Late Holocene Animal Use in Southern Kamchatka

Katsunori Takase, Masaki Eda, Michael A. Etnier, and Alexander I. Lebedintsev

Abstract. This study purposed to reveal animal use in southern Kamchatka by examining the largest archaeofaunal collections recovered by Tamara M. Dikova and Nikolai N. Dikov. Radiocarbon dates of charcoal and caribou antler demonstrated that materials for this study were dated during the past 1,600 years, including three cultural periods: Nalychevo Culture (the 15–19th centuries AD), Tar'ya Culture (the mid-first millennium AD), and the intermediate period between them (the early second millennium AD). The taxonomical distribution suggested the significance of true seals and caribou as hunting games. Various roles of sites around Cape Lopatka for seasonal hunting, trade, and manufacturing bone tools were inferred based on bone composition. Caribou antlers, drift whale carcasses, and long bird bones were important materials for making bone tools. The first example of wolf eel and Steller's sea cow remains associated with archaeological sites on the Siberian side of the North Pacific were also reported.

In the past two decades, the chronological study of prehistoric cultures in Kamchatka has made significant progress from the Upper Paleolithic to the second millennium AD (Goebel et al. 2003, 2010; Ponomarenko et al. 2002; Ponkratova 2006; Ptashinsky 2012; Takase 2013, 2014, 2020c). These studies have enabled broader research perspectives focusing on the impact of natural disasters on humans and long-distance cultural interaction with North America, the Japanese Islands, and Sakhalin (Goebel et al. 2010; Gomez Coutouly and Ponkratova 2016; Kuzmin et al. 2008; Pendea et al. 2015; Phillips 2011; Takase 2021). One of the most remarkable results in southern Kamchatka is elucidating the occupation history of the Kuril Ainu, an Indigenous people of the northern and central Kuril Islands. Archaeology has revealed that this ethnic group emerged not only in the Kuril Islands

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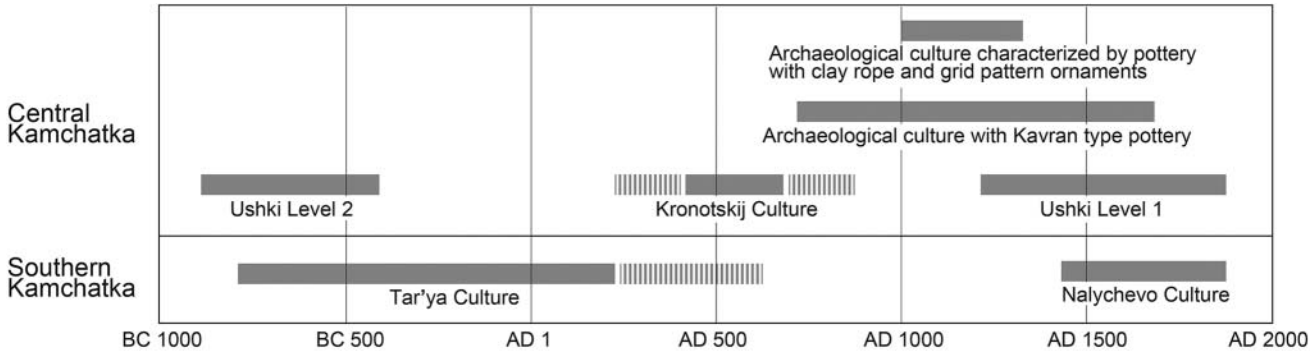

Figure 1. Chronological sequences of archaeological cultures in central and southern Kamchatka based on Dikov (1977, 1979), Ponomarenko (1985, 1993, 2000), and Takase (2013, 2014, 2015b, 2020c).

but also in a wide area in southern Kamchatka in the mid-15th century AD (Takase 2013, 2015a, 2019; Takase and Lebedintsev 2016). Their major withdrawal from Kamchatka occurred at the beginning of the 18th century (Takase 2020c). They then lived only in the Kuril Islands by the beginning of the 19th century, as demonstrated by ethnographic documents (Torii 1919). Archaeological research has also revealed that southern Kamchatka was an uninhabited area or a region with an extremely low population density between the termination of the Tar'ya Culture (the 3rd century AD or later) and the colonization by the Kuril Ainu (the 15th century AD) (Takase 2020c:Fig. 1).

Despite such advances in Kamchatkan archaeology, the region's prehistoric economy remains unclear. This situation is mainly due to the scarcity of animal and human remains recovered in recent archaeological excavations. Another cause is the lack of detailed information on abundant archaeofaunal materials retrieved before the 1990s. This study examines animal bones in the most extensive archaeological collections from southern Kamchatka. Although artifacts in the collections suggest that faunal remains can be dated to the Late Holocene, animal bones have not been thoroughly examined. Based on the full details of the highest priority archaeofaunal collections, our work hoped to reveal the characteristics of animal use in southern Kamchatka during the Late Holocene.

Materials

We examined archaeofaunal remains from southern Kamchatka retrieved by Tamara M. Dikova (1983) and Nikolai N. Dikov (1977, 1979) in the 1960s and 1970s. They are currently curated in the North-Eastern Interdisciplinary Scientific Research Institute (NEISRI), Far Eastern Branch of the Russian Academy of Sciences, Magadan, Far Eastern Russia. Artifacts in the collections have been reexamined in previous studies (Gjesfjeld et al. 2020; Takase and Lebedintsev 2016, 2019). However, animal bones in these collections are poorly understood because only minimal information has been included in the site reports (Dikov 1977; Dikova 1983), and no researcher has revisited them. Dikov's main study area was the Kamchatka River basin in central Kamchatka, which explains the limited number of animal bones from southern Kamchatka in his collection (Dikov 1977, 1979). Thus, a considerable proportion of faunal remains for our study was from those collected by Dikova (1983).

The archaeofaunal materials are stored in 47 wooden boxes in a storage room at NEISRI; the outer size of most containers is approximately $48 \times 39 \times 7.5$ cm. The bones collected from 18 sites in southern Kamchatka can be classified into three regional groups from the socioecological viewpoint (Fig. 2). The Kamchatka Peninsula is one of the regions with the most active volcanism in the world, with the eastern part of the peninsula being strongly influenced by volcanic activity and tectonism (e.g., Pinegina et al. 2014). The geomorphology in this region is characterized by the development of steep terraces and inlets, and archaeological sites tend to be located on terraces facing the ocean and rivers. In contrast, a low and level geomorphological surface is widely distributed on the west coast; this region is thus characterized by lagoons, sand dunes, back marshes, and natural levees. Archaeological sites in this region are located on dunes or lower river terraces, except for sites around inland crater lakes.

The geomorphological features in Cape Lopatka, the southern tip of the Kamchatka Peninsula, resemble those of the west coast. However, the depositional condition is particularly poor in this region owing to the extreme wind, and the ground surface is occasionally eroded. Indeed, Dikova (1983) recognized that the wind blew cultural layers at the Lopatka I and IV sites,

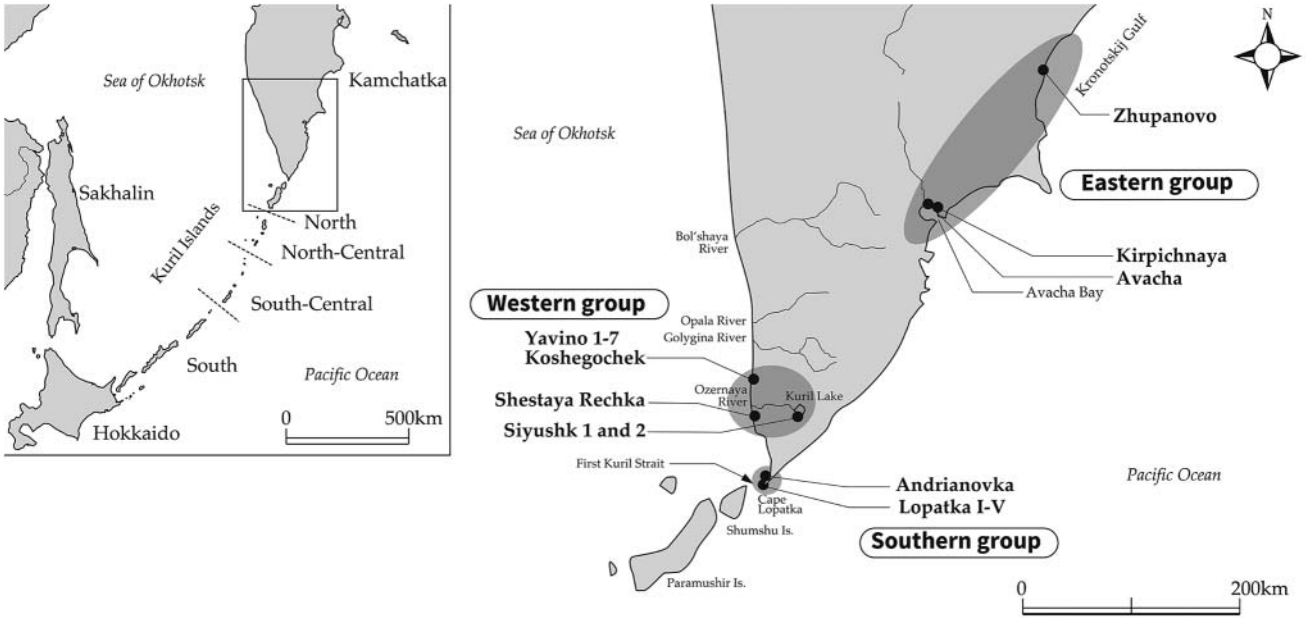

Figure 2. Map showing the locations of the archaeological sites.

scattering archaeological remains on the ground's surface or burying them in redeposition. Shumshu Island, the northernmost island of the Kuril Islands, is a succession of Cape Lopatka, although the First Kuril Strait currently separates them. The island is characterized by flat geomorphology and a low sandy surface, whereas the Kuril Islands mainly consist of volcanoes. Vegetation on the island is similar to that in Cape Lopatka: tundra is dominant, and no forest vegetation can be seen except shrubs such as creeping pine (*Pinus pumila*). Consequently, terrestrial resources, such as wood, bark, pine nuts, and fungi on wood, are relatively scarce in these regions. Caribou (*Rangifer tarandus*) are not distributed in the entire Kuril Islands and Cape Lopatka, and the central and northern Kuril Islands are basically out of the habitat of brown bears (*Ursus arctos*).

Nevertheless, many archeological sites are distributed around the First Kuril Strait, suggesting that the region had a significant meaning for prehistoric people. According to a written record in the mid-18th century AD, there were no sedentary settlements around Cape Lopatka; however, this place was relevant for the Itel'men (the Kamchadal), the Indigenous people in central and southern Kamchatka, for seasonal hunting and trade with people in the Kuril Islands (Steller 2003:12). Because no people were occupying Cape Lopatka permanently, it is reasonable to regard that the place was also occasionally used by the Kuril Ainu for seasonal hunting and transportation. This understanding can be supported by abundant seamammal bones, hunting implements of the Ainu, and trade goods such as glass beads and bone ornaments from the region (Dikova 1983; Takase and Lebedintsev 2019).

Given these geomorphological, ecological, and cultural factors, we classified the archaeological sites examined in this study into three regional groups: eastern, western, and southern (Fig. 2).

The eastern group consists of three sites between Avacha Bay and Kronotskij Gulf (Avacha, Kirpichnaya, and Zhupanovo sites) (Fig. 2). The western group consists of nine sites around Kuril Lake and the estuary of the Ozernaya River, where it flows into the Sea of Okhotsk (Siyushk 1, Siyushk 2, Shestaya Rechka, Yavino 1–4, Yavino 7, and Koshegochek sites). The southern group contains six sites around Cape Lopatka (Andrianovka and Lopatka I–V sites). These sites were excavated mainly by Dikova (1983), but only materials from the Kirpichnaya site in the eastern group were collected by Dikov (Dikov 1977:116–117). The detailed provenance of specimens from the Zhupanovo site is unknown because both archaeologists did not include information on excavations at this site in their publications. However, the site was later investigated by disciples of Dikova and Dikov (e.g., Ponomarenko 1985), and materials from other researchers might be included in these collections.

Dikova (1983) and Dikov (1977) briefly described the stratigraphy, archaeological features, and artifacts from each site except Zhupanovo. However, markings on each bone specimen show only the site's name and year of investigation. No inventories and field notes have been preserved

showing the relation between the specimen IDs and provenance in the sites, although some bones have unique specimen IDs recorded on the surface of the materials. Thus, we could not specify each bone's vertical and horizontal positions. Moreover, methods for recovering faunal remains during and after excavations were not elaborated on in the site reports, indicating that a careful examination is required for discussion in the present study.

Methods

Specimens were identified based on morphological features by M. Etnier (mollusks, fish, birds, and mammals) and M. Eda (birds) with limited direct access to comparative reference specimens. To confirm these identifications, we photographed some archaeofaunal materials and compared them with osteological references stored at NEISRI and Hokkaido University Museum. The presence or absence of cut and manufacturing marks was also recorded for each specimen.

We used accelerator mass spectrometry (AMS) radiocarbon dating to determine the age of the faunal remains. To avoid the marine reservoir effect, we dated charcoal fragments housed with animal bones and caribou antlers. The resulting conventional radiocarbon ages were calibrated by OxCal ver.4.4.3 (Bronk Ramsey 2009) using the IntCal20 calibration curve (Reimer et al. 2020).

Results

The total number of specimens was 1,965. Table 1 shows the identification results according to the number of identified specimens (NISP), and Tables 2–6 indicate the frequency of bone elements in each taxon. This collection mainly consisted of materials from the southern (n = 1,186, 60%) and western (n = 715, 36%) groups of sites; bones from the eastern group of sites accounted for only 3% (n = 64) of all specimens. Mammal bones accounted for 60% of all materials (Table 1), and the proportion of fish and bird bones was 19% and 6%, respectively. The number of sea urchins and barnacles was minimal (n = 23, 1.2%).

Table 7 shows our radiocarbon dating results, and Figure 3 depicts the probability distribution of the calibrated dates. According to the criteria proposed by van Klinken (1999), all the bone samples showed satisfactory levels of carbon and collagen recovery (Table 7). Because only charcoal and caribou antlers were used for radiocarbon dating, we did not need to consider the marine reservoir effect. The calibrated dates demonstrated that the faunal collections examined in this study originated within the past 1,600 years (Fig. 3).

Table 8 shows the results of our observation of the processed bones. The most frequently processed bone element was caribou antler. Long bones of birds and mammals also tended to be occasionally processed, and some of them were modified into hunting and fishing implements, adzes, needles, and wedges.

Discussion

Dates of Materials

Calibrated dates can be classified into three historical periods (Fig. 3). The youngest dates fall under a period in the 15th century AD or later. The intermediate period is the first half of the second millennium AD (11th to 14th century AD). The earliest dates were from the mid-first millennium AD (5th to 7th century AD). In assessing the dates, we considered the old-wood effect. Thus, the collections might be divided into two periods because dates in the intermediate stage could be integrated into the youngest period. However, dates of both charcoal and caribou antlers were included in each period. It is improbable that Kuril Ainu's occupation goes back to the 14th century AD or earlier. Therefore, we recognized three historical periods and that faunal remains were involved in each stage.

The most recent period (15th century AD or later) should be assigned to the Nalychevo culture represented by the Kuril Ainu (Fig. 1). Notably, there was no archaeological culture in southern Kamchatka during the intermediate period (11th to 14th century AD). Okhotsk culture people migrated from Hokkaido to the northern Kurils during the 7th and 9th centuries AD, and possibly, their remnants persisted there in the 10th century AD or later (Fitzhugh 2019; Fitzhugh et al. 2016). Okhotsk people in the Kuril Islands frequently used obsidian from Kamchatka, although the Okhotsk culture did not expand to southern Kamchatka (Phillips 2011). In contrast, the northern and central Kuril Islands had numerous sites from the culture (Baba 1936; Fitzhugh et al. 2016; Kumaki et al. 2010; Takase 2015b; Takase and Kato 2016; Takase et al. 2017). Given that Okhotsk people did not live in southern Kamchatka, people in central and northern Kamchatka must have carried lithic raw materials to the Kuril Islands, based on the distribution of several large production areas of obsidian are distributed in these regions (Grebennikov et al. 2010; Grebennikov and Kuzmin 2017). During the period, archaeological cultures that produced ceramics decorated by cord-mark ornament (Kavran type), clay ropes, and grid pattern impressions were widespread in central and northern Kamchatka, as shown in Figure 1 (Krenke 2002; Ponomarenko 1985; Takase 2015b;

Table 1. Results of identifications.

		Southern Group							Western Group										Eastern Group			
Taxa		**Andrianovka**	**Lopatka I**	**Lopatka II**	**Lopatka III**	**Lopatka IV**	**Lopatka V**	**Lopatka sites (mixed)**	**Shestaya Rechka**	**Yavino**	**Yavino 1**	**Yavino 2**	**Yavino 3**	**Yavino 4**	**Yavino 7**	**Koshegochek**	**Siyushk 1**	**Siyushk 2**	**Avacha**	**Kirpichnaya**	**Zhupanovo**	**Total**
Barnacles	Cirripedia	2	7	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	11
Sea urchins	Echinoidea	—	—	—	1	—	—	—	11	—	—	—	—	—	—	—	—	—	—	—	—	12
Shells	Gastropoda	9	1	—	—	—	—	—	4	3	—	2	—	1	—	—	—	—	—	—	—	20
Whelks	Buccinidae	6	5	—	—	—	—	1	—	—	4	1	—	—	—	—	—	—	—	—	—	17
Periwinkles	Littorina	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
Limpets	Nacellidae	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
File dog winkle	*Nucella lima*	7	4	—	—	—	—	—	72	—	—	—	—	—	—	—	—	—	—	—	—	83
Buccinums	Buccinidae	2	2	—	—	—	—	1	11	—	—	—	—	—	—	—	—	—	—	—	—	16
Moon snails	Naticidae	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Land snails	Gastropoda (Land)	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	2
Bivalves	Bivalvia	39	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	42
Mussels	Mytilidae	14	1	—	—	—	—	—	13	—	—	—	—	—	3	—	—	—	—	—	—	31
Horse clam	*Tresus capax*	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Cockles	Cardiidae	2	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Vertebrates	Vertebrata	2	9	8	8	—	—	—	1	10	—	2	—	—	—	—	—	—	—	—	1	41
Bony fish	Osteichthyes	11	6	1	1	1	—	—	7	—	—	—	—	—	198	—	—	—	—	—	—	225
Flounders	Pleuronectidae	3	1	—	—	—	—	—	1	—	—	—	—	—	9	—	—	—	—	—	—	14
Halibut	*Hippoglossus stenolepis*	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Cod	*Gadus macrocephalus*	12	30	—	2	2	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	50

(Continued)

Table 1. *(Continued)*

Taxa		Southern Group							Western Group										Eastern Group			Total
		Andrianovka	Lopatka I	Lopatka II	Lopatka III	Lopatka IV	Lopatka V	Lopatka sites (mixed)	Shestaya Rechka	Yavino	Yavino 1	Yavino 2	Yavino 3	Yavino 4	Yavino 7	Koshegochek	Siyushk 1	Siyushk 2	Avacha	Kirpichnaya	Zhupanovo	
Salmon	Salmonidae	1	2	—	2	—	—	—	—	—	—	—	—	—	58	—	—	—	—	—	—	63
Wolf eel	*Anarrhichthys ocellatus*	5	1	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
Greenlings	Hexagrammos	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Sharks	Lamniidae	—	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11
Birds	Aves	38	16	—	5	—	—	—	3	—	—	5	—	—	6	—	—	1	—	—	3	77
Albatrosses	*Phoebastria*	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	4
Alcids	Alcidae	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Ducks	Anatinae	1	—	—	1	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	4
Loons	*Gavia*	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	2
Cormorants	*Phalacrocorax*	6	3	3	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15
Corvids	Corvidae	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	5
Gulls	*Larus*	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Hawks/eagles	Accipitridae	5	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
Mammals	Mammalia	28	19	2	1	—	—	8	6	1	—	34	—	6	150	—	2	—	2	1	9	269
Land mammals	Mammalia (land)	1	9	—	—	2	—	—	—	—	—	3	—	—	—	—	—	—	—	—	1	16
Hares	*Lepus*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Caribou	*Rangifer tarandus*	69	44	2	2	—	—	13	1	1	—	8	—	1	—	1	1	—	—	—	21	164
Horse	*Equus caballus*	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	2
Carnivores	Carnivore	5	6	—	—	1	—	11	—	—	1	—	—	—	1	—	—	—	—	—	1	26
Canids	Canidae	—	3	—	—	—	—	—	1	—	—	3	—	—	—	—	—	—	—	—	—	7
Foxes	*Vulpes*	2	21	1	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	1	1	28

(Continued)

Table 1. *(Continued)*

		Southern Group							Western Group										Eastern Group			
Taxa		**Andrianovka**	**Lopatka I**	**Lopatka II**	**Lopatka III**	**Lopatka IV**	**Lopatka V**	**Lopatka sites (mixed)**	**Shestaya Rechka**	**Yavino**	**Yavino 1**	**Yavino 2**	**Yavino 3**	**Yavino 4**	**Yavino 7**	**Koshegochek**	**Siyushk 1**	**Siyushk 2**	**Avacha**	**Kirpichnaya**	**Zhupanovo**	**Total**
Dog	*Canis lupus familiaris*	—	—	—	—	—	—	—	—	—	—	2	—	—	1	—	—	—	—	—	—	3
Brown bear	*Ursus arctos*	3	34	7	—	1	1	3	—	—	—	4	—	—	—	1	—	3	—	—	—	57
Sea mammals	Mammalia (marine)	35	20	3	1	—	—	4	5	—	—	2	—	—	—	1	—	—	—	1	13	85
Pinnipeds	Pinnipedia	10	—	——	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	12
Otariids	Otariidae	2	2	1	—	—	—	2	—	—	—	1	—	—	—	—	—	—	—	—	—	8
Steller sea lion	*Eumetopias jubatus*	6	12	2	1	—	—	5	1	—	—	8	—	—	—	—	—	—	—	—	—	35
Northern fur seal	*Callorhinus ursinus*	10	3	1	—	—	—	3	—	—	—	—	—	1	—	—	—	—	—	—	2	20
Phocids	Phocidae	170	16	15	48	1	—	9	2	—	—	5	—	—	5	—	—	—	—	—	—	271
Common seal	*Phoca vitulina*	5	1	—	1	—	—	1	—	—	—	1	—	—	—	—	—	—	—	1	—	10
Ringed seal	*Pusa hispida*	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	12
Bearded seal	*Erignathus barbatus*	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Sea otter	*Enhydra lutris*	16	19	2	—	—	—	16	—	—	—	—	—	—	—	—	—	—	—	—	—	53
Walrus	*Odobenus rosmarus*	2	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	4
Whales	Cetacea	56	25	1	2	—	—	13	—	—	—	—	—	—	—	—	—	—	—	—	—	97
Dolphins	Phocoenidae	1	—	—	—	—	—	1	2	—	—	—	—	—	—	—	—	—	—	—	—	4
Steller's sea cow	*Hydrodamalis gigas*	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Total		**604**	**347**	**51**	**80**	**11**	**1**	**92**	**147**	**15**	**5**	**83**	**1**	**10**	**439**	**3**	**3**	**9**	**2**	**6**	**56**	**1965**

Table 2. Fish bones from the southern and western groups.

	Southern Group									Western Group				
	Bony fish	Flounders	Cod	Salmon	Wolf eel	Greenlings	Halibut	Sharks	Total	Bony fish	Flounders	Cod	Salmon	Total
Cranium	—	—	1	—	—	—	—	—	1	2	—	—	—	2
Frontal	—	—	2	—	—	—	—	—	2	—	—	—	—	—
Maxilla	—	—	—	—	—	—	—	—	—	2	—	—	—	2
Vomer	—	—	1	—	—	—	—	—	1	—	—	—	—	—
Dentary	—	—	3	—	6	—	—	—	9	—	—	—	—	—
Angular	—	—	1	—	1	—	—	—	2	—	—	—	—	—
Basioccipital	—	—	1	—	—	—	—	—	1	—	—	—	—	—
Ceratohyal	—	—	1	—	—	—	—	—	1	—	—	—	—	—
Cleithrum	—	—	6	—	—	—	—	—	6	—	2	—	—	2
Cleithrum?	1	—	—	—	—	—	—	—	1	—	—	—	—	—
Post cleithrum	—	—	1	—	—	—	—	—	1	—	—	—	—	—
Hyomandibula	—	—	1	—	—	—	—	—	1	—	—	—	—	—
Opercle	—	—	—	—	1	1	—	—	2	—	—	—	—	—
Parasphenoid	—	—	1	—	—	—	—	—	1	—	1	—	—	1
Quadrate	—	—	—	—	—	—	1	—	1	—	—	—	—	—
Haemal spine	—	3	—	—	—	—	—	—	3	—	—	—	—	—
Basypterygium	—	—	—	—	—	—	—	—	—	—	—	—	3	3
Otolith	—	—	—	—	—	—	—	—	—	—	—	1	—	1
Vertebra	2	1	26	5	—	—	2	11	47	89	7	3	55	154
Indet.	17	—	1	—	—	—	—	—	18	112	—	—	—	112
Total	**20**	**4**	**46**	**5**	**8**	**1**	**3**	**11**	**98**	**205**	**10**	**4**	**58**	**277**

Vasil'evsky 1971). Although these clay vessels have not been found in southern Kamchatka, we hypothesized that people using them temporarily visited southern Kamchatka and the northern Kurils for hunting and trade, and animal bones left by them might be included in the specimens in our study.

No archaeological culture has been identified in southern Kamchatka during the oldest period (5th to 7th century AD). Before this stage, the Tar'ya culture had been distributed over a wide area of southern and central Kamchatka (Dikov 1977, 1979). Radiocarbon dates from southeastern Kamchatka indicate that this archaeological culture is dated from the 8th century BC to the 3rd century AD (Takase 2015a, 2020c). The late stage of the Tar'ya culture must have been damaged by a destructive eruption of the Ksudach Volcano in southern Kamchatka. The tephra of this explosion (KS1) is dated to 1806 ± 16 BP (Fig. 2, Braitseva et al. 1997). However, the precise timing for the termination of the Tar'ya culture has not been thoroughly elucidated (Ponomarenko 2014; Takase 2020c), especially in areas that were not seriously affected by the volcanic explosion, such as the west coast of the peninsula, central Kamchatka, and Cape Lopatka. The Tar'ya culture could have persisted into the mid-first millennium AD in these regions, and archaeofaunal materials of this stage might be involved in the specimens in the current study. This hypothesis is supported by the fact that radiocarbon dates of this period were obtained from the Lopatka I site, where volcanic ash from Ksudach was not distributed, and the

Table 3. Bird bones from the southern, western, and eastern groups.

	Southern Group									Western Group					Eastern Group		
	Birds	**Albatrosses**	**Alcids**	**Cormorants**	**Corvids**	**Ducks**	**Gulls**	**Hawks /eagles**	**Total**	**Birds**	**Corvids**	**Loons**	**Ducks**	**Total**	**Birds**	**Albatrosses**	**Total**
Cranium	2	—	—	1	1	—	—	—	**4**	—	—	—	—	—	—	—	—
Mandible	3	—	—	—	—	—	1	—	**4**	—	—	—	—	—	—	—	—
Maxilla	—	—	—	1	—	—	1	—	**2**	—	—	—	—	—	—	—	—
Axis	1	—	—	—	—	—	—	—	**1**	—	—	—	—	—	—	—	—
Cervical vertebra	4	—	—	—	—	—	—	—	**4**	1	—	—	—	**1**	—	—	—
Thoracic vertebra	2	—	—	—	—	—	—	—	**2**	—	—	—	—	—	—	—	—
Sacral vertebra	1	—	—	—	—	—	—	—	**1**	—	—	—	—	—	—	—	—
Coracoid	—	—	—	1	—	—	—	—	**1**	—	—	—	—	—	—	—	—
Furculum	1	—	—	—	—	—	—	2	**3**	—	—	1	—	**1**	—	—	—
Humerus	1	1	—	2	—	—	—	2	**6**	—	2	1	—	**3**	—	—	—
Humerus?	1	—	—	—	—	—	—	—	**1**	—	—	—	—	—	—	—	—
Scapula	1	—	—	2	—	—	—	—	**3**	—	—	—	—	—	—	—	—
Radius	3	—	—	2	—	—	—	1	**6**	1	—	—	1	**2**	—	1	**1**
Sternum	1	—	1	—	—	1	—	—	**3**	—	—	—	—	—	—	—	—
Pelvis	1	1	—	1	—	—	—	—	**3**	—	—	—	—	—	—	—	—
Femur	—	—	—	—	—	—	—	—	**—**	1	—	—	—	**1**	—	—	—
Tibia	—	—	—	—	—	—	—	1	**1**	—	—	—	—	—	—	—	—
Ulna	1	—	—	1	—	—	1	—	**3**	—	1	—	1	**2**	1	—	**1**
Ulna?	1	—	—	—	—	—	—	—	**1**	—	—	—	—	—	—	—	—
Tibiotarsus	—	—	1	—	—	—	—	—	**1**	—	—	—	—	—	—	—	—
Tarsometatarsus	—	—	—	1	—	—	—	—	**1**	—	—	—	—	—	—	—	—
Rib	1	—	—	—	—	—	—	—	**1**	—	—	—	—	—	—	—	—
Carpometacarpus	—	—	—	3	—	1	—	—	**4**	—	1	—	—	**1**	—	1	**1**
Phalanx	2	—	—	—	—	—	—	1	**3**	—	—	—	—	—	—	—	—
Indet.	32	—	—	—	—	—	—	—	**32**	12	—	—	—	**12**	2	—	**2**
Total	**59**	**2**	**2**	**15**	**1**	**2**	**3**	**7**	**91**	**15**	**4**	**2**	**2**	**23**	**3**	**2**	**5**

Zhupanovo site, which is far from the volcano (Figs. 2 and 3). An explanation that people of the Kronotskij culture (around the late first millennium AD) (Ponomarenko 1985) in central Kamchatka seasonally visited southern Kamchatka is also plausible. This scenario is a variant of the Tar'ya remnant hypothesis because bearers of this culture are likely descendants of the Tar'ya people in central Kamchatka.

Animal bones from these periods appear mixed, as shown by the dates from the Lopatka I and Zhupanovo sites (Fig. 3). This is not surprising given that multiple cultural layers were investigated in these sites (Dikova 1983). Artifacts from

Table 4. Mammal bones from the southern group.

	Mammals	Land Mammals	Caribou	Carnivores	Canids	Foxes	Brown Bear	Sea Mammals	Pinnipeds	Otariids	Steller Sea Lion	Fur Seal	Phocids	Common Seal	Ringed Seal	Bearded Seal	Sea otter	Walrus	Whales	Dolphins	Steller's Sea Cow	Total
Antler	—	—	125	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**125**
Cranium	3	—	1	5	—	—	3	—	—	—	1	—	3	—	—	—	1	—	—	—	—	**17**
Frontal	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	**2**
Frontal+nasal	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**1**
Cranium+occipital	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	**1**
Occipital	—	—	—	—	—	—	1	—	—	—	—	—	6	—	—	—	—	—	—	—	—	**7**
Maxilla	—	—	—	—	—	1	2	—	—	—	1	—	—	—	—	—	2	—	—	—	—	**6**
Maxilla/mandible?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
Maxilla+molar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	**1**
Premaxilla—maxilla	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	**2**
Zygomatic	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	**1**
Canine	—	—	—	5	2	5	—	—	—	—	1	—	16	3	3	—	5	—	—	—	—	**40**
Upper canine	—	—	—	—	—	—	4	—	—	—	3	—	—	—	—	—	1	—	—	—	—	**8**
Lower canine	—	—	—	—	1	8	8	—	—	—	2	1	1	1	—	—	—	—	—	—	—	**22**
Post canine	—	—	—	—	—	—	—	—	—	1	5	—	4	—	4	—	—	—	—	—	—	**14**
Molar	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	1	—	—	—	—	**4**
Upper molar	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	5	—	—	—	—	**6**
Lower molar	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	**6**
Premolar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	**4**
Upper premolar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—	—	—	—	**5**
Lower premolar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	**1**
Tooth	—	—	—	7	—	—	5	1	—	—	—	—	—	—	—	—	—	—	—	—	—	**13**
Tooth/tusk?	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**2**
Tusk	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	**2**
Incisor	—	1	—	2	—	—	3	—	—	—	2	—	—	—	—	—	—	—	—	—	—	**8**
Bulla	—	—	—	1	—	—	—	—	—	—	—	—	31	—	—	—	—	—	—	—	—	**32**
Bulla?	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	**1**
Mandible	—	—	2	—	—	5	1	—	—	—	—	1	6	3	2	—	6	—	—	—	—	**26**
Mandible?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	**2**
Atlas	—	—	—	1	—	—	1	—	—	—	—	—	8	—	1	—	—	—	—	—	—	**11**
Axis	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—	**4**
Hyoid	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	**1**

(Continued)

Table 4. *(Continued)*

	Mammals	Land Mammals	Caribou	Carnivores	Canids	Foxes	Brown Bear	Sea Mammals	Pinnipeds	Otariids	Steller Sea Lion	Fur Seal	Phocids	Common Seal	Ringed Seal	Bearded Seal	Sea otter	Walrus	Whales	Dolphins	Steller's Sea Cow	Total
Cervical Vertebra	1	—	—	—	—	—	—	—	—	—	—	—	12	—	—	—	—	—	—	—	—	**13**
7th cervical or 1st thoracic vertebra	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	**2**
Thoracic vertebra	—	—	—	—	—	—	—	—	—	—	2	4	20	1	—	—	—	—	—	—	—	**27**
Thoracic vertebra disk	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	**1**
Lumbar vertebra	—	—	—	—	—	—	—	—	—	—	—	—	16	—	—	—	—	—	—	1	—	**17**
Caudal vertebra	—	—	—	—	—	—	—	—	—	—	—	1	2	—	—	—	1	—	3	1	—	**8**
Vertebra	—	—	—	—	—	—	—	—	5	—	—	—	3	—	—	—	—	—	7	—	—	**15**
Vertebra disk	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	1	—	—	**3**
Scapula	2	—	—	—	—	—	—	—	1	1	1	—	11	—	—	—	4	—	—	—	—	**20**
Humerus	—	—	—	—	—	1	2	—	—	1	—	1	14	—	—	—	2	—	—	—	—	**21**
Ulna	—	—	—	—	—	—	1	—	—	—	—	—	3	—	—	—	—	—	—	—	—	**4**
Radius	—	—	—	—	—	—	1	—	—	—	2	1	5	—	—	—	—	—	2	—	—	**11**
Metacarpal	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**1**
Sternum	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	**3**
Sternum+manubrium	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	**1**
Sacral vertebra	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	**2**
Sternebra	—	—	—	—	—	—	—	—	—	—	—	2	2	—	—	—	—	—	—	—	—	**4**
Pelvis	—	—	—	—	—	—	—	—	—	—	—	—	18	—	—	—	—	—	—	—	—	**18**
Ischium/pubis	—	—	—	—	—	—	—	—	—	—	—	—	7	—	—	—	—	—	—	—	—	**7**
Femur	—	—	1	—	—	1	6	—	—	—	—	—	15	—	—	—	2	—	—	—	—	**25**
Tibia	1	—	1	—	—	—	2	—	—	—	—	—	10	—	1	—	1	—	—	—	—	**16**
Metatarsal	—	—	—	—	—	—	—	—	—	—	—	—	7	—	—	—	1	—	—	—	—	**8**
Rib	2	—	—	1	—	—	—	8	2	2	1	1	13	—	—	—	3	—	15	—	—	**48**
Rib?	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	**2**
Rib/fibula?	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	**1**
Baculum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	—	—	—	—	**3**
Scaphlolunar	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	**1**
Phalanx	—	—	—	—	—	2	4	—	—	1	1	—	4	—	—	—	—	—	1	—	—	**13**
Astragalus	—	—	—	—	—	—	—	—	—	—	—	—	10	—	—	—	—	—	—	—	—	**10**
Calcaneus	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	**2**
Indet.	47	11	—	—	—	—	—	51	1	—	—	—	—	—	—	—	—	—	64	—	—	**174**
Total	**58**	**12**	**130**	**23**	**3**	**25**	**49**	**63**	**10**	**7**	**26**	**17**	**259**	**8**	**11**	**1**	**53**	**2**	**97**	**2**	**1**	**857**

Table 5. Mammal bones from the western group.

	Mammals	Land Mammals	Caribou	Horse	Carnivores	Canids	Foxes	Dog	Brown Bear	Sea Mammals	Pinnipeds	Otariids	Steller's Sea Lion	Northern Fur Seal	Phocids	Common Seal	Walrus	Dolphins	Total
Antler	—	—	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**7**
Cranium	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	**2**
Maxilla	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	**1**
Maxilla/mandible?	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**2**
Canine	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—	—	**2**
Upper canine	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	**2**
Lower canine	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	**2**
Post canine	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	**1**
Premolar	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	**1**
Tooth	—	—	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**3**
Tusk	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	**1**
Bulla	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	**2**
Mandible	—	—	—	—	—	—	1	1	—	—	—	—	—	—	1	—	—	2	**5**
Atlas	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**1**
Axis	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	**2**
Cervical vertebra	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	**1**
Thoracic vertebra	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**2**
Lumber vertebra	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	**1**
Vertebra disk	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	**2**
Scapula	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**1**
Humerus	—	—	—	—	—	1	—	—	—	—	—	—	—	1	2	—	—	—	**4**
Ulna	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	**1**
Radius	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	**1**
Metacarpal	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	**3**
Femur	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
Tibia	—	—	—	—	—	1	—	—	2	—	—	—	—	—	—	—	—	—	**3**
Tibia?	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**2**
Metatarsal	—	—	—	—	—	—	—	—	2	—	—	—	—	—	1	—	—	—	**3**
Patella	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	**1**
Rib	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	**2**
Hamate	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	**1**
Scaphoid	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	**1**
Phalanx	—	—	—	—	—	—	—	—	1	—	—	1	1	—	1	—	—	—	**4**
Astragalus	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	**2**
Indet.	194	1	—	—	—	—	—	—	—	7	—	—	—	—	—	—	—	—	**202**
Total	**199**	**3**	**13**	**2**	**2**	**4**	**1**	**3**	**8**	**8**	**2**	**1**	**9**	**1**	**12**	**1**	**1**	**2**	**272**

Table 6. Mammal bones from the eastern group.

	Mammals	Land Mammals	Hares	Carnivores	Foxes	Caribou	Sea Mammals	Northern Fur Seal	Common Seal	Ringed Seal	Walrus	Total
Antler	—	—	—	—	—	21	—	—	—	—	—	**21**
Tooth	—	—	—	1	—	—	—	—	—	—	—	**1**
Tusk	—	—	—	—	—	—	—	—	—	—	1	**1**
Mandible	—	—	1	—	1	—	—	—	—	1	—	**3**
Axis	—	—	—	—	1	—	—	—	—	—	—	**1**
Scapula	1	—	—	—	—	—	—	—	—	—	—	**1**
Humerus	—	—	—	—	—	—	—	—	1	—	—	**1**
Sternum	1	—	—	—	—	—	—	—	—	—	—	**1**
Sternum+xiphoid	—	—	—	—	—	—	—	1	—	—	—	**1**
Rib	—	—	—	—	—	—	3	—	—	—	—	**3**
Baculum	—	—	—	—	—	—	—	1	—	—	—	**1**
Phalanx	—	—	—	—	—	—	1	—	—	—	—	**1**
Indeter.	10	1	—	—	—	—	10	—	—	—	—	**21**
Total	**12**	**1**	**1**	**1**	**2**	**21**	**14**	**2**	**1**	**1**	**1**	**57**

the Siyushk 1 site could be assigned to the Nalychevo culture period. Indeed, almost all the artifacts from this site are of the Nalychevo culture, and radiocarbon dates from this site are primarily dated to the 15th century AD or later. However, we also obtained two radiocarbon dates from the 11th to 12th century AD from this site (Takase 2013). Similarly, Fig. 3 shows that the Yavino 5 site should be dated from the 11th to 12th centuries AD. Dikova (1983) reported an older age from this site, dated between the sixth and tenth centuries AD (1300 ± 100 BP, MAG-724), overlapping with the earliest period in our study. Thus, materials from the Shiyushk 1 and Yavino 5 sites may also contain materials from multiple periods.

Dates from the Andrianovka site are in the 15th century AD or later, which could indicate that all materials from this site should be related to the Nalychevo culture (Fig. 3). However, three cultural layers were recognized at this site (Dikova 1983); the upper cultural layer was assigned to the Nalychevo culture, whereas the middle and lower cultural layers were dated to the Tar'ya Culture period. Indeed, harpoon heads of the Tar'ya culture have also been found in the materials from this site (Takase and Lebedintsev 2019). Faunal remains were found from all cultural layers in the field (Dikova 1983:60–62). Dikova recognized that artifacts and bones might be mixed between the upper and lower levels owing to complicated layers created by overlapped archaeological features, including a hearth. As such, dates from the Andrianovka site in Figure 3 could be interpreted to fall under only the Nalychevo culture period contingently. However, it is difficult to exclude the possibility that animal bones older than the Nalychevo culture are also included in materials from this site.

Consequently, faunal remains in each site consisted of materials from various periods in the past 1,600 years. There is no clue to specify more accurate dates for each bone component. Thus, we approached the bone specimens from each site as a minimum unit, indicating that we cannot discuss the temporal change in animal use. Instead, we focused on "averaged" animal use characteristics in southern Kamchatka during the past 1,600 years and the spatial difference between site groups.

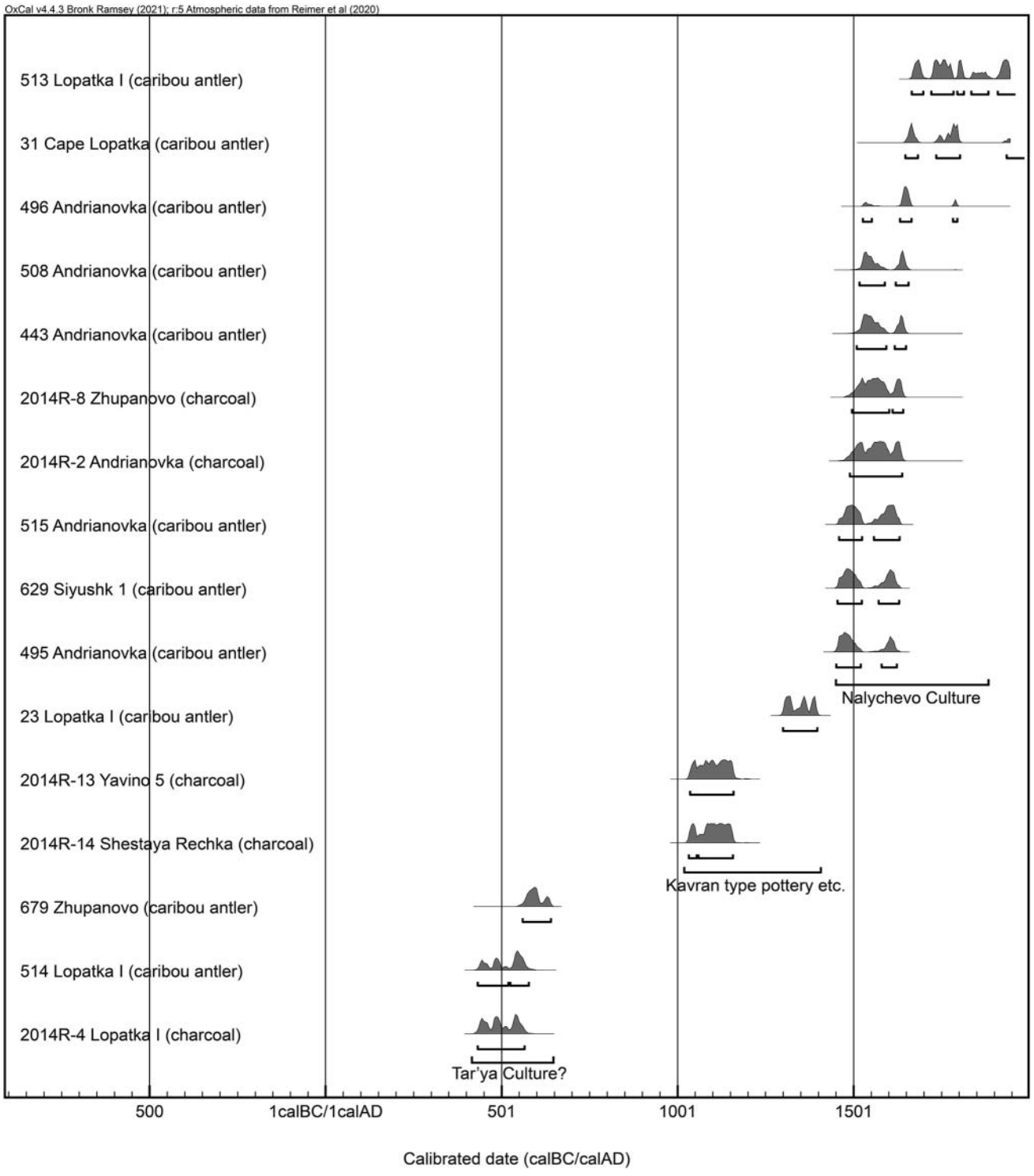

Figure 3. Calibrated age of radiocarbon dates (two sigma deviation) (OxCal 4.3.2, Bronk Ramsey [2009]; calibration curve: IntCal20 [Reimer et al. 2020]).

Table 7. Results of radiocarbon dating.

Specimen ID	Site Provenance	Site group	Specimen	Pretreatment†	δ13C (‰) (AMS)	Conventional 14C Age (yr BP)	Collagen recovery (%)	Carbon recovery (%)	Lab # (IAAA-)
2014R-2	Andrianovka Hearth	Southern	Charcoal	AAA	−29.7 ± 0.25	330 ± 20	—	—	170071
2014R-4	Lopatka I Pit house	Southern	Charcoal	AAA	−26.0 ± 0.28	1,560 ± 20	—	—	170072
2014R-8	Zhupanovo 1st cultural layer	Eastern	Charcoal	AAA	−28.7 ± 0.21	320 ± 20	—	—	170073
2014R-13	Yavino 5 25cm BS	Western	Charcoal	AAA	−28.0 ± 0.19	940 ± 20	—	—	170074
2014R-14	Shestaya Rechka 30-60cm BS	Western	Charcoal	AAA	−23.3 ± 0.28	950 ± 20	—	—	170075
23	Lopatka I	Southern	Caribou antler	CoEx	−20.4 ± 0.29	620 ± 20	14.9	45.0	170077
31	Cape Lopatka	Southern	Caribou antler	CoEx	−21.3 ± 0.27	210 ± 20	18.6	45.0	170078
443	Andriaovka	Southern	Caribou antler	CoEx	−20.9 ± 0.23	300 ± 20	8.4	46.0	170079
495	Andriaovka	Southern	Caribou antler	CoEx	−17.9 ± 0.27	380 ± 20	17.4	45.0	170080
496	Andriaovka	Southern	Caribou antler	CoEx	−21.6 ± 0.22	260 ± 20	20.0	46.0	170081
508	Andriaovka	Southern	Caribou antler	CoEx	−21.8 ± 0.23	290 ± 20	18.2	45.0	170082
513	Lopatka I	Southern	Caribou antler	CoEx	−19.6 ± 0.3	160 ± 20	7.0	44.0	170083
514	Lopatka I	Southern	Caribou antler	CoEx	−23.3 ± 0.25	1,550 ± 20	9.5	45.0	170084
515	Andriaovka	Southern	Caribou antler	CoEx	−17.9 ± 0.27	360 ± 20	15.8	45.0	170085
629	Siyushk 1	Western	Caribou scapla	CoEx	−20.5 ± 0.27	370 ± 20	4.3	42.0	170086
679	Zhupanovo	Eastern	Caribou antler	CoEx	−22.3 ± 0.26	1,480 ± 20	18.7	45.0	170087

† AAA: The Acid-Alkali-Acid pretreatment process to eliminate carbonates and secondary organic acids. CoEx: Collagen extraction from the bone/tooth sample.

Table 8. Results of observations for bone modification.

		Pointed Weapon	Pointed Weapon (Unfinished)	Bone Arrowhead	Bone Arrowhead (Unfinished)	Harpoon Head	Harpoon Head (Unfinished)	Harpoon Preform?	Foreshaft	Foreshaft (Unfinished)	Spear Head	Fishhook	Fishhook Shank	Bone Adze	Bone Adze (Unfinished)	Adze Socket	Bone Knife	Bone Stick	Bow Nock	Wedge	Comb	Needle	Needle Case	Handle of Iron Knife	Toggle	Ornament	Pendant	Unknown Bone Product	Processed	Processed?	Bone Chip	Total
Vertebrates	Indet.	—	—	2	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	**7**
Birds	Humerus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	**1**
	Humerus?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	**1**
	Radius	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	**3**
	Ulna	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	**2**
	Ulna?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Indet.	—	—	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11	—	—	—	—	—	—	1	1	—	**21**
Albatrosses	Humerus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	**1**
	Radius	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Carpometacarpus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	**1**
Cormorants	Radius	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	**1**
Gulls	Ulna	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	**1**
Hawks/eagles	Humerus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	**1**
	Radius	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	**1**
Mammals	Scapula	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Tibia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Tooth/tusk?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—	**2**
	Indet.	1	—	6	—	5	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	1	—	—	1	6	6	1	**30**
Land mammals	Indet.	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	**5**

(Continued)

Table 8. *(Continued)*

		Pointed Weapon	Pointed Weapon (Unfinished)	Bone Arrowhead	Bone Arrowhead (Unfinished)	Harpoon Head	Harpoon Head (Unfinished)	Harpoon Preform ?	Foreshaft	Foreshaft (Unfinished)	Spear Head	Fishhook	Fishhook Shank	Bone Adze	Bone Adze (Unfinished)	Adze Socket	Bone Knife	Bone Stick	Bow Nock	Wedge	Comb	Needle	Needle Case	Handle of Iron Knife	Toggle	Ornament	Pendant	Unknown Bone Product	Processed	Processed ?	Bone Chip	Total
Brown bear	Femur	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	**3**
	Tibia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Ulna	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
Canids	Canine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
Caribou	Antler	1	—	5	1	8	1	—	1	—	—	—	2	2	—	—	—	1	1	6	3	—	—	1	2	1	1	3	87	3	1	**131**
	Cranium	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Scapula	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Femur	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Tibia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	**1**
Sea mammals	Rib	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	4	—	—	**7**
	Rib?	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**1**
	Rib/fibula?	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**1**
	Indet.	3	1	4	—	—	2	—	3	1	2	1	—	1	—	—	1	1	—	10	—	—	—	—	—	—	1	—	24	—	2	**57**
Otariids	Upper canine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Scapula	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Rib	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	**3**
Fur seal	Sternabura, xiphoid	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	**1**
	Sternum+ manubrium	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**

(Continued)

Table 8. *(Continued)*

		Pointed Weapon	Pointed Weapon (Unfinished)	Bone Arrowhead	Bone Arrowhead (Unfinished)	Harpoon Head	Harpoon Head (Unfinished)	Harpoon Preform?	Foreshaft	Foreshaft (Unfinished)	Spear Head	Fishhook	Fishhook Shank	Bone Adze	Bone Adze (Unfinished)	Adze Socket	Bone Knife	Bone Stick	Bow Nock	Wedge	Comb	Needle	Needle Case	Handle of Iron Knife	Toggle	Ornament	Pendant	Unknown Bone Product	Processed	Processed?	Bone Chip	Total
Phocids	Scapula	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	**2**
	Rib	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
Walrus	Tusk	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	**1**
Whales	Maxilla/ mandible?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Mandible?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Caudal vertebrae	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Radius	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Vertebra	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	**3**
	Rib	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	12	—	—	**14**
	Rib?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1		—	—	—	—	—	—	—	—	—	**1**
	Phalanx	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	**1**
	Indet.	—	—	—	—	—	—	—	1	—	1	—	—	1	—	—	—	—	—	14	—	—	—	—	—	—	—	34	1	1	**53**
Total		**5**	**1**	**29**	**1**	**13**	**4**	**1**	**5**	**1**	**3**	**1**	**2**	**5**	**1**	**1**	**1**	**6**	**1**	**32**	**4**	**21**	**3**	**1**	**3**	**1**	**3**	**5**	**205**	**12**	**5**	**376**

Taphonomic Aspects

The details of the fieldwork method for recovering faunal remains were not mentioned in the site reports (Dikov 1977; Dikova 1983). Here, we compared descriptions of animal bones with identified materials to examine the taphonomic aspects of the collections. The site reports included information on animal bones from the Andrianovka, Lopatka I–III, Lopatka V, Shestaya Rechka, and Avacha sites. Faunal remains from these sites were confirmed in the storage room at NEISRI (Table 1). At the Andrianovka site, Dikova (1983) found shells and animal bones, including sea mammals and birds, from the upper cultural layer, and these specimens can be seen in the collection. Ribs of seals (Phocidae) are characteristically discovered from this layer (Dikova 1983:59); five specimens were confirmed in the collection. According to the report, lower cultural layers are characterized by an abundance of fish vertebrae, deer antlers, and bird sternums (Dikova 1983:61–62). The collection from this site contains six fish vertebrae, 49 caribou antler pieces, and two bird sternum fragments, although confirming that they were discovered from the lower cultural layers is impossible. At the Lopatka I and Shestaya Rechka sites, Dikova (1983:41, 103) recovered shells, terrestrial and sea mammal bones, bird bones, and fishbones, and they can be seen in the collections (Table 1). Thus, faunal remains from the Andrianovka, Lopatka I, and Shestaya Rechka sites are consistent with Dikova's report.

Conversely, we found discrepancies between information in the site reports and faunal remains at the Yavino 1–7, Yavino 9, Koshegocheck, Shiyushk 1 and 2, and Kirpichnaya sites. No information on animal bones from these sites was included in the books (Dikov 1977; Dikova 1983); however, we confirmed faunal remains from these sites (Table 1). The number of specimens from these sites is generally small, although the Yavino 7 site yielded the second-largest faunal component in the collections. Although we confirmed many fishbones from this site, they are primarily vertebrae, suggesting that they might be biased by a sampling method (Table 2).

Additional discrepancies were present. Dikova (1983:108) stated having found whale bones at the Yavino 8 site, yet there were no whale bones in the collection. Similarly, vertebrae of pinnipeds were not in the Lopatka III site assemblage, although they were mentioned as characteristic remains from this site (Dikova 1983:31). At the Lopatka II site, no brown bear teeth are in the collection, which is in contrast to the two bear canine teeth reported found on the ground surface at this site (Dikova 1983:39). A whale rib bone was listed found at the Lopatka V; however, there is no such specimen in the collection. According to the report, the Avacha site also yielded many animal bones from the first (upper) and second (middle) cultural layers. In particular, seal ribs and an abundance of fishbones were characteristic of the first cultural layer (Dikova 1983:123). However, the collection contains only two specimens of unidentifiable mammal bones, and no fishbone is present (Table 1).

These discrepancies between the reports and faunal collections suggest that not all faunal remains retrieved in the fieldwork were brought from Kamchatka to Magadan. Some specimens could have also gone missing while organizing materials for study and preservation in the storage room. A high proportion of vertebrae (53.6%) in the entire fishbone collection and the scarceness of bird bones (6.1%) suggest that sampling methods biased them. Moreover, the number of shells is not significant (11.2%). However, shell layers were excavated in the Lopatka I, Lopatka III, Andrianovka, Shestaya Rechka, and Avacha sites, indicating the selection of materials in the field. At the Lopatka II site, a 1×1-m area was set up for detailed investigation (Dikova 1983:36), yet the number of fish and bird bones from this site is minimal compared with mammal bones (Table 1). The use of screens for recovering small bones was possibly not systematically employed during the excavations. Photographs of the fieldwork in site reports indicate that hand-picked materials from the ground surface may also be included in the collections (Dikova 1983:21, 29, 41). Given such methodological inadequacy and inconsistency in the recovery of faunal remains, quantitative analyses of the collections cannot work effectively, especially for invertebrates and bones of birds and fish. Therefore, we focused on the qualitative aspects of the data regarding the collections. Even when the frequencies of bone specimens are required to be examined, we dealt with only a rough tendency of representative mammal species.

Characteristics of Animal Use

Use of Sea Mammals

We identified the common seal (*Phoca vitulina*), ringed seal (*Pusa hispida*), bearded seal (*Erignathus barbatus*), northern fur seal (*Callorhinus ursinus*), Steller sea lion (*Eumetopias jubatus*), sea otter (*Enhydra lutris*), walrus (*Odobenus rosmarus*), whales (Cetacea), dolphins (Phocoenidae), and Steller's sea cow (*Hydrodamalis gigas*). The abundance of sea-mammal bones shows their relative significance in the subsistence of southern Kamchatka (Table 1). The high proportion of rib and vertebra bones in whale remains is characteristic. These bones were occasionally processed

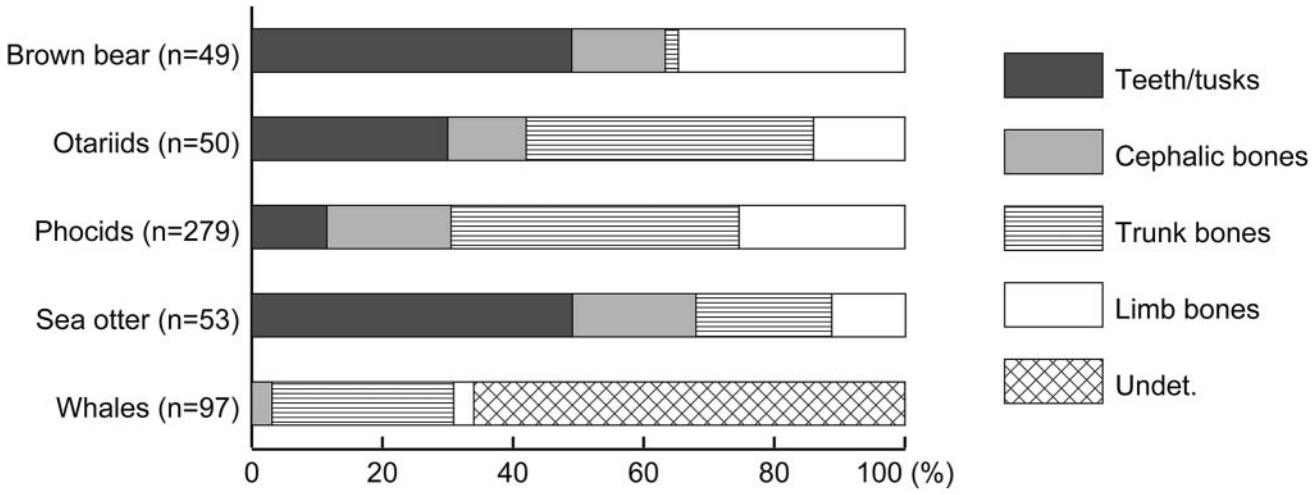

Figure 4. Proportions and composition of mammals from all site groups.

into tools, such as adzes and wedges (Fig. 4, Table 8). The Koryak in northern Kamchatka conducted whale hunting, whereas the Itel'men hunted only smaller cetacean species (Watanabe 2013). Given the lack of reliable information on whale hunting among the Indigenous peoples and the large harpoon heads in southern Kamchatka, whale ribs and vertebrae seem to have been brought from carcasses as materials for bone tools.

In contrast, pinniped remains consist of teeth, cephalic bones, limb bones, and trunk bones (Fig. 4). Such a pattern represented by diverse skeletal elements could reflect a practice in which they were locally hunted around the sites in this region. The abundance of pinniped remains indicates that they comprised an essential food resource in southern Kamchatka during the past 1,600 years. This supposition is supported by the hunting tools found, such as regular-sized harpoon heads and stone points for inserting into them (Dikova 1983; Takase and Lebedintsev 2019). Isotopic evidence of food residues remaining on ceramic surfaces and ethnographic documents of the Kuril Ainu in the 19th century also supports the significance of pinnipeds (Takase 2020b; Torii 1919).

The northern fur seal was the most crucial species among pinnipeds taken in Hokkaido throughout the Middle and Late Holocene (Takase 2020a). Although they do not come ashore when wintering around the Japanese Islands (Gentry 1998; Wada 1971), pups frequently land on the seashore during storms in southern Hokkaido, the main wintering area for fur seal pups. Prehistoric people in Hokkaido used pups from 5000 BC, and offshore hunting of adult and juvenile fur seals was conducted from 3800 BC (Takase 2020a). Hunting northern fur seal and Steller sea lion were likely much easier in Kamchatka and the Kuril Islands than in Hokkaido because of these species' use of breeding islands and the Steller sea lion's reuse of haulout localities (Altukhnov et al. 2012; Burkanov and Loughlin 2005; Trukhin 2009). However, true seals, not otariids (northern fur seal and Steller sea lion), were dominant in the faunal collections from southern Kamchatka (Table 1), and this tendency is common with archaeofaunal remains from the northern Kuril Islands (Gjesfjeld et al. 2020). Current archaeofaunal data indicate that the northern fur seal and Steller sea lion were not hunted in southern Kamchatka and the northern Kurils as much as in the Hokkaido region. The small number of otariid pup bones from southern Kamchatka and the northern Kurils supports this supposition, whereas the active use of true seals is a characteristic of these regions.

Sea otter was also used in this region (Table 1). Given that its high-quality pelts had a significant value as trade goods, sea otter bones comprise a high proportion of the entire faunal remains found at the Kapsul site on Urup Island, a hunting settlement of the Russian-American Company in the southern Kuril Islands (Fitzhugh et al. 2007). However, the number of sea otter remains is much smaller than that of pinnipeds in southern Kamchatka; thus, obtaining furs was not necessarily the primary cause for occupying southern Kamchatka for the Kuril Ainu and other prehistoric Kamchatkan people.

Although southern Kamchatka is outside their habitat range, walrus remains were identified in all site groups. In Kamchatka, this species is currently distributed only on the northeastern coast of the peninsula. According to an ethnographic document from the early 20th century (Jochelson 1908:574), walrus was seasonally hunted by Koryak hunters around Karaga Island in

northeastern Kamchatka, indicating that this area was the southern border of the animal's habitat. There were four walrus remains in these collections (Table 1); all of them were tusks (Tables 1–4), one of which was modified into an ornament (Table 8). Apparently, walrus was not hunted in southern Kamchatka, but tusks were brought as trade goods from northeastern Kamchatka or further north. Additionally, recovering them from drift carcasses should also be considered because we observed stranded walrus carcasses in the central Kuril Islands on two occasions in the 2000s, one on Rasshua Island and one on Shiashkotan Island (Etnier, personal observation) (Fig. 2).

Notably, three bone fragments of Steller's sea cow were identified at the Lopatka II site in the southern group of sites (Table 1). They originated from the premaxilla-maxilla of a single individual (Fig. 5:1). Steller's sea cow is the largest sirenian species at 7–8 m long with a maximum weight estimated at 4.4–10 t (Anderson and Domning 2002; Scheffer 1972). Vitus Bering's second expedition team discovered this species in the Commander Islands in 1741. Its population diminished rapidly after its discovery and died out as early as 1768. The proposed reasons for the extinction include overkilling (Domning 1978; Stejneger 1887) and reduction of kelp (the primary food of sea cows), the latter attributed to a sea urchin population explosion brought about by active hunting of sea otters (Anderson 1995; Anderson and Domning 2002; Haley 1980). Recent studies support the hypothesis of the overkilling of the sea cow by Western hunters (Turvey and Risley 2006). Holocene fossils of this species indicate that their distribution was limited to the western Aleutian Islands and perhaps St. Lawrence Island (Crerar et al. 2014; Domning et al. 2007). During the Pleistocene, sea cows inhabited a much larger area of the northern Pacific Ocean, and isotope analysis suggests that their main food in that era was kelp, as it was in the Holocene (Corbett et al. 2008).

Two ribs found on Kiska Island in the Aleutian Islands have been the only reported Steller's sea cow remains discovered in connection with an archaeological site (Lech et al. 2012). The specimens from the Lopatka II site in the present collection represent the second discovery in the North Pacific and the first instance in the Eurasian continent as materials from archaeological sites. Steller (1899:200) reported that carcasses of the sea cow occasionally washed ashore from Kronotskij Cape to Avacha Bay on the east coast of the Kamchatka Peninsula, and it is also reasonable to assume that they had drifted from the Commander Islands (Domning et al. 2007). Sea cow carcasses likely drifted down to a region between Avacha Bay and Cape Lopatka along with walrus carcasses (Fig. 2). Thus, the bone fragments from the Lopatka II site could have been taken from a carcass or semifossilized bones in the Kamchatka Peninsula and then brought to the site. However, the purpose of carrying them to the site remains obscure because there are no processing and modification traces on the bone fragments.

Vivianite, a hydrated iron phosphate mineral ($Fe_3(PO_4)_2 \cdot 8H_2O$), can be seen on the surface of the sea cow remains. No specimen of other species in the Kamchatka collections contained vivianite (Fig. 5:1a, 1c, 1e). Vivianite crystals in archaeological materials have already claimed the attention of several researchers (Dillian and Bello 2008; McGowan and Prangnell 2006; Zwaan and van der Sluys 1971). Its formation requires sources of iron, phosphate, water, and low levels of oxygen and sulfide, and microbial activity also appears to be necessary (McGowan and Prangnell 2006; Rothe et al. 2016). At the Ainu Creek site on Urup Island, the southern Kuril Islands, anoxic, often waterlogged conditions have provided a suitable environment for preserving organic materials. Vivianite is frequently observed on the bone surfaces from this site. Because the presence of vivianite indicates a history of the depositional environment during the formation of archaeofaunal remains (Fitzhugh et al. 2009a:18–19), vivianite encrustations on the sea cow bone fragments from the Lopatka II site indicate that the formation process of these specimens is different from that of the other materials from the site. This observation indirectly supports the estimation that people in southern Kamchatka collected sea cow bones from a drift carcass or semifossilized remains.

Use of Terrestrial Mammals

Caribou was the most abundant terrestrial animal in all site groups (Table 1). Kamchatka is the southernmost habitat of caribou in the Eurasian continent, indicating that the climate of this peninsula is too warm for this species. Nevertheless, wild caribou lived in the mountainous area between the Golygina River basin and Bol'shaya River basin in southern Kamchatka until the 1970s (Mosolov 1994:Fig. 2). Paleoenvironmental research in Kamchatka demonstrates that the past 1,600 years should be regarded as a relatively cooler period (Brooks et al. 2015; Dirksen et al. 2015). These conditions supported the herds of wild caribou not only in northern and central Kamchatka but also in the mountain range of southern Kamchatka. Moose (*Alces alces*), wolf (*Canis lupus*), and Siberian bighorn sheep (*Ovis nivicola nivicola*) were not identified, although they are present as potential game animals in Kamchatka.

In the western group of sites, cephalic, trunk, and limb bones account for a relatively higher proportion (46%) of caribou remains (Fig. 6). This

Figure 5. Bones from the Lopatka I (5), Lopatka II (1), Lopatka IV (3), and Andrianovka sites (2, 4, 6) [1: Steller's sea cow (premaxilla-maxilla); 2, 3, 5: wolf eel (dentary); 4: wolf eel (angular); 6: wolf eel (opercle); arrows indicate vivianite crystals].

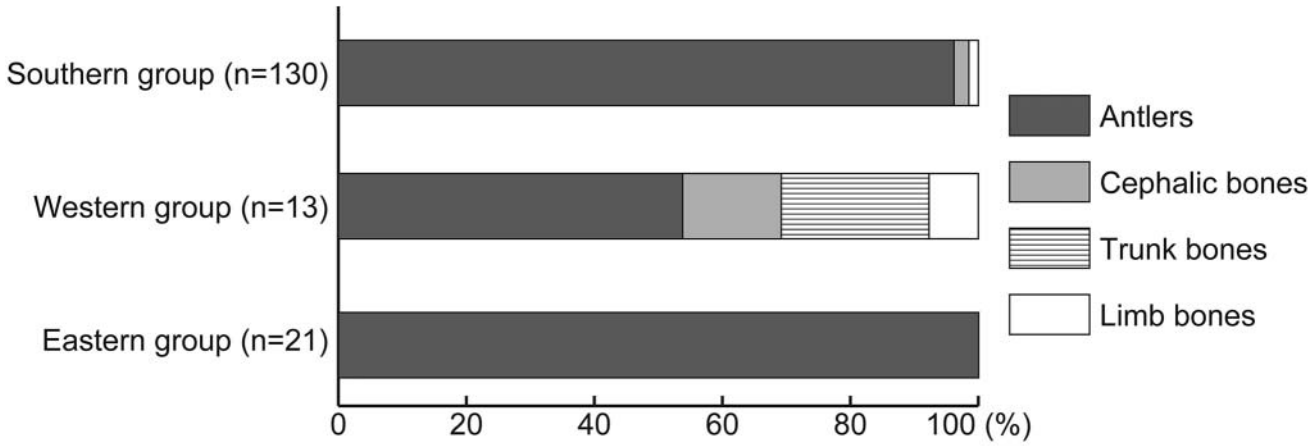

Figure 6. Proportions and composition of caribou bones in each site group.

may show that humans living in this site group had better access to wild caribou because this area is close to the caribou habitat of the 20th century. However, the recovered caribou elements mainly consisted of antlers in other site groups; antlers made up 96% (n = 130) and 100% (n = 21) of all caribou remains from the southern and eastern site groups, respectively (Fig. 6). Although the southern group of sites is outside caribou habitat, many antlers were recovered there. It is improbable that caribou remains, excluding antlers, were left in the sites during the fieldwork because various anatomical parts of pinniped, brown bear, and sea otter remains were collected from this site group (Table 4). Thus, the abundance of antlers in the caribou remains shows, to some extent, the actual situation of bone composition in this region. The antlers were carried from caribou habitats, such as the western group of sites, and accumulated at the southern tip of the Kamchatka Peninsula because antlers were the most significant material for various bone tools (Table 8).

The Kuril Islands are also outside the caribou habitat range, but the antler was one of the most popular materials for bone tools (e.g., Kumaki et al. 2010; Takase and Kato 2016). Although caribou remains in the northern Kuril Islands were confirmed by an archaeological research project conducted in the 1930s (Baba 1936), the details have been unknown because materials were lost during World War II. However, a recent interdisciplinary project in the Kuril Islands (Kuril Biocomplexity Project, KBP) clarified the absence or tiny proportion of caribou remains in faunal materials from the Kuril Islands (Fitzhugh et al. 2007, 2009a, 2009b; Gjesfjeld et al. 2020). As caribou was not a common food resource in the Kuril Islands, antlers were not frequently carried from Kamchatka to the Kuril Islands. Thus, bone tools were mainly produced around Cape Lopatka after antlers were accumulated there, and then finished products were brought to the Kuril Islands. Numerous antlers indicate that sites around this cape also played an essential role as workshops for crafting bone tools. Sites around Cape Lopatka were important for workshops and seasonal hunting and trade. In the eastern site group, antlers constituted the sole recovered deer remains. The reason for this uniformity is unclear because caribou could be hunted in the mountainous area near the site group. As the number of specimens is considerably small in this region, further examination is necessary to determine if the high proportion of antlers is a product of sampling bias or the actual pattern associated with the caribou's use.

Brown bear represents the second most abundant terrestrial mammal in the collection (Table 1). Bear skulls are essential ritual items for the prehistoric and contemporary Indigenous peoples living around the Sea of Okhotsk and the Amur River basin (e.g., Hallowell 1926; Ikeda 2000; Jochelson 1908). In the samples, more than 50% of the recovered brown bear specimens are teeth and cephalic bones (Fig. 4). However, no ritual usage of bear skulls can be deduced from the archaeological specimens in this study, nor are there any processed bear teeth in the collection (Table 8). There is also no reliable, detailed information on rituals and nonutilitarian use of bear remains in ethnographic documents of the Kuril Ainu and Itel'men (Krasheninnikov 1764; Orlova 1999; Steller 2003; Torii 1919). Therefore, it is difficult to conclude that the abundance of teeth and cranial bones in the Kamchatka record is related to ritual activities.

Although the dog (*Canis lupus familiaris*) is well known to be an essential animal for hunting and sledding in Kamchatka (Krasheninnikov 1764; Levin and Potapov eds. 1961; Orlova 1999), their

remains are scarce in these collections (Tables 1, 4–6). The Kuril Ainu and Sakhalin Ainu did not use dog sleds like Hokkaido Ainu; however, they began to use dog sleds by adopting technology from the Indigenous peoples of adjacent areas during historic times. Suzuki (2017) estimated that the Kuril Ainu actively used dog sleds starting in the early 19th century to make transportation more accessible; this coincided with the arrival of the Russian-American Company to the Kuril Islands. A recently disclosed Russian ethnographic document (Bugaeva and Gorlova 2021:154–155) also supports this assertion and indicates that the Kuril Ainu did not use dog sleds in the mid-18th century. This would explain the scarcity of dog remains in the site assemblages because the Kuril Ainu no longer occupied southern Kamchatka when they started using dog sleds. Nevertheless, they might have had dogs before the introduction of dog sleds. Prehistoric people in southern Kamchatka had dogs before the Nalychevo culture period, as evidence from the Upper Paleolithic shows (Dikov 1979, 1996). Thus, it is too early to conclude that dogs have not been used in southern Kamchatka for the past 1,600 years. As for the horse (*Equus caballus*), it was introduced after the Russians arrived in Kamchatka; thus, horse teeth discovered from the western site group probably date to the end of the 17th century AD or later (Tables 1 and 5).

Use of Invertebrates, Fish, and Birds

Invertebrates such as whelk (Buccinidae), periwinkle (Littorina), sea urchin (Echinoidea), and barnacle (Cirripedia) were identified, and these species can also be seen in the Kuril Islands (Etnier 2009). However, specimens in this study are not suitable for estimating their significance as food owing to the inadequacy of the recovery methods.

As for fish, cod (Gadidae), salmon (Salmonidae), greenling (*Hexagrammos*), halibut (*Hippoglossus stenolepis*), flounders (Pleuronectidae), and sharks (Lamniidae) are likely to have been targeted in southern Kamchatka (Tables 1 and 2). A similar tendency can be seen in the northern Kurils (Gjesfjeld et al. 2020). Wolf eel (*Anarrhichthys ocellatus*) is a notable species appearing at the Andrianovka, Lopatka I, and Lopatka IV sites (Fig. 5:2–6). This species is distributed over a wide area in the North Pacific region, but it has rarely been found in archaeological sites. No wolf eel bones have been found in archaeological sites along the coast of the Sea of Okhotsk, Kurils Islands, or Hokkaido. The only other wolf eel bones associated with an archaeological site in the North Pacific were some 100 teeth and jaw fragments from a midden site (SLO-2) in California (Fitch 1972). These eels are believed to have been caught in traps as no nonhuman predators are indicated at the site. Wolf eels primarily eat invertebrates such as urchins, mussels, and crabs (Love 1996), and this would make them difficult to catch using hook-and-line methods. Accordingly, modern fishers easily trap wolf eels, but not many are taken with hook-and-line techniques. The method for catching wolf eels in southern Kamchatka cannot be determined because of the scarcity of fishing gear from archaeological sites and ethnographic information on traps used for benthic marine fishing.

Identified birds were albatrosses (*Phoebastria*), alcids (Alcidae), ducks (Anatinae), loons (*Gavia*), cormorants (*Phalacrocorax*), corvids (Corvidae), gulls (*Larus*), and hawks/eagles (Accipitridae) (Tables 1 and 3). Among them, only albatrosses can serve as a seasonal indicator. *Phoebastria* albatross breed in the winter on the oceanic islands of the North Pacific, such as Izu, Ogasawara, and Hawaii, and forage near the Kamchatka Peninsula from June to September (Tickell 2000); they were mainly caught in southern Kamchatka during these months. Long bird bones such as the humerus, ulna, and radius were important materials for making tools. In particular, large bones of albatrosses, cormorants, gulls, and hawks/eagles were frequently used for making needles and needle cases (Table 8). Bird bones, as well as mammal bones, were important materials for bone arrowheads in this region (Table 8).

Conclusions

Our study of the largest archaeofaunal collections from southern Kamchatka has revealed that the assemblages date to the past 1,600 years. However, it was impossible to arrange bone components in order of chronological stages during the period due to a lack of provenience data. We also confirmed that not all materials were necessarily retrieved from the sites. Furthermore, the frequencies of bones, especially smaller specimens, were highly likely to have been biased by nonsystematic recovery methods in the field. Nevertheless, we estimate that sea mammals were one of the region's most significant animal resources. Although whale was not necessarily actively hunted, whale ribs and vertebrae were collected from carcasses for tool-making purposes. Pinnipeds were essential food resources, and true seals were estimated to have been more important than northern fur seals and Steller sea lions. Sea otter was also hunted, but there was no evidence indicating pelts were important trade goods. Meanwhile, the presence of walrus tusks may reflect the trade between southern and northeastern Kamchatka. We reported that Steller's sea cow remains were first discovered at archaeological sites in the Eurasian continent; however, they were probably opportunistically taken from drift carcasses or semi-fossilized remains.

Caribou was also one of the significant animal resources. It was hunted in the western region of southern Kamchatka, and antlers were accumulated around Cape Lopatka to make bone tools that were exported as finished products to the Kuril Islands. The high proportion of teeth and cranial bones of brown bears in the sites might indicate a spiritual significance was attached to brown bears, but there is no clear evidence of their usage in ritual. Although fish (e.g., cod, salmon), birds (e.g., cormorants, albatross), and invertebrates (e.g., whelk, sea urchin) were identified in the assemblages, it is difficult to evaluate their dietary significance because of collection procedures. However, the wolf eel is a notable species because they are the first examples from archaeological sites on the Eurasian side of the North Pacific. Because of their seasonal migrations, Albatross were likely hunted mainly in summer in southern Kamchatka. The bones from these relatively large birds were frequently used for making bone needles and needle cases.

In future research, the results of our study should be closely compared with other archaeofaunal collections from southern Kamchatka. The most relevant materials are animal bones from the Ryabukhina site in the A. K. Ponomarenko collection housed at Kamchatka Regional Unified Museum. Shell middens containing many animal bones were excavated, although the site report pictured only bone tools and processed bones (Ponomarenko 1993). Because this site is near Cape Lopatka, the accumulation of caribou antler and active bone-tool production must be examined using the collection. Many finished and unfinished bone tools made using caribou antlers illustrated in the report appear to support the result of our study; however, further examinations of the entire collection are necessary for reliable discussion. Our excavations restored another significant collection on Shumshu Island in 2016 (Takase et al. 2017). Faunal remains were legally moved to Burke Museum at the University of Washington and housed with archaeofaunal remains collected by KBP, forming the most extensive archaeofaunal collection from the entire Kuril Islands. Our 2016 campaign materials provide detailed information on the northern Kuril Islands, and the abundance of true seals and the scarcity of caribou remains are important issues to compare with this study. There is room for improving the understanding of animal use in southern Kamchatka through examinations of these materials.

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