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Diet of the Kuril Ainu as Evidenced from Charred Materials Adhering to Ceramic Surfaces

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Abstract: The Kuril Ainu are the indigenous people of the Northern and Central Kuril Islands and also occupied Southern Kamchatka from the mid-15th to late 17th centuries according to recent archaeological studies. Although ethnographic documents have indicated that seafood, particularly the meat and fat of sea mammals, was the most important component of their diet, few studies have investigated this. Therefore, the aim of the present study was to gain a better understanding of their diet by undertaking stable carbon and nitrogen isotope analysis of charred materials adhering to the surfaces of clay pans. We found that cooked meals consisted of seafood mixed with herbivores and/or C3 plants, supporting the information provided in ethnographic documents. We also determined that the radiocarbon dates of the charred materials from the pottery surfaces were 280 to 600 years older than those of wood charcoal samples from the same cultural layers as the pottery due to the marine reservoir effect. Further examination of the radiocarbon dates of marine animals such as shellfishes and fishes collected from the same sites will contribute to studies on the marine reservoir offset in this region.

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1. Introduction

Recent archaeological studies have revealed that the indigenous people of the Northern and Central Kuril Islands, who are known as the Kuril Ainu, emerged in the mid-15th century (Takase 2013, 2015, 2019). From this period until the end of the 17th century, they occupied not only the Northern Kuril Islands but also a wide area of Southern Kamchatka (Takase 2015, 2019). However, their habitation area in Kamchatka was rapidly decreased in the beginning of the 18th century, following which they likely only inhabited the Northern and Central Kuril Islands until the 19th century according to ethnographic documents (e.g., Torii 1903, 1919).

Written records indicate that the Kuril Ainu actively engaged in trade with adjacent peoples, such as the Hokkaido Ainu and Russians, to obtain daily necessities (e.g., Kawakami 2011), resulting in sea mammal hunting being very important to them as it allowed animal furs to be obtained for trade. In addition, sea mammals appear to have been a more significant component of their diet than terrestrial mammals, fishes, birds, and plants (Krasheninnikov 1755, Georgi 1776, Sasaki 2015). However, despite

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our understanding of the economy of these people, their diet remains poorly understood because there have been very few archaeological studies on faunal materials excavated from the shell middens. Although a study on archaeofaunal collections from the Northern Kuril Islands and Kamchatka is currently being undertaken (Takase, Tezuka *et al.* 2017, Takase, Shubina *et al.* 2017, Takase and Lebedintsev 2019, Gjesfjeld *et al.* 2020), close examinations of these materials have not yet been completed. Therefore, in the present study, we investigated the foodcrusts on the surfaces of clay pans to elucidate the diet of the Kuril Ainu.

2. Materials and methods

The materials examined in this study were the charred substances that adhere to the surfaces of clay pans known as Naiji pottery. This pottery is an imitation of the iron pans of medieval Japan and was produced by the Kuril Ainu to compensate for the shortage of these iron pans being imported from Japan. Thick charred material occasionally adheres to the exterior surfaces of these clay pans, while the interior and the bottom surfaces tend to be clean. Stable carbon and nitrogen isotope analysis was undertaken on samples of charred materials collected from six clay pans that were excavated from the Listvennichnaya sites in Southeastern Kamchatka (Figures 1 and 2). Archaeological excavations were conducted in this region in 2015, from which detailed information on the pit dwellings and stratigraphy has previously been reported (Takase 2018). All of the clay pans that were found in Listvennichnaya Bay (Figure 3) were assigned to type Ia or type Ib pottery dating from the mid-15th century to the end of the 17th century based on pottery typology and radiocarbon dating (Takase 2013, 2019, Takase and Lebedintsev 2016).

In total, seven samples were obtained from the Listvennichnaya excavation in 2015 (Table 1). Three pairs of samples, named “L-I-04” and “L-I-05,” “L-II-45” and “L-II-46,” and “L-II-47” and “L-II-48,” were taken from the exterior and interior surfaces, respectively, of three clay pan fragments (Figure 3.1, 3.3, and 3.4), while only one sample, named “L-II-49,” was taken from the exterior surface of a fourth fragment due to this potsherd having a clean interior surface (Figure 3.2).

Stable isotope analysis was also conducted on a further three specimens, named “M-Fig3-1,” “M-Fig6-13,” and “NAL-15-2,” which were collected from the exterior surfaces of Naiji pottery obtained from the Tri Sestry, the Bol’shaya Sarannaya, and the Nalychevo 15 sites, respectively, in Southeastern Kamchatka (Table 1). The ceramic fragments from the Tri Sestry and the Bol’shaya Sarannaya sites were found by A. K. Ponomarenko (1993) (Figure 1) and are currently preserved in the Kamchatka State United Museum in Petropavlovsk-Kamchatsky, Russia. Typologically, the ceramic potsherd from the Bol’shaya Sarannaya site (“M-Fig6-13”) is classified as type Ia or type Ib Naiji pottery dating from the mid-15th to late 17th centuries (Figure 3.5), while the ceramic fragment from the Tri Sestry site (“M-Fig3-1”) should be assigned as type II pottery dating to the 18th century or later (Figure 3.6), making this the youngest material examined in the present study. The specimen of charred material from the Nalychevo 15 site (“NAL-15-2”) is also preserved in the Kamchatka State Unified Museum and is a potsherd of type Ia or type Ib pottery. Although isotope analysis and radiocarbon dating results have already been reported for this specimen (Takase 2009), it was included in the present study for comparison.

All 10 of the above-mentioned samples were also radiocarbon dated by accelerator mass spectrometry (AMS), using the program OxCal (ver. 4.3; Bronk Ramsey 2009) and the IntCal13 calibration curve (Reimer *et al.* 2013) for the calibration of conventional dates. In addition, AMS radiocarbon dating was

Figure 1 Map showing the location of archaeological sites regarding this study

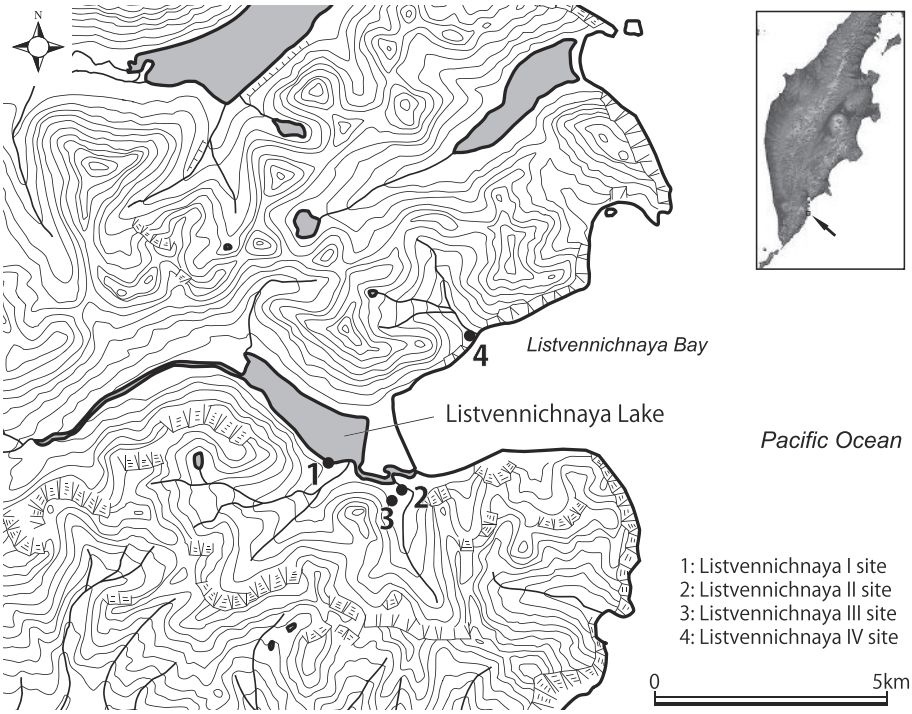

Figure 2 Archaeological sites in Listvennichnaya Bay

undertaken on samples of charred materials collected from the exterior surfaces of five Naiji pottery fragments (samples "K-4035-177-183," "K-4035-181," "K-4035-215," "K-4035-189," and "K-4035-195") (Table 1). These ceramic potsherds were excavated in Listvennichnaya Bay by Sten Bergman in the 1920s (Bergman 1924, Schnell 1932) and are currently preserved in the Museum of Far Eastern Antiquities in Stockholm, Sweden. From a typological viewpoint, all of these fragments are classified as type Ia or type Ib dating from the mid-15th to late 17th centuries. Both the stable isotope analysis and radiocarbon dating were conducted by the Institute of Accelerator Analysis Ltd., Kanagawa, Japan.

3. Results

The δ^{13}C and δ^{15}N values of the charred materials adhering to the surfaces of the Naiji pottery fragments are shown in Table 1. Although no data could be obtained on the carbon and nitrogen concentrations and ratio for specimen "NAL-15-2," there were generally no serious issues in recovering these elements from the samples. The δ^{13}C values of the samples from the interior surfaces ranged from −23.5‰ to −22.5‰, whereas those of the samples from the exterior surfaces were 2.3‰−1.4‰ lower, ranging from −25.8‰ to −23.9‰. By contrast, all of the δ^{15}N values ranged from 9.35‰ to 12.4‰, with no significant difference between the exterior and interior surfaces (Table 1).

The radiocarbon dates of the charred material samples from the pottery surfaces ranged from 430 BP to 1040 BP (Table 2), with the samples from the interior surfaces of the ceramic fragments (i.e., "L-I-04," "L-II-45," and "L-II-47") being 140 to 660 years older than those from the exterior surfaces (i.e., "L-I-

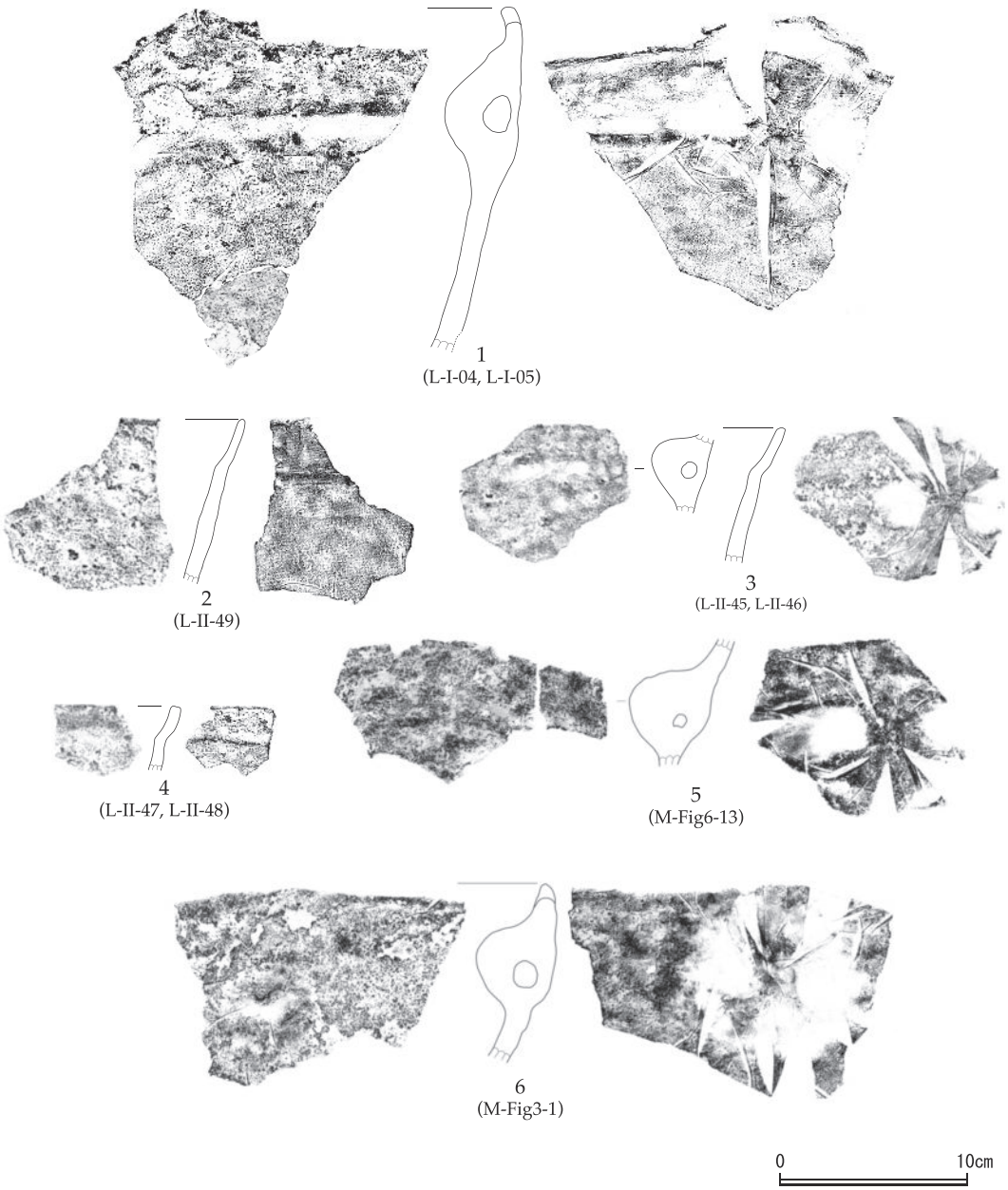

Figure 3 Ceramic fragments analyzed in this study

05," "L-II-46," and "L-II-48"). By contrast, the radiocarbon dates of 26 wood charcoal specimens collected from the same cultural layers as the potsherds in the Listvennichnaya sites ranged from 150 BP to 440 BP (Takase n.d.), indicating that the charred materials on the ceramic surfaces were 280–600 years older than these.

Table 1 Stable carbon and nitrogen isotope data and the C/N ratio of charred materials on the surfaces of the ceramic fragments, as measured by mass spectrometry

Specimen ID	Site	Provenance	δ^{13}C (‰) (MASS)	δ^{15}N (‰) (MASS)	C concentration (wt %)	N concentration (wt %)	C/N ratio (wt)	C/N ratio (atomic)
L-I-04	Listvennichnaya I	Pottery fragment shown in Fig.3.1, interior surface	−23.5	10.4	7.5	59.1	7.9	9.2
L-I-05	Listvennichnaya I	Pottery fragment shown in Fig.3.1, exterior surface	−24.4	10.8	3.72	65.9	17.7	20.7
L-II-45	Listvennichnaya II	Pottery fragment shown in Fig.3.3, Pit Dwelling No.9, interior surface	−22.5	10.6	8.44	50.9	6	7
L-II-46	Listvennichnaya II	Pottery fragment shown in Fig.3.3, Pit Dwelling No.9, exterior surface	−24.1	10.6	4.39	47.7	10.9	12.7
L-II-47	Listvennichnaya II	Pottery fragment showin in Fig.3.4, Pit Dwelling No.9, interior surface	−22.5	10.9	7.42	52.2	7	8.2
L-II-48	Listvennichnaya II	Pottery fragment shown in Fig.3.4, Pit Dwelling No.9, exterior surface	−25	10.6	3.84	65.7	17.1	20
L-II-49	Listvennichnaya II	Pottery fragment shown in Fig.3.2, Pit Dwelling No.9, exterior surface	−23.9	12.4	5.22	66	12.6	14.7
M-Fig3-1	Tri Sestry	Exterior	−25.2	9.35	0.926	70.9	76.6	89.3
M-Fig6-13	Bol'shaya Sarannaya	Exterior	−25.8	10.7	3.2	68.5	21.4	25
NAL-15-2	Nalychevo 15	Exterior	−24.5	12.0	—	—	—	—

Table 2 Results of the accelerator mass spectrometry (AMS) radiocarbon dating of charred materials on the surfaces of the ceramic fragments

Specimen ID	Site	Surface	Archaeological culture	Sample type	14C age (BP)	δ13C (‰) (AMS)	Lab code
L-I-04	Listvennichnaya I	Interior surface	Nalychevo	Charred material on the pottery surface	660±20	−24.06±0.45	IAAA-162712
L-I-05	Listvennichnaya I	Exterior surface	Nalychevo	Charred material on the pottery surface	520±20	−24.46±0.48	IAAA-162713
L-II-45	Listvennichnaya II	Interior surface	Nalychevo	Charred material on the pottery surface	970±20	−22.77±0.42	IAAA-162720
L-II-46	Listvennichnaya II	Exterior surface	Nalychevo	Charred material on the pottery surface	430±20	−26.37±0.47	IAAA-162721
L-II-47	Listvennichnaya II	Interior surface	Nalychevo	Charred material on the pottery surface	1020±20	−22.23±0.43	IAAA-162722
L-II-48	Listvennichnaya II	Exterior surface	Nalychevo	Charred material on the pottery surface	760±20	−25.73±0.35	IAAA-162723
L-II-49	Listvennichnaya II	Exterior surface	Nalychevo	Charred material on the pottery surface	800±20	−25.22±0.42	IAAA-162724
K-4035-177-183	Listvennichnaya Bay	Exterior surface	Nalychevo	Charred material on the pottery surface	790±20	−25.03±0.57	IAAA-162727
K-4035-181	Listvennichnaya Bay	Exterior surface	Nalychevo	Charred material on the pottery surface	810±20	−25.56±0.42	IAAA-162728
K-4035-215	Listvennichnaya Bay	Exterior surface	Nalychevo	Charred material on the pottery surface	860±20	−24.94±0.44	IAAA-162729
K-4035-189	Listvennichnaya Bay	Exterior surface	Nalychevo	Charred material on the pottery surface	790±20	−24.62±0.51	IAAA-162730
K-4035-185	Listvennichnaya Bay	Exterior surface	Nalychevo	Charred material on the pottery surface	760±20	−24.51±0.54	IAAA-162731
M-Fig3-1	Tri Sestry	Exterior surface	Nalychevo	Charred material on the pottery surface	910±20	−25.21±0.35	IAAA-162725
M-Fig6-13	Bol'shaya Sarannaya	Exterior surface	Nalychevo	Charred material on the pottery surface	740±20	−25.24±0.46	IAAA-162726
NAL-15-2	Nalychevo 15	Exterior surface	Nalychevo	Charred material on the pottery surface	1040±30	−25.88±0.52	IAAA-83379

4. Discussion

The plot of the δ^{15}N values against the δ^{13}C values for the charred material samples shown in Figure 4 indicates that these materials should be regarded as foodcrusts of seafood mixed with herbivores and/or C3 plants. Although all of the specimens fell within a relatively narrow range, samples from the interior surfaces of the pottery tended to exhibit higher δ^{13}C values than those from the exterior surfaces. Carbon from firewood in charred material on the exterior surface may offer a possible explanation.

Our findings indicate that seafood was the main ingredient in the diet of the Kuril Ainu. According to ethnographic documents from the mid- and late 18th century (Krasheninnikov 1755, Georgi 1776, Sasaki 2015), sea mammals were the primary food of the Kuril Ainu, although they also used other marine and terrestrial resources as food, such as seaweeds, fishes, brown bears (*Ursus arctos*), foxes (*Vulpes vulpes*), birds, and wild plants. Similarly, ethnographic records from the late 19th century also demonstrate the use of various sea mammals, fishes, birds, wild plants, and seaweeds by the Kuril Ainu (Torii 1903, 1919), although there is no detailed information on the proportion of each food type. Torii (1919) described that the Kuril Ainu usually ate meals in the morning and evening, sometimes having supplemental meals between these. For breakfast, which was the main meal of the day, they cooked seaweed soup with meat from the Steller sea lion (*Eumetopias jubatus*), ducks, and fishes. Steller sea lion meat was prepared using the fat of this sea mammal, which was processed by storing it in a bag made of Steller sea lion hide, along with salt, which was produced by boiling seawater in the iron pans, and Japanese soy sauce. Thus, the Steller sea lion appears to have been frequently used.

In Figure 4, all of the specimens are plotted within an area that lies between sea mammal and herbivore/C3 plant rather than between sea fish and herbivore/C3 plant. The relatively high δ^{15}N values

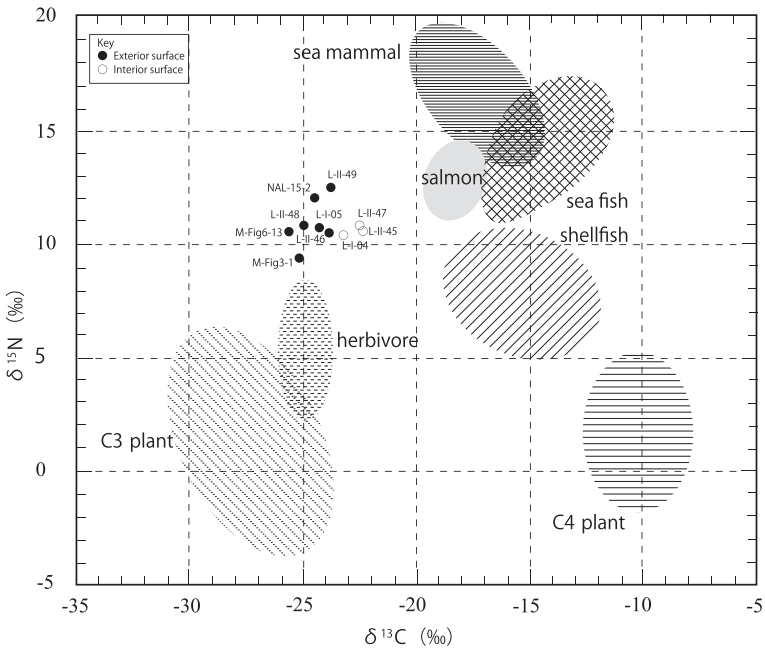

Figure 4 Plot of the δ^{15}N values against the δ^{13}C values of charred materials adhering to the surfaces of the ceramic fragments

indicate that the seafood mainly originated from the muscle and fat of sea mammals at higher trophic levels. Theoretically, large pinnipeds such as the Steller sea lion will have higher δ^{15}N values than other otariids and phocids, and this expectation has been well supported by the analysis of the muscle tissues of present-day sea mammals (Hobson *et al.* 1997). However, studies of the bones and teeth of sea mammals dating further back have indicated that δ^{15}N values vary greatly because they reflect not only the age, sex, and habitat but also temporal changes in predatory behavior, the environment, and migration routes (e.g., Hobson and Sease 1998, Hirons *et al.* 2000, Newsome *et al.* 2007). Therefore, the higher δ^{15}N values do not conclusively demonstrate that the Steller sea lion was the most important sea mammal. However, it is safe to say that sea mammals were more important to the Kuril Ainu than other marine resources, such as fishes and shellfishes.

The findings of this study also suggest that the ingredients of a Kuril Ainu meal consisted of herbivores and C3 plants as well as seafood, although the species that were mixed with the seafood could not be identified. Acorns and walnuts are the most relevant C3 plant foods in Hokkaido and the southern Kuril Islands, but there are no useful nuts in the northern Kuril Islands and southern Kamchatka, indicating that seaweed is a strong candidate for the plant food that was mixed with sea mammal meat because it was a common food item for the Kuril Ainu (Torii 1919). In terms of the herbivore, caribou (*Rangifer tarandus*) and moose (*Alces alces*) represent possible foods in southern Kamchatka because the occupation area of the Kuril Ainu overlapped with the habitat of these species. Sample "M-Fig3-1" from the Tri Sestry site, which was the only specimen in this study that was dated to the 18th century or later, contained larger amounts of herbivore/C3 plant than the other samples (Figure 4), suggesting that the relevance of this food type may have increased in this period. However, further examinations are required due to the small number of specimens from this period. Although caribou and moose were not distributed in the Kuril Islands, caribou bones have been found on Paramushir Island (Baba 1939). However, detailed information on these archaeofaunal materials is lacking because a considerable part of this collection was lost by a bombing during World War II. A number of caribou bones have also been found in archaeological sites on Cape Lopatka, at the southern tip of the Kamchatka Peninsula. However, according to our ongoing study on this collection, since these were mostly antlers, it is likely that they were carried from other areas in Kamchatka to the northern Kuril Islands to be used as materials for bone tools. Thus, the use of caribou as a food in the Kuril Islands has not yet been confirmed.

All of the radiocarbon dates that were derived from the charred materials adhering to the pottery surfaces were 280 to 600 years older than those of wood charcoal samples collected from the same cultural layers at the same sites (Figure 5). The δ^{13}C and δ^{15}N values of samples from the interior surfaces of these specimens indicate that these older ages were mainly caused by the marine reservoir effect (Figure 4). Although the late Holocene reservoir offset (ΔR) has not yet been revealed for Southeastern Kamchatka, Fitzhugh and Brown (2017) proposed a value of 508 ± 127 years for the Central and Northern Kuril Islands, and Dumond and Griffin (2002) found that the radiocarbon dates of marine animals tend to be 450 to 750 years older than those of wood charcoal in the eastern Bering Sea. Therefore, although radiocarbon dating has not yet been conducted for the marine resources that have been excavated from the archaeological sites used in the present study, we expect that similar results will be obtained for Southeastern Kamchatka. To study the marine reservoir offset in this region, further examination of the radiocarbon dates of marine animals such as shellfishes and fishes collected from the same area should be conducted.

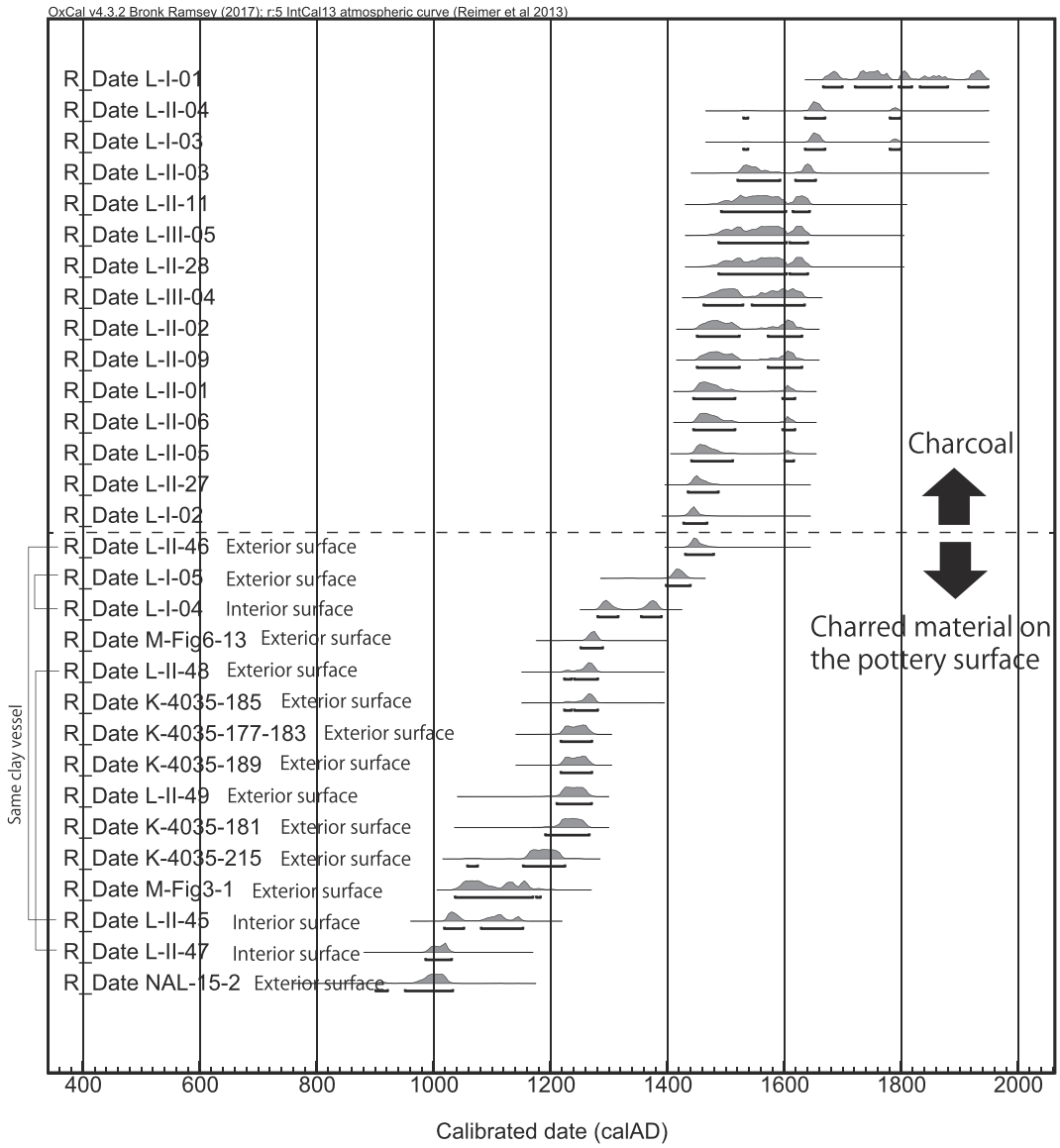

Figure 5 Probability distribution of the calibrated dates of wood charcoal and the charred materials on the surfaces of the ceramic fragments analyzed in this study (detailed information on radiocarbon dates of wood charcoal is discussed in Takase n.d.)

5. Conclusion

In this study, we gained an insight into the diet of the Kuril Ainu by conducting stable carbon and nitrogen isotope analysis of charred materials adhering to the surfaces of Naiji pottery. Our findings indicated that the cooked meals of these indigenous people consisted of seafood mixed with herbivore and/or C3 plant materials, supporting our understanding of their diet based on ethnographic documents. We also determined that the radiocarbon dates of the charred materials from the pottery surfaces were 280

to 600 years older than those of wood charcoal samples from the same cultural layers as the pottery due to the marine reservoir effect. Therefore, further examination of the radiocarbon dates of marine animals collected from the same sites will contribute to our understanding of the marine reservoir offset in this region.

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