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AT THE JUNCTION OF ETHNOGRAPHY, ZOOLOGY AND PHYSICS: NEW DATA ON THE BEAR CULT ON SAKHALIN ISLAND (RUSSIAN FAR EAST)[1]

Abstract: This paper presents the results of a study of 17 brown bear skulls from two destroyed sanctuaries dated no later than the middle of the 20th century, from the Chamgu River (eastern slope of the V. Sakhalin Mountains, Central Sakhalin), apparently from the last monuments of the bear cult on the Island and probably the only one from which materials have been preserved. The skulls of varying sizes, from small to very large, belonged to sub-adults, adults, and mature males and females. Most of the skulls carry specific traces of blows to the head, inflicted mainly in the area of the fronto-parietal and squamous (temporal region) bones; other spots are visible on two skulls. Carbon and nitrogen stable isotope signatures pointed to marine, terrestrial and mixed forms of diets among the bears. The correlation of a bear diet with age and sex is outlined. A variety of bear diets, sizes and individual age of skulls suggests that skulls fell into human hands by different ways (hunting / a growing popularity of so-called bear festivals). There is also a substantiation of the belonging of the sanctuaries to the representatives of the two peoples of Sakhalin, Nivkhs and/or Uilta.

Keywords: brown bear skulls, modern cult, sanctuary, Nivkhs, Uilta, Sakhalin Island, Russia.

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На стыке этнографии, зоологии и физики: новые данные о культе медведя на острове Сахалин (российский Дальний Восток)

Аннотация: Представлены результаты исследования 17 черепов бурого медведя из двух разрушенных святилищ, датированных временем не позднее

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середины XX в. с реки Чамгу (восточный склон Восточно-Сахалинских гор, центральный Сахалин), очевидно, из последних памятников медвежьего культа на острове и вероятно, единственных, с которых сохранились подобные материалы. Черепа разных размеров, от мелких до очень крупных, принадлежали полувзрослым, взрослым и зрелым самцам и самкам. Большинство черепов несут однотипные следы ударов, нанесенных преимущественно в области лобно-теменной и чешуйчатой (височной области) костей, на двух черепах видны пятна охры. Сигнатуры стабильных изотопов углерода и азота указывают на морскую, наземную и смешанные формы питания медведя. Намечена корреляция рациона медведя с возрастом и полом. Разнообразие рациона медведя, размеров и индивидуального возраста черепов свидетельствует о том, что черепа попадали в руки человека разными путями (охота/традиционное выращивание для так называемых медвежьих праздников). Приведено обоснование принадлежности святилищ представителям двух народов Сахалина, нивху и/или уйльта.

Ключевые слова: черепа бурого медведя, современный культ, святилище, нивхи, уйльта, остров Сахалин, Россия.

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Introduction

Among the indigenous population of Siberia and the Far East, a bear held pride of place in the concept of the world structure. One of the early evidences of bear worship was revealed at the cave site of the Late Palaeolithic – Early Neolithic (16-6 ka BP) in Eastern Sakhalin mountains [25; 26; 27; 59]. Indeed, in the houses of the Okhotsk culture located at Hokkaido Island (VII-X AD) i.e. Moyoro, Tokoro-chasi, Kafukai 1, bear skulls were piled in a special place reserved for bear worship [35]. Similarities in celebration of bear holidays by the cultures of Siberia and the Far East have been described by many researchers [20; 30; 45; 44; 59; 63; 67]. The God of forest and mountains (metot-us'-kamuy / nuburi-kamuy) was depicted as a big bear [51]. In the minds of the peoples of Siberia and the Far East a bear was both an animal and a creature of higher order simultaneously. The people did not pray to a bear, but to the Upper God, while a bear was playing the role of the messenger. Such antinomic conviction was mirrored in bear myths and the ritual side of bear holidays [59]. Hence, the sites containing bear skulls (poles, trees, special barns, with or without decorations) may be considered as sanctuaries.

Solemn crowded events associated with the killing of brown bear raised in a cage or caught while hunting were typical for the Ugrians, Nivkhs, Ainu, Ulchi,

Oroks / Uilta and many others [4; 18; 51; 53; 58; 60; 63]. Unfortunately, despite published ethnographic descriptions of bear ceremonies the material evidence of such events, except for decorations and utensils, is quite scarce.

The ritual character of the remains of brown bear has been proven for the Nivkh recent sanctuary of the Kshiusvongun clan located at the mouth of the Agnevo River [17].

The latest evidences of a bear cult were found in the valley of the Chamgu River (about 50 ° 57 ′ N, 143 ° 37 ′ E), 1.5 km above its mouth (Fig. 1). The Chamgu River is a 48 km long mountain water stream with a catchment area of 382 km^2, which originates from the highest point of Sakhalin, Mount Lopatina (1609 m above sea level), on the eastern slope of the East Sakhalin Mountains, and falls into the Sea of Okhotsk [54]. Material comes from two ruined sanctuaries placed at a distance of several meters from each other on the swampy terrace of the Chamgu River. Approximately 100 meters from these sanctuaries two air burials were found, the remains of people in them were damaged. According to the local witnesses, who had seen an already destroyed sanctuary and scattered skulls of brown bear, initially the skulls were piled in a round pyramid placed within a wooden frame, with their noses being directed outwards. As they told V. Yudin, the sanctuaries functioned from the late 19th to the half of the 20th century. In the paper [66], in Fig. 95, skulls are arranged in rows, which were done only in order to make a photograph. Before 1970s, the place of worship lost its sacred meaning and was completely destroyed.

We used a multidisciplinary approach combining osteological determination of age at death and sex of the studied individuals, microstructure pattern and Attenuated total reflectance-Fourier transform infrared spectroscopy (ATR-FTIR) to document possible handling of the specimens, and carbon and nitrogen stable isotopic analysis to establish the dietary behavior of each studied individual. So, the purpose of our study is to study the surviving evidence of the bear cult using a set of methods in order to reconstruct the processes that took place on Sakhalin relatively recently.

Materials and Methods

Here we present for the first time the results of a study of bear skulls from the practically lost ethnographic objects of the Chamgu River. The objective of our work was to shed the light on the nature and features of human impact traces on materials studied, to present main biological characteristics (age, sex, sizes, diet) of

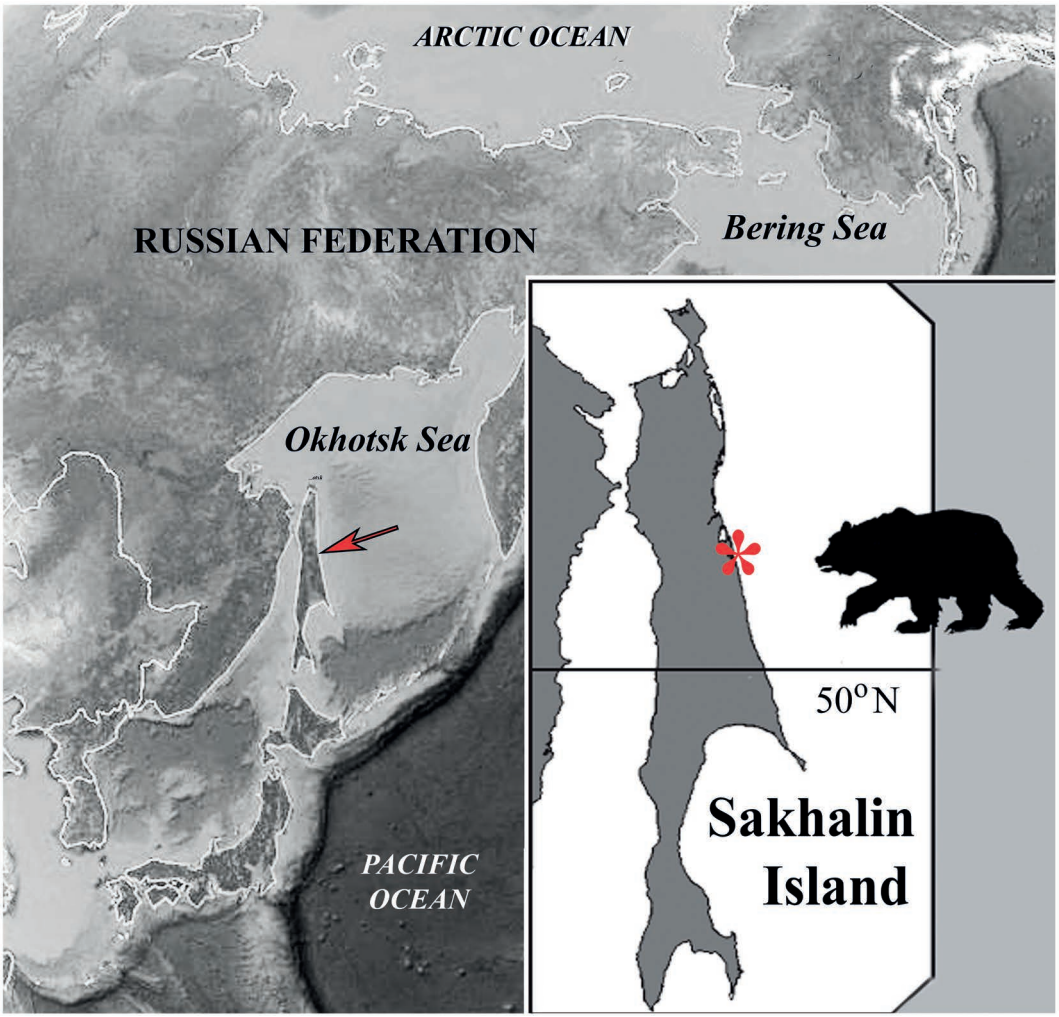

Fig. 1. The location of the Sakhalin Island in the Far East of Eurasia[1]

sacrificed animals and to interpret the mentioned objects and materials from ethnographic perspective.

Of about 70 skulls (the number of fragments and the initial quantity is not known) from two sanctuaries, only 9 lower jaws remained well conserved. There are no sufficient grounds to assume that the skulls were brought to the sanctuary

[1] The inserted scheme shows the location of the Chamgu River mouth, where the sanctuary was located (indicated by the asterisk)

without their associated lower jaws, or, conversely, together with them. Since this bone is flattened and significantly smaller than the skull, it can be easily lost in the forest litter. Moreover, similar to canines a lower jaw can be picked up by tourists as a "souvenir". Such features of the jaws may explain their low occurrence. Specimens were collected by local residents and are now stored at the Institute of Biology and Soil Science, Far East Branch of the RAS.

The studied material consists of 17 skulls of brown bear *Ursus arctos*, the isotope analysis was carried out for 14 skulls. The selection of these specimens from about 70 skulls was based on their completeness and relatively good preservation, although canines and cheek teeth were often absent or not fully represented. The presence of artificial features and injuries on the skulls was noted, for instance ocher spots on two skulls (specimens 182, 363), a trace of fire (specimen 227) and obvious pathology plus canine resurfacing (specimen 205). High humidity, heavy precipitations and positive temperatures during a significant part of the year led to a rapid decay of sanctuaries located in the open air at the mouth of the Chamgu River and to a specific preservation of the skulls, such as rough skull surface, acidic dissolution of compact bone tissue along the traces of plant roots, and greyish color of skulls.

The choice of methods for studying brown bear skulls from destroyed but relatively recently functioning sanctuaries is determined by the nature of these materials: series of skulls with traces of human impact and the absence of other artifacts, without which archaeologists usually with difficulty imagine their investigations, i.e. archaeological (inventory) and natural-historical (enclosing or underlying sediments) contexts.

Age determination of skulls was carried out according to the state of the dental system and fusion of cranial sutures. In all skulls, permanent teeth were completely erupted. In brown bear, this occurs at the age of one year and a half [62]. Juvenile (cub) skulls in the collection from the Chamgu River are absent. Brown bear reaches adulthood at the age of about three [3] or four [65] years. Tooth wear is not the most reliable age marker as it depends on the diet [9]. Indeed, the teeth of bears consuming highly abrasive foods (nuts, gammarus) are more worn in comparison to bears of the same age whose diet is based on softer foods (grass, berries, small animals, salmon) [9]. Hence, a more reliable method for bear age evaluation is based on cranial suture obliteration and synostosis [62].

In this study, skulls were categorized into four age groups (subadult, adult, mature, old: table 1) following personal data of V. Yudin, who has a profound experience studying brown and Himalayan bears inhabiting the Far East of Russia.

The first group (subadult, 1.5–4 years old) consists of skulls with non-sutures. The sutures could be similar in length to the ones of adult specimens, but their width is smaller. The obliteration of cranial sutures of the cerebral part begins at the age of four. Usually such skulls show a complete tooth arcade, cheek teeth are not worn, or little worn.

Table 1

Stable isotope composition in brown bear skulls from the sanctuary on the Chamgu River

No	Specimen No	Age	Sex	Size	%N	Coll. (mg)	Coll. yield	%C coll	%N coll	C:N	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)
1	181	sad	-	LL	5.1	24.0	240.0	43.0	15.0	3.4	-15.4	16.2
2	182	ad	F	M	4.4	27.1	225.8	43.6	15.3	3.3	-19.0	6.7
3	184	sad	-	M	4.8	25.1	251.0	43.2	15.2	3.3	-18.8	6.3
4	185	mat	M	L	4.6	27.4	228.3	46.0	15.8	3.4	-17.5	10.2
5	192	sad-ad	?F	M	4.8	24.1	241.0	44.0	15.4	3.3	-19.2	5.5
6	194	sad	-	M	4.5	27.2	226.7	44.0	15.4	3.3	-18.7	9.2
7	195	mat	M	M	4.6	27.8	231.7	44.6	15.7	3.3	-18.3	8.9
8	196	sen	M	M	4.3	22.7	189.2	43.1	15.2	3.3	-17.8	9.8
9	209	sad	-	M	5,2	25.9	259.0	43.3	15.1	3.3	-19.3	3.1
10	213	ad-mat	M	L	4.4	24.9	207.5	41.8	14.7	3.3	-18.5	6.7
11	226	ad	M	M	5.2	27.1	260.8	41.4	14.5	3.3	-18.5	7.6
12	227	ad	M	S	4.8	30.7	226.4	39.8	14.1	3.3	-19.3	6.5
13	230	sad	-	M	4.8	16.8	125.4	44.7	15.6	3.3	-18.4	8.4
14	362	sad	-	M	5.5	29.3	271.3	42.7	14.8	3.4	-18.7	7.2

Age: sad – subadult; ad – adult; mat – mature; sen – old; size: LL – very large; L – large; M – average; S – small. Sex: F – female; M – male.

The category of adult bears (over four years old) includes skulls with obliterated cranial sutures of the cerebral part and the early stage of synostosis. The teeth are worn, and cheek teeth may have fractures. The width of the skull increases with the age.

The mature group consists of skulls with cranial sutures of the cerebral part having undergone synostosis, where the sutures of the facial part are obliterated and immovable though clearly visible. Their teeth are heavily worn with significant fractures observed in cheek teeth and canines. The approximate age of such animals is over 15 years.

Skulls with complete obliteration of cranial sutures and immovable nasal bones are assigned to the category of old animals. Their teeth are heavily worn, even up to the roots. Such skulls indicate an age of 25 years and older.

Since there in no detailed methodology determining the age of Sakhalin bears, it was rather complicated to define more precisely the age of animals (whose skulls were analyzed).

Sexing was carried out visually based on the fact that the male's skull is more massive and larger, the frontal area rises more steeply and the zygomatic arches are wider. The difficulty in determining sex is related to the age of individuals as in animals younger than three years old these differences are still weakly expressed [65]; they appear best in bears at the age of four – five years and older.

Size class is determined visually in comparison: LL – very large; L – large; M – average; S – small (table 1).

Microstructure patterns. We studied the microstructure of left and right canines of the specimen no. 205 to determine the origin of the traces using EPSON PERFECTION 2580 PHOTO scanner with a resolution of 300 dpi. The polished areas of apical surface of the canine crowns were soaked in 70° alcohol for 5 hours and then analyzed using light Keyence Digital Microscope VHX-1000 (Keyence Corporation, Japan) with 5–50× lenses.

Stable Isotope Analysis

For the analysis of stable isotopic composition, small pieces (0.3–0.7 g) for analysis of stable isotope composition were taken from all 14 skulls from the distal part of the zygomatic process of the temporal bone. First, they were cleaned in chloroform/methanol 2:1 solution to remove fat remains [14]. After successive cleaning in Millipore water and acetone, the bone chunks were ground manually to powder and sieved to a grain size less than 0.7 mm. To evaluate the concentration of collagen in samples, an elemental analysis using Vario EL elemental analyzer was performed: it determines the percentage of nitrogen and, therefore, the remaining amount of collagen [7]. Sulfanilic acid from Merck was used as the standard for calibration. The standard error for %N was 0.1%.

Collagen extraction was performed in the Laboratory of Biogeology (University of Tübingen) following the protocol of Bocherens et al. [6]. Around 120 mg of bone powder was used for collagen extraction. After mineral dissolution in 1 M HCl for 10 minutes, bone demineralized powder was incubated in 0.125 M NaOH to eliminate the remaining lipids and humic acids that was followed by a solubilization step. Finally, the samples were freeze-dried.

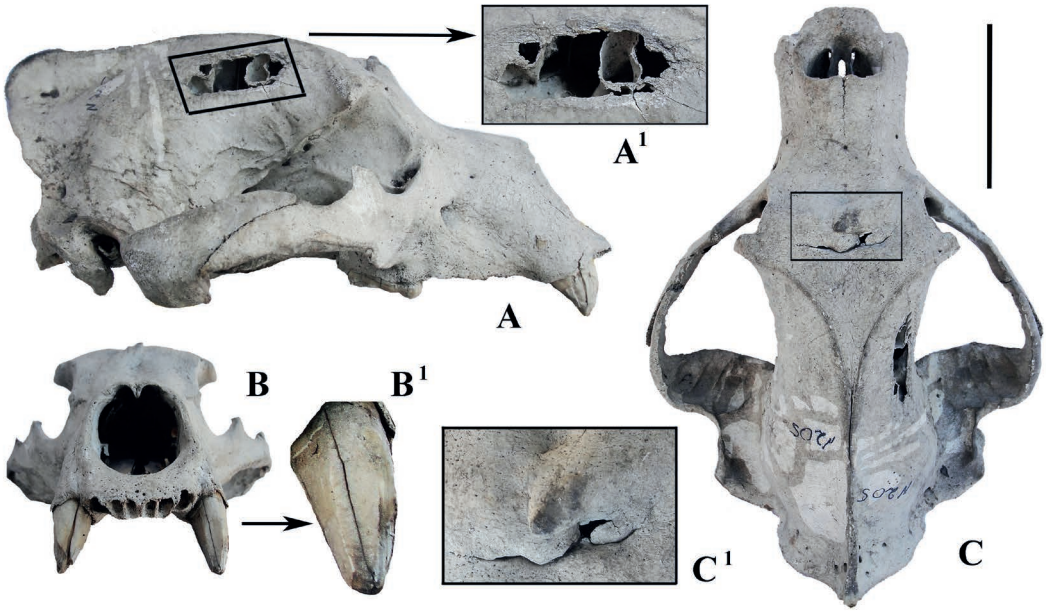

Fig. 2. The skull of brown bear male 205
A – right side view: significant artificial bone damage (A1).
B – front view; with magnification: left canine with specific trace (B1).
C – left side view (no damage is visible). C – top view: callus on the frontal bone compacts (C1).
Scale: 10 cm

The carbon and nitrogen isotope measurements were performed in duplicate in the Institute of Environmental Science and Technology (ICTA) in Barcelona (Spain) using Thermo Flash 1112 (Thermo Scientific VC) elemental analyzer coupled to Thermo Delta V Advantage mass spectrometer with Conflo III interface. This measures the ratios of 13C/12C and 15N/14N relative to the respective international standards (V-PDB for carbon and AIR for nitrogen). The international laboratory standard, IAEA 600 (caffeine), was used for calibration, and all the results were adjusted using two well-known bone collagen proteins analyzed in different laboratories for more than 10 years. An analytical error always below 0.2‰ (1σ) was determined for $\delta^{13}C$ and $\delta^{15}N$ in all the repeated analyses.

Attenuated total reflectance-Fourier transform infrared spectroscopy (ATR-FTIR)

The paint scrapings were taken from two skulls to determine their chemical composition, from the maxillary bone No. 182 (from the appearance resembling fat), and from the left parietal bone closer to the arrow-shaped crest No. 363. In-

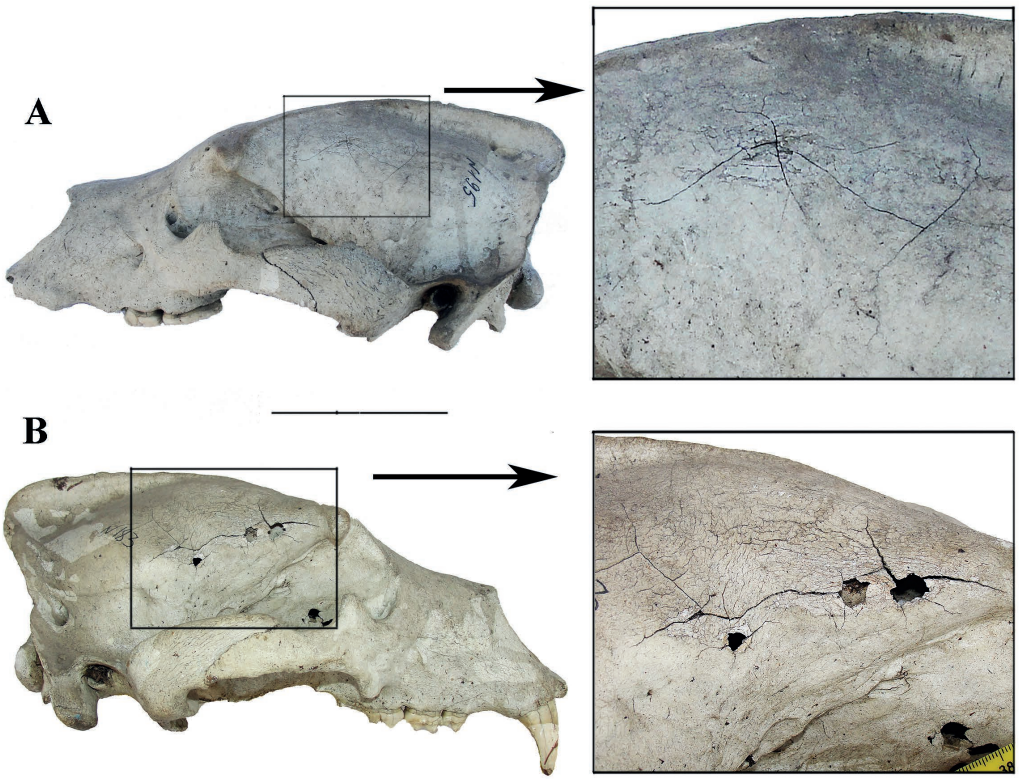

Fig. 3. Traces of human impact on the skull of brown bear
A: skull 195, direct impact with a heavy object without penetration; bone tissue in cracks.
B: skull 183, penetrating direct impacts.
Scale: 10 cm.

frared spectroscopy was used for qualitative analysis of selected samples under the study. ATR-FTIR (attenuated total reflectance Fourier transformation infrared spectroscopy) spectra were recorded with Nicolet 380 FTIR spectrometer (Thermo Scientific, Inc., Madison, WA, USA). The spectra were analyzed with the appropriate software (OMNIC Lite Software, Madison, WA, USA). Post-processing of the recorded spectra was performed with OriginLab 2015.

Results

General characteristics of the brown bear skulls from the sanctuaries

The studied skulls belong to bear males and females of different age. The sample did not include the skulls of bear cubs as all the skulls had erupted teeth. There

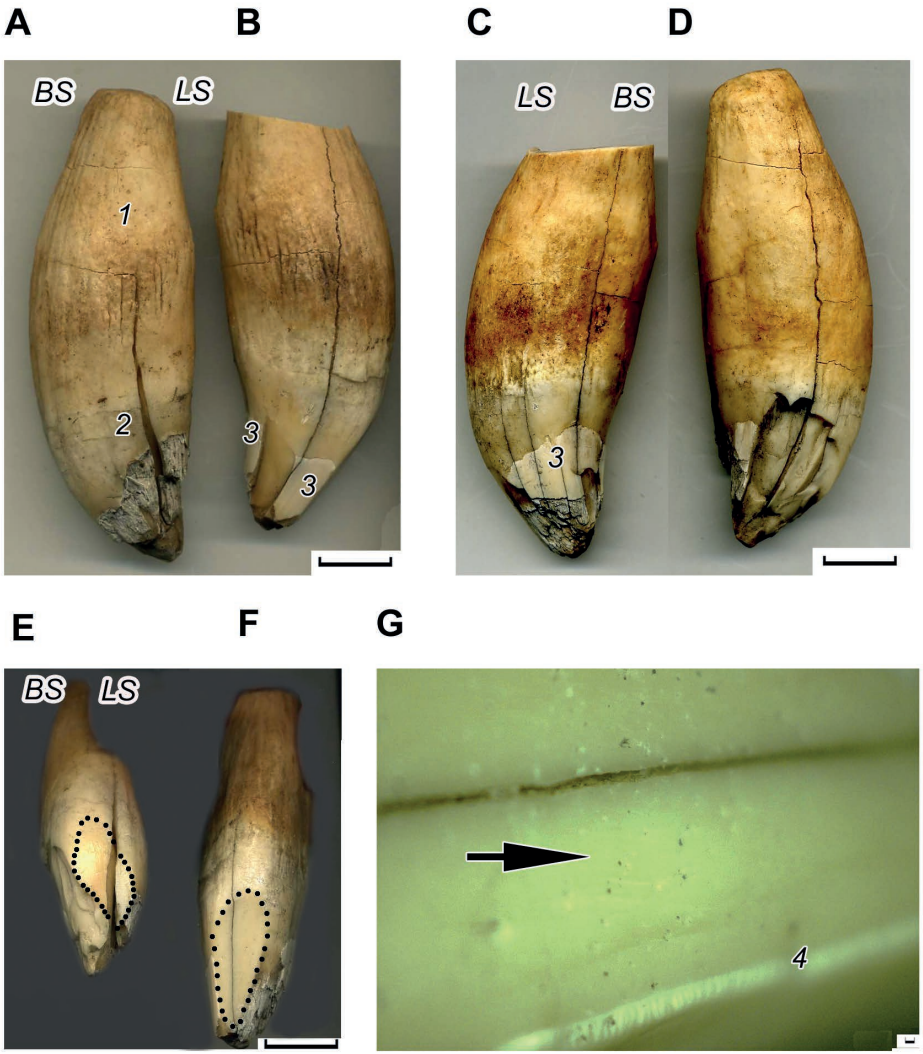

Fig. 4. Photomicrographs (A–G) of the canines of brown bear (skull 205)
A, D, E – the right canine.
B, C, F, G – the left canine.
F, F – apical view of the canines; the polished areas indicated by a dotted line.
G – the polished area of left canine, pits and short strokes indicated by an arrow. BS – the buccal side;
LS – the lingual side. 1 – a tooth root; 2 – a tooth crown; 3 – an enamel fragment; 4 – the enamel tubules.
Scale: A–F = 10 mm; G = 0.10 mm.

Fig. 5. The visualization of the uneven reddish spot (of 44x10 mm in size) on the surface of the bear's skull 363 (right) using digital stereo microscopy clearly confirmed the presence of reddish colored microparticles (left) (scale: 10 cm)

were no remains of extremely old and juvenile bears. The maximum recorded age of Sakhalin brown bear is 27–30 years [28]. The individual age spectrum of the skulls noted in table 1.

The size of bear skulls varied from small to very large. For the extreme cases, the values of the total length of the skull range from 277 to 395 mm, while of

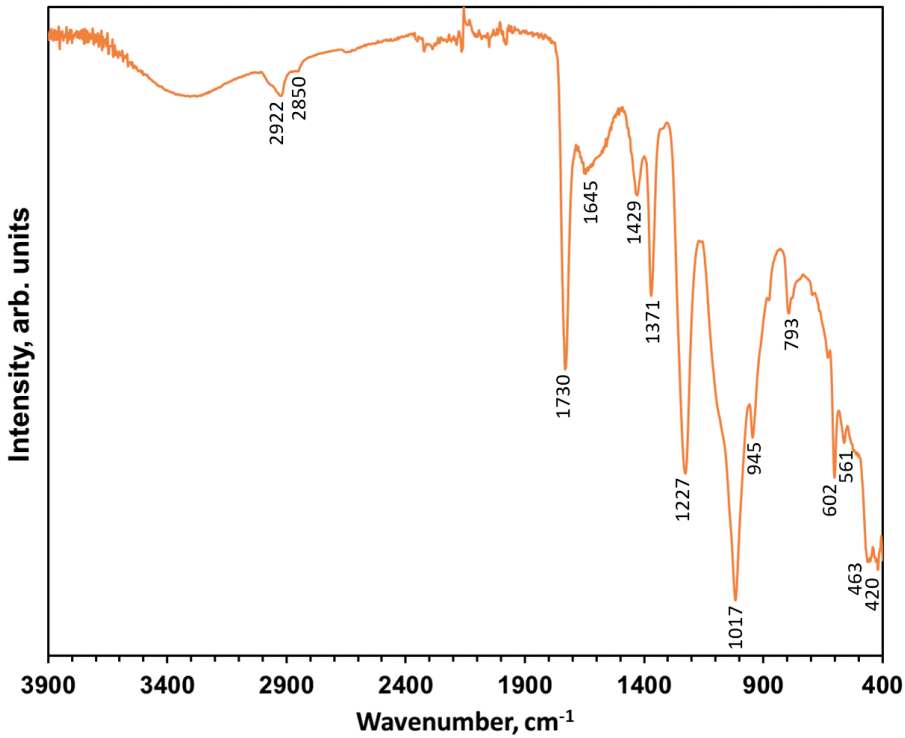

Fig. 6. ATR-FTIR spectrum of the sample 363

zygomatic width are 250 and 172 mm, respectively. Skull 205 is the only one with found pathology (Fig. 2, C[1]) after trauma presumably left from canine blow of an adult bear at early age.

In this study, we restrict ourselves to listing the characteristic traces of human impacts (this will be the subject of a separate upcoming study):

(1) Traces of blows at bear skulls can be attributed to three main types: (i) blowing with significant damage to the bone tissue and with penetration into the skull (but, as a rule, not into brain cavity). Such blows leaving the traces of 60×35 mm were probably directly applied with a heavy sharp flat object (possibly by an ax) (Fig. 2A[1]). Sometimes cracks running from skull fractures have a radial pattern; (ii) insignificant traces in the form of radial cracks radiating from one point and caused by direct blows at the cerebral part of the skull, without penetration into the brain cavity. Presumably (i) and (ii) demonstrated the results of different force applied although it was of the same direction. This action was probably caused by

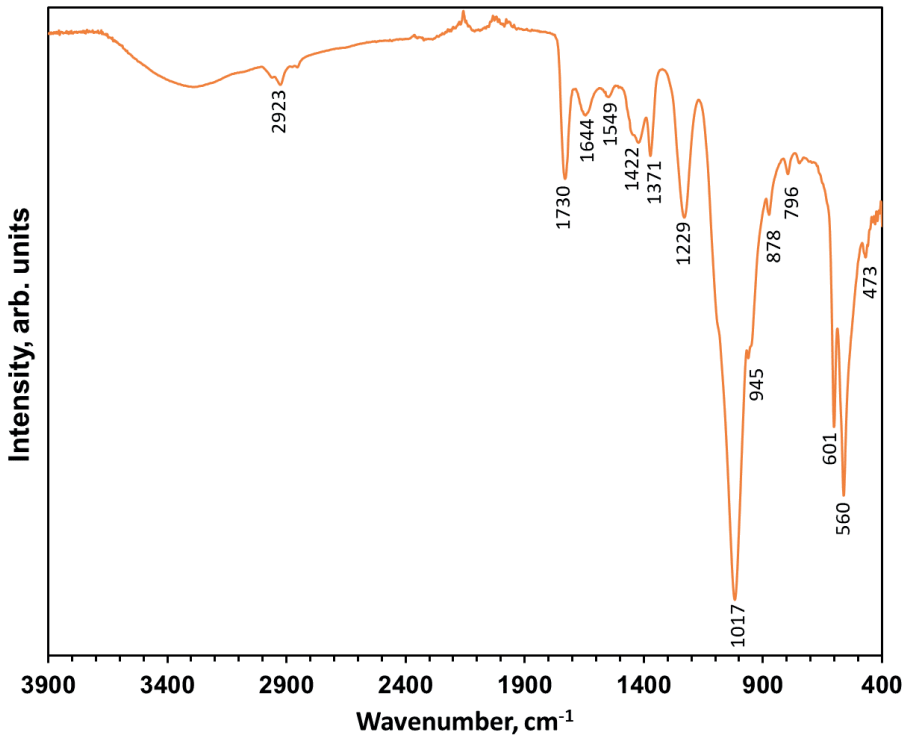

Fig. 7. ATR-FTIR spectrum of the sample 182

a heavy blunt object; (iii) direct penetrating blow, likely caused by an arrowhead or a bullet, of 0.8 cm in diameter (skulls №№ 183, 227 etc., Fig. 3). On some skulls, these effects are combined, showing a variety of impacts.

The most often damaged areas are: the temporal region, the parietal and frontal bones of the skull, less often the supraorbital process of the frontal bone and nasal bones (Fig. 2 A[1]).

(2) Abraded anterior surfaces of canine crowns in skull 205 (Fig. 2 B[1] and Fig. 4). On the anterior surface of canine crowns oval "polished" enamel areas are observed (Fig. 2 B[1] and table 2); such area is larger on the left canine crown.

Table 2

Metric data of studied canines of the brown bear scull 205

Samples	Height, mm	Width, mm, max	Square of polished area, mm^2
Right canine	–	26.6	75.8
Left canine	73.2	26.4	97.0

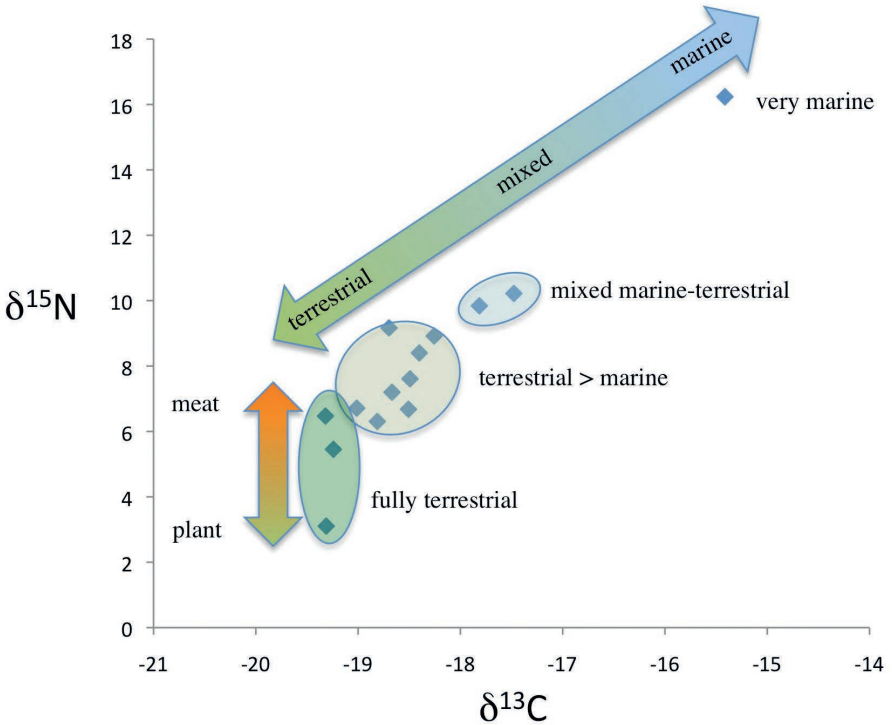

Fig. 8. $\delta^{13}C$ and $\delta^{15}N$ values of bone collagen from the 14 analyzed brown bear skulls. Estimates of terrestrial versus marine food intake are based on Kuzmin [32]

The surface of these areas is completely smooth, with the exception of a small fragment on the left canine, in which small dark and light pits (50–60 microns) and short and narrow (60 microns) scratches are visible. The pits are located in several wavy lines across the tooth, at the same distance from each other, equal to 320 ± 8.0 microns (n = 10). The short strokes run parallel to each other and along the long axis of the tooth. Such traces arise from long friction on metal uneven objects.

(3) The coloring matter on the skulls 182 and 363 (Fig. 5). Identification of the origin and nature of reddish colored spots has been carried out using ATR-FTIR. In skull 363 spectrum (Fig. 6), 2922cm^{-1} and 2850 cm^{-1} peaks are due to CH stretching in−CH3 and−CH2−groups present in long chain fatty acids while the 1730 cm^{-1} reflects stretching vibration of C=O (carbonyl) present in egg yolk [47]. The presence of protein is confirmed by registering of two strong features at 1644 cm^{-1}. These bands are associated with the C=O stretching vibration and a combination

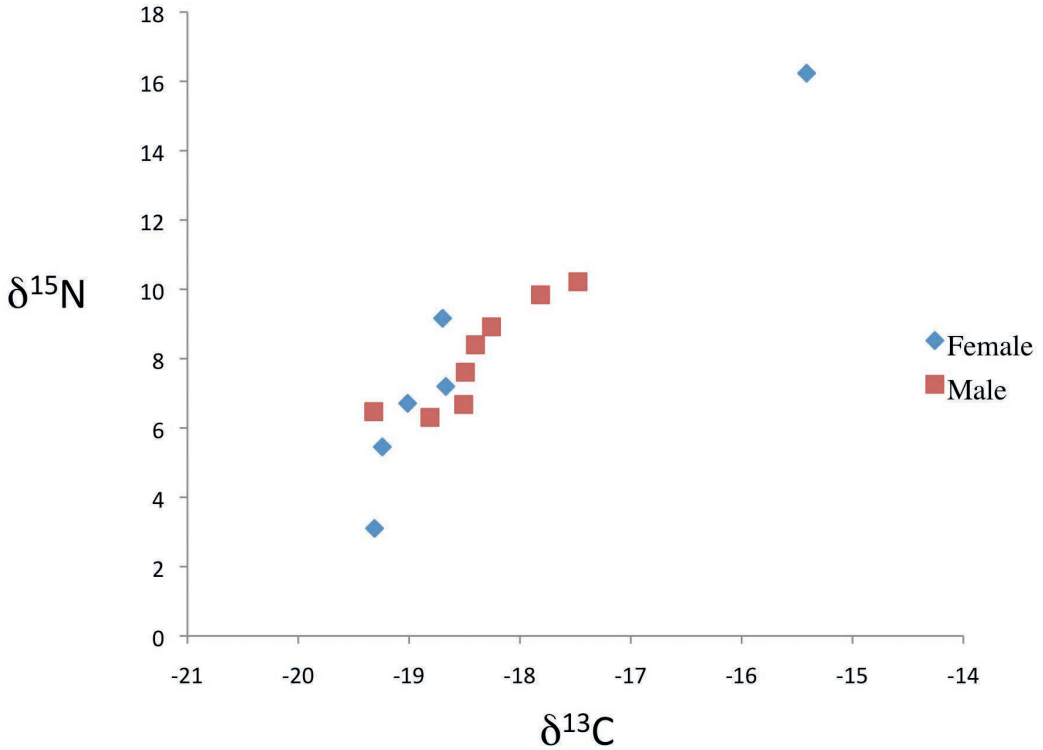

Fig. 9. $\delta^{13}C$ and $\delta^{15}N$ values of bone collagen of male and female brown bears from the analyzed sanctuary

of N-H bending and C-N stretching vibrations in amide complexes, respectively. However, there are no bands typical for bone collagen (see for details [33]). This observation additionally confirms the presence of egg yolk protein within this pigment. Peak registered at 1429 cm^{-1} is associated with the stretching vibrations of the -COO- and C-H band, while the bands at 1017 cm^{-1} and 945 cm^{-1} are associated with out-of-plane Si-O as well as Si-O stretching vibration, respectively, which are typical for clay minerals [34]. The visible band at 1227 cm^{-1} was related to asymmetric stretching of PO2 vibrations of the phosphate groups that might indicate the presence of hydroxyapatite of the bone (skull) origin. Additionally, the presence of hydroxyapatite was strongly confirmed by the registered peaks at 602 cm^{-1}, 561 cm^{-1} and 563 cm^{-1} which represent ν4 O–P–O bending vibrations of PO_4 groups, while bands at 463 cm^{-1} and 420 cm^{-1} are related to the ν2 bending vibration of PO4 group [55]. Interestingly, on the registered FTIR spectra, two bands at 793 (796)

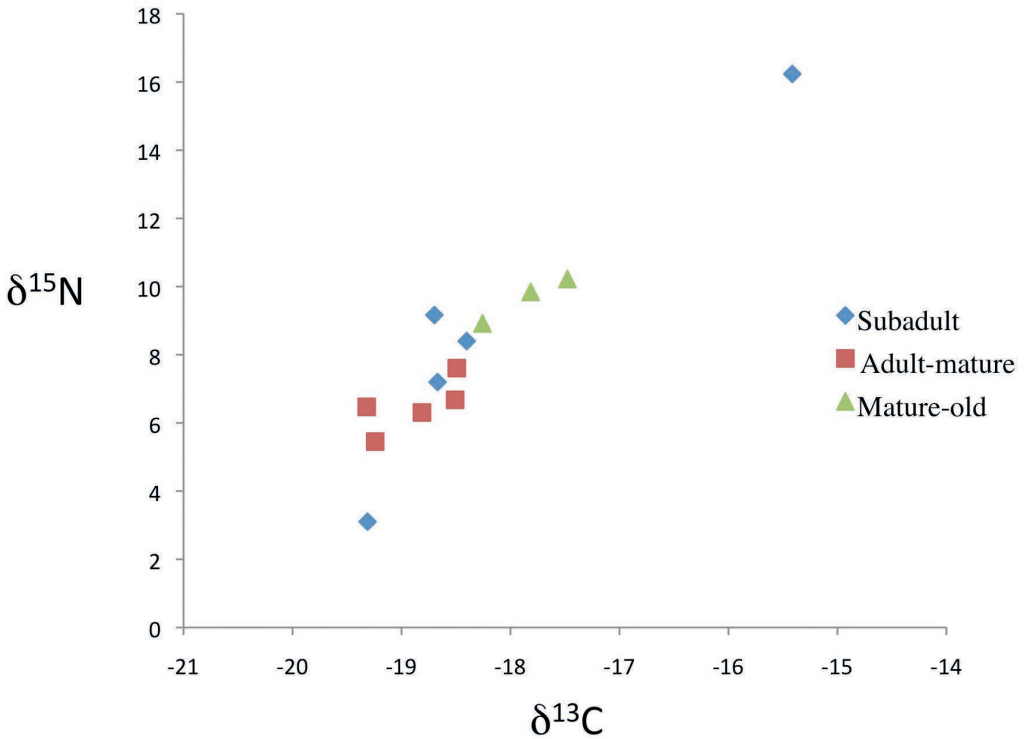

Fig. 10. $\delta^{13}C$ and $\delta^{15}N$ values of bone collagen of brown bears from the analyzed sanctuary according to their ontogenic stage

cm^{-1} and at 878 cm^{-1}, respectively, are also visible (see also table 3). They might be related to the vibration features of iron oxides [5]. It is well recognized that, for example, the major bands of goethite are observed at about 793 cm^{-1} and 898 cm^{-1} [13; 19]. The occurrence of iron oxides deposits on Sakhalin Island as essential parts of corresponding iron-based ores has been reported in the literature previously (see [38]). Similar FTIR analysis data were obtained for skull 182 (Fig. 7).

Table 3

Assignment of the registered IR peaks

Wavenumber [cm^{-1}]	Assignment
2922	CH_2 assym. stretching vibrations
1730	C=O stretch, absorption band of fatty acid ester
1645	Amide I band

Wavenumber [cm^{-1}]	Assignment
1429	Stretching vibrations of -COO-
1371	Stretching C–O, deformation C–H, deformation N–H
1227	PO2 asymmetric
1017	C-O-C fatty acids esters; C-O-H vibrations
945	Confirms the presence of a disordered lattice phosphate apatite
793	Guanine in a C3'endo/syn conformation in the Z conformation of DNA
602	ν_4PO_4 (hydroxyapatite)
561	ν_4PO_4 (hydroxyapatite)
463	ν_2PO_4 (hydroxyapatite)
420	ν_2PO_4 (hydroxyapatite)

Thus, on the basis of obtained analytical data, we can hypothesize that the red pigment used in the case under this study is typical for natural iron oxides- and egg yolk- containing mineral-based red pigments, which have been traditionally used for bone and skull paintings in diverse geographical areas (see for overview [43]).

(4) Traces of charring, poorly visible in the area of damage to some skulls (e.g. 227). This is probably a consequence of the burning of the bear's head with fire.

Stable isotope analysis: results and diet of sacrificed brown bears

Below is the data on the diet of the bear to understand the results obtained by the isotope method. The nitrogen content analyzed in all 14 bear bone specimens was very high, ranging from 4.3 to 5.5 % N (table 1), in the same range as was recorded for fresh bones [7]. Accordingly, the yields of collagen extraction were also similar to those of fresh bones, with an average of 227.4 $mg.g^{-1}$ (table 1). All collagens exhibited chemical composition (%C, %N and C:N) in the same range as collagen from fresh bone, so it is clear that the preservation was excellent and that the isotopic values measured on collagen reflect the biogenic values and can be interpreted in palaeobiological terms.

The isotopic values pointed to large variations, with values ranging from –19.3 to –15.4 ‰ and from 3.1 to 16.2 ‰ for $\delta^{13}C$ and $\delta^{15}N$ values, respectively (table 1). There is a clear co-variation of $\delta^{13}C$ and $\delta^{15}N$ values that reflect a diet ranging from purely terrestrial (low $\delta^{13}C$ and low $\delta^{15}N$ values) to a diet essentially composed of marine food, such as salmon (high $\delta^{13}C$ and high $\delta^{15}N$ values), the values in-between indicate a mixed diet (Fig. 8). In terms of possible influence of sex, both

males and females cover a wide range, the females more so due to the occurrence of one outlier with very high $\delta^{13}C$ and $\delta^{15}N$ values (Fig. 9).

If the specimen 181 with a strong marine signal is not considered, then the males seem to have consumed more salmon than the females. In terms of age at death, the subadults (skulls 181, 192, 194, 209, 230, 362) exhibit the widest range of isotopic variation, including both specimens at the extremes of the whole range, with extremely low (No 209) and high (181) isotopic values. Older adults (185, 195, 196, 226, 227) showed more grouped results indicative of a terrestrial or mixed diet, with the adult–mature ones having predominantly terrestrial diet range and the mature–old skulls being in an isotopic range, which indicates a mixed terrestrial and marine diet (Fig. 10). This suggests different ways of getting bear skulls to the sanctuary: raising in captivity and killing a wild bear on the hunt.

Discussion

In the 19th century – the first half of the 20th century, the territory at the Chamgu River was occupied by two ethnic groups, Uilta and Nivkhs. Sakhalin Island has been always a unique contact zone between the island and continent worlds, at the border of Eastern and North Eastern Asia [64]. In the 19th century, three main Sakhalin ethnic groups, Nivkhs (the old term Gilyaks), Uilta (the old term Oroks, Orochon) and Ainu as well as Evenki and Yakuts who appeared there in the end of the 19th century had close inter-ethnic connections, especially in the central and northern parts of the island [57; 46]. The coast of the Sea of Okhotsk, Lunsky and Nabilsky bays and the plain adjacent to this area were characterized by alternate residence and ethnocultural exchange between Uilta and Nivkhs [46]. While Uilta led a nomadic life, Nivkhs developed reindeer husbandry [48]. Those inhabiting the territories to the south, neighboring with the Japanese and Ainu, switched from reindeer-farming to fishing [46]. Each ethnic group, however, had its own burial ritual and the rules to celebrate bear holidays. While evaluating the relationship of sacred objects found at the Chamgu River to peoples inhabiting Sakhalin we would like to discuss the following issues: (i) ethnic territory, (ii) burial ritual and (iii) preservation of bear remains.

(i). Territory. The name Chamgu or “Cham Gueri” means “Eagle River” in Nivkh language [16]. Though at the map of Mogami Tokunai (1786) published by Philipp Franz von Siebold (1930) the Chamgu, Nampi Rivers and Lunsky bay belong to the “LAND DER OROTSKO’S”, i.e. the land of Oroks [61]. Uilta were the neighbors of Ainu and Nivkhs for a long time. The people of Orok-Ainu kin

known as Geta nomadized in the middle part of Sakhalin [44]. It was reported that "Oroks"–Uilta were easily related with Nivkhs and Olcha at the Lower Amur [44]. In 1913, Merkushev R. V. visited seven Uilta settlements located at the coast of the Sea of Okhotsk, from Cape Delil-de-la-Kroiera (51°N) to Piltun Bay [46]. The ethnographic map of Shrenk L. [50, p. 324], however, marks Chamr-vo settlement as Nivkh territory, while Uilta owned only the territory of nomad camps. In the first half of the twentieth century, Nivkhs reindeer herders inhabited the area at the mouth of the Chamgu River. During salmon spawning they went up the river for fishing [48]. According to Bibikova E. A., the elder of Uilta group and a philologist, in the first half of the twentieth century Uilta lived in this area separately from Nivkhs though keeping contacts with them (personal communication to Vasilevski A. A., 2021). Men led a nomadic life in the mountains pasturing reindeer and then they came back to the settlements to join their families. There were no Ainu settlements in Chamg-vo.

(ii). Burial ritual. Uilta and Evenki traditionally buried their relatives in coffins placed on the ground (air burial). On the other hand, Evenki who moved to Sakhalin from the continent at the end of the 19th century "were orthodox, had Russian first names, last names and patronymic, buried the dead according Orthodox practices putting a cross on the grave" [57]. The burial rituals of Ainu were described by the ethnographer Onuki-Tirni [42]: "...the coffin is buried and then a small hill grows. Though this was possible only in summer. When the earth was frozen Ainu put two logs on the ground and placed a closed coffin on the logs, Ainu said that their traditions differed significantly from Oroks rituals, the latter used to build specific tall poles to place the coffin at" [42]. In some cases, the entrails of the deceased were removed and the body was dried and put into the coffin that was placed on low (30–40 cm) platforms [42; 12]. Moreover, while describing Ainu rituals air burial was not mentioned neither by Dobrotvorskiy M. M. (1875), who investigated Ainu graves, nor by Shternberg L. Y. (1933). The reports of Ishchenko [64] on air burial of shamans, the bodies of which were put in sacks and placed on trees, are not supported by evidence. Finally, the practice of putting the coffins on snow [42] was only the first stage of earth burial.

Cremation was a typical burial ritual of Nivkhs until 1960s. Traditionally, a farewell ceremony was followed by the cremation of body on a funeral pyre and placing the ashes in a small toy house with a door and a window [51]. In 2003, in the lower reaches of the Nabil River, Vasilevski A. A. (an co-author of this paper)

personally studied Nivkh cemetery with two types of burial. In the traditional type of burial dozens of metal bowls with holes were placed between trees. As was reported by a Nivkh woman, Nadezhda Ekzayn (personal communication with Vasilevski A. A. on April, 20, 2021), the ashes of cremated relatives were kept under these bowls. From 1960s, however, Nivkhs were forbidden to carry out cremation. Indeed, Alexandr Ekzayn, the brother of Nadezhda Ekzayn, was buried in the coffin at the same cemetery.

Taking into account this information the revealed cases of air burial located at the Chamgu River did not belong to Ainu, Nivkhs or Christian Evenki. Most likely these findings are related to nomadic Uilta. According to Pilsudskiy, despite the adoption of Christianity "Oroks"–Uilta did not celebrate Christian holidays acknowledging only bear holiday, the ceremony of which was carried out in agreement with all the rules. Although Uilta denied its religious character [24]. The findings of the remains of air burial in the second half of the 20th century may be interpreted as the preservation of the Uilta traditional burial ritual to place coffins above the earth in taiga. In this way they marked their identity, their right on religious practices and the territory within the borders of which they led a nomadic life.

(iii) Damage on the skulls. Vasiliev (1948) reported that "Nivkhs and northern Ainu struck the skull in a specific point employing a special axe. Depending on the sex of the bear, the hole was made in left or right parietal bone for male and female bears, respectively. Orochi, Udekhe, Nanais also made a small round hole in one of the parietal bones" [59]. The most of skulls from the Chamgu River show the traces of crushing fracturing blows. According to Kreynovich (1982) observations, continent Nivkhs used to strike bear skulls, whereas Nivkhs inhabiting Sakhalin did not damage neither skulls, nor bones considering them taboo [30]. He assumed that the bear skull cleaned from meat was struck with an axe to take the brain out [30; 49]. Though the holes in the skulls were not connected with the brain chamber. Kreynovich describes, however, that the head with the lower jaw was fried and the brain was taken out through occipital opening [31; 30]. Obviously damages to the skulls observed at the same sites indicate a tradition. Perhaps they resulted from a ritual final blow releasing a soul from animal's head [1].

The traces of ocher at skulls also point to the ritual character of conducted ceremonies. Though only two skulls show the presence of ocher we believe that the paint must have faded from the other skulls with time and due to climatic conditions. In Nivkh culture, the rituals related to death were always accompanied with

the use of ocher. We suggest that the ways each Nivkh kin handled bear remains should be studied separately [31; 30].

(iv) Preservation of bear remains and the beliefs of afterlife connection between human and bear souls. The information on the sites the bear skulls were revealed at is rather scarce. Though obviously there must have been a purpose for the collection of the dozens of bear skulls at one place. Such tradition can be related to Ainu, Uilta and Nivkhs. According to Pilsudski, "before sunrise all the bones and the skull should be taken out of the house and put at the place dedicated to a specific purpose" [44]. Ainu and Nivkhs were reported to have the same tradition [31; 42; 44; 59].

Both Nivkhs and Uilta preserved bear skulls in special sanctuary warehouses (hereinafter referred to as sanctuary warehouses). While traveling to Sakhalin Oroks in 1904, Pilsudski recorded the tradition to preserve bear skulls in a sanctuary warehouse [44]. Ainu, on the other hand, put a bear skull on a pole fixed in the ground and Uilta preserved the skulls on platforms placed in sanctuary warehouses [44]. Uilta believed the bears to be the carriers of souls to the Afterlife [67]. In the end of the 20th century, Uilta inhabiting northern Sakhalin did not celebrate bear holidays, but buried bear bones in the earth without any ritual [15]. Vasiliev reported that Oroks, Nanais, Ulchi, Samagira, Nivkhs, Evenki, Lamuta, Itelmens, Yakuts and Khanty hung the skulls of slaughtered bears on trees, not in sanctuary warehouses [59]. "The bear head was smoked and placed on the platform. Nobody should see where it is placed" [63]. Next, the bear head was eaten and the bones were buried in the forest [63]. Ainu preserved the skulls on forked poles fixed in the ground [52]. Old skulls were replaced with the new ones [52]. In the 20th century, Nivkhs practiced a step-by-step solemn placement of a bear head. It was placed on a special "burial platform", next to the bones the "things to be taken with" were put, i.e. a cauldron, an axe, a rifle, arrowheads. The bear head was decorated with earrings made of nettle, which were spun with dog's hair and Siberian red lily bulbs, head wreath from wood chips smeared with cranberry juice. After bear brain had been eaten its fur was skinned from the head, the head was smeared with jellied meat and smoked at taboo fire. Then a skull was kept at a sanctuary warehouse in special willow chips [31; 29]. Nivkhs buried the skulls in the forest or hung them onto trees only when the sanctuary warehouse was full and had to be emptied for new sanctuary objects [56].

Detected features including the presence of sanctuary house and non-specific, but not round, holes in bear skulls allow us to assume that at least one of the sanctu-

aries at Chamgu River belonged to Nivkhs. However, the presence of people buried in coffins in the open-air style right next to the sanctuaries points to the presence of Uilta there which is in line with real ethnic situation in Sakhalin at the first half of the 20th century. The disappearance of cultural borders between the peoples inhabiting Sakhalin might have led to the borrowing and modification of traditions and to the joint use of ritual objects.

Polished areas on the front surface of the canines (skull 205) are an indirect evidence of the contact with humans indicating that the animal rubbed its teeth against some rather soft objects, for example a tree trunk. The bear cubs were kept in wooden cages or log cabins, which explains the absence of major damage (for example, deep and wide grooves) on the surface of these areas. However, the local presence of transverse wavy lines of orderly located pits and longitudinal short scratches suggests that the animal also rubbed against some kind of knotty structure. The latter is also interesting as the skull belonged to a mature individual, which, for some reason, was kept before slaughter for over seven years.

Nivkhs kept bear in the cage up to the age of three (males) and four (females) years, respectively [30], as later they became uncontrollable. Oroks/Uilta traditionally raised a bear cub in a cage for 3–4 winters, but later "in view of the less and less fondness for the festival and the smaller number of guests … they killed the bear after being two winters in the cage" [44]. It could be assumed that bears younger than 2–4 years (almost half of the studied skulls, table 1) were grown and slaughtered, except for hunted bears, and the older ones for sure were hunted. However, the obtained data including the reconstructed diet of bears (see below), is more complicated. The skull 205 is an interesting example showing a rather complicated fate of sacrificed animals depending on their age: polished surfaces of canines point to animal captivity, moreover, the captivity lasted longer than it was reported according to ethnographic records. An alternative scenario for this specimen could be the following: a bear cub kept in captivity escaped and lived longer than the other imprisoned animals. The use of its skull in the ritual indicated by the traces of blows points to the slaughter of that bear, perhaps during hunting.

According to Yudin, one of the co-authors, the bears kept in wooden cages/warehouses are active and prone to experiments including escape attempts. Due to restricted mobility such animals become quite inventive and persistent, i.e. constantly chewing on the walls of their prison. If the walls are made of thick wooden logs, enamel abrasion of canines occurs inevitably. Most likely this was the reason

of enamel abrasion observed in canines of № 205. Free bears, on the other hand, can occasionally gnaw the cambium of 20–30 years old fir trees, the wood of which is soft, licking the juice. However, this does not leave the traces on animals' teeth.

Although visually some skulls display significant morphological differences, it is difficult to trace consistent morphological patterns, especially since their size and sex varied. Obviously, the use of physicochemical methods, first of all, the method of stable isotopes, allowed us to identify visually indistinguishable features of bear's ecology.

Brown bear feeding behavior in Central Sakhalin

The brown bear diet includes vegetative and reproductive parts of plants, as well as animals of all types. The proportion of each food component varies seasonally.

In the active period of the year (April – November), early spring, spring – summer and autumn dietary cycles are distinguished. Early spring is characterized by mainly herbivory diet with scarce food resources, predominantly (up to 80–90 %) berries and nuts preserved from previous autumn, and young shoots of plants that appear shortly [8; 66].

As the snow cover disappears, the bears descend into the river valleys where they eat plants that have begun to vegetate. Animal food (spawning fish preserved from autumn) is present sporadically in the diet (5–8 %) in accordance with the intensity of the autumn spawning course. With the onset of the growing season in the lowlands, bears move to the middle and lower sections of river valleys, where they feed on shoots of herbaceous plants, foliage of shrubs, dig anthills, and catch small mammals and invertebrates. Starving individuals pursue reindeer (*Rangifer tarandus*) and pick up carrions [66].

The summer season (June – early July) is characterized by the beginning of the salmon fish spawning period, making the rivers attractive to bears. Pink salmon (*Oncorhynchus gorbuscha*) enters the rivers first; chum salmon (*O. keta*) comes last in September – October, right up to frosts. Rotation of species of spawning fish determines the duration of the period of food resource abundance. Salmon is the most stable food in Sakhalin. Therefore, in years of crop failure of berries and nuts, bears do not make vertical migrations, but stay constantly in the vicinity of rivers. In such years, up to 90 % of their diet is composed of fish. The coincidence of crop failures of berries and nuts with weak spawning is a disaster, because bears are starving and do not gain enough body fat for normal wintering. In such autumn periods, bears are active until a stable snow cover is formed.

Seasonal replacement of food is determined mainly by its availability. After feeding on fish, bears go to the berry-beds (*Vaccinium praestans, Vaccinium vitis-idaea, Sorbus* sp., *Rosa* sp., *Ribes* sp., *Padus asiatica,* etc.) or into the thickets of cedar dwarf. Later there are reverse movements. These shuttle-type movements and a change in diet provide the necessary variety of diets and contribute to the accumulation of necessary fat deposits [66].

Bears have a physiological need to switch to another food, which is well manifested in years that are favorable for the plant and animal feed (fish). If there is insufficient food, then the diet is composed of all food items, including sea washed deposits at the coast and wastes from settlements.

Diet of bears whose skulls were collected in sanctuaries

The range of $\delta^{13}C$ and $\delta^{15}N$ values clearly indicate that the protein fraction of analyzed bears diet ranged from purely terrestrial to almost purely marine food, with many specimens having a mixture of both in varying proportions. Though it is known that brown bears in Sakhalin consume more marine food (salmon) during summer and autumn [22], such seasonal changes in the dietary input of bears were not reflected by the obtained isotopic data as collagen isotopic values reflect an average of several years [21; 37]. The bears with a mixed isotopic signal probably reflect seasonal dietary behavior, while the ones with purely terrestrial signal did not consume salmon, consistent with observations that some bears do not feed on salmon in Sakhalin [22]. Most of analyzed adult females consumed less salmon than males (Fig. 8). This could be due to the avoidance of areas with access to salmon by females with cubs to limit the risk of infanticide by males, a behavior observed for brown bears in Alaska [2]. Interestingly, the skull with the highest marine content in its diet belonged to a female of very large size (specimen 181), which is consistent with the trend that bear size increases with higher proportion of consumed salmon observed in North America [23; 39]. However, in the Far East of Russia, observations show that large individuals, not inferior in size to grizzly and kodiak, inhabit the areas where salmon fish do not occur, in particular, on the western slopes of Sikhote-Alin, in the south-western regions of Primorsky Krai, in the central part of Sakhalin Island with a limited volume of salmon fish [8; 11; 66; 10; 24]. The size and weight are mainly influenced by accessibility and variability of feeds. According to the type of food, brown bear is omnivorous. Eating only meat (fish) is caused by the lack of other food. The predominance of meat or plant foods in the diet does not significantly affect brown bear morphotypes and the general morphological properties of populations. Historically formed population properties

are preserved with a certain amplitude of variability over the years, in full dependence on the availability of feed resources. Therefore, very large size bears with marine diet among Sakhalin bears do not seem to follow the typical pattern in the area, but rather matches the trend seen in north-western North America.

Among the bear specimens with terrestrial isotopic signal, the specimen with low $\delta^{15}N$ values most probably consumed essentially plants, while the detection of high $\delta^{15}N$ values could indicate a diet rich in animal proteins, although this is not certain since some plants also exhibit higher $\delta^{15}N$ values [36]. Moreover, single compound amino-acid nitrogen isotopic analysis of brown bear bone collagen showed that there was no obvious correlation between $\delta^{15}N$ values of bulk collagen and consumed animal protein [40; 41].

If we consider that the age category "subadult" corresponds to bear individuals sacrificed after being kept captive and fed by their human keepers, this category is characterized by the largest isotopic diversity, including the most extreme isotopic values, reflecting either a purely terrestrial or essentially marine dietary input. This could reflect different habits in feeding the captive bears depending on the tribe or the food available, sometimes only of terrestrial origin, sometimes to a large extent composed of fish or marine mammal meat (including dry fish, available all year long), a similar type of feeding behavior not found in wild animals that have access to marine food only seasonally. Since mature and old skulls are very unlikely to have been kept captive long enough to reach this stage, we can assume that such wild individuals were killed during hunting events, and the proportion of marine food in their diet is consistent with the yearly diet composition of brown bears on Sakhalin Island (see above).

Conclusions

Our research shows that an integrated approach to the study of surviving materials, even from destroyed archaeological sites, makes it possible to reconstruct some aspects of the brown bear cult that are not currently observed and are known mainly from old ethnographic data.

Brown bear skulls belonging to the animals of different size, age and sex from two modern (before the first half of the 20th century) open sanctuaries at the Chamgu River are valuable for archaeozoological and ethnographic reconstructions as similar evidences of bear cult in Sakhalin are quite rare. The results of our study are one more step to fill this gap. It should be especially noted that apparently these

sanctuaries, the last (or among the last) of recently functioning ones in Sakhalin, demonstrate the signs of leaving the traditions, which was caused by the influence of the neighboring peoples and the modern world. Stable isotope analysis pointed to a significant diet range from purely continental to pure marine, with transitional mixed options. At this stage of the study, we assume that this may be due to both the feeding conditions in captivity and the variety of diets of free-living bears. The study of the skulls showed their heterogeneity, caused by human activities and natural factors, the significance of each has yet to be determined. We assume that the location of Uilta cemetery in the proximity of Nivkh storage of the bear skulls at the Chamgu River indicates the joint use of this area.

From the late Pleistocene to the present, humans and bears coexisted in Sakhalin Island, interacting in the same environment and sharing the same spatial and food resources. This led to the interconnection between the life cycles of the species, *Ursus arctos* and *Homo sapiens*.

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We declare no conflicts of interest.

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