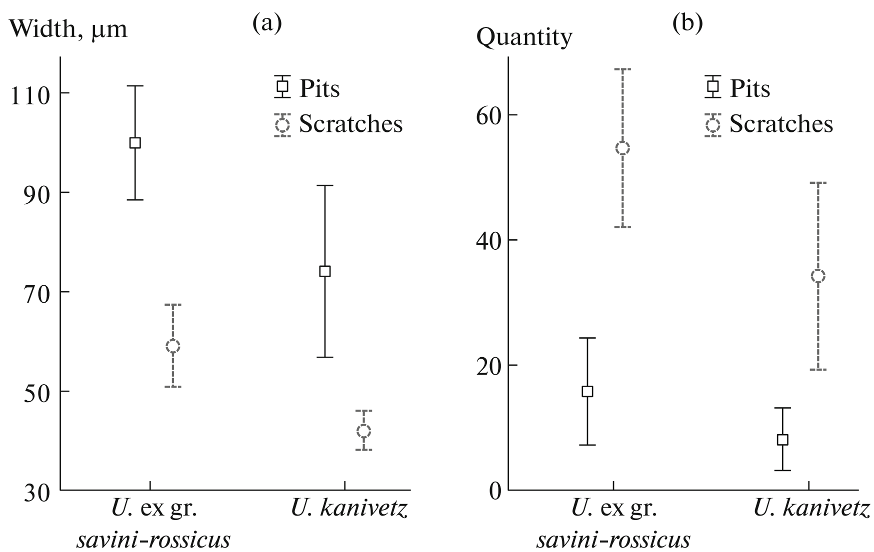

Fig. 2. (a) Mean values and confidence intervals for the width and (b) the total number of pits and scratches on the labial surface of the incisors of small and large cave bears.

microscope. Quantitative and quantitative analyses of tooth microwear variables were carried out on an area of 6 mm^2 using the semi-automatic Microwear 4.02 software (Ungar, 1994–2002, United States) (Fig. 1). Interspecific differences in microwear were assessed by analysis of variance (ANOVA) using Statistica 8.0 software (StatSoft, United States, 1984–2007).

RESULTS

The analysis showed no significant interspecific differences in the amount of micro-damage on the labial surface of the incisors between the two species of cave bears (Fig. 2). There is a general trend towards a decrease in the number of microwear elements on the enamel surface in the large cave bear. The average number of pits/scratches was 15.8/54.6 in the small cave bear and 7/37.2 in the large cave bear, respectively (Fig. 2b); however, differences in the number of pits ($F(1; 19) = 4.13$, $p > 0.05$) and number of scratches ($F(1; 19) = 3.88$, $p > 0.05$) were nonsignificant.

Interspecific differences were identified by the width of the pits/scratches on the enamel. The average value of the width of pits/scratches was 99.9/59.1 μm in the small cave bear and 74.11/42.0 μm in the large cave bear, respectively (Fig. 2a). Differences in the width of pits ($F(1;19) = 7.38$, $p < 0.05$) and scratches ($F(1;19) = 18.74$, $p < 0.001$) are statistically significant. On the labial surface of the incisors of the small cave bear, the damage is coarser, while the widths of both pits and scratches exceed the values of these elements in the large cave bear (Fig. 2a).

As a result of the analysis of tooth enamel microdamage, which is widely used in paleoreconstructions of trophic features of terrestrial mammals, statistically significant differences in the size of microtraces on the non-occlusal surface of the incisors of large and small cave bears were established.

At present, the interpretation of the microwear of the teeth of bears is debatable. Based on the analysis of traces of microwear on the occlusal surfaces of the molars, conclusions have been drawn that cave bears were more carnivorous than brown bears [17], were omnivorous [18], and had a mixed diet [19]. Given the latest data from a comprehensive analysis of the paleodiet based on isotopic analysis and microwear of molars, we subscribe to the hypothesis of a plant-based diet for cave bears [20].

Previously, it was noted that the amount of gross damage to the occlusal surface of the molars of the large cave bear was greater than in the small one, which may indicate differences in the composition of food [7]. Considering the data that we have obtained on the size characteristics of damage on the incisors of these species, it can be assumed that, when foraging, the incisors of the small cave bear were more severely impacted, which is possibly associated both with the substrate on which forage plants grew and with a shift in the herbivorous diet of the small cave bear towards rhizophagy.

Differences in the characteristics of the microwear elements of the labial surfaces of the incisor of the studied species, together with data on the microwear of the occlusal surfaces of the molars [7], indicate a difference in the feed composition and/or feeding behavior of these species. For a more complete description of the differences in the diet and food preferences of cave bears, it is necessary to conduct a comprehensive analysis of micro- and macrowear of the surfaces of the lower incisors, canines, and cheek teeth.

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COMPLIANCE WITH ETHICAL STANDARDS

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

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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