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Bioarchaeological Analysis of Human Remains from the Destroyed Early Neolithic Cemetery of Moty – Novaia Shamanka (Cis-Baikal)

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Abstract. Moty – Novaia Shamanka (MNS) is an Early Neolithic (7560–6660 HPD cal BP) destroyed Kitoi cemetery, located on the lower Irkut River in Siberia. In 2014–2015, small rescue excavations were conducted by archaeologists from Irkutsk State University. MNS dates to the period between the two phases of use identified at the nearby Shamanka II Kitoi cemetery (Southwest Baikal). This paper presents the results of a bioarchaeological study of the human skeletal remains from MNS and discusses these findings in relation to hunter-gatherer life-history at this site and in the Cis-Baikal region. The human skeletal materials from MNS show life history markers, including isotopic signatures, consistent with the other Early Neolithic Kitoi samples. However, one individual shows anomalous isotopic signatures similar to those found, to date, only in one other Kitoi burial. Lastly and surprisingly, radiocarbon dating identified one Early Bronze Age individual (4970–3470 cal BP).

Keywords: Cis-Baikal, Early Neolithic, Kitoi culture, human skeletal remains, paleopathology, nonmetric traits, radiocarbon chronology, stable isotopes.

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Биоархеологический анализ человеческих останков из разрушенного ранненеолитического могильника Моты – Новая Шаманка (Прибайкалье)

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Аннотация. Могильник эпохи раннего неолита (7560–6660 тыс. кал. л. н.) Моты – Новая Шаманка, относящийся к китойской погребальной традиции, находится в нижнем течении р. Иркут. В 1990–2000 гг. могильник, располагавшийся на песчаном бугре эолового генезиса высотой до 7 м, был уничтожен тяжелой строительной техникой в процессе планировки поверхности на территории одной из усадеб. В результате техногенного воздействия человеческие останки и предметы сопроводительного инвентаря были перемешаны, раздроблены и хаотично перемещены по территории усадьбы. В статье представлены результаты биоархеологического исследования антропологического материала, полученного в результате археологических раскопок 2014–2015 гг. Образцы костей семи индивидуумов были отправлены в Оксфордский университет (Великобритания) для радиоуглеродного датирования и анализа стабильных изотопов углерода (δ^{13}C) и азота (δ^{15}N). На основе полученных данных сделан вывод, что могильник использовался в основном в раннем неолите, но одна дата относится к эпохе ранней бронзы (4970–3470 тыс. кал. л. н.). Радиоуглеродные даты показывают, что период его функционирования относится к хронологическому промежутку между фазами 1 и 2 ранненеолитического могильника Шаманка II, расположенного на южном побережье оз. Байкал. Результаты исследования стабильных изотопов углерода и азота для пяти ранненеолитических индивидов соответствуют большинству данных, характерных для всего ранненеолитического китойского населения Приангарья. Но для одного индивидуума получены изотопные сигнатуры, сильно отличающиеся от основного блока данных по китойскому населению. Подобные показатели отмечены только у одного индивида во всей выборке, а именно из захоронения № 42.02 могильника Шаманка II. Данные, полученные в результате палеопатологического исследования и анализа неметрических признаков, соответствуют таковым по другим выборкам по китойскому населению раннего неолита. Результаты демонстрируют, что, за исключением могилы бронзового века и одного ранненеолитического индивида с аномальными изотопными сигнатурами, история жизни и диетические характеристики популяции, оставившей могильник Моты – Новая Шаманка, вписываются в общую канву китойского населения раннего неолита.

Ключевые слова: Прибайкалье, ранний неолит, китойская культура, скелетные остатки человека, палеопатология, неметрические признаки, радиоуглеродная хронология, стабильные изотопы.

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Introduction

The Early Neolithic (EN; 7560–6660 HPD cal BP) [Spatio-temporal patterns … , 2021; Middle Holocene hunter ... , 2021] Kitoi cemetery Moty – Novaia Shamanka (MNS) lies on the eastern bank of the Irkut River, 40 km southwest of Irkutsk (Fig. 1). The site was partially excavated in 2014 and 2015 by co-author V. I. Bazaliiskii (Irkutsk State University) and colleagues as a salvage project following its destruction 20 years earlier. This ancient cemetery, originally constructed on a low-lying hill that would have stood out from its surrounding marshy landscape, was bulldozed in the 1990–2000s for flood management and the development of the village of Moty – Novaia Shamanka [The Moty – Novaya Shamanka ... , 2016]. MNS is significant because of its distinctive geographic location. As such, information on the life history of the people interred here is important to the broader culture history of the Cis-Baikal region, especially our understanding of the Kitoi mortuary tradition. This paper presents a bioarchaeological analysis of the human skeletal remains excavated from MNS, including stable isotope results, paleopathological lesions, degenerative changes, and non-metric traits. These are all indicators of hunter-gatherer life history and will be discussed in the context of other Kitoi bioarchaeological datasets. Although the MNS skeletal remains are highly fragmented and commingled, there is still much information to be gleaned regarding life history, especially considering the distinctiveness of the site.

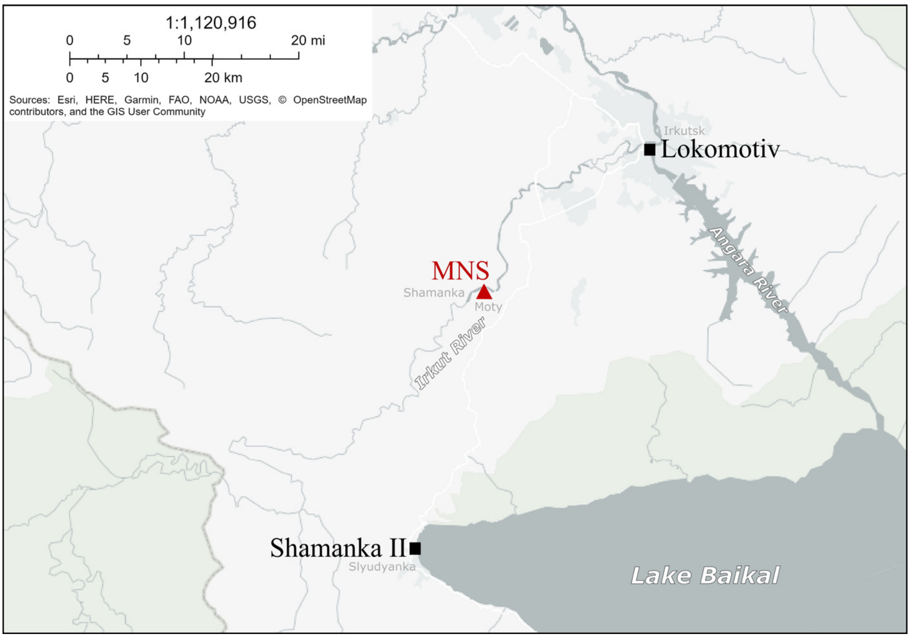

Figure 1. Map of MNS in relation to Early Neolithic Kitoi cemeteries Lokomotiv and Shamanka II

Situating MNS within the culture history of the Cis-Baikal region

Archaeological investigations in the Cis-Baikal region, Russia, have been extensive, with most information on ancient hunter-gatherers coming from mortuary sites and bioarchaeological analysis. The Baikal Archaeology Project (BAP), under which this research was conducted, focuses on Middle Holocene (ca. 8630–3470 HPD cal BP)

[Spatio-temporal patterns … , 2021; Middle Holocene hunter ... , 2021] hunter-gatherer lifeways. The BAP takes an Individual Life Histories approach, focusing on the study of biocultural changes within individuals' lifetimes to better reconstruct population dynamics and variation [Zvelebil, Weber, 2013]. This has led to bioarchaeological and mortuary data collection protocols that target all or most individuals within a population. The MNS collection contained 1245 human bone fragments of varying, but generally poor, preservation, representing a minimum of nine individuals, seven of whom were identified as groupings of related bones [see Bourgeois, 2020; A Four-Stage Approach … , 2021].

Kitoi cemeteries tend to be situated within historically marshy landscapes (at time of use), often at points of higher elevation such as hilltops or river banks [Bazaliiskii, 2010]. The generally good skeletal preservation and large sizes of Kitoi mortuary sites contribute greatly to the heightened archaeological visibility of the Kitoi in comparison to other EN groups. The classic Kitoi mortuary tradition incorporates the abundant use of ochre in single, supine interments in graves that are frequently arranged into rows, and often rich in grave goods (Fig. 2).

Figure 2. Grave artifacts from the MNS cemetery: *1* – bone ornamented needle cases with needles; *2* – lithic arrowheads; *3* – composite fishhooks of Kitoi type

The regional and topological location of the MNS cemetery is typical of other Kitoi sites; however, it is geographically unique because it is the only documented Kitoi cemetery located along one of the Angara's left tributaries as opposed to locations at river confluences (e.g., Lokomotiv and Kitoi) or on the shore of Lake Baikal (Shamanka II) [The Moty – Novaya Shamanka ... , 2016]. Although, other burials and EN Kitoi sites are beginning to be uncovered along tributaries or outside of these areas. The available ^{14}C dates place MNS towards the end of the EN [The Moty – Novaya Shamanka ... , 2016]. Therefore, the MNS remains are from the period directly preceding wide-scale cultural change taking place at the beginning of the Middle Neolithic (MN), which is defined by a discontinuity in the use of formal cemeteries, thus the lack of a bioarchaeological record, in the entire Cis-Baikal region occurring between 6660 and 6060 HPD cal BP [Chronology of middle ... , 2016; Spatio-temporal patterns … , 2021; Middle Holocene hunter ... , 2021]. Both the chronological and geographic characteristics of MNS make it an important site to understanding Middle Holocene culture history in the Cis-Baikal region. Until now, little was known about the size, demographic characteristics, or life history of the people interred at MNS due to the high level of destruction affecting all aspects of this Kitoi cemetery.

Methods

A four-stage approach to re-associate fragmented and commingled human remains was applied to the MNS collection [Bourgeois, 2020; A Four-Stage Approach … , 2021]. During the re-association process, samples were taken from fragments of distinct individuals (based on MNI and re-association). Seven samples were submitted to the University of Oxford, UK, for radiocarbon dating and stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope analysis. The dates were corrected for the Freshwater Reservoir Effect (FRE) and further analyzed using the SUM and KDE_Model functions in OxCal. Radiocarbon dates and stable isotope results were analyzed using the Pearson correlation coefficient to search for chronological trends in diet (further explained below). Archaeological age of the human skeletal materials examined in this paper can be assessed in relative and chronometric terms. Relative dating, based on the morphology of the grave goods recovered from the site as well as some aspects of mortuary ritual inferred from archaeological observations, strongly suggests the EN chronology of this dataset [The Moty – Novaya Shamanka ... , 2016]. More specifically, the materials are associated with the Kitoi mortuary tradition. However, Bazaliiskii and colleagues also suggest the presence of a generic Neolithic and Early Bronze Age (EBA; 4970–3470 cal BP) [Spatio-temporal patterns … , 2021; Middle Holocene hunter ... , 2021] cultural layer at the site.

More detailed analysis of the radiocarbon evidence, regardless of how small the dataset is, requires that all dates are first corrected for the FRE affecting all dates on human skeletal remains in the Cis-Baikal region [Analyzing radiocarbon reservoir ... , 2014; A freshwater old ... , 2013; Freshwater reservoir offsets..., 2014; Highly variable freshwater ... , 2015; Freshwater reservoir effects ... , 2022]. Which of the available correction equations should be applied depends primarily on the geographic location of the cemetery and, secondarily, on carbon and nitrogen stable isotope results associated with each date, the latter characterizing diet of the dated individuals. Four equations have been developed for the Cis-Baikal region: (1) for the Angara valley and Southwest Baikal microregions combined; (2) for the Little Sea microregion; (3) for the Upper Lena microregion; and (4) a generic correction for the entire Cis-Baikal [Highly variable freshwater ... , 2015; Chronology of middle ... , 2016; Middle Holocene hunter ... , 2021; Turning Eastward ... , 2021]. As long as the stable isotope results associated with each dated individual fall within the variation range established for a given archaeological microregion, the equation developed for this particular area is used. However, in cases where stable isotope data suggest a “non-local” diet, an equation for a different microregion, if known, is more appropriate to use [e.g., see Middle Holocene hunter ... , 2021].

During the re-association process, life history indicators were recorded according to standard criteria. These included, where possible, observable non-metric traits, entheseal morphology, pathological lesions, degenerative changes, and dental characteristics such as tooth wear and dental calculus [e.g., Brothwell, 1981; Buikstra, Ubelaker, 1994; Finnegan, 1978; Hauser, De Stefano, 1989; Lieverse et al., 2007; 2016; Mays and Holst, 2006; Oettlé, Demeter, L'Abbé, 2017; Ortner, 2003; Saunders, 1978; Smith, 1984; Scott, 1979]. In some cases, it was also possible to estimate age and sex using standard criteria [Acsadi, Nemeskeri, 1970; Bass, 1995; Buikstra, Ubelaker, 1994]. This data was used independently of the stable isotope analyses to observe the presence of paleopathological, degenerative, and non-metric indicators of life history. Stable isotope and paleopathological/non-metric trait analyses were conducted separately, as the high level of fragmentation and commingling limited our ability to determine individuality.

Results and discussion

Chronology: ^{14}C dates and stable isotope results. The chronometric age was initially provided by one Accelerator Mass Spectrometry (AMS) radiocarbon date done on a human tooth[1], which confirmed the EN chronological position of this collection initially suggested by archaeological criteria [The Moty – Novaya Shamanka ... , 2016]. The seven additional AMS dates reported here were obtained from skeletal samples selected in such a way as to ensure that they represent different individuals (Table 1). The results also confirm the EN chronology of MNS, but one date clearly belongs to the EBA. Consequently, it seems that the cemetery originally consisted of at least two mortuary components: EN Kitoi – the dominant one as suggested by the large number of objects considered diagnostic grave goods for this mortuary tradition [Bazaliiskii, 2010; The Moty – Novaya Shamanka ... , 2016], and EBA Glazkovo – as suggested by one radiocarbon date – probably a minor mortuary component. The EBA individual identified here is excluded from further stable isotope analyses, which is conducted on distinct individuals who have dated to the EN.

Comparison between stable isotope results for the EN MNS sample and the rest of the currently available Kitoi datasets can be summarized as follows (Fig. 3, Table 2)[2]:

- The MNS individuals firmly belong to the distribution range established for Kitoi (n = 224) and characterized by elevated δ^{15}N (14.8‰ ± 0.78, n = 224, 4.8‰ range) suggesting substantial contribution of freshwater foods (mainly fish) to the diet of all these groups;
- Both carbon and nitrogen stable isotope results for the MNS individuals fall into the middle of the respective distributions for the entire Kitoi dataset;
- MNS δ^{13}C values show relatively little variation (–16.2‰ ± 0.31, range 0.8‰, n = 5), which is consistent with minor isotopic variation expected of fish in most northern lotic freshwater ecosystems [Boutton, 1991; Brönmark, Hansson, 1998; Giller, Malmqvist, 1998; France, 1995; Hunter–gatherer foraging ... , 2011];
- MNS δ^{15}N values are more variable (14.7‰ ± 0.71, range 2.0‰, n = 5), which is indicative of the equally variable contribution of aquatic food to the diet of these individuals;

[1] The two dates reported in [The Moty – Novaya Shamanka ... , 2016] are both on the same sample.
[2] Due to the large differences between sample sizes, statistical methods are not employed in this comparison.

Table 1

Radiocarbon dates and stable isotope results for MNS

№	MASTER_ID	Source	Sample № .	Element	Age	Sex	Period	Mortuary tradition	Date BP	±	Corrected Date BP	±2	Mean Cal Date BP	±3	$\delta^{13}C$	$\delta^{15}N$	% Yld	%C	CN
1	MNS_2014.RP B.01	24a-77	H 2019.352	Right petrous bone	A[1]	U[2]	EN	Kitoi	6677	24	6220	68	7119	90	-15,9	14,7	9	44,9	3,2
2	MNS_2014.RP B.03	Item 76 (2014)	H 2019.354	Right petrous bone	A	U	EN	Kitoi	6709	24	n/a		n/a		-18,6	10,7	10,3	45,3	3,2
3	MNS_2015.RP B.04	19B-22	H 2019.355	Right petrous bone	A	U	EN	Kitoi	6663	25	6079	69	6957	106	-16	15,7	6,5	44,3	3,2
4	MNS_2015.RP B.05	19B-22	H 2019.356	Right petrous bone	A	U	EN	Kitoi	6700	24	6248	68	7152	92	-16,7	14,7	10,7	46	3,2
5	MNS_2015.RP B.06	25B-90	H 2019.357	Right petrous bone	A	U	EN	Kitoi	6754	24	6292	68	7210	91	-16,1	14,8	11,6	44,4	3,2
6	MNS_2015.T1_ C11[3]	Trench 1; Conjoin #11	H 2019.370	Femur	J	U	EN	Kitoi	6669	24	6335	68	7267	83	-16,2	13,7	7,5	43,9	3,2
7	MNS_2014.RP B.02	13-1	H 2019.353	Right petrous bone	A	U	EBA	Glazkovo	3574	19	3357	67	3600	88	-18,6	12,8	9,7	46	3,2

[1] A= adult; J= juvenile.
[2] U= Unknown.
[3] Individual different from those represented by right petrous bones (RPB).

- One individual from MNS shows a set of isotopic results (MNS_2014.RPB.03: $\delta^{13}C = -18.6‰$, $\delta^{15}N = 10.7‰$) very similar to those displayed by one individual from the Shamanka II cemetery located on Southwest Baikal (SHA_2004.042.02: $\delta^{13}C = -18.0‰$, $\delta^{15}N = 10.5‰$), both characterized by low $\delta^{13}C$ and very low $\delta^{15}N$ values; both individuals are obvious outliers not only within their respective datasets but also relative to the entire Kitoi sample.

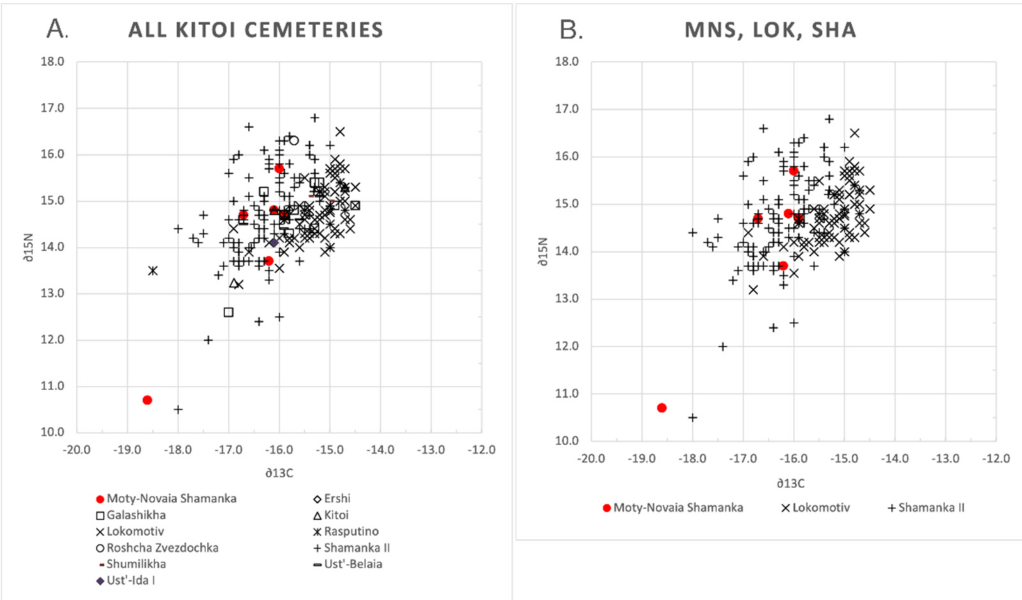

Figure 3. Stable isotope results for MNS and other Kitoi cemeteries from the Cis-Baikal region: (A) MNS and all other Kitoi cemeteries; (B) MNS, Lokomotiv, and Shamanka II; [after Middle Holocene hunter ... , 2021]

Table 2

Summary of carbon and nitrogen stable isotope results for MNS and a few other Kitoi cemeteries from the Cis-Baikal region [Middle Holocene hunter ... , 2021]

Cemetery / Sample	Microregion	$\delta^{13}C$	S.d.	Range	$\delta^{15}N$	S.d.	Range	N
MNS	Angara (lower Irkut)	-16,2	0,3	0,8	14,7	0,71	2	5
Galashikha	Angara	-15,6	0,7	2,5	14,7	0,8	2,8	11
Lokomotiv	Angara	-15,2	0,5	2,4	14,8	0,6	3,3	80
Ust'-Belaia	Angara	-15,9	0,6	1,5	14,7	0,28	0,7	5
Shamanka II	Southwest Baikal	-16,2	0,5	3,3	14,8	0,6	4,8	119
Entire Kitoi	Cis-Baikal	-15,8	0,8	4	14,8	0,78	4,8	224

Based on this comparison, it seems that the FRE correction equation developed for the Angara and Southwest Baikal microregions combined and employed to correct radiocarbon dates from both areas and from all archaeological periods (Mesolithic to Bronze Age, including EN Kitoi), should be applicable also to most MNS individuals. Of course, similarity of diets doesn't automatically imply equal similarity of the FRE, but this caveat is equally applicable to all other areas and localities within the Angara–SW Baikal microregion and, presently, cannot be addressed any further. In any case, it is much better to correct the MNS dates with the correction equation that appears to work well for this area than not to correct them at all.

Also, as was the case with the one individual from Shamanka II (SHA No. 42.02) showing outlier stable isotope results, it seems that it is presently better not to correct a similar individual from MNS (MNS_2014.RPB.03) as none of the available correction equations appears to be applicable to these two cases. Nevertheless, it is very interesting and archaeologically meaningful that another individual with such isotopic signature has been discovered at another Kitoi cemetery. This discovery answers at least one question: the area where these two individuals spent much of their adult lives was not located on the lower Irkut River. Recent isotopic research on human skeletal materials from the Fofanovo cemetery in the delta of the Selenga River eliminated that area as the potential adult home range of these two individuals [Turning Eastward ... , 2021], thus pointing towards the valley of the middle Irkut, directly west of Lake Baikal, as, perhaps, a likely option.

This leaves five MNS radiocarbon dates and associated stable isotope results for further analysis. While the MNS dataset is small, recent analysis of 560 sets of radiocarbon dates and stable isotope data for Middle Holocene hunter-gatherers from the entire Cis-Baikal region has demonstrated that useful insights can be still gained particularly if examined in the context of other relevant datasets [Spatio-temporal patterns..., 2021; Middle Holocene hunter..., 2021]. In this case, the context is provided by 225 radiocarbon dates and 224 sets of isotopic results from 10 Kitoi cemeteries (9 located on the Angara and 1 on Southwest Baikal), rather a substantial dataset[3]. The analysis employs the same methods used in these two studies: "SUM" and "KDE_Model" functions from OxCal (a program developed for the analysis of radiocarbon and other chronological information) to examine distribution of burial events and chronological position of various cemeteries relative to one another, and the Pearson product-moment correlation coefficient (PCC) between radiocarbon dates and stable isotope measurements to search for dietary trends.

The "SUM" function is applied to datasets with fewer than five radiocarbon dates while the "KDE_Model" is used to analyze five or more dates [Bronk Ramsey, 2017; Spatio-temporal patterns ... , 2021]. The results from these two functions are broadly comparable, the main difference being that the "KDE_Model" provides more information about temporal distribution of the dated events. Thus, it can provide additional insights about chronological patterns of cemetery use (breaks or tempo) or patterns within other units of analysis such as entire mortuary traditions of microregional groups [Spatio-temporal patterns ... , 2021], which, however, is of limited utility for this analysis because the MNS sample is very small (n = 5). These two functions are also similar in that neither provides quantitative estimates of temporal boundaries for the examined time intervals. In sum, the main purpose of both functions as used in this paper is to assess the chronological position of the MNS sample relative to other relevant Kitoi datasets.

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[3] The radiocarbon age of SHA No. 42.02 individual is based on the dates obtained for sequential samples of molar dentine representing a period of life of this individual prior to moving out of the Southwest Baikal microregion and adopting a different diet and corrected using stable isotope results from obtained for same samples. Consequently, the number of Kitoi dates analyzed is 225 while the number of corresponding isotopic results is 224.

The graphs generated by the chronological analysis of corrected radiocarbon dates (Fig. 4) allow a few observations. First, the results confirm what the initial assessment of the uncorrected and corrected dates already suggested: the MNS cemetery firmly belongs to the chronological interval defined for the Kitoi mortuary tradition and more specifically to the middle of its entire range while comparison with several larger Kitoi groups of dates generates a few additional insights.

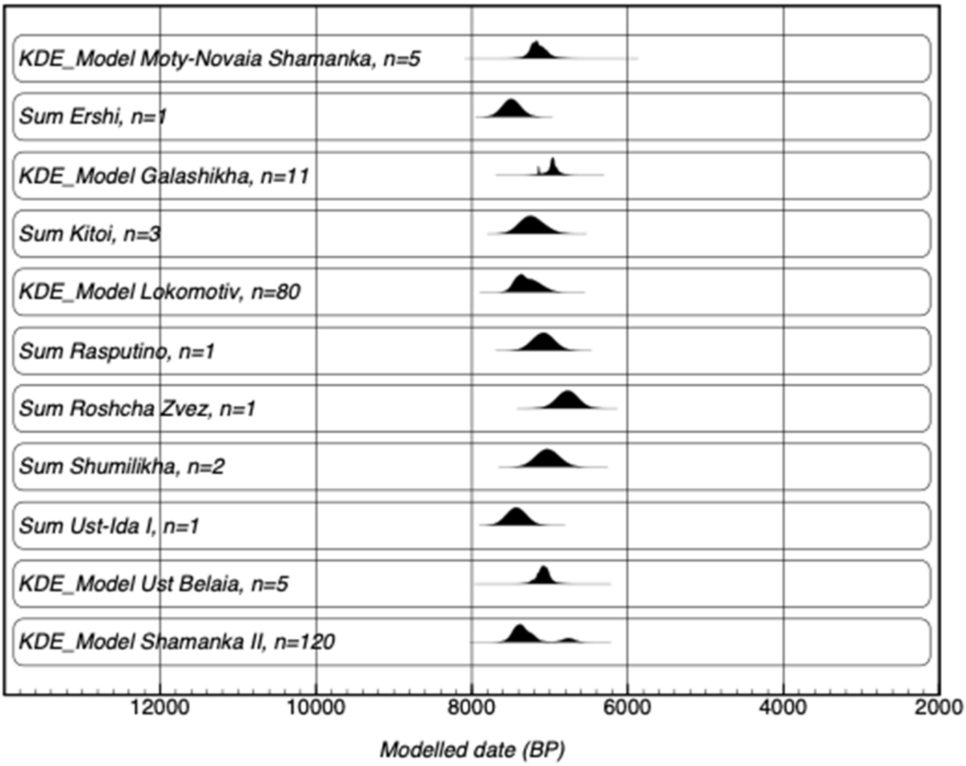

Figure 4. Chronological position of MNS and other Kitoi cemeteries
[after Spatio-temporal patterns..., 2021]

Second, despite the small size of the MNS sample, it may be meaningful that, relative to Lokomotiv and Shamanka II, MNS appears to be in use past the peaks of these two large Kitoi cemeteries, both of which show distributions of burial events skewed towards the beginning of their use (Fig. 5A, D, and E). In other words, establishment of MNS may have coincided with the decline in the use of Lokomotiv and the end of Phase 1 at Shamanka II (Fig. 5). Moreover, MNS almost fills in the gap between Phase 1 and Phase 2 at Shamanka II on Southwest Baikal.

Third, the frequency of burial events at MNS is an order of magnitude lower (probability density for MNS is about 0.02, while for the other groups it is between 0.2 and 0.3) than at Lokomotiv and Shamanka II on the Angara and SW Baikal, respectively, as well as Kitoi in the Angara valley or the entire Kitoi mortuary tradition (Fig. 5). However, not much should be read into this difference because of the substantial contrast in sample sizes between MNS and the other analytical units. Whether or not MNS also featured equally high density of burial events as the other two large Kitoi cemeteries could only be established if MNS were excavated and dated in the manner similar to these two cemeteries, which, however, is not possible because of the almost complete destruction of MNS.

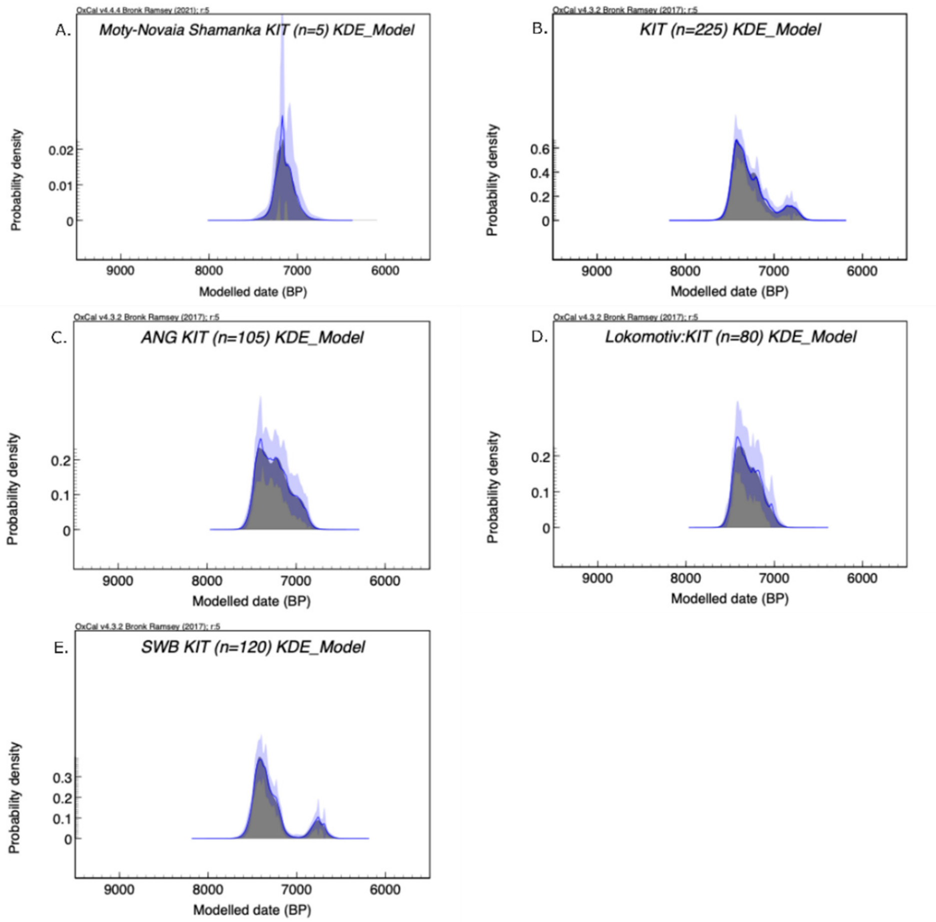

Figure 5. Detailed chronology of the MNS cemetery and of Kitoi mortuary tradition in the Angara valley and on SW Baikal [after Spatio-temporal patterns ... , 2021]: (A) MNS (lower Irkut); (B) entire Kitoi excluding MNS; (C) Kitoi in the Angara valley; (D) Lokomotiv; (E) Kitoi on Southwest Baikal (i.e., Shamanka II)

The last matter to consider in this section is the search for dietary trends, that is directional change in diet structure over time. As in a few recent studies [Biogeochemical data ... , 2016; Chronology of middle ... , 2016; Middle Holocene hunter ... , 2021], such search employs the PCC tests between mean calibrated radiocarbon dates and δ^{13}C and δ^{15}N measurements obtained from the same samples of human skeletal remains. The tests show (Fig. 6) no correlation between the dates and δ^{13}C values (PCC: r = –0.29, $r^2 = 0.08$, $p = 0.64$) and a very strong negative correlation with δ^{15}N measurements (PCC: r = –0.91, $r^2 = 0.83$, p = 0.03).

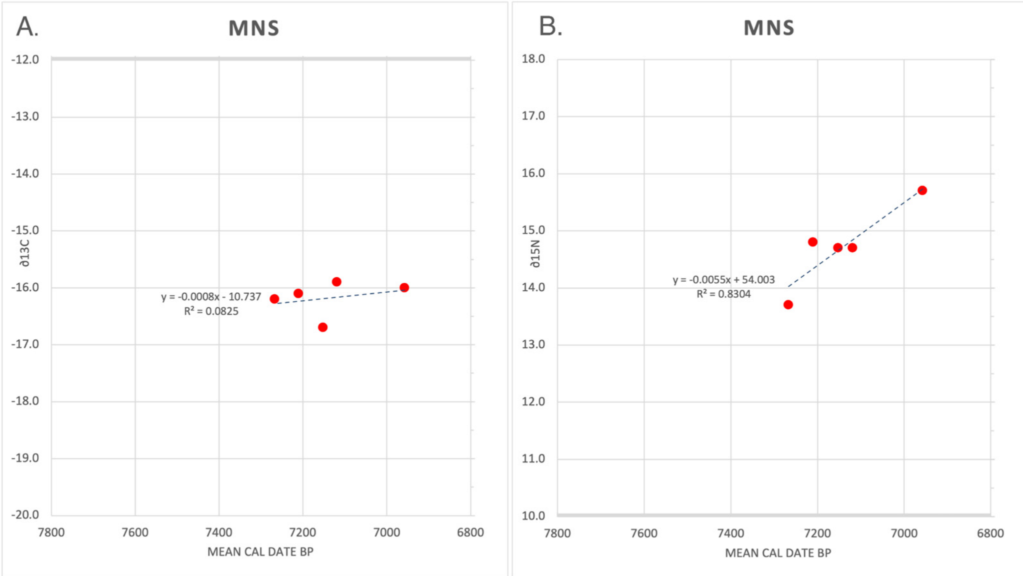

Figure 6. Scatterplots of corrected radiocarbon dates and stable isotope results for MNS: (A) ^{14}C dates by $\delta^{13}C$; (B) ^{14}C dates by $\delta^{15}N$

It is tempting to dismiss the very strong negative correlation between radiocarbon dates and $\delta^{15}N$ measurements, suggesting increased dietary reliance on local fish (i.e., from the Irkut river) on the account of the very small sample size; however, a few circumstances suggest that doing so could not be entirely warranted [Middle Holocene hunter ... , 2021]. First, the pattern repeats similar trends found in a few other Kitoi datasets, such as: Shamanka II Phase 1, SE Cluster row burials; Shamanka II Phase 2; and, Lokomotiv Clusters 2, 4, and 5 – all three also involving increased consumption of local fish over time. Second, although dating to the EBA, the most clearly observable dietary trend has been identified for the Khadarta IV cemetery in the Little Sea microregion, Lake Baikal, on a sample of nine individuals, thus not that much larger than MNS. And third, prior to the FRE correction, the MNS dataset shows no statistically significant correlations, which is also exactly what all other datasets with identified dietary trends within the entire Cis-Baikal region display too. In other words, after the FRE correction, the stable isotope results "find" their more or less historically correct chronological position and display patterns otherwise "erased" by the FRE. Thus, although tentative, the dietary trend displayed by the five MNS individuals is not entirely unexpected and fits well with the spatial and chronological dietary variation so well established for the EN Kitoi hunter-gatherer groups in the valley of the Angara River and on the coast of Southwest Baikal.

Paleopathological and degenerative changes. As common among other Kitoi collections, such as those from Lokomotiv and Shamanka II [Osteoarthritis in Siberia's..., 2007; Revisiting Osteoarthritis ... , 2016], the majority of post-cranial pathological lesions observed for MNS are indicative of osteoarthritis (OA; Table 3). OA is diagnosed based on the combined presence of pitting (porosity), periarticular lipping (osteophytes), and eburnation of articular surfaces that reflect the degeneration of the synovial joints [Ortner, 2003; Waldron, 2012; Weiss, Jurmain, 2007]. Although OA has a multifactorial etiology that includes systemic risk factors such as age, sex, and body size, the contributory effects of biomechanical stress are well documented [e.g., Cooper, 1995; Prevalence of osteoarthritis ... , 2015; Stanley, 1994; Osteoarthritis of the knee..., 2006]. As a result, OA can inform about past activities and behaviour.

Within the manual and pedal elements, OA lesions were present on both the proximal and distal joint surfaces. It did not appear that any of these elements were duplicates of the same bone, although this was difficult to confirm due to varying levels of completeness and because it was impossible to re-associate these elements based on other characteristics [A Four-Stage Approach ... , 2021]. There were also two cases of vertebral OA, one including two articulating vertebrae [as per Gestsdóttir, 2014; A Four-Stage Approach ... , 2021]. Generally, osteoarthritic changes in the vertebrae (such as those identified at MNS) and upper and lower limbs have been found to be more severe, suggesting engagement in activities causing higher levels of biomechanical stress, among EN men than women and among individuals interred at Lokomotiv compared to those from Shamanka II [Osteoarthritis in Siberia's ... , 2007; Revisiting Osteoarthritis ... , 2016]. This dichotomy in OA severity between these two large Kitoi cemeteries was striking. It revealed variation in activity and behaviours that reflects the interplay of local ecological conditions, social organization, and environmental change during the EN period [Lieverse, 2020].

Other common pathological lesions in this collection were age- and/or activity-related degenerative changes and indicators of non-specific inflammation. These included lesions such as vertebral osteophytosis on the inferior and superior vertebral centra, enthesophytes and exostoses on vertebrae, and periosteal bone formation on a fibula and tibia. There were also a few cases of pitting in articular surfaces of manual and pedal elements which are of unknown etiology. A pathologically thin pubis was also identified, but its incompleteness prohibited further assessment of etiology. Interestingly, while uncommon, a similar case has been documented on another EN individual, an adult female, from Shamanka II. That case was associated with a large smooth depression on the dorsal surface of the pubic body and morphological changes (angling) to the normally flat symphyseal face, both features observed on a second adult female from Shamanka II. While the etiology behind these changes remains unknown, their presence on female pubic bones suggests possible associations with parturition.

The cranial and dental fragments in the MNS collection also presented numerous pathological and degenerative changes (Table 4). Three crania within the MNS collection had antemortem damage and fine-grained pitting of the external auditory meatus, indicative of chronic otitis externa [Mays, Holst, 2006; Purchase, 2016]. Porosity and resorption of alveolar bone, often indicative of periodontitis or dental attrition, was present in each dental fragment in the MNS collection (both maxillary and mandibular). The prevalence of chronic ear infection is not uncommon among Cis-Baikal Middle Holocene individuals, with most cases expressed as some form of otitis (otitis externa, otitis media, and/or mastoiditis), possibly relating to habitual swimming in the cold waters of the area [Purchase, 2016]. The high rates of these lesions, proportionate to the preservation of auditory meati from MNS, are therefore consistent with other EN and Middle Holocene cemeteries in this area. This was accompanied by five instances of antemortem tooth loss, three cases of antemortem tooth breakage, and one case of non-carious pitting on the occlusal surface. In general, tooth wear was moderate with one outlier in which advanced attrition obliterated the entire crown surface of all teeth present.

Table 3

Post-cranial pathological lesions identified within the MNS collection

Skeletal Element	Identifier	Side	Lesion Description	Suspected Etiology
Metacarpals	25a-8	Left, 2nd	Osteophytes on the proximal articular facet and pitting on the styloid process	Unknown
	24a-178	Right, 4th	Pitting on the lateral depression of the head	Unknown
Carpals	25a-25	Right, pisiform	Pitting on the body	OA
	25-10	Right, hamate	Pitting on the plantar face	Unknown
Hand phalanges	19в-44	Right, intermediate	Osteophytes along the proximal articular edges	OA
	19в-46	Right, proximal 1st	Osteophytes along the border of the head, the proximal articular surface, eburnation on the head	OA
			Enthesophytes along medial and lateral borders	Entheseal change (non-specific)
	N/A	Distal	Osteophytes on both medial and lateral proximal sides	Entheseal change (non-specific)
Metatarsals	19в-49	Left, 1st	Osteophytes on the medial plantar head	OA
	x-49	Left, 1st	Osteophytes on the medial plantar head, eburnation on the head	Possible OA
Foot phalanges	21г-23	Right, proximal 1st	Pitting in the facet	Unknown
	19в-45	Right, proximal 1st	Osteophytes on dorsal side of the head and on the lateral side of the articular facet, eburnation on lateral condyle of head	OA
Ossa coxae	25a-27	Left, pubis	Very thin pubis	Unknown
Vertebrae	27б-26	C5	Enthesophytes on the spinous process	Non-specific
			Vertebral osteophytosis	Degeneration
	27б-23	C4	Destruction of the left superior articular facet	OA
	20б-5[4]	C1	Exostosis on inferior border of the facet for the dens	OA (same individual as 20б-4)
	20б-4[4]	C2	Exostosis on the dens	OA (same individual as 20б-5)
	21в-6	T11	Exostoses between the superior articular processes	Non-specific
Ribs	19a-1	Right	Large exostosis on the tubercle; large, smoothed pit on the head (lateral to the tubercle)	OA
Fibulae	20в-15	Right	Exostoses on the interosseous and posterior border	Entheseal change (non-specific)
	20г-3[4]	Left	Diffuse periosteal bone formation (periostitis) on the posteromedial border	Non-specific
Tibiae	20в-24[4]	Right	Periosteal bone formation (periostitis) on the anterior crest and posterior and anterior borders, some remodelled	Non-specific

Table 4

Cranial and dental pathological lesions and tooth wear in the MNS collection

Skeletal Element	Identifier	Side/Teeth Present[5]	Tooth Wear[6]	Lesion Description	Suspected Etiology	Presence of Third Molars
Crania	х-76[7]	Right, temporal	N/A	Destruction and fine-grained pitting of the right external auditory meatus	Chronic otitis externa	N/A
	14-6[7]	Left, parietal	N/A	Minor porosity on the ectocranial surface	Unknown	N/A
	19в-22/ 20б-2[7]	Right, temporal	N/A	Destruction and fine-grained pitting of the right external auditory meatus	Chronic otitis externa	N/A
	24г-15	Occipital	N/A	Porosity on the occipital superior to the nuchal crest	Unknown	N/A
	19в-22	Right, temporal	N/A	Destruction and fine-grained pitting of the right external auditory meatus	Chronic otitis externa	N/A
Maxillary teeth/Alveolar bone	19в-1[7]	13–17, 23, 25–27	Moderate	Porosity and resorption of alveoli	Periodontitis	Congenitally absent
	19г-3[7]	Left, 26, 27	Minor	Porosity and resorption of alveoli	Periodontitis	N/A
				AMTL[8] of teeth 24 and 29, complete alveolar resorption	Attrition	
				AMTB[9] of teeth 25 and 26	Attrition	
	19в-17	Right, 14–17	Moderate	AMTL of teeth 12 and 15, complete alveolar resorption	Attrition	N/A
				Porosity and resorption of alveoli	Periodontitis	
	27б-25	Left, 23–28	Moderate	AMTB on buccal edge of crown of tooth 26	Attrition	Present
				Half of lingual occlusal surface worn on tooth 27	Attrition	
				Pitting on the occlusal surface of tooth 28	Non-carious pitting	
				Porosity and resorption of alveoli	Periodontitis	
	16-1	Right, 13, 15, 16	Advanced	AMTL of tooth 14, complete alveolar resorption	Attrition	N/A
				Porosity and resorption of alveoli	Periodontitis	

End of Table 4

Skeletal Element	Identifier	Side/Teeth Present[5]	Tooth Wear[6]	Lesion Description	Suspected Etiology	Presence of Third Molars
	20-1	Left, 24,25	Moderate	Porosity and resorption of alveoli	Periodontitis	N/A
	19в-5	Left, 23–26	Moderate	Porosity and resorption of alveoli	Attrition	N/A
	19в-5	Right, 13–17	Moderate	Porosity and resorption of alveoli	Attrition	N/A
Mandibles	17б-6	35, 36	Advanced	None	Attrition	N/A
	19в-20/19в-20[7]	44–47, 33–37	Moderate	Minor dental calculus[10]	Attrition	Congenitally absent
				AMTL of tooth 31	Attrition	
				Porosity and resorption of alveoli	Attrition	
Teeth	20в-9	Right mandibular, 44 or 45	Minor	None	Attrition	N/A

[5] As per FDI World Dental Federation notation.
[6] Canine and premolar dental wear follow Smith, 1984, whereas "Minor" = stages 1–3, "Moderate" = stages 4–6, "Advanced" = stages 7–8. Molars follow Scott, 1979 whereas "Minor" = stages 1–4, "Moderate" = 5–8, "Advanced" = 9–10.
[7] Also presented [A Four-Stage Approach..., 2021].
[8] AMTL = Antemortem tooth loss.
[9] AMTB = Antemortem tooth breakage.
[10] Code 1 according to [Brothwell, 1981].

Non-metric traits. The expression of non-metric traits found within the MNS collection was also fairly typical for the EN period. The observation of non-metric traits (NMT; Table 5) was, again, substantially compromised by poor preservation. This restricted results to particular skeletal elements, namely cranial and dental. Among the most obvious (and thus identifiable) NMT documented were squatting facets on tali and distal tibiae, while others included a suprascapular notch and circumflex sulcus on a scapula, and three distinct talar facets on all (four) calcanei [Buikstra, Ubelaker, 1994; Finnegan, 1978; Saunders, 1978; Winder, 1981]. Squatting facets are commonly found in Kitoi individuals, having been identified in all age groups at Shamanka II and Lokomotiv. They are indicative of physical activities (e.g., habitually walking over undulating terrain [Macintosh, 2011]) and habitual resting positions (e.g., and squatting, kneeling, and heel sitting [Smith, Woollen, 2020]) causing ankle hyperdorsiflexion. Circumflex sulci and suprascapular notches were also among the most frequently scored traits identified at Shamanka II and Lokomotiv. Squatting facets and circumflex sulci were significantly more common in individuals from Lokomotiv than from Shamanka II [Macintosh, 2011]. These traits in MNS are thus consistent with contemporary Kitoi sites. Unfortunately, the high level of commingling and fragmentation of the MNS collection renders the NMT data incomplete, and thus insufficient for a useful comparison between MNS and the other two EN cemeteries.

Table 5

Non-metric traits (NMT) identified in the MNS collection

Skeletal Element	Identifier	NMT
Mandibles	19в-20/19в-20[11]	Torus absent, mylohybrid bridge absent
	27б-8	Mylohybrid bridge absent
Scapulae	20б-3, 19в-19[11]	Suprascapular notch, circumflex sulcus
Tibiae	19в-71	Squatting facet
	19в-74	Squatting facet
	24а-10[11]	Squatting facet
	24а-9[11]	Squatting facet
Tali	21--3	Squatting facet
	19в-34	Squatting facet
Calcanei	19--5	Three discrete talar articular surfaces
	20в-35	Three discrete talar articular surfaces
	19в-73	Three discrete talar articular surfaces
	26в-16	Three discrete talar articular surfaces
Frontal (crania)	13-6, 14-6[11]	Retained metopic suture
	19в-11, 19в-17, 20в-22[11]	Right supraorbital notch, left supraorbital foramen, left supraorbital zygomatico-facial foramen, marginal Tubercle
Parietal (crania)	19в-22, 20б-2	Left parietal foramen
	24г-15, 22в-31	Left parietal foramen
Teeth	19в-15	Labial enamel extension on teeth 17 and 27
	19г-3	Labial enamel extension on tooth 27
	19в-5	Labial enamel extension on tooth 17
	19в-5	Labial enamel extension on tooth 16
	27б-25	Labial enamel extension on teeth 27 and 28
	19в-20/ 19в-20	Teeth 36 and 46 have five cusps, 47 and 47 have four cusps

[11] Also presented [A Four-Stage Approach ... , 2021].

Non-metric traits observed in the cranial and dental material included absent mylohybrid bridges and absent tori on the two mandibles preserved enough to observe them. Further, cranial fragments showed numerous instances of parietal and supraorbital foramina, one marginal tubercle, and one retained metopic suture. Not enough incisors were present to observe the frequency of shovelling, but all present maxillary premolars had one root, and many teeth had enamel extension on the facial side. All maxillary molars exhibited hypocones, although tooth wear prohibited the assessment of size, but no Carabelli's cusps or protostylids were observed. All osteological data collected from MNS, at least to the extent that they could be studied considering their fragmentation and commingling, indicate that the life history of those interred here was consistent with the Shamanka II and Lokomotiv EN groups.

Conclusion

Stable isotope analysis demonstrated that $\delta^{13}C$ and $\delta^{15}N$ signatures at MNS fit into the middle of the Kitoi distribution range and showed a reliance on aquatic foods. This analysis, however, also yielded two interesting findings. First, AMS radiocarbon dates indicated that MNS was an active cemetery in both the EN and EBA periods, although dates are predominantly from the EN Kitoi. Second, $\delta^{13}C$ and $\delta^{15}N$ signatures from one individual at MNS were anomalous when compared to all other EN Kitoi individuals in the Cis-Baikal dataset except one other from Shamanka II. These two individuals show signatures that suggest they lived the majority of their adult lives at an unknown locale far away from where they were buried (i.e., the Angara and SW Baikal microregions). Although the implications of the two (MNS and Shamanka II) individuals with unique isotopic signatures remain unclear, they suggest at least some long distance migration during the EN. Further exploration into the isotopic signatures within EN populations will be needed to clarify this emerging pattern.

Due to the poor preservation of the skeletal collection, paleopathological and NMT analyses did not provide many insights on life history at the population level. However, the paleopathological lesions and degenerative changes found in the MNS collection were consistent with EN Kitoi individuals in this region. Preliminary analyses showed that MNS differed from all other EN Kitoi mortuary sites in the Cis-Baikal by being the only known Kitoi cemetery not located on the Angara or the coast of southwest Baikal. In regards to the first point, our analysis suggests that the life history and dietary trends at MNS are largely consistent with other EN Kitoi groups. Therefore, the anomalous location of MNS is likely a result of survey or reporting bias, where most sites have been found in connection with the development of current urban areas and farming activities, or a rarity indicative of population density in this area. This study demonstrates that fragmented and commingled human remains can still hold research potential, even if substantially limited by poor preservation. Despite the small sample size, isotopic analysis provided important chronological and dietary information that contributes to a deeper understanding of this group of people life history in the Cis-Baikal region.

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