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Flexible approaches: Adapting analytical techniques and research designs to suit variable landscapes and cultural structures

Humanity is highly adaptable based on evidence from regional culture histories, dominant climatic patterns, ecosystem availability, and subsistence practices. Astounding resourcefulness in solving short- and long-term challenges is routinely demonstrated by cultural groups pursuing variants of agro-pastoralism, hunting, fishing, gathering, and horticulture.

Pursuing specific economic strategies often leads cultural groups to exhibit similar patterns of social organization and material culture. Observation of this trend has led anthropologists to note, and archaeologists to infer, that describing a population based on socio-economic structure allows readers to extrapolate broader patterns of behavioral and cultural patterns. The interpretive value of such analogies lies in the degree of similarity between the organisms or structures being compared; an assumption that may not be equally valid under all circumstances. In archaeological literature there is persistence of socio-economic categorizations (e.g., hunter-gatherers, pastoral nomads, and sedentary agriculturalists); perhaps due to explanatory efficiency but perhaps determined culturally according to the norms of Western culture.

The assumption that there will be identifiable modes of cultural structure and patterns of behavior often serves as a starting framework for the integration of analytical techniques. Challenges frequently arise when the analytical method used is based on an explanatory framework infused with assumptions that are poorly suited, or not valid for the given region, time, or population under study.

Most of the Earth's landmass is located in the northern hemisphere, where arctic, boreal, and sub-boreal environments dominate. Archaeologically, this vast territory is characterized by long sequences of hunter–gatherer adaptations which in many places retained their viability until historical times. There are also a host of localized ecotones that provide seasonal access to resources that are more broadly expected to relate to specific climatic zones, or provide mutually exclusive modes of subsistence.

For example, portions of Scandinavia and Japan support both grain agriculture and seal/whale hunting, one requiring temperate conditions, the other ice floes, with the results being myriad combinations of reliance on domesticates and wild resources and the maintenance of technological suites and socio-economic structures necessary to provide both flexibility and labor organization to survive (Friedman, 2012; Pinhasi and Stock, 2011; Temple, 2010).

Environmental conditions favoring preservation of organic materials such as human and animal osteological remains, organic residue on pottery, hides, and textiles allow for the application of various new methods in the archaeological sciences. Consequently, research on northern hunter–-gatherer adaptations has recently seen a period of dynamic growth in the development and application of scientific techniques in archaeology (e.g., chemical techniques for diet, mobility, and chronology, artifact sourcing, genetics, bioarchaeology, cultural exchange models, GIS models, and geophysical methods). Many of these techniques were developed within the intellectual framework of non-historical sciences and only demonstrated archaeologically on select regions and periods of time.

Studies of northern hunter-gatherer groups have forced a reexamination of analytical methods, as gaps appeared between material culture available, the potential scientific data contained in a given assemblage, and the research questions being asked. This explanatory gap is often the result of differences between the underlying assumptions and the capabilities of analytical techniques to be applied in new and different ways from established examples.

This special issue presents current scientific research on northern hunter–gatherers in Eurasia and North America with emphases on novel techniques, integrative approaches, modeling of hunter–gatherer adaptive strategies and behavior, examination of the underlying theoretical assumptions related to archaeological scientific techniques and how explanatory structures must be adapted in order to address specifically some of the unique complexities relating to reconstructing the behavior of hunter-gatherers.

This special issue is structured in order of scale of analysis, starting with large-scale studies. The ultimate goal is to help produce a clearer picture of how researchers approach the intellectual nuances of analyzing northern-hunter-gatherers at the scale(s) of individual life-history, site-specific, and regional/population levels of analysis comparable with traditional archaeological assemblages.

One aspect of research often thought of as unique to hunter-gatherers is colonization of unpopulated territory (Kelly, 2003). The arrival of new predators will impact any ecosystem, leading to disruption and eventually a new balance. Humans are distinct from other predators in that they can simultaneously influence a variety of floral and faunal environmental factors. Insofar as environments without previous human histories (e.g., North America prior to Late Pleistocene deglaciation) the reaction to the arrival of new predators has often been portrayed as catastrophic. Humans have been deemed responsible for large-scale ecological collapses in many regions (e.g., Australia, New Zealand, Madagascar) (Burney and Flannery, 2005).

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New human inhabitants have to learn and adapt to a combination of familiar niches and resources, and alien territories in terms of raw material acquisition and unfamiliar floral and faunal risks. The story of how humans interact with new environments will be more complex than either complete destruction upon arrival, or the simple imprinting of previous patterns of ecological exploitation in new regions. The question is not whether humans will have impact(s), or that they may well be catastrophic for floral and faunal communities, but rather that we must recognize that newcomers will not be operating "optimally" and there will be behavioral peculiarities with the archaeological evidence of colonization. Examples of oddities would be characteristics like the preferential use of distant raw material sources when local sources of equal and greater quality may be available but difficult to locate, or the avoidance of faunal/floral resources similar to those used in ancestral lands but potentially unfamiliar in new landscapes.

There are however multiple ways in which the concept of colonization can be characterized, through the progression of exploration, learning curves in unfamiliar territory, expedition(s), ephemeral settlement, and eventual settlement persistence (Rockman and Steele, 2003). Expedition(s) by people seeking resources may entail a high degree of mobility for many generations. This will make it difficult to identify the difference between an ephemeral site, chosen for sufficiency and re-used over extended periods of time, and the intentional choice of settlement and/or interaction sites (e.g., potlatch sites) that will be influenced by cultural as well as environmental interactions.

Kitchel (This Special Issue) uses lithic sourcing on chert quarries in Maine, Vermont, Massachusetts, New Hampshire, and Quebec to pursue goals of analytical refinement and settlement model testing. Researchers sourcing chert, and other cryptocrystalline silicates, have had highly variable success with geochemical methods of provenance analysis, dependent largely on regional geological histories. Visual identifications for regional chert sources have suggested that colonizing groups were rapidly familiar with their landscape. If these groups were familiar with the landscape however, then can they still be thought of as explorers or colonizers?

Clear recognition of raw material sources through geochemical, petrographic, or other indisputable means are central to being able to analyze material procurement strategies, so the demonstration that a given geochemical method (i.e., EDXRF) can discriminate between sources is an important element to the analytical side of this research. Once proven effective, it can then be used to investigate the visibility of aspects of the landscape learning process attributed to colonizing groups. In this case, by the time regional populations were archaeologically visible, their familiarity with the landscape was sufficient to have already surpassed the early stages of the colonization process.

This process of landscape learning and adaptation is not unique to hunter-gatherers, and process by which we examine archaeological evidence under circumstances where prior human evidence is absent improves our ability to analyze situations that may include technologically limited colonization. Northern British islands (e.g., Orkneys, Hebrides) show scant evidence for Mesolithic human presence, with long-term colonization not occurring until the Neolithic and requiring substantial adaptation of modes of subsistence that rely on more moderate conditions than are generally experienced there. For example, lacking adequate pastureland, Orkney sheep adapted to eat seaweed as a result of foddering and/or land use practices (Balasse et al., 2009; Jones and Mulville, 2016; Schulting et al., 2017). Several steps of colonization did occur in this region, but the rewards of settlement in this region were apparently not outweighed by the costs of material and effort in pursuing these environments. Another possibility is simply that exploration inadvertently eliminated the desirable plant, terrestrial animal and coastal resources (i.e., shellfish). The returns rates of this landscape were thus lower than other potential areas, discouraging settlement until demographic pressure of technical solutions changed circumstances (cf. Bettinger, 2015).

The reliance on domesticates precludes characterization of these Neolithic colonizers as hunter-gatherers, yet genetic information on red deer (*Cervus elaphus*) populations in the Orkneys(Stanton et al., 2016) and Ireland (Carden and Edwards, 2012) demonstrate that they were brought from the continental mainland by Neolithic colonizers. Without this genetic evidence, recognition of wild faunal materials could easily support conclusions of hunter-gatherer modes of subsistence in use in the region. Instead, we have to recognize that late Mesolithic and early Neolithic populations in the north Atlantic had intimate relationships with species that researchers are not traditionally familiar with identifying as humanly-moderated wild hunting stocks, or even as potential domesticates (cf. Sturdy, 1975).

The situation on the Orkneys is not radically different from the process by which arctic and subarctic hunter-gatherer groups became closely tied to reindeer/caribou (*Rangifer tarandus*) herds, through the process of hunting, familiarization, and ultimately shifting to nomadic pastoral control of previously wild reindeer stocks in some regions, while retaining periodic hunting on a mass-scale in other regions (Anderson, 2000; Binford, 1983; King, 2002). Landscape modification (e.g., Innes and Blackford, 2003; Innes et al., 2010; Simmons and Innes, 1987) is more often associated or directly attributed to agricultural groups, yet plays a strong role in their ability to survive in both hunting and pastoral groups.

In regions with strong ethnographic histories (e.g., Canada, Siberia, United States), this insight is often conflated with the overuse of analogies to explain prehistory. The production of storable surpluses is often attributed primarily to agro-pastoral groups.

Groups were argued to have had storage/intensification capabilities using similar socio-economic structures with animal products (e.g., salmon, bison, and reindeer) to those observed during ethnographic periods. Explanations for the similarity in long-term provisioning were often asserted to depend on links larger agricultural cultures as trading partners. Understanding that there were radical alterations of behaviors in prehistory or that intensification could occur in situ without the impetus of external trading and cultural influences from more sedentary groups still meet with skepticism. The reality that the domestication of the horse in Eurasia, and that the reintroduction of Spanish horses in North America radically altered indigenous behavior in both individual group subsistence decisions and spheres of cultural interaction that spanned the continent is becoming increasingly recognized (Anthony, 2007; Wood, 1998).

Bethke et al. (This Special Issue) investigate the extent to which social modification of the landscape enabled (or encouraged) the abilities of populations to organize and execute bison mass-harvests to produce storable surpluses for difficult winter hunting conditions and for products tradable to populations peripheral to the plains where horticultural efforts led to regional population centers and viable markets for bison-hunters. This research team integrated magnetic surveys with targeted excavations, and a faunal analysis strategy aimed at honoring the cultural sensitivity of the region, to preserve the integrity of subsurface deposits, and specifically address the extent to which processing efforts represented intensified methods and how they changed over time. The analytical challenges in this case centered around ensuring that remote sensing techniques could adequately address large-scale questions of prehistoric patterns of land use and that faunal analysis could detect behavioral changes without extensive excavation. Tailoring landscape scale surveys and research techniques to identify changes in a dynamic culturally-modified natural environment is difficult, but the results of this study both demonstrate the effectiveness of the effort and the utility of incorporating multi-tiered research strategies for problems that impacted regional landscapes.

That analytical method(s) can influence the outcome of research investigations should come as no surprise. The extent to which the availability and choice of methods can dictate future understanding and discussion of regional prehistoric behaviors is perhaps less well recognized. At the Kutoyis Complex (Bethke et al., This Special Issue), it was already understood that large scale bison hunting and processing were occurring well before the arrival of European horses or trade goods. Integrating regional landscape-scale surveys with a research goal of ascertaining the production goals of the types of processing sites identified in the region helped to demonstrate that intensification of processing techniques was underway to produce storable and tradable goods instead of some variant of a local group maximizing their butchery skills on an organized hunt as an infrequent success. Literature regarding mass-kill sites (cf., Brink, 2008; Ives, 1990; Wood, 1998) has asserted that these events were rare or even impossible prior to the availability of horses to help herd and guide bison to kill zones, yet archaeological evidence clearly demonstrates that this was not the case and that regional cultural histories had already produced an intensified economic processing system that was further advanced by the later adoption of horses (Ives, 1998; Wood, 1998).

In England, a similar landscape-scale mystery has been perpetuated in research literature for many decades. Star Carr is a well-studied Mesolithic site with rich material culture and a puzzling absences of fish bones as compared with contemporary Mesolithic sites (Conneller et al., 2012). Lacking archaeological evidence for fish bones, even inferences drawn from material culture proxies for fishing technologies and/or material prerequisites for large scale fishing in the region could only be discussed as parts of a trade system as there was an absence of zooarchaeological data to support regional fish exploitation. Archaeological evidence is inherently biased by taphonomic processes that dictate what survives; however, these records are then further biased by the recovery methods employed. Flotation systematically applied to archaeological research in concert with a reexamination of use-wear on tools has not only discovered that fish were present at Star Carr (Robson et al., The Special Issue), but also provided insight into the species exploited and processing techniques employed during the Mesolithic. Integrating these lines of evidence with spatial analysis has further evidenced how patterns of site-use and consumption behaviors can influence archaeological evidence.

This type of problem, where an absence of evidence gets presented as evidence for absence, is not unique to England. Similar circumstances are found in Cis-Baikal, Siberia. Here, faunal materials and skeletal elements from species such as red deer (*Cervus elpahus*) and moose (*Alces alces*) that were converted into various tools and combinations of carvings and figurines depicting cow-moose in particular were recovered from cemeteries. This suggested that large terrestrial herbivores were central to middle Holocene subsistence economy and cultural symbolism. This led to culture historical patterns of Neolithic and Bronze Age behaviors focused on hunting (Okladnikov, 1950, 1955; Weber, 1995). The story became more complicated because of routine recognition that both abundant and complex fishing technology was present throughout the Neolithic and Bronze Age assemblages, in proportions and level of technical proficiency that did not support a hunter culture focused on large terrestrial herbivores, but rather one that incorporated substantial aquatic resources into the diet.

Faunal reconstructions were limited in the region and a zooarchaeologically-focused recovery effort at Ityrkhei, in the Little Sea micro-region of Cis-Baikal, yielded abundant fish bones (Losey et al., 2008). Flotation and fine sieving at other sites, along with extensive isotopic dietary reconstructions have also evidenced the harvesting of fish as a regionally important subsistence activity (Katzenberg and Weber, 1999; Losey et al., 2012; Novikov and Goriunova, 2005; Scharlotta et al., 2016; Weber et al., 2002; Weber et al., 2011). At present, research efforts addressed what methods and species were of importance in the social complexity observable throughout the region and the extent this dietary focus impacted regional chronologies, as fish consummation impacts old-carbon reservoir effects (Nomokonova et al., 2013; Schulting et al., 2014; Weber et al., 2016).

Aligning multiple lines of proxy evidence for more comprehensive understanding and explanation of prehistoric behaviors is tremendously beneficial, providing internal verification of the inferences drawn from a single line of evidence. Multi-tiered and multi-proxy research approaches also help to eliminate the risks of missing evidence that can result from diagenetic, taphonomic, and recovery methodological impacts. In Mesolithic Scandinavia (Eriksson et al., This Special Issue), both the risks and rewards of employing different proxies is demonstrated. Interments on opposite sides of a river, with contemporary radiocarbon dates, were recovered from a complex cultural landscape that could be presented as either prioritizing similarities in mortuary treatments, or differences in material culture. Four different isotopic series were analyzed in both human and faunal materials to investigate the sources of variability. Sulphur isotopes failed to produce useful results. Faunal materials were not transported over large distances as indicated by strontium isotopes. Both of these series could have presented problematic results if not also assessed along with carbon and nitrogen isotopes. These dietary isotopes indicated a stronger dietary use of aquatic resource than evidenced by faunal remains and helped to demonstrate that the sulphur results were not in line with other isotopic data. The intriguing results were that the childhood origins of individuals interred at two cemeteries were completely different in spite of geographic proximity and similarities in dietary behavior and material culture. Additionally, this difference in adult mobility is visible in spite of the dampening effects of aquatic resources, prominent in Mesolithic diets.

Returning to Cis-Baikal, a similar multi-proxy research approach was being pursued, though with different goals. Terminology associated with studies of migration and mobility is frequently conflated in geochemical literature. The goal(s) of Scharlotta (This Special Issue) were to highlight how technical advances in how skeletal materials are chosen for geochemical analysis and the analytical protocols followed can influence the explanatory power of the resulting dataset. Reducing sample sizes necessary for analysis are beneficial for multiple reasons, in this context the greatest value is in refining the time scale of individual behaviors being studied so that annual and sub-annual blocks of time are being accessed, with chronological precision suitably refined to make credible arguments for mobility practices instead of being limited to questions relying on permanent, life-changing events that should be termed migration.

Refining the level of analytical precision to both chronology and behavioral proxies allows clear answers to questions about whether people were moving themselves, or moving food and raw material(s).The types of cultural structures and group interactions that can be reconstructed using a combination of individual life histories and chronologies that span generations or centuries can differentiate between information/resource sharing visits and kinship practices that are otherwise only visible in ethnographic records.

Expanding on the scale of analysis needed to track movements of varying geographic scale and temporal permanence are questions about who is moving and why. Genetic analysis is powerful in this regard as kinship networks play a central role in hunter-gatherer societies (Ives, 1998). As we saw in Scandinavia, even contemporary cemeteries on opposite sides of a river can represent different populations. Co-existing populations practicing only marginally different subsistence economies or degrees of social interaction with outside groups can have surprisingly different outcomes over multiple generations as a result of the vagaries of subsistence practices, information and spouse-sharing networks.

In Cis-Baikal, the results of Y-chromosomal DNA research have produced surprising results for paternal affinity at different cemeteries. Moussa et al. (Special Issue) note that two major cemeteries in the Angara drainage and southern Lake Baikal share paternal descent from a common ancestor. This would suggest that a relatively small settlement population replaced previous regional inhabitants and spawned a large portion of a regional cultural historical tradition. This contrasts with mitochondrial DNA research that shows genetic separations between smaller cemetery populations and phases of cemetery use. This would suggest greater incorporation of earlier Cis-Baikal populations, or minimally the females. Future work in the region will aim to correlate the mobility/migration records provided by geochemistry with this type of DNA data to reconstruct regional kinship networks.

Although the primary goal of aDNA work in Cis-Baikal was to determine the relationships between the populations attributed to different micro-regions and cultural historical groups, there was recognition that allele markers common in North American native groups are also present in middle Holocene Cis-Baikal. This provides good evidence that the progenitors of both Neolithic Siberian groups and North American colonizers were closely related. This information should not be conflated with the idea that Cis-Baikal populations directly colonized either northeastern Siberia, or North America. There was substantial admixture and genetic drift over the millennia and it is unlikely that there was extensive genetic flow between Cis-Baikal, the Siberian Artic, the Russian Far East, or any part of North America after these groups separated and became isolated from one another by distance and geographic barriers.

Initial settlement of Cis-Baikal and Arctic Siberia precedes the early Neolithic site by more than 20,000 years (Goebel, 1999; Kuzmin and Keates, 2005). Admixture, migrations, and climatic shifts among other factors have impacted the population affinities, densities, levels of interaction, and historical territories. To investigate the temporal depth of the lineages of contemporary indigenous Siberian populations, Lee et al. (This Special Issue) applied mitochondrial genetic techniques to human remains from four sites between the Yana and Kolyma rivers, well within the Siberian Arctic. The skeletal materials covered the chronological range from 27,000 years ago to ethnohistoric times, so provided a good proxy for large scale fluctuations in Siberian genetic diversity. Haplogroups were identified, showing genetic continuity for 8000 years or more in Siberia, supporting conclusions that particularly northern Siberia was largely depopulated during the last glacial maximum (LGM).

This timing of the origins of the genetic lineages that dominated middle and late Holocene archaeological sites in Siberia, and is still identifiable in contemporary indigenous Siberians is very exciting. So too the timing as the Mesolithic-Neolithic transition in Cis-Baikal is near this 8000 year marker and further supports migration of new population(s) throughout major areas of Siberia when climatic conditions improved.

Part of the story of genetic research on early Siberian arctic and subarctic sites is that of excellent preservation. The same conditions that make human adaptation all the more impressive help to preserve organic materials that are lost at the overwhelming majority of archaeological sites. Characteristic of this point is the research by Britton et al. (This Special Issue) at Nunalleq, Alaska where stable isotope analyses could be conducted on archaeological hair fragments from non-mortuary contexts. Mummified remains and select other burial conditions such as bogs will preserve hair and other soft tissue, but the specialized conditions necessary make these materials quite rare. This is unfortunate because they contain highly detailed records of dietary behavior that are crucial for hunter-gatherer populations with variable diets. This research also represents a case study where sulphur isotopes were effectively used to demonstrate mixed aquatic consumption patterns that would be extremely difficult to accurate infer from faunal remains, or homogenized bone isotopic data.

Further extending the research into isotopic composition of human hair, zooarchaeological materials were analyzed from Nunalleq to investigate the validity of viewing dogs as dietary proxies for human paleodiet in high-latitude societies (McManus-Fry et al., This Special Issue). Dogs are an important aspect of adaptations to the Arctic, providing transportation and logistical support, defense against predators such as bears, and in cases of emergency, fallback food and hide/fur resources. Material evidence routinely indicates dogs as scavenging on waste materials in middens, or self-provisioning to a certain degree. This expectation cannot be asserted in areas where carbohydrate and vegetal food options are scarce or absent and animal protein will comprise the bulk of dietary options for both humans and dogs.

Under these circumstances there are three provisioning strategies that could be hypothesized, 1) Humans and dogs sharing the same foods, though likely different parts of the same animals; or 2) Dogs being fed specialty diets with animal resources that are not regularly used by humans (i.e., unpalatable or otherwise problematic); and 3) Humans will overexploit seasonal resources whenever possible, feeding the surpluses that cannot be stored to dogs, treating them as a storage proxy and then feeding on the dogs whenever other resources declined or failed. The first hypothesis would correlate well with an assumption that dog's economic utility will place them on par with other human members of the community and only sacrificed or consumed under very dire circumstances, similar to those under which cannibalism might also be observed. The latter two rely on the clear distinction between human-animal and domestic-wild, with dogs occupying a place only slightly more secure than prey animals.

Zooarchaeological evidence from Siberian sites (e.g., Losey et al., 2011) and ethnographic studies (Sirina, 2006) have shown the complexity of dog-human relationships. At Nunalleq, researchers used a combination of techniques to establish that in this region, dogs make for good proxies of human paleodiets, though the faunal evidence suggests that they were scavenging parts of prey animals not consumed by humans rather than being directly provisioned.

Studies of landscapes at Kutoyis (Bethke et al., This Special Issue) and Star Carr (Robson et al., This Special Issue) have successfully identified or inferred processing locales for fish and animal products. These could be identified based on physical remains present; through there are many aspects of butchery, processing, and storage that do not leave direct archaeological evidence. Butler et al. (This Special Issue) take this landscape approach a step further, using a combination of multi-elemental compositional and biomolecular analyses to investigate a hunter-gatherer site in the Canadian Arctic for evidence of caribou processing sites comprising solely organic residues. Various biochemical and geochemical compositional changes occur with the incorporation of organic materials, thus their traces can be identified if preservation conditions are good. Identifying chemical archives of anthropogenic soils provides access to behavioral patterns completely absent from most archaeological sites. Using this information, Butler et al. (This Special Issue) also identified a surprise in seasonality evidenced in the site structure, with larger and longer-term habitation sites in exposed conditions during the late fall and early winter, previously thought to have already had regional populations retreating to sheltered forested environs for the winter.

As noted in Cis-Baikal research, the recognition of analytical challenges in producing chronological data, particularly through hurdles such as variable freshwater reservoir corrections, can provide a surprising silver lining. The accumulation of isotopic and radiocarbon data provides detailed dietary and chronological histories of hunter-gatherer communities, and often yields greater understanding of prehistoric complexity that can be difficult to ascertain from coarser material culture reconstructions. Implementing a freshwater reservoir correction at Lake Burtnieks, Latvia (Meadows et al., This Special Issue) had a similar outcome, revising understanding of regional subsistence strategies through the middle Holocene. Confounding factors of linked uncertainty between diet and chronologies make it difficult to determine the relative importance of regional trends over individual variation (i.e., dietary agency). In Latvia, there were three major transitions identifiable once the chronological and dietary picture was revised with new analytical methods, 1) A shift away from high-trophic foods; 2) A diversification of diets over the subsequent millennia; and 3) A later narrowing of diets again, refocusing on intensive harvesting of freshwater species.

The final three papers of this issue focus on lithic and ceramic technologies as proxies for dynamic behaviors in northern Pacific islands. Island hunter-gatherer communities are particularly sensitive to changing cultural landscapes, as they often lack sufficient material resources and population density to be self-sufficient over extended periods of time. Hokkaido and Sakhalin are large enough to maintain cultural groups that don't require routine contact with other regions; however, outlying islands like Rebun and the Kurils need routine contact with other islands as members of long-distance exchange networks for material goods and genetic diversity. Lynch et al. (Special Issue) used pXRF to study cultural changes, closely correlated with shifting patterns of obsidian procurement and trade. On Rebun, the sources of obsidian reflect shifting cultural centralization on Hokkaido and later migration of Okhotsk groups from Sakhalin.

Morisaki et al. (This Special Issue) focuses on how the lithic record shows regional adaptations that results from climatic fluctuations. The 8.2 ka climatic event is well known to European researchers, yet in northern Japan, Jomon populations experienced a radical change as a result of this event as well. Sophisticated blade technologies arose following this climatic event. Identifying driving forces underlying rapid cultural evolution can be challenging as under normal circumstances there will be extant populations with material culture that works well enough in various conditions as to make active modification and/or displacement challenging. Some aspect of the climatic fluctuation at 8.2 ka presented a strong selective pressure favoring the replacement of existing lithic toolkits with more sophisticated blade technologies.

Finally, we reach the Kuril Islands, forming a chain northeast of Hokkaido to Kamchatka (Gjesfjeld, This Special Issue). Compositional analysis of ceramic assemblages provides a quantitative method to investigate the migration and interaction between Epi-Jomon and Okhotsk cultural groups, contemporaries in the region. Long distance exchange networks are to be expected to link culturally similar settlements across island chains, but the logistical solutions arrived at by different hunter-gather cultural groups highlight the risks of overlooking the cultural specifics of regional material culture in favor of subsistence economic classifications. Seasonal migrations and exchange networks linking remote settlements to larger islands and continental regions with higher population density and access to materials such a raw clay and obsidian.

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