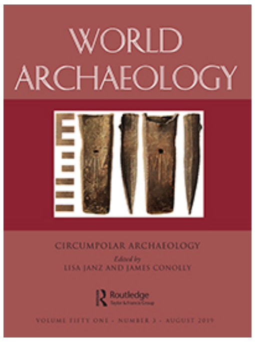

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EDITORIAL

Margins of the centre or critical peripheries?

Introduction

Building an understanding of cultural innovations and the mechanisms of their dispersal, in which new technologies, foods, or ideas were made available for adoption or rejection, requires both good data and good theory. Not surprisingly, our picture of long-term patterns of inter-regional cultural interaction has largely been shaped by the study of European prehistory, given that the discipline grew out of early intellectual advances in European antiquarianism (Trigger 2006). However, increased global interest in a rigorous and evidence-based understanding of the human past has now begun to shape our understanding of prehistory in notable ways. Recent and transformative examples include the identification of a Pleistocene tradition of figurative rock art in Southeast Asia (Aubert et al. 2018, 2019), new understanding of the distribution and chronology of Early Pleistocene hominins in China (Li et al. 2017), and the earliest use of pottery as early as the Late Pleistocene by Northeast Asian hunter-gatherers (Keally, Taniguchi, and Kuzmin 2003). Many of the basic theories and approaches for understanding regional interaction that had developed from the framework of Mediterranean and European archaeology have been reinforced by this global florescence, but that regional emphasis has sometimes also affected an ignorance of alternative trajectories – largely those of politically and economically underrepresented groups, including the indigenous peoples of colonized nations and the hunter-gatherer and nomadic pastoralist societies that exist on the periphery of powerful nation states (e.g. Teixeira and Smith 2008; Hall, Kardulias, and Chase-Dunn 2011). This tendency is reinforced by the widespread, and often implicit, acceptance of world-systems perspectives within archaeology. One of the most influential models for understanding the inter-regional flow of materials, world-systems theory focuses on economic relationships between core, semi-periphery, and periphery countries as regulated by economic structures and power relations emanating from the core (e.g. Wallerstein 1974). These models were widely adopted within archaeology and applied at temporal scales far beyond the historic colonial-capitalist systems they were meant to describe (Hall and Chase-Dunn 1993).

Critiques of core-periphery models later emphasized the decision-making power of smaller-scale and formative state societies (Alexander 1999; Eerkens, Kantner, and Vaughn 2009; Hall 1986; Kardulias 1990; Stein 1999), but even today those societies remain underrepresented in theory-building while continuing to be characterized as peripheral (Peregrine 2007). This reinforces the idea that the archaeology of such regions has little to offer aside from their role in the literature as regional curiosities, sources of raw material supply for 'centres', or examples of the great reach and power of 'civilizations'. As archaeology becomes more global, however, it is increasingly evident that more isolated small-scale societies offer critical knowledge on inter-regional relations and inform on some of the most common trajectories in human development. A recent study of global prehistoric land-use has, for example, shown that from ~8000 to 4000 BC, during the initial stages of plant and animal domestication, Southwest Asia was peculiar in its rapid uptake of systems of food production

(ArchaeoGLOBE Project 2019). The more common pattern observed was a gradual transition from a mixed foraging-farming economy to more intensive agricultural or pastoral lifeways, often after 2000 BC. What this means is that the regions described in this volume could be said to be more representative of human cultural patterns throughout most of the Holocene, as opposed to the agriculturally based sedentism and early urbanization observed in Southwestern Asia. The value of more detailed examination of regions that are traditionally considered as peripheral is that they not only comprise the significant portion of pre-industrial human populations, but also that 'life in the margins' provides considerable insight into how most people experienced life and interacted with centres of technological innovation and social transformation over this period.

The articles in this volume illustrate connections to larger global trends known to have been driving intensification of production and urbanization in agricultural centres in China, Southwest Asia, and the Mediterranean, but they more importantly highlight how local innovations preceded and interacted with a series of cultural changes that largely determined the nature of hunter-gatherer relations across northern Eurasia and North America. The nature of these relations defined how trade with sedentary states – whether in Bronze Age Europe, Iron Age China, or colonial period Canada – were to be negotiated. These examples reveal the largely autonomous nature of hunter-gatherer cultures with respect to their 'civilized' neighbours, including the quite peripheral role that those neighbours most often played in indigenous politics. While periods of heightened trade and interaction can be identified – marked here most notably by the tantalizingly absent evidence for either wholesale adoption of metallurgy or sustained interaction with domesticated species – it is the long breaks between first contact and regular use of these innovations that are perhaps even more compelling. Despite clear evidence for both the presence of metals and knowledge of metal production in far eastern Siberia beginning in the mid-second millennium BC (Dyakonov et al. 2019; Popov, Zhushchikhovskaya, and Nitikin 2019), iron was not regularly used and imported into Chukotka and Alaska until the eleventh century AD, more than a thousand years after its first introduction and nearly 2000 years later than its spread into Northeast Asia (Dyakonov et al. 2019; Mason and Rasic 2019). While this delay has been attributed to a glut on supply (Dyakonov et al. 2019), it is equally possible that these materials were not sufficiently capable of being integrated into local tool kits to the extent that a desire for them sufficiently stimulated demand.

Innovation in critical peripheries

The Circumpolar North (lands on or above the 60th parallel) is traditionally considered to represent the primitive margins of human societies (Lubbock 1865; Holly 2002) – groups who have relied primarily on hunting and gathering until very recently (after 1850 AD, see ArchaeoGLOBE Project 2019). Nevertheless, the archaeology of the region reveals one of the most remarkable feats of human adaptation: its very colonization was dependent on multiple cultural innovations that enabled the successful dispersals and settlement of environments defined primarily by a narrow range of evolutionarily specialized mammalian fauna. Colonization of the circumpolar north would not have been possible without the series of innovations that arose from increasing institutional and economic complexity across Northeast Asia, beginning at ~6000–5000 BC with widespread coalescence and resource management (Janz 2016; Popov, Tabarev, and Mikishin 2014; Shelach-Lavi et al. 2019). Of equal importance, a range of new ideas and technologies accompanied the use and limited production of metals as it spread into northern and eastern Siberia and Alaska, including plant and animal domestication (Popov, Zhushchikhovskaya, and Nitikin 2019), new funerary practices (Dyakonov 2019), increasingly elaborate and durable art (Mason and Rasic 2019) and the mobilization of long-distance trade and migration (Friesen and O'Rourke 2019; Gjesfjeld et al. 2019; Mason and Rasic 2019).

The most relevant development to understanding the trajectory of societies covered here is the development of effective sea-mammal hunting (Takase 2019). This allowed local groups to progressively settle previously unoccupied and environmentally marginal settings (see Gjesfjeld et al. 2019). The geographic impact of this development is exemplified in the Thule, descendants of Bering Sea walrus/whale hunters, whose colonization of the vast Arctic coastlines stretched from Chukotka to Greenland (Friesen and O'Rourke 2019; Raghavan et al. 2014). This migration was one of the only two major population expansions beyond the Amundsen Gulf in the Canadian Arctic, expanding settlement of territories previously uninhabited for hundreds of years, and enabling the establishment of Inuit and associated cultures across a huge swath of the world's northernmost coastlines (Friesen and O'Rourke 2019). Here, from a broader perspective, we see the diffusion and incorporation of elements of Eurasian-derived ritual behaviour, material culture, and/or technology that eventually reached the eastern Canadian Arctic within a few hundred years of those influences arriving directly from Europe with Viking settlers. Over the course of ~5000 years, we can therefore more clearly envision exactly the types of large-scale shifts in material culture that we seem to think of elsewhere as occurring in the blink of an eye in earlier periods (see also Hoffecker 2005).

Relationship to 'centres'

Metallurgy, derived from western Eurasia (Roberts, Thornton, and Piggott 2009), as well as the attendant spread of domesticated plants and animals originating in Southwest Asia and China (Dyakonov et al. 2019; Popov, Zhushchikhovskaya, and Nitikin 2019), represent the enduring influence of 'centres'. These examples highlight not only the vast scale of diffusions in human ingenuity; the story of their diffusion additionally highlights great variation in the choices that northern peoples have made in selecting foreign innovations (e.g. metals), rejecting them or delaying their adoption (e.g. cereal cultivation), and adopting them with modifications (e.g. reindeer domestication – see Anderson et al. 2019). Evidence for the sporadic and non-permanent adoption of low-level cereal agriculture in the Russian Far East (Popov, Zhushchikhovskaya, and Nitikin 2019) and wide variability in the adoption of metallurgy across eastern Siberia (Dyakonov et al. 2019; Popov, Zhushchikhovskaya, and Nitikin 2019) exemplify the reality that technological change is often possible but not always sufficiently desirable.

Other important innovations are decidedly local in character. The pace of maritime exploitation and colonization of new territories across Hokkaido, the Kuril Islands, the Bering Sea, and even the Canadian Arctic exemplifies periods of exclusively indigenous cultural shifts. Hunting sea mammals on the open ocean were critical to the establishment of large villages in Hokkaido (Abe et al. 2016) and to the development of whaling cultures across the Pacific Rim. Although the exploitation of aquatic resources arose in the Palaeolithic, and maritime economies based on fishing and opportunistic exploitation of sea mammals were established early in the Holocene, it is not until the middle Holocene that we see the series of technological changes capable of catalysing complex extractive economies. Each stage of development facilitated larger cultural changes. The early colonization of the Kuril Islands, for example, Gjesfjeld et al. (2019); Yanshina and Kuzmin (2010), is broadly contemporary with the oldest evidence for harpoon heads in Hokkaido at ~5800 BC (Takase 2019). By ~3800 BC, both adult and juvenile seal remains are found in local faunal assemblages, suggesting that a shift had occurred from opportunistic hunting in coastal nurseries to the targeted exploitation of feeding grounds in the open ocean (Takase 2019). Much farther east, harpoon technology and maritime-based subsistence were established by 4000 BC in both the Kodiak and Aleutian Islands (Davis, Knecht, and Rogers 2016; Fitzhugh 2016). Advancement in maritime craft-building and harpoon technology would have been required for open-sea hunting (particularly in the case of walrus and whale exploitation in later periods – see Mason and Rasic 2019). Parallel developments in maritime hunting technology on both sides of the Pacific are certainly possible, but the contemporaneity reflects a widespread continuity in resource exploitation that is more likely to have developed under either extensive geographical exchange of knowledge or under the influence of highly specific climatic drivers. Indeed, genetic affinities highlight enduring and cohesive networks across Chukotka, western Alaska, and the Aleutians (Rubicz et al. 2003; Gilbert et al. 2008; Crawford, Rubicz, and Zlojutro 2010; Rasmussen et al. 2010; Raghavan et al. 2014). Evidence of long-distance trade as seen in the distribution of both forged metal (Dyakonov et al. 2019) and Siberian obsidian (Mason and Rasic 2019) clearly illustrates the potential for diffusion of both ideas and objects, and reminds us that it is easy to underestimate the geographical scale over which knowledge transfer could occur.

The archaeological record reveals not just technological and genetic diffusion, but the influence of economic drivers. While these are theoretically closely linked to centre–periphery models, the importance of local developments is more compelling – and more instructive at a broader scale – when we investigate this relationship through the lens of critical peripheries. Takase (2019) highlights the culmination of a gradual trend towards intensified use of ocean resources that took place during the Final to Epi-Jomon transition in Japan ~600 BC. During this time the percentage, by *weight*, of fish in faunal assemblages reached 40–70% in Central Hokkaido and >70% elsewhere in Hokkaido. According to Takase (2019), this shift was interrelated with the rise of prestige status among fishers, including access to exotic goods such as shell and stone tube beads from southwestern and central Japan. In the Kuril Islands, the first major population pulse also dates to the first millennium BC, which Gjesfjeld et al. (2019) connect to greater intensification on marine mammal use and improved harpoon technology. These developments correspond with a tremendous rise in the accumulation of wealth and the mobilization of luxury goods (e.g. beads, textiles, horses) across East Asia, as evidenced archaeologically not only in the amplified circulation of iron, but also in the rise of production nuclei, fortified cities, increasingly elaborate burial structures with extravagant grave goods, and widespread shifts towards intensified production economies capable of fuelling revenue for trade (Di Cosmo and Maas 2018; Honeychurch 2015; Jaang 2015; Janz et al. forthcoming; Sun et al. 2018).

This burst of heightened materialism and long-distance trade in exotic and luxury goods clearly stimulated a new emphasis on marketable resources. We see here not only economic changes but also the spread of human settlement into regions that could help facilitate the social networks and resource acquisition necessary for heightened success in trade networks. Exotic trade goods (e.g. stone beads, metal tools, domesticated livestock) were often the primary focus of interaction with the 'centres'. The role of 'peripheries' in those exchanges is typically less clear. They are assumed to have been suppliers of exotic raw materials to acquisitive centres (Peregrine 2007). In eastern Siberia and Hokkaido there are indications of the exotic imports associated with long-distance trade relationships, but no clear evidence of what goods were provided in return (but see Gjesfjeld 2014). Presumably, many such goods were organic perishables – skins, herbs, oil, and dried meats tend to characterize hunter-gatherers exports (e.g. Gjesfjeld 2014) – and the compostable nature of such goods remains an enduring problem in our ability to recognize the role of hunter-gatherers in long-distance trade networks (see Morrison and Junker 2002). Changes in settlement are one way to recognize key shifts in extractive resource exploitation connected with intensified trade partnerships, as noted by Hudson (2004) for the Okhotsk and Satsumon cultures of Hokkaido. Determining whether these regions played other contributory roles, perhaps as innovators themselves, is an important question but under-scrutinized as innovations emerging in economic centres are rarely questioned as other than locally based (but see Jaang 2015)

The next major period of circumpolar innovation and development resulted from the convergence of advances in sea-mammal hunting, wider adoption of metallurgy, and long-distance exchange. This suite of developments was increasingly influential after ~500 AD when it reached its height and became closely entwined with the florescence of the Old Bering Sea culture (Mason and Rasic 2019). Engraving tools of metal allowed ivory to be manipulated in new ways (Mason and Rasic 2019) and walrus hunting itself was closely tied to the commercial export of ivory (Laufer 1913; Mason 1998, 2009), which Mason and Rasic (2019) frame as 'an economic linchpin that likely catalysed the entry of Bering Strait into the Eurasia world system'. The trade in ivory is an obvious marker of the contribution of hunter-gatherer societies to the economic development of state-level societies and the progressive intensification of their imperialist interests at a global scale.

Our critical peripheries perspective on the Circumpolar North provides a new lens through which we can view expansions and intensifications in trade, distribution/supply, and warfare between ~1000–1850 AD. This period represents a time when hunter-gatherer groups around the world were often becoming more interested in the commodities of their agricultural neighbours, enhancing the incentive for heightened extraction that would facilitate ever increasing levels of interaction, and eventually cooperative exploitation. By 'opting-in' to global supply chains, hunter-gatherers created heightened demand and opportunities for growth in production centres, as well as driving greater competition and extractive behaviour in their own territories. Such opportunities would have been critical to the expansion of production networks in China that originated in the Bronze Age (Jaang 2015), just as similar centre–periphery relationships drove the Viking slave trade with Rome, European maritime exploration during the Renaissance, and the African–Caribbean slave trade. Instead of conceptualizing these processes as under the control of urban agricultural centres, however, we turn the colonial nature of world-system theory on its head (c.f. Hall, Kardulias, and Chase-Dunn 2011) in order to investigate trails of interaction across the circumpolar north with the focus squarely on the 'periphery'.

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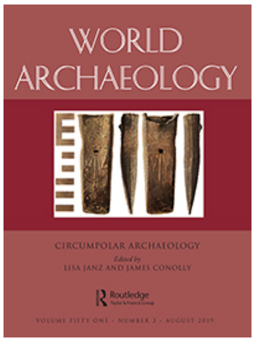

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ARTICLE

The spread of metal and metal production technology in the Far Northeast and Alaska over the second millennium BC to the first millennium AD

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ABSTRACT

Findings and traces of early metallurgical production in the Far Northeast of Asia and Alaska show that the spread of bronze and iron metallurgy took place mainly along the Lena River towards of the Far Northeast, as well as to Taimyr. Spread of metallurgical technology is confirmed by the casting mould for a burin or awl, which was discovered in Eastern Chukotka on the Amguema River. However, metals in Chukotka were obviously too rare to trade until the first millennium AD. An eastward decline in emphasis on metals is evidenced. Across the Bering Strait, into Alaska, iron appeared nearly two thousand years later than it existed within the the Far Northeast of Asia. Traces of metallurgy production were not found in Alaska. The spread of metals across Northeast Asia to Alaska indicates the existence of lasting and persistent connections between the Lena River Basin, the Far Northeast and Chukotka.

KEYWORDS
Northeast Asia; Arctic; Yakutia; Chukotka; Alaska; metal production

Introduction

The development of bronze-casting metallurgy in the third and second millennia BC in Northeast Asia was to have an historic impact not only on the cultural evolution of ancient tribes in Yakutia and the Far Northeast but on production growth and expanded trade, and economic ties as well. It is thought that few bronze artefacts initially arrived in the Yakutia territory from Siberian metal production centres as early as the Late Neolithic, in the Ymyyakhtakh period (4 350–2 950 ^{14}C BP), by the end of the third millennium BC. Later on, in the second and first millenia BC, people with an advanced bronze (Ulakhan-Segelennyakh culture 3 900–3 350 ^{14}C BP; Ust'-Mil' culture 3 400–2 000 ^{14}C BP; Sugunnakh culture 2 950–1 050 ^{14}C BP) and iron culture (2 500–1 000 ^{14}C BP) began to turn up in the Far Northeast. They included tribes of Ymyyakhtakh descent north of the Arctic Circle who also demonstrated bronze metallurgy skills from the first millennium BC through to the first millennium AD. From about the 8th century BC, signs of an Iron Age civilization gradually spread from Yakutia as far as north of the Arctic circle. Similarly, iron appears on the Okhotsk coast in the first

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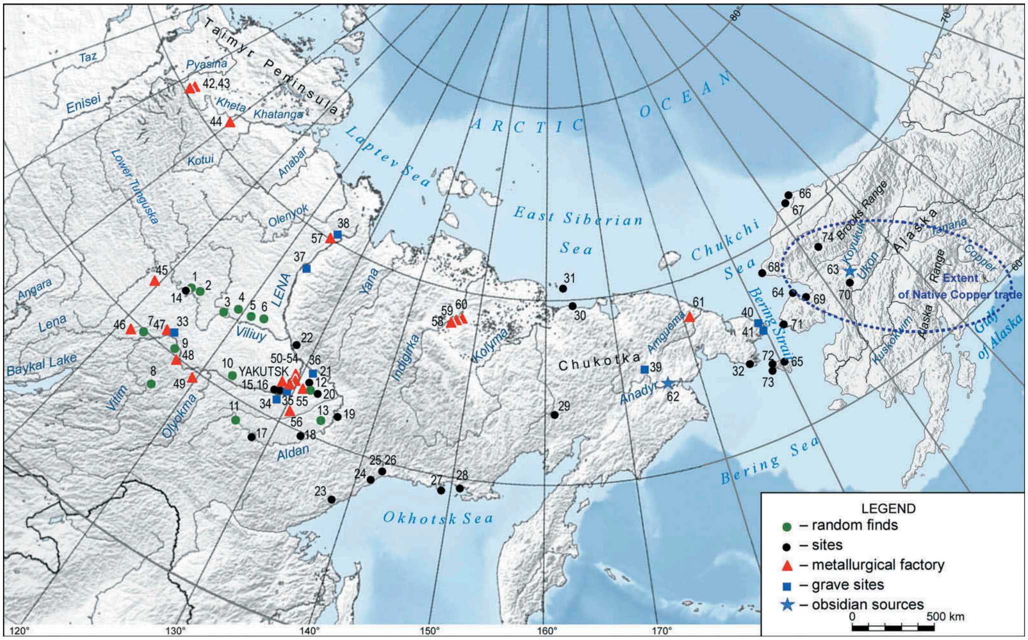

Figure 1. Map of the spread of metal and metal products technology in the Far Northeast and Alaska over the second millennium BC to the first millennium AD. **Random finds of bronze items:** 1. Syul'dyukar knife; 2. Viliuy cauldron; 3. Nyurba celt; 4. Sil'gumdzha sword; 5. Tyung spearhead; 6. Khotu-Tuulaakh sword; 7. Peleduy dagger; 8. Pronino celts; 9. Patom celts; 10. Markha spearhead (Lena River); 11. Ukulan sword; 12. Sendiele sword; 13. Notora spearhead (Aldan River); **Sites with finds of bronze and iron objects:** 14. Khatyngnakh II; 15. Ulakhan-Keteme II; 16. Chasovnya I; 17. Ugino I; 18. Ust'-Mil' I; 19. Kerbi I (Andreevskaya I); 20. Buor-Die IV; 21. «58 km»; 22. Yuuke (Sangary); 23. Uika; 24. Nandan; 25. Kukhtuy VII; 26. Kuhtuy VIII; 27. Spafaryeva; 28. Ol'skaya; 29. Bol'shoy Elgakhchan I; 30. Cape Baranov; 31. Chetyrekhstolbovoy Island; 32. Sireniki. **Burials with bronze or iron**. 33. Mur'ya burial; 34. Diring-Yuryakh cemetery; 35. Pokrovsk burials I, II; 36. Dyupsya burial; 37. Bugachan burial; 38. Ichchilakh burial; 39. Ust'-Belaya cemetery; 40. Uelen cemetery; 41. Ekven cemetery. **Bronze casting and Iron factory**: 42. Kholodnaya II; 43. Kholodnaya III; 44. Abylaakh I; 45. Vakhunaika; 46. Mastakh Peleduiskiy; 47. Mukhtuya; 48. Malyi Patom; 49. Ulakhan-Segelennyakh; 50. Pokrovskoe; 51. Kullaty; 52. Orbita-16 km; 53. Oblastnaya Bol'nitsa; 54. Usun-Ebe I; 55. Chuya II; 56. Tangkha II; 57. Siktyakh I (Stariy Siktyakh); 58. Sugunnakh; 59. Deniska-Yuryuete; 60. Yuryung-Taas III; 61. Amguema. **Obsidian sources:** 62. Krasnoe; 63. Batza Tena. **Sites with Bronze artifacts:** 64. Cape Espenberg; 65. Ivaaq. **Sites with Iron or Copper artifacts:** 66. Birnirk; 67. Walakpa, 68. Ipiutak; 69. Deering; 70. Norutak Lake; 71. Point Spencer; 72. Ayveghyaaq; 73. Mayughaaq; 74. Punyik Point.

millennium BC as well. The most far-flung locations for bronze production from the first millennium BC to the first millennium AD were to be found along the lower reaches of the Indigirka River and in Eastern Chukotka (Figure 1). Metal objects can be determined to have been imported to Alaska from the late first millennium to the early second millennium BC. Material evidence compiled in recent years together with new data enable us to trace by what routes and over what period of transit time bronze and iron were to make their way, together with the technology for their production, in the Far Northeast and Alaska during the second millennium BC through the first millennium AD.

Random bronze and iron findings in the Far Northeast

Random bronze finds were known to have turned up in the Far Northeast as far back as the 19th century, but it was over the 20th century that especially large amounts of bronze were found. Mainly they were objects that had been perfectly formed through advanced manufacturing techniques. Examples included bronze swords with unique shapes that had been uncovered at the bottom of the drained Sil'gumdzha Lake (Figure 2) and in Khotu-Tuulaakh (Figure 3), in the lower reaches of the Viliuy River, as well as in the vicinity of Ukulan village on the Aldan River (Figure 4, *4*) and near Sendiele on the Lena (Figure 5) (Okladnikov 1955a, 1959; Borisov 1961; Ertyukov 1990). A particularly striking find was the Scythian style bronze cauldron located on the Viliuy River (Figure 6). Single bronze artefacts, like the aforementioned swords, or spearheads from the Markha river in the Lena basin and from the Notora river in the Aldan basin (Figure 4) (Okladnikov 1955a), and celts (Pronino, Mur'ya, Nyurba, and Patom) (Figures 7 and 8) (Okladnikov 1955a; Fedoseyeva 1970; Dyakonov and Bravina 2015), that were random discoveries ascribed to the Ust'-Mil' culture are now being classified as early Iron Age artefacts. Similar spears were known from the Tyung River off the Viliuy and from the Notora off the Aldan (Okladnikov 1955a; Ertyukov 1990). Some similarity in shape and proportions would place these spearheads anywhere from the 7th century to the 6th century BC.

A wonderful specimen was found on a towpath in the Lena's Peleduy Estuary in 2008 in the form of a broken bronze dagger with a buckle-shaped crest (Figure 9). Daggers like it were quite prevalent in the Karasuk period in areas from the Yenisey region to Mongolia and Northern China.

Most of these bronze artefacts are considered to have been imports, even though there is practically nothing that quite compares with them elsewhere. For example, the decoration along the hilt of the Sil'gumdzha sword is typical in of parts of Mongolia and Ordos, from where it would seem to originate, possibly appearing around the 8th century or 7th century BC. The Khotu-Tuulaakh sword has a fairly distinctive Scythian look, with the ornamental detail and format pointing to parts of Northern China as well as Northern Angara region. The Khotu-Tuulaakh sword may possibly only have been around during the early Scythian period or at most from the 7th century to the 5th century BC when swords of a similar shape were current. The celts that turned up in Yakutia seemed for all intents and purposes to be consistent with the one Pronino type of axe, while other similar celts are considered to be typical of the Tsepan' culture in Northern Angara region, where they also derive from random acquisitions (Privalikhin 2011). Like the Krasnoyarsk-Angarsk varieties, they were present in the 6th century and 5th century BC (Generalov and Dzyubas 1995).

The genesis of Ukulan and Sendiele swords is still unclear. A nearly identical equivalent to the Ukulan sword, though more diminuitive, is known to have occurred in parts of Dunbey in the Shan'chzhi province (Okladnikov 1959; Komissarov 1982, 1988; Ertyukov 1990). It is imagined that the Ukulan sword might have been brought into the Yakutia region, whereas the more massive, less sophisticated Sendele model could have been produced locally. Both swords, by virtue of their different technical attributes and equivalents, probably date at the earliest from the 7th century BC. A bronze knife with a slightly curved back is known to have been found with the acquisitions from the Syul'dyukar site in a surface collection (Viliuy R.) (Figure 10) (Ertyukov 1990, 78).

The chemical composition of the bronzes showed that both spears from Markha, the Hotu-Tuulaakh sword, the Mur'ya celt, the Ust'-Mil' knife were made of arsenic bronze (arsenic impurities

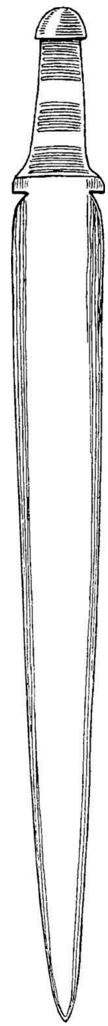

Figure 2. Sil'gumdzha sword (by Okladnikov 1955a).

were 4.5%, 2.1%, 1%, 0.75%, in the absence of tin or the presence of trace elements). The spear from Notora, the needle from the Bugachan burial are made of arsenic-tin bronze (arsenic – 1.2%, 0.9%, tin – 5%, 4.5%, respectively). The Ukulan sword is made of tin bronze (tin – 8%, arsenic – 0.2%). The Viliuy cauldron is probably made of copper ore with a high iron content (3–10%) (Leskova and Fedoseyeva 1975).

Random bronze finds indicate both the existence of broad-ranging trade and barter, and the development of an indigenous bronze-casting industry in Yakutia in the Early Metal Age. That such objects have been dated back to predominantly early times reveals how active the ties were that spread far to the south and southwest, and into the steppe and taiga regions of Siberia, even at the stage when Early Iron Age people were only just beginning to move in to the Lena area, while maintaining traditional, longstanding trade and family ties.

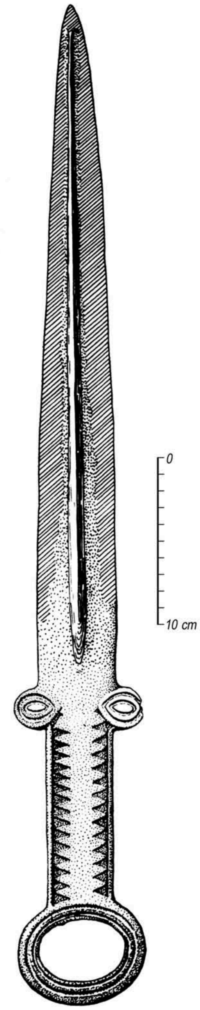

Figure 3. Khotu-Tuulaakh sword (by Mochanov et al. 1991).

Bronze and iron artefacts from the second millennium BC to the first millennium AD found in situ at sites in the Far Northeast and Alaska

The earliest signs of bronze or copper in Yakutia were found amidst material gleaned from the Late Neolithic Ymyyakhtakh Diring-Yuryakh burial ground dating to the 3rd millennium BC, in the mid reaches of the Lena river. Tiny, oxidized bits of metal, remaining from copper or bronze objects carried off by the robbers, were discovered around the skull and mid-portion of Skeletal Frame No. 4 at the Diring-Yuryakh burial ground (Fedoseyeva 1988; Mochanov and Fedoseyeva 2017, 399). The sole radiocarbon date currently available – 3840 ± 50 BP (GIN-4794) (Cal BC 2464–2146, ±2σ, Calib 7.0.4[1]) – was obtained from a human bone at interment site II. Nevertheless, one cannot rule out the possibility of a freshwater reservoir effect, which would have made the date seem older, as has been observed in Neolithic graves in Yakutia.

Figure 4. 1, 2, 3. Bronze spearheads (1, 2. Markha River (Lena basin); 3. Notora River (Aldan basin)). 4. Ukulan sword (Aldan River) (by Okladnikov 1955a).

A few bronze artefact findings are known to have emerged as well from Bronze Age cultural layers. As such, Layer II at the Ust'-Mil' I site on the Aldan River yielded a bronze knife with a bone handle (Figure 11) (Fedoseyeva 1970). The fragment of a bronze knife and an iron celt were found by Ertyukov in a mixed layer at the Andreyevskaya I (Kerbi I) site on the Aldan (Figure 12) (Mochanov et al. 1983; Ertyukov 1990). The Ugino site, also on the Aldan, provided an arsenical bronze belt buckle fragment (Ertyukov 1990, 82). Nataliya Antipina discovered a piece of a bronze knife blade during excavations at the Khatyngnakh II site (Layer II) on the Viliuy (Figure 13) (Mochanov et al. 1991; Ertyukov 1990).

Prokopiy Nogovitsyn extracted a piece (the tip) of a bronze or copper knife, resembling the knife blade from Ust'-Mil', from a cultural layer along the middle Lena, at the Ulakhan-Keteme II

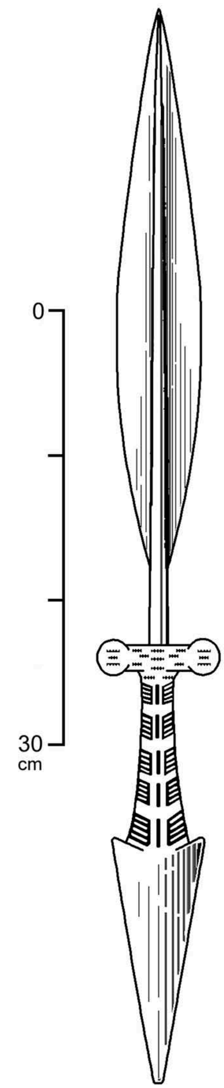

Figure 5. Sendiele sword.

mixed period site (Neolithic/Bronze Age/Early Iron Age). The multi-layer settlement of Malyi Patom in Southwest Yakutia is known to have produced four-sided bronze armour-piercing arrowheads. Bits and fragments of iron have also been turned up there, as well as a miniature spearhead-like dart tip.

Bronze and iron finds were not infrequent among Early Iron Age remains in Yakutia. When construction work destroyed a gravesite in the village of Mur'ya on the Lena, a bronze celt was brought to light (Fedoseyeva 1970). A copper or bronze spike was also unearthed amidst Neolithic and Early Iron Age finds in a mixed layer at the Chasovnya I site that bore a strong resemblance to another such item found by Okladnikov at the Pokrovsk grave in the 1940's. In 1992 in the same place in the town of Pokrovsk, where Okladnikov had discovered the Pokrovsk grave site,

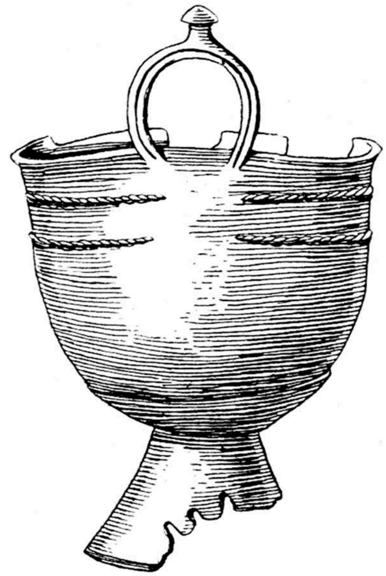

Figure 6. Viliuy cauldron (by Okladnikov 1955a).

construction work destroyed yet another ancient burial place that contained material comparable to the Pokrovsk site. It was listed as the Pokrovsk Burial Site II. It was there that iron oxide was detected in the bone intermediaries for arrows, and the burial ground was tentatively declared to be Early Iron Age (2230 ± 40 BP (Beta-198197) and 2160 ± 20 BP (IAAA-170062),[2] Cal BC 387–202 and Cal BC 354–118 (the 4th to the 2nd century BC) (Stepanov and Zhirkov 2006; Amory et al. 2006).

A fragment of an iron implement was uncovered in a mixed layer at the '58 km' site, discovered on the right bank of the Lena in the Ust'-Aldan District. Two iron plates were found at the Buor-Die IV site in the Churapcha district of Central Yakutia.

A small piece of an iron plate was discovered in amongst material at the Dyupsya grave site in the Ust'-Aldan district (Stepanov 2010) (Cal BC 785–430 [AA-98295] and Cal BC 794–542 [Beta-422228], indicating 8th century through to the 6th/5th century BC).

In 1987, the multi-layer Ulakhan-Segelennyakh site was discovered in the Olyokma river basin, on the Tokko River tributary. Sixteen cultural layers were identified that contained remains from the Late Neolithic (cultural layers XVI–VIII), the Bronze Age (cultural layer VII), and material from the Iron Age and Early Middle Ages (cultural layers VI–III). Layers VI–III from this site revealed diverse iron objects, including awls or engravers, knives, arrowheads, armour plates and fishhooks.

On the lower Lena amongst the Bugachan grave goods a needle and four small coppers or bronze plates were found. A copper plate was discovered at the Ichchilyakh grave site, near the Siktyakh settlement in the lower reaches of the Lena (Okladnikov 1946). Generally speaking, bronze and copper goods and bronze-casting skills were quite widespread in the Early Iron Age. A small iron awl was uncovered together with Early Iron Age pottery at one of the sites along the Yuuke River, on the right tributary of the Lena, near the Sangar settlement (Okladnikov 1945, 72; 1955a, 198)

Along the lower reaches of the Indigirka River at the Sugunnakh and Deniska-Yuryuete sites attributed to the Sugunnakh of the Ymyyakhtakh tradition, fragments of bronzework were unearthed

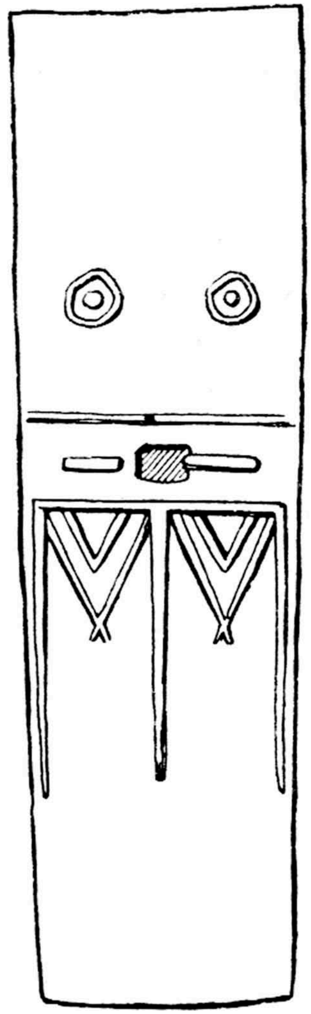

Figure 7. Pronino celts (Okladnikov 1955a).

together with the remains of bronze-casting production amidst typically Ymyyakhtakh-like material (Everstov 1999b). At Sugunakh itself metal objects took the form of a punch and a plate as well as pieces of cutting implements. The Deniska-Yuryuete site contained part of a copper artefact.

In Chukotka, where the Neolithic persisted late, bronze metallurgy would scarcely seem to have been developed. Finds of any bronze artefacts are very rare, but include two bronze burins and an awl from the Ust'-Belaya burial mound in Anadyr'. Two radiocarbon dates were obtained there: 2860 ± 65 BP (RUL-186) and 2900 ± 95 BP (Kril-244) (Cal BC 1219–850 and Cal BC 1382–845) (Dikov 1977). A 'typical Ymyyakhtakh set' was found at the Bol'shoy Elgakhchan I site, located in the upper reaches of the Omolon River (at the Kolyma tributary): it was thought to be a 'hunter's bag' tookit and was found alongside stone objects, two bronze implements, a burin and a knife (Kir'yak 1993).

Iron appeared in Chukotka at the start of the first millennium AD, yet finds of iron artefacts there have also been very limited. An iron knife with a bone handle and a graver were found at the Cape Baranov (Lebedintsev 1990, 208). Chetyryekhstolbovoy Island, in the Kolyma Estuary leading into

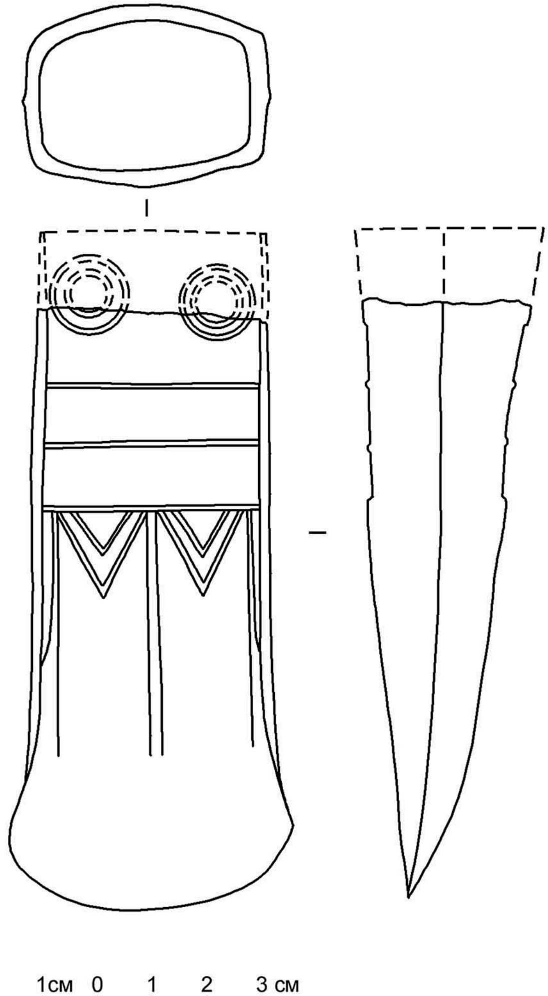

Figure 8. Mur'ya celts (by Fedoseyeva 1970).

the Eastern Siberian Sea, produced a bone handle still bearing traces of metal in the side groove and an iron burin (Beregovaya 1954; Okladnikov and Beregovaya 1971). The items were dated to the middle of the first millennium AD: the Birnirk period (Arutyunov, Glinskiy, and Sergeyev 1977). During the 1959 excavations of the Old Bering Sea culture a graver with an iron blade was located at the Uelen burial mound (Levin and Sergeyev 1960, 117). In 1974, Arutyunov and Sergeyev uncovered an iron burin at the Ekven burial mound in grave № 204. That was the second find of a metal implement dated to the Old Bering Sea period in the early years of the first millennium AD (Arutyunov, Glinskiy, and Sergeyev 1977, 102).

Iron artefacts appear on the Okhotsk seacoast by the end of the first millennium BC and possibly earlier. A fragment of an iron knife was discovered at the Uika site outside Ayan. Bone artefacts showed traces of having been worked by a metal instrument. Preliminary dating placed the site in the first half of the first millennium AD. Horizon I at the Nagdan site contained a piece of iron artefact. Horizon IV, which Fedoseyeva assigns to the Okhotsk culture, yielded a harpoon tip with

Figure 9. Peleduy dagger.

a narrow groove at the end to hold a metal point. The site was provisionally identified as being from the first millennium AD. Iron arrowheads and a rod were found at the Kukhtuy VII site, with a radiocarbon date 1550 ± 100 BP (MAG-703). An iron tip and a piece of a bronze ring were picked up at the Kukhtuy VIII settlement. Charcoal provided a date of 1900 ± 100 BP (MAG-700). In the settlement on the Isle of Spafar'yeva a bronze fragment of an awl and a knife were found that bear a resemblance to the bronze knife at the Ust'-Mil' I site (Lebedintsev 1990, 207–210). Ol'skiy Island revealed an iron graver mixed in with stone implements in the shell layer at the 'Upper' site (Levin and Sergeyev 1960).

The general pattern of bronze and iron artefact finds shows a general decline in their number as one moves from the south to the Far Northeast, obviously to do with certain challenging circumstances, both geographic and techno-cultural.

Traces of bronze-casting and ironworking in the Far Northeast from the second millennium BC to the first millennium AD

It was long maintained that all of the bronze artefacts that were randomly discovered in the Far Northeast were imports obtained through ancient barter or trade operations or by means of a long-

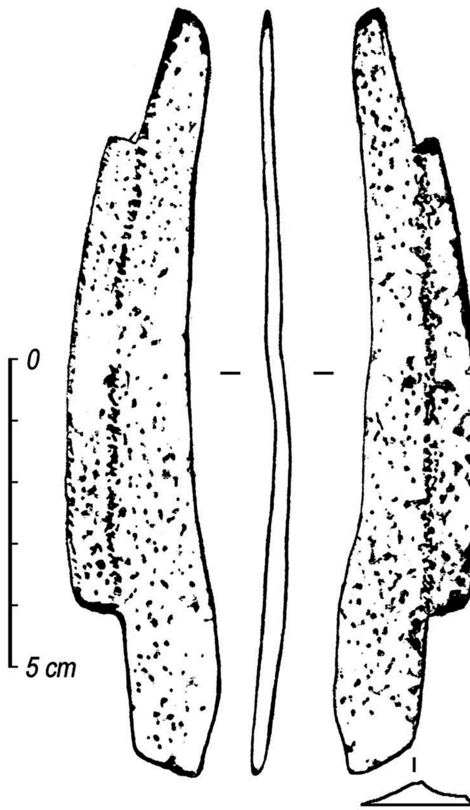

Figure 10. Syul’dyukar knife (by Ertyukov 1990).

distance relay transmission. Those erroneous views were discredited as early as the 1940’s following the work of the Lena Historical-Archaeological Expedition under Aleksey Okladnikov, during which bronze-casting workshops were uncovered adjacent to the Regional hospital in Yakutsk, in the Kullaty site, as well as in the area of the village of Pokrovsk in the Middle Lena, and near the village of Stariy Siktyakh in the lower reaches of the Lena. In one of the outbreaks in the Stariy Siktyakh settlement on the Lower Lena, along with stone tools and abundant coal, fragments of two ladles (one with a handle), and an ingot of copper or bronze were discovered (Okladnikov 1946). In the site of the Oblastnaya Bol’nitsa, the traces of a bronze foundry include the remains of clay smearing from smelting furnaces, a fragment of one half of the mould for the manufacture of an axe-celt of the Bronze Age, several fragments of ladles, and clay core (Okladnikov 1950, 92, 104). In the village of Pokrovsk in an ancient site along with thin-walled ornamented ceramics of the early Iron Age, fragments of a ladle were found, in the form of a rectangular bowl with a drain nose (Okladnikov 1950, 20). In the site of the Kullaty, fragments of a flat-bottomed low vessel, like a saucer, with traces of fusion and slag streaks were found, the height of the walls of the vessel was 3 cm, the diameter was probably more than 15 cm (Okladnikov 1950, 40) (Figure 14). Those finds provided incontrovertible proof of the existence of an indigenous bronzecasting industry among the ancient tribes of Yakutia (Okladnikov 1941, 1945, 1946, 1950, 1955a).

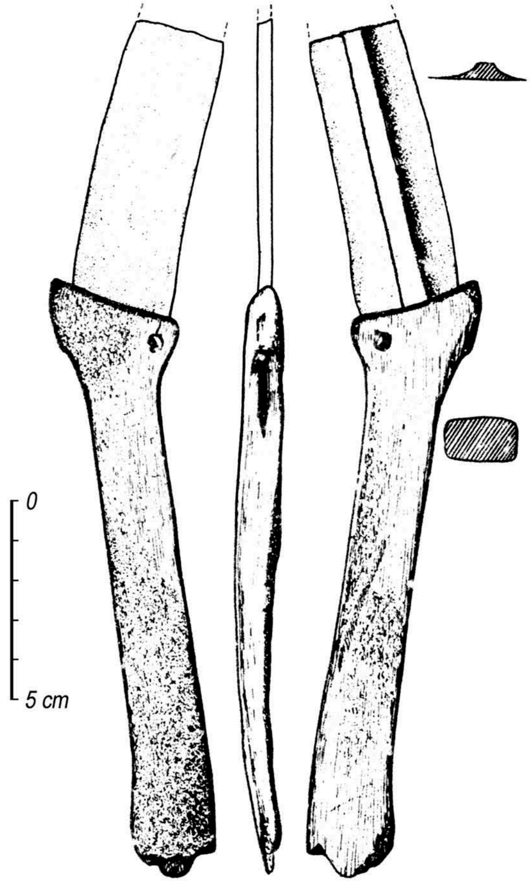

Figure 11. Ust'-Mil' knife (by Mochanov et al. 1983).

The earliest evidence to date of a bronze-casting industry in Yakutia – or anywhere in the whole of the Far Northeast – is the 20 fragments of ladles found in cultural layer VII at the Ulakhan-Segelennyakh site on the Tokko River (within the Olyokma River basin – a right tributary of the Lena) (Alekseyev 1996, 71). The Ulakhan-Segelennyakh cultural layer VII was dated with two radiocarbon readings from charcoal: 3570 ± 140 BP (IM-1011) and 3120 ± 120 BP (IM-1009), indicating an age of the 19th–14th century BC (Alekseyev and Dyakonov 2009, 35).

Other indications of bronzecasting in Central Yakutia were to turn up subsequently at a number of other sites. In the 1990s two more bronzecasting workshops were discovered in the Tuymaada valley, outside Yakutsk: Usun-Ebe I and Orbita-16 km, small bronze drop-ingots were found in these sites. For the time being there are two sites known to exist in the Lena-Amga interfluve where traces of metal casting have been identified. A metal ingot was found among Bronze Age and Early Iron Age pottery at the lakeside Chuya II settlement in the Megino-Kangalasskiy district. Another fragment of a ladle turned up amidst mixed material at the Tangkha I site, located on the right headland of the Tangkha River mouth, by the Amga River tributary. On the Mastakh Peleduyskiy site on Peleduy River in 2018 a small piece of metallic slag was found here in the pit among Ust'-Mil' and Early Iron Age pottery.

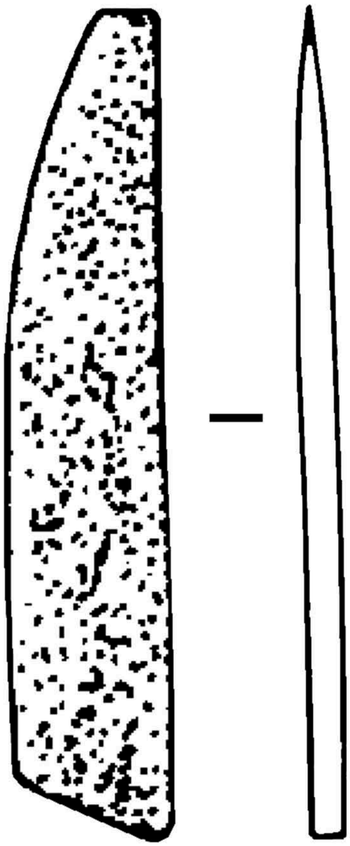

Figure 12. Kerbi knife (by Ertyukov 1990).

The Malyi Patom settlement, which offers mixed finds, is located at the mouth of the Malyi Patom River in the Middle Lena and was one of the region's metallurgical centres in the Bronze and Early Iron ages. That is where a crucible bearing traces of bronze smelting was discovered as well as fragments of a ladle.

On the left bank of the Lena at the Mukhtuya site, which has since become part of the current town of Lensk, the dwelling of a blacksmith and metal caster was uncovered. It was there in 1941 that Okladnikov detected, from the presence of clay coating and iron bloom alongside, the remains of a small forge hearth. Next to the iron bloom there were three iron arrowheads. Judging from the tiny size of the bloom, one could surmise that production was limited to strictly necessary quantities (Okladnikov 1955a, 199).

In 1975 Nikita Arkhipov explored a 16 sq.m. blacksmith's house in the upper reaches of the Viliuy, on the Chona's left bank, 2 km up from the Vakhunayka estuary. A smithy's catalon hearth could be infered from the 60 cm wide, uneven circle formed by scorched clay. Along the eastern periphery of the scorch mark a piece of iron bloom was uncovered. Four iron objects were also found there: a knife, a triangular iron arrowhead, a fish hook, and an item presumed to be for fishing (Arkhipov 1989).

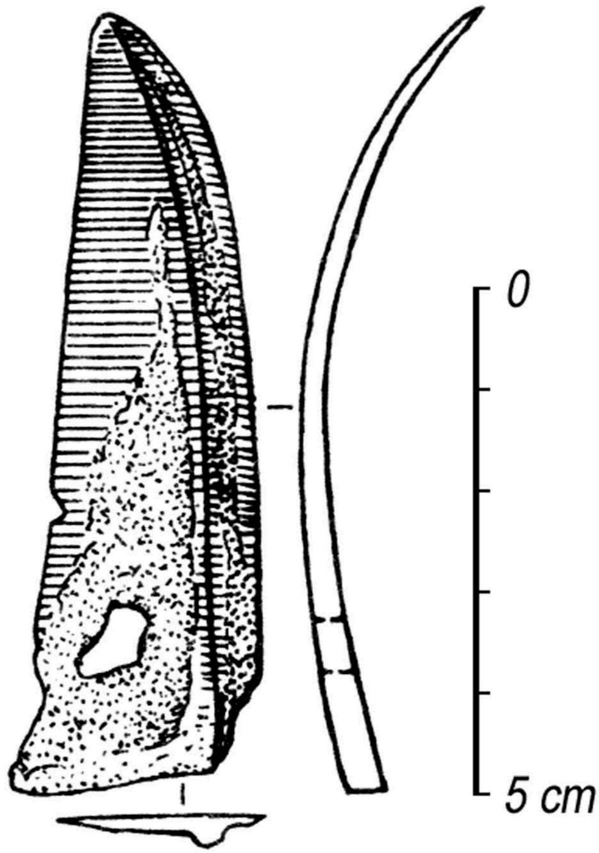

Figure 13. Khatyngnakh knife (by Mochanov et al. 1991).

On the Deniska-Yuryuete site, parts of ladles, and bronze remains in the form of shaped splash ingots and ovoid drops, as well as the fragment of an object cast from copper and a fragment of a casting mould were found (Everstov 1999b, 55). X-ray micro-spectrometry of the metal found at the Deniska-Yuryuete site indicated the use of pure copper (Everstov 2015, 41). On the northern side of the excavation site the remains of a fire-pit were noted containing charcoal at various levels. Samples of coal were extracted from the lowermost fire-pit and a date obtained of 1749 ± 164 BP (IM-1184) (Everstov 1999a, 53; 2015, 38). According to this date Cal BC 87 – Cal AD 640, the site would derive from the Sugunnakh Epi-Ymyyakhtakh culture.

In the Sugunnakh site dozens of samples of metal splash-ingots were found. The items were found both in fragments or completely intact. Still in one piece was a puncture and a flat plate for some indeterminate purpose. The bronze puncture has four facets and tapers smoothly to a point.

Three fragments of bronze artefacts were also found, which in all likelihood were cutting implements. The blade on the first fragment was double-edged (Everstov 2017, 151). X-ray micro-spectrometry of the Sugunnakh metal artefacts revealed them to be made of straight bronze, with insignificant traces of some impurities (Everstov 1999b, 55; 2015, 41).

Besides metal, fragments of ladles or small vessels were found at various levels that had been used to pour molten metal into casting moulds. Most of the ladles were made of pure clay, crazed at the edges, sometimes fire-damaged and scorified (Everstov 2017, 151–152). When a hole was sunk to investigate the Yuryung-Taas III site on the Indigirka River, discovered by Viktor Dyakonov, a ladle fragment was uncovered among the Sugunnakh cultural artefacts, providing evidence of bronze-casting at the site.

In recent years, under a research grant to Prof. Katsunori Takase at the Institute of Accelerator Analysis in Japan JSPS KAKENHI (15H01899), ten new AMS radiocarbon dates were obtained for sites in the lower Indigirka. Accordingly, four dates were produced for Sugunnakh that indicate calibrated intervals of 8th – 7th century BC and 1st – 3rd century AD. Two dates came up for the Deniska-Yuryuete settlement within the range of 10th – 5th century BC. The Yuryung-Taas II site was dated to AD 890–1020, and the Yuryung Taas III to 900–770 BC and AD 420–540.

The Taimyr Peninsula was a prominent metallurgical centre in the Far North, where Leonid Khlobystin documented traces of bronze-casting and bronze that went back as far as the bearers of the Ymyyakhtakh tradition with waffle-impressed pottery at the Abylaakh I, Kholodnaya II and III, and Pyasina V sites. Finds attesting to there having been bronze-casting at Abylaakh include: 4 ladles, bronze drops, a piece of a clay casting mould for a celt, fragments of sandstone moulds for casting anthropomorphic figures, and some abrasives (Khlobystin 1998, 87–97). Carbon dating of the hearth dates the settlement to 3100 ± 60 BP (LE-790) (Cal BC 1498–1216). The Kholodnaya III site yielded sherds of a waffle-impressed vessel with a layered structure and bits of wool in the clay mass, together with the broken off edge of a ladle. Stone implements recovered at the site were shaped in a characteristically Ymyyakhtakh manner (Khlobystin 1998, 96). The remnant of a ladle was also identified at the Kholodnaya II site.

In the view of L.P. Khlobystin (Khlobystin 1998, 95), the discovery of a foundry at the Abylaakh settlement demonstrates that archaeological classification of Ymyyakhtakh cultural remains from the end of the second millennium BC should be considered as Bronze Age. Spectral analysis of a drop of bronze from the Abylaakh I site revealed the presence of large concentrations of tin (up to 7–8%), which L.P. Khlobystin suggests could have arrived in the Taimyr from sources of the Indigirka. He believes that the Taimyr-Yakutia metalworking centre was bound up with the Ymyyakhtakh culture; nickel-free copper from the sources of the Taimyr and tin from the sources of the Indigirka probably served as the raw materials base (Khlobystin 1998, 161–162).

There are fewer finds farther east. In Eastern Chukotka, there has been only one object found so far that provides a link to bronze-casting: a casting mould to produce awls or burins turned up at the Amguema site (at the mouth of the Perevalniy Creek that flows into the Amguema River from the left). The investigating team have attributed it to the North Chukotkan culture (Pitul'ko and Brykin 1990, 106, 111, Ill. 3, *1*). Finally, a graver with a metal blade was discovered in the Punuk settlement of Sireniki on the Bering Sea coast (Rudenko 1947, Table 23, *12*). The traces of bronze-casting and ironmaking as well as the pattern of bronze and iron finds indicate that such technological progress gradually peters out east of the Indigirka and the Kolyma.

Consideration of the findings

Investigators have noted two main routes that could have brought the technique of bronzeworking to the Far Northeast: either along the Lena artery or via the Pacific coast. Originally, metal started to come to Yakutia from Trans-Baikal and Cis-Baikal along the Lena, Olyokma, and Vitim waterways, possibly as early as the end of the third millennium BC during the Glazkovo period (Okladnikov

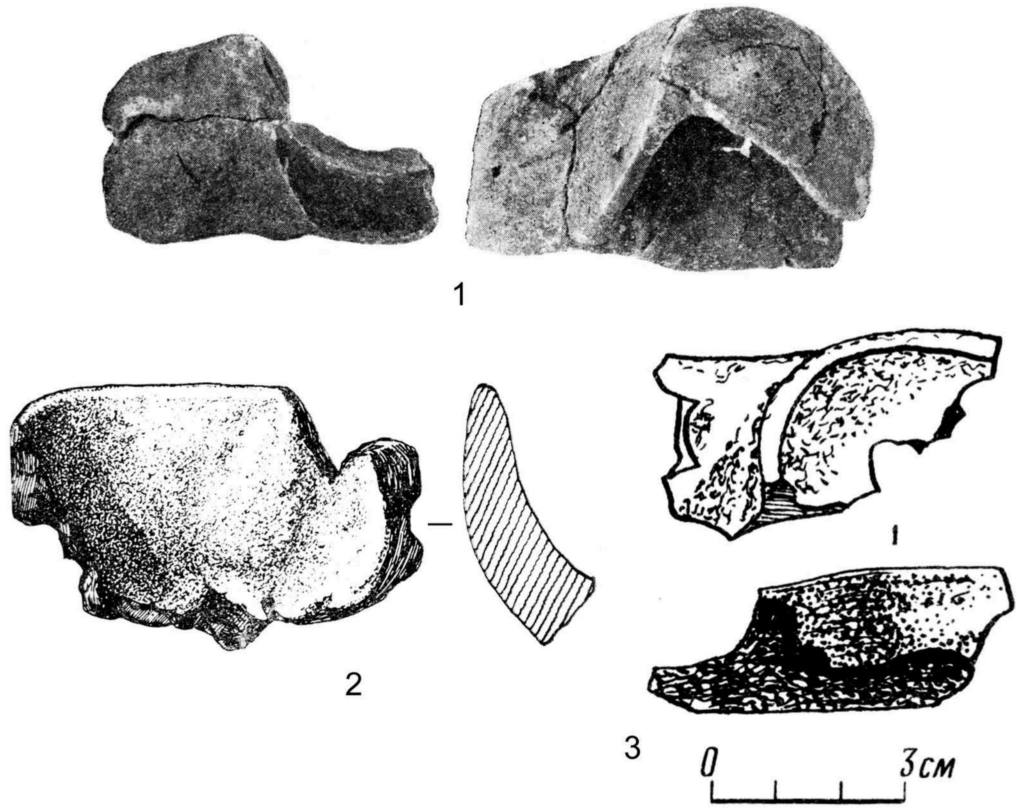

Figure 14. 1. Ladle from Oblastnaya Bol'nitsa site; 2. Ladle from Pokrovsk sites; 3. Ladle from Siktyakh (by Okladnikov 1946, 1950).

1955b, 58, 59; Grishin 1975, 97). By the second millennium BC, Yakutia was already seeing its own bronze-working industry develop, as may be deduced from the remains of the Ulakhan-Segelennyakh civilization (3900–3300 ^{14}C BP) which in cultural terms is related to both the Glazkovo and the Ymyyakhtakh cultural-historical periods (Dyakonov 2012). An advanced bronze culture was associated with the Ust'-Mil' culture in Yakutia (3400–2000 ^{14}C BP). Individual sites were pinpointed in the Arctic on the Taimyr, the lower Lena, the upper Yana, the lower Indigirka and the lower Kolyma. However, judging from the meagre finds or indeed the absence of any original ceramics decorated with appliquéd roll, the culture did not spread extensively beyond the Arctic Circle.

The Epi-Ymyyakhtakh Sugunnakh culture (3000–1000 ^{14}C BP) represented descendants of the Ymyyakhtakhs who continued to live in the Far Northeast after mastering bronze metallurgy (Dyakonov and Takace 2018). The bronze-making techniques may have been passed on from the Ust'-Mil' or Sugunnakh people to Chukotka: there is a singular find of a casting mould for awls or burins at Pereval'ny Creek, off the Amguema River, attributed to the North-Chukotkan culture of the late second millennium – first millennium BC (Pitul'ko and Brykin 1990, 106, 111, ill. 3, *1*). There is also some evidence of the use of bronze in the Chukotka Ust'-Bel'skaya culture, but there is currently no direct proof that they had their own metallurgy. Bronze-working had come to the Taimyr natives of the Ymyyakhtakh cultural tradition as early as the end of the second millennium BC (Khlobystin 1998).

Nikolay Dikov identified North-Chukotkan and Ust'-Bel'skaya cultures in Chukotka, east of the Kolyma (Dikov 1979, 134–161). Bronze burins and a rectangular awl were unearthed in various graves at the Ust'-Belaya burial mound (Dikov 1979, 142, 144, 148, ill. 55, 1, 3). The similarity in the findings prompted Svetlana Fedoseyeva to include both cultures thereafter in the Ymyyakhtakh area (1980, 168). According to Vladimir Pitul'ko, 'the difference between the two hypothetically distinct cultures is strictly negligible, whereas together they form an Eastern Chukotkan variation of the Ymyyakhtakh cultural tradition' (Pitul'ko 2003, 132). Carbon dating of North-Chukotkan and Ust'-Bel'skaya cultural findings has placed them anywhere from the end of the second to the beginning of the first millennium BC (Pitul'ko 2003, 139, 147). Thus, the radiocarbon age of charcoal samples from interments in the Ust'-Belaya burial mound was: 2860 ± 95 BP (RUL-186) (Cal BC 1281–820) and 2920 ± 95 BP (Kril-244) (Cal BC 1395–898) (Dikov 1977, 124, 137, 239). The age of the North-Chukotkan culture was determined by the date from a site on Chirovoye Lake (Eastern Chukotka): 2800 ± 100 BP (Dikov 1977, 121), (Cal BC 1224–798). Overall, these dates could point to the boundary between the Ymyyakhtakh and Epi-Ymyyakhtakh periods in the Eastern Siberian Arctic. If one accepts that a separate distinction be made for the Sugunnakh Epi-Ymyyakhtakh culture, then the 2800 ± 100 BP date from the Chirovoye Lake site would appear to establish its lower limit.

From the 8th century BC to the 5th century AD the Early Iron Age culture was widespread in Yakutia, along with the developed bronze foundry, iron metallurgy was mastered and widespread. Some iron culture monuments are also recorded in the lower reaches of the Lena River and in Viliuy River. The culture behind the Bugachan, Ichchilyakh, and Kullaty gravesites has as yet to be fully determined. Aleksey Okladnikov placed them in the early Bronze Age on the basis of the copper and bronze artefacts on site, whereas Svetlana Fedoseyeva assigned them to the Ymyyakhtakh culture. These days there are grounds to suppose they might actually fall within the early phase of the Iron Age in the first millennium BC, as they display the identical type of burial goods to what was found in the Pokrovsk I, II, and the Dyupsya interment sites (Stepanov 2014; Stepanov, Kuz'min, and Jull 2014); however, Stepan Everstov holds that these burial sites could be from the Sugunnakh culture (Everstov 2017). Yet another intriguing suggestion is that of the Krasnoyarsk researcher Vasiliy Privalikhin, who associates all these graves with the Tsepan' culture, the bearers of whom arrived in Yakutia from Northern Angara River region (Privalikhin 2011). Were that to have been the case, the early Iron Age Tsepan' expansion, cultural area and cultural influence would simply be seen as an overall advance, extending from Angara River region to the shores of the Arctic Ocean and Kolyma, an assumption that naturally elicits certain questions and calls for additional substantiation.

Ivan Konstantinov had noted even earlier that the body of Early Iron Age pottery in Yakutia showed a resemblance to Middle Angara pottery (Konstantinov 1978). Today, it is clear that iron-working in Yakutia in the Early Iron Age did trace its origins from that ancient metallurgical centre near Lake Baikal. The latest discoveries lend further support to the notion that cultural communities from the taiga regions of Angara, Cis-Baikal, and Trans-Baikal played a part in forming Early Iron Age cultural complexes in Yakutia. There is no question but that the Tsepan' culture made a major contribution to affirming and propagating Iron Age lifeways in the Lena area; however, to our mind, they did not serve as the ethno-cultural basis for all the diverse Early Iron Age cultural entities in Yakutia; rather, they themselves were part and parcel of that cultural community that began to conquer the vast territory of the Northeast Asia on the cusp between the Bronze and the Iron Ages.

Burial grounds in the Early Iron Age in Yakutia can be divided into two time periods: the Dyupsya (from the 8th to the 5th century BC) and the Pokrovsk (from the 4th to the 3rd century BC) They are similar in terms of the funerary implements entombed in the graves, yet dissimilar in how the burials were carried out, with genetic and anthropologic differences to be discerned as well. Nevertheless, the two periods are still difficult to isolate on the basis of the physical make-up of the Iron Age sites and settlements, where the pottery and the range of implements are virtually indistinguishable. By the same token, there is no clear differentiation either with Early Middle Age remains in Yakutia (7th century – 8th century AD), which were identified according to material in the Ulakhan-Segelennyakh multilayer settlement in the lower Olyokma basin.

The Bronze and Early Iron Age cultures of Yakutia with their cultural and technological achievements had an unquestionably large impact on the development of other cultures in Yakutia and in the Far Northeast, including on various ethnocultural enclaves descended from more ancient cultural societies. For metal and for bronze-casting and iron-making skills to penetrate east of the Verkhoyansk Mountains and beyond to Chukotka, there would clearly be the challenge of vast tracts of unpopulated land and entrenched cultural traditions among ancient societies. It can also be assumed that the development of its own metallurgical production in Chukotka and Kamchatka, in particular the development of bronze metallurgy, did not allow the low prevalence of copper and tin ores to take place. Modern industrial copper deposits are known in the Kolyma basin – on Anyui, in the upper reaches of the Anabar – on the Chaunsky ridge, near the coast of the Okhotsk Sea – on the Ichigeysky ridge, near the coast of the Bering Sea – in the upper Vaamychgyn (Evseev 2004). In Yakutia, copper and tin deposits have long been known in the Lena, Vilyui, and Yana river basins (Maak 1886, 43; Okladnikov 1955a), where evidence was found of the smelting and production of bronze tools. In addition, the proximity of Lena land to large metallurgical centres, which were the regions of Cisbaikal, Transbaikal, South Siberia and China, played a significant role. The spread of bronze technology in Chukotka may also have been facilitated by the weak promotion of direct carriers of the secrets of metallurgical production outside its range in Yakutia. It is thought that iron came to Chukotka and the Bering Sea coast at the start of the first millennium AD. Most of the rare iron finds there consist mainly of gravers unearthed in Birnirk and Old Bering Sea period Inuit settlements and gravesites, indicating that iron appeared here no later than the middle of the first millennium AD.

Aleksey Okladnikov wrote in his time that iron could have made its way into these regions of Northeast Asia from parts of the lower Lena and Amur rivers (Okladnikov 1956, 101). Levin and Sergeyev (1960, 122) postulated that iron arrived in the Bering Strait via the Okhotsk coast and from northern parts of Yakutia. Other researchers have since increasingly subscribed to the idea that iron made its way along the Okhotsk coast from Primor'ye, which was an influential metallurgical centre in the Far East during the 9th – 8th centuries BC (Arutyunov and Sergeyev 1969, 160; Vasil'evskiy 1973, 142; Dikov 1979, 282). Another version of the Primorsk theory is that iron ore may have been supplied from the Sea of Japan region (Aleksandrov, Arutyunov, and Brodyanskiy 1982, 92).

Chemical analysis of implements from the Uelen burial mound did indicate from ore provenience that the iron implements were not made from random, reworked meteorite finds, but were actual artefacts that derived from local or foreign production (Arutyunov and Sergeyev 1975, 185). The dearth of metal, by comparison with other material remains at the ancient Inuit sites that were studied, demonstrates its very limited availability and use. Metal was used essentially for drills and gravers, and only occasionally for knife blades (Levin and Sergeyev 1960, 119). That may have to do with the local production process per se or to the scarcity of raw material that specifically dictated that process.

Even in a later period, there was only limited evidence of metals and metallurgical production in Chukotka, the islands of the Bering Sea and Alaska, as evidenced by written documents of the 18th century compiled by the expedition of Vitus Bering (Al'kor and Drezen 1935). According to the Cossack Kuznetskiy, who was captured by the Chukchi, it is known that the Chukchi had ' … spears, also arrows, iron, bone and stone … ' (Al'kor and Drezen 1935: 183). The 'Note on the Chukchi Land,' compiled from the words of the Chukchi Khekhgitit on 5 August 1763, states that the inhabitants of the 'Great Land' (Alaskan Eskimos) 'have needles made of red copper for sewing dresses and they take copper in their land only as they make that copper, he, Khekhgitin, does not know, and they don't have any iron things, and instead of iron axes they have axes made of jasper stone, with which they cut down the forest … ' (Al'kor and Drezen 1935: 185). From the 'interrogation of the Chukchi girl Itteni' it is also known that ' … they have no iron and axes on that Great Land (Alaska), and although they have iron knives, there are very few of them who receive from the local Chukchi. The axes are made of stone, but they have no copper, silver and gold … ' (Al'kor and Drezen 1935: 186).

A significant layer of shared mythology and folklore among peoples of the Far North, Bering Sea and Alaska testifies to long-standing and ancient ties of historical, cultural and economic interaction, reflected also in the common elements of spiritual culture (Menovshchikov 1969, 1974, 1988; Meletinsky 1979; Kurilov 2005; Berezkin 2007). As such, it is interesting that such a significant event as the appearance of metals (bronze and iron) in the everyday life of the peoples of Chukotka and the Far Northeast did not leave more traces in the oral traditions of the northern peoples. One of the Kerek tales, judging by the content, of a late period, for example, tells about the origin of iron things (dummies, knives, rifles) collected on the seashore: that they represented the remains of a mythical creature of the Kala-cannibal (cannibalistic creature), the owner of an iron hook and an iron body (Sangi 1985).

Metal and its role in Alaska

The discovery of bronze within Alaska might be expected, considering its proximity to Chukotka where a mould for casting bronze awls or burins bit is authenticated on the northern Amguema River within 50 km of the Chukchi Sea around 1000 BC (Pitul'ko and Brykin 1990), roughly contemporaneous with the bronze that was bestowed as grave goods (Dikov 1963) at the Ust'-Belaya site on the Anadyr River. Nonetheless, only two occurrences of bronze or 'white metal', its alloy, are known within Alaska. Both isolated finds of bronze occur along the coast; only one has an age associated with it. The farthest south was obtained by Native diggers within the Ivaaq mound on the north coast of St. Lawrence Island, as confirmed by a resident of Savoonga, Alaska, in an email exchange in 2011. The meagre, anecdotal contextual data from this locality indicates that several cast bronze pieces were encountered in the lowest levels of the mound, in relative association with Okvik materials. Farther north, within Kotzebue Sound, at Cape Espenberg, the Rising Whale site (KTZ-304) contained several bronze pieces, discovered in 2011, most prominently a piece of cast metal resembling a buckle or horse fitting, secured with a piece of sea mammal leather. The leather provided a direct age, when calibrated, dated around AD 1200, the age of the house adjacent the passageway fill that contained the 'buckle' that resembles horse fittings from northeastern China (Cooper et al. 2016). The path of bronze northward at this late phase may be related to production from northern China, as opposed to the bronze foundries in the Indigirka River or Taimyr Peninsula that date nearly two millennia earlier (see above).

The transfer and trade of iron to the Bering Strait also seems to indicate a delayed arrival. As seen above, an advanced iron metallurgy was relatively common throughout Yakutia by the late centuries BC. The role of iron in the prehistory of the Bering Strait remains problematic;

few archaeologists have argued for its instrumentality as an agent of cultural evolution (implicit in Semenov 1964) also more typically inverse with artististry, cf. 'the [Punuk] style became impoverished and mechanical' (Rudenko 1961, 177). The Bering Strait region is long-renowned for an elaborate and profound art engraved on walrus ivory (Mason 1998). The pioneering archaeologists of the 1920s who encountered the Old Bering Sea culture had emphasized that the engraving was deep and gouged into the material, especially the presumed earliest, Okvik culture (Collins 1937; Rainey 1941). To Collins (1937), the seeming crudeness of the carving indicated that iron was not widely, if at all, used in the earliest Bering Strait cultures. However, Semenov (1964) argued unequivocally for the use of metal for engraving among Inuit and Yupik on the grounds that ivory is an intractable medium in the absence of metal tools, 'stone burins are in general not suitable for making deep, narrow and short slots' (165). Smelted iron used as an engraving bit was authenticated by petrographic analysis from the Ipiutak site by Larsen and Rainey (1948, 82–83), who recognized its 'paramount significance' and believed its age preceded Old Bering Sea and Okvik, establishing it as the earliest, Asian derived metal in the Americas, at least in 1948. By 1960, iron engraving tools were recovered at nearly a dozen sites within the Old Bering Sea, Ipiutak, Birnirk and Punuk cultures (Larsen and Rainey 1948; Ford 1959, Dikov 1963; Levin and Sergeyev 1964; Stanford 1976, as summarized in McCartney 1988), including Sirenki (Rudenko 1961), Ekven (Bronshtein, Dneprovsky, and Savinetsky 2016), and Uelen (Levin and Sergeyev 1964), Cape Baranov (Semenov 1964, 163), as well as at Point Hope (Larsen and Rainey 1948), Deering (Bowers 2009), at Birnirk and on St. Lawrence Island from an Old Bering Sea burial at Mayughaaq (Bandi and Blumer 2004), and from Punuk levels at Ayveghyaaq (Collins 1937, 237). A piece of the Ipiutak iron was analysed by spectrographic methods – confirming that it was terrestrial iron (Larsen and Rainey 1948, 254: Plate 101).

The trade in iron crossed ethnic boundaries, presumably as an object of desired exchange, perhaps of high-status transactions by traders. Most of the iron tools within the Bering Strait were employed as engraving tips (e.g. Ayveghyaaq, and as 'small mass[es] of iron rust,' as at Birnirk (Ford 1959, 171) and a small engraving tip within an Ipiutak house at Deering, dated between AD 670 and 870 (1250 ± 40 BP, Beta-138562, Bowers (2009), 90, 236). 'A short section of iron,' used as an engraving bit was recovered at Walakpa by Stanford (1976, 49) in a poorly dated 'early Thule' level. Two very sizable iron tools were recovered on the Bering Strait coast; both are undated. The first is a large, thick ulu blade inset into a handle, found within a purported Ipiutak component at Pt. Spencer in 1948 by Larsen ([1979] 1980). Even larger iron objects, two axes, nearly 8 cm long, were placed within a well-apportioned Old Bering Sea grave near Mayughaaq (Bandi and Blumer 2004, Figs. 18, 19) – these objects, obtained by Native diggers, are probably the largest in the North American arctic. Iron was transported farther inland into Alaska as well. For example, an iron 'drill-bit' recovered within a mid-first millennium (ca. AD 600–900) house in the interior Koyukuk drainage (Clark 1977, 81, Pl. 1:x) is contemporaneous with the 7th to 9th century AD Deering find (Bowers 2009). In view of the poor preservation of iron, the size of the two largest finds and the distribution of smaller finds indicates that the iron trade into Alaska was extensive, especially when the high number – over 300 – of narrow slotted engraving tools (only fit for iron tips) is considered (McCartney 1988, 65–66).

The prehistory of copper use in Alaska, originating its southcentral region near the Copper River drainage represents a drastically different process and history of relationship to metal use in northwest Alaska and lacks any tie to Siberia (Cooper 2012). After AD 1000, Native copper found within placer deposits in southcentral Alaska was worked by cold hammer, sharpened and employed as thin sheets of unknown function, as well as for nose and ear adornments, awls, drills, knives and arrow points as a ‘prestige technology’ within a number of Athapaskan, especially the Ahtna, and Tlingit societies focused near the Copper River drainage outcrops, recovered at 54 localities from the Alaska Peninsula to the northern Yukon, with several finds in northern Alaska (Cooper 2012). Native copper was traded into northwest Alaska by the 14th to 15th centuries AD (Cooper et al. 2016), used as weights in fish lures at Cape Espenberg and as bracelets at the Punyik Point site in the Brooks Range (Kunz et al. 2005). A trade in copper also extended southward into the Northwest Coast (Cooper 2012). Ethnographic records indicate the copper trade was monopolized by the high-ranking Ahtna who sought power, and who had exclusive property rights to sources. The Ahtna copper trade extended no further than Kotzebue Sound and did not penetrate Chukotka, as far as presently known. Indigenous copper was cold-hammered, using techniques diffused from farther south in the Copper River drainage.

That iron and bronze did not reach Alaska sooner is interesting in light of the evidence for significant transport of obsidian into Alaska since about 2500 BC from the Krasnoe volcanic field on the middle Anadyr drainage (Rasic 2016), a location very close to bronze-bearing graves dated to 1221–849 BC (Dikov 1963). The transport of obsidian eastward across Bering Strait highlights long-standing routes of dispersal, which are all the more significant since obsidian was also available more locally at Batza Tena in inland northwest Alaska and already widely traded millennia earlier (Rasic 2016).

Conclusion

Analysis of finds and traces of early metallurgical production shows that the initial route followed by bronze and iron metallurgy lay principally along the Lena River towards the Far North and Far Northeast, as well as via the lower Lena, the Taimyr, and the Indigirka. It is from these regions where singular paleometal cultures were formed within the context of the Ymyyakhtakh, or the Sugunnakh Epi-Ymyyakhtakh culture, from the late second millennium to the mid first millennium BC. For the time being, the only reliable traces of Far Northeastern bronze-casting on the Asian continent have been identified in the lower reaches of the Indigirka River Basin. It is possible that metal then started to move on from there into Chukotka by the first millennium AD, where independent production may have sprung up as well, but the bulk of any metal would have been imported. Local production is evidenced by a casting mould for a burin or awl, associated with the Northern Chukotka culture, that was discovered in Eastern Chukotka on the Amguema River.

Findings reveal the iron trail to have run along the Okhotsk seacoast, an obvious indication that the Priamursk or Primorsk iron metallurgy centre had established ties with and influence upon the Chukotka region at the start of the first millennium AD. Iron-making never extended north of the Arctic Circle in Yakutia, although Early Iron Age sites do exist in the lower reaches of the Lena. Traces of bronze-casting and iron-making, together with the way bronze and iron finds were distributed, suggest that technological progress gradually tailed off as one moved east of the Indigirka and the Kolyma.

As described above, metallurgy was practiced across Yakutia and Chukotka, with bronze or iron tools deposited either in burial mounds, as at Ust’-Belaya on the middle Anadyr River (Dikov 1963) or within archaeological sites such as Cape Baranov near the Kolyma River delta (Okladnikov and Beregovaia [1971] 2008). The earliest iron is found within the Kukhtuy VIII site on the Sea of Okhotsk and is dated by charcoal to the early centuries AD (Lebedintsev 1990, 145, 206), with a few more iron pieces several centuries later at an adjacent site. Some centuries later, iron objects and slag extend from the Lena River towards and along the littoral of the Sea of Okhotsk (Lebedintsev [2010] 2015), where in the 10th century AD the Koryak people were using iron for a wide variety of things, including rivets and end blades for harpoon heads. At the Oksa I site, an iron leister was used as early as AD 500 correlative to deposits dated between AD 1050 and 1260. Bronze is also reported in Old Koryak sites, with a find of Chinese coins minted in the Northern Song dynasty (AD 1038–1040) (Lebedintsev [2010] 2015).

From there, somewhat later, metal then began to be relayed from Chukotka into Alaska through the Old Bering Sea people and other ancestors of the Inuit, though no autonomous bronze or iron metallurgy took hold in Alaska itself. Iron appears in Alaska during the late first millennium AD and by the 11th century AD, iron from Siberia was regularly transported into Alaska by either of two pathways: along the Chukchi Sea, and another southern route along the Sea of Okhotsk. The northern pathway was followed by Birnirk peoples to and from Cape Baranov (Okladnikov and Beregovaia [1971] 2008), crossing to Ekven, Point Hope and Point Barrow, while another, possibly more plentiful, route ended in the hands of Old Bering Sea and, later, Punuk peoples on St. Lawrence Island (cf. Collins 1937). Copper working also appeared after AD 1000 but was derived from American traditions.

The spread of metals and metallurgy throughout the Far Northeast suggests long-standing trade routes and/or cultural connections along river drainages and sea coasts. An eastward decline in emphasis on or access to metals is evidenced and this extends across the Bering Strait, into Alaska. Here, despite the movement of other materials such as obsidian, iron did not appear until the first millennium AD, nearly two thousand years later than it existed within the the Far Northeast of Asia. Neither bronze nor iron were ever locally produced. The spread of metals across Northeast Asia and Alaska suggest close and persistant connections between the Lena River Basin and the Far Northeast, as well as later connections between Chukotka and Primor'ye. Metals may have been too valuable and rare in Chukotka to have been readily offered as a trade item prior to the first millennium AD, after which the evidence suggests that trade became more regular or movements between regions more fluid.

Notes

1. Here in after for the calibration of dates, the Calib 7.0.4 program is used with a value of ±2 sigma.
2. The radiocarbon dating was obtained by Prof. Katsunori Takase on a research grant JSPS KAKENHI (15H01899) at the Institute of Accelerator Analysis Ltd. in Japan using accelerated Mass Spectrometry (AMS).

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No potential conflict of interest was reported by the authors.

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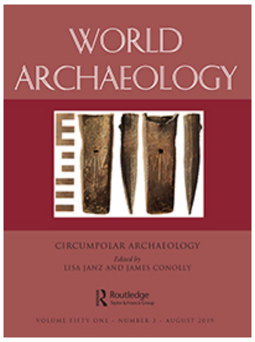

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Paleometal Epoch in the Primorye (south of the Far East of Russia)

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ARTICLE

Paleometal Epoch in the Primorye (south of the Far East of Russia)

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ABSTRACT
Archaeological investigations of Paleometal Epoch in the Primorye (south of the Far East of Russia) are generating insight for the introduction of metals into the Pacific coastal areas of prehistoric Eurasia. The chronological framework covers the turn of the 2nd –1st mil. BC to the beginning of 1st mil. AD. The temporal limits of bronze-bearing and iron-bearing cultural units of Primorye region overlap. The limited degree of local metal production and re-working during the Paleometal epoch still suggests progressive changes in the material culture of prehistoric populations of the southern Russian Far East.

KEYWORDS
Russia; Primorye; Paleometal Epoch; archaeological sites and cultures; characteristic artefacts; peculiarities of development

Introduction

The article considers archaeological evidence for the introduction of metals into the Pacific coastal areas of prehistoric Eurasia. The research area includes the southern continental part of the Russian Far East neighbouring with Northeast China in the west, with the Korean Peninsula in the south, and with the Lower Amur region in the north. Our discussion spans the turn of the 2nd –1st mil. BC to the beginning of 1st mil. AD. According to the most recent archaeological systematization of the southern areas of the Russian Far East, this period is defined as the Paleometal Epoch. It represents a shift from the use of stone as the primary raw material for tool-making, through to the adoption of metal due its specific properties and technological possibilities.

Archaeological sites of the southern Russian Far East with early evidence of metal introduction have been studied actively since the late 1950s to early 1960s. Initially, the investigations of these sites followed the classic paradigm of Bronze and Iron Ages or Periods (Okladnikov 1963; Andreeva 1977; Derevianko 1973; D'iakov 1989; Kon'kova 1989). As more data accumulated, the specific character of metals and the metal-working development process in the eastern peripheral region of Eurasia became more obvious. The term 'Paleometal' or 'Paleometal Epoch' was then used for the designation of a particular phase of regional culture-historical dynamics (Aleksandrov, Arutyunov, and Brodiansky 1982; Brodiansky 1985). The term was first coined by Vasily A. Gorodtsov and used in the Russian/Soviet archaeology of the 1920s. It was applied to prehistoric sites and cultures of the southern Russian Far East that contained evidence of early and still rather limited acquaintance with metal artefacts and metal-processing technology (Gorodtsov 1927). The term 'Paleometal' was only adopted more widely in the archaeology of various regions of Siberia, European Russia and Central Asia after the 1990s.

Direct evidence for the introduction of bronze and iron into the southern Russian Far East are is still quite scarce in comparison to other Eurasian regions where archaeological definitions of the 'Bronze age'

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and 'Iron age' refer to specific phases in the culture-historical periodization that reflect specific stages in early metallurgy and metal-processing development (Wells 1990; Koryakova and Epimakhov 2007; Lang 2007; etc.). According to current data, the appearance of first metalwares in the southern Russian Far East, in particular, bronze goods, was the consequence of cultural impulses from the centres of bronze metallurgy and metalwork in Southern and Western Siberia. The invention of iron is also thought to be a reflection of external cultural influences, as there is only a short chronological gap between the appearance of bronze and appearance of iron artefacts in the research area. In general, the Paleometal epoch is considered to be a particular stage in the prehistory of the Russian Far East that is marked by progressive changes in material culture and technologies. One of the most notable markers of the Paleometal epoch in Primorye is the appearance of polished stone copies of bronze daggers and spear tips (Derevianko 1973; D'iakov 1989; Kon'kova 1989; Brodiansky 2009; Zhushchikhovskaya 2005).

The total number of archaeological sites attributed to the Paleometal epoch in the research area is about 400. Of these, 20 sites have been studied in the course of large-scale excavations. The main type of Paleometal archaeological sites are settlements. Settlement types include those with pit-dwelling structures, settlements without pit-dwelling structures (seasonal camp-like settlements), and settlements with pit-dwelling structures and burial grounds. Cemeteries as separate archaeological sites are not detected. The most common artefact categories are ceramics, including pottery and spindle-whorls and stone items. Metallic artefacts that were found outside the excavated sites are few in number. Bone artefacts are uncommon, probably due to the acidic soils in this region, and are only preserved at several sites. The determination of Paleometal sites chronology is based on radiocarbon dating; more 70 dates are currently available (Kuzmin, Boldin, and Nikitin 2005; Brodiansky 2013).

The precise systematization of archaeological evidence for the Paleometal is still hotly debated. The basic unit for the systematization of prehistoric remains is the 'archaeological culture.' According to established definitions, an archaeological culture is a group of sites located within a certain territory, all dated to a specific period of time and distinguished by peculiar features and shared elements of material culture, lifestyle, subsistence patterns, and spiritual culture. This definition is applied widely in Russian archaeology to systematize the remains of diverse (pre)historic periods. The categorization of archaeological cultures does not seem to work well as an effective method of systematization during the Paleometal epoch because of high variability, with many seemingly unique archaeological assemblages. In other cases, some cultural unity in the assemblages of sites is suggested, but accurate definition of archaeological cultures remains challenging. Thus, we use the following gradient units of systematization: 'site,' 'cultural group of sites,' and 'archaeological culture.'

We first present a general overview of the main archaeological evidence from the Paleometal Epoch in the Primorye region. First, we will focus on some basic features of archaeological units that are interesting in examining larger societal changes. Second, we discuss patterns in the underlying technological and economic changes that accompanied the process of metal introduction in 1st mil. BC, particularly changes as they relate to the preceding Neolithic. We conclude by suggesting that evidence of an established metallurgical tradition in Primorye is lacking and that the region may have primarily played a role in the transit metal into the north, rather than the production of such goods.

Paleometal complexes

Site Siny Gai – A

Siny Gai site is located in the central part of Primorye near Khanka Lake (Figure 1). The settlement is located on a high terrace. The settlement consisted of several dozen dwellings. Dwelling constructions

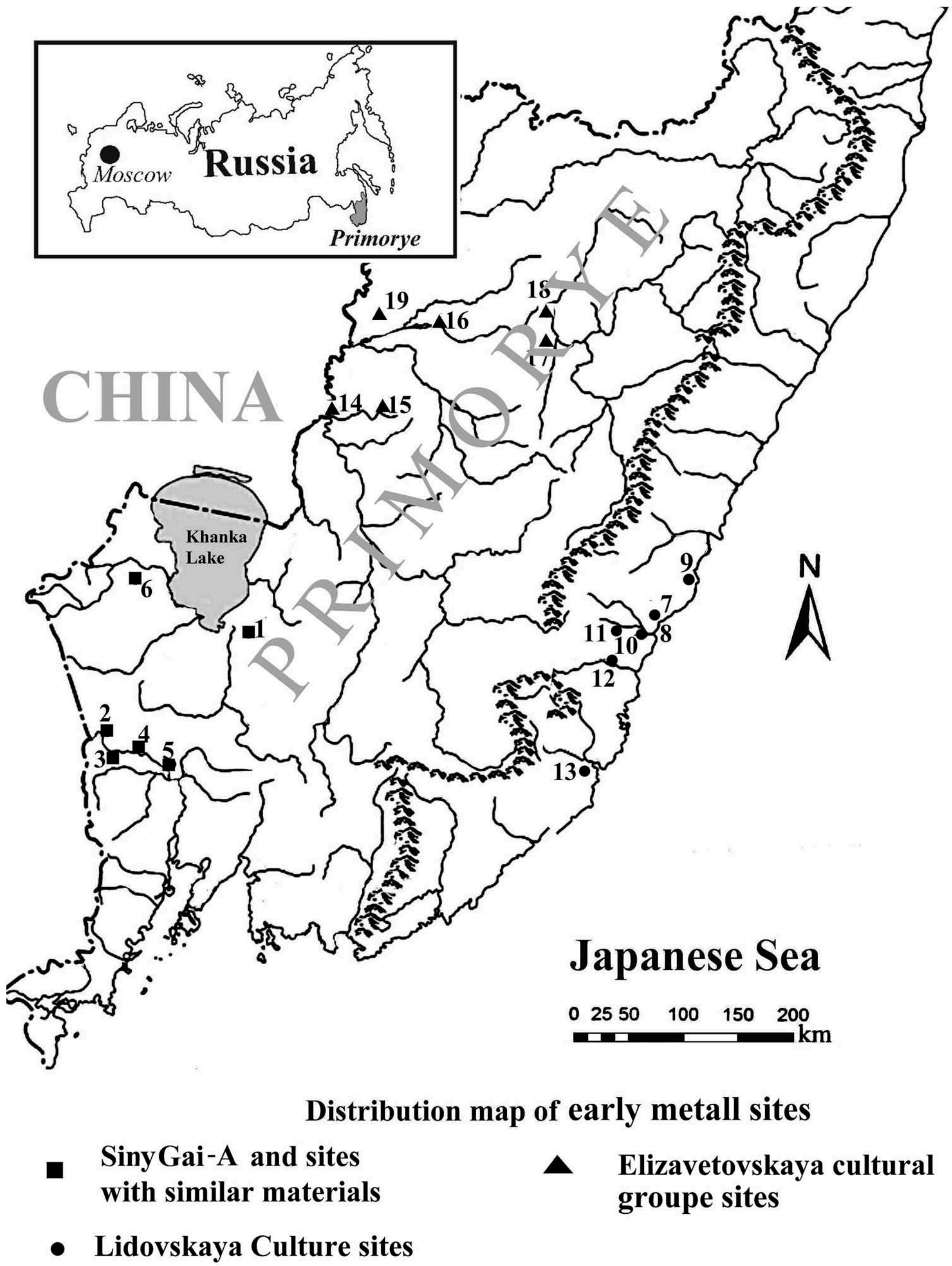

Figure 1. Maps of early metal sites.

Site Siny Gai – A and sites with similar materials:
1. Siniy Gai-A
2. Novoheorhievka 3
3. Chernyatino 2
4. Sinelnikovo 1
5. Zolotoy Kolos
6. Novoselyshche 4

Lidovskaya culture:
7. Lidovka
8. Rudnaya Pristan'
9. Blagodatnoe 3
10. Monastyrka 3
11. Vodorazdel'naya
12. Suvorovo 6
13. Glazkovka 2

Elizavetovskaya cultural group of sites:
14. Glazovka 1
15. Eelyzavetivka 1
16. Roshchino 6
17. Dal'niy Kut 15
18. Kamenushka 1
19. Znamenka 1

at Siny Gai site and other sites in the Siny Gai cultural group are usually round or rectangular in plan. Traditionally, their size is small or medium (18–60 m^2). Fire-pits are located in the centre, often lined with stone slabs.

This site materials are of great value as they mark the first appearance of bronze in the research area. The assemblage of 21 bronze items discovered in the upper cultural horizon of Siny Gai-A in 1969–1973 remains unique and the most significant until the present day for the territory of the Russian Far East (Brodiansky 2013). The bronze assemblage includes 'tailed' knives, semi-spherical buttons, pendants, fishhook, lamella-like plates, and unrecognizable fragmented objects (Figure 2, *1–8*). Morphological features of these artefacts, in particular knives (Figure 2, *1–3*) and buttons, are quite close to famous Karasuk-type bronzes produced in the Minusinsk Basin and neighbouring regions of southern Siberia during the 2nd mil. BC. The examination of Siny Gai bronze alloy compositions and geochemical characteristics confirm their Siberian origin (Kon'kova 1989, 1996). Siny Gai remains the only site where a representative series of early bronzes has been found. Single amorphous bronze specimens, which show some cultural similarities with Siny Gai, were also discovered at sites of the central Primorye region (Brodiansky 1985).

Most of the stone tools are made of siliceous and polished slate rocks. Multiple ground chopping tools (axes, adzes, chisels etc.) have oval, lenticular or rectangular section and suggest intensive woodworking (Figure 3, *1–6, 9–10*). There are also lots of polished arrows and dart points, reaping and tailed knives with a handle. Some polished stone tools are replicas of bronze items – daggers or spearheads. There are numerous grain graters and grinding stones, including scaphoid ones, and abrasives from sandstone rocks. A large assemblage of items was found at Siny Gai, including: spikes, harpoons, daggers, fish hooks, picks, and elements of compound bows (Figure 3, *7–8, 13–14*). One of the unique artefacts is protective armour made of rectangular bone or figured plates and decorated with geometric patterns (Figure 3, *11–12*). Ornaments are represented by pendants, beads, discs made of bone, stone and ceramics (Figure 2, *11–12*; Figure 3, *15–16*).

Pottery assemblages from Siny Gai and similar sites in western Primorye demonstrate a compositional variety of ceramic pastes, each relatively uniform in morphology, including: shell-tempered, grog-tempered, and gravel-tempered pastes. The former is most distinctive in the context of cultural interpretation and is interpreted as imported (Zhushchikhovskaya 2005). Shell-tempered, or mollusc-tempered paste does not match traditional ceramic technologies, which are focused on the use of local raw materials (Zhushchikhovskaya 2005). Other technological features include the coiling method of shaping, surface treatment by slipping without polishing, and firing at the temperatures up to 700–750ºC in oxidizing and 'smudging' regimes. There are two main morphological types: 1) vessels with a restricted orifice, short neck and shouldered body, and 2) bowl-like vessels with unrestricted open orifice (Figure 2, *9, 13–14*). Necked vessels are mostly of medium and small size, and bowls are of small size. Large-sized containers are not common.

Most of the date for Siny Gai sites fall between 1134–834 BC (Table 1), including the radiocarbon data for Siny Gai-A (Brodiansky 2013).

Elizavetovskaya cultural group of sites

The Elizavetovskaya cultural group of sites are spread across northern Primorye, on the western slopes of Sikhote-Alin, and along the Ussuri, Bolshaya Ussurka and Bikin river basins (Figure 1). The settlements are located on high river terraces and rocky ledges. Some of them are reinforced with primitive open shafts and ditches. The most well-known sites are Elizavetovka-1, Glazovka-1, Dalny Kut-15, Roshchino-6. These consist of small camps and large settlements. Dwelling constructions of

Figure 2. Siny Gai-A Site. Bronze artefacts (1–8), ceramic artefacts (10–14).

1–9, 13–14 – From the funds of the Museum of Archaeology and Ethnography of the Scientific Museum of FEFU
10 – According:Brodiansky (2013, fig. 199,*7*)
11 – According:Brodiansky (2013, fig. 201,*8*)
12 – According:Brodiansky (2013, fig. 201,*24*)

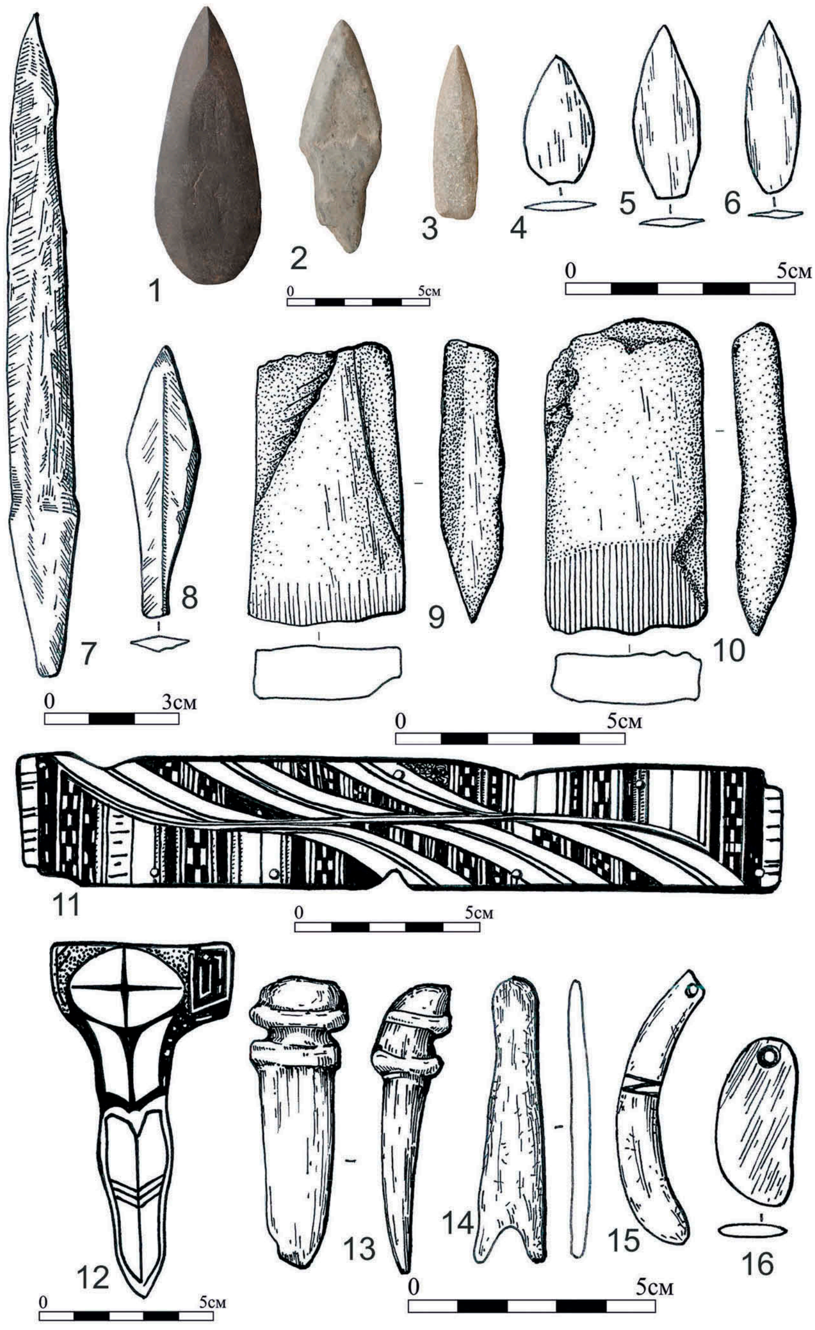

Figure 3. Siny Gai-A Site. Stone artefacts (1–6, 9–10, 16), bone artefacts (7–8, 11–15).

1–3 – From the funds of the Museum of Archaeology and Ethnography of the Scientific Museum of FEFU;
4–6 – According: Brodiansky (2013, fig. 183, *5,6,7*)
7–8 – According: Brodiansky (2013, fig. 185, *3,10*);
9–10 – According: Brodiansky (2013, fig. 169, *1,3*);
11–12 – According: Brodiansky (2013, fig. 160, *1,3*);
13 – According: Brodiansky (2013, fig. 186, *7*);
14 – According: Brodiansky (2013, fig. 185, *19*);
15–16 – According: Brodiansky (2013, fig. 201,*9,16*)

Table 1. Radiocarbon dates for Paleometal sites in Primorye.

Site	Data (BP)	Laboratory Code	Material	Calibrated date
	Siniy Gai Culture			
Siniy Gai	2820± 55	SOAN -1541	charcoal charcoal	1128-834 BC
Siniy Gai	2875± 45	SOAN-1540		1134-924 BC
	Elizavetovka Culture			
Elizavetovka 1	2690±20	IAAA-122175	charcoal charcoal	898-807 BC
Elizavetovka 1	2700±20	IAAA-122176	charcoal	900-810 BC
Elizavetovka 1	2640±20	IAAA-130756		833-792 BC
	Lidovka Culture			
Suvorovo 6	2935±50	SOAN-3023	charcoal	1370-980 BC
Suvorovo 6	2540±40	AA-36623	charcoal	800-520 BC
Suvorovo 6	2320±55	SOAN-3022	charcoal	510-210 BC
Lidovka 1	2610±45	SOAN-1390	charcoal	900-560 BC
Lidovka 1	2570±60	SOAN-1388	charcoal	890-410 BC
Lidovka 1	2530±40	SOAN-1424	grain	800-530 BC
Lidovka 1	2450±50	SOAN-1389	charcoal	770-410 BC
Suvorovo 8	2560±90	SOAN-4305	charcoal	900-400 BC
Suvorovo 8	2465±60	SOAN-4309	charcoal	800-400 BC
Suvorovo 8	2400±55	SOAN-4306	charcoal	760-390 BC
Suvorovo 8	2350±35	SOAN-4310	charcoal	480-380 BC
Suvorovo 8	2345±50	SOAN-4308	charcoal	540-260 BC
Suvorovo 8	2335±60	SOAN-4307	charcoal	760-210 BC
Suvorovo 4	2420±50	AA-36624	charcoal	760-400 BC
Suvorovo 3	2040±45	AA-27560	charcoal	170 BC – AD 70
Suvorovo 9	1920±50	SOAN-4311	charcoal	40 BC – AD 230
	Yankovskaya Culture			
Slavianka 1	2830±40	LE-2496	charcoal charcoal	1130-900 BC
Olenii G	2710±25	SOAN-1538		910-820 BC
Zaisanovka 2	2600±50	OS-2675	charcoal	990-540 BC
Zaisanovka 2	2480±50	Beta-124173	charcoal	800-400 BC
Malaya Podushechka	2450±50	MSU-499	charcoal	770-410 BC
Olenii A	2195±25	SOAN-1537	charcoal	370-190 BC
Olenii A	2155±25	SOAN-1535	charcoal	360-120 BC
Olenii A	2050±20	SOAN-1536	charcoal	110-10 BC
Olenii A	2050±280*	FESU-PIG-84	charcoal	790 BC - AD 530
Barabash-3	2415±45	SOAN-7267	charcoal	593-399 BC
Barabash-3	2435±90	SOAN-7268	charcoal	795-387 BC
Barabash-3	2220±60	SNU07-R081	charcoal	399-151 BC
Barabash-3	2180±60	SNU07-R080	charcoal	385-91 BC
Pospelovo-1	2805±40	MTC-16139	charcoal	1056-838 BC
Pospelovo-1	2780±40	MTC-16140	charcoal	1006-830 BC
Russky-1	2715±40	MTC-16141	charcoal	928-802 BC
Russky-1	2900±40	MTC-16145	charcoal	1214-973 BC
Russky-1	2790±40	MTC-16146	charcoal	1021-831 BC
Russky Ayaks-1	2460±40	MTC-16144	charcoal	601-410 BC
Cherepaha-7	2470±60	LU-8010	charcoal	771-409 BC
Cherepaha-7	2830±90	LU–8011	charcoal	1220-815 BC
Cherepaha-7	2660±110	LU-8012	charcoal	1052-480 BC
Cherepaha-7	2530±100	LU-8013	charcoal	832-401 BC
Cherepaha-7	2310±80	LU-8014	charcoal	559-170 BC
Cherepaha-7	2400±90	LU–8015	charcoal	792-358 BC
Cherepaha-7	2820±110	LU–8016	charcoal	1282-798 BC
Cherepaha-7	2150±80	LU–8017	charcoal	387-20 BC
Cherepaha-7	2390±60	LU–8018	charcoal	671-382 BC
Cherepaha-7	2280±70	LU–8019	charcoal	541-164 BC
Cherepaha-7	2240±35	MTC-17887	charcoal	391-202 BC
Cherepaha-7	2440±35	MTC-17888	charcoal	594-404 BC
Cherepaha-7	2495±35	MTC-17889	charcoal	789-503 BC
Cherepaha-7	2215±35	MTC-17890	charcoal	389-198 BC
Cherepaha-7	2235±35	MTC-17891	charcoal	388-202 BC
Petrova Island	2050±20	SOAN-1542	charcoal	110-10 BC
	Krounovskaya Culture			
Konstantinovka 1	2530±90	GIN-6962	charcoal	820-410 BC
Korsakovka 2	2420±50	Ki-3619	charcoal charcoal charcoa	760-400 BC
Korsakovka 2	2080±70	GIN-8288	l charcoal charcoal	360 BC - AD 60

(*Continued*)

Table 1. (Continued).

Site	Data (BP)	Laboratory Code	Material	Calibrated date
Krounovka 1	2280±40	LE-2635		400-210 BC
Krounovka 1	2190±40	LE-2634		380-130 BC
Olenii A	2180±260*	FESU-PIG-82		830 BC – AD 380
Olenii A	1800±120*	FESU-PIG-81	charcoal	50 BC – AD 530
Kievka	1980±50	MAG-367	charcoal charcoal charcoal	100 BC - AD 110
Kievka	1820±80	LE-4184		AD 20-390
Petrova Island	1770±25	SOAN-1543		AD 140-340

the Elizavetovskaya cultural group are usually rectangular or sometimes circular in plan. The fire-pits are shallow without any design features, and the area of dwellings is small: 15–20 m^2 (Nikitin 2012)

The stone tool assemblages are characterized by the complete absence of retouched finds; all items are made by polishing (Figure 4, *2–5*). Polished arrowheads are triangular or leaf-shaped and strongly flattened (Figure 4, *5*). Axes and adzes have a rectangular shape and a rectangular cross-section. Reaping knives are made on slate tiles, the blade is elaborately polished and has a rectangular or tailed shape and can be with or without a hole. In addition, grinding plates and stones (usually segmented), and conical-shaped abrasives with a hanging hole were also found (Figure 4, *6–7*). It is also worth noting that the materials of Elizavetovskaya cultural group do not include stone replicas of bronze items.

At the same time, the assemblages from the Elizavetovskaya cultural group of sites do include bronze tools: flat knives with a straight back, a bevelled blade and a short straight handle with a hole (Figure 5, *1–3*). These items are made of tin bronze (Nikitin 2012). A single arrowhead with a triangular cross section and convex hemispherical metal plates – buttons with an eyelet on the back side was also found. Several items and finds indicate possible smelting of bronze: ceramic ladles (Figure 5, *4*), fragments of a ceramic nozzle, and pieces of slag (Figure 5, *5–6*).

The pottery of the Elizavetovskaya cultural group of sites is represented by flat-bottomed vessels with a significant morphological variety of forms (Figure 5, *7–14*). The assemblages include large vessels (10–50 L) characterized by a convex spherical body and prominent straight necks of various heights, as well as different-sized pots, cans, and bowls. The walls are thin (0.3–0.7 cm). All the pots are made by coil-building and hand-moulding. The moulding paste consisted exclusively of clay and mineral tempers with noticeable inclusions of mica. Surfaces were smoothed and sometimes weakly polished. Most of the ware is unornamented. Part of the ceramic fragments have traces of staining.

The rims were typically not ornamented, but a single specimen has evidence of thin horizontal lines under the edge. On the decorated ware, ornamentation was located on a straight neck in the form of zigzag double incised lines, bounded above and below by horizontal traced lines or applied rollers, or at the base of the neck in the form of two rows of rounded imprints and triangular pin marks under the horizontal line (Figure 5, *10–12*). Sometimes the spherical body was decorated with applied narrow rollers: horizontal or arc-shaped diverging from one point (Figure 5, *13*). In addition to the pottery, there were cone-shaped spindle whorls with a prominent neck, rings and discs.

There are three radiocarbon dates for the Elizavetovskaya cultural group of sites, all falling at 900–792 BC (Table 1) (Nikitin 2012; Kuzmin, Boldin, and Nikitin 2005)

Lidovskaya culture

Sites of this culture are spread in northeast Primorye, mostly along the eastern Sikhote-Alin' mountain area, and along the coast of the Sea of Japan (D'iakov 1989) (Figure 1). They include

Figure 4. Elizavetovskaya cultural group of sites. Stone artefacts (1–7).

1–7 – From the funds of the Museum of Archaeology and Ethnography of the Institute of History, Archaeology and Ethnography Far Eastern Branch of the RAS

the remains of camp-like settlements and large long-termed settlements consisting of several dozens of pit-dwellings. The sites Lidovka-1, Blagodatnoe-3, Rudnaya Pristan' have been excavated on a large scale. The floorplan of pit-dwellings, most of which are rectangular in shape, range from around 40 m^2 to 100 m^2. Hearths are located in the centre of the floor area. The chronology of Lidovskaya cultural group falls mostly in the interval 900–210 BC according to the set of 20 carbon dates (Kuzmin, Boldin, and Nikitin 2005).

The stone artefact assemblage includes a large series of flaked and polished tools made of flint and slate. Flaked tools, including arrowheads, dart-heads, scrapers, brackets, drills, cutting tools, represent the Neolithic tradition of bifacial retouching (Figure 6, *5*). Polished tools include axes and adzes of rectangular and trapeze-like shapes, up to 8–12 cm in length (Figure 6, *3, 7*), arrowheads (Figure 6, *4, 6*), in particular the ones with parallel faces and two-sided grooves, tailed knives, and a small series of reaping knives (Figure 6, *1, 2*). One group of polished artefacts represents the

Figure 5. Elizavetovskaya cultural group of sites. Bronze artefacts (1–3, 5, 6), ceramic artefacts (4, 7–14).

1–14 – From the funds of the Museum of Archaeology and Ethnography of the Institute of History, Archaeology and Ethnography Far Eastern Branch of the RAS

Figure 6. Lidovskaya culture . Stone artefacts (1–10).
1–10 – From the funds of the Museum of Archaeology and Ethnography of the Scientific Museum of FEFU

replicas of Karasuk-type cast bronzes – leaf-like handled blades with longitudinal rib (Kon'kova 1989, 37–39) (Figure 6, *8, 9*). Other stone tools and implements are grinding slabs, grinders, abrasive slabs, anvils, pebble net-sinkers. A separate group of stone tools are roughly-processed shouldered hoes (Figure 6, *10*).

The pottery assemblage of the Lidovskaya culture includes flat-bottomed ceramic vessels made by coiling method. Distinctive traits are thin walls (0.3–0.5 см) and surface treatment by burnishing. Basic shapes are necked vessels with rounded body (Figure 7, *5*), pots with a wide orifice, and bowls. Pottery was fired at temperatures 700–750°C in an oxidizing regime. In many cases ceramic vessels are decorated by various impressions along the rim, narrow applique horizontal rollers or straight horizontal lines at zone of neck and shoulders junction, or at shoulders. There are rare cases of surface decoration with red ochre slipping. Other categories of ceramic artefacts are necked spindle-whorls and the series of roughly stylized anthropomorphic figurines (Figure 7, *1–4*).

The subsistence pattern of Lidovskaya culture combines the attributes of production economy. Farming is represented by a complete set of agricultural tools (hoes, reaping knives, pestles, grinding slabs and hand stones) in combination with findings of cereal grains – millet. Stone figures of wild boars may indicate the domestication of pigs. But at the same time, terrestrial hunting and gathering played a large role in the household of the Lidovans. The presence of stone sinkers highlight the importance of fishing.

For Lidovskaya cultural group of sites, approximately 20 radiocarbon dates have been determined, but most of them relate these materials to the 800–400 BC (Table 1). (Kuzmin, Boldin, and Nikitin 2005)

Yankovskaya culture

Sites of the Yankovskaya culture were first discovered in the late 19th century and systematically investigated since the second half of the 1950s (e.g. Okladnikov 1963; Andreeva, Zhushchikhovskaya, and Kononenko 1986; Brodiansky and Rakov 1992; Aikens, Rhee, and Zhushchikhovskaya 2010; Vostretsov and Gelman 2011; Yanshina and Shoda 2014; Zhushchikhovskaya 2018). The most densely occupied area in this cultural zone is a narrow area along the seacoasts of Peter the Great Bay in southern Primorye (Figure 8). Many coastal sites are marked by deposits of shell mounds up to 1–1.5 m thick. Some of the sites are also located about 4 to 20 km from the coast in some river valleys, and in few cases sites at a distance of more than 25–30 km from the sea. The total number of discovered sites is more than 100. According to radiocarbon dating, temporal boundaries of the Yankovskaya culture generally range from about 1200–800 BC to 400–100 BC. Large scale excavations are at both at sites with pit-dwellings and at seasonal camps without long-term pit-dwellings. The floorplan of the pit-dwellings, which are mostly of rectangular shape, range from around 20 m^2 to 270 m^2. Artefact assemblages from pit-dwellings do not provide evidence of social differentiation between houses. Evidence of mortuary practices were also discovered at some settlements. Three kinds burials were identified – individual, double and also burials consisting of multiple individuals with the skeletal remains in no strict anatomical order. The buried persons were not accompanied by particular types of grave goods. Only single artefacts were found in some of the burials.

Stone artefacts unearthed at Yankovskaya culture settlements are represented, firstly, by polished axes and adzes, arrowheads, harpoon heads, knives, spearheads, and reaping knives (Figure 9, *1–3, 9–13, 18–22*). A special group is the daggers interpreted as replicas of bronze daggers (Figure 9, *20–22*). Other stone artefacts include ornaments, in particular greenstone tubular beads, pebble net-

Figure 7. Lidovskaya culture. Ceramic artefacts (1–5).

1- According: D'iakov (1989, fig. 15)

2–5 – From the funds of the Museum of Archaeology and Ethnography of the Scientific Museum of FEFU

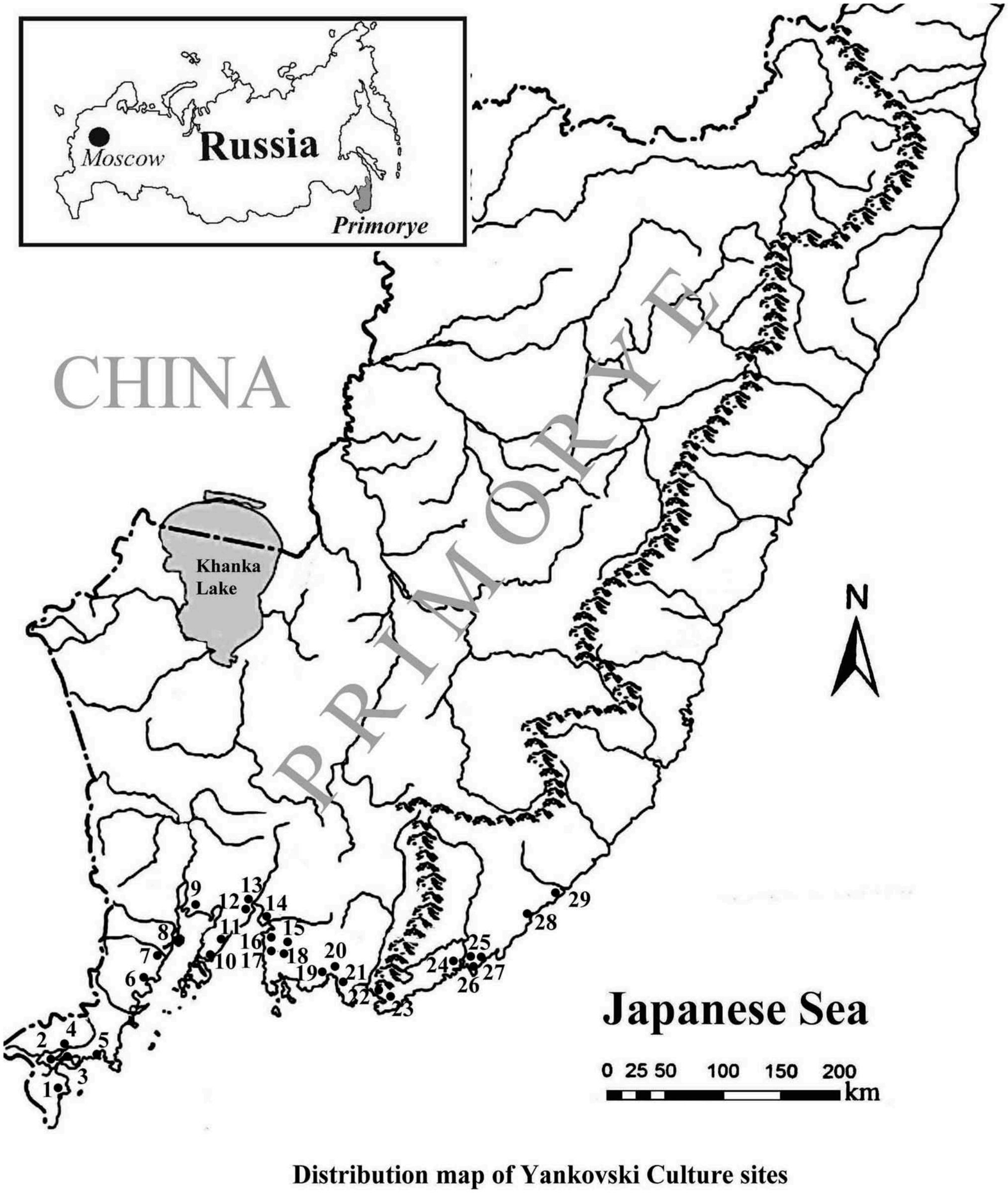

Figure 8. Map of Yankovskaya culture sites.

1. Lebedinoe (Swan)
2. Cape Shelekha
3. Possiet grotto
4. Gladkaya (Smooth)
5. Bousman
6. Bezverhovo
7. Barabash 3
8. Peschani .
9. Chapaevo
10. Ulysses
11. Lazurnaya
12. Oleniy .
13. Cherepaha .
14. Podyapolskogo
15. Malaya Podushechka
16. Noviy Mir
17. Solnechni Bereg
18.Solontsoviy
19. Volchanets
20. Novo-Litovsk
21. Lebedinoe
22.Lashkevych
23. Kozmino
24.Melkovodnoe
25. Kievka
26. Sokolowski
27. Petrova Island
28. Zarya
29.Valentin Peresheek

Figure 9. Yankovskaya culture. Stone artefacts (1–3, 9–22), Bone artefacts (4–8).

1–8- From the funds of the Museum of Archaeology and Ethnography of the Scientific Museum of FEFU;
9–20 – From the funds of the Museum of Archaeology and Ethnography of the Institute of History, Archaeology and Ethnography Far-Eastern Branch of the RAS

sinkers, abraders, ground slabs (Figure 9, *14–17*). The well-preserved bone artefacts in shell-mound deposits include various points, needles, fishhooks, and ornaments (Figure 9, *4–8*).

Pottery assemblages are representative at all sites. The main shapes are flat-bottomed pots and jars with restricted orifices, often necked and rounded bodies, bowls, and dishes. In some cases, the vessels are ornamented by zonal geometric compositions produced by incising, appliqué, and punctates (Figure 10). There are two recognized technological standards in pottery production: that for common, ordinary wares; and that for special wares. The latter are mostly footed bowls and dishes produced of thin-textured paste, treated carefully, in some cases covered with a red ochre slip. The ceramics were fired in simple kilns. In a single case, remains of one such device was discovered (Zhushchikhovskaya 2005, 2013).

The Yankovskaya culture provides evidence of the earliest coexistence of iron and bronze artefacts in the southern Russian Far East and the Primorye region. Iron implements are represented by multifunctional axes, knives, arrowheads, and fishhooks; all are few in number. There is no accurate data on local iron production; however, a single instance of local production was discovered at the site Barabash-3 in southwestern Primorye. Here the remains of furnace-like construction and an assemblage of cast iron axes were unearthed from inside a pit-dwelling. According to the preliminary results of analysis, technological features and the chemical composition of these metal artefacts, are similar to iron-working traditions of the Korean peninsula during the 1st mil. BC (Kang 2008; Kluyev 2008).

The subsistence pattern of the Yankovskaya culture is reconstructed as a complex one combining foraging and production. Exploitation of marine resources played a significant role in the economy of the coastal settlements. Additional activities included terrestrial hunting and wild plant gathering. The assemblages of osteofauna from the Yankovskaya culture sites contain not only the bones of wild animals but small numbers of specimens of domesticated pigs and dogs. There are a few sites with evidence of agricultural activity where carbonized cereal remains were found as well as grinding slabs and stone reaping knives. In general, the agricultural component appears not to have played a significant role in the subsistence pattern.

The majority of dates for the Yankovskaya culture fall between 990–120 BC (Table 1) (Kuzmin, Boldin, and Nikitin 2005)

Krounovskaya culture

The Krounovskaya culture was identified in the 1960s and is one of the primary research subjects of the Paleometal epoch (Okladnikov and Shavkunov 1960; Brodyansky and Diakov 1984; Zhushchikhovskaya and Kononenko 1987; Derevianko et al. 2005; Vostretsov 2005; Zhushchikhovskaya 2005; Aikens, Rhee, and Zhushchikhovskaya 2010; Zhushchikhovskaya and Nikitin 2014). The area of this culture extends from the west to the southeast of Primorye region (Figure 11). The sites number more than 100. They are mostly located in river valleys, and in rare cases along the seacoast. Researchers determined the nuclear zone of this culture to be in the Razdol'naya river basin in western Primorye, which is characterized by wide valley plains with fertile alluvial soils. Radiocarbon dating defines temporal boundaries of the Krounovskaya culture generally from about 700 BC – AD 100. Large scale excavations have focused on sites with long-term pit-dwellings, all rectangular in shape. The dwelling floors vary in size from 48m^2 to 115m^2 at the settlements in the fertile nuclear zone, and from 10m^2 to 30m^2 at settlements in the southeastern forested mountain zone. Most of the Krounovskaya culture site pit-dwellings are marked by good preservation of construction details and artefact assemblages. The distinctive feature of house interiors was the construction of a channel-type under-floor heating system built of stones, earth and clay. Storage pits are discovered in the houses at

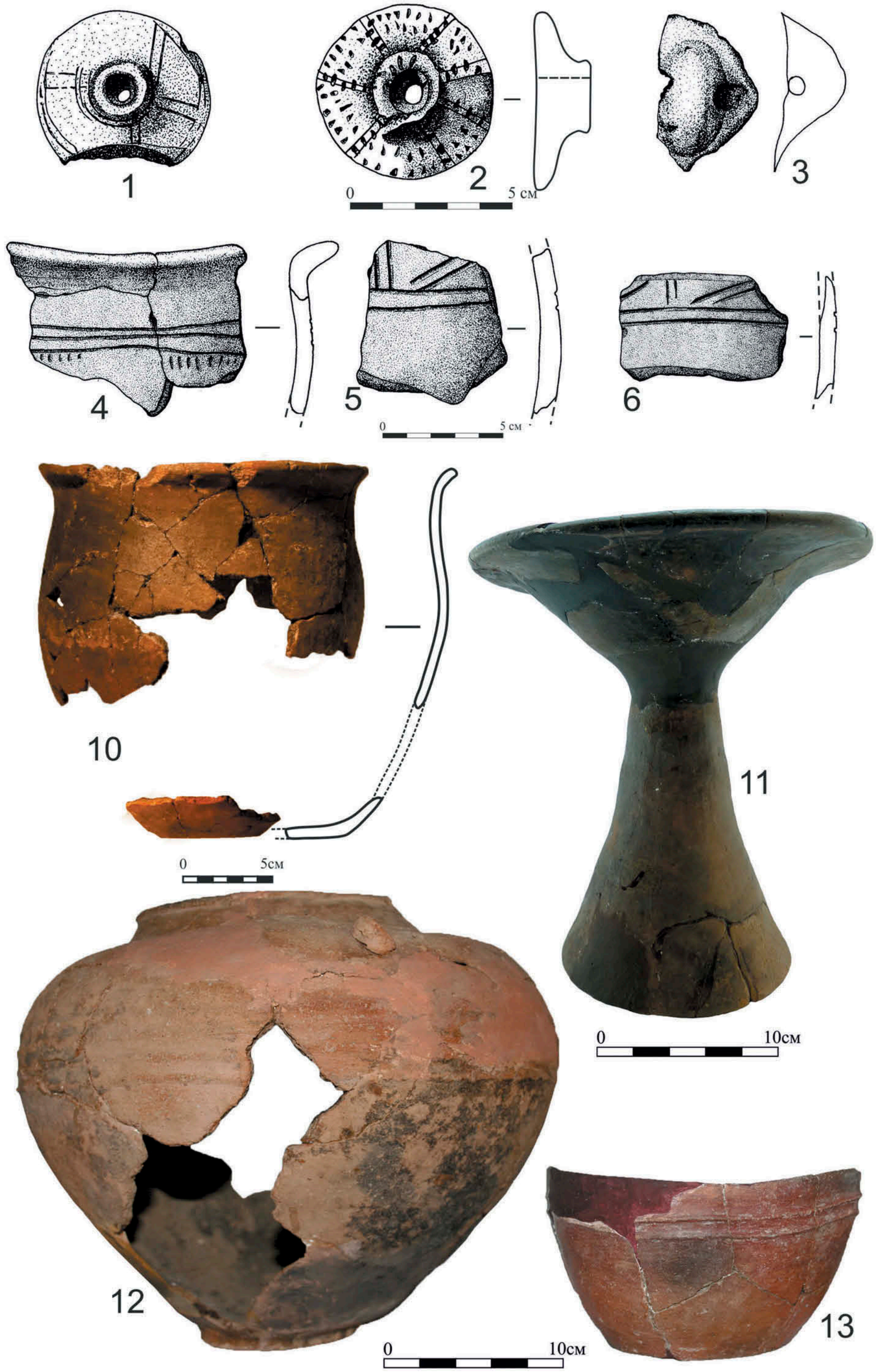

Figure 10. Yankovskaya culture. Ceramics artefacts (1–13).

1–10, 12–13- From the funds of the Museum of Archaeology and Ethnography of the Scientific Museum of FEFU;
11 – From the funds of the Museum of Archaeology and Ethnography of the Institute of History, Archaeology and Ethnography Far Eastern Branch of the RAS

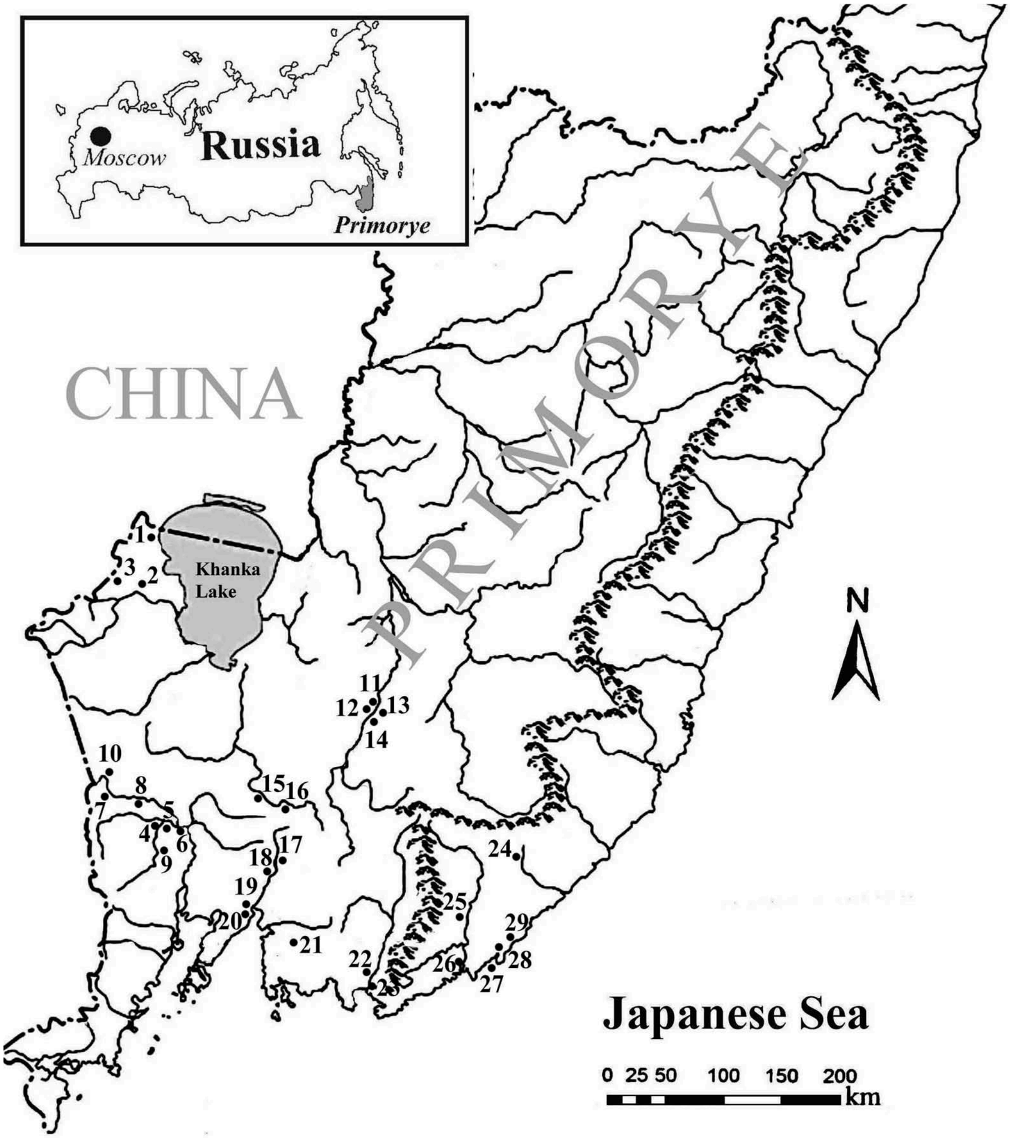

Figure 11. Map map of Krounovka culture sites.

1. Semipatnaya
2. Novoselyshche4
3. Dvoryanka 3
4. Krounovka
5. Korsakovka
6. Borisovka
7. Konstantinovka
8. Chernyatino
9. Putcilovka 2
10. Fadeevka 1
11. Staraya Gordeevka 4
12. Novogordeevka 1
13. Romanovka
14. Anuchino 1
15. Nikolaivka
16. Otradnoye 2
17. Mnogoudobnoe 1
18. Izvestkovaya Sopka
19. Oleniy A
20. Sherepaha 13
21. Solontzoviy
22. Zolotaya Dolina 2
23. Bulochka
24. Sokolchi
25. Kievka
26. Zvezdochka
27. Petrova Island
28. Shalamaev Key
29. Buhta Oleniya

some sites. Artefacts assemblages from pit-dwellings do not provide clear evidence of social differentiation between houses. Burials, communal structures, and defensive structures have not been discovered at Krounovskaya culture sites.

Stone artefacts unearthed at settlements of the Krounovskaya culture include polished 'shouldered' axes (Figure 12, *1–3*), rectangular-shaped adzes, reaping knives, pebble net-sinkers, polishing stones (for ceramic treatments), ground slabs, abraders, hammers, anvils (Figure 12, *9–21*). Polished stone weaponry, in particular the arrowheads and spearheads, knives and daggers, are not present; this is in sharp contrast to the Yankovskaya culture assemblages.

Almost all excavated pit-dwellings contain well preserved assemblages of pottery (Figure 13, *1–2, 10–19*). There are distinguishable 'coarse' and 'fine' wares. 'Coarse' pottery includes storage containers up to 40–60 cm high, medium-sized pots for kitchen needs, and serving bowls. All of them are common utensils in each house. 'Fine' pottery is represented by black-polished footed bowls, supposedly, used for ritual or ceremonial needs. Neither group of pottery is ornamented. At the Chernyatino-2 settlement, the remains of a pottery-firing kiln were unearthed. Technical capabilities of this device allowed for temperatures of up to 900^{o}C.

Krounovskaya culture sites provide evidence of both iron and bronze artefacts. Iron implements are represented by a few specimens of multifunctional axes, knives, narrow adzes, arrowheads, and fishhooks (Figure 13, *3, 20–23*). There are no traces of local iron metallurgy. However, an examination of use-wear on stone artefacts detected their use in metalworking operations – sharpening, hammering. Bronze items are the only evidence of metal at the Krounovskaya culture sites (Figure 12, *4–9*), but the Petrova island settlement provided the remains of a potential bronze-casting workshop containing metal slags, ceramic crucibles, bronze ingots, and fragments of bronze artefacts.

The subsistence pattern of the Krounovskaya culture was a mixed strategy combining food production and foraging. The production branch played a more significant role than evidenced for the Yankovskaya culture. Agricultural activity is confirmed by repeated finds of carbonized cereals (millet, barley, wheat) and the osteofauna includes domestic pigs, dogs, and cows, alongside some wild animals.

Most of the Krounovskaya culture dates are between 400 BC and AD 390 (Table 1) (Kuzmin, Boldin, and Nikitin 2005)

Broader changes in material culture

Even the limited degree of local metal production and re-working, as well as general interest in bronze and iron tool types, during the Paleometal epoch suggests underlying progressive changes in the material culture of prehistoric populations in the southern Russian Far East. These developments have a clear lineage in the local stone and ceramic assemblages, which are the most representative categories of both Neolithic and Paleometal era remains. At the same time, the Paleometal lithic assemblages demonstrate significant changes in morphology, manufacturing techniques, and tool composition in comparison to the Neolithic era. The Paleometal cultures of Primorye are characterized by a sharp reduction or complete disappearance core-blank production, wherein a wide variety of objects were produced on blanks through retouch. Instead, polishing begins to play a leading role in lithic production techniques. In connection with this, raw material preferences also changed – with a greater emphasis on slate, while obsidian and siliceous rocks became rare. Retouched items are nearly absent in the Yankovskaya and Krounovskaya cultures. One prominent feature is a great number of polished woodworking tools (e.g. axes, adzes, chisels). There is greater diversity in sizes, but almost all of them have a rectangular cross section, in contrast with the oval or triangular cross sections of Neolithic types. Agricultural tools became increasingly important and include hoes,

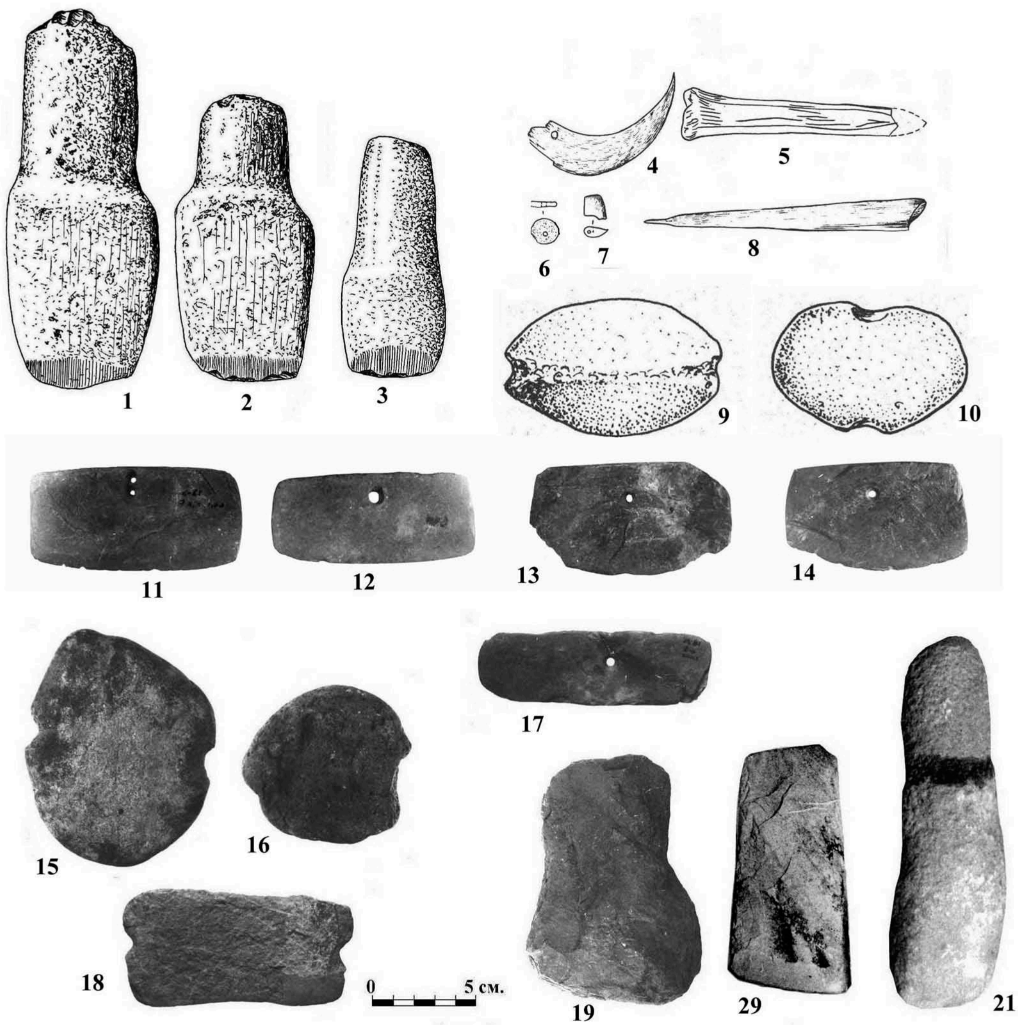

Figure 12. Krounovskaya culture. Stone artefacts (1–3, 9–21), bone artefacts (4–8).

1–3, 9–21 – From the funds of the Museum of Archaeology and Ethnography of the Institute of History, Archaeology and Ethnography Far Eastern Branch of the RAS
4–8 – According: Brodyansky and Diakov (1984, 34, Fig. 12 *5,6,7*)
9–10 – According: Brodyansky and Diakov (1984, 34, Fig. 10, *1–3,5,6*).

ploughshares, reaping knives, pestles, grinding slabs and hand stones. The peculiarity of Paleometal cultures in Primorye is the presence of stone polished replicas of bronze tools – Lidovskaya spearheads and 'tail' knives, as well as Yankovskyaya and Krounovskaya daggers. Finally, the Paleometal epoch is characterized by the appearance of segmented beads made of greenstone.

Pottery assemblages and pot-making traditions also indicate significant changes and innovations compared with the Neolithic epoch (Zhushchikhovskaya 2005). The appearance of metal and metalworking technology was an important technological innovation related to progressive developments in firing technology. The evidences of this innovation are mainly connected with iron-bearing sites. Average firing temperatures of the Neolithic pottery were mostly 600–650°C, but the firing temperatures of the Paleometal pottery from iron-bearing sites increased up to 700–800°C, or

Figure 13. Krounovskaya culture. Bronze artefacts (3–9), Iron artefacts (20–23), Ceramics artefacts (1–2, 10–19).

1, 17 – According: Derevianko et al. (2005, 12, table."R");
2,3,13,16,18,23 – From the funds of the Museum of Archaeology and Ethnography of the Institute of History, Archaeology and Ethnography Far Eastern Branch of the RAS;
20–22 – According: Brodyansky and Diakov (1984, 34, Fig. 9, *6,7,8*).
4 – 9 – According: Okladnikov and Shavkunov (1960).
12–16, 18–19 – From the funds of the Museum of Archaeology and Ethnography of the Institute of History, Archaeology and Ethnography Far Eastern Branch of the RAS

even 850ºC. The special 'smudging' technology, which improves impermeability of the vessels, was likewise related and used intentionally.

These features correspond to kiln-firing rather than the open firing technique used in Neolithic pot-making. Indeed, there is some archaeological evidence of pottery kilns at iron-bearing sites. There are two known kiln finds in Paleometal period sites in the Primorye region. One is a poorly preserved assemblage of firing-oven structures built of clay mixed with straw, uncovered at the Yankovskaya settlement Malaya Podushecka (770–410 BC). It was determined that firing constructions were of small size and simplest single-chambered up-draught type. Supposed firing temperature in these primitive kilns was around 700–800ºC (Zhushchikhovskaya and Nikitin 2014). The second kiln was excavated at the Krounovskaya culture site of Chernyatino-2. There is no absolute date for this site, but it is estimated to date to around AD 400. The kiln was of a tunnel-like, slightly sloping, cross-draught type and was built of clay on a wooden frame. Near the kiln were samples of ceramic firing waste. Scanning electron microscopy (SEM) analysis of ceramics from around the kiln indicated a firing temperature in the interval of 750 – 900ºC. Ceramics kilns of a more developed, but similar, type were invented in the neighbouring Korean peninsula in AD 400–300. (Zhushchikhovskaya and Nikitin 2019). Presumably, the invention of hot-metal working and kiln-firing were simultaneous processes which both took place in 1st millennium BC.

The main change in the Paleometal pottery morphology was a significant increase in vessel shapes and sizes compared with the Neolithic epoch. The structural features of pottery types can be divided into vessels with restricted or unrestricted orifices. This division is reflects the development and elaboration of ceramic container functions. There are distinguishable storage, kitchen and table-serving vessels varying by shapes and sizes. This is a sharp contrast to the morphological uniformity of the Neolithic epoch. Specific pottery for special functions (ritual or ceremonial) first appeared in iron-bearing cultures and mark a change in the complexity of social needs. Fundamental changes took place in pottery decoration principles. Ornate ceramic vessels dominated Neolithic pot-making. Distinctive features included covering much of the entire vessel surface with simple compositions of repeated stamp-impressed elements. Methods of pottery decoration in the Paleometal epoch contrast in the regular use of plain and undecorated pottery within many cultures. In other cases, where pottery was more often decorated, ornamentation was characterized by horizontal zonal compositions using laconic geometric motifs. These changes in pottery-making traditions and technologies indicate new tendencies in technological, economic and cultural fields of life. Notably, similar pottery-making dynamics are recognized for the Paleometal period in other territories of the southern Russian Far East, in particular, Sakhalin Island and Priamurye region (Zhushchikhovskaya 2009).

Aside from the above noted technological changes, the late Palaeometal Epoch appears to correspond with a shift away from foraging towards a greater focus on production. Cereal grains are present beginning in the Late Neolithic, but more common at Siny Gai, Yankovskaya and Krounovskaya culture sites (Sergusheva and Vostretsov 2009). Domesticated animals, including dogs, pigs, are likewise present at Siny Gai, Yankovskaya and Krounovskaya culture sites. The care of domesticated plants and animals represents a major shift in economic traditions that are increasingly common in light of these other major technological shifts. Such shifts underscore increased interaction with and influence from metallurgical agrarian communities to the south, suggesting that the Paleometal Epoch marked several significant departures from traditional lifeways.

Conclusion

Bronze-bearing and iron-bearing cultural units of the Primorye region overlap chronologically. Most of the early radiocarbon dates indicate the appearance of bronze about 900 BC, and iron at about 500 BC. So, iron came into the Primorye region shortly after bronze; however, the two metallurgical traditions largely co-existed within the Primorye territory. It should be noted that there is some tendency towards spatial separation between areas occupied primarily by either bronze- or iron-bearing cultural units. There is no evidence of temporal sequences representing a chronological transition from bronze- to iron-use.

The bronze-bearing archaeological units of Primorye Paleometal Epoch contain evidence of acquaintance with finished bronze artefacts, but few traces of their production or re-working. In general, evidence of any bronze use is quite limited and connected mostly with the sites of the western and northwestern Primorye, primarily with the Siny Gai-A site and the Elizavetovka cultural group. Morphological and technological features of bronzes, in particular, the 'tailed' knives and semi-spherical buttons, indicate clear Siberian Karasuk traditions of metal production and therefore suggest the importation of finished objects (Kon'kova 1989, 1996; Chernykh 2008). Early bronzes of the Primorye region are considered the result of contacts with continental Eurasian cultures. The character and details of these contact and exchange networks remain unclear, and this important topic is worthy of further research. The limited single finds at the Elizavetovka-1 and the unique collection of bronze artefacts from Siny Gai-A site do not allow us to assign Primorye as a metallurgical centre or an important point in manufacture of bronze products.

The iron-bearing cultures offer a broader array of evidence for the use of metals. The evidence for acquaintance with finished iron artefacts are few in number, but are still present at most excavated sites of the Yankovskaya and Krounovskaya cultures. The common type of iron artefact in these cultures is the multifunctional, rectangular-shaped sleeved axe. Iron axes of the same or similar types were distributed widely in Eurasia from the mid-1st mil. BC. There is a close similarity between iron axes from Primorye Paleometal sites and sites of the Korean peninsula during the second half of 1st mil. BC (Nelson 1993). This observation corresponds to preliminary conclusions about similarities in chemical composition between iron axes from Barabash-3 and contemporary iron artefacts from the Korean peninsula (Kang 2008; Kluyev 2008). Probable technological connections between iron-bearing cultures of the Primorye region and the neighbouring Korean peninsula are compelling avenues for future research.

Finds from Yankovskaya and Krounovskaya contexts indicate only a limited knowledge of both hot and cold metal-working. Barabash-3 (Yankovskaya culture), is the only evidence of iron-working for Primorye. Iron from Barabash-3 artefacts are similar in their characteristics to iron from the Korean peninsula. Such finds are limited and are not accompanied by evidence of local metallurgical development. It seems most likely that early iron objects were imported from other areas. Therefore, we cannot support the existence of a metallurgical manufacturing centre in Primorye. At best, Primorye was a transit territory for the penetration of iron products into the more northern regions (Dyakonov et al. 2019).

To summarize, archaeological records indicate that during the Paleometal epoch in Primorye region there was no local bronze production nor any evidence for metal-working centres. Bronze-use was limited to finished artefacts of imported origin. There are a few finds related to production and metal-working activities among iron-bearing cultures, but the evidence is limited. Indirect evidence of an acquaintance with metal artefacts is represented by stone replicas of bronze weapons like daggers, spearheads and other blade-shaped items. This phenomenon, known at the Yankovskaya and Lidovskaya culture sites, requires further investigation to clarify the cultural provenance of the interesting stone imitations of metal objects.

To conclude, we have aimed to present a general introductory overview of the main developments in the Palaeometal Epoch in the southern parts of the Russian Far East. This article should not be regarded as a comprehensive description or interpretation of all the relevant archaeological records from the region. Many key aspects of this important cultural stage require further research and analysis.

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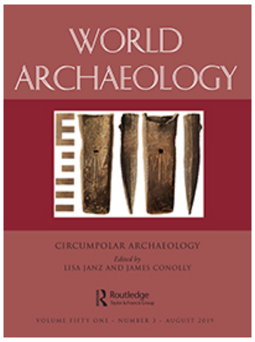

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Long-term marine resource use in Hokkaido, Northern Japan: new insights into sea mammal hunting and fishing

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ARTICLE

Long-term marine resource use in Hokkaido, Northern Japan: new insights into sea mammal hunting and fishing

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ABSTRACT
Based on examinations of archaeofaunal remains from 153 components from 122 sites in Hokkaido, Northern Japan, this study highlights that northern fur seals were the most important game for sea mammal hunting from the early Early Jomon (7000 calBP) and proposes a hypothesis that offshore hunting technology for hunting adult fur seals was established prior to the late Early Jomon (5800 calBP). This study also reveals that the importance of fishing for subsistence rapidly increased during the very end of the Final Jomon (2600 calBP) and the Early Epi-Jomon (2400 calBP–1800 calBP). Fishing focusing on bastard halibut and swordfish was actively conducted for status-building by Early Epi-Jomon fishers in some areas. Mortuary analyses indicate that ritual leaders were not necessarily capable fishers and/or hunters in the Jomon communities. However, during the Early Epi-Jomon, only successful fishers and/or hunters had the power to control rituals and the long-distance trade.

KEYWORDS
Sea mammal hunting; fishing; Jomon; Epi-Jomon; Hokkaido

Introduction

Hokkaido is located around the southern border of a sub-arctic environment in the Northwestern Pacific; its fauna includes brown bear, sea otter, salmon, halibut, and herring. Otariids seasonally migrate between Hokkaido and the neighbouring areas of the Kuril Islands, Sakhalin, and Kamchatka. Phocids such as ringed seal and harbour seal also inhabit the area, along with whales, dolphins, and killer whales. According to carbon and nitrogen isotope analysis of human bones and food crust on the ceramic surfaces, people in Hokkaido have highly depended on marine resources throughout the Holocene (Yoneda et al. 2002; Naito et al. 2010; Tsutaya et al. 2013; Kunikita et al. 2018). However, the trajectory of development in hunting and fishing and the social meaning of marine resource use remain poorly understood in this region. This study presents comprehensive new insights into these features through examinations of archaeofaunal remains, implements for hunting and fishing, and grave goods.

Materials and method

The analyses in this study are mainly based on a database of archaeofaunal remains, which contains information on animal bones collected thus far from 153 components of 122 archaeological sites in Hokkaido. Figure 1 shows the location of the representative sites examined in this study and six sub-regions based on geomorphological features and marine currents. The sequence of archaeological

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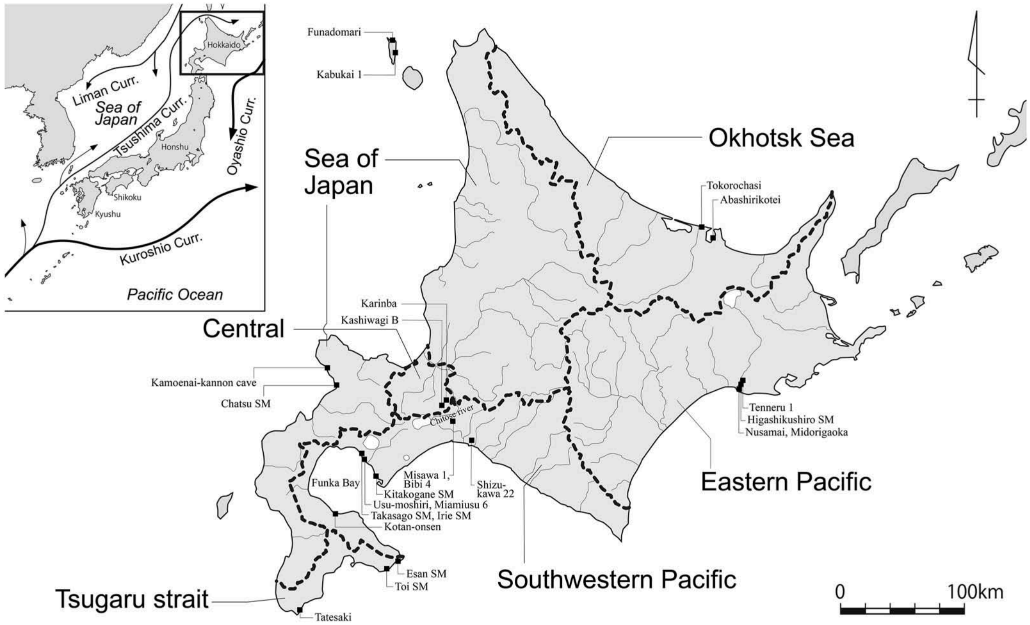

Figure 1. Map showing sub-regions and the location of sites.

cultures is shown in Figure 2. Although paddy rice cultivation was introduced in Western and Central Japan in the first millennium BCE, hunter-gatherer society persisted well into the Epi-Jomon cultures (fourth century BCE–sixth century CE) in Hokkaido. The Okhotsk culture, which contains artefacts similar to those of Sakhalin and the Lower Amur Basin, is regarded as somewhat exotic; its main bearers generally have been regarded as immigrants to Hokkaido, although they were eventually assimilated into the Satsumon culture, a direct ancestral culture of the Ainu. Currently, the Ainu culture is archaeologically recognized by the extinction of pit houses and clay vessels, and the beginning of the culture is dated to a period between the twelfth–thirteenth centuries CE.

This study examines spatio-temporal changes in the occurrence, species, sex, and age of excavated faunal remains. In addition, quantitative and qualitative data on hunting/fishing implements and grave goods were used to estimate the social meanings of food acquisition.

Results

Sea mammal hunting

More than 2800 harpoon heads have been discovered from mainly shell midden sites in the study area. Figure 3 shows the relationship between the number of harpoon heads and the ratio of sea mammal bones to terrestrial mammal bones in each region. A close relationship between these items indicates that sea mammals were hunted using harpoons, which might also have been used for catching large fishes. Although the oldest harpoon head in Hokkaido dates to the late Initial Jomon (7800 calBP), there is virtually no data on mammal remains from this period. However, sea mammal bones from the beginning of the Early Jomon (7000 calBP) have been found from midden sites.

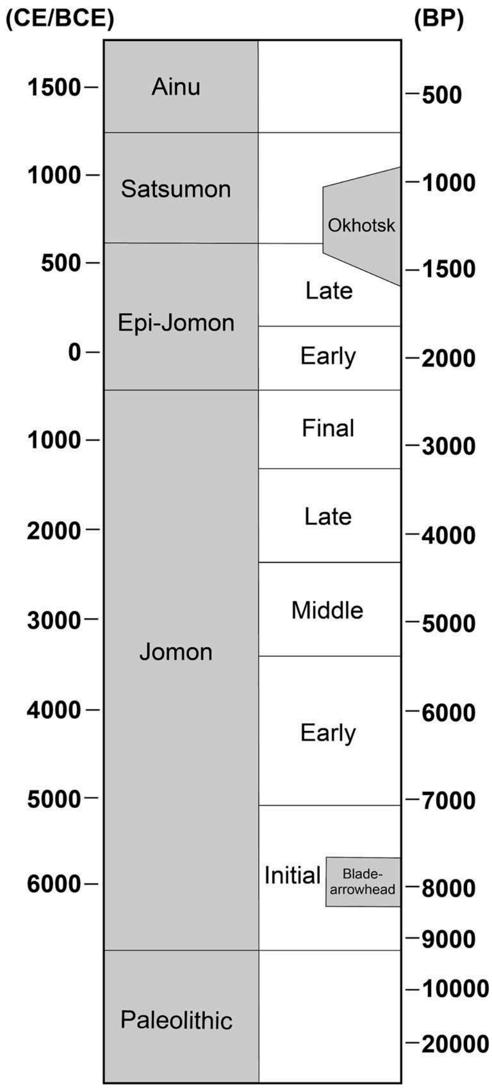

Figure 2. Chronological sequence in Hokkaido.

Figure 4 shows the species composition of sea mammal bones excavated from Hokkaido. Notably, the number of specimens for the Ainu culture period remains small, and most of the Satsumon specimens are from a single site, namely, the Aonae shell midden site on the Sea of Japan coast. As such, Japanese sea lion accounts for a considerable proportion of the archaeofaunal remains. Results relating to these two periods may be biased by the scarceness of data across sub-regions, but it appears evident that northern fur seal was the most important game for sea mammal hunting in the Jomon, the Epi-Jomon, and the Okhotsk cultures.

Figure 5 shows sex and age data of excavated northern fur seal remains in Hokkaido. Pups account for one-third to three-quarters of northern fur seal in the Southwestern Pacific. Currently, Funka Bay is one of the wintering places for northern fur seal pups, and archaeofaunal evidence indicates that they have migrated to this bay since at least the Middle Holocene. Killing them with a simple stick has been documented in modern examples in the Bering Sea (Elliot 1881; Scheffer 1970). This practice

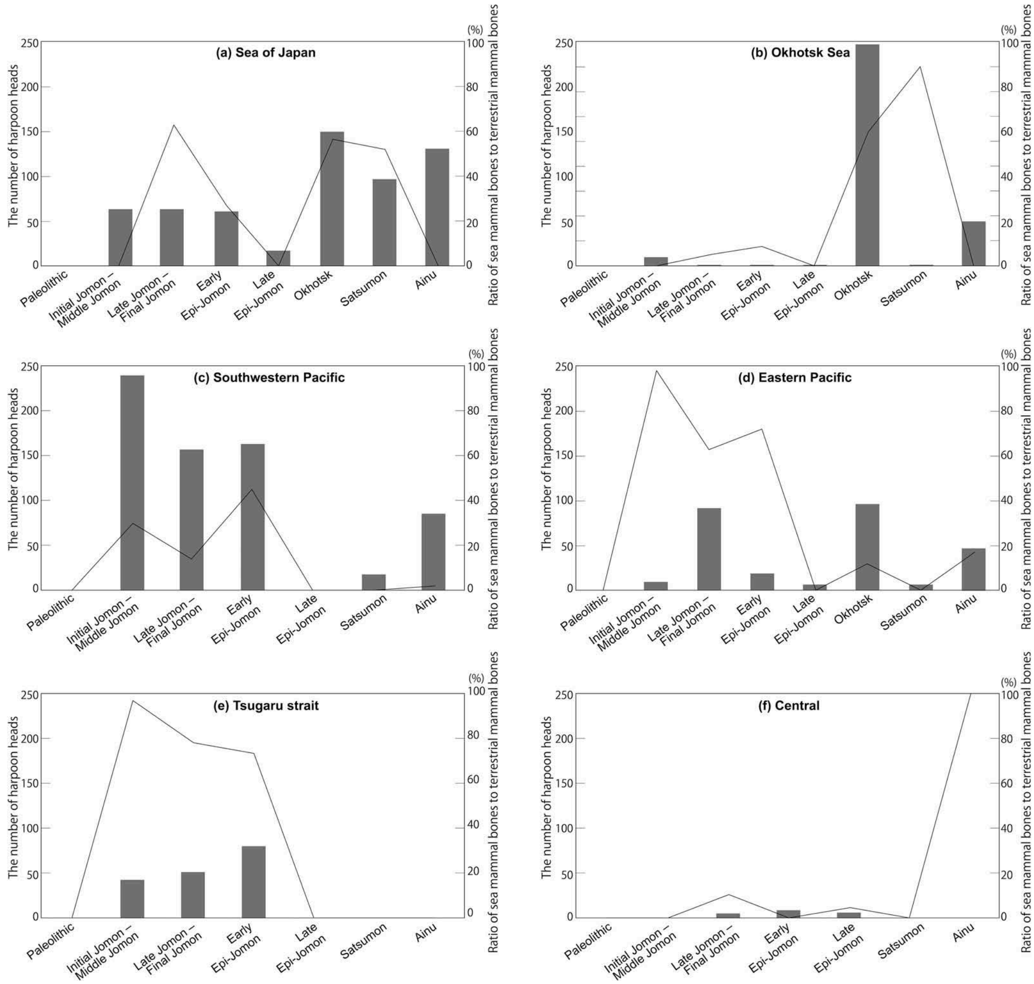

Figure 3. The occurrence of harpoon heads (bar) and the ratio of sea mammals in the entire mammal bones (line) in each region.

also has been postulated for ancient Hokkaido because northern fur seal pups occasionally land due to underdeveloped physical strength (Niimi 1990; Nishimoto 1993; Kami 2001; Takahashi 2008).

In contrast, adult and juvenile fur seals were the main targets of hunting in other areas. Surprisingly, adults and juveniles account for nearly all northern fur seal remains at the late Early Jomon (5800 calBP) shell middens at the Tenneru and Higashikushiro sites. Female remains tend to exceed those of males at sites in the Eastern Pacific and Tsugaru Strait, whereas males far exceed females in the Okhotsk Sea and Sea of Japan. Although fur seal's migration behaviour in the Middle and Late Holocene should be examined using archaeological materials in future studies, it remains unclear if such disparities were caused by sex-based differences in migration routes due to limited information on the life history.

Fishing

Archaeofaunal remains suggest that the importance of fish greatly increased from the very end of the Final Jomon (2600 calBP) and the Early Epi-Jomon (2400 calBP–1800 calBP) in the entire region.

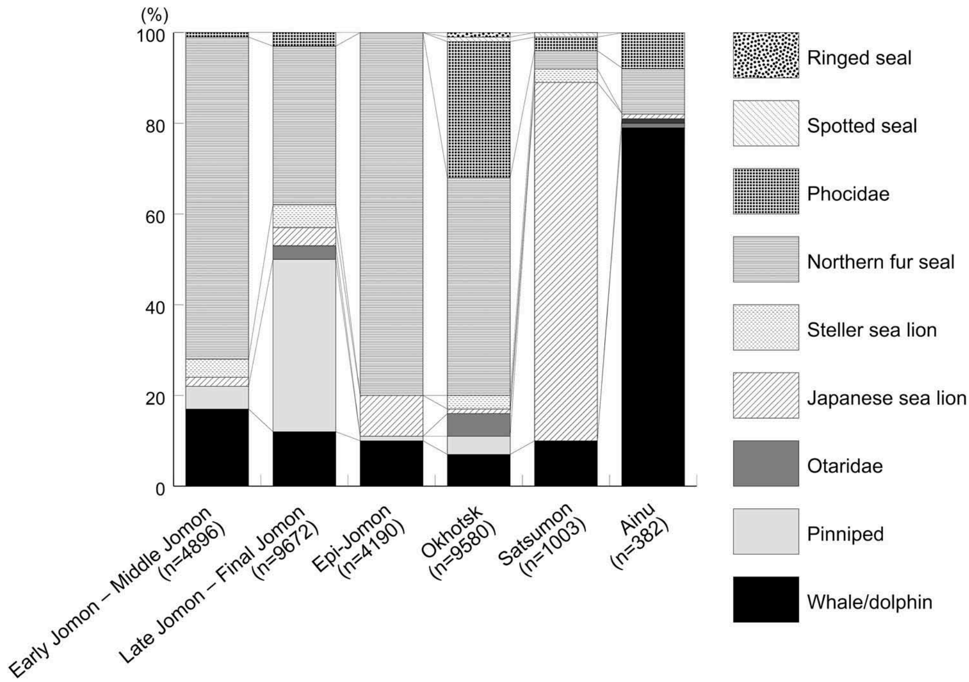

Figure 4. Sea mammals from archaeological sites in Hokkaido.

Figure 6 shows the occurrence rates of mammals, fish, birds, and shellfish at archaeological sites in Hokkaido with results from Central Hokkaido (a) and other areas (b) shown separately. With the use of water-flotation, even tiny bone fragments have been identified in Central Hokkaido site reports, in which the bone quantities are reported according to weight as opposed to the number of identified specimens (NISP), as is done in other areas. Mammal bone is dominant during the Late and Final Jomon in Central Hokkaido, whereas the proportion of fish rapidly increased from the very end of the Final Jomon and the Epi-Jomon, and this tendency continued in the Satsumon culture (Figure 6 (a)). Notably, nearly all fish bones in this region are identified as chum salmon (*Oncorhynchus keta*), and mammal remains mostly consisted of sika deer (*Cervus nippon yesoensis*). Fishing of chum salmon appears to have significantly increased at the very end of the Final Jomon and the Epi-Jomon, and the weight of fish bone accounts for about 40–70% of the entire faunal remains from this period. For example, in Central Hokkaido, 3867.516 g of faunal remains have been collected from sites of the very end of the Final Jomon and the Early Epi-Jomon, and weight of fish bone is 1507.848 g (39%). In the Satsumon culture, total weight of collected archaeofaunal remains is 1700.251 g. Among this, the weight of fish bone is 1160.199 g (68%).

In other areas, northern fur seals and sika deer were the dominant mammal species, and Clupeidae (mostly herring), Salmonidae (salmon), Gadidae (mostly cod), Scorpaenidae (scorpion-fish), Hexagrammidae (greenling), and flatfish were the major fish species. As in Central Hokkaido, the importance of fish rapidly increased at the very end of the Final Jomon and the Epi-Jomon; fish bones account for over 70% of faunal remains from this period (Figure 6(b)). Fish were also a significant part of the diets of the Okhotsk, the Satsumon, and the Ainu cultures.

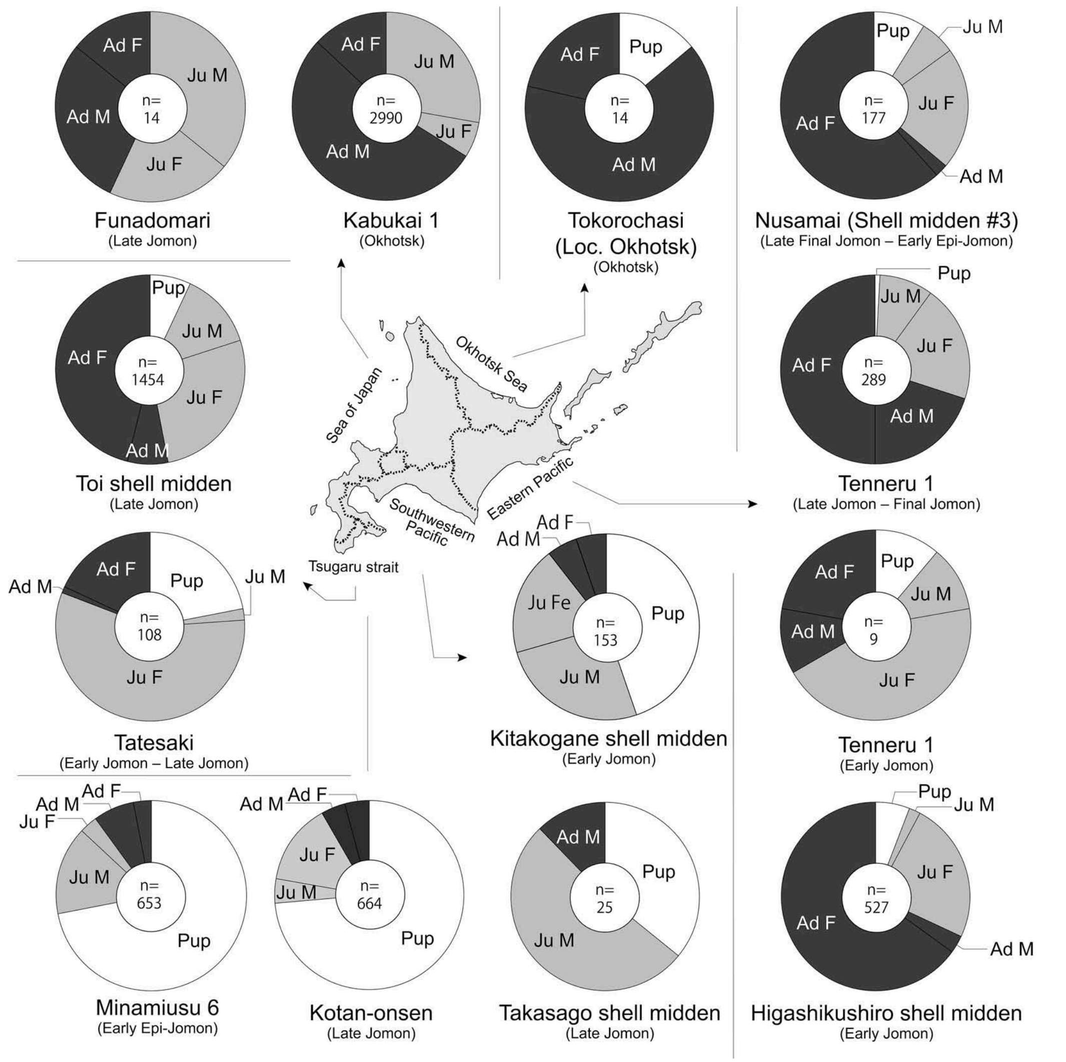

Figure 5. Age and sex of northern fur seal excavated from archaeological sites in Hokkaido (Ad: adult; Ju: Juvenile; PUP: pup; M: male; F: female) (Funadomari: Education Board of Rebun Town 2000; Kabukai1: Oba and Ohyi 1976, 1981; Tokorochasi: Graduate School of Humanities and Social Sciences The University of Tokyo 2012; Nusamai: Education Board of Kushiro City 1996, 1999; Tenneru: Hokkaido Center for Rescue Archaeology 2008, 2011; Higashikushiro shell midden: Takahashi 2010; Toi shell midden: Education Board of Toi Town 1993; Tatesaki: Hokkaido Center for Rescue Archaeology 2017; Kitakogane shell midden: Education Board of Date City 2013; Minamiusu 6: Sapporo Medical College 1983; Kotan-onsen: Education Board of Yakumo Town 1992; Takasago shell midden: Oshima and Dodo 1987).

Discussion

Development of sea mammal hunting in Hokkaido

Northern fur seals were the most significant sea mammal game in Hokkaido during the Jomon and Epi-Jomon cultures. Although this idea was proposed based on limited information collected from midden sites in the 1980s (Nishimoto 1984), it is supported by the quantitative examination on

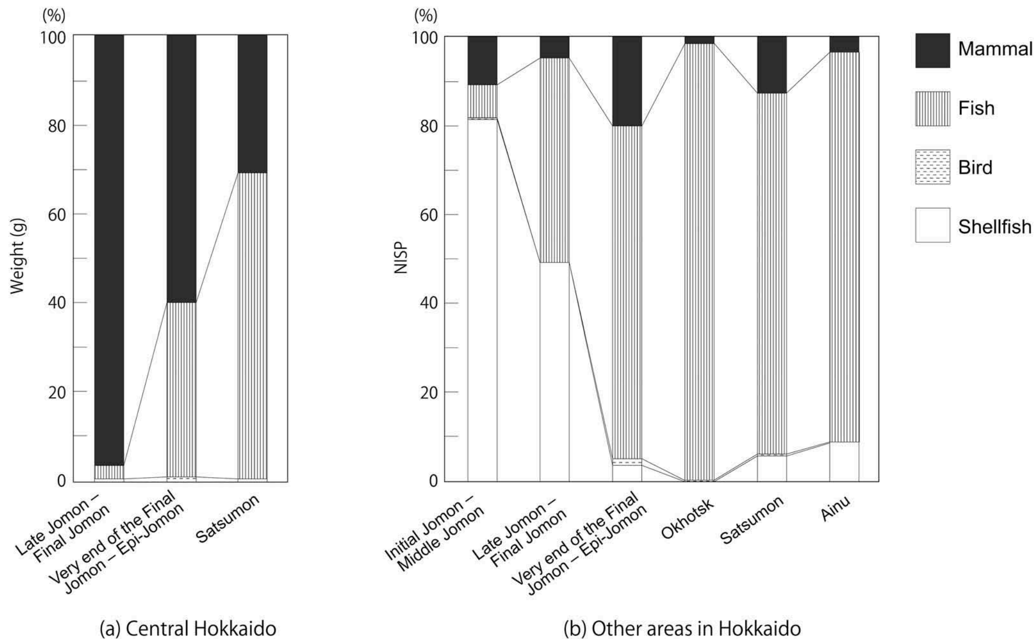

Figure 6. Composition of archaeofaunal remains in Hokkaido.

current archaeofaunal remains. Fur seal utilization focusing on pups was established in the Southwestern Pacific during the early phase of the Early Jomon (7000 calBP), whereas adult and juvenile fur seal hunting emerged in the late Early Jomon (5800 calBP) in the Eastern Pacific and possibly the Southwestern Pacific and Sea of Okhotsk. Technology for hunting adult and juvenile sea mammals expanded from the Pacific side to the Sea of Japan during the end of the Middle Jomon and the beginning of the Late Jomon (4500 calBP). These periods mark a formative stage in the development of sea mammal hunting in Hokkaido (Niimi 1990; Takahashi 2008).

There is no doubt that adult and juvenile fur seals were hunted using harpoons at least from the Early Jomon in Eastern Hokkaido. Kaneko (1973) classified Jomon toggle harpoon heads into two types: Type 1 is characterized by a pointed bone tip without a slit for a stone point (Figure 7.4, 5, 7–10, 13, 14), whereas Type 2 has a slit for inserting a point (Figure 7.1–3, 6, 11, 12, 15–16). These two types of harpoon heads coexisted from the Early Jomon to the Ainu culture, thus indicating that they were used for different purposes. Since Type 2 harpoon head has a heavier body and stronger penetration than Type 1, this tool was likely developed mainly for hunting large sea mammals such as adult fur seals, Steller sea lions, Japanese sea lions, and dolphins (Takahashi 2008). Thus, Type 2 harpoon heads in the Early Jomon, as well as archaeofaunal remains, demonstrate the existence of adult fur seal hunting from this period.

Two hypotheses can be proposed concerning Early Jomon hunting areas: first, adult and juvenile fur seals were hunted offshore. This notion is supported by behavioural and ecological patterns whereby modern adult and juvenile fur seals stay in open ocean preying on capelins, pollocks, mackerels, and squids during winter (Wada 1969, 1971; Gentry 1998). If the first hypothesis is true, then open sea hunting technology for adult fur seal had been established as early as the late Early Jomon. Alternatively, adult and juvenile may have been hunted in inlets formed during sea level rises associated with the climatic optimum, as Takahashi (2008, 42) speculated. However, adult and

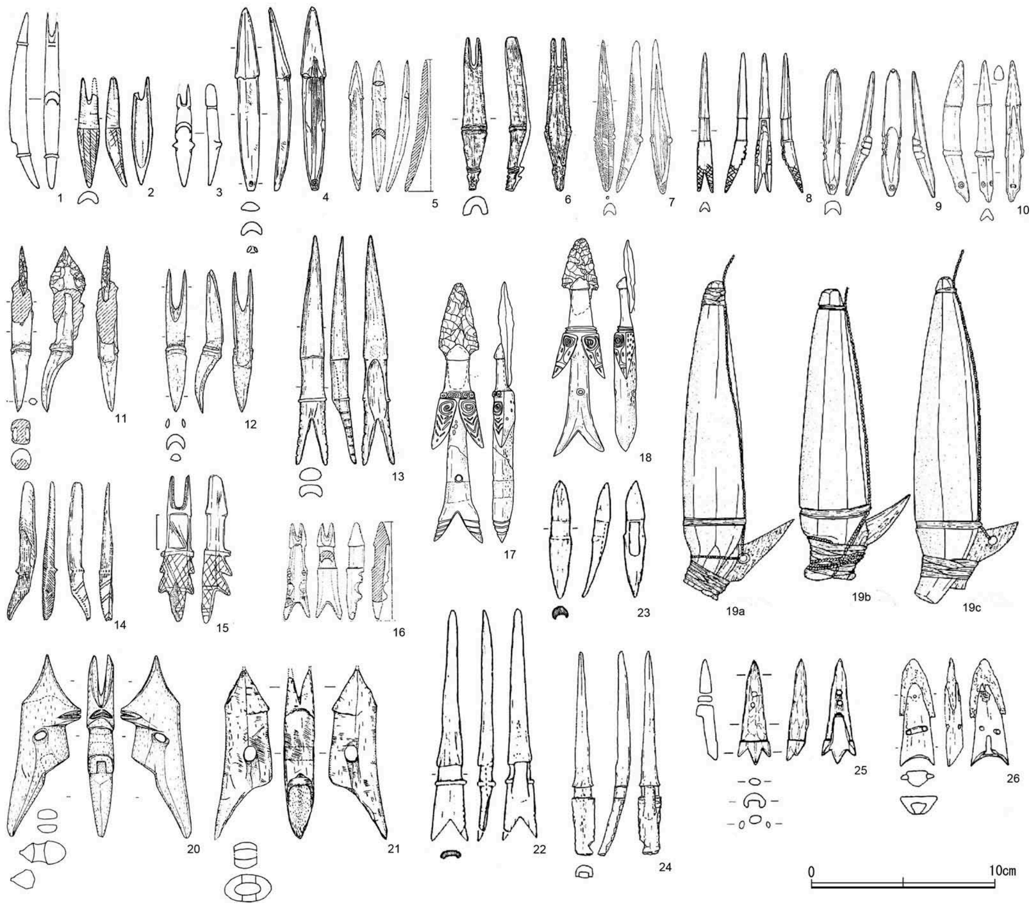

Figure 7. Harpoon heads and composite fish hooks using 'fish-shaped stone objects' in Hokkaido (1–5: the Early Jomon; 6–10: the late Middle Jomon to the early Late Jomon, 11–15: the Late Jomon; 16: the Final Jomon; 17–19: the Epi-Jomon; 20 and 21: the Okhotsk; 22–24: the Satsumon; 25 and 26: the Ainu) [1 and 5: Kitakogane shell midden (Kaneko 1973; Watanabe 1973b); 2 and 3: Higashikushiro shell midden (Kaneko 1973; Sawa 1974); 4: Shizukawa 22 (Education Board of Tomakomai City and Tomakomai Center for Rescue Archaeology 2002); 6: Chatsu shell midden (Institute for Cultural Properties in Hokkaido 1990); 7: Kotan-onsen (Education Board of Yakumo Town 1992); 8: Takasago shell midden (Education Board of Abuta Town 1998); 9 and 15: Irie shell midden (Education Board of Abuta Town 1994); 10: Toi shell midden (Education Board of Toi Town 1993); 11, 12 and 14: Funadomari (Education Board of Rebun Town 2000); 13: Midorigaoka (Sawa 1974); 16: Mitsuya shell midden (Watanabe 1973b); 17 and 18: Usu-Moshiri (Oshima 2003); 19: Estimated use of 'fish-shaped stone object' (Takase 1996); 20 and 21: Kabukai 1 (Oba and Ohyi 1976, 1981); 22–26: Kamoenai Kannon cave (Ishizuki 1983; Education Board of Kamoenai Village 1984; Chiyo 2003)].

juvenile fur seals are generally do not land during wintering (Gentry 1998), and they stay offshore around Northern Japan as well (Wada 1969, 1971). Considering modern fur seal behaviours, this hypothesis is highly improbable; however, it is worth using archaeological records to verify past life history patterns of northern fur seals from the viewpoint of historical ecology. For example, if currently unknown fur seal breeding and wintering spots previously existed in Hokkaido as argued in California (e.g. Burton et al. 2002; Newsome et al. 2007), or if they came into inlets chasing fishes into narrow gaps in rock reefs, then prehistoric people might have been able to hunt them in inlets. Thus, both hypotheses should be closely examined in future studies.

However, the author supports the former hypothesis for the following reason: the late Early Jomon coincides with a marine regression period when the coastline moved back to the present location in Funka Bay. Some lagoons formed by the climatic optimum remained in the Eastern Pacific as late as the Middle and Late Jomon; however, Old Kushiro Bay was already a narrow lagoon in the late Early Jomon, with an estimated length of less than 25 km and a width of less than 5 km. Thus, it is unlikely that many adult fur seals came to stay in the inlet. Manila clam (*Ruditapes philippinarum*) accounts for a considerable proportion (86.2%) of shells at the Higashikushiro midden located at the mouth of the lagoon, whereas Pacific oyster (*Crassostrea gigas*) comprises less than 1.2% of such remains (Takahashi 2010). Myida (*Myoida Goldfuss*) are dominant among shells at the Tenneru site located 5–6 km inland from the mouth of the lagoon. Thus, although a salt-water environment was still preserved in this inlet in the late Early Jomon, the bottom of the lagoon was likely sandy and the inlet was not very deep, representing a less hospitable environment for adult fur seals. Moreover, only a small number of fur seal remains at the Tenneru site are associated with the Early Jomon, whereas they are relatively abundant at the Higashikushiro shell midden site. The scarcity of fur seal bones at the former site implies that they were brought from other places rather than hunted in the lagoon. Notably, fur seal bones are numerous at Tenneru even among Late and Final Jomon assemblages, when the inlet was less than 5 km in length and less than 2 km in width (Kushiro City Archives of Local History 2008) and thus, too small and shallow to hunt adult fur seals. Abundant limb bones and the scarceness of trunk bones also support the likelihood that northern fur seals were not hunted near Tenneru during the Early and Final Jomon.

Therefore, the present study preliminarily supports a hypothesis that offshore hunting technology using harpoons was established in the late Early Jomon. Even in Southwestern Hokkaido, where pups were actively caught, adults and juveniles account for one-quarter to two-thirds of fur seal assemblages, indicating that offshore hunting was also conducted in the region (Figure 5). Northern fur seal was a familiar species for Jomon people on the Pacific side of Hokkaido because pups had been actively used from the early Early Jomon. Hunting technique for large sea mammals was also developed on the Pacific coast for hunting adult northern fur seals. During the late Middle Jomon and early Late Jomon, technology for hunting adult otariids diffused to the Sea of Japan. Archaeofaunal remains demonstrate that the population size of Steller and Japanese sea lions in the Sea of Japan was larger than the Pacific Ocean, indicating that offshore hunting of various large sea mammals was actively performed in the entirety of Hokkaido from this period. However, the lack of any significant change in species composition suggests that there were no new major innovations in hunting technology itself (Figure 4). Although minor improvements of harpoon heads can be seen during the Middle and Late Holocene, a major technological advance in sea mammal hunting was not achieved until the Satsumon culture, when metal points for toggle harpoon heads were introduced.

Understanding the development of sea mammal hunting in Hokkaido has a significant meaning for revealing its diffusion process in Northeast Asia. Yamaura (1996) proposed that sea mammal hunting technology diffused from the Amur River Basin to Hokkaido via Sakhalin. Although there are no ancient harpoon materials in the Amur River basin and Sakhalin, Yamaura focuses on the Blade-arrowhead culture (8400 calBP to 7800 calBP, Kunikita 2016) which spread from these regions and ultimately settled in Hokkaido. The oldest harpoon material in Hokkaido is an unfinished harpoon head from the Abashirikotei site, which may date as far back as 7800 calBP. In Hokkaido, harpoon heads of the Blade-arrowhead culture are poorly understood due to the lack of contemporary shell midden and bog sites; however, the presence of numerous stone net sinkers suggests that this culture was closely related to the exploitation of aquatic resources. Carbon and nitrogen stable isotope analysis of food crust on the ceramic surfaces indicates a higher dependence on marine resources for the Blade-arrowhead culture than for other cultures in the Initial Jomon (Kunikita 2015).

On the other hand, seasonal whale hunting was actively conducted from the end of the sixth millennium BCE in Western Japan (Kawamichi 2007). The Boisman culture, which is the earliest archaeological culture in the Primor'e exhibiting evidence of maritime adaptation, has been dated to ca.8300 calBP, well before the occurrence of active marine resource use in the Japanese Islands (Brodianski and Rakov 1992; Popov and Tabarev 2008; Popov, Tabarev, and Mikishin 2014). Although the relationship between the Boisman culture and marine resource use in Western Japan remains unclear, the earliest convincing data for maritime adaptation in the Northwest Pacific dates to between 9000 calBP and 7000 calBP (Fitzhugh 2016). In Hokkaido, sea mammal utilization emerged during this period, and, as indicated in this study, open ocean hunting technology was established in 5800 calBP. In future studies, examinations in the Lower Amur Basin and Sakhalin will be important to exploring the origin and expansion of sea mammal utilization in the Northwest Pacific. Sea mammal hunting was possibly conducted in these regions because there are breeding areas of otariids in these regions and it was easier to hunt them than in Hokkaido. However, if no strong evidence emerges of ancient sea mammal hunting in these regions, we must consider the hypothesis that it originated in Hokkaido.

Changes in fishing strategies over time

The importance of fishing in subsistence rapidly increased in Hokkaido between the end of the Final Jomon and the Epi-Jomon (Figure 6). Figures 8 and 9 show the species composition of fish remains in each region. In Central Hokkaido, salmon was consistently the main fishing game from the Jomon to the Ainu periods, and site distributions suggest that its importance to subsistence increased between 2600 and 2400 calBP in accordance with a higher dependence on fish resources. For example, Jomon sites in Sapporo were mainly situated in hilly areas or on terraces, whereas Epi-Jomon sites tended to be located on the natural levees in the alluvial lowlands where salmon spawning beds concentrate. Salmon was also a significant resource for the Jomon cultures in the Southwestern Pacific; however, this was a local tendency only observed in the Chitose River Basin (Figure 1), and its importance was much less in coastal areas. This micro-regionality and the small size of the Satsumon culture assemblage are reflected in the inconsistency between Figures 8 and 9. In Sea of Okhotsk, Clupeidae and salmon appear to have been important in almost all of the archaeological cultures. However, it is too early to conclude because the sample size is small in the Jomon, Epi-Jomon, and Satsumon cultures: it is still difficult to understand the trajectory of fish use in this region. Therefore, ethnographic reports on the importance of salmon resources in the Ainu culture (e.g. Watanabe 1973a) align with archaeological data from the Central and Chitose River Basin areas in the Southwestern Pacific.

However, Clupeidae, cod, scorpionfish, greenling, and flatfish were more important than salmon at some Jomon sites in the Sea of Japan and Eastern Pacific. Significant differences between Figures 8 and 9 in the Tsugaru strait suggest that the main fishing game differed from site to site, indicating that salmon was not significant for all Jomon settlements in this region.

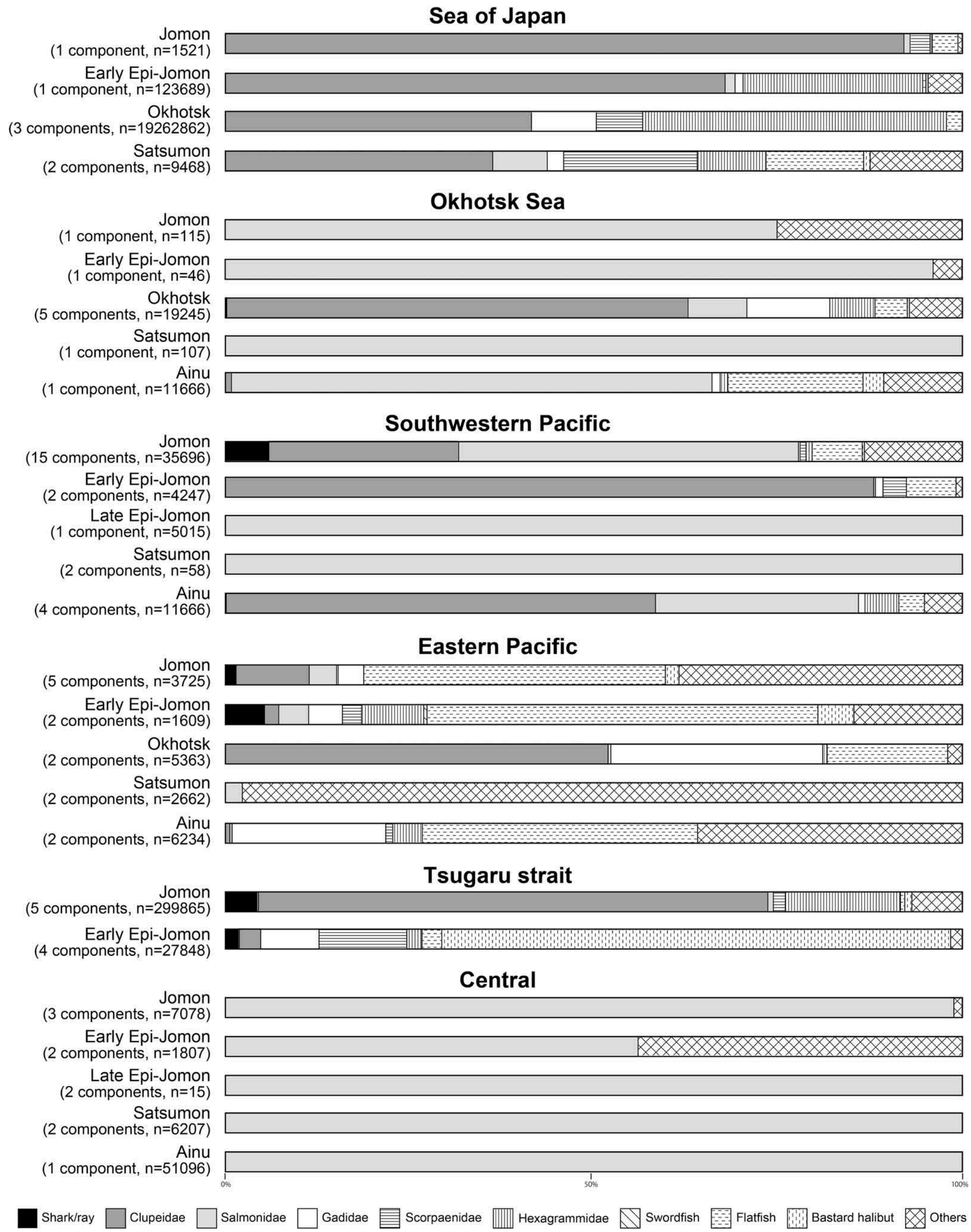

Figure 8. Fish composition in Hokkaido created by aggregating results reported based on NISP.

Although studies of Jomon subsistence patterns tend to emphasize the importance of salmon, particularly in Eastern Japan (Yamanouchi 1964; Okamura 2018), it was not necessarily the primary fishing game in all areas, even in Hokkaido. Salmon is also the main food resources for the indigenous peoples in the Northwest coast. However, it is not always the most important fish in all areas; herring, flatfish, scorpionfish, and cod are more important than salmon in some areas

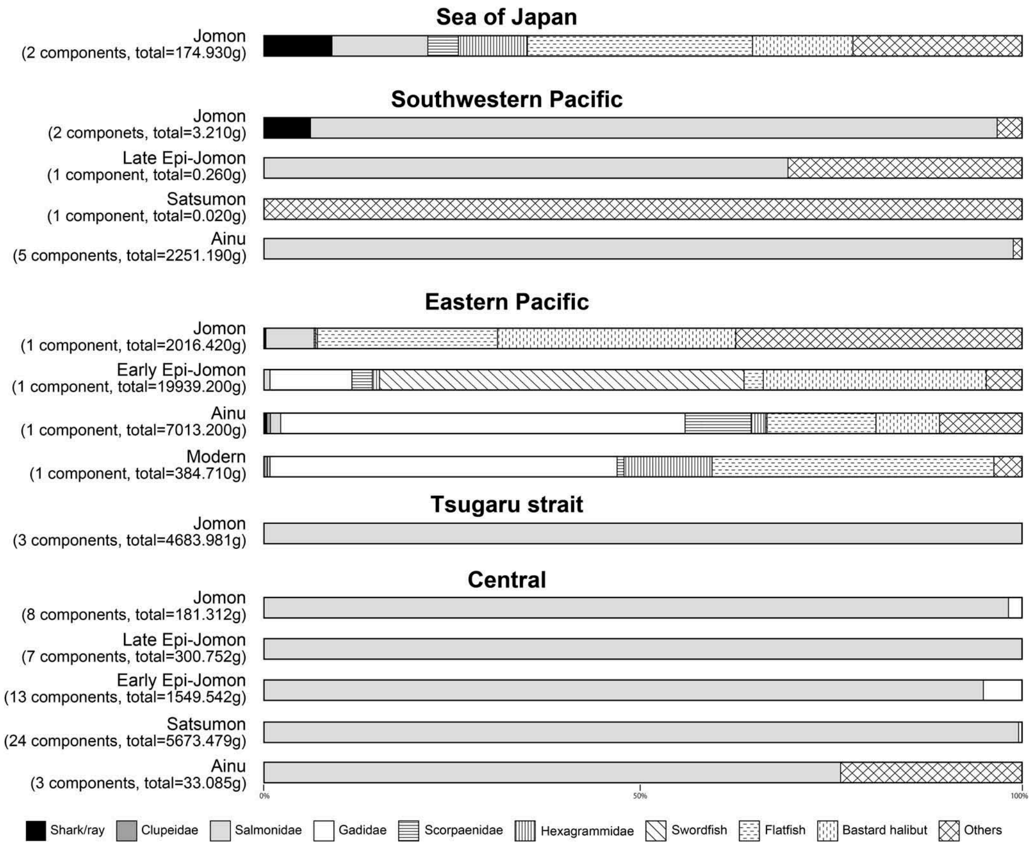

Figure 9. Fish composition in Hokkaido created by aggregating results reported based on weight.

(McKechnie and Moss 2016). In Southeast Alaska, the importance of salmon rapidly increased from 1100 CE, while herring and cod had critical significance between 1900 BCE and 800 CE (Ames and Maschner 1999). Archaeological evidence from the North Pacific indicates that ethnographically documented indigenous economies highly dependent on salmon cannot necessarily be extended to the Early and Middle Holocene.

Patterns of Early Epi-Jomon fishing also raise an issue regarding the social meanings of this activity. Swordfish (*Xiphias gladius*) is among the top-ranked species associated with the Early Epi-Jomon in the Eastern Pacific (Figure 9); however, such fishing is not be seen at Jomon sites. Bastard halibut (*Paralichthys olivaceus*) accounts for two-thirds of fish bones at Early Epi-Jomon sites in the Tsugaru strait, and reconstructed body sizes from 60 to 100 cm (Figure 10) suggest a focus on larger fish because the maximum size of this species is approximately 100 cm.

Large bastard halibuts were likely caught using a fish-shaped stone object, a short-life tool with composite fishhook shank, sinker, and lure functions that emerged and vanished during the Early Epi-Jomon (Takase 1996). The length of this tool ranges from 10 to 30 cm; thus, as shown in Figures 7.19, composite fishhooks using this implement can be very large. This tool was made using various kinds of stone materials such as shale, tuff, mudstone, sandstone, and schist, and its wide morphological range indicates that fishers experimented to find the ideal material, shape, and size to catch larger bastard halibuts. This evidence suggests that catching large bastard halibuts was an important means for status-building in the society (Takase 2014), and similar significance can be attributed to swordfish fishing in the Eastern Pacific. Competitive relations among fishers encouraged the improvement of fishing gear for catching large bastard halibut.

It is still unknown why bastard halibut became an increased centre of focus in Early Epi-Jomon economy. It is not a dangerous fish to catch along the coast during the egg-laying season in spring and summer. There is no clear evidence showing that this fish was exported to Honshu Island. If fish were used as trade goods in these earlier periods, salmon, not bastard halibut, would have been the more desirable resource, as we see in later periods. Around Hokkaido, other large flatfish such as barfin flounder (*Verasper moseri*) and Pacific halibut (*Hippoglossus stenolepis*) are also available. However, Epi-Jomon people did not show any interest in these species, focusing instead on technologically specialized fishing of large halibut.

Similarly, elaborately decorated large harpoon heads indicate that hunting sea mammals using luxury gears also works as a strategy to gain social prestige for hunters (Figure 7.17 and 18). Certainly, decorated and oversized harpoons must have been used to gain social prestige for hunters, or perhaps even as display of earned status. This highly decorative gear was not just for display, but was also used as attested by the presence of broken decorated and large harpoon heads in shell midden sites. It is notable that the utilization of large and elaborately ornamented harpoons in the Epi-Jomon culture was not associated with an increased proportion of adult and juvenile fur seals (Figures 5, 7.17, and 18). Thus, the emergence of luxury harpoon heads was not necessarily related to a significant advance in hunting technology, but rather, can be regarded as a result of status-building among hunters/fishers.

Nevertheless, fishing based on salmon and Clupeidae replaced an emphasis on bastard halibut near the beginning of the Late Epi-Jomon (1800 calBP-1350 calBP). As such, these specialized fishing activities in the early Epi-Jomon were short-lived. Resource decline of large bastard halibut due to

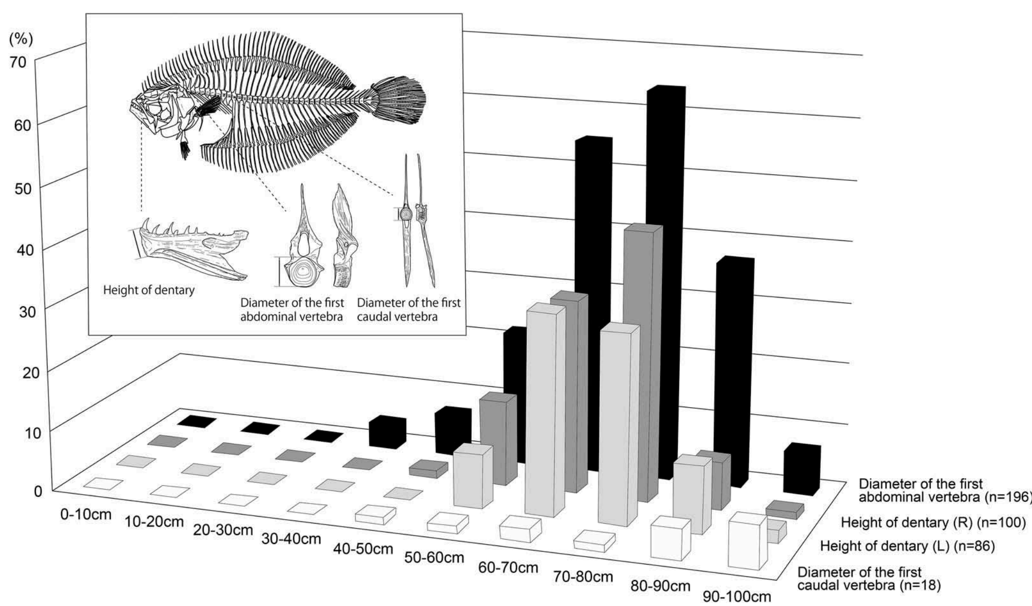

Figure 10. Result of size reconstruction of bastard halibut using dentary bones and vertebrae from the Esan shell midden (modified from Takase 2014).

overexploitation is not conceivable because there is no evidence for a decrease in body-size over time. Another possible reason for the decline in the procurement of this species is the increased importance of trade in the Late Epi-Jomon. During this period, artefacts and graves of the Epi-Jomon can be also seen in northeastern Honshu, indicating that Epi-Jomon people often visited north-eastern Honshu and some of them lived there to get iron tools through trade. Archaeofaunal remains from Central Hokkaido strongly suggest that salmon was one of the most important resources for trade as well as hide indicated by a number of obsidian end scrapers. In the Late Epi-Jomon, catching and processing sites of salmon have been also excavated (Ishii 1998; Takase 2014). Thus, it is notable that completely different fish use can be seen in a wide area of Hokkaido between the Early and Late Epi-Jomon. Therefore, it seems likely that salmon replaced bastard halibut because the importance of iron tools was rapidly increasing and salmon was useful in both subsistence and trade. As such, fishing activities during the Epi-Jomon are unique compared to other Jomon cultures.

Social implications of specialized fishing strategies

Fishing and hunting skills provided a means to evaluate the abilities of community members. Successful fishers and hunters could obtain high status and had access to luxury goods introduced by long-distance trade. Representative exotic elements of the Early Epi-Jomon include shell beads and bracelets produced more than 2000 km from Hokkaido in the Southwestern Islands, as well as tube beads produced in the early agrarian society of Western and Central Japan. Imported prestige goods were commonly interred in graves at the Usu-moshiri cemetery site as Figure 11 shows, along with many hunting and fishing implements (arrowheads, harpoon heads, stone points for harpoons, fish-shaped stone objects, fishhooks, etc.) and processing tools (stone adzes, various scrapers and knives, etc.). In contrast, few fishing and hunting tools are present in graves that lack prestige goods at this site.

The mechanism to attain access to luxury goods and long-distance trade through fishing has not been thoroughly revealed. The scarceness of bastard halibut bone in Honshu indicates low demand on this fish, thus the author expects that bastard halibut was not exported from Hokkaido as mentioned above. In addition, fish processing stations have not yet been discovered in the Early Epi-Jomon. Instead, we should pay attention to lithic raw material such as greenschist and obsidian exported from Hokkaido. In northeastern Honshu, considerable proportion of stone axes and adzes were made of greenschist collected in Central Hokkaido (Sato 2016: Sato et al. 2016). Chemical analysis suggests that obsidian brought from Eastern Hokkaido was used in northeastern Honshu (e.g. Takase 2012). Although bastard halibut was not necessarily trade goods for exporting to Honshu, capable fishers gained high status through fishing and could take control of short-distance trade in Hokkaido, and then gain access to exotic elements through long-distance trade. Power for controlling long-distance trade was competitively exploited among the most successful fishers.

Figure 11 also presents examples of graves in the Late and Final Jomon. During this period, prestige goods included ceremonial maces and ornaments such as lacquer products and stone beads, thus suggesting the conferring of ritual power upon associated individuals. The relationship between graves with prestige goods and hunting/fishing tools is not very close at Jomon sites, while hunting/fishing tools can be frequently seen in graves without prestige goods. Processing tools, mostly stone axes/adzes, were commonly associated with prestige goods; however, these were not necessarily special grave goods because they were also associated with graves lacking prestige

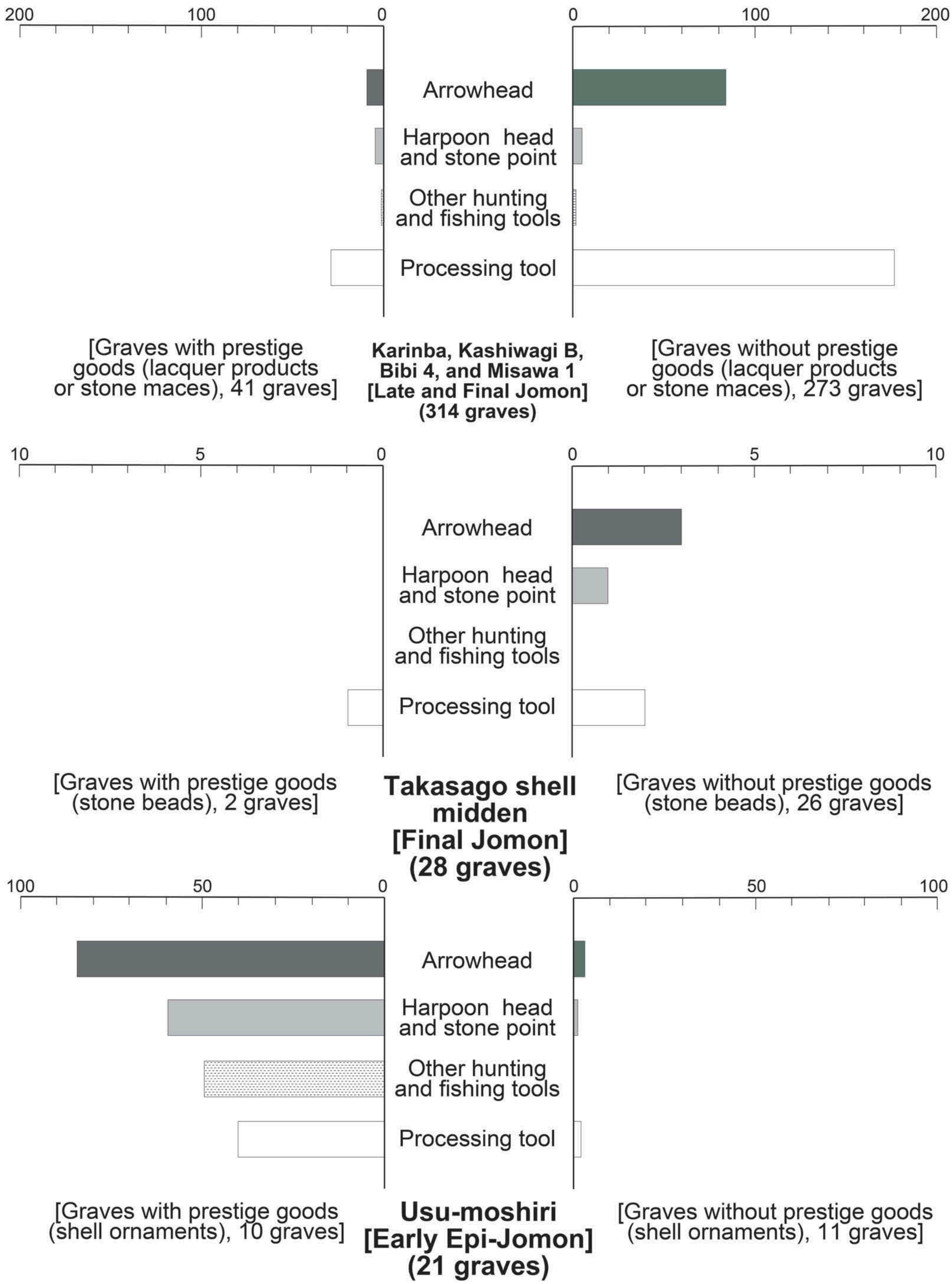

Figure 11. Grave goods from the Late Jomon to the Early Epi-Jomon (Education Board of Eniwa City 1981; Education Board of Hokkaido 1977, 1979; Uwaya 2003).

goods. A t-test of the occurrence of hunting and fishing tools per grave pit derived from data provided in Figure 11 indicates that there is a correlation between the existence of prestige goods and hunting/fishing tools in the Early Epi-Jomon ($p = 0.023$), while there is not such a correlation in the Late and Final Jomon ($p = 0.774$).

It is reasonable to conclude that people interred with prestige goods likely played important roles in rituals during the Late and Final Jomon because they have buried with ceremonial goods. However, there is no clear evidence showing that they were also capable fishers and/or hunters since hunting and fishing tools were not necessarily special grave goods for them. In contrast, successful fishers and hunters controlled wider aspects of the society during the Early Epi-Jomon in the Southwestern and Eastern Pacific areas of Hokkaido. In addition to numerous exotic goods imported from Southwestern and Central Japan, the internments of such individuals included ritual objects such as bone spoons with bear and whale decorations, bear sculptures (probably used for head belts), and long, ornamented needles (likely used for binding hair). These grave goods are regarded as the property of buried individuals, with the increasing number of grave goods in the Early Epi-Jomon suggesting the development of individual ownership (Aono 1999). This opinion is supported by human bones wearing shell ornaments imported from the furthermost areas. Moreover, a wide variety in morphological features of fish-shaped stone objects suggests that they were also produced and owned by each fisher. Possibly, they never gave and distributed this tool to other fishers because they personally took a process of trial and error to make an effective fishing implements for catching large bastard halibuts. Not only ornaments but other kinds of grave goods were owned by buried people. Therefore, individuals with abundant hunting and fishing gears, ornaments, and ritual implements are both successful fishers and/or hunters and considered qualified to control rituals and trades. Contrastingly, the gap of grave goods in the Late Epi-Jomon is much smaller than that of the Early Epi-Jomon; fishing focusing on salmon in this period is not closely related to status building. Although trade increased during this time, it seems like that competitive relationships between fishers declined. This suggests that catching salmon for trade was a communal activity, while hunting bastard halibut was an individual enterprise.

Ethnographic models of Melanesia as well as the Northwest have been often used for interpretations of inequality in Jomon societies (e.g. Takahashi 2005). Compared to models on social complexity in Melanesia, important persons of the Epi-Jomon have similar features to big-men (Sahlins 1963) because they are characterized by the accumulation of wealth through controlling trade and exchange as well as special abilities regarding subsistence and rituals. On the other hand, important persons of the Jomon seem to correspond to great men (Godelier 1982) because they played a significant role as ritual leaders which is one of the categories of occupation for great men, but they were not necessarily capable hunters/fishers and did not tend to accumulated personal property. However, further studies are needed as there is a large difference in the social situation, such as the existence of war, assassination, livestock, and farming between prehistoric Hokkaido and the modern societies in Melanesia. Moreover, the redistribution in the Epi-Jomon has not yet been clarified, although it may have had a critical meaning for the status of big-men in that society.

Nevertheless, the evolving social implications of hunting and fishing activities could provide an effective perspective for understanding the development of the prehistoric society in the Northwestern Pacific. Ethnographic evidences suggest that the social roles of catching large fishes and sea mammals encompass both food acquisition and status-building (Watanabe 1990; Anzai 2002; Takahashi 2008). However, this is not a general truth across all maritime hunter-gatherer societies because major shifts in the social meaning of fishing and hunting activities appear to have occurred between the Jomon and Epi-Jomon periods in Hokkaido. Furthermore, there is no large change in graves and grave goods at cemetery sites of the Early Jomon when technology for hunting sea mammal was established. Thus, it is difficult to determine if there was an increase in the power of hunters and fishers in accordance with the emergence of sea mammal hunting in Hokkaido. Hunting and fishing mastery was not required to enforce rituals in Jomon societies, whereas it represented an essential qualification for controlling both rituals and trade in Early Epi-Jomon communities.

In Hokkaido, some researchers have concluded that the social stratification can be seen in the Late Jomon based on examinations of cemetery sites (Inui 1981; Yabuki 1985; Seagawa 1983; Segawa 2007; Kimura 2003; Sakaguchi 2011; Uwaya and Kimura 2016). They have noted the earthwork burial circles, communal cemeteries with a circular embankment, emerged in the late Late Jomon. The maximum diameter of an embankment is approximately 80 m, suggesting a large-scale cooperative activity in the community. Although some archaeologists do not regard them as an evidence of the social stratification (Harunari 1983; Hayashi 1983; Fujiwara 2007), researchers have estimated that chiefs were buried in the centre and inside of these cemeteries, and based on the quantitative and qualitative differentiation in grave goods, it seems likely that a stratified society continue to the Early Epi-Jomon. However, the scarceness of excavations and the lack of human bones from these cemeteries has made it difficult to ascertain the social role of the important people buried within them. Thus, this study is significant in terms of clarifying the foundation for and benefits of status-building within Jomon and Epi-Jomon cultures, and serves as a starting point for future studies on the social roles of important people in these societies.

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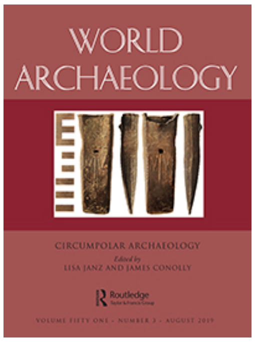

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Biogeography and adaptation in the Kuril Islands, Northeast Asia

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Biogeography and adaptation in the Kuril Islands, Northeast Asia

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ABSTRACT

The Circumpolar North is generally recognized as a challenging environment to inhabit and yet, we know relatively little about how people managed their welfare in these places. Here, we add to the understanding of maritime hunter-gatherers in the subarctic North Pacific through a comparative approach that synthesizes biogeographic and archaeological data from the Kuril Islands. We conclude that our faunal, ceramic and lithic evidence support expectations from biogeography as assemblages from low biodiversity and insular regions show limited diet breadth, more locally produced pottery and a conservation of lithic resources. However, we highlight that these ecological factors did not strictly determine the occupation history of the archipelago as radiocarbon data suggests all regions experienced similar demographic fluctuations regardless of their biogeography. These results imply additional pressures influenced the strategic use and settlement of the Kuril Islands and the need for increased chronological resolution to disentangle these complex historical factors.

KEYWORDS

Archaeology; biogeography; Kuril Islands; hunter-gatherers; Circumpolar

1. Introduction

Maritime hunter-gatherers can be broadly defined as those groups whose subsistence relies primarily on wild resources extracted from the sea. However, given that many northern regions have had an only intermittent human presence (Hoffecker 2005; Friesen and Mason 2016) and have been less intensively studied, the archaeological record of Arctic and sub-Arctic maritime hunter-gatherers is often scant. This is unfortunate as the archaeology of northern foragers presents valuable opportunities to study long-term interactions between humans and their environments. This is especially true given the challenging climates, inherent instability of high-latitude ecosystems and their reliance on local resources for survival (Damm et al. 2019).

Here, our approach is to compare archaeological and radiocarbon evidence from maritime hunter-gatherers that inhabited a subarctic landscape: the Kuril Islands, an archipelago that stretches from the northernmost Japanese island of Hokkaido to the southern tip of the Kamchatka peninsula (see Figure 1). We start from the well-established premise that islands make good areas for studying historical hunter–gatherer relationships to ecological variability (Keegan and Diamond 1987; Vitousek 2002; Fitzpatrick and Keegan 2007; Kirch et al. 2007; Rick 2007; Braje

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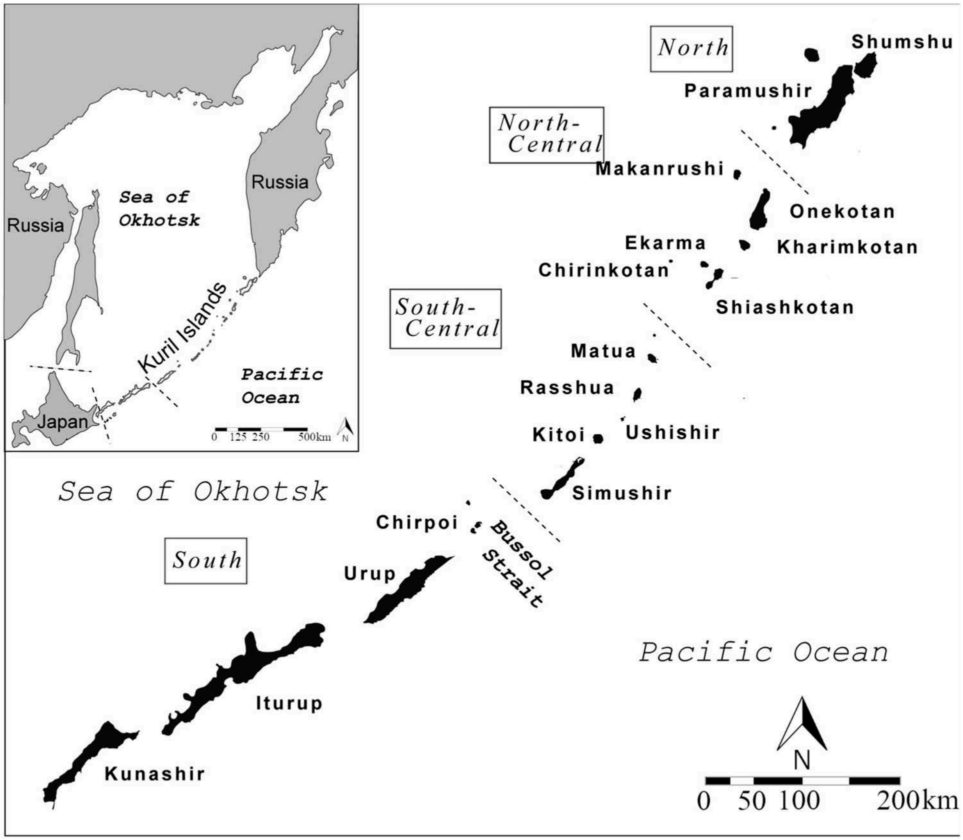

Figure 1. Map of Kuril Islands showing major islands and biogeographic regions discussed in the text with major straits labelled with dashed lines (Map is redrawn from a base-map by Adam Freeburg and adapted from Fitzhugh et al. 2016).

et al. 2017; DiNapoli and Morrison 2017; DiNapoli and Leppard 2018). This is not because hunter-gatherer behaviours are determined in any simple sense by geography, but because differences within island chains structure differences in the character of environmental challenges that settlers had to manage strategically and often socially (Fitzhugh and Hunt 1997; Lape 2004; Lawson et al. 2005; Fitzpatrick and Anderson 2008; Fitzhugh, Phillips, and Gjesfjeld 2011; Hudson, Aoyama, and Hoover 2012; Leppard 2015; Giovas 2016).

The analyses presented here follow predictions drawn from biogeographical principles predicting the vulnerability of populations based on their geographical and ecological circumstances related to island contexts (Fitzhugh and Hunt 1997; Brown and Lomolino 2000; Steadman 2006). Brown and Lomolino (2000) show how simplistic biogeographical predictions do not apply cleanly or linearly in biology. In addition to simple distances (dispersal filter) and area (habitat availability/heterogeneity) relationships, factors such as the dispersal ability and migratory range of taxa, their reproductive rates, habitat requirements, tolerance for seasonal variability, degree of generalist versus specialist adaptations are all important factors in local ecological diversity and resilience. As Fitzpatrick et al. (2007) observe, biological and archaeological research has successfully challenged the more deterministic ecological predictions of early island biogeography expectations without undercutting the more general utility of the approach. The early models, applied both to human and non-human populations, took too little account of variations in physical, biological, and cultural characteristics such as ocean currents, climatic conditions, dispersal abilities, energetic needs, and for humans, such considerations as seafaring technologies, political organization, and belief systems.

We use the principles of island biogeography in this study for heuristic and comparative purposes under the assumption that humans, like other species, face increased risks of starvation and population decline or extinction when confronted with periodic and unpredictable subsistence failure that they are unable to mitigate through diversification, storage, mobility, or trade. All else being equal, remote islands present more limited opportunities for colonization and small islands have fewer habitats to support taxonomic diversity. As a result, islands that are both small (or more precisely, that have more limited habitat area to support biotic production and diversity – terrestrially and/or in surrounding marine zones) and far from the source of biotic replacement are more hazardous for settlement by hunter-gatherers who depend on locally available flora and fauna for their livelihoods. While humans develop a range of strategies to overcome these risks, they are not immune to them, and archaeological evidence should provide a window through which to examine how people managed these risks and how they sometimes failed to do so.

These principles lead to a range of archaeological expectations for the histories of hunter-gatherer groups settling islands of varying geographic and ecological characteristics. For example, one can expect the settlement to occur sooner on islands closer to source mainlands. More remote settlement, especially on smaller islands (islands of reduced habitat and productivity), should be limited to those equipped to invest in more intensive production, higher mobility, or more social and economic networking over longer distances. Social networks are particularly important where local populations are small so as to maintain sufficient access to marriage partners and to compensate for the greater risk of relying on vulnerable (low diversity) local ecosystems. Larger islands (larger habitats), in general, should support more sustainable settlement, while small and remote islands might be abandoned and reoccupied more frequently.

We build from this foundation to address three key questions using previously unreported analyses of zooarchaeological, artifactual, and radiocarbon evidence:

- How mobile were populations living in the Kuril Islands?
- Do biogeographical and ecological differences relate to regional differences in the occupation and cultural history of the archipelago?
- Do more remote and ecologically precarious islands show more punctuated occupation histories compared to others?

Broadly speaking, we see these questions as helping to evaluate the extent to which the settlement of the Kuril Islands was a risky prospect for small, maritime hunting and gathering communities. We attempt to answer these questions in part by evaluating the degree of human resilience documented by archaeological continuity in comparison with regional differences in remoteness, access to outside/mainland resources and networks, and biogeographic richness and abundance. Furthermore, we anticipate that hunter-gatherer peoples commonly develop effective strategies for mitigating environmental risks through the diversity of their harvesting practices, logistical and residential mobility, and the intensity and structure of their social networks. Here, we report the results of zooarchaeological and artefact analyses relevant to addressing these questions and to a broader understanding of how maritime hunter-gatherers managed the challenges of subarctic landscapes.

2. The Kuril Islands

The Kuril archipelago is a volcanic island arc consisting of approximately 32 islands that stretch from the island of Hokkaido, Japan to the Kamchatka peninsula, Russia. From 2006 to 2010, this chain of islands was the focus of Kuril Biocomplexity Project (KBP) field research, which broadly aimed to explore the history of occupation and interaction within the context of a remote, island region (Fitzhugh 2018). Building from a human ecodynamics foundation, KBP developed a multidisciplinary understanding of how changes in socio-ecological systems altered the stability and resilience of Kuril human populations in the past. The broad methodological scope of the project incorporated experts in marine geology, volcanology, palaeoclimatology, palaeobotany, and archaeology. The research presented here also builds from archaeological work performed in 2000 in collaboration with the International Kuril Islands Project (IKIP) as well as the more recent Kuril Ainu Archaeological Project (KAAP).

Some of the most significant features of the Kuril archipelago are the dramatic differences in both terrestrial and aquatic/marine biogeography between islands at the ends and centre of the archipelago (see Figure 1). Due to a combination of larger landmass and closer proximity to Hokkaido, the southern islands maintain a much higher level of biodiversity (Pietsch et al. 2003). This includes many different types of trees and shrubs (Anderson, Lozhkin, and Minyuk 2008), insects, molluscs, and fish (including anadromous salmonids) (Pietsch et al. 2001, 2003; Fitzhugh et al. 2016) and terrestrial mammals including bears, hares, weasels and rodents (Hoekstra and Fagan 1998). Likewise, Paramushir and Shumshu in the North have occasional large terrestrial animals that swim over from Kamchatka and rivers large enough to support anadromous salmonid populations. The islands at the ends of the archipelago are also large enough to develop a diverse range of intertidal and benthic communities and a greater variety of marine animals that feed on them. In contrast, the islands in the central part of the archipelago have relatively depauperate terrestrial ecosystems (Hoekstra and Fagan 1998; Pietsch et al. 2003) and lack anadromous fish streams/rivers.

To facilitate our comparative approach, we partition the Kuril Islands into four regions: South, South-central, North-central and North (see Figure 1). The boundaries between these regions are largely based on the biogeographical differences highlighted above. The South region includes islands up to the Bussol Strait and is characterized by greater biodiversity and closer proximity to Hokkaido. The South-central and North-central regions extend North from the Bussol Strait to the strait that separates the islands of Onekotan and Paramushir (occasionally referred to as the 'Fourth Strait'). These islands, also referred to as the 'remote islands' (Gjesfjeld 2019), are substantially smaller in size, maintain much lower biodiversity and are more geographically isolated. The North region is largely comprised of the islands of Paramushir and Shumshu, which has higher biodiversity than the South-central and North-central regions, but lower than the South region.

The geographic configuration of the Kuril Islands, in combination with varying local ecologies, provides a unique opportunity to explore the influence of biogeography on the human occupation of the region. Our starting expectations suggest that settlement of large islands with greater biodiversity and that are closer to the population centres of Hokkaido and Kamchatka should have higher rates of immigration and a greater degree of archaeological and faunal diversity (Fitzhugh et al. 2004). Conversely, smaller islands farthest from source areas with lower biodiversity are viewed as being more precarious and likely to have lower archaeological and faunal diversity, as well as higher rates of both population immigration and extinction.

The earliest evidence of human occupation in the Kuril Islands dates to around 8000–7600 calBP and can be found at the Yankito site complex on the southern island of Iturup (Yanshina and Kuzmin 2010; Kuzmin et al. 2012). The northernmost island of Shumshu also appears to have been settled, at least intermittently by 6000 years ago, probably from Kamchatka, by crossing the relatively narrow First Kuril Strait (Fitzhugh et al. 2016; Takase et al. 2017). The first prolonged occupation of the more remote islands North of the Bussol strait and south of Shumshu is associated with the Late/Final Jomon and early Epi-Jomon cultural phases as defined in Hokkaido (Fitzhugh et al. 2016). The more intensive occupation of the remote islands (up to Shiashkotan Island) by Epi-Jomon populations is particularly notable, as this culture is commonly recognized as an extension of Jomon hunter-gatherer culture (from the south) but with greater intensification on marine mammals and improved harpoon technology (Okada 1998; Fitzhugh et al. 2016). The Epi-Jomon culture of Hokkaido was quite different in subsistence and settlement patterns to the earlier Jomon period (Takase 2014). In the Kuril Islands, Epi-Jomon settlements are characterized by relatively small, single-room house pits (approximately 15–30 m^2) often situated in larger multi-component sites (Fitzhugh 2019; Fitzhugh et al. 2016). Evidence for this initial population pulse is clearly recognized in an island-wide paleodemography model, where the density of calibrated radiocarbon dates increases substantially during the Late/Final Jomon and early Epi-Jomon period (Figure 2).

A second major observation from the paleodemography model is the strong pattern of population 'booms and busts' with increases in population density followed by declines. This pattern is not

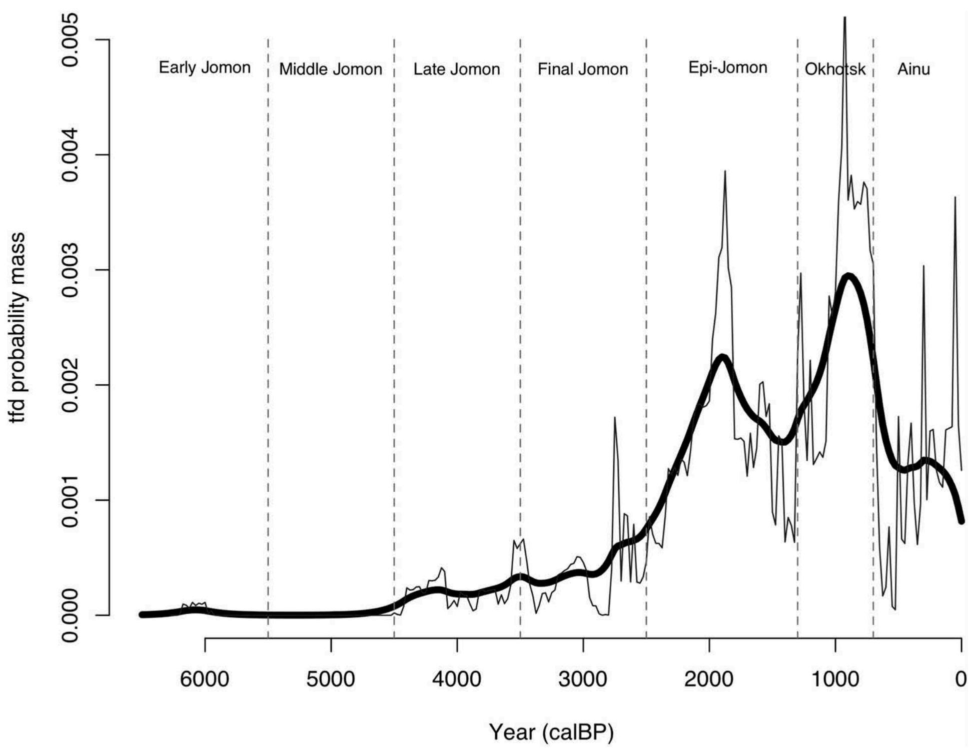

Figure 2. Temporal frequency distribution of calibrated radiocarbon probabilities from 364 dates from Kuril archaeological sites (Fitzhugh et al. 2016). In addition, approximate dates for cultural periods identified in the Kuril Islands. Solid black line represents a kernel density estimate (KDE) and grey line indicates the summed probability distribution (SPD).

only recognized during the Epi-Jomon period (2400–1300 calBP) but is repeated with even greater intensity during the later Okhotsk cultural period (1300–700 calBP). The Okhotsk culture is recognized as a distinct culture from the preceding Epi-Jomon culture. The Okhotsk originated in the western Sea of Okhotsk around the Soya Strait, in the vicinity of southern Sakhalin and northern Hokkaido (Amano 1979; Sato et al. 2007; Deryugin 2008). Archaeological sites associated with the Okhotsk culture can be found throughout the Sea of Okhotsk coast from Sakhalin to the Kurils occasionally displaying large houses and fortified settlements (*chasi*), although no chasi were definitively identified in the remote Kuril Islands (Fitzhugh et al. 2016; but also see Takase et al. 2017; Fitzhugh 2019). The Okhotsk occupation of the Kuril Islands, particularly the North-central region, is intensive but short-lived with a dramatic decline in radiocarbon dates and artefacts around 700 calBP. It is now believed that the later Ainu culture is the result of assimilation between Okhotsk population and Jomon-descendent Satsumon communities (Tobinitai culture) across southern and eastern Hokkaido (Hudson 1999, 2004). The Ainu culture eventually spreads throughout Hokkaido and into the Kuril Islands and southern Kamchatka (Torii 1919; Takase 2013) with ethnohistorical evidence suggesting the Kuril Ainu developed a unique subculture with distinct dialects and practices (Snow 1897; Krasheninnikov 1972; Fitzhugh et al. 2016).

3. Comparison of archaeological remains and radiocarbon data

The data presented here come from archaeological survey conducted by the KBP, the earlier International Kuril Islands Project (IKIP), and the subsequent Kuril Ainu Archaeological Project (KAAP). In total, these projects recorded 110 archaeological sites on 16 of the largest islands in the Kuril archipelago (Fitzhugh 2019). It should be noted that less archaeological work has taken place in the North region and therefore insights into the occupation of this region should be considered preliminary.

3.1. Faunal remains

All of the faunal data presented here was excavated by various KBP research teams from 2006–2008. Multiple excavation units (typically 1 m x 1 m, but occasionally 2 m x 2 m) were situated in areas either known from surface examination to contain preserved midden deposits or suspected due to their proximity to surface features of semi-subterranean house pits (Fitzhugh et al. 2007, 2009b, 2009a). Excavated faunal materials were water-screened through 6.4 mm (1/4″) screens with 3.2 mm (1/8″) fractions systematically saved for future analysis. Samples from the 3.2 mm fraction were examined for evidence of small-bodied fish such as herring (*Clupea pallasii*) and sardine (*Sardinops sagax*). Only remains from the larger (6.4 mm) screens are reported here, but we note that no herring or sardines were encountered in either the larger or smaller screen fractions in any of the four assemblages. If small-bodied fish species are present in our samples, our results may be partially impacted (Butler 1993; Partlow 2006); however, our assemblages are clearly dominated by cod (*Gadidae*) or greenling (*Hexagrammidae*) so diversity indices are unlikely to change significantly. Bulk midden samples from KBP excavations are retained at the Burke Museum of Natural History and Culture in Seattle, WA.

Birds and mammals were analysed in their entirety, while invertebrate and fish remains were sub-sampled with different quantification methods used depending on the taxonomic group under consideration. The number of urchins (*Strongylocentrotus* spp.) in each assemblage was documented by counting the number of mouthparts present (demipyramids from the 'Aristotles's lantern'). Gastropods were quantified using minimum number of individuals (MNI), based either on whole valves or relatively complete spires. Bivalves were quantified with the number of identified specimens (NISP) using only hinges. Finally, fish, birds, and mammals were quantified using NISP (but ribs, vertebrae, and phalanges of birds and fish were not identified above the level of Class).

Throughout the Kurils, the most abundant archaeofauna encountered came from archaeological contexts attributable to the Okhotsk occupation phase of approximately 1,200 and 700 calBP (either by dating or association with diagnostic artefacts). In the rare cases where we discovered fauna from earlier or later phases, the deposits were disturbed in such a way that chronological separation was not possible. This is especially the case for the organically well-preserved site of Ainu Creek on Urup Island, which had Epi-Jomon and Okhotsk components that were mixed by road-building activities between our visit in 2006 and the excavations of our Russian colleagues in July 2007. With this and a few other minor exceptions, the regional patterns discussed here should relate primarily to the lifeways of Okhotsk period settlement. The inability to track the change in faunal use through time and across the archipelago was an unexpected and disappointing element of the KBP research effort.

Fauna was regularly preserved only where shells were present and therefore it is not surprising that our collections include many invertebrate shell remains. It is difficult to compare the relative abundance of urchins to other invertebrate taxa in any meaningful way, but note that urchin remains were present in sites from all of the four regions (see Table S1 in the supplemental information). With the exception of minor amounts of mussel (*Mytilus* sp.) in sites from the South-central, North-central, and North regions, bivalves are only present in sites from the North region. However, sites from all regions had abundant gastropod remains, primarily periwinkle (*Littorina* sp.) with lower, but consistent amounts of various whelk species (*Buccinium* sp. and *Nucella* spp.) (Table S1 in supplemental information). In fact, during excavations of shell midden deposits, our team routinely encountered lenses of nearly pure urchin tests (body fragments) or periwinkle shells. A source of considerable speculation among our team, we have yet to derive a reasonable explanation for the near absence of bivalves from the South or remote island regions.

The geographic patterning of fish remains is even more striking than the patterning of the invertebrate remains. In the south, a high diversity of fish was targeted, including sharks (*Lamniidae*), salmonids (*Salmonidae)*, sculpins (*Cottidae*), greenlings (*Hexagrammidae*) and cod (*Gadidae*). Three of these groups (sculpins, greenlings, and cod) made significant (defined here as ≥ 10% of the overall NISP for that Class) contributions to the assemblage. In the South-central region, the fish assemblage is dominated by greenlings to the near exclusion of all other taxa. Sites in the North-central region were specifically targeting cod, perhaps as part of a seasonal procurement system. Finally, sites in the North region are uniquely focused on salmon and cod (see Table 1).

Bird remains are slightly less geographically patterned than the fish remains, but nevertheless still show some significant patterning (Table 1). For instance, only one region, the South, had a significant contribution of raptors. Albatross (*Phoebastria*) were only significant in the South and South-central region, whereas gulls (*Larus; Rissa*) were significantly represented only in the archaeofaunas from the North region. Alcids (*Alcidae)*, including auklets, puffins, and murres as well as cormorants (*Phalacrocorax*) are nearly ubiquitous in archaeological assemblages throughout the archipelago, but the Procellarids (also called 'tubesnouts') are restricted to the South-central and North-central regions. Note that the specimens identified as 'cf. *Fulmarus glacialis*' or 'most likely to be northern fulmar' (see Table S1) are all from juveniles, indicating that nearby breeding colonies were being targeted for at least part of the year.

Table 1. Table recording the number of identified specimens (NISP) for key taxonomic groups organized by region. Values in parentheses indicate the relative proportion of each taxonomic group to their class totals. Additional details including species identifications and the number of unanalysed and unidentified specimens can be found in Table S1 in the supplemental information.

Taxonomic Group	South	South-central	North-central	North
Gastropods	1423 (100.0)	8382 (99.8)	4790 (99.3)	2212 (78.1)
Bivalves	-	20 (0.2)	33 (0.7)	621 (21.9)
ALL INVERBRATES	1423	8402	4823	2833
Sharks	15 (2.9)	1 (0.0)	-	-
Salmon	7 (1.3)	24 (0.7)	-	907 (54.3)
Sculpins	227 (43.2)	6 (0.2)	4 (0.3)	2 (0.1)
Greenlings	212 (40.3)	3515 (99.1)	112 (8.2)	31 (1.9)
Cod	65 (12.4)	1 (0.0)	1247 (91.5)	666 (39.9)
Flatfish	-	-	-	65 (3.9)
ALL FISH	526	3547	1363	1671
Loons, Grebes	14 (1.1)	2 (0.0)	5 (1.6)	5 (3.3)
Albatrosses	314 (25.3)	1262 (24.0)	6 (2.0)	2 (1.3)
Tubesnouts	70 (5.6)	609 (11.6)	97 (31.8)	-
Cormorants	309 (24.9)	179 (3.4)	64 (21.0)	76 (50.3)
Auklets, Puffins, Murres	136 (11.0)	2807 (53.4)	59 (19.3)	18 (11.9)
Ducks, Geese Swans	42 (3.4)	232 (4.4)	33 (10.8)	26 (17.2)
Gulls	39 (3.1)	66 (1.3)	9 (3.0)	21 (13.9)
Raptors	312 (25.1)	72 (1.4)	10 (3.3)	-
Songbirds	5 (0.4)	23 (0.4)	11 (3.6)	3 (2.0)
Ptarmigan	-	-	11 (3.6)	-
ALL BIRDS	1241	5252	305	151
Dogs, Foxes	74 (2.8)	70 (10.0)	37 (16.9)	6 (4.3)
Other Carnivores	218 (8.3)	34 (4.8)	15 (6.8)	31 (22.0)
Fur seals, Sea lions	289 (11.0)	216 (30.7)	93 (42.5)	31 (22.0)
True seals	487 (18.6)	287 (40.8)	49 (22.4)	61 (43.3)
Artiodactyls	9 (0.3)	1 (0.1)	-	-
Dolphins, Porpoises	970 (37.0)	16 (2.3)	-	-
Other Cetaceans	578 (22.0)	79 (11.2)	25 (11.4)	12 (8.5)
ALL MAMMALS	2625	703	219	141

Not surprisingly, marine mammals were harvested throughout the Kuril Islands. However, data from the middens show that the situation is nuanced. For instance, although Otariids (fur seals and seal lions) and Phocids (harbour seals, largha seals, and ringed seals) made significant contributions (again defined as ≥ 10% of the class total) in all four regions (Table 1), the overall relative abundance of Otariids was higher in the more insular South-central and North-central regions. And although Cetaceans (whales and dolphins) were utilized throughout the archipelago, it is only in the South region that dolphins (*Phocoenidae*) contribute significantly. Finally, and most counter-intuitive, terrestrial mammals are most significant to the overall mammal assemblage in the South-central and North-central regions – regions where terrestrial mammal assemblages have the lowest biodiversity (Hoekstra and Fagan 1998). This pattern is driven nearly exclusively by the presence of domestic dogs (*Canis familiaris*) and red foxes (*Vulpes vulpes*). The remains of dogs and foxes were found in undistributed midden contexts and initially interpreted as being food remains, but other uses for these animals are plausible (hunting, protection, furs, etc.). Exactly how the bones of red foxes ended up in prehistoric midden deposits is currently unknown, especially in the remote islands of the archipelago. Prehistoric introduction of foxes into island systems has been documented elsewhere (Rick et al. 2009) and cannot be ruled out in the Kuril Islands. A full analysis of the fox remains including aDNA, isotopes, and direct radiocarbon dating is forth-coming (Etnier et al. in prep).

The taxonomic richness of the faunal assemblage shows a general similarity between the number of taxa exploited in the South (39), South-central (43), North-Central (36), and North

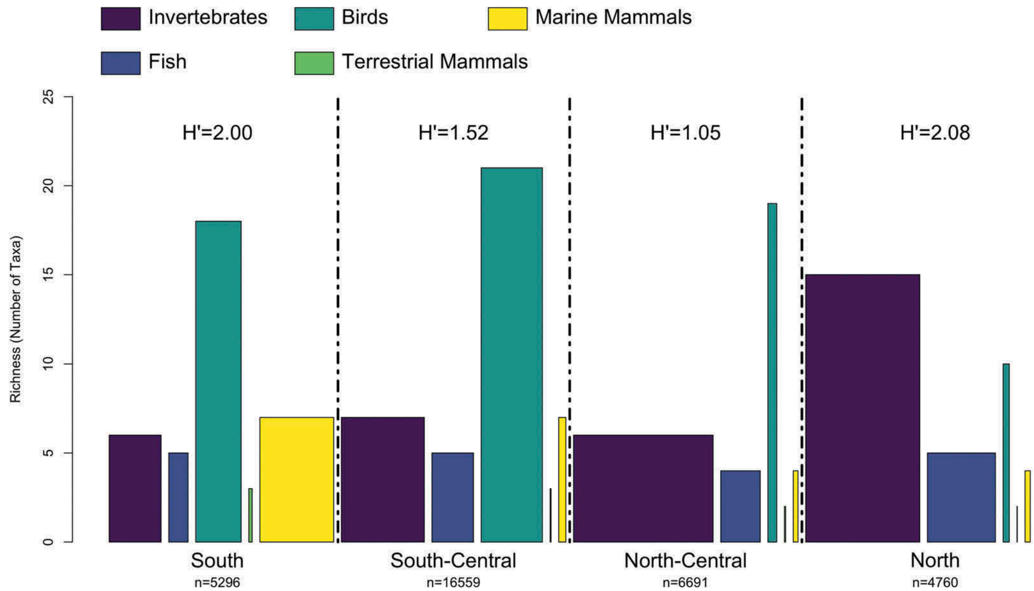

Figure 3. Barplot of richness (number of taxa) by region for faunal remains that could be identified to their taxonomic group. The width of bars indicates the proportion of each taxonomic group's NISP to the total NISP of the regional assemblage (n). A Shannon-Weaver diversity index (Shannon and Weaver 1948) indicated as H′ is also included for each region, which provides a measure of diversity accounting for both the richness and evenness of the faunal assemblages.

(35). However, this pattern can be deceptive. When differences in evenness (i.e. the abundances of each taxa) are accounted for, the diversity is lower in the South-central and North-central regions (see Figure 3). This suggests a narrower diet breadth of populations in these regions with a concentration on only a handful of taxa (greenling, puffin, cod). This is consistent with the patterns previously identified in a smaller study of faunal remains from the islands of Chirpoi and Shumshu (Fitzhugh et al. 2004).

3.2. Lithic artefacts

We evaluated the degree of lithic management in the Kuril Islands through the examination of size, use and knapping technique of flakes. Our starting expectation was that the size and use of flakes should be related to the abundance of lithic raw materials in each region as it is reasonable to expect that smaller raw materials are more often used on remote islands due to the relative paucity of lithic raw materials available there. Furthermore, the occurrence of pressure flaking should be higher on smaller and insular islands as tools will be retouched and resharpened repeatedly to use lithic materials more efficiently.

In the Kuril Islands, local raw materials such as basalt, chert, shale, and chalcedony were the primary materials used for producing stone tools. Earlier studies, based on primarily undated surface collections, found that although obsidian as a non-local material was also used, its occurrence is consistently lower than local materials (Fitzhugh et al. 2004; Phillips and Speakman 2009). Analyses of the cortex, size, striking platform, and flake scars of debitage in the IKIP collection indicate that lithics from the Kurils were more intensively worked and curated compared to materials from Sakhalin (Fitzhugh et al. 2004). This suggests that predictions based on island biogeography are generally supported; local raw lithic materials are limited on smaller insular islands.

A similar tendency can be seen in the larger collection obtained by KBP for which we present new results here. Like earlier studies, these findings are limited in chronological discrimination by their collection context. Despite the large number of radiocarbon dates generated by KBP (discussed below), artefacts included in this analysis derive from a much larger number of excavation and surface collection contexts, mostly without clear cultural diagnostics or dates. Use of the full data set for geographically robust comparisons necessarily masks temporal variability within sites and regions. Future analyses will explore chronological aspects of these patterns to the extent possible with these data, while additional archaeological excavation and expansion of well-dated assemblages throughout the archipelago is needed. We anticipate that realizing that goal will likely take years if not decades of additional research.

Turning to the patterns seen in KBP lithic data sets, we sought to evaluate the patterns seen previously that suggest technology was influenced by island insularity and size. Here we report on flake size and the utilization of larger flakes by island region as a proxy for the conservation of toolstone. The frequency of relatively large flakes (>4 cm) from South-central and North-central regions is lower than those from the South and the North, indicating that larger cores were more limited in insular small islands (Table 2). Large flakes are useful not only for making formal stone tools but for various temporary uses. If they were intensively curated, a greater percentage of large flakes should have been utilized not to waste lithic raw materials. However, the ratio of utilized large flakes (large flakes with micro-flakings generated by use) is very low in the South-central region. In contrast, the percentage of utilized large flakes to all large flakes is high (21.7%) in North-central, suggesting that lithic raw materials were more intensively curated in North-central than South-central region.

We applied high-power magnification to examine use-wear and reveal the degree of lithic raw material curation and the purpose of flake use (Keeley 1982). Use-wear polish was detected on 17 specimens of 154 retouched flakes (11.0%). 'Dry-hide polish' (Keeley 1982) could be seen on 16 of those specimens, while 'wood polish' was discovered on the remaining, single specimen, suggesting that utilized large flakes were mainly used for hide-working (Figure 4). Notably, almost all of the utilized large flakes (16 specimens) with use-wear polish were from the South region; only a single specimen with 'dry-hide polish' was discovered from the North. Additionally, no heavily developed use-wear polish was discovered in any of the lithic materials. Thus, large flakes were actively produced in the South and frequently used for processing hide in the region, but they were likely to be expedient tools. However, we could not reveal the use of large flakes in the South-central and North-central regions. Although large pieces of lithic raw material were more difficult for prehistoric

Table 2. Raw counts and occurrence of large flakes (>4 cm) made of local raw materials and large flakes with micro-flakings.

Region	Total weight (g)	Count of large flakes (> 4 cm)	Percentage of large flakes (per 1,000g)	Count of utilized large flakes	Percentage of utilized large flakes to total large flakes
South	63463.4	1318	20.8%	109	8.3%
South-central	22015.2	257	11.7%	3	1.2%
North-central	15026.8	161	10.7%	35	21.7%
North	5857.0	78	13.3%	7	9.0%
Total	**106362.4**	**1814**	**17.1%**	**154**	**8.5%**

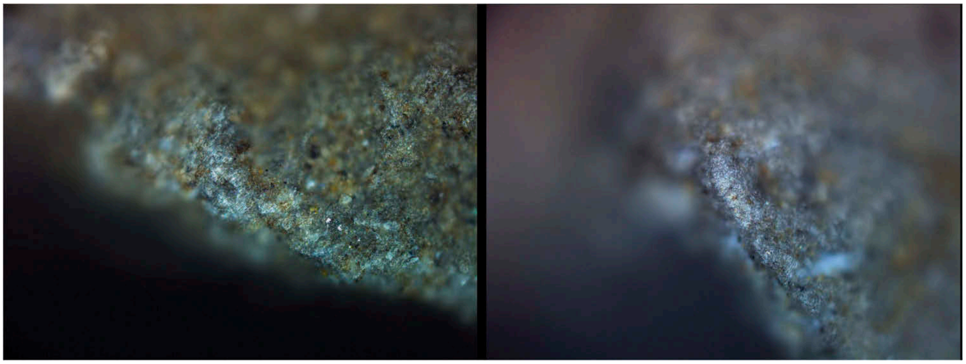

Figure 4. Use-wear polish observed on flakes from the Ainu Creek 1 site (taken by a digital camera Wraymer NT1000 mounted on a metallurgical microscope Olympus BX-FM). The width of each picture is approximately 900 μm.

people to obtain in both the South-central and North-central islands, there were differences. Apparently, people living in the South-central islands had more access to large flake cores and could afford to discard large flakes more frequently. Raw materials were more heavily curated in the North-central islands resulting in high frequencies of utilized large flakes. Whether this was because of more limited access to large nodules in local raw materials or to a more intensive reduction of imported raw materials we cannot yet resolve.

Although the Kuril Islands are volcanic in origin, there is no high-quality obsidian available for making stone tools in the archipelago itself. Instead, obsidian was imported into the Kuril Islands from Hokkaido and Kamchatka (Kuzmin, Glascock, and Sato 2002; Kuzmin and Glascock 2007; Kuzmin et al. 2008; Phillips and Speakman 2009; Phillips 2010; Kuzmin 2012). Figure 5 shows the relationship between obsidian debitage size and crack velocity estimated using an angle formed by fracture wings as seen in Figure 6 (Tomenchuk 1985; Hutchings 1999). Estimated crack velocity is classified into three groups related to the knapping technique (Takakura and Izuho 2004). Group I (<500 m/s) has a strong correlation with pressure flaking, and Group II (500–900 m/s) is closely related to indirect percussion with hard hammers or direct percussion with soft hummers. Finally, Group III (900 m/s) represents direct percussion with hard hummers. The size of obsidian debitage from the Kuril Islands tends to be smaller than that from southern Kamchatka and the number of obsidian flakes from the South-central and North-central is much smaller than other regions. Also, pressure flaking (Group I) was more frequently used in the Kuril Islands compared to Kamchatka, the difference in flake size is not very large between groups in the South-central and North-central islands. This indicates that smaller obsidian raw materials were carried into the Kuril Islands and were more intensively curated in the South-central and North-central regions. Although some large flakes made of local materials were an expedient tool for processing hide, obsidian was used as a valuable lithic raw material throughout the Epi-Jomon and the Okhotsk cultures.

In summary, the lithic remains collected from the KBP project reinforces and expands the patterns observed in earlier analysis (Fitzhugh et al. 2004) showing that the central islands had more limited access to large cores and high-quality raw materials, especially obsidian. The addition of micro-wear and microscopic fracture analyses adds additional insights about the function of flake tools and the nature of lithic tool production in these islands.

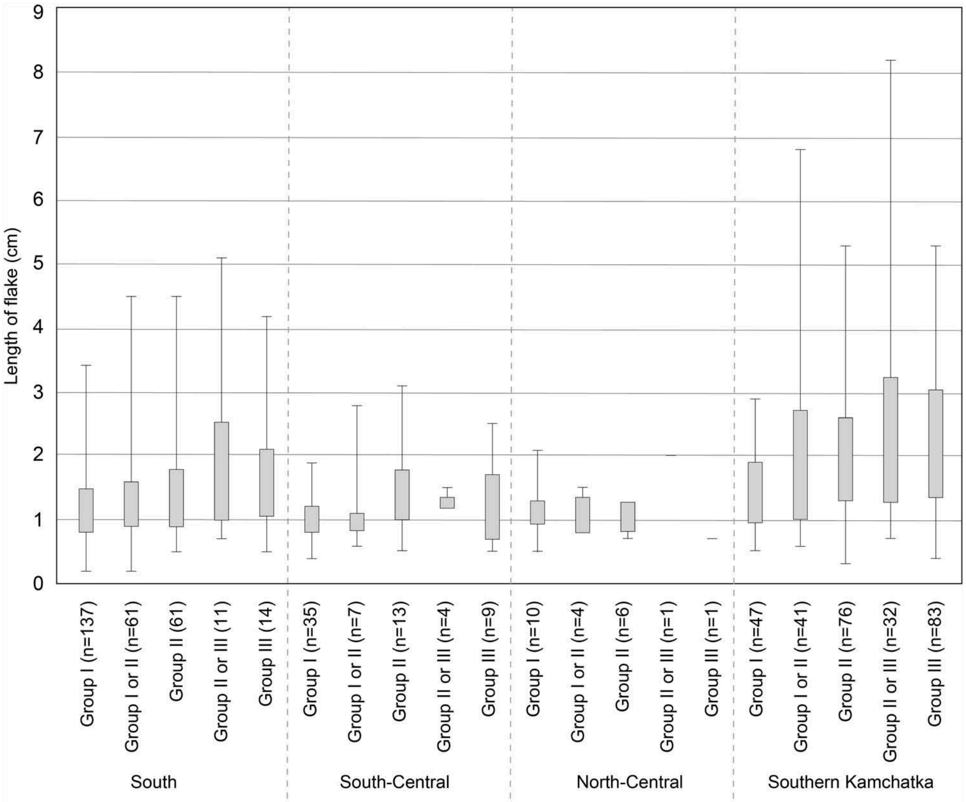

Figure 5. Relationship between obsidian flake size and the crack velocity estimated based on the fracture wings. Groups I-III indicate the classification of crack velocity; Group I: <500 m/s); Group II: 500–900 m/s; Group III: <900 m/s.

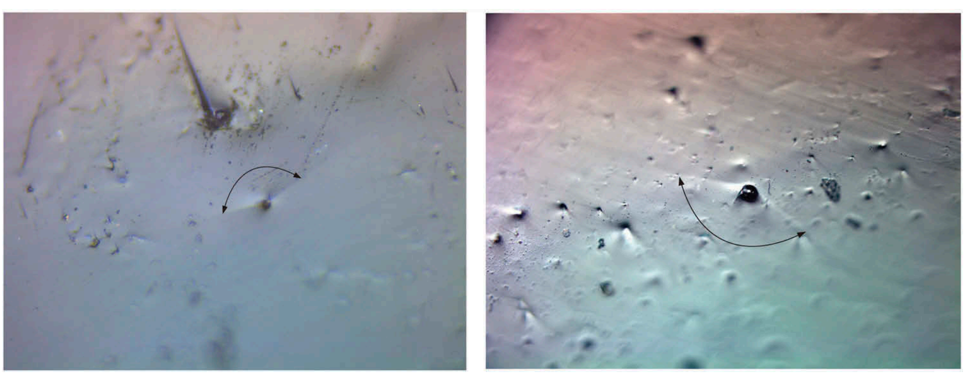

Figure 6. Examples of observed fracture wings from the sites of Vodopadnaya 2 (left) and Ainu Creek 1 (right). The width of each picture is approximately 900 μm.

3.3. Pottery

The analysis of ceramic remains, based on previous work by Gjesfjeld (2014), has two primary goals. The first is to broadly identify the cultural history of each region and the second is to infer the relative proportion of pottery produced non-locally. Sampling of the ceramic assemblage recovered by KBP proceeded by first selecting sherds that displayed decorative and diagnostic features, then undecorated sherds that could be identified as a part of the vessel rim or base, and finally a random sample of the remaining plain body sherds (see Table 3). It is important to note that Epi-Jomon sherds commonly display cord-marking decoration making them easier to identify and assign to a cultural affiliation. Okhotsk sherds will not as often display diagnostic features and therefore a significant portion of unassigned pottery sherds are likely affiliated with the Okhotsk culture. Wall and base thickness between Epi-Jomon and Okhotsk sherds is significantly different from each other (Gjesfjeld 2019) and were generally used as further criteria for assigning cultural affiliation where other diagnostic attributes were absent.

Diagnostic ceramics from all three regions indicate definitive occupation by both Epi-Jomon and Okhotsk populations. Pottery associated with the Epi-Jomon culture is prevalent throughout the archipelago with diagnostic pottery found as far North as the site of Drobnyye 1 on the island of Shiashkotan in the North-central region, see Figure 7. The overall trend is that ceramic assemblages from the South and South-central regions display fairly similar proportions of diagnostic pottery associated with the Epi-Jomon and Okhotsk cultures, suggesting a fairly strong connection between the occupation histories of the two regions. The ceramic assemblage from the North-central region highlights a stronger Okhotsk presence given the high proportion of sherds diagnostic of Okhotsk-style pottery. It is important to note that pottery associated with the Middle, Late and Final Jomon periods are found in the South islands and described in further detail in the appendix of Fitzhugh et al. (2007). Two sherds associated with the Tobinitai pottery tradition were also found at the Olya I site located on Iturup Island in the South region, but none were found further North. A handful of Ainu (Naiji) pottery sherds was also found through surface and test pit surveying in the South-central and North-central regions (Fitzhugh et al. 2007, 2009b, 2009a) as well as on southern Kamchatka (Takase 2013; Takase and Lebedintsev 2016, 2019). Given the limited amounts of Tobinitai and Naiji pottery found during KBP excavations, they are not included in analysis performed below, and these archaeological cultures are assumed not to have contributed significantly to the patterns discussed here for fauna, lithic or pottery.

The relative proportion of pottery produced on each island was estimated using results from the geochemical compositional analysis of ceramic artefacts (Gjesfjeld 2018). Here, we use compositional data on ceramic artefacts collected through the bulk analysis of 279 pottery sherds using

Table 3. Comparison of pottery sherds from regions of the Kuril Islands including the total number of sherds recovered from KBP (N), the number of sherds sampled from each region (n), the count of diagnostic sherds selected for analysis, and the number of diagnostic sherds assigned to either the Epi-Jomon or Okhotsk cultures (the few remaining diagnostic sherds were assigned to either Jomon or Naiji). *The exact number of sherds from the Ainu Creek 1 site is unknown and so an estimate of 1000 sherds was used here.

Region	N	n	Count of diagnostic sherds	Count of sherds identified as Epi-Jomon	Count of sherds identified as Okhotsk
South*	2203	682	317	271	46
South-central	1908	357	161	133	28
North-central	201	62	21	9	12
North	32	14	1	0	1
Totals	**4344**	**1115**	**500**	**413**	**87**

Figure 7. Selection of Epi-Jomon and Okhotsk ceramics from the South (top), South-central (middle) and North-central (bottom) regions. SM# refers to the Sakhalin Museum accession number (if available) and FS# refers to the KBP field specimen number.

inductively coupled plasma-mass spectrometry (as outlined in Gjesfjeld 2018). Islands were chosen as the unit of analysis as it is expected that the geochemistry of each island is more similar to itself than to other islands, particularly those located in different regions. Islands that had fewer than 15 total samples were not included in this analysis due to statistical concerns when using fewer observations (sherds) than variables (elements).

The determination of island or off-island ceramic production was accomplished using a robust outlier detection algorithm implemented in the robCompositions package (Templ, Hron, and Filzmoser 2011), available in the R statistical environment (R Core Team 2019). This algorithm (outCoDa) calculates Mahalanobis distances from transformed compositional values in order to identify a majority of compositional values from each island. A threshold value, similar to a significance level, is then used to determine the ceramic sherds from each island that are most likely to be compositional outliers (Templ, Hron, and Filzmoser 2011).

Results of the outlier detection analysis indicate a majority of pottery sherds recovered from the same island have similar geochemical compositions. The South islands of Iturup and Urup have the greatest proportion of geochemical outliers, whereas the islands of Rasshua and Shiashkotan in the North-central and South-central regions have the lowest proportion (see Figure 8). These results are

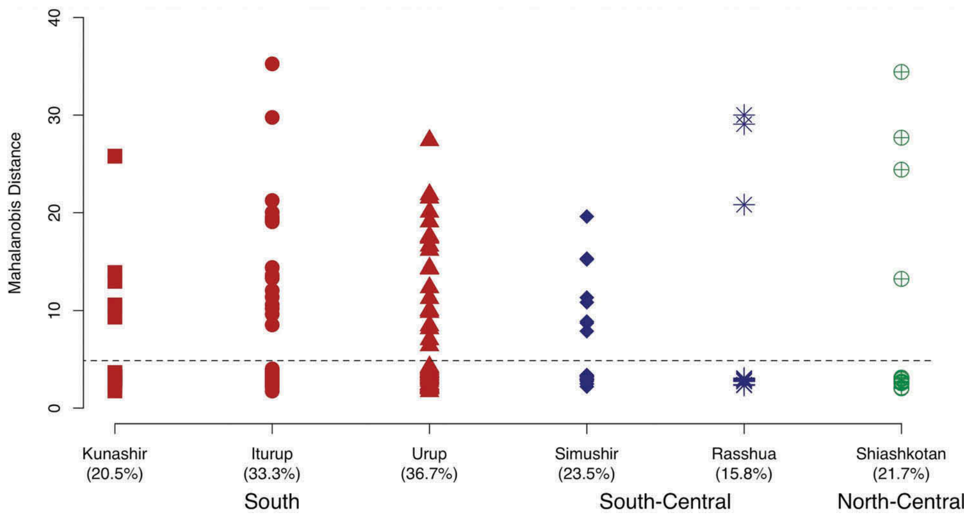

Figure 8. Results of outlier detection on geochemical data from pottery samples. Percentages represent the proportion of samples that are considered outliers based on a 95% significance level. The dashed line indicates the Mahalanobis distance threshold value based on the use of 16 elements chosen for their discrimination properties.

generally reflective of island size with larger numbers of raw clay sources and greater geochemical variability most likely on the larger islands in the South. Overall, the geochemical analysis suggests that most pottery was produced, used, and discarded on the same island as recovered archaeologically, strengthening previous results reported at the site level (Gjesfjeld 2014).

3.4. Radiocarbon dates

Over the last two decades, archaeology has witnessed a dramatic rise in the aggregation, quantification and interpretation of radiocarbon datasets. Extending from a 'dates as data' approach (Rick 1987), radiocarbon data are used to estimate the density and distribution of occupation aggregated over any number of archaeological sites or regions. This approach is affected by sample size, differential preservation, and uneven sampling of archaeological deposits (MacInnes, Fitzhugh, and Holman 2014; Fitzhugh et al. 2016; Brown 2017). The methods used for constructing population changes derive from recent statistical advancements in modelling radiocarbon dates (Crema 2012; Brown 2015, 2017; Crema, Bevan, and Shennan 2017). Broadly speaking, the summed probability distributions (SPDs) are the aggregation of all the calibrated radiocarbon dates from each region. The composite kernel density estimate (KDE) provides a smoothed version of the SPD using randomly sampled calendar dates, with additional details discussed by Brown (2017). An island-wide model of Kuril population dynamics was developed using a series of protocols to control for various biases (Fitzhugh et al. 2016), and here we use the same approach for investigating the population dynamics within each region of the Kuril Islands.

The paleo-demographic models of the Kurils by region (see Figure 9) broadly parallel population trends seen in the aggregated, island-wide model (Figure 2). The South and South-central regions both show an initial rise and fall in population density between 3000 and 1500 calBP and a second rise and fall in population density from 1500 calBP to 550 calBP. These trends are consistent with

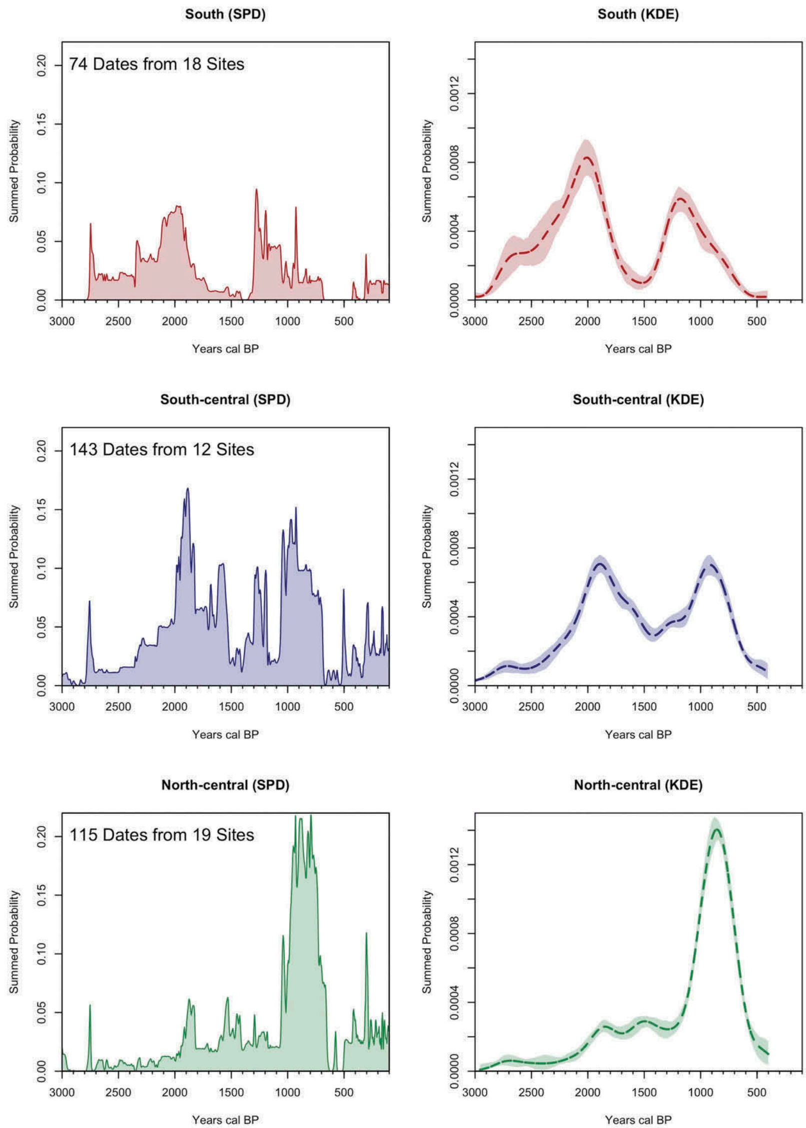

Figure 9. Summed probably distributions and composite kernel density estimates for the South, South-central and North-central regions. Radiocarbon dates come from Fitzhugh et al. (2016) with analytical functions implemented using the rcarbon package (Bevan and Crema 2018) available in the R statistical environment (R Core Team 2019).

diagnostic archaeological data, specifically pottery remains, which also suggest occupation of these regions during the Epi-Jomon (2400–1300 calBP) and Okhotsk (1300–700 calBP) periods. The North-central region shows a somewhat different population trend with a much less apparent population increase through the Jomon and Epi-Jomon phases (3000 to 1300 calBP). The Okhotsk population surge and subsequent collapse are represented in the North-central region between 1200 and 550 calBP, similar to the islands to the south. The North region has only 32 radiocarbon dates, which was considered too few to produce a reliable SPD. Once again, this estimate of population density is consistent with archaeological remains that suggest the widespread presence of the Okhotsk culture in the islands of the North-central region.

4. Discussion

4.1. How mobile were populations living in the Kuril Islands?

Anthropologists have long recognized the importance of mobility on hunter-gatherer lifeways (Kelly 2013), and while many hunter-gatherer groups are mobile, there is substantial variation in how and when groups move. The Kuril Islands offer a unique perspective on hunter-gatherer mobility as resources are unequally distributed with some islands having significantly higher diversity or abundances of resources. Furthermore, the geography of the island chain limits the movement between regions due to the presence of large open-water straits that can be difficult to navigate (Etter 1949; Turk 2005; Fitzhugh, Phillips, and Gjesfjeld 2011). As Captain Snow (1897, 22) notes in his diary about the Kuril Ainu, 'The Kurilsky inhabiting the central islands frequently shifted their quarters from one island to another. When the "flitting" took place it was a matter of serious consideration. The weather had to be watched very closely both for storms and fogs. Should the latter set in when they were at sea, there was a great risk of them not being able to find their destination'.

The analysis of faunal remains provides evidence for the occupation of the archipelago minimally during the spring and summer seasons. As discussed above, many faunal remains from the South-central region are Alcids, which include auklets, puffins and mares. These related species typically only spend the spring and early summer onshore, while spending the rest of the year offshore and dispersed into small groups (Harding et al. 2005; Golubova 2002). Unfortunately, evidence for year-round occupation is currently limited as none of the taxa (or age classes) from the faunal assemblage are able to distinguish winter seasonality. However, the combination of mostly local pottery production, obsidian exchange, pit houses, and redundant resources from island to island broadly implies more fixed residential patterns with occasional logistical movement for the trade and/or exchange of resources and information.

4.2. Do biogeographical and ecological differences relate to regional differences in the occupation and cultural history of the archipelago?

The results of our comparative analysis indicate differences in the faunal remains, lithic artefacts, ceramic artefacts and population histories of Kuril biogeographic regions. Broadly speaking, artefacts and faunal remains from the South region are consistent with biogeographical expectations as there is greater diversity in faunal taxa, lithic raw materials, lithic flake sizes, pottery decorations, and raw clay sources in this region.

The South-central and North-central regions also demonstrate broad consistency with biogeographical expectations. This can be identified in the faunal assemblages, which show these regions having lower diversity when accounting for both richness and evenness. Low diversity in the South-central region is largely driven by the higher abundances and richness of birds in the faunal assemblage. The North-central region has a slightly different pattern with a greater abundance of invertebrates and a lower abundance of birds, a pattern more similar to the North region. Overall, this pattern suggests a reduced diet breadth in the North-central region with opportunistic exploitation of birds and marine mammals, but more concentrated exploitation of specific fish and invertebrate resources.

Despite important similarities, important differences are also seen in the faunal assemblages of the South-central and North-central regions. One of the most significant discrepancies is the types of fish being exploited: the South-central region is largely characterized by greenling, while the North-central fish assemblage is dominated by Pacific cod (Table 1). This could indicate that people used different harvesting strategies and fishing locations in the two regions as greenling are often found nearshore in kelp beds and rocky shoreline, whereas cod tends to be found in deeper water closer to sandy sea beds. Alternatively, the differences may also relate to changes in water temperatures and the habitat conditions in the two regions. The northern Kuril straits are influenced by ocean waters flowing into the Sea of Okhotsk from the East Kamchatka Current and the Bering Sea Gyre. Pack ice also sometimes makes it south to the more northerly islands in winter (as it does the southernmost islands near Hokkaido because of the counter-clockwise circulation of sea ice in the Sea of Okhotsk). As a result, and compared to the South-central islands, water temperatures around the North and North-central islands may have been more optimal for Pacific cod. This possibility could be evaluated with a more detailed comparison of modern cod distributions and paleo-proxy evidence of water temperature in the past.

Our comparative analysis broadly indicates that differences in the archaeological remains from each region are connected to differences in biogeography and ecology. The South-central and North-central regions are characterized by lower ecological diversity and greater insularity compared to the South and North regions, and the archaeology shows these regions having lower faunal diversity, higher proportions of locally produced pottery, fewer obsidian artefacts, and smaller flake sizes. These archaeological similarities between the South-Central and North-Central make it even more interesting that the two regions have such different occupation histories. As illustrated by the paleodemography model (Figure 9) the South-central region was intensively occupied during both the Epi-Jomon and Okhotsk periods while the North-central region had much less Jomon and Epi-Jomon occupation compared to the later Okhotsk surge. Given that we are unable to characterize the faunal and artefact patterns by time period, the statistical differences noted may in fact capture distinctive cultural practices of each group. In other words, we interpret some of the differences discussed above as potentially indicative of differences in how Epi-Jomon and Okhotsk populations were engaging with the landscape and resources of each region. These results fit with growing evidence (Gjesfjeld 2019) that the Okhotsk and Epi-Jomon occupations of the Kuril archipelago were both socially and structurally dissimilar (Takase 2014; Fitzhugh 2019).

4.3. Do more remote and ecologically precarious regions show more punctuated occupation histories compared to others?

The ability to buffer variability in the environment is commonly recognized as an important feature of foraging communities, especially those living in marginal landscapes (Damm et al. 2019; Minc and Smith 1989; Halstead and O'Shea 1989). A common expectation is that communities living in more remote and ecologically precarious regions will be more vulnerable due to low species abundance and variety. Our comparison of archaeological remains and occupation histories between Kuril biogeographic regions enables us to comment broadly on the validity of this expectation. The paleodemography model discussed above (Figure 9) clearly shows a series of population booms and busts, one associated with the Epi-Jomon occupation and one associated with the Okhotsk occupation. The severity of the Epi-Jomon collapse is different between the South and South-central regions, with the more ecologically diverse South region showing a more rapid decline and near-complete abandonment by 1500 calBP compared to the less diverse South-central region. This may indicate that the cause of the collapse originated, not from ecological hardship, which should have affected the more remote and less ecologically diverse regions more, but from developments outside the archipelago. In contrast, the decline associated with the Okhotsk occupation shows a trend more consistent with ecological vulnerability. In this case, the southern islands show a more gradual decline in population density starting around 1100 calBP as compared to the precipitous, if somewhat later, declines in the South-central and North-central regions occurring between 800 and 550 calBP.

One hypothesis that emerges from our regional comparison is that population decline in the South region starting around 1100 calBP may have helped to fuel the population rise in the South-central and North-central regions around this same time period. This may be an outcome of migrants moving north or a reduction in Okhotsk seasonal mobility or social networks to the south. Either scenario has the occupation of the South-central and North-central islands strongly intensifying between 1100 and 800 calBP and potentially moving Okhotsk communities closer to the carrying capacity of these more ecologically precarious regions where they would be more vulnerable to unpredictable hazards. As discussed elsewhere (Fitzhugh et al. 2016), the ultimate cause for the dramatic decline in Kuril population starting around 800 calBP is still unclear, but it is likely a combination of events including changes in climate, social networks, political relationships, and possibly even epidemic diseases. Broadly speaking, we can suggest that remote and ecologically precarious regions may in fact demonstrate more punctuated changes in demography, but this is more likely to happen when communities are already at or near the ecological capacity of their landscape.

5. Conclusion

In this paper, we have presented a comparative biogeographic analysis to better understand human resilience and adaptation in the Kuril Islands. Our approach is facilitated by the unique configuration of the Kuril Islands and the distinctive biogeographical differences that exist between regions. Overall, various lines of archaeological evidence are consistent with biogeographic expectations of greater ecological and human vulnerability in the more precarious South-central and North-central regions. The depressed ecological diversity and relative isolation of these regions likely posed greater risks to their settlement by small, maritime foraging communities. The archaeological record discussed here, and elsewhere (Fitzhugh, Phillips, and Gjesfjeld 2011; Gjesfjeld 2014; Fitzhugh et al. 2016), shows evidence of the adaptive strategies used by Kuril communities to mitigate these risks. The strategies used by Kuril populations undoubtedly encouraged the settlement and occupation of the archipelago, but ultimately the scarcity and vulnerability of resources in combination with unpredictable social, economic and environmental changes made the Kuril Islands a challenging and risky place to live. Even so, the comparative, biogeographical analyses presented here help to direct our attention to social, economic, and cultural patterns operating at different spatial scales. These factors altered the occupation history of the archipelago in ways that are refracted through, but not determined, by biogeography and relative isolation. Teasing apart these more complex factors demands better chronological resolution over larger archaeological data sets from a range of sites throughout the archipelago. With opportunities for continued collaboration in archaeological research in the Kurils, we look forward to investigating these patterns further in ongoing and future research.

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Data accessibility

Radiocarbon dates used in the research were previously published in Fitzhugh et al. (2016), available at doi:10.1016/j.quaint.2016.02.003. Geochemical compositional data on ceramic artefacts are curated in the Digital Archaeological Record (tDAR) available here: doi:10.6067/XCV85M66NM. Additional data generated from the Kuril Biocomplexity Project including information on faunal remains can also be found curated in the tDAR project archive available here: doi:10.6067/XCV8BC40ZG.

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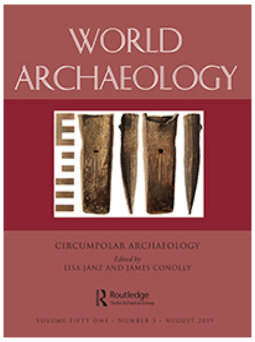

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ARTICLE

Biogeographic barriers and coastal erosion: understanding the lack of interaction between the Eastern and Western Regions of the North American Arctic

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ABSTRACT

For most of the past 5,000 years, the North American Arctic has seen distinct cultural developments in its eastern and western regions, with the boundary between them located in the Amundsen Gulf region in northwestern Canada. This boundary was traversed by two major migration episodes that define the 'big picture' of North American Arctic archaeology, but for much of the remainder of prehistory, there are only rare indications of communication or movement across it. In this paper, we assess the reasons for this boundary, the evidence for interaction across it, and the implications for cultural developments on both sides. In order to approach these issues, we also attempt to understand the significant gaps in the archaeological record caused by the region's severe coastal erosion, currently accelerating due to warming climates.

KEYWORDS

Arctic; archaeology; interaction; Mackenzie Delta; coastal erosion; biogeographic barriers

Introduction

For most of the last 5,000 years, the North American Arctic has seen distinct cultural developments in its western (Alaska and northwestern Canada) and eastern (Canadian Arctic and Greenland) regions. The division between these two 'halves' occurs around the Amundsen Gulf region in northwestern Canada. Through most of Arctic prehistory, there is no evidence for interaction across this divide (Figure 1).

In this paper, we seek to understand the reasons for this lack of interaction through a reanalysis of the archaeological record in the Mackenzie Delta region, which is directly adjacent to this critical 'frontier' or 'boundary' (Parker 2006). By understanding when, and how intensively, it was occupied, we can further our understanding of why west-east interaction was so rare. Our reconstruction of the region's prehistory will be considered through the lens of recent studies of coastal erosion, which has severely impacted all marine-oriented components of regional settlement patterns. We conclude that during much of its culture history, the Mackenzie Delta region was likely occupied for longer periods and more intensively than is generally recognized. This reemphasizes the significant *lack* of interaction between west and east, and likely reflects the presence of a pronounced biogeographic barrier to settlement and interaction in the Amundsen Gulf region.

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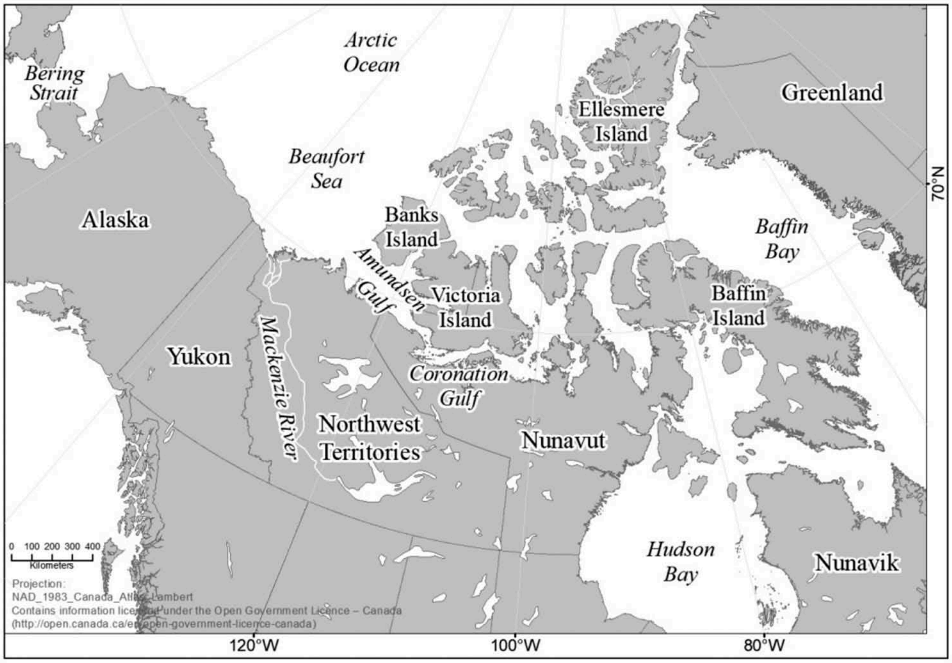

Figure 1. The North American Arctic. Culture history of the region is traditionally divided into west (Alaska and northwestern Canada) and east (central and eastern Canadian Arctic and Greenland), with the division occurring in the Amundsen Gulf region.

West vs. East in Arctic culture history

The North American Arctic is vast, and its human history complex. While two distinct cultural traditions have been archaeologically defined throughout the North American Arctic region (Paleo-Inuit and Inuit), these traditions developed through largely separate cultural sequences in the western and eastern parts of the region (Mason and Friesen 2017). The following outline is simplified, and ignores the period before ca. 3000 BC, since it is only after this time that the Eastern Arctic was peopled (Figure 2).

Western Arctic

The earliest tradition defined for coastal regions of the Western Arctic is Paleo-Inuit, though alternate names exist including Paleo-Eskimo and Arctic Small Tool tradition (which often refers only to the earliest part of Paleo-Inuit). The initial phase of the western Paleo-Inuit sequence is known as the Denbigh Flint complex, whose ultimate origin lies in the Neolithic cultures of Siberia. In Alaska, Denbigh is poorly dated (Tremayne and Rasic 2016); however, based on extrapolation from adjacent regions, it likely originated around, or just prior to, 3000 BC. Denbigh people inhabited a variety of environments, but most noteworthy is the fact that they were able to live on outer coasts, targeting marine mammals, at least seasonally (Tremayne 2015). In a poorly understood process, Denbigh developed, probably with influence from other regions, into what is often called the Norton tradition around 800 BC, which includes three phases: Choris, Norton, and Ipiutak (Dumond 2000). The Choris phase (800–500 BC) is known from only a few sites in coastal and

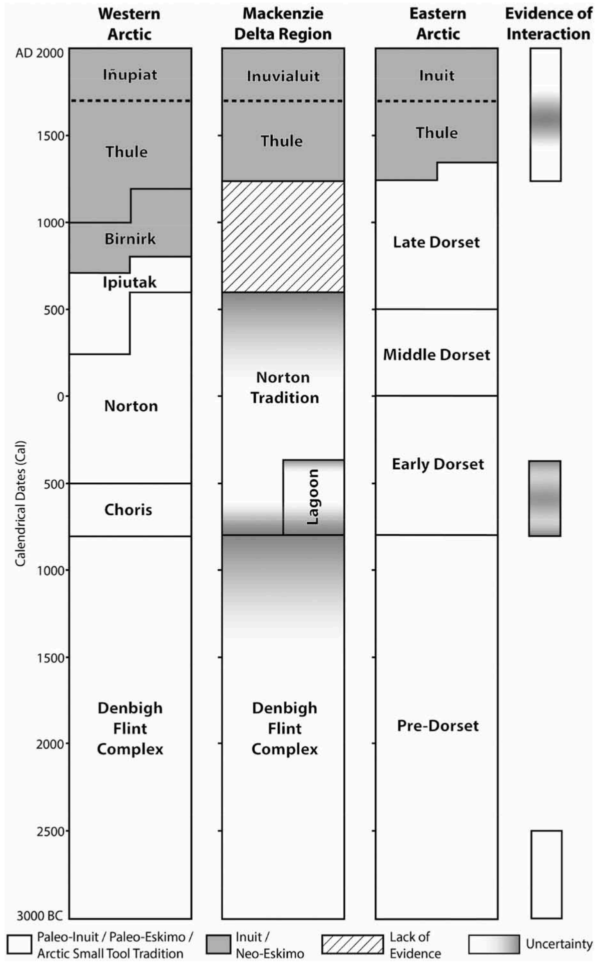

Figure 2. Simplified culture history of the North American Arctic, comparing the cultural sequence in the Mackenzie Delta region to the better-known regions to its west and east. The Western Arctic sequence is based on archaeology in northwestern Alaska, due to its proximity to the Mackenzie Delta. Periods of known migration or interaction between east and west are indicated in the right-hand column.

interior northwest Alaska (Darwent and Darwent 2016). It is most noteworthy for incorporating the earliest ceramics in the region, as well as a range of house types including semi-subterranean forms. The following Norton phase (500 BC – AD 600) saw a massive expansion in terms of size and number of sites, and geographic extent, with substantial settlement as far south as the Alaska Peninsula. Norton economies continued to focus on coastal resources, with an emphasis in many regions on fish (Dumond 2016). The final phase of Norton is known as Ipiutak (AD 250–800). It is restricted to coastal and interior regions of northwestern Alaska and incorporated many new developments including a marked increase in distinctive art, often associated with mortuary contexts (Dumond 2000; Mason 2016a).

The second major tradition is known as Inuit, Neo-Eskimo, or Northern Maritime. In the Western Arctic its earliest form, Old Bering Sea (roughly 250 BC-AD 700), developed in the Bering Strait region; its ultimate origin is unclear. Old Bering Sea developed through phases known as Birnirk (AD

700–1200) and Punuk (AD 800–1200), demonstrating ever-increasing prowess in the hunting of large marine mammals including walrus, grey whales, and bowhead whales (Mason 2016b). By around 1000 AD, it had developed into a form recognizable as 'Thule', similar in many respects to the Yupik, Iñupiat, and Inuit societies of the 19th century. Thule lived in many regions across the Western Arctic, with the largest and most permanent villages consisting of semi-subterranean houses on outer coasts, and had complex and elaborate subsistence and transportation technologies.

Eastern Arctic

The Eastern Arctic sequence consists of the same two primary traditions but is otherwise quite different from that of the west (Friesen 2017; Maxwell 1985). Early Paleo-Inuit in the east are known as Pre-Dorset in most of the Canadian Arctic, Independence I in the High Arctic, and Saqqaq in East and West Greenland. Early Pre-Dorset originated as a migration of Denbigh people from Alaska around 3000 BC, but over the next four millennia, eastern Paleo-Inuit developed numerous different regional expressions relying on a mix of marine and terrestrial resources. The single most noteworthy development is the transition from Pre-Dorset to Dorset during the period following 800 BC. This process is poorly understood, but results in the 'new' Dorset cultural configuration including semi-subterranean winter houses in many regions, the origin or greatly increased use of snow houses, new categories in many classes of lithic and organic material culture, and an increased frequency and diversity of figurative representation, mainly seen in small carvings of animals and humans. Dorset develops through Early, Middle, and Late phases, lasting until the late 13th or early 14th AD century in several regions (Friesen 2017).

Eastern Paleo-Inuit were replaced by Inuit as a result of the 'Thule migration', a series of population movements by Thule Inuit from Alaska beginning around AD 1250. Within about a century, Thule had settled much of the Canadian Arctic and parts of Greenland. In subsequent centuries, Thule populations continued to expand, and gradually developed into the regionally diverse Inuit societies of the historical and modern Arctic (Friesen 2017).

West–East interaction

With this basic outline of relevant culture history established, we now turn to our focus: evidence for periods when interaction existed between east and west. Before discussing specific periods, we must make two general points. First, the term 'interaction' is used here in its most general sense to refer to *any* evidence for connections across space. This includes direct movements of people; trade in food, finished artefacts, or raw materials; the spread of specific artefact forms or other traits; and genetic evidence for interaction. The second point is that *within* each of the two main regions – Western and Eastern Arctic – interaction was frequent and is often highly visible in the archaeological record, particularly as seen in trade and simultaneous shifts in material culture traits across broad areas (Mason and Friesen 2017). However, it is the interaction *between* the two regions that is our focus here.

Before proceeding to the distant past, we will consider the recent period, as reconstructed from the ethnohistoric record. In the nineteenth century, two very distinct Inuit societies lived on either side of Amundsen Gulf. In the Mackenzie Delta region to the west, ancestral Inuvialuit (Mackenzie Inuit) occupied coastal regions in often large and dense settlements, relying in some cases on hunting of beluga and bowhead whales (Alunik, Kolausok, and Morrison 2003). They were similar in many ways to Iñupiat farther west along the Alaskan coast, with whom they were in regular contact.

To the east were the Inuinnait (Copper Inuit) of the Coronation Gulf region. Inuinnait were culturally very different, being a more mobile and smaller-scale society, living on the sea ice in snow house villages in the winter (Jenness 1922). Importantly, these two Inuit societies were not contiguous; rather, there was an uninhabited gap of around 500 km between them on the coast of Amundsen Gulf. In the mid-19th century, there was a well-developed trading relationship across this gap, with Inuvialuit providing iron ultimately derived from Russian sources, and Inuinnait providing soapstone lamps from sources around Coronation Gulf. However, Morrison (1991) has made a strong case that this trade existed for only a few decades in the 19th century; before that contact was at best sporadic.

Turning to the archaeological record, the earliest indication for connections between west and east is associated with the initial migration of Paleo-Inuit from Alaska (Denbigh) to the eastern Arctic (Pre-Dorset). Immediately following this migration, these populations may have had tenuous contact across the Amundsen Gulf region. However, material culture developments on both sides are not well understood, and there are currently no indications of trade or sustained interaction – perhaps unsurprisingly given that both societies were probably characterized by low population densities.

Following this initial migration, the two Paleo-Inuit sequences developed largely in isolation. To the west, Denbigh was replaced by Choris, Norton, and Ipiutak with no clear indication of trade or other influences from the east. In the Eastern Arctic, Pre-Dorset eventually developed into Dorset during the period around 800–0 cal BC, with a significant shift in many aspects of material culture and lifeway. Over the years, there has been frequent speculation that these changes may result from the arrival of new populations or from other external factors. Influence from the Western Arctic, particularly important in the present context, is sometimes suggested (e.g. Fitzhugh 2002; Savelle and Dyke 2014).

The Thule migration of around AD 1250 represents a second clear-cut connection between west and east. Following the initial migration(s) from Alaska to the east, some level of contact was likely maintained for at least a century or two; in fact, a 'return migration' from east to west has been suggested as a mechanism for introducing some ostensibly eastern traits to the west (Collins 1937). For the remainder of the Inuit period, a low and sporadic level of contact may have been maintained between the Mackenzie Delta and the Coronation Gulf area, as indicated by occasional copper and soapstone in the former region which must have come from the latter. This level of interaction appears to have increased significantly in the 19th century, as outlined above, largely as a result of the introduction of Russian iron and a linked Alaskan demand for soapstone (Morrison 1991).

Reconstruction of the Mackenzie Delta region's Paleo-Inuit archaeological record

Thus, with the exception of the two major migration episodes, there is very little archaeological evidence for interaction between the Western and Eastern Arctic. Given the common origins and many shared elements of environment and society across the North American Arctic, how can we begin to understand this lack of frequent or sustained contact? A good place to start is to assess the nature of the archaeological record in the Mackenzie Delta region, which is directly adjacent to the boundary between the two areas. As outlined above, for the last 750 years during the Inuit (Neo-Eskimo) period, we see clear evidence for interaction occurring during the initial Thule migration, and later in the 19th century, with much more sparse evidence between these two temporal extremes. During this period, the Mackenzie Delta was continuously occupied by ancestors of the Inuvialuit. But what do we know about the much longer Paleo-Inuit archaeological record in the

Mackenzie Delta region, before the arrival of Thule? Any discussion of this topic must begin with the fact that there has been relatively little archaeological survey in the region, and that which has occurred has often prioritized outer coasts. There is a low overall density of sites, with a significant number of undiagnostic lithic scatters (Figure 3). These lithic scatters often have low archaeological visibility due to frequent heavy vegetation; they are usually seen only in blowouts or other erosional features. Therefore, for all periods we assume that the known site distribution is a limited and likely unrepresentative sample.

Denbigh Flint complex

The earliest part of the Paleo-Inuit period in the Mackenzie Delta will be referred to here as Denbigh Flint complex, given its proximity to related Alaskan components (cf., Pilon 1994). Sites of this period in the Mackenzie Delta generally reflect the high mobility of Denbigh, and are small, often with no organic preservation. Site visibility is low – in fact, several components including at the Cache Point, Cache, and Sukunnuk sites were 'accidentally' found when excavating Inuvialuit sites of the past 750 years (Friesen 2009; Swayze 1994). To generalize, most Denbigh sites are located inland from contemporary shorelines; with some sites over 100 km inland (Figure 4).

One site that is particularly important in relation to several periods is Engigstciak, a small bedrock outcrop 22 km from the coast on the Yukon North Slope. Engigstciak is located in the Porcupine

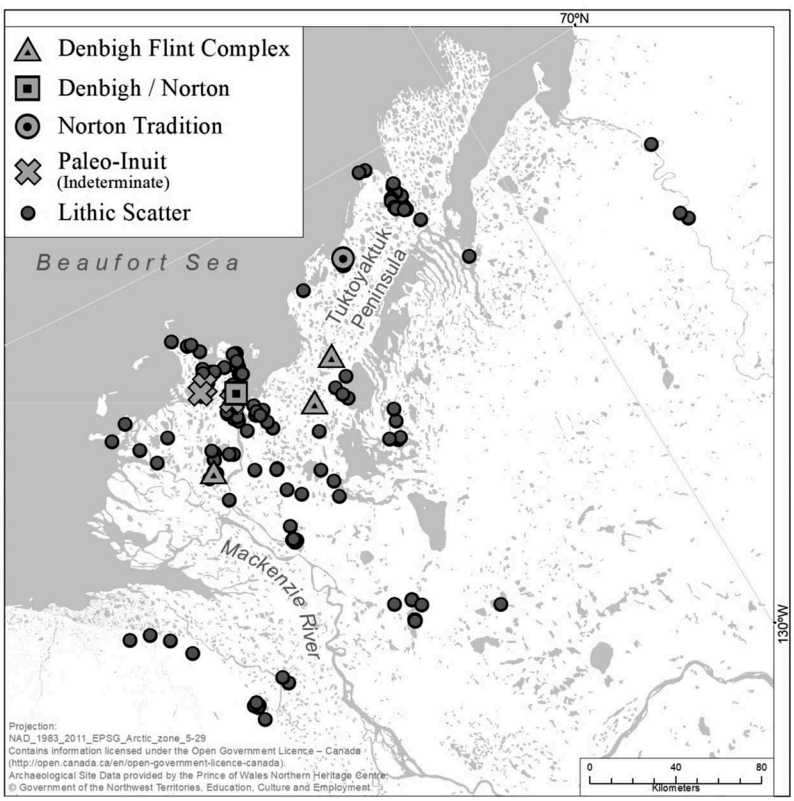

Figure 3. The Mackenzie Delta/Tuktoyaktuk Peninsula region showing known Paleo-Inuit sites as well as undiagnostic lithic scatters, many of which probably relate to Paleo-Inuit settlement.

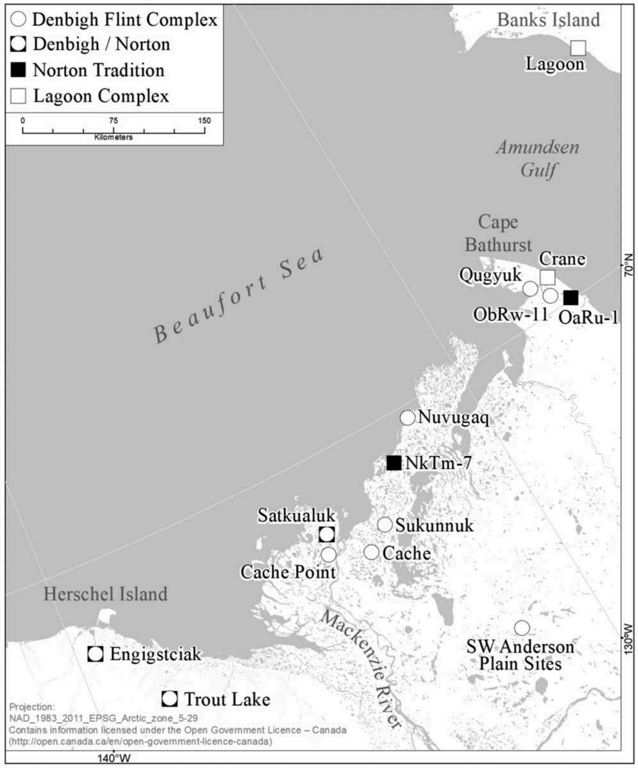

Figure 4. Paleo-Inuit sites in the broader Mackenzie Delta region.

caribou herd's calving ground on the Yukon Coastal Plain and has attracted hunter-gatherers for at least the last 11,000 years (Cinq-Mars et al. 1991), up to and including recent Inuvialuit seasonal occupations. Excavations in the 1950s (MacNeish 1956, 1959) yielded diverse and dense archaeological deposits, in contexts with such severe solifluction and cryoturbation that it was difficult to isolate specific components (Mackay, Mathews, and MacNeish 1961). However, those related to Denbigh, labelled 'New Mountain' by MacNeish (1956), are particularly common and clearly represent a repeated occupation of this near-interior location.

Overall, the Denbigh settlement pattern appears to reflect small groups with high residential mobility, and a significant level of reliance on interior resources, with caribou probably particularly important. Chronology is poorly understood; however, based on dates from early Pre-Dorset sites farther east, Denbigh occupation of the Mackenzie Delta region must have begun by 3000 BC, and interpretation of the few available dates from within the region indicates the occupation lasted at least as late as 1500 BC and perhaps as late as 800 BC (Pilon 1994).

Norton tradition

The Norton tradition, as defined by Dumond (2000) for Alaska, includes three main phases: Choris, Norton, and Ipiutak; no components relating to Ipiutak have been identified in the Mackenzie Delta region. Only five sites are identified from the combined Choris and Norton phases, though of course some of the undiagnostic surface lithic scatters may also relate to these periods. Two of these five

(NkTm-7 and OaRu-1) are small sites in near-interior locations (Le Blanc 1994a); a third, Trout Lake, is 45 km from the coast (Greer 1991). The two other sites deserve more discussion. Satkualuk, on the coast near the mouth of the Mackenzie River East Channel, contains an artefact assemblage that is consistent with a Choris phase (early Norton tradition) occupation, based on linear-stamped ceramic sherds and a range of lithic industry traits (Sutherland 2006). The seven AMS radiocarbon dates from the site cover a very wide range and may indicate that more than one component is represented. However, the most secure date, on terrestrial mammal bone from a buried context (2230 ± 60 BP; 400–120 cal BC (2 sigma); Sutherland 2006), falls slightly after the date of transition between Choris and Norton phases in Alaska.

The final site to be discussed is Engigstciak, which is the key to understanding the regional Norton tradition record. The Norton-related occupations at this multi-component site are numerous and substantial. As one indication of their density, from his excavation of only a small proportion of Engigstciak MacNeish (1959) reported over 6,000 ceramic sherds from the site's four Norton-related horizons; this number is much higher than those recovered from the Choris type site in Kotzebue Sound, Alaska (281 sherds; Giddings and Anderson 1986) and in the Norton component at Iyatayet, Alaska (ca. 1000 sherds; Giddings 1964). The few relevant radiocarbon dates from Engigstciak are not reliable; however, based on artefact attributes, the impression is of a relatively long-lived Norton occupation. This is seen most clearly in the ceramics. Cord-marked surface decoration occurs in the lowest levels at Engigstciak; this trait is diagnostic of the earliest Choris beach ridges at Cape Krusenstern in Alaska (Giddings and Anderson 1986), and thus likely dates to ca. 800 BC or shortly thereafter. Other components at Engigstciak have a preponderance of linear-stamped and/or check-stamped ceramics; reflecting general patterns of changing decoration in Alaskan sites (though it must be noted that ceramic typologies do not provide precise chronological information in Alaskan Norton contexts; Darwent and Darwent 2016). Given the lack of diagnostic Ipiutak phase artefacts, the Norton tradition occupation probably ended before AD 600; there are not enough data to provide a more precise terminal date. Following the Norton tradition occupation, we have no firm evidence for occupation of the region until the Thule migration around AD 1250; the Mackenzie Delta may have been abandoned during this period (see Figure 2).

Lagoon complex

The third Paleo-Inuit horizon in the region is the Lagoon complex. It is known from only two sites, both of which are well reported and yielded extensive artefact and faunal assemblages. The Lagoon complex has special significance for this study because its easterly location, combined with an unusual mix of material culture traits, has led to its consideration as a possible point of contact between the Western and Eastern Arctic.

The first site, Lagoon, is on southern Banks Island (Arnold 1981). Its fauna, including large numbers of migratory waterfowl, as well as seal, muskox, and other taxa are consistent with summer occupation but may also include other seasons. Arnold's (1981) analysis of material culture indicated a mix of traits, some clearly related to the Norton tradition to the west, others relating to Pre-Dorset or Dorset to the east. The second site, Crane, is located on the Cape Bathurst Peninsula in the middle of the calving ground of the Cape Bathurst caribou herd, and likely represents a summer occupation (Le Blanc 1994a). Le Blanc's (1994a) artefact analysis indicated a close connection to the earlier-excavated Lagoon site, and a similar mix of western and eastern traits.

In terms of chronology, there are 10 radiocarbon dates on caribou or muskox bones from the two sites. With the exception of one outlier, nine are tightly clustered between 2370 ± 120 and 2540

± 100 BP (Arnold 1981; Le Blanc 1994a). When calibrated and modelled in Oxcal (Bronk Ramsey 2009), this indicates occupation of these sites fell between 970 and 340 cal BC; however a date earlier than 800 BC is unlikely given the Norton tradition influence. The precise span within this range cannot be reconstructed with certainty but might only be a few centuries in length. Thus, Lagoon potentially overlaps chronologically with later Denbigh, Choris, and early Norton in the Western Arctic; and with late Pre-Dorset and Early or Transitional Dorset in the Eastern Arctic.

Erosion of the Beaufort Sea coast

In order to assess the representativeness of the Mackenzie Delta region's archaeological record, it must be understood within the context of regional geology. The Beaufort Sea area is an extra-ordinarily dynamic landscape, due in large part to the notoriously high impacts of coastal erosion taking place in the region. Rates of shoreline change throughout much of the western Arctic are a result of compounding factors such as the warming of permafrost (Jones et al. 2018), the unlithified nature of ice-bonded coastal landforms (Irrgang et al. 2019), and the rates of landform subsidence which amplify global sea-level rise effects (Solomon 2005). The Western Arctic's current form is a product of coastal processes which have been shaping the landscape since the end of the last glacial period. Long-term erosion-forcing mechanisms in the Beaufort Sea area have been attributed to periodic storm events and the protracted influence of sea-level rise (SLR) (Solomon 2005), with varied levels of intensity determined by local factors such as ice-content, surficial geology, and coastal geomorphology (Lantuit et al. 2012).

Modern rates of shoreline change have been calculated for many areas of the Beaufort Sea shore (Figure 5), with averaged erosion values as high as −10 m/a reported for some locations (Lantuit et al. 2012; Schwarz 2011). While the rates of change illustrated in Figure 5 are long-term averages calculated over variable temporal periods and spatial extents, they highlight that much of the coastal region is being subjected to appreciable erosive forces, with some locally delineated rates calculated at much higher levels in recent years (cf. Cuncliffe et al. 2019; Irrgang et al. 2019; Jones et al. 2018). Projecting further back in time, Shaw et al. (1998) noted that changes to western Arctic coastal regions would have largely resulted from extreme levels of sea-level rise following the initial retreat of glaciers roughly 15,000 years ago. They further suggested that even 7000 years ago, a substantial portion of the continental shelf along the Beaufort Sea would have been exposed, resulting in a shoreline position over 100 km further north than at present (p.368). Even when SLR rates slowed following the initial period of glacial retreat, negative uplift rates which represent areas in which the land is currently subsiding (all areas north and west of the zero isobase in Figure 5, per Tarasov and Peltier (2004)) would have continued contributing to appreciable erosive impacts in the region, removing any material traces of early lifeways. Note that the zero isobase runs directly through the Amundsen Gulf region, discussed further below. Thus, while all coastal archaeological sites in the Mackenzie Delta region are expected to be impacted by land subsidence, the situation in Amundsen Gulf varies. Most of its coasts are subsiding but in some areas, particularly at its eastern margins, archaeological site erosion is not intensified by the influence of sea-level rise.

During recent fieldwork in the vicinity of Richards Island and the Tuktoyaktuk Peninsula (Friesen 2015), many of the more recent Inuvialuit ancestral sites visited showed signs of shoreline erosion impacts. All of the more prominent coastal villages were either actively eroding or had been destroyed in the years since their initial documentation. Furthermore, three villages referred to by Inuvialuit Elders (Hart 2011) appear to have been destroyed by shoreline retreat prior to the formal recording of archaeological sites in the region (O'Rourke 2018). Given that none of these village sites

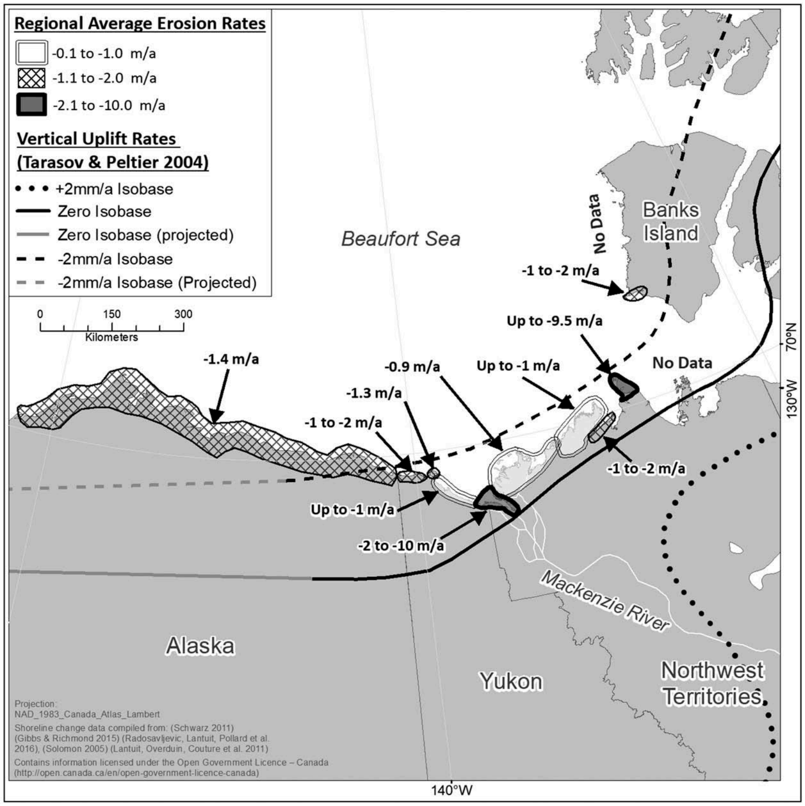

Figure 5. Erosion rates on the Beaufort Sea coast; erosion rates over the last half of the twentieth century exceed one metre per year, as indicated by the negative values. Note the zero isobase; for areas north and west of this line, the earth's surface is subsiding, leading to increased relative sea-level rise and greater rates of erosion.

are known to have been more than 800 years old, it seems highly unlikely that significantly older coastal sites would have survived.

Implications for regional Paleo-Inuit settlement patterns

Researchers working in the Mackenzie Delta region have long been aware of coastal erosion and its potential impacts on the archaeological record (e.g. Arnold 1988; Yorga 1980). However, we believe that when considered together, the archaeological and geomorphological patterns described above have even greater significance than is usually recognized. The most noteworthy pattern in the Mackenzie Delta archaeological record is the near-complete absence of coastally oriented sites during the entire Paleo-Inuit period, despite the fact that there were clearly substantial and long-lived populations in the region. The rare sites that are situated near to the modern coast, such as Qugyuk (Denbigh), usually contain faunal samples indicating a focus on terrestrial resources (Le Blanc 1994b). The Lagoon site on Banks Island is a partial exception to this pattern; it yielded a significant amount of ringed seal bone, though waterfowl and muskox were also common (Arnold 1981). Satkualuk, in the outer Mackenzie Delta, also had some seal bones in its small faunal sample (Sutherland 2006). This situation can be contrasted with the fact that in much of the rest of the North

American Arctic, most Paleo-Inuit groups had at least a seasonal coastal orientation, and many had marine-focused economies. Our conclusion is that in the main study area around the Mackenzie Delta, literally *all* major Paleo-Inuit coastal sites, probably including most winter occupations, have been destroyed by severe erosion. To put this another way: archaeologists are able to study directly only the 'interior' parts of the settlement pattern; most known sites, including lithic scatters, are probably associated with summer and fall hunting of caribou.

Consideration of the rich site of Engigstciak on the Yukon North Slope provides a particularly sobering indication of just how profound coastal site loss has been for the Paleo-Inuit period. This site is dominated by Denbigh and Norton tradition components, yet there is a complete lack of adjacent coastal occupations for either of these two periods. The outer coast is only 22 km from Engigstciak, and Pauline Cove on Herschel Island, location of substantial Thule and later Inuvialuit settlement focused on marine resources, is about 35 km away – a few days' journey. Based on our knowledge of Denbigh and Norton occupations in Alaska, it is virtually inconceivable that they did not inhabit coastal locations on the Yukon North Slope, such as at Pauline Cove. When first encountered by archaeologists, Pauline Cove contained a substantial component of Thule (earliest Inuit, dating to ca. AD 1250–1500) houses at the Washout site, directly adjacent to more recent pre-contact and contact period Inuvialuit houses (Yorga 1980). Washout, as the name suggests, has now completely washed out to sea (Friesen and Hunston 1994). It is not just possible, but likely, that these same outer coasts of Herschel Island, which provided access to rich marine life, held substantial occupations during the Denbigh and Norton periods. In fact, Engigstciak is probably a seasonal hunting camp occupied only during the summer and early fall while the Porcupine caribou herd is in the region, by people who spent much of their time on the outer coast. This is precisely the pattern for Inuvialuit settlement in the immediate region over the past few hundred years. However, given that the 700-year-old Washout site is now completely gone, it is hardly surprising that Denbigh and Choris/Norton sites from over 1,000 years earlier are missing.

A similar pattern holds in the Mackenzie Delta proper. Major Paleo-Inuit coastal winter sites are gone, and all that remains are special purpose camps, mainly in interior areas. The difference between the two areas (Mackenzie Delta and Yukon North Slope) is that in the former, special hunting camps were likely widespread since the landscape does not hold many specific locations that are particularly advantageous for caribou hunting. On the Yukon North Slope, however, Engigstciak was a uniquely optimal hunting location, thus concentrating past human activities leading to relatively dense archaeological deposits.

Turning to a consideration of the three main Paleo-Inuit periods, for the earliest, Denbigh, it is particularly difficult to infer the nature of the 'missing' coastal occupations. As noted above, Denbigh is the most geographically widespread Paleo-Inuit society in the region, with a relatively high number of sites recognized, and some sites well over 100 km from the coast (Pilon 1994). Furthermore, Denbigh-related components are common at Engigstciak in northern Yukon. Our tentative conclusion is that the Denbigh occupation of the region is relatively long-lived, with a greater emphasis on interior resources than occurred in later Paleo-Inuit periods. This is consistent with contemporaneous settlement patterns to the west (Denbigh in north Alaska) and east (Pre-Dorset in coastal and interior regions). There must have been coastal settlements in the Mackenzie Delta region, but their number and size cannot be inferred with any certainty.

For the subsequent Norton tradition, a somewhat different situation exists. For this period, a higher proportion of the known sites are near the coast, with only one site (Trout Lake) more than 22 km inland. Furthermore, the better-understood Choris and Norton settlement patterns in Alaska are more closely associated with coastal occupations, though interior and riverine resources were also targeted during both of these phases. Satkualuk on the East Channel of the Mackenzie River is instructive in this regard – it is located on a bluff overlooking flats which may represent recent infilling of open water; thus it mimics in some ways more recent beluga whale hunting sites, where lookouts were maintained on bluffs overlooking shallows. This functional interpretation is currently untestable, since the site yielded very few bones, none of which were from beluga (Sutherland 2006). We think it most likely that there were substantial coastal winter settlements throughout the region during the Norton period (Choris and Norton phases) – not a single one of which has survived.

The third period, Lagoon, remains enigmatic. With only two definite sites located east of the Mackenzie Delta, each representing mainly warm-season occupations, we do not have a well-rounded understanding of its settlement pattern. However, we believe that an important part of the puzzle relates to chronology. Calibration of the dates leads to its placement between 970 and 340 BC. This coincides with dates for the Choris and early Norton phases from Alaska; and the presence of cord-marked pottery at Engigstciak suggests that the Yukon North Slope, and probably the Mackenzie Delta, were populated fairly early in the Choris period. Thus, the temporal overlap and spatial proximity of Choris and Lagoon imply the potential for a close connection between the two; this is also emphasized by the identification of 'clinker' lithic raw material from Cape Bathurst (near the Crane site) in the Satkualuk assemblage in the Mackenzie Delta (Sutherland 2006). This was either traded from Lagoon to Choris contexts, or Choris people procured it directly, potentially bringing them into contact with Lagoon occupations. The status of Lagoon as a closely related, if idiosyncratic, extension of Choris is, therefore, reinforced.

Implications for pan-Arctic interaction

As summarized above, there are only four well-documented periods of interaction or population movement between the Western and Eastern Arctic during the past five millennia: early Denbigh/Pre-Dorset times immediately following the initial Paleo-Inuit migration of ca. 3000 BC; the Lagoon complex occupation of ca. AD 800–400; the early Thule period following the Thule migration of ca. 1250 BC; and the period of intensified trade between Inuinnait and Inuvialuit in the nineteenth century (Figure 2).

Our reappraisal of the Paleo-Inuit archaeological record in the Mackenzie Delta region indicates that there was a substantial occupation for a significant duration during several periods, despite the lack of surviving coastal sites. This makes the lack of evidence for contact between the Eastern and Western Arctic even more striking than previously understood. This is particularly so for the Norton tradition occupation, which was not only substantial but also appears to have lasted for a significant length of time beginning around 800 BC. At times, Norton tradition settlement extended as far east as Cape Bathurst and, in the closely related Lagoon complex form, to Banks Island. Importantly, the material culture from the two Lagoon complex sites are commonly understood to represent a sort of 'hybrid' of Choris/Norton phase traits with eastern Paleo-Inuit traits; in particular, those associated with earlier Denbigh/Pre-Dorset peoples in the region, and also Dorset. However, there is no clear indication that Lagoon had any significant impact on subsequent cultural developments to its East or West. It is not even certain that the closest area of the Eastern Arctic, western Victoria Island, contained substantial Pre-Dorset or Early Dorset populations at this time. Savelle and Dyke (2002) have reported fluctuating but generally low numbers of dwellings (a proxy for population size) on corresponding beach ridges, which may include some periods of full abandonment.

This is particularly germane to the one remaining period sometimes suggested as indicating a significant level of interaction between West and East: the development of Dorset culture in the Eastern Arctic in the period following 800 BC. Dorset developed from Pre-Dorset in almost precisely the temporal window identified for the Norton tradition/Lagoon complex occupations in the Mackenzie Delta region, in a process that is still poorly understood (Desrosiers 2009; Houmard 2018; Ryan 2016; Savelle and Dyke 2014). Discussions around Dorset origins sometimes raise the possibility of western Arctic influence, due to the apparent abruptness of the appearance of Dorset, and the presence of some traits in common (e.g. Fitzhugh 2002; Savelle and Dyke 2014). However, when one looks at Norton and Lagoon assemblages as a whole, they are very different from Dorset – it is difficult to trace almost any specific trait or attribute from one to the other. For example, semi-subterranean houses occur in Choris and Norton phases in Alaska, and we assume that they were present in now-destroyed sites from those periods in the Mackenzie Delta region. They are also one of the most highly visible newly-occurring aspects of material culture associated with Dorset in the East. However, the specific form of these houses is not identical, and there is a large gap in the Coronation Gulf/Victoria Island region in which they have never been found (Savelle and Dyke 2014, 273). Thus, we are currently unable to trace the transmission of this house attribute from west to east, and it is therefore quite possible that it was an autochthonous development in the Eastern Arctic. The same could be said of the similar adoption in both macro-regions of ground slate technology and ground 'burin-like tools'. Finally, recent genetic research has indicated direct continuity of population from Early Paleo-Inuit (Saqqaq) to Dorset within the Eastern Arctic without any significant level of population replacement at the origin of Dorset (Raghavan et al. 2014). Thus, while some level of western contact remains possible in influencing the origin of Dorset, if present it appears to have been limited in scope, and narrow in time frame. Ultimately, this reemphasizes the overall rarity of interaction between West and East.

Discussion: Amundsen Gulf as a biogeographic barrier

What explains this paucity of interaction, extending across millennia and a diverse set of cultures, especially given the frequent evidence for interaction *within* each of the Western and Eastern Arctic regions? The most likely explanation is that the region immediately to the east of the Mackenzie Delta, centred on Amundsen Gulf, acted as a persistent barrier to settlement. To the west of Amundsen Gulf, as outlined above, the Mackenzie Delta was occupied through large parts of the last 5,000 years. To the east, following several pulses of Pre-Dorset settlement (Savelle and Dyke 2002), two separate Dorset migrations (Middle Dorset ca. 100 BC and Late Dorset ca. AD 1000) expanded as far west as the west coast of Victoria Island, but not any farther onto the mainland coast of Amundsen Gulf or Banks Island. While archaeological survey in the Amundsen Gulf region has been limited, for the best-studied period, Thule, most sites are interpreted as very short stays by migrating groups in transit, rather than longer-term attempts at permanent settlement (Morrison 2009). In other words, the archaeological record that does exist in Amundson Gulf results mainly from occasional migration episodes *across* the region, rather than protracted settlement *within* the region.

Across the Arctic, past human occupation is tightly constrained by the density, seasonality, and reliability of faunal resources. When considered in this light, a number of aspects of Amundsen Gulf's biogeography provide a rationale for its lack of long-term settlement. Many aspects of the biology of Amundsen Gulf and the Eastern Beaufort Sea, of which it is a part, have not been studied in detail. However, the region is generally considered to have relatively low marine productivity, as seen in a relatively low biomass and species diversity of sea birds and low species diversity of marine mammals; marine fish have not been studied in detail (Stirling 2002; cf., Geoffroy et al. 2011). In terms of large marine mammals, walrus and narwhal are effectively absent; bowhead and beluga whales are present in the summers, but their movements are not concentrated in ways that allow them to be hunted reliably. Seals, the focal resource in many Arctic regions, are limited to only two species in Amundsen Gulf: ringed and bearded; the latter being relatively uncommon (Stirling, Archibald, and DeMaster 1977). The dominant species in most faunal samples from the known sites on the Amundsen Gulf coast is ringed seal (Arnold 1986; Moody and Hodgetts 2013; Morrison 2009). However, ringed seal populations in the region are subject to periodic population reductions of significant scale, as occurred in the mid-1970s and mid-1980s (Smith and Stirling 1978; Stirling 2002; Stirling, Archibald, and DeMaster 1977). This is probably linked to high inter-annual variability in snow cover and sea ice behaviour, as seen, for example, in the timing and duration of spring break-up (Galley et al. 2008).

Not only are Amundsen Gulf ringed seals subject to population fluctuations, but they are also a resource obtainable mainly in the winter (Moody and Hodgetts 2013). This leaves summer, a critically important season for all Arctic hunter-gatherer economies. While a number of resources were potentially available during the summer, two stand out as particularly important based on subsistence patterns in adjacent regions: caribou and fish (especially Arctic char). Local fish populations are not well studied; however, Harwood and Babaluk (2014) report that there is only a single river on the mainland coast of Amundsen Gulf, the Hornaday, which has a large run of Arctic char. The next large stock is over 300 km east on Victoria Island (Harwood and Babaluk 2014). Caribou are present in the form of the Bluenose West and Bluenose East herds. These herds calve in the region; however, inter-annual variability in precise herd movements, combined with longer-term herd size fluctuations that impact all caribou herds to some degree (Nagy et al. 2005), may make them an unreliable resource here. On Banks Island, muskox herds are present (Gunn, Shank, and McLean 1991); however, they are notorious in their population fluctuations and are unlikely to be a reliable resource over the long term.

In summary, while current studies do not allow a comprehensive review of the biology and archaeology of the Amundsen Gulf coast, the data that do exist indicate that it was a region where it was difficult even for technologically advanced hunter-gatherers to make a living; and perhaps impossible to settle over the long term due to fluctuations or uncertainties in the availability of most potential resources. Without a long-term occupation, there were no populations to transmit material objects or ideas from one side to the other of this 500-km stretch of coast. This situation is all the more noteworthy given our reconstruction of the Paleo-Inuit archaeological record in the adjacent Mackenzie Delta region. When the effects of severe coastal erosion are considered, we infer relatively intensive and long-term settlement during several Paleo-Inuit periods. This reemphasizes the remarkable *rarity* of contact across Amundsen Gulf, despite lengthy occupations to its east and west. Amundsen Gulf thus represents a profound biogeographic barrier to interaction, with parallels to contexts such as the Sahara Desert during dry climate cycles (Drake et al. 2011; El-Shenawy et al. 2018), Bass Strait separating Tasmania from mainland Australia (Cosgrove 1999), and some stretches of the Pacific ocean following its initial peopling (Fitzpatrick and Anderson 2008).

The costs of maintaining contact across this space were far higher than the benefits, except under exceptional conditions. Such conditions are seen in the nineteenth century interactions between Inuvialuit and Inuinnait. These trips by Inuvialuit traders were not intended to settle new areas or to obtain subsistence resources. Rather, they appear to have been targeted trading voyages across Amundsen Gulf to acquire soapstone, and perhaps copper and other items during some periods.

This, in turn, was driven, at least in part, by intensifying interaction networks in Alaska, resulting from increasing access to Russian materials including the iron that was the main trade item desired by Inuinnait. If this external influence had disappeared, the Eastern and Western Arctic may have fallen once again into mutual isolation.

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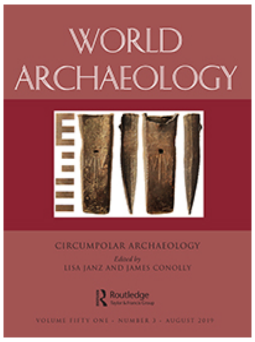

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ARTICLE

Walrusing, whaling and the origins of the Old Bering Sea culture

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ABSTRACT
For a century, archaeologists have puzzled over the enigma of successful whaling unfolding with no predecessors prior to the last two millennia. The emergence of social complexity is linked with the appearance of the Old Bering Sea (OBS) aesthetic engraved on walrus ivory implements found in sites with large cemeteries and thick middens. Significantly, many OBS sites co-occur with major haulout locations for Pacific walrus, whose procurement engendered relationships that, along with seafaring or hunting technology, were the pivotal drivers that fostered whaling. Our revision of extant ^{14}C assays to correct for marine carbon produces a younger 'Low' chronology placing the OBS florescence between AD 650–1250, with its earliest phase Okvik and allied Ipiutak communities from AD 300 to 600. The lithic technology of OBS is distinctive in its notched bifaces with affinities to 3000-year-old Chukchi Archaic assemblages. Later influences on OBS development include Ipiutak lithic technology and suggest migration, and either adversarial, or trading relationships with Alaska. The acquisition of rare commodities (driftwood, iron and obsidian) contributed to differential success and resulted in inequality recorded in burials.

KEYWORDS
Alaska prehistory; Chukotka prehistory; social complexity; warfare; radiocarbon calibration; lithic technology; obsidian

1. Introduction

The massive girth of bowhead and grey whales represented not just a calorific windfall to prehistoric hunters and their families and communities, and an equivalent boon to personal and group prestige that accrued in a heroic physical and organizational feat required for a successful capture. The whale hunt still transfixes the popular imagination and establishes a strong cultural identification for people from Bering Strait to Point Barrow (Kishigami 2013). While the precise mechanisms leading to whaling remain enigmatic, Old Bering Sea people were among the first groups, globally, to whale (Dinesman et al. 1999; Bronshtein, Dneprovsky, and Savinetsky 2016). Long known is that Old Bering Sea (OBS) arose *ex nihilo*; appearing in an historic instant, conventionally dated two millennia ago. More germane to origins of whaling was the profound influence on OBS culture, economy, and sociopolitical organization cast by the pursuit of a different quarry, walrus. Fashioned almost exclusively on walrus ivory are designs of mesmerizing complexity and dexterity (Arutiunov 2009; Bronshtein 2009; Wardwell 1986), 'a virtuosity unequalled … in the arctic' (Collins 1940, 550). More than an artistic medium, the export of ivory served as an economic linchpin that likely catalysed the entry of Bering Strait into the Eurasian world system (Laufer 1913; Collins 1937; Mason 1998, 2009). As Collins (1940, 549–550) observed

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' … probably the abundance of walrus … made possible the initial concentration of population at numerous places around Bering Strait.' Collins (1940, 549) puzzlingly minimized the dangers of walrus hunting as well as the social capital and skills necessary for walrus hunting, so evident in ethnographic and historic data (Ellanna 1988). The coevolution of human and walrus represents an entanglement (Hodder 2012), a concept that serves as a useful device to focus discussions about OBS origins. Is the walrus a keystone species (Garibaldi and Turner 2004) that catalysed complexity in Bering Strait? When and where were walrus first hunted? Did walrusing lead to whaling (Hill 2011a, 2011b)?

The Old Bering Sea culture has not witnessed a theoretical initiative to comprehend the processes of its origin (cf. Dikov [1979] 2004, 161), although Collins (1935, 467) offered a few speculations, linking it to the European Upper Palaeolithic, the Baltic Iron Age or the Ainu. Despite its aesthetic 'superstructure of local origin,' Collins (1943, 231) argued, the underlying OBS lithic technology was 'unmistakably' derived from the Siberian Neolithic of the Baikal. In a comparative approach, (Dikov [1979] 2004) favoured an immediate Asiatic, Chukotkan source. This paper is a preface to discuss the developmental processes and origins of Old Bering Sea viewed through the lens of walrus, the activities and social structures related to their acquisition, and the products resulting from them. Several avenues provide entry points: a historiographic discursion provides background on the origins of OBS research as it relates to nineteenth century industrial ivory trading, followed by a discussion of the geomorphic constraints on OBS sites, many of which are anthropogenic mounds adjacent to the walrus haul-outs. The coincidence of the earliest phase 'Okvik' with the walrus was fortuitously memorialized by Rainey's (1941, 467) use of the Yup'ik toponym: 'place where many walrus haul up.' Our analyses of OBS assemblage composition concentrates on the temporally persistent stone tools that resemble 5000 to 3000 year old assemblages associated with walrus hunters within the Bering Sea region (Schaaf 2017).

1.1 Historiographic preface: stages in solving the 'Eskimo problem'

From the outset, antiquarian interests within Bering Strait were intermeshed with the walrus. By 1865, ancient walrus ivory artefacts were objects of desire for Euro-American whalers, succeeded by curio-seeking gold miners around Nome in the late 1890s (Hollowell 2016). Local Alaska Native people obliged, securing ivory, first from ancient middens exposed by erosion, and, later, mined with shovels and picks (Hollowell 2004). The origins of the Old Bering Sea culture remain problematic in part due to these circumstances: from the 1870s to the 1920s uncontrolled digging driven by curio dealers and souvenir collectors preceded any archaeological research in Bering Strait, destroying or disturbing a considerable portion of the OBS archaeological record. Unfortunately for modern researchers, the initial scientific excavations co-occurred with this 'ivory rush' and in some cases rather than curbing the damage, archaeologists contributed to it by purchasing raw and worked ivory; e.g., Otto Geist recovered 3.6 metric tons of ivory from the Punuk Islands in the 1931 season (Hollowell 2004, 238). Uncontrolled digging and imprecise 1920s excavation techniques destroyed archaeological deposits and generated collections with confusing assemblages of items from mixed contexts. An equally complicating factor is accelerating site destruction (Crowell 1984) by subsistence diggers (Staley 1993) that reflects the commoditization of the carved objects (Wardwell 1986). In 2013, a single carved human figurine in 'black' ivory was auctioned in San Francisco for $197,000 (Hollowell 2016, 144).

2. Inferring the location of Old Bering Sea origins

Spatial extent of the Old Bering Sea culture

The centre of Old Bering Sea culture is apparent from the location of its largest sites and greatest site density (Ackerman 1984, 107–108; Dikov [1977] 2003; Crowell 1984, 38–40): St. Lawrence Island (n = 10) and eastern Chukotka (n = 12) (Figure 1), while the broadest penumbra of its influence is delineated by isolated finds. The first enigmatic OBS 'winged objects' (atlatl counter weights) were purchased at widely separated locales in 1879–80, including one near Kuskokwim Bay (Nelson 1899; Collins 1959), and two others from Point Hope (Collins 1929, 8–9, l.6; Mathiassen 1929, 45–46). By 1945, materials related to OBS or its presumed earliest phase, Okvik (Collins 1964; Larsen 1968; Van Pelt [1975] 2008, Dumond 1998) were encountered across western Alaska (Mathiassen 1929, 39–45; Hrdlička 1930, 175–177) from the Diomede Islands in Bering Strait (Jenness 1928; Morrison 1991), to Seward Peninsula along Lopp lagoon (Giddings and Anderson 1986, 104, pl. 61p), up the Tuksuk Channel on Seward Peninsula (Collins 1929, 7–8, pl. 5) and as far north as Utqiagvik (Barrow) (Wissler 1916; Ford 1959; Carter 1966). Assuming that the 19th century purchase records provide reliable provenience data, the extent of OBS penetration across western Alaska remains problematic – were the objects trade items, trophies or curios, or do they represent OBS settlements not yet sufficiently revealed through excavations? One circumstance seems conclusive, no decorated OBS object occurs more than 5 km from the coast.

OBS and Okvik are considered contemporaneous but discrete aesthetic schemata by Arutiunov and Bronshtein (1985) and Bronshtein, Dneprovsky, and Savinetsky (2016, 486), with few, if any, 'pure' sites. Several OBS objects, e.g., a harpoon head and a winged object, were excavated within houses of the Ipiutak culture at Point Hope (Larsen and Rainey 1948, 73, Fig. 14, Pl. 27:19, 20), but were dismissed as 'intrusive' by Collins (1951, 432). Following its 1939 discovery, the Ipiutak style was judged part of Old Bering Sea culture, 'employing the same [aesthetic] elements as [OBS], despite its very different lithic assemblage' (Collins 1951, 432, pl., 2). Arutiunov and Bronshtein (1985, 20) concurred: '[o]rnamentally, the proximity between OBS and Ipiutak [is] . . . .very close. The basic motifs and composition styles of OBS I are fully present in Ipiutak.'

A seminal breakthrough in delimiting the Old Bering Sea culture occurred in the 1940s when Rudenko ([1947] 1961) encountered substantial sites on the south and north coasts of the Chukotsk Peninsula, an area later evident as the OBS core. In subsequent surveys, Dikov ([1977] 2003) extended the OBS domain northwest to Kolyuchin Bay (Figure 1). Not far from Cape Dezhnev is the Paipelghak site, first explored in 2002, that reveals a well-preserved OBS assemblage (Dneprovsky 2018), 1 m below a late 13th century AD Birnirk house (Dneprovsky 2006). In recent decades, only isolated OBS decorated objects have been found on the western Alaska shore (Figure 1): one within a collapsed structure at Qitchauvik within Golovin Bay (Mason et al. 2007), another in a subsurface test pit along Ikpik lagoon (Anderson and Junge 2017) and one by a resident of Shishmaref near the village (as confirmed via email correspondence). No locality beyond the Chukotka-St. Lawrence Island core area has produced an OBS settlement or cemetery.

Researchers along the coasts of the OBS core on St. Lawrence Island (cf. Crowell 1984) in the late 1920s and '30's, such as Geist and Rainey (1936) and Collins (1937) encountered huge mounds, 6 to 8 m high, at Kiyalighaaq, Okvik, and Kukulek, with the latter comprised of two mounds extending across 250 m ['the largest mound[s] in the Bering Sea region . . . ' (Geist and Rainey 1936, 53)]. Ten major OBS sites, most unexcavated or recorded by archaeologists, were mapped in the late 1970s by Crowell (1984, 38–40) on St. Lawrence Island. The impressive high mounds are entirely anthropogenic in origin and represent accumulations of generations of house construction materials and refuse disposal; indicating sizable

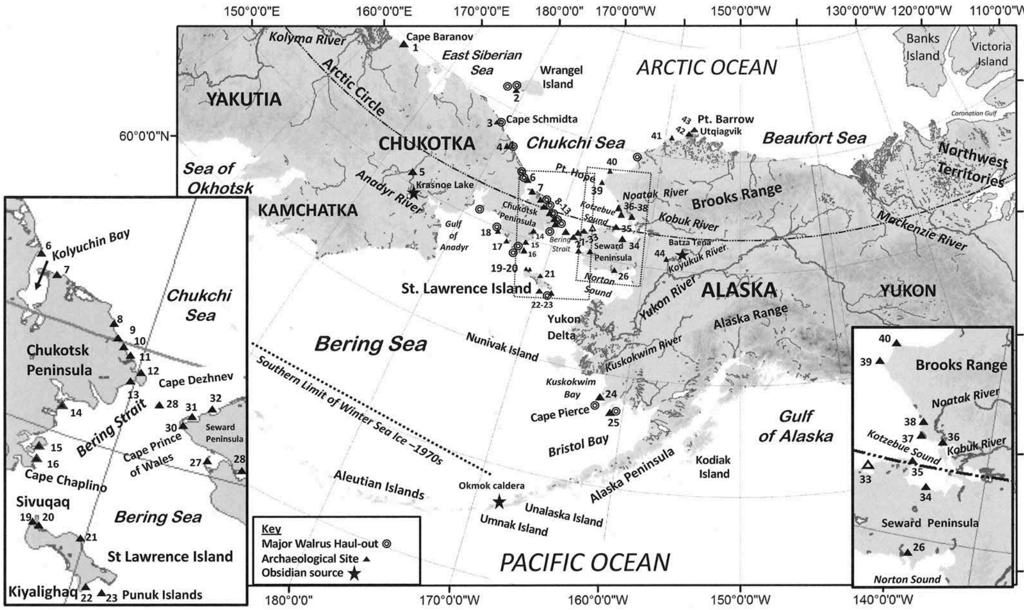

Figure 1. Sites associated with the Old Bering Sea culture and the preceding Chukchi Archaic tradition. Major seasonal walrus haul-outs (>10,000 walrus) are marked (Fischbach et al. 2016). The southern limit of winter sea ice is marked for the 1970s. Insets show areas with dense site concentrations: lower left, Bering Strait; at lower right, Kotzebue Sound, northwest Alaska. Chukchi Archaic sites plotted (nos. 2, 18, 23, 24, 1-Cape Baranov; 2-Devil's Gorge; 3-Cape Schmidta; 4-Vankarem; 5-Ust-Belaya; 6-Kolyuchin; 7-Dzenretlen; 8-Seshan; 9-Chegitun; 9-Paipelghak; 11-Uten; 12-Uelen; 13-Ekven; 14-Masik; 15-Whale Alley; 16-Chini; 17-Sirenki; 18-Un'un'en; 19-Mayughaaq; 20-Hillside; 21-Kukulek; 22-Kiyalighaaq; 23-Okvik; 24-Security Cove; 25-Qassayiq; 26-Qitchauvik; 27-Pt. Spencer; 28-Tuksuk Channel; 29-Diomede Islands; 30-Kurigitavik; 31-Lopp Lagoon; 32-Ikpik; 33-Shishmaref (isolated find); 34-Deering; 35-Cape Espenberg; 36-Tulaagiaq; 37-Cape Krusenstern (Old Whaling); 38-Battle Rock; 39-Ipiutak; 40-Uivvaq, 41-Nunagiak; 42-Kugusuguruk; 43-Birnirk, 44-Hahanudan Lake.

populations and long, continuous human occupation, although laterally extensive 'heavy sod layers' may indicate periodic site abandonment, at least at Kukulek (Geist and Rainey 1936, 45). Several mounds were under attack by storm waves at the base in the 1920s, and the deepest excavations into the 'great middens' discovered beach sand or 'sterile' clay atop gravel ca. 1 m below sea level, interpreted as marine deposits (Geist and Rainey 1936, 55, 186; Rainey 1941, 467–468). The resulting paradigm expected that clay deposits established the lower *possible* limit of occupation, yet the presence of unworked walrus bone at Okvik within the ostensibly sterile sand is noteworthy since it hints at the possibility of an earlier, pre-OBS human occupation or at least ecological conditions that would have allowed the mid and late Holocene (pre-2500 BP) human settlement of St. Lawrence Island (Rainey 1941, 468). The fact that the lower sand and clay strata were routinely excluded from archaeological testing leaves the question of earlier, pre-OBS cultural deposits on St. Lawrence Island largely unanswered. At the northwest cape of St. Lawrence Island, Sivuqaq, neither the Mayughaaq mound on the oldest beach ridge, nor the adjacent upland Hillside site (Dumond 1998) has evidence of any occupation earlier than OBS. A similar situation prevails at the easterly extreme of Chukotka, East Cape or Cape Dezhnev, with its twin sites on opposite facing shores, one on the Bering Sea, the other on the Chukchi Sea. At the south-facing Ekven site, now-eroding cultural deposits are still above modern mean sea level (Moulin 2014) and at the north-facing

Uelen mound lies on a barrier bar while its cemetery lies on an adjacent slope (Arutiunov, Levin, and Sergeev 1964; Arutiunov and Sergeev [1969] 2006.). The lesson drawn from this absence was that Okvik and OBS peoples were the first settlers along Bering Strait. The corollary is that its origin lay elsewhere, or alternatively, under the eroded deposits of a slowly rising eustatic sea level, documented by Jordan and Mason (1999) and Mason and Jordan (2001). Only a rigorous exploration in the intertidal zone can address the possibility of earlier occupations.

While the OBS settlement of St. Lawrence Island was substantial, based on the size and depth of its sites, the island should be excluded, tentatively, as a source for the Old Bering Sea culture, in view of its lack of pre-OBS archaeological sites. The search for OBS origins is thus shifted to four alternative regions (Figure 1), in order of OBS site density:

(a) the north Chukotka coast from Cape Baranov to Kolyuchin Bay (Jenness 1940);
(b) the south Chukotka coast and Anadyr River valley (Dikov 1977 [2004]; and as a corollary, the Sea of Okhotsk (Bronshtein 2009, 159);
(c) Seward Peninsula and Norton Sound (Mason et al. 2007);
(d) Bristol Bay/Yukon River delta (Fitzhugh 1988).

Dated OBS or related sites occur only in the first three regions; the fourth, Bristol Bay and the Yukon Delta, has early evidence of walrusing, as we shall see (sec. 2.3), with the persistence of OBS motifs into the Late Prehistoric period (Nelson 1899). A strong case could be constructed for the Yukon delta as a source for OBS (Fitzhugh 1988, 87), considering the common Yup'ik speech that binds Chukotka and St. Lawrence to the Yukon Delta, the centre of the Yup'ik language (Woodbury 1984, 51–56). However, relevant archaeological data from this region are completely lacking. A fifth locale is proposed by Qu (2014): central China at the mouth of the Yang-tze River, with proposed similarities to OBS iconography, e.g., the double circle motif, employed by Neolithic Liangzu coastal fishermen 5000 to 4000 years ago. Considering the great distance and absent culture links in the intervening corridor to Bering Strait between 2100 BC and the first millennium AD, or ancient human genetic affinities, we defer consideration of the Chinese Neolithic hypothesis.[1]

2.1 Chronology: the timing of Old Bering Sea origins

Antiquarians and collectors, in reifying commodity value, prefer an Old chronology for the Old Bering Sea phenomenon that emphasizes the oldest uncalibrated ^{14}C ages of 2600 to 2500 ^{14}C yr BP, a 'High' or old chronology. In a recent example, within an exhibition catalogue, Mooney (2015) placed Okvik before 200 BC with the entire OBS sequence predating AD 500. This practice reflects the persistent psychological bias of the first OBS ^{14}C assay (C-505): 2258 ± 230 ^{14}C years BP (Collins 1953; Giddings 1960, 123).[2] As is well known, uncalibrated ^{14}C assays are not reliable if marine carbon was ingested either by sea mammals or human predators; marine carbon distribution reflects a centuries long process of global oceanic circulation (Broecker 1991). Radiocarbon ages from human remains and ivory artefacts, among the most commonly dated OBS materials over many decades of research, are among the most problematic for dating, often systemically biased towards older ages. To account for marine carbon biases across Bering Strait, several research consortia have obtained multiple paired terrestrial and marine samples from similar, precise archaeological contexts. Using different data sets from the southern Bering Sea to Point Barrow, four ΔR calculations for the Bering Strait carbon reservoirs are now available, ranging from as low as ca. 200 to >500 years (Table 1). Past calibration efforts (e.g., Gerlach and Mason 1992; Blumer 2002) relied on

Table 1. R Marine Carbon Offset Calculations for the Greater Bering Strait Region.

ΔR Marine	Researchers	Location
188 ± 27	Khassanov and Savinetsky 2006, similar to Dyke et al. 1996 for the Canadian arctic	Chukotka – Eastern
460 ± 41	Dumond and Griffin 2002	St. Lawrence Island
486 ± 65 or 506 ± 69	McNeeley et al. 2006	Chukchi Sea
404 ± 111	Reuther et al. n.d.	Kotzebue Sound/S. Chukchi Sea
450 ± 84	Krus et al. 2019	North Chukchi Sea – Pt Barrow

less precise marine corrections, with larger standard errors. The insertion of ΔR values into calibration programs yields alternative chronologies of varying precision for the Old Bering Sea culture. We favour the ΔR with the lowest sigma, 450 ± 84 yrs (Krus et al. 2019) which yields a more precise calibrated age range. For humans, we assume a diet of ca. 80% marine (cf. Coltrain et al. 2016:691). Our latest corrections rely on the Oxcal 4.2 programs of Reimer et al. (2013) to calibrate the major date lists of Russian, Swiss and American researchers (Tables 2–8).

While a significant corpus of Okvik and OBS ^{14}C dates has accumulated over the past two decades, generating a robust chronology must consider several pre-existing conditions. Most OBS sites (especially on St. Lawrence Island) remain either undated or poorly dated (Rainey and Ralph 1959; Crowell 1984) so that OBS chronology is determined by a small number of sites, and relies on mortuary contexts that may not reliably track temporal or geographic trends, due to extended curation, trade or gifting behaviour (Mason 2009). Few age assignments derive from distinct episodes of site occupation – living surfaces – or individual diagnostic artefacts (cf. Rainey and Ralph 1959; Ralph and Ackerman 1961; Gusev, Zogoroulko, and Porotov 1999; Blumer 2002). Although the two cemeteries of Uelen and Ekven (Figure 1) and three archaeofaunas from northern Chukotka benefit from a large series of ^{14}C ages (Table 3, 4), nearly all are on animal and human bone that are complicated by marine reservoir effects (Dinesman et al. 1999; Flegontov et al. 2019), as discussed above. Further, many dated burials lack diagnostic grave goods (Dikov [1974] 2002,,

Table 2. Calibrated Radiocarbon Ages from Northern Chukotka Old Bering Sea sites (Dikov Dikov [1977] 2003).

Site, Feature	Laboratory No.	^{14}C yrs BP	Calibrated Age Calendar Yr BC/AD	Material Dated	Reference
Vankarem	MAG-201	870 ± 50	AD 1040-1257	Charcoal, 'burnt beams'	Dikov [1977] 2003, 188, 227]
Koliyuchin*	MAG-221	1215 ± 30	–	Wood and baleen	Dikov [1977] 2003, 188, 227]
Koliyuchin	MAG-223	1220 ± 25	AD 696-886	Charcoal	Dikov [1977] 2003, 188, 227]
Chini, house	MAG-33	1330 ± 26	AD 650-766	Charcoal	Dikov [1977] 2003, 153, 227]
Chini,* burial 5	MAG-228	1605 ± 40	–	Wood and unidentified fur – poss. sea mammal	Dikov [1977] 2003, 153, 227]
Uten**	MAG-417	1600 ± 100	AD 239-645	Charcoal	Shilo et al. 1977
Uten** burial 2	MAG-354	1750 ± 100	AD 63-535	Wood 'bed'	Dikov [1977] 2003, 169, 227
Dzhenretlen	MAG-233	1990 ± 190	476 BC-AD 527	Charcoal	Dikov [1977] 2003, 183, 227]
Seshan, buried horizon	MAG-104	2022 ± 100	356 BC-AD 217	Charcoal	Dikov [1977] 2003, 175–176, 227]

* Excluded from consideration due to nature of mixture of materials assayed.
** Incorrectly listed as Uelen in (Gerlach and Mason 1992, 75).

Table 3. Calibrated Radiocarbon Ages from Cape Dezhnev: Ekven cemetery (Dinesman et al. 1999, 128-129; Flegontov et al. 2019). Human bones were the material assayed in all the burials.

Site, Grave Number N.A. = Not available, not provided by reference	Laboratory Number	Radiocarbon Age ^{14}C yr BP	Calibrated Years AD [2 sigma]	Associated OBS diagnostic objects [illustrated in Arutiunov and Sergeev, [1975] 2006, Leskov and Müller-Beck 1993]	Reference
Ekven, burial 254	leame-818	763 ± 100	1524-1953*		Dinesman et al. 1999
Ekven, burial 230	Iemae-949	869 ± 68	1448-1953*		Dinesman et al. 1999
Ekven, burial 35	Iemae-819	939 ± 110	1321-1831		Dinesman et al. 1999
Ekven, burial 123	Iemae-698	1180 ± 80	1201-1528		Dinesman et al. 1999
Ekven, burial 49B	Iemae-689	1235 ± 88	1124-1491	OBS II ornamental plaque	Dinesman et al. 1999
Ekven, burial 255	Iemae-798	1329 ± 129	975–1465	OBS I two linehole har hd, OBS I winged obj., circle/dot, OBS I zoomorph. sculp.	Dinesman et al. 1999
Ekven, burial 251	Iemae-786	1353 ± 65	1054-1391	OBS I foreshaft OBS I hat ornament	Dinesman et al. 1999
Ekven, burial 274	Iemae-799	1361 ± 150	885-1469	OBS I winged obj.	Dinesman et al. 1999
Ekven, burial 236	Iemae-950	1365 ± 85	1029-1400		Dinesman et al. 1999
Ekven, burial 260	Iemae-800	1386 ± 81	1022-1391	2 Okvik II decorated ulu handles	Dinesman et al. 1999
Ekven, burial 251	Iemae-785	1399 ± 152	921-1512	(see above, B-251)	Dinesman et al. 1999
Ekven, burial 225	Iemae-943	1440 ± 123	876-1405		Dinesman et al. 1999
Ekven, burial 141	Iemae-674	1481 ± 72	918-1291	OBS III dual holed har hd, Naulock har hd	Dinesman et al. 1999
Ekven, N.A.	PSUAMS-5329	1485 ± 15	1009-1265		Flegontov et al. 2019
Ekven, burial 218	Iemae-948	1487 ± 82	898-1295		Dinesman et al. 1999
Ekven, N.A.	PSUAMS-4837	1600 ± 15	890-1154		Flegontov et al. 2019
Ekven, burial 143	Iemae-678	1613 ± 71	771-1195		Dinesman et al. 1999
Ekven, burial 124	Iemae-783	1634 ± 60	771-1165		Dinesman et al. 1999
Ekven, burial 285C	GIN-7144b	1640 ± 50	778-1146		Gusev, Zogoroulko, and Porotov 1999
Ekven, burial 238	Iemae-788	1667 ± 89	692-1154	OBS II winged obj. dual circles	Dinesman et al. 1999
Ekven, burial 226	Iemae-944	1683 ± 79	687-1123		Dinesman et al. 1999
Ekven, burial 63	Iemae-816	1747 ± 123	577-1147	Okvik har hds, winged obj., socket piece	Dinesman et al. 1999
Ekven, burial 301	GIN-7145	1750 ± 50	680-1009	OBS II chiselled handle	Gusev, Zogoroulko, and Porotov 1999
Ekven, burial 293	Iemae-930	1755 ± 97	605-1060	Naulock, Tuquok har hds,	Dinesman et al. 1999
Ekven, N.A.	PSUAMS-5476	1760 ± 15	695-990		Flegontov et al. 2019
Ekven, burial 302	GIN-7146	1760 ± 40	680-996	OBS II har hd, OBS II/III winged obj.,	Gusev, Zogoroulko, and Porotov 1999
Ekven, N.A.	PSUAMS-5325	1780 ± 15	683-970		Flegontov et al. 2019
Ekven, burial 285B	GIN-7144a	1800 ± 40	657–964	OBS II/III socket pc., winged obj. OBS II Offering vessel, OBS II/III, Ulu handle, OBS II, ritual handle OBS II, zoomorph. carv. OBS II	Gusev, Zogoroulko, and Porotov 1999
Ekven, burial 284	Iemae-922	1808 ± 72	670-1043	OBS II har hd	Dinesman et al. 1999
Ekven, burial 283A	Iemae-923	1873 ± 69	540-940	Meat hook w. OBS II, III	Dinesman et al. 1999
Ekven, N.A.	PSUAMS-5474	1895 ± 15	599-833		Flegontov et al. 2019
Ekven, N.A.	PSUAMS-3736	1900 ± 20	587-831		Flegontov et al. 2019
Ekven, N.A.	PSUAMS-5324	1945 ± 15	561-771		Flegontov et al. 2019
Ekven, N.A.	PSUAMS-3737	1950 ± 20	553-770		Flegontov et al. 2019
Ekven, N.A.	PSUAMS-5477	1960 ± 20	546-767		Flegontov et al. 2019
Ekven, burial 250	Iemae-784	1965 ± 73	419–822	OBS I foreshaft like Ipiutak, OBS I winged OBS I har hd, buckle w OBS II	Dinesman et al. 1999
Ekven, N.A.	PSUAMS-5475	1985 ± 20	479-760		Flegontov et al. 2019
Ekven, N.A.	PSUAMS-3738	2030 ± 20	440-691		Flegontov et al. 2019
Ekven, N.A.	PSUAMS-4836	2050 ± 15	431-679		Flegontov et al. 2019
Ekven, N.A.	PSUAMS-5328	2055 ± 15	430-675		Flegontov et al. 2019

(*Continued*)

Table 3. (Continued).

Site, Grave Number N.A. = Not available, not provided by reference	Laboratory Number	Radiocarbon Age ^{14}C yr BP	Calibrated Years AD [2 sigma]	Associated OBS diagnostic objects [illustrated in Arutiunov and Sergeev, [1975] 2006, Leskov and Müller-Beck 1993]	Reference
Ekven, N.A.	PSUAMS-5478	2090 ± 20	395-660		Flegontov et al. 2019
Ekven, burial 121	Iemae-705	2102 ± 99	213-715		Dinesman et al. 1999
Ekven, burial 285B	Iemae-937	2118 ± 84	238-681	See above: GIN-7144a, B-285B.	Dinesman et al. 1999
Ekven, burial 291	Iemae-924	2133 ± 71	220-658		Dinesman et al. 1999
Ekven, N.A.	PSUAMS-4835	2155 ± 20	314-622		Flegontov et al. 2019
Ekven, N.A.	PSUAMS-5479	2230 ± 20	224-538		Flegontov et al. 2019

Table 4. Calibrated Radiocarbon Ages from from Cape Dezhnev: Uelen cemetery (Flegontov et al. 2019). Human bones, were the material assayed in all the burials.

Site, Burial number N.A. = Not available, not reported	Laboratory Number	Radiocarbon Age ^{14}C yr BP	Calibrated Years BC/AD [Two sigma]	Reference
Uelen, N.A.	PSUAMS-5332	1695 ± 15	AD 815–1119	Flegontov et al. 2019
Uelen, N.A.	PSUAMS-3739	1765 ± 20	AD 733–1041	Flegontov et al. 2019
Uelen, burial 22	PSUAMS-1958	1810 ± 20	AD 695–1004	Flegontov et al. 2019
Uelen, burial 13*	PSUAMS-3740	2535 ± 25	88 BC-AD 248	Flegontov et al. 2019
Uelen, burial 13*	PSUAMS-1962	2560 ± 20	111 BC-AD 231	Flegontov et al. 2019

*Arutiunov and Sergeev ([1969] 2003) re-numbered graves each year of the 1957–60 excavations (e.g. 13(57), 13(58); hence, several burials may be considered no. 13. The most likely grave seems the double Burial 13(59) that was considered to be Okvik, based on a handful of objects (p, 59). However, a child's burial in 13(58) contained a distinctive Okvik bear figurine (p. 192). The objects from Burial 13 collected in 1958 were illustrated in Fig. 13 of Levin (1964).

[1977] 2003; Bandi 1984; Dinesman et al. 1999; Gusev, Zogoroulko, and Porotov 1999) or lack adequate contextual documentation (Flegontov et al. 2019); therefore, their OBS affinities may be questionable. The first significant Russian chronometric enterprise, that of Dikov (Dikov [1977] 2003, relied on charcoal or wood extracted from several sites (Table 2) in northern and southern Chukotka. Wood and charcoal, while circumventing marine reservoir issues, present other problems and may date older by decades or centuries than the desired event horizon due to the potential bias of whole tree effects and, less so, by transport delay (Alix 2005, 91) since nearly all wood in the treeless arctic is delivered as driftwood. On St. Lawrence Island, Swiss researchers in the 1960s and 1970s (Bandi 1984; Bandi and Blumer 2002; Blumer 2002) submitted wood or ivory samples associated with human remains, although many burials lacked diagnostic objects (Table 5). At Mayughaaq (Figure 1), OBS grave offerings were infrequent, as in the contemporaneous Punuk interments (Staley and Mason 2004). Excavated OBS houses at Mayughaaq (Collins 1937) were ^{14}C dated in the 1950s, using wood artefacts that were archived by the Smithsonian Institution (Rainey and Ralph 1959; Ralph and Ackerman 1961; Dumond 1998) (Table 5, 6). In addition, several ^{14}C ages are available from outlying areas on St. Lawrence Island, including the Okvik site (Table 7).

The result of our corrections and calibrations is a Low, or more recent, OBS chronology, consistent across nearly all the assays from the 1950s to 2010s, including the imprecise solid carbon and driftwood samples (Table 2–9). A possible exception is a possible early OBS presence at two north Chukotka sites (Figure 1), Seshan and Dzenretlen, that were dated by wood or charcoal in the 1970s (Table 2) (Dikov [1977] 2003, 228). Large uncertainties allow only that, respectively, the two settlements may precede AD 217 and AD 530 (Gerlach and Mason 1992). Four ^{14}C ages from other Chukotka sites (Uten, Kolyuchin and Chini) parallel the Low Chronology in evidence elsewhere, and

Table 5. Calibrated Radiocarbon Ages from Sivuqaq, St. Lawrence Island. Mayughaaq burials were excavated by Bandi (1984) and Mayughaaq houses were excavated by Collins (1937). For Bandi's assays, the radiocarbon ages follow the Conventional Radiocarbon Age presented by Blumer (2002, 104-105).

Grave Number	Laboratory Number	^{14}C years BP	Calibrated Age AD	Associated diagnostic Objects	Reference
G 11	B-3204	460 ± 70	1458-1675		Bandi 1984, 61
G X	B-894	752 ± 51	1280-1427		Bandi 1984, 61
G VIII	B-890	812 ± 70	1176-1417		Bandi 1984, 61
G 24	B-2434	822 ± 70	1165-1410	OBS II 'staff frag,' OBS I semi-winged disc	Bandi 1984, 61
G 39c	B-3209	880 ± 80	1075-1361		Bandi 1984, 61
G 16	B-2862	912 ± 61	1088-1313		Bandi 1984, 61
G 14	B-2860	922 ± 90	1033-1344		Bandi 1984, 61
G 59	B-2855	942 ± 51	1080-1285		Bandi 1984, 61
G 58	B-2850	952 ± 61	1061-1288		Bandi 1984, 61
G 50	B-2858	962 ± 70	1041-1294		Bandi 1984, 61
G 39b	B-3207	990 ± 70	1017-1281		Bandi 1984, 61
G 39a	B-3208	1000 ± 70	1005-1275		Bandi 1984, 61
G 2	B-2431	1012 ± 90	941-1291		Bandi 1984, 61
G 49/4	B-3213	1040 ± 70	948-1244		Bandi 1984, 61
G 42/12	B-3218	1070 ± 70	909-1214		Bandi 1984, 61
G 42/16	B-3210	1130 ± 70	835-1145	2 Sicco harp hds, decorated	Bandi 1984, 61
G 45	B-3214	1150 ± 80	796-1141		Bandi 1984, 61
G 42/17	B-3211	1260 ± 70	728-1011		Bandi 1984, 61
G 42/1	B-2852	1270 ± 70	720-1003		Bandi 1984, 61
G 26	B-3206	1310 ± 60	700-941		Bandi 1984, 61
G 102	B-2859	1502 ± 80	498-734		Bandi 1984, 61
G 26	B-3205	1510 ± 60	465-775		Bandi 1984, 61
G-34	**B-2877**	**2551 ± 41**	**40-490**	**Walrus ivory harpoon head**	**Bandi 1984, 61**
25 m N from NW corner, Cut 26	P-85	1002 ± 108	776-1244	Driftwood, associated with ivory harpoon head, 80–100 cm level	Ralph and Ackerman 1961, 7
House 3	P-88	1231 ± 108	634–1017	Outer pc. lg. Log,entrance (Driftwood) 2.5 m level "early Punuk period"	Ralph and Ackerman 1961, 7
House 4	P-84	1296 ± 108	558–979	Roof beam (Driftwood), associated with OBS whaling harpoon head, 1–1.4 m level	Ralph and Ackerman 1961, 7
House 3	P-80	1398 ± 116	407–886	Wood (Driftwood), associated with OBS harpoon heads 80 cm level	Ralph and Ackerman 1961, 7
Cut 7	P-71	1630 ± 230	161 BC-AD 879	Fire drills (Driftwood), 46 and 51 cm level	Ralph and Ackerman 1961, 7
Cut 7	P-93	1664 ± 150	20–642	Wood objects, (Driftwood), 37 cm level	Ralph and Ackerman 1961, 7
House 5	P-83	1013 ± 111	776–1244	Shaft, driftwood, 'early Punuk period' 1.35 m depth	Ralph and Ackerman 1961, 7

reveal two OBS occupations: one between AD 200 and 530 the other from AD 650 to 850. The more extensive mortuary record from Cape Dezhnev offers improved resolution from on Ekven (n = 46, Table 3) and Uelen (n = 4, Table 4) (Dinesman et al. 1999; Gusev, Zogoroulko, and Porotov 1999; Flegontov et al. 2019). Nearly all the Cape Dezhnev ^{14}C ages are younger than AD 500, although one Uelen (burial 13) has an age firmly prior to AD 200 (Table 4, Flegontov et al. 2019). The six oldest assays at Ekven are inconclusive because of 400 yr sigma values that extend from the early 3rd century to the early 8th century AD (Table 3). One grave, B-285B, has two assays with ranges that overlap in the late 7th century, but that could be as old as AD 280 or as young as AD 965 (Table 3). In any case, the two Cape Dezhnev cemeteries increased in use after AD 500, with an intensification

Table 6. Calibrated Radiocarbon Ages from Sivuqaq: Hillside site (Dumond 1998).

Site/Context fl = floor, under paving	Material	Laboratory No.	^{14}C yr BP	Calibrated Age AD – 2 sigma	Reference
Hillside, house 3	*Salix* spp.	Beta-78214	1100 ± 70	691-1013	Blumer 2002, 101
Hillside, house 3	*Betula* spp.	Beta-88491	1210 ± 80	654-968	Blumer 2002, 101
Hillside, house 4	Driftwood	B-892	1341 ± 61	565-770	Blumer 2002, 101
Hillside, house 2 fl	Driftwood	P-94	1393 ± 121	356-883	Blumer 2002, 101
Hillside, house 2 fl	Driftwood	P-70	1385 ± 230	76-1020	Blumer 2002, 101
Hillside, house 3	Driftwood	P-325	1425 ± 65	428-666	Blumer 2002, 101
Hillside, house 5	Driftwood	B-2872	1442 ± 80	406-680	Blumer 2002, 101
Hillside, house 5	Driftwood	B-2871	1432 ± 51	432-662	Blumer 2002, 101
Hillside, house 1	Driftwood	P-95	1578 ± 105	178-648	Blumer 2002, 101
Hillside, house 2 fl	Grass	Beta-93159	1680 ± 40	245-506	Blumer 2002, 101
Hillside, house 5	Driftwood	B-2874	1722 ± 51	138-394	Blumer 2002, 101
Hillside, house 1 fl	Grass	Beta-93160	1770 ± 40	135-379	Blumer 2002, 101
Hillside, house 3	*Salix* spp,	Beta-78213	1800 ± 90	24-417	Blumer 2002, 101
Hillside, house 5	Driftwood	B-2873	1782 ± 80	31-396	Blumer 2002, 101

Table 7. Calibrated Radiocarbon Ages from Outlying St. Lawrence Island.

Site/Context	Laboratory Number	^{14}C yr BP	Calibrated Age AD	Material	Reference
Kiyalighaaq human skin	I-7584	1661 ± 81	967-1404	Human skin	Smith and Zimmerman 1975, Blumer 2002
Kiyalighaaq human skin	P-2090	1610 ± 80	1022-1428	Human skin	Smith and Zimmerman 1975, Blumer 2002
Kiyalihgaq human skin	SI-1656	1545 ± 70	1073-1451	Human skin	Smith and Zimmerman 1975, Blumer 2002
Kukulek ivory	Beta-144992	2110 ± 40	560-957	Ivory	Blumer 2002
Okvik ivory	Beta-81490	2670 ± 60	125-390	Ivory	Blumer 2002
Okvik ivory	Beta-81489	2330 ± 60	271-706	Ivory	Blumer 2002

Table 8. Calibrated Radiocarbon Ages of Alaska sites with Okvik or Old Bering Sea objects.

Laboratory Number	Site, Feature	^{14}C years BP	Calibrated Calendar Years AD	Associated objects	Material Assayed	Reference
K-2743	Ipiutak, House 32	1320 ± 70	534-772	Flaker handle with circle and rayed motif	Antler	Mason 2006, 105; Larsen and Rainey 1948, 94
K-2746	Ipiutak, House 69	1390 ± 20	603-881	Harpoon head with Okvik motifs, 2 side blades	Wood	Mason 2006, 105, Larsen and Rainey 1948, 73
Beta-408915	TEL-105 Test pit 1, 40 cm bd	540 ± 30	1320-50, 1390-1435	OBS winged object, Punuk decorations	Charred Picea spp. wood	Anderson and Junge 2017, 114, illustrated in Fig. 6d.
Beta-142948	Qitchauvik House 1	1510 ± 40	440-635	Browband with OBS II designs	*Picea* sp. timber #17 outer rings	Mason et al. 2007, 63
Beta-142946	Qitchauvik House 1	1570 ± 40	410-585	Browband with OBS II designs	*Picea* sp. timber #15 outer rings	Mason et al. 2007, 63
Beta-142947	Qitchauvik House 1	1600 ± 40	390-550	Browband with OBS II designs	*Picea* sp. timber #19 outer rings	Mason et al. 2007, 63

Table 9. Newly Calibrated Radiocarbon Ages from the Tulaagiaq site (N0A-061), Alaska (cf. Anderson 1978).

Laboratory Number UGAMS-	Sample Identification Number	^{14}C years BP	Calibrated Calendar Years AD	δ^{13}C‰	Material Assayed
35535	NOA-061-238	1670 ± 20	335-418	−19.00	Caribou Collagen
35536	NOA-061-269	1660 ± 20	341-421	−19.17	Caribou Collagen
35537	NOA-061-277	1610 ± 20	396-535	−18.51	Caribou Collagen
35538	NOA-061–370	1660 ± 20	341-421	−18.92	Caribou Collagen
35539	NOA-061-435	1650 ± 20	343-426	−18.70	Caribou Collagen

ca. AD 700, and a plateau from AD 1000 to 1250 (Table 3, 4). Comparing the ^{14}C ages from Dinesman et al. (1999) and Gusev, Zogoroulko, and Porotov (1999) with the diagnostic grave goods listed by (Arutiunov and Sergeev [1975] 2006), we find that the OBS I, II and III styles (defined by Collins 1929, 1937) are not sequential or temporally specific (cf. Bronshtein 2002). All three OBS styles co-occur even within 11th to 13th century burials (Table 3, cf. Dumond 1998, 292). On St. Lawrence Island, our re-calibration (Table 6) of the Hillside site (cf. Blumer 2002; Dumond 1998) and the wood samples from the Mayughaaq cemetery at Sivuqaq (Bandi 1984, 64) also conforms to a Low chronology that lasts from AD 500 until 1360 (Table 5). This wood-based chronology, although rarely associated with diagnostic grave goods, complements the Ekven data set that relies on human bone: no burials were placed at Mayughaaq prior to AD 500, while seven were interred between AD 500 and 1000, and the overwhelming majority (17) buried between AD 1000 and 1350 (Table 5). In all, the Low chronology allows the construction of an emergingly robust chronology for the Okvik and Old Bering Sea phenomena.

A weak case can be offered that the Okvik culture was active as early as the 1st century AD by accepting the oldest intercept ranges of calibrated ivory and driftwood at the Okvik site (Table 7, cf. Blumer 2002, 102), assays complicated by whole tree effects. An early OBS or Okvik occupation may have occurred, as well, at Dzenretlen and Seshan. More firmly, the common ranges of Okvik assays locates its occupation within AD 300 to 650 on the Hillside, and the earliest burial (G-34) within Mayughaaq (Table 5; cf. Blumer 2002, 86; Dumond 1998, 300). Then, OBS witnessed a growth spurt during the 6th to 7th centuries across the entire region. Also concordant with this late 1st millennium age for OBS are six 1950s solid carbon ages (Rainey and Ralph 1959) from two Mayughaaq houses ('early Punuk' House 3 built atop the earlier House 4, Collins 1937, 69–76) that were both occupied AD 500–1000 (Figure 4(b)). Outlying St. Lawrence Island (Figure 1) has produced few ^{14}C dates (Table 7): at the base of Kukulek mound, an OBS decorated ivory harpoon head dated between AD 282 and 618 (Houlette 2009, 111); weren't calibrated, it is contemporaneous with both the Uelen and Hillside Okvik occupations. A younger OBS occupation occurred at Kiyalighaaq – Southeast Cape, based on the calibrated age of human tissue with OBS-design tattoos (Smith and Zimmerman 1975), between AD 1050 and 1400 (Table 7).

Along the Alaska coast from Seward Peninsula north to Point Hope (Figure 1), several localities had occasional OBS visitations or interactions at intervals from 100 BC to the 14th century AD (Table 8, 9). The presumed oldest, lacking ^{14}C assays, lies near Bering Strait, within Lopp Lagoon, and includes a whaling harpoon head with a circle-and-dot motif and is considered younger than 2400–2200 BP, the ^{14}C age of a nearby occupation of the Norton culture (Giddings and Anderson 1986, 30, 98, 104, pl. 61p). At Qitchauvik (Figure 1), on southern Seward Peninsula, an ivory browband with OBS II decorations was recovered within a 5th to 6th century AD (Table 8) Ipiutak men's house (Mason et al. 2007). At Point Hope, a century later, an Okvik harpoon head and a bone flaker were discarded within two Ipiutak (Figure 1) houses (Table 8); respectively, House 32 occupied AD 603–881 and House 69 occupied AD 534–774 (Larsen and Rainey 1948; Mason 2006). Several hundred years later, between AD 1320–1435 (Table 8), an idiosyncratic OBS winged object with Punuk designs was left near Ikpik lagoon (Figure 1) (Anderson and Junge 2017).

To summarize, our revised, calibrated OBS chronology for Chukotka and St Lawrence Island circumscribes a consistently dated early OBS, Okvik, occupation between AD 300 and 600 at four localities: Uelen, Sivuqaq-Hillside, Mayughaaq and Okvik, with relatively few dates from cemeteries and possibly reflecting a similarly low population. After AD 500, an expanding OBS population is associated with more numerous burials especially between AD 500 and 1000, a process that continued during the succeeding centuries until AD 1400, co-occurring with Punuk and Birnirk occupations (Staley and Mason 2004; Mason 2016b). This conclusion significantly expands the previously reconstructed OBS time span between AD 400 and 1100 offered by Gerlach and Mason (1992, 64) that relied heavily on only 18 assays, mostly run using the solid carbon method of the 1950s. However, the firmly established temporal priority of Okvik relative to OBS differs from the contemporaneity model of Arutiunov and Bronshtein (1985) described above (sec. 2.0). In addition, the possibility should be entertained that the earliest Ipiutak occupations *are* indeed older than most OBS occupations, an ironic twist, confirming the original intuition of Larsen and Rainey (1948) that was first questioned by Collins (1953).

3. The walrusing hypothesis of emergent social complexity

The Pacific walrus (*Odobemus rosmarus divergens*) offers its hunters a bounty, beyond its flesh consumed by both humans and dogs. In particular, the skin provides a flexible, readily processed membrane to stretch over wood boat frames. Two to three female walrus skins were required to cover an umiak, the larger 'women's' boat (Braund 1988, 51), against only one for a kayak (Golden 2015, 404–405). Walrus skin has a number of other uses, for cordage and containers and the amount of edible flesh and organs from an adult male is substantial (500 kg, Anderson and Garlich-Miller 1994, 22). The twin tusks provide a medium for sculpture, especially with iron tools (Semenov 1964), and the raw material to manufacture, as well as carve, tools such as ulu handles, pottery paddles, harpoon heads, foreshafts, socket pieces, atlatl counter weights, human figurines and animal effigies (Figure 3). Once a society moved within the orbit of the walrus, for food and material, a cultural edifice was constructed, as Hodder (2012, 95) observes ' . . . the material objectness of things tends to trap humans into specific forms of co-dependency.' The term co-dependency is justified by theorists because the walrus is an equal participant (Hill 2011b, 408), with agency, or will, all its own, as are the skin boat and other soul-animate objects (cf. Anichtchenko 2016). The bowhead, as well, acted with its will (Whitridge 2004). Walrus co-dependency led to a series of intersecting and re-enforcing interrelationships that favoured shifts in gendered craft specialization, leadership, differential success in securing surplus, in population growth and, consequently, in social status. The use of walrus ivory in mobiliary sculpture may be correlated to the risk involved in its procurement that led to a need for prophylaxis, the deployment of protective signs on the harpoon system, especially the foreshaft and counterweight stabilizer. The development of walrus-related rituals (e.g., amulets or cranial displays) is a proxy for its societal role: however, firm evidence of walrus signifying rituals does not occur after Old Bering Sea, within the Punuk culture (Hill 2017). This delayed social response notwithstanding, the long term consequences of entanglement/co-dependency must explain the success and rapid development of walrus hunting societies.

3.1 Inferences towards OBS origins: walrus and wood distribution

The co-occurrence of Old Bering Sea communities and walrus haul outs, locales used to rest or congregate onshore (Figure 1), was obvious in the 1920s along the coasts of Bering Strait, because of the adjacent anthropogenic mounds (Collins 1940, 549; Hill 2011a). However, walrus haul-outs are not permanent locations; e.g., Nordenskiöld (1885, 445) observed that northern Chukotka was walrus-depleted, but noted that a century earlier, the British Capt. James Cook had observed thousands of walrus. Collating the entire ethnohistoric record, Fischbach et al. (2016) distinguished 150 walrus haul-outs used from 1852 to 2016 on both the Bering and Chukchi Sea coasts. Chukotka offers the highest number of large haul-outs (those with >10,000 animals) (Figure 1). Haul-out density (Fischbach et al. 2016) tracks overall walrus population size and should predict successful hunting encounters. The walrus zone of Chukotka parallels the cold water, offshore nutrient hot-spots that reflect oceanographic forcing (Mason and Gerlach 1995a). Significantly, the Gulf of Anadyr, southwest of Bering Strait (Figure1), is the only area with spring haul-outs dominated by female and young walrus, a potential boon to prehistoric hunters since this age/sex cohort poses less danger than large, aggressive adult males. Five major haul-outs, all associated with archaeological sites, occur from Cape Dezhnev to Kolyuchin Bay, and three more northwest to Cape Schmidta and three southwest to Cape Chaplino (Figure 1). St. Lawrence Island has a single large haul-out (Figure 1), on the Punuk Islands (Fischbach et al. 2016). Reflecting the nutrient limitations of warm water offshore (Mason and Gerlach 1995a), the lengthy Alaska coast is less inviting for migrating walrus, with only three major haul-outs: two critical ones in the south, within Bristol Bay (Cape Pierce and Round Island), and one in the north at Point Lay (Figure 1). Several Alaska locations are striking as past haul-outs: several on the Alaska Peninsula and on or near the Seward Peninsula (Golovin Bay near Qitchauvik, Cape Douglas near Pt Spencer, King Island south of Wales, the Diomedes, and Cape Espenberg), as well as north at the Uivvaq site at Cape Lisburne and near Pt. Franklin. However, modern, or 19th century, walrus distributions may not be representative of the deeper past: a considerable amount of walrus bone was collected from the 1500 yr old Point Hope Ipiutak occupation (Larsen and Rainey 1948; Mason 2006), but presently the location is not a major haul-out. Based on haul-out density, one might postulate that intensive walrus hunting in Chukotka catalysed the development of OBS; however, present data suggest a lengthy delay and a more southerly origin for walrusing.

3.2 The antiquity of walrusing: midden proxies and archaeology

Radiocarbon dated archaeofaunas, in theory, offer a proxy that could confirm the priority of walrusing over whaling the western arctic and preceding or co-occurring with OBS. For a palaeoecological inquiry, Dinesman et al. (1999) obtained ca. 100 ages from middens at the Chegitun, Ekven and Masik sites (Table 10) across northern Chukotka, assaying the bones of bowhead, grey whales and walrus. Unfortunately, as a proxy for the priority of walrus, the results were inconclusive (Figure 2): only six on bowhead whales and ten on walrus predate 1700 ^{14}C yr BP, prior to calibration and adjustment for old carbon (Table 10). Following calibration, the age of the Ekven, Masik and Chegitun whale bone middens still cluster between AD 500 and 1000 (Figure 2), contemporaneous with the mortuary ^{14}C data from Ekven and Uelen, discussed above (sec. 2.1, Tables 3, 4). One bowhead skull could pre-date AD 1, but with calibration, its probable age can be established only within a 500 yr range, and is possibly as recent as AD 300. Similarly, the earliest walrus assay falls between AD 500–1000, younger than the oldest bowhead. We conclude that in

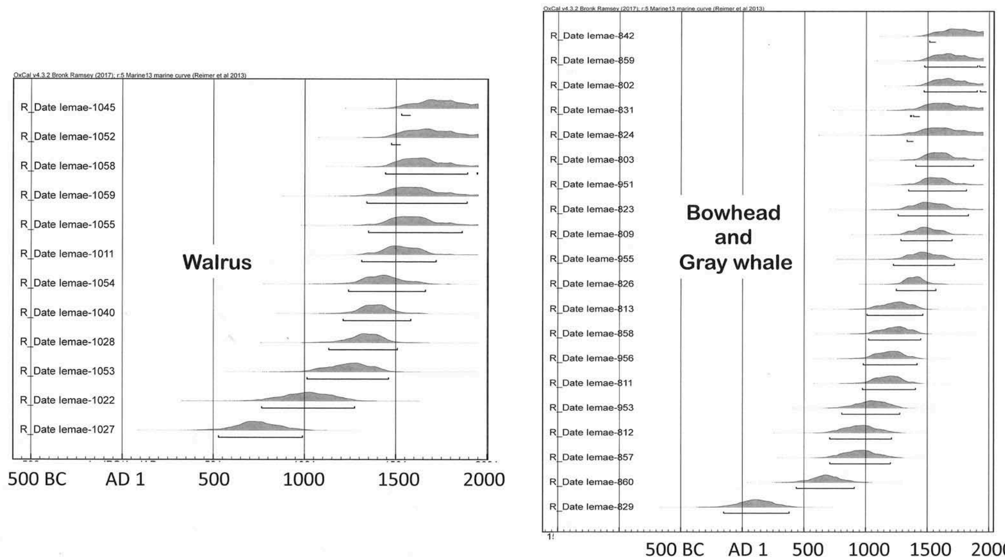

Figure 2. Plot of calibrated age ranges from three Chukotka archaeofaunas at Chegitun, Ekven and Masik. Only the assays older than 1000 14C yr are plotted. Evidence of whaling and walrusing are first recorded in those five centuries; however, no priority for walrusing can be established from the pattern of dated archaeofaunas. [Source: Dinesman et al. 1999:127-128].

Table 10. Radiocarbon Dates on archaeofaunal remains from Old Bering Sea middens in Chukotka (Dinesman et al. 1999, 127–128). Oldest uncalibrated age, ^{14}C yr BP, in parenthesis, cf. Figure 4.

Sea Mammal Species	Chegitun	Ekven	Masik
Bowhead whale (*Balena mysticetus*)	27 (1798 ± 99 BP)	31 (2166 ± 68 BP)	17 (1628 ± 93 BP)
Grey whale (*Eschrichtius gibbosus*)	27 (1809 ± 137 BP)	34 (2505 ± 129 BP)	25 (1251 ± 100 BP)
Walrus (*Odoberus romarus*)	–	27 (2111 ± 67 BP)	–
Total Number of ^{14}C assays	**54**	**92**	**42**

Chukotka, priority cannot be established for walrusing over whaling, given the analytical uncertainties of ^{14}C dating, the factors of marine carbon correction and calibration.

The chronology of early walrus exploitation is clearer in Alaska, with a crucial data point from southern Alaska at the Qayassiq site within Bristol Bay. Qayassiq sits on a bluff above the Round Island haul-out (Schaaf 2017) and is the oldest coastal archaeological site north of the Alaska Peninsula. In its basal Component I, a lanceolate chert biface, likely a spear point, was associated with a walrus cranium and wood charcoal (Figure 4) dated to 3730–3590 BC [4920 ± 40 BP (Beta-195,225) Schaaf (2017, 11, 26)]. The lithic technology of Qayassiq resembles eastern Aleutian Island assemblages termed the Margaret Bay phase (Knecht, Davis, and Carver 2001), a direct link to the Aleutian Islands that is also apparent in the presence of obsidian in Component I from the Okmok caldera on Umnak Island in the Aleutian chain, and that the subsequent Qayassiq Component II, two millennia later, parallels coeval Aleutian cultural phases: from 1420 to 1260 BC [3070 ± 30 BP (Beta-406,789)] Qayassiq mirrors a technological shift towards stemmed bifaces and ground slate (Schaaf 2017, Fig. 49c, l). However, unlike the Aleutians, pottery was produced or obtained within Bristol Bay, under the direct or indirect influence of Siberian pot-makers. Significantly, then, the conjunction of ceramics from Eurasia and Aleutian obsidian indicate that the people at Qayassiq participated in wide extra-regional relationships before 500-300 BC (Schaaf 2017, 35), as was the case in the subsequent OBS period, over a millennium later. The interval around 3000 BC (4200 BP) also marked a persistent extension of seasonal sea ice south into the eastern Aleutians, a circumstance that extended the range of effective walrus hunting (Davis 2001). In sum, the Round Island sequence serves as a yard stick for technologies associated with walrusing and provides a lynchpin for the underlying origin of Old Bering Sea technologies.

4. The origin of Old Bering Sea in relation to the lithic substratum of the Chukchi Archaic

The distinctiveness of OBS lithic technology was noticed by Collins (1935, 461): '[o]ne of the striking differences between Old Bering Sea and [the subsequent] Punuk cultures was in stone technique. The older [OBS] culture abounded in chipped stone many … merely flakes with … chipped edges' while [t]he Punuk sites … .yielded very few chipped stone implements, the great majority … . produced by rubbing [i.e., grinding]."]." Here Collins recognized two distinctive features of the OBS lithic technology: first, a simple approach to flaking sequences with many tools appearing as minimally modified flakes, and second that flaking remained a major mode of tool manufacture alongside ground or polished tool manufacture; only in subsequent periods would flaked stone become a small niche in the overall technological repertoire. However, a sharp contrast between the rudimentary OBS and the finely worked Ipiutak lithic technology was appreciated by Collins (1964, 103): 'one of the most striking features of Ipiutak is its stone industry' – the converse, the simplifying distinctiveness of Okvik lithics, in its more expedient character, did not as impress Collins or other researchers.

Within the Hillside Okvik houses, lithic tools (n = 382) consisting of chipped jasper or chert (27%) and ground slate (73%), owing to preservational factors, comprise a substantial portion ('the largest artifact group') of the assemblage (Maier [1979] 2008, 70), similar to many Okvik sites (Figure 3). The reporting of lithics is, however, uneven: while many graves at Mayughaaq had offerings of stone tools, very few were recovered within the lower levels of Kukulek (Geist and Rainey 1936, 213–233) or the Okvik site (Rainey 1941, 530-535) that was dominated by slate blades, not chert or jasper. Okvik stone tools had many functions: scraping wood and hide, drilling holes, engraving bone, and for cutting meat. Both ground slate and chipped stone bifaces are weakly shouldered or corner notched, often asymmetrical, used either as knives, lances or ulus (Collins 1937, 148, 406; pls. 40,41). Tanged bifaces were common at Hillside (Maier [1979] 2008, 78), Okvik (Rainey 1941), the Uelen cemetery (Dikov 1967) and Near-Ipiutak middens at Point Hope (Larsen 1968; Van Pelt [1975] 2008). The Okvik site had 50 corner-notched, flaked slate blades (Rainey 1941, 532–535, Fig. 32:1–3) while unstemmed lanceolate bifaces were used at Hillside, at Nunligran and Uelen in Chukotka and at Ipiutak houses and graves (Maier [1979] 2008, 79).

For the lithic assemblages from the crucial Cape Dezhnev cemeteries, only tentative conclusions are possible, owing to a lack of analysis and the limited illustration of lithics, except within the 20 Uelen burials (Figure 3) excavated by Dikov (1967). Okvik burials were more common at Uelen than at Ekven (Arutiunov and Bronshtein 1985, 17–18), (Dikov 1967; Arutiunov and Sergeev 1969] 2006.:148, as statistically demonstrated by Dumond (2008, 291). The Uelen burials contained 6–10 cm long flaked bifaces or ground stone blades, the 'heads of darts and small spears,' with a tapering tang and shoulder notching (Arutiunov and Sergeev 1969] 2006., 148); corner notching on spear points, knives and end blades was common at

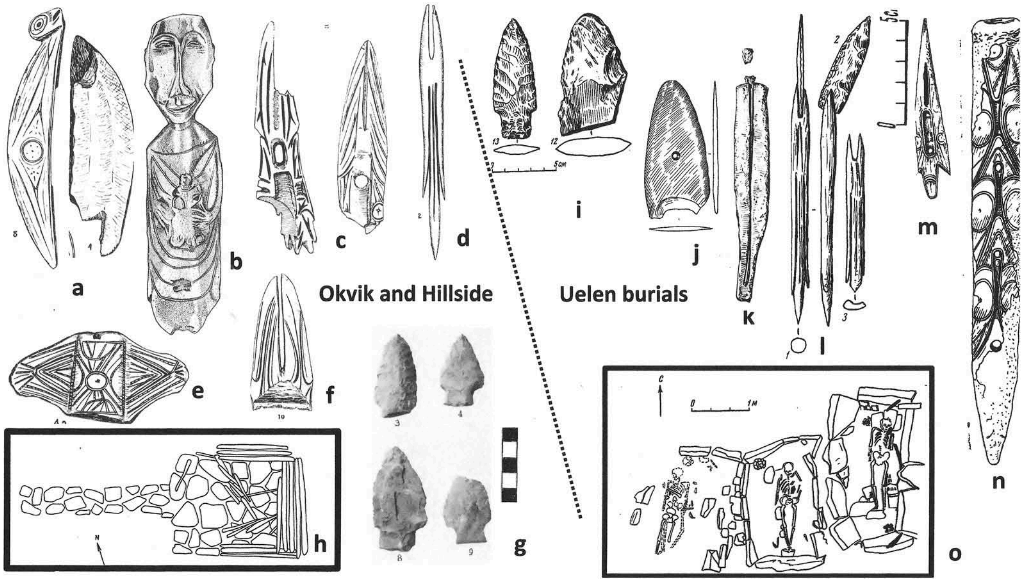

Figure 3. Diagnostic objects from Old Bering Sea assemblages at the Okvik site, St. Lawrence Island (Rainey 1941; Collins 1937) and the Uelen burials (B-) (Dikov 1967).

Left: Okvik /Hillside/ Hillside: a–Knife handle, R fig. 19:8; Slate blade Rainey 1941, fig. 19:4; b–"Okvik" Madonna, Rainey 1941, fig. 27; c–Harpoon heads with Okvik designs, open and closed socketed Rainey 1941, fig. 37; d–Ivory barbed arrowhead (R fig. 14:2) e–winged object Rainey 1941, fig. 26:4a; f–Ivory Whaling harpoon head Rainey 1941, fig. 9:10; g–Shouldered bifaces Collins 1937, pl. 40:3,4,8,9; h- Plan view of Okvik house at Hillside site Collins 1937, fig. 3.

Right: Uelen burials (Dikov 1967): i–Corner notched bifaces from B-2; j–Slate end blade, likely for whaling B-4; k–engraving tool (Levin 1964) l–Bone arrowheads with sharp barbs, lanceolate end blade, B-7; m–closed socket harpoon heads, B-4; n–Socket piece with OBS designs, B-4; o–Plan view of Uelen Burials 2, 3 and 4

Ekven as well (Arutiunov and Sergeev [1975] 2006: Fig. 61:15, Fig. 68:9, 10]. The presumably younger Ekven bifacial technology demonstrated a strong relationship with other technological traditions, e.g., Norton and Ipiutak, according to; Dikov [1979] 2004, 162–163]; cf. Dumond 2000).

4.1 The longue durée*: Chukchi Archaic notched point assemblages*

Trait comparisons of stone tools as fundamental units of analysis retain promise in the 21st century for inferring descent and technological affinities within traditions (Ramenofsky and Steffen 1998). The sample universe employed determines the mesh of inferences, as Russian researchers extend comparisons to Sakhalin and southward, and Americans examine materials from the Northwest Coast of North America; offering twin reference points for Bering Strait technological traditions (Giddings 1960). In Dikov's ([1979] 2004, 140–143, 169–170]) holistic and qualitative reading, Okvik can be separated from the OBS culture that formed later. First, an Okvik ancestry could be reconstructed from nearly all the technological substrata across Bering Strait and beyond; even in generalized commonalities with the Strait of Georgia or Kachemak Bay sequences (Dikov [1979] 2004, 142), citing Borden (1962). Okvik arrow points resembled Ipuitak to Dikov ([1979] 2004, 142), who reified one type (Larsen and Rainey 1948: Fig. 20a) over others. To Dikov, OBS technology has a 'substantial similarity [to] the Norton culture,' but its bifacial technology, especially projectile points and adzes do not resemble the Chukotkan Ust'Belaya culture (Dikov [1979] 2004, 162). However, Dikov continued, 'a measure of the "[OBS] culture can be traced to . earlier cultures …, " namely from Choris, ca. 1st millennium B.C., and [earlier, to] … the stemmed, truncated leaf shaped arrow points [of] the Old Whaling culture, early in the 2nd millennium B.C.,' defined below as part of the Chukchi Archaic tradition. The ultimate trail of affinities, over the *longue durée* indicated a 'predominance of Asiatic sources for OBS culture over American ones' Dikov ([1979] 2004, 167). Lithic technology in this perspective operates like a palimpsest of interactions and descent relationships and that common bifacial technologies suggests that several streams of influence operated over two millennia prior to the advent of the Old Bering Sea culture of Bering Strait.

In defining a Chukchi Archaic tradition, Mason and Gerlach (1995a) proposed that notched point assemblages tracked the annual walrus migration, south to north, from Security Cove along Kuskokwim Bay to Cape Krusenstern in Kotzebue Sound to Devil's Gorge in the northern Chukchi Sea (Figures 1, 4). Ackerman (1984):107, Ackerman (1988, 66–67) had earlier noted the affinities between Old Whaling and Devil's Gorge, postulating a single archaeological culture. The Devil's Gorge complex has both weakly notched bifaces (Figure 4) and a variety of retouched flakes (Dikov 1988, 86–87). The notched points from Security Cove (Figure 4) are undated and ascribed to caribou hunters (Ackerman 2004, 155), despite the site's proximity to the Cape Pierce walrus haul-out (Figure 1). Farther north, the Old Whaling occupation at Cape Krusenstern (Figure 4) was re-dated by charcoal to between 1000–800 BC (Darwent and Darwent 2005, 143) while four ^{14}C ages on charcoal place the Devil's Gorge occupation possibly earlier, 1500–1000 BC (Dikov 1988, 85), contemporaneous with the

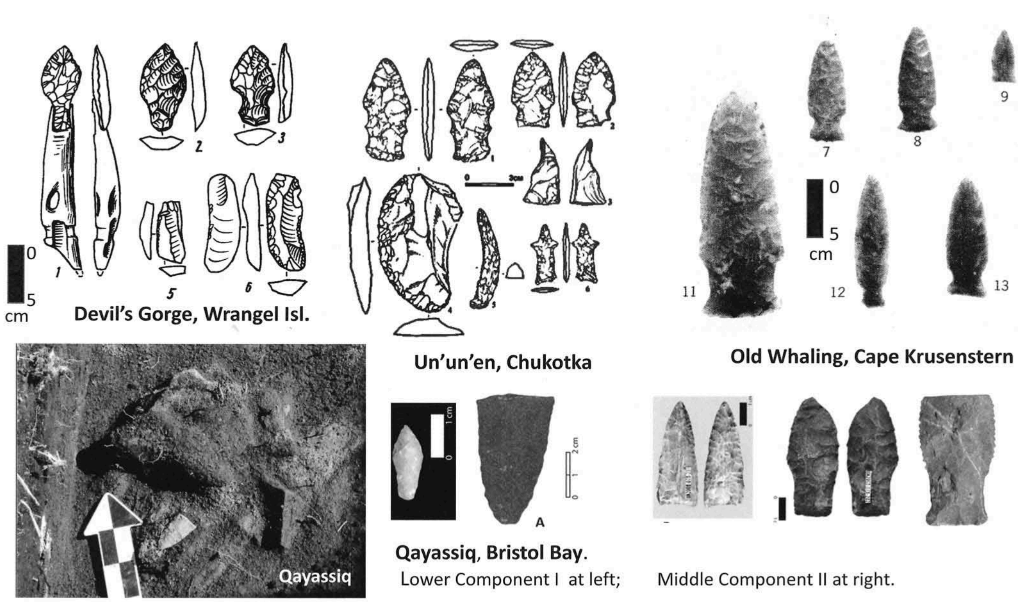

Figure 4. Bifacial technology from Chukchi Archaic sites, Qassayiq (Schaaf 2017) at bottom, Devil's Gorge (Dikov 1988), Un'en'en (Odess et al. 2008) and Old Whaling (Giddings and Anderson 1986), upper. Note the similar base treatment in widely separated sites over several thousand years.

controversial but indirectly dated Un'un'en assemblage in southern Chukotka that also contains notched bifaces (Figure 4) resembling the other sites, as well as a pictographic representation purported to whaling from an umiak (Odess et al. 2008; Pringle 2008). The Qayassiq site (Figure 4) contains stratified evidence of two millennia of walrus hunting and a transition from lanceolate to notched bifaces (Schaaf 2017); its technology, as discussed (sec. 3.2) betraying southern links to the Aleutians (Knecht, Davis, and Carver 2001). Nonetheless, its youngest age range of ca. 1250 BC leaves over a millennium until the oldest ages for Old Bering Sea occupations.

5. Discussion: social and environmental processes as contributory to the origin of Old Bering Sea

The development of the Old Bering Sea culture followed as a consequence of two or three millennia of entanglement (Hodder 2012) with the Pacific walrus, subject to a cascade of environmental, social and psychic interfaces, both exogenous and internal. At its core are a dependence on several key resources, especially wood and stone, whose availability was geographically constricted – a circumstance that occasioned inter-community collaboration, in either trade or alliance. Several practices or materials were exogenous to the OBS system, ceramic technology and iron, and whose possession lent power and status to the agents who obtained the commodities. Conflicts between competing OBS communities were fuelled by improved military technology form Eurasia (Collins 1937; Mason 2009). The processual end game of the OBS culture was formulated in its mortuary cult that emphasized cosmology, gendered position and social capital. Finally, the OBS edifice was constructed within a turbulent interval of climatic changes, the Late Antique Little Ice Age, that co-occurs with the major demographic surge of the OBS culture between AD 500 and 1000.

5.1 Watercraft and wood supply factors

The transformative role of watercraft within OBS cannot be over-stated, in its sophisticated engineering, design and elaborate production (Braund 1988). The developmental history of the iconic umiak remains obscure; in theory, it was comingled with the origin of the Old Bering Sea culture since an umiak keel was collected 1 m below surface at Mayughaaq apparently in association with OBS material (Collins 1937, 158–159). Certainly, by the 11th century AD, umiak technology is well-documented across the Bering Strait region, at least in Birnirk sites (Anichtchenko 2016, 449; Alix, Mason, and Norman 2018, 53). A geographic consideration is that 'the most difficult and time-consuming task' was procuring the 'proper driftwood tree roots' that were essential for the umiak keel (Braund 1988, 26). Therefore, wood supply was a critical factor since Chukotka, at least in the late 19th century, was poor in driftwood and dependent on St. Lawrence Island for wood resources (Braund 1988, 96). As such, driftwood accumulation areas may be a reliable predictor of early Old Bering Sea settlement locations. Nevertheless, a single boat frame might last 40 years while a skin cover required replacement every 2 to 3 years. The distance limitation of umiak travel serves as another important referent because of the water-logging of the skin hull during long haul non-stop voyaging. While St Lawrence Island lies within direct travel range from Siberia, it is too far from mainland Alaska for direct transits (Braund 1988, 97). Further, watercraft – especially the umiak – represent much more than travel by water, the project of their craft is freighted with mystical purpose: boats have agency, legacy and spirit (Anichtchenko 2016), representing an ideological shift as well.

5.2 Lithic sourcing and the role of trade in OBS origins

St. Lawrence Island provides a useful waypoint to track the flow of flaked stone raw materials, and, by proxy, other material and non-material valuables, across the Bering Strait. Suitable stone for knapping is rare, possibly unknown, on St. Lawrence Island, despite its basaltic geology (Patton, Wilson, and Taylor 2011). The source area of the chert and jasper used by OBS peoples is more difficult to determine. Small deposits of chert are known in eastern St. Lawrence Island at Myghapowit Mountain (Patton, Wilson, and Taylor 2011), but are distant from coastal settlements and are of unknown knapping quality. The apparent lack of primary reduction debris or a dominant, local toolstone among OBS assemblages on the island suggests that flaked stone raw materials were largely or exclusively imported to St. Lawrence Island from mainland sources, either Chukotkan or Alaskan. High quality chert is abundant across northwestern Alaska, a possible source (Rasic 2016).

Despite its rarity within St. Lawrence Island OBS sites, obsidian serves as a powerful referent since geochemical sourcing can establish unequivocally its provenance. OBS obsidian from St. Lawrence Island derives from two distant interior sources (Figure 1): (a) >675 km west, at Lake Krasnoe on the middle Anadyr River in Chukotka, 150 km inland (Grebennikov et al. 2018) and (b) >640 km east, Batza Tena on the Koyukuk River in Alaska, 240 km inland (Clark and Clark 1993). Obsidian artefacts occur in small numbers in OBS or Okvik contexts at the Hillside site; nearly all are from Chukotka, with a single piece from the Alaska source. No obsidian is yet reported from Ekven or Uelen, with uncertain implications. Obsidian at St. Lawrence Island indicates the extraordinary range of the exchange networks among OBS people, considering >650 km *linear* distance from both sources, with the travelled distance being much greater, implying that obsidian was obtained through down-the-line trade rather than direct procurement, in view of the interior location of the sources. At an equally broad regional scale, recall the >1000 km travel distance required for Okmok obsidian (Figure 1) to reach the Chukchi Archaic people that hunted walrus at Qayassiq in Bristol Bay, again, likely evidence of a long and indirect trade.

5.3 The acquisition of ceramics and iron and the origin of Old Bering Sea

The millennium between the Chukchi Archaic and OBS marks the flowering of Choris and Norton societies across Bering Strait (Ackerman 1982, 1988; Dumond 2000, 2016). The ceramic-using Choris and Norton cultures within northwest Alaska represent an extension of the Ust-Belaya culture of the Anadyr River (Dikov [1979] 2004) – a technological input critical to engendering OBS. Beyond storage capabilities, the large and wide-mouthed vessels reveal the need to serve a larger community (Anderson 2019, 141). The introduction of pottery, from Siberia to Alaska serves as a crucial indicator of the social binding (Anderson 2019) that led to Old Bering Sea – ceramics even reached as far south as Bristol Bay walrus hunters over 2,500 years ago during the Chukchi Archaic (Schaaf 2017).

In one extreme but plausible perspective, without iron, the art of OBS is impossible (Fitzhugh 1988, 103). The use of iron in engraving was not recognized until the microscopic investigations of Semenov (1964, 166) who proposed that only iron gravers could have produced the precise, thin and deeply inscribed OBS designs. Previously, Collins (1937, 303–304) and Rainey (1941, 561) argued that iron was introduced only during the Punuk culture, then considered younger than Old Bering Sea. Does the metal point the way to the manner of external influences? To the control of trade by individuals, 'chieftains' or walrusing or whaling crew captains. Iron of metallurgical production was obtained from Eurasia (Dyakonov et al. *this issue*), initially around AD 600, the period of OBS intensification. Evidence for iron use by OBS and its ally or competitor Ipiutak is widespread

(Dyakonov et al. *this issue*) across Alaska (McCartney 1988), consisting of corroded nubs iron at Birnirk (Ford 1959), Cape Baranov (Okladnikov and Beregovaia [1971] 2008), within a richly provided Uelen burial (Levin and Sergeev 1964, 320), at several Ipiutak sites (Larsen and Rainey 1948; Bowers 2009), with substantial iron chunks, e.g., within a Mayughaaq burial (Bandi and Blumer 2004) and at Point Spencer (Larsen 1979/80). Significantly, iron was encountered within the 6th to 8th century Ipiutak site at Hahanudan Lake on the Koyukok River, close to the Batza Tena obsidian source (Clark 1977; Gerlach and Mason 1992, 62, 72).

5.4 Evidence of warfare and interaction

Conflict and violence attended the birth of Old Bering Sea culture, as recorded by 'crouching' figures (Wardwell 1986, 68) of submission (Arutiunov and Sergeev [1975] 2006:Fig. 54:5) or in burial position (Levin 1964, 314). Arrowheads, typically of antler or bone, with aggressively shaped, needle-sharp side barbs were first obtained from the Okvik site by Rainey (1941, 546); who, in view of the absence of terrestrial mammals, thought that the design of the barbed points indicated warfare. Similar sharply barbed points are known from Mayughaaq Hillside (Collins 1937, Pl. 29, 5), Uelen (Arutiunov and Sergeev 1969] 2006.:Fig. 64]), Ekven (Arutiunov and Sergeev [1975] 2006:Fig. 67), and Paipelghak (Dneprovsky 2018, Fig 11, 4) as well as at contemporaneous Ipiutak sites on mainland Alaska (Larsen and Rainey 1948). The remarkable number of sharply barbed arrowheads is an under-appreciated feature of this period and some archaeologists have associated the tools with mundane caribou hunting activities, despite the fact that, the admittedly limited, faunal data suggest caribou were a minor component of OBS and coastal Ipiutak diets (Larsen and Rainey 1948; Mason 2006). By re-interpreting the arrowheads as weapons of war, the character of OBS is shifted in regard to social process (Mason 1998, 2006, 2016b). The complexity of the socio-political scene during the mid to late 1st millennium AD is evident from the shores of Kotzebue Sound, which were occupied by Ipiutak societies at the same time OBS groups occupied St. Lawrence Island and Chukotka. Dated to the 4th century AD (Table 9) a burial at Tulaagiaq, near the Noatak River delta, contained two burials of young children interred with nearly 300 arrowheads, as well as fishing gear (Anderson 1978). Remarkable in this case is the large number of weaponheads, and the apparently high status ascribed to these young individuals. At the Battle Rock site, named by Giddings (1967, 190) for a legendary, epic shamanic battle that occurred nearby, > 220 arrowheads, many with short, sharp barbs, were placed within a rock lined precinct of a secondary burial containing disarticulated post-cranial bones of three young men (Giddings and Anderson 1986, 177–184, pl. 104) – apparently, war casualties. Both locales were long believed to pre-date the principal Ipiutak occupations, termed Near Ipiutak (Larsen 1968), the new ages from Tulaagiaq are considerably younger, thus firmly placing the site in the Ipiutak period, making it coeval with the early centuries of the Okvik culture, a time of competition and conflict between regional polities. We conclude that men armed with Ipiutak lanceolate bifaces and arrowheads entered the OBS social system, either as adversaries or as trading partners, altering its social and technological traditions.

5.5 Migration and interaction as inferred from ancient DNA

Ancient DNA analyses offer intriguing but, as yet, only general clues about prehistoric relationships across Bering Strait; Flegontov et al. (2019) analysed genome-wide data from, and directly ^{14}C dated, 48 individuals from Alaska and Chukotka, including 19 samples from OBS burials at the Ekven and Uelen cemeteries (sec. 2.1). OBS samples group within the Eskimo-Aleut lineage, exhibiting bi-directional gene flow within Chukotka 2000 years ago: a process that involved a population that was coast-oriented, 'Paleo-Eskimo'-derived ancestral Aleut-Yupik-Inuit population, that encountered a Chukotko-Kamchatkan population from interior Chukotka, a narrative similar to Dikov ([1979] 2004) archaeologically-informed scenario. Flegontov et al.'s (2019) proposal for the development of the ancestral Eskimo-Aleut lineage is germane to our speculations about the archaic roots of walrus hunting in the Bering and Chukchi seas. The ancestral Eskimo-Aleut lineage, hypothetically, formed ca. 5000 years ago in the southern Bering Sea near Bristol Bay and the upper Alaska Peninsula (Flegontov et al. 2019); this datum co-occurs with. evidence of walrus procurement ca. 5000 BP at the Qayassiq site, providing a key linkage between genetic history, cultural and economic practices. Crucially, Flegontov et al. (2019) situate the evolution of ancestral Aleut-Yupik-Inuit within the Old Whaling and Choris archaeological cultures north of the Seward Peninsula dating from 1000 to 500 BC, posited as the immediate forebears of OBS populations that witnessed a significant amount of admixture with the neighbouring Chukotko-Kamchatkan population around 2000 BP. This sequence accords with the technological model of a walrus-tracking Chukchi Archaic (Mason and Gerlach 1995b) as well as the Asiatic model of Dikov ([1979] 2004) and that we described above (sec. 4.1). However, no genetic analyses from Old Whaling or Choris cultures are yet available and the hypothesized relationships are based primarily on their age and location being adequately close to existing aDNA data points.

5.6 Status and gender in OBS burials

Grave offerings, occasionally with carved ivories, formed an essential part of the Old Bering Sea culture; its numerous, large cemeteries are repositories of social history and, unfortunately, fodder for International collectors (e.g. Wardwell 1986; Mooney 2015). Of the >1000 graves excavated across Bering Strait, few, however, contain a bounty of grave goods, <10% at Ekven (Arutiunov and Sergeev [1975] 2006], Leskov and Müller-Beck Leskov and Müller-Beck 1993; Mason 1998) and considerably fewer at Mayughaaq (Bandi 1984; Staley and Mason 2004). The skewed disparity in grave offerings is telling evidence of status, although offerings with men and women can be similar – possibly, evidence of gender equality or inherited influence. The grave goods inform the expected narrative: those with power and status in life were so endowed in death. Political and spiritual power in OBS likely derived from successful crew leadership in whaling (or walrusing), insightful spiritual awareness (shamanic) was earned, with some inherited status, e.g., child burials with 'wealth.' The status and role of traders, in obtaining iron, obsidian or skins, is unknown, although the find of iron at Uelen accompanied a 'conspicuous,' well-endowed Okvik burial (Levin and Sergeev 1964, 320), Burial-6(59) of Arutiunov and Sergeev ([1975] 2006, 56–57). The power brokers were both symptoms of differential success and the agents that ultimately orchestrated the displays. Unknown is whether craft specialization was apparent in OBS societies, as it was in Ipiutak where some households apparently specialized in ivory carving (Mason 2006). Lacking in most OBS sites is evidence of community-wide performance within a distinct precinct as in the men's or community house (*qargi*) of later times, noting that the competing or allied Ipiutak peoples did employ the *qargi* and employed labrets for social display or representation as well (Mason 2016a).

The focus by OBS on figurative and mobiliary art was essential ['very numerous in the Okvik deposit.' (Rainey 1941, 551)], serving to define or reflect its cosmology and culture, with a certain mysticism in its production (Arutiunov 2009). Humans were portrayed and inscribed as oval headed, armless pillars, as 'Venus' figures and as two-faced, 'Janus' (Bronshtein 2009, 159). Multiple figures emerge from the sculpted ivory, with winged objects presenting the heads and bodies of transformative creatures (Bronshtein 2009, 156–159); most iconic is a small figure emerging in Burial 285B, (Bronshtein 2009, 138, 145).[3] The concept of man as a spiritual agent is the essence of OBS (Arutiunov 2009) exemplified in the transformative Okvik 'Madonna' (Figure 3) (Rainey 1941, 522, 551–552) or 'bear mother' (Collins 1969/70), an interpretation dismissed by Van Pelt ([1975] 2008, 200–201). In total, the ivory sculpture reflects the shift in consciousness as a new ontology was created (Hill 2011b), a metaphoric edifice (Hodder 2012) centred on the walrus (Hill 2017). Thus, the figurative art manifests that agency dominated the mindscape, actions that reflected the pre-eminence of the shaman ('a powerful, brooding quality that suggests unknown connections with the spirit world,' to quote Wardwell 1986, 36), the whaler, the warrior and, very likely, the trader as well. The world of OBS agency was one in flux due to climatic changes of the Late Antique Little Ice Age.

5.7 Climatic forcing

The newly derived Low Chronology presented above for Old Bering Sea places its intensification AD 500–1000, and its origin, during the Late Antique Ice Age, whose parameters for western Alaska were reviewed by Mason et al. (2019). Nearly all beach ridge complexes of northwest Alaska and Chukotka witnessed large storms, reflecting an intensification of storm energy, especially during the 5th century AD, that led to the greater upwelling of nutrients from the ocean floor and heightened marine mammal productivity (Mason and Gerlach 1995a). Nonetheless, a strictly climate determinist view cannot explain the successful actions of OBS crews and captains – the organization of labour and the technology must be available to benefit from 'positive' climate forcing. Although the chronometric data are admittedly thin, OBS nautical and hunting technology seems to have preceded the Late Antique Little Ice Age. The sparsity of any early ages lends an *ex nihilo* appearance to OBS. In view of the present heightened erosion along its shores, one must conclude that it is very likely that evidence of the Chukchi Archaic walrus hunting communities met a similar fate: site destruction through erosion and sea level rise – for decades, archaeologists have lamented the absence of deposits at Point Hope, earlier than AD 200 (Mason and Jordan 1993).

6. Conclusions

Attractive as it as a postulate, we question Hill's (2011a, 59) conclusion that 'whaling … emerged as an alternative strategy that only became viable when walrus [populations] were depleted.' The ability of prehistoric hunters to affect the populations of thousands of walrus seems unlikely, as an understatement. The cascade of co-dependency (Hodder 2012; Hill 2017) was more overpowering. Apparently, a societal disadvantage lay in any single community's ability to track or consistently follow the location of haul-outs, as Burch (1972) argued for inland caribou hunters. This disadvantage was likely mitigated by enhanced regional communication employing watercraft, and possibly by cross-community marriage or trading alliance(s) (Whitridge 1999). To revise the axiom: without walrusing, there would or could be no whaling. The conventional wisdom, that only whaling catalysed greater complexity, still holds, with a caveat: The extant chronometric data are insufficiently resolved to fully discount or confirm the walrus-hunting priority hypothesis for Chukotka or St. Lawrence Island. In southern Alaska, walrus were hunted for thousands of years prior to the hunting of whales (Schaaf 2017) and, as Chard (1962) mysteriously intuited, southwest Alaska engendered the 'Eskimo' ethnos, lent credence by recent ancient DNA analyses (Flegontov et al. 2019).

However, without a surplus, the 'economic intensification' (Hill 2011a, 59) generated by walrusing, the mechanisms allowing whaling crew's differential success to result in wealth and status would not have developed. An external kicker was necessary, according to Whitridge (1999), because the taking of a bowhead overwhelmed a small community's needs – unless the surplus could be leveraged for exchange, for other goods and values, for example, caribou skins produced by reindeer herders in interior Chukotka. Inferential evidence suggests that reindeer pastoralists entered Chukotka from southern Siberia, with the onset of whaling (Krupnik 1993, 161; cf. Okladnikov 1964, 1970); although reindeer herding in Chukotka intensified during the Little Ice Age, after AD 1600, animated by a 'conducive social climate' associated with Russian expansion (Krupnik 1993, 165).

Various lines of evidence draw any discussion of OBS origins towards Chukotka and its insular extension, St. Lawrence Island. Foremost was the reliable supply of walrus at the Punuk Island haul-out and near Cape Dezhnev. A secondary catalyst that intensified interaction and alliance formation involved the requisites of skin boat technology, contingent on the specificity of the driftwood resource, limited as it was to eastern St Lawrence Island. Further, a St Lawrence Island co-dependency with Chukotka was enhanced due to the island's limited toolstone resources, a need that was met by Alaska sources as well. The Cape Dezhnev/St. Lawrence polity – for lack of a better word, with its surplus of ivory and oil would have drawn products and people to its shores. Storage capabilities (i.e, ceramics) were also inherited from Chukotkan sources. The heritage and direction of the interacting populations can be further read in the lithic substrata of the Bering Strait – people of the walrus along the Alaskan shores. Already, ca. 1000 BC the directionality of the migrating walrus herds occasioned the organization; the agency that produced Old Bering Sea culture arose as differential hunting success was multiplied, husbanded within families and communities, marked by aesthetic currency and in response to the bounty offered by the Little Antique Ice Age of the first millennium AD.

Notes

1. As an aside, megaliths with spiral motifs employed within Korean Bronze Age cultures, probably date ca. 5000 BC (Jeon 2013, 209) offer yet another tantalizing, remote pathway over the *longue durée* for whaling across northeast Asia; at least the subsistence base bears more resemblance to Bering Strait. In either the Chinese or Korean case, even if substantiated further, a deep time origin seems of little immediate explanatory power.
2. Obtained on long-lived spruce (*Picea* spp.) wood from an Okvik house at the Hillside site, this assay was run by solid carbon methods (Ralph and Ackerman 1961). The calendar age was presented without calibration, as was standard at the time, with the age for Okvik set in quick-drying cement by Giddings (1960, 123). Only a few years later, a gas-process assay from the same Okvik context yielded an age of 1461 ± 65 ^{14}C yr BP (P-325) AD 428–666 (Ralph and Ackerman 1961, 7). Dumond (1998, 274) offers an extended discussion of the alternative dating possibilities.
3. The transformational winged object with a head emerging is from Burial 285B, which contains two ^{14}C ages (Gusev, Zogoroulko, and Porotov 1999, Table 1), calibrated Table 3, the youngest, likely most reliable is 1800 ± 40 BP (GIN-7144a), AD 855–1260.

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No potential conflict of interest was reported by the authors.

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