Environmental change and cultural dynamics of Holocene hunter–gatherers in Northeast Asia: Comparative analyses and research potentials in Cis-Baikal (Siberia, Russia) and Hokkaido (Japan)

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\textbf{Abstract}

While substantial progress has been achieved in hunter–gathering research over the last century, it is still the case that the understanding of the cultural dynamism, variability, and resilience of Holocene hunter–gatherers remains rather impoverished. Emerging archaeological insights suggest that the prehistory of many forager societies included periods of sudden cultural transformation, marked by major shifts in subsistence strategies, settlement patterns and associated social life. Recent theoretical and methodological advances are enabling archaeologists to reconstruct the cultural dynamics of Holocene hunter–gatherers in an unprecedented degree of detail. This is especially true in regions that contain large prehistoric cemeteries, which can provide the base data for bioarchaeological reconstruction of individual life histories, shedding light on forager life-ways, their subsistence strategies and mobility patterns. Renewed attention is also being directed at the role of unstable environments and climate, which would have formed important contextual factors influencing how local cultural dynamics were played out. However, identifying explicit causal links between environmental instability and culture change remains empirically challenging. This paper investigates the major sequences of Holocene hunter–gathering culture change in two regions of Northeast Asia and details how the new Baikal–Hokkaido Archaeology Project will be researching the causal factors driving these cultural processes, including the possible role of climate and environment.

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1. Introduction: Holocene hunter–gatherers

The hunter–gathering life style, in its various modes, has sustained humankind during most of its c. 2.5 million year history and remains important in a few places even today (Kelly, 1995; Fuentes, 2009). In contrast, farming and pastoralism are much more recent, arising no more than 10,000 years ago under the most recent interglacial environmental settings. In some places, the shift to food production (e.g., the Near East) was followed by farming dispersals and the eventual rise of villages, cities, and states. However, in many other areas, prehistoric groups did not switch to farming but first intensified foraging (hunting, fishing, and gathering) and only much later adopted agriculture (e.g., Japan, Baltic, and much of northern Eurasia), while other groups remained as complex hunter–gatherers well into the historic period (e.g., Hokkaido and American West and Northwest Coast). More generally, in the vast area of northern Eurasia, stretching from northern Scandinavia through to the Pacific, hunter–gatherers define most of prehistoric archaeological record.

To date, most hunter–gathering research has focused on three main topics: (1) the evolution of the foraging life style during the Pleistocene; (2) the transition from foraging to farming during the Holocene; and (3) the impacts of the modern world on ‘surviving’ hunter–gatherers, all with literature too large to provide a representative sample here (e.g., Zvelebil, 1986; Forsyth, 1992; Lee and Daly, 1999; Price, 2000; Schweitzer et al., 2000; Morrison and Junker, 2002; Whittle and Cummings, 2007; Pluciennik and Zvelebil, 2008; Fuentes, 2009). In broad terms, the first two topics have been the domain of archaeology, the third of ethnography, and while substantial progress has been achieved on each of these three themes, the collective archaeological knowledge of the dynamism, variability, and resilience of Holocene hunter–gatherers remains...
rather impoverished. More specifically, there is a lingering assumption that, after adjusting to the post-glacial environmental regime, most of these groups, outside of the few places where hunter–gatherers developed high levels of complexity, remained relatively static and marginalized over long periods, until they either adopted elements of food production or were overwhelmed by farmer colonists (Zvelebil, 1986; Bettinger, 2001).

Hunter–gatherer complexity, however, is itself often poorly defined concept: some definitions focus on specific cultural traits (typological approach), others view complexity in a manner akin to the concept of ecological diversity (dimensional approach), and some believe it possible to integrate these two rather very different tacks (e.g., Fitzhugh, 2003). Due to space limitations, only a few clarifying points are provided on this matter. As there is no inherent reason why any given set of socio-cultural characteristics (e.g., institutionalized control of non-kin labor, permanent leadership, and hereditary ranking; Arnold, 1996) should carry more weight than any other set (e.g., rich resources, high population density, rich burials, regional exchanges, feasting, excessive rituals, and wealth accumulation; Hayden, 2001), here, as elsewhere in the paper, hunter–gatherer complexity is understood not in such typological but rather in dimensional terms. According to the latter view, hunter–gatherer complexity is understood as “...the degree of internal differentiation and specialization of the components of the system” (Burch and Ellanna, 1994, p. 5; see also: Price and Brown, 1985, pp. 7–8). These circumstances together, including the confusing typological definitions, have created an important gap in the current understanding of Holocene hunter–gatherer cultural diversity, capacity for change, and complexity in general. This is especially true in northern Eurasia.

Recent archaeological research is leading to a fundamental revision of these assumptions making it increasingly clear that many Holocene hunter–gatherer groups had rather rich and dynamic histories. These were often marked by sudden and apparently cyclical shifts in subsistence, settlement patterns and social life, rather than by directional change toward higher complexity and/or the adoption of agro-pastoralism. To be sure, Holocene environments provided a context for behaviors and adaptive strategies that were far more variable than those of either Pleistocene or modern foragers (Bettinger, 2001). Furthermore, these strategies were also affected, although to varying degrees, by both the internal social dynamics of prehistoric populations and their coeval interactions with local climates and environments which themselves were undergoing changes throughout the Holocene (Anderson et al., 2007).

While reconstructing these basic regional patterns of culture change has seen major advances in recent decades, explanation of the underlying processes and ascribing causality is far more challenging. Advocates of the New Archaeology, or processual archaeology (Trigger, 2006), understood cultural patterns to have been structured by adaptations to climate and environmental change (e.g., White, 1959; Binford, 1968); that is, if climate changed, cultures were forced to respond. This approach tended to downplay the role of human agency and the meaningful constitution of social life, especially in the study of prehistoric hunter–gatherer societies. In contrast, interpretive archaeologists explicitly adopted human agency as the principal means by which cultural change took place, and also emphasized the importance of meaningful social action as a key driver of cultural transformation (e.g., Hodder, 1986; cf., Trigger, 2006). Although environmental factors were not denied, the focus on agency, routine social practice and cultural landscapes tended to render environment a rather invisible, or passive, role in accounts of socio-cultural culture change (e.g., Hodder, 1986, 1990; Barrett, 1994; Tilley, 1994; Dobres and Robb, 2000; Barrett, 2001; Gardner, 2004). This paper argues that to understand fully Holocene hunter–gatherer culture change it is necessary to integrate these different traditions of investigation (e.g., the roles of individuals and groups, settlement systems and exchange patterns, and the roles of social landscapes and biophysical environments). Approaches which draw upon neo-Darwinian evolutionary theory offer the best analytical framework for achieving these goals.

At the heart of this approach is a renewed emphasis on the roles and actions of human individuals, the reconstruction of their biographies, and their interactions with environments as a means of understanding long-term cultural transitions. Methodologically, new techniques and approaches in bioarchaeology now reveal a variety of details about individual life histories of prehistoric people which, together, generate an unprecedented level of insight into past social, cultural, economic, and demographic dynamics. Similarly, paleoenvironmental research is also moving expeditiously toward high-resolution proxy records, reconstructions, and models. Moreover, both developments are a welcome and critical contribution to the ongoing examination of the human–environment continuum including the causal links between them, however difficult this may be. These challenges and research potentials provide the main focus for the new Baikal–Hokkaido Archaeology Project (BHAP), which seeks to reconstruct and explain patterns and processes of culture change, primarily through detailed comparative analysis of archaeological cemetery complexes in these two regions of Northeast Asia.

As BHAP is driven primarily by archaeological questions, this paper outlines the main research goals and methods employed in this investigation. The paper reviews the current state of knowledge on prehistoric human–environment interactions within the settings of the two study areas, Cis-Baikal and Hokkaido. The paper also serves as a general introduction to the special issue on the Holocene environmental history of the broader Northeast Asian region and it attempts to identify which aspects of this work are particularly important and relevant for archaeological research, and especially for BHAP.

2. Archaeology and hunter–gatherer agency: new perspectives and methods

Hunter–gatherer archaeology has gone through several broad research paradigms, from progressive social evolution and culture-historical approaches, through to the ecological and adaptive concerns of New Archaeology, which tended to see forager cultures as being closely constrained by technology and environments (Jordan, 2008; cf., Cummings et al., in press). More recently, increasing attention has been paid to understanding hunter–gatherer cultural landscapes, social identities, personhood, and spirituality (Tilley, 1994; Barrett, 2001; Fowler, 2004, pp. 130–54; Coneller and Warren, 2006; Cannon, 2011).

In addition, new theoretical and methodological developments signal ways in which these quite different perspectives can be productively combined around the reconstruction of distinct historical forager trajectories that unfolded in different environments and regions of the globe, as well as the role of human agency in these transitions. Integration of these perspectives and techniques therefore requires that archaeologists reconstruct the life histories and roles played by individual persons in the social dynamics and cultural changes affecting larger populations over longer time periods. More specifically, the approach adopted to understanding the role of prehistoric human agency in long-term cultural change can be termed the ‘life history approach’ or ‘bio-archaeology of individual life histories.’ The approach has been facilitated by a continuous growth over the last 10–15 years in the area of bio- and archaeological sciences, and human osteology (see,
Zvelebil and Weber, in press, for a recent and brief review of these techniques). Most of these methods have now become a main-
stream of human bioarchaeological research and combined can now provide considerable insights into the variation of past human behavior at the individual level. Furthermore, when entire ceme-
tery populations are analyzed in this manner, insights are gained into the population dynamics, interaction patterns, migrations, subsistence practices, and health and demography of the commu-
nities that generated the spatio-temporal variation in the archae-
ological record.

The cemeteries themselves also inform about the location of the area where individuals spent at least the last portion of their lives and characteristics of the employed mortuary protocols (grave architecture and associated objects, body position and treatment) inform about world views, social organization, inter-personal relations, and concepts and beliefs relating to death and commemoration of ancestors and kin. Together these different lines of evidence permit examination of additional aspects of individual life histories, including their social positions, symbolic systems, interactions with their social and natural environment, and their own biological condition. Although actions of individual persons are less traceable in materials from habitation sites, such localities, nonetheless, serve up invaluable data on subsistence and diet, including feasibility, procurement techniques, food processing, and dietary breadth and prey choices, and insights into settlement patterns, and ritual life: all directly pertinent to the implementa-
tion of the life history approach.

An important role in this approach is also played by extensive radiocarbon dating programs. First, the dating of actual human remains provides the most direct temporal placement of all other information associated with them. Second, large series of dates allow identification of temporal variation and patterns in the data that are otherwise invisible or obliterated by typological dating; the middle Holocene culture-history of the Baikal region provides a good example of this issue (Weber, 1995; Weber et al., 2010b). Third, they make it possible to employ quantitative methods (Buck et al., 1994, 1996; Ramsey, 2009a, 2009b) to measure the impact of stochastic effects on the distribution of radiocarbon dates in which, in turn and among other things, allows improved assessment of the tempo of culture change. Fourth, improved chronological resolu-
tion facilitates closer matching of archaeological and paleoen-
vironmental sequences. None of this can be achieved with only a few dates.

Overall then, the life history approach — when applied to prehistoric forager populations — allows archaeologists: (1) to reconstruc-
t long segments of individual life histories from birth to death; (2) to assess variation in prehistoric human behavior; and (3) to place this behavior in the context of dynamic interactions with the socio-cultural and natural ecological settings (Schulting and Richards, 2001; Schulting, 2010; Weber and Goriunova, in press; Zvelebil and Weber, in press). More generally, the approach addresses the question of how the daily decisions, strategies, and responses of specific human individuals feed into cumulative patterns of long-term culture change and cultural variation that only archaeologists are able to reconstruct.

Although research of this kind has enormous potential across all fields of archaeological inquiry, its application to Holocene hunter—gatherer remains is less than straightforward. First, there is global paucity of hunter—gatherer skeletal remains resulting from the fact that most such prehistoric groups did not use formal cemeteries. Second, where they did use formal cemeteries, the cases are iso-
lated in space, sample sizes are small and/or bone preservation is poor, and the archaeological time spans they represent are short. Third, in the several parts of the world that are important for hunter—gatherer research (e.g., North America and Australia), ethical and legal issues have made the study of human remains problematic. And fourth, availability of concurrent habitation sites is frequently limited. This substantially narrows the range of geographic areas and time periods to which the approach can be applied.

Focusing on areas with rich mortuary records, the Baikal Archaeology Project (BAP) — the direct predecessor of BHAP, developed a research model that succeeded in maximizing the potential information that could be extracted from the inter-
disciplinary analysis of human skeletal remains within their wider environmental setting. Building on these promising meth-
odological foundations, it also identified two key regions where such an approach could be expanded and diversified: Cis-Baikal of Eastern Siberia (the area immediately north and west of Lake Bai-
kal) and Hokkaido of Northern Japan (Fig. 1). Both regions feature abundant archaeological materials from habitation sites and cemeteries with large collections of well-preserved human remains that date to different periods transcending much of the Holocene. In both places, hunter—gatherers also shifted to a more intensive exploitation of aquatic resources at the start of the Holocene. From this shared baseline each region then went through a few cycles of culture change, each involving major restructuring of subsistence, demographic, cultural practices, settlement patterns and social life. It is the documentation and explanation of these different trajec-
tories in Cis-Baikal and Hokkaido that is the main research objec-
tive of the current BHAP research.

Archaeology is a comparative science and the scholarly value of examining a single case study (Cis-Baikal) can be vastly increased by the insights that can be gained through systematic comparison of two case studies that share a number of cultural and environ-
mental characteristics. For this reason, BHAP is grounded on the study of hunter—gatherer cultural change in two regions — Cis-
Baikal and Hokkaido. Importantly, while empirical information about the Holocene hunter—gatherer archaeology in these two regions is increasing, understanding of the specific mechanisms driving the local trajectories remains insufficient and requires a program of multidisciplinary research to resolve, which is the primary goal of BHAP.

The remainder of the paper first outlines the basic patterns of culture change in the two regions. Next, the work conducted at Cis-
Baikal by the earlier BAP is discussed, focusing on the key challenges involved in the attempts to explain these cultural changes, high-
lighting the possible causal links with what appears to be coeval shifts in environments and climate. This enables definition of several important research questions that can only be addressed by detailed environmental reconstructions of and by integration of these insights with bioarchaeological and archaeological datasets in order to examine past human—environment relations in a com-prehensive manner. Although answers to these questions are among the main goals of the BHAP, they are also beyond the direct scope of this paper. Highlighting the renewed importance of detailed envi-
ronmental reconstructions in these two research settings also provides justification — and a general intellectual and geographic framework — for the remaining papers in this special volume.

2.1. Cis-Baikal hunter—gatherer Holocene sequence

The extensive program of bioarchaeological work completed to date by BAP on the Cis-Baikal materials has been published in numerous research papers summarized recently in an edited volume (Weber et al., 2010a) with new studies appearing regularly (e.g., Bezrukova et al., 2011; Waters-Rist et al., 2010; Losey et al., 2011; Mackay et al., 2011; Scharlotta et al., 2011; Waters-Rist et al., 2011; Weber et al., 2011; Katzenberg et al., in press: Shepard, in press; Weber and Goriunova, in press). Clearly, the
authors’ views on the subject are evolving (Weber and Bettinger, 2010), and in some ways now differ from accounts and insights presented in earlier publications (Weber, 1995; Weber et al., 2002; Weber and McKenzie, 2003). For example, while it seemed natural at first to identify and emphasize the differences between the Early Neolithic (EN), Late Neolithic (LN) and Early Bronze Age (EBA) strategies, it is becoming clearer that the most important defining characteristic of the Middle Holocene culture change is its cyclical pattern and that EN, LN, EBA strategies probably were much more similar to one another than was previously accounted for. The following summary, presented first by Weber and Bettinger (2010, p. 503), summarizes the main points of this new perspective:

**Late Mesolithic, 8800–8000 cal. BP:** no formal cemeteries, hunting, some fishing and sealing, small, dispersed, and mobile population, limited social differentiation.

**Middle Neolithic, 6800–5800 cal. BP:** no formal cemeteries, hunting, some fishing and sealing, small, dispersed, and mobile population, limited social differentiation.

**Late Neolithic, 5800–5200 cal. BP:** formal cemeteries, hunting, fishing and sealing, larger and evenly distributed population genetically different from EN, moderate physical and physiological stress, moderate mobility and social differentiation.

**Early Bronze Age, 5200–4000 cal. BP:** formal cemeteries, hunting, fishing and sealing, large and evenly distributed population genetically continuous with LN, moderate physical and physiological stress, moderate mobility and social differentiation.

The explicit emphasis on individual variation and integration of multiple lines of evidence contributed significantly to these new findings. The individual life history approach, applied most comprehensively so far to the EBA cemeteries of Khuzhir-Nuge XIV and Kurma XI in the Little Sea area on Lake Baikal (Fig. 2), revealed a number of new insights and allowed identification of several units of analysis otherwise impossible to see in mortuary data alone. Of particular relevance is: (1) distinction between the game-fish-seal
and game-fish diets in the Little Sea area and the lack of such distinction elsewhere in Cis-Baikal; (2) identification of individuals born locally within Little Sea and those born elsewhere; (3) association between the game-fish-seal diet and the Little Sea locals as well as between the game-fish diet and the Little Sea non-locals; (4) asymmetrical movement of people between Little Sea and the other micro-regions of Cis-Baikal; (5) presence of grave and burial clusters within the Khuzhir-Nuge XIV cemetery defined on the basis of diet type; and (6) identification of rather short, relative to what radiocarbon dates imply at their face value, intervals of cemetery use (Weber and Goriunova, in press; Weber et al., 2011; Weber, 2012). None of these important insights would be granted by application of one method only. Similarly original findings are expected from the other cemeteries in Cis-Baikal (Khadarta IV, Lokomotiv, Shamanka II, and Ust'-Ida) where much of this kind of work is still in progress. In sum and as noted before (Weber and Bettinger, 2010, p. 503), the recent work shows unequivocally that hunter–gatherer culture change in Cis-Baikal was neither directional nor slow but rather cyclical and punctuated by short periods of rapid change. Consequently, elucidation of the mechanisms underlying these cycles becomes the express goal of future research. On Hokkaido, even though the life history approach has not been applied there as extensively as in Cis-Baikal, the generally similar pattern of cyclical changes encourages comparison between the two regions.

2.2. Hokkaido hunter–gatherer Holocene sequence

The Holocene foragers of Hokkaido are located at a cultural and ecological junction between farmers in the warmer southern latitudes of central and western Japan and Southeast Asia, and hunter–gatherers of the colder climes of Northeast Asia. It is increasingly clear from the archaeological record that Hokkaido's prehistoric hunter–gatherer groups were well-connected within
both the southern and northern networks (Fitzhugh, 1999); many pottery styles, cultivation of sweet chestnuts and millet, and metallurgy spread from the south while the blade arrowhead technology (Kimura, 1999), some metals, short-grain barley, and the Okhotsk culture arrived from the north (Nomura and Udagawa, 2006a, 2006b, 2006c; Yamada, 2006).

In Hokkaido, where foraging persisted through to the historic Ainu which is much longer than at Cis-Baikal, the general culture-historical and behavioral trends exhibit a pattern of the following shifts (Koyama, 1978; Aikens and Rhee, 1992; Habu, 2002, 2004; Ikawa-Smith, 1992; Yamaura and Ushiro, 1999; Habu et al., 2003; Nomura and Udagawa, 2006a, 2006b, 2006c; Onishi, 2009):

- **Incipient Jomon**, 14,000–10,000 cal. BP: individual graves (no formal cemeteries), terrestrial mammal hunting, gathering, river and coast fishing, highly mobile groups (no pit-houses).
- **Initial Jomon**, 10,000–6000 cal. BP: few formal cemeteries, marine and terrestrial mammal hunting, gathering, river and coast fishing, small hamlets with pit-houses, storage, seasonally mobile groups, round-bottom and flat-bottom pottery in SW and NE Hokkaido, respectively, migration of the Blade Arrowhead Culture people into eastern Hokkaido by ~8000–7000 cal. BP.
- **Early Jomon**, 6000–5000 cal. BP: few formal cemeteries, marine and terrestrial mammal hunting, gathering, river and coast fishing, large villages with circular houses, storage, shell middens, seasonally mobile groups, disappearance of regional differences in pottery styles.
- **Middle Jomon**, 5000–4000 cal. BP: formal cemeteries, marine and terrestrial mammal hunting, nut and intensive shellfish gathering, river and coast fishing, villages and small hamlets with pit-houses, storage, large shell middens, growing social differentiation (SW Hokkaido), seasonally mobile groups and limited social differentiation (NE Hokkaido).
- **Late to Final Jomon**, 4000–2700 cal. BP: large circular cemeteries (stone circles and mound burials), elaborate burials (Late Jomon), hunting–fishing–gathering, declining villages (Final Jomon), substantial social differentiation.
- **Epi Jomon**, 2700–1500 cal. BP (6th cent. AD): SW Hokkaido — formal cemeteries, hunting–fishing–gathering, localized rice farming, first iron tools; NW Hokkaido — rare and small cemeteries, small villages, shell middens, dog breeding for food, moderate social differentiation, seasonally mobile groups.
- **Okhotsk (NE Hokkaido)**, 6th–10th cent. AD: formal cemeteries, intensive marine mammal hunting, hunting–fishing–gathering, domestic pigs, ritualized bear husbandry, villages, more iron tools, substantial social differentiation.
- **Satsumon (SW Hokkaido)**, 7th–13th cent. AD: large formal cemeteries with tumulus graves, localized rice and more widespread millet and wheat farming, large permanent villages, more iron tools, intensive trade, substantial social differentiation.
- **Historic Ainu**, 13th–19th cent. AD: formal cemeteries, marine and terrestrial mammal hunting, fishing, gathering, rare pigs, ritualized bear husbandry, localized rice (SW Hokkaido only) and spreading millet and wheat farming, permanent villages, fortified stockades and the emergence of local Ainu political authorities, intensive trade, substantial social differentiation.

Overall, like Cis-Baikal, Hokkaido’s sequence involves a number of cultural transitions, some apparently quite major, but the factors triggering them and the mechanisms by which they came about remain unclear due to, at least partly, the shortage of dedicated research. First, while the economic basis of Holocene hunter–gatherers on Hokkaido (i.e., aquatic foods and sika deer) is perceived as generally stable, the changes in human population size, distribution and organization, socio-political differentiation, and sedentism and mobility suggest otherwise (see Habu’s views regarding the pattern of frequent changes in Central Japan; Habu, 2004). Second, although the presence of two different foraging strategies — coastal and interior — on Hokkaido has been recognized both ethnographically and archaeologically (Kikuchi, 1986; Watanabe, 1986; Kobayashi, 1992), the interactions between them remain not well understood. Third, more attention deserves also the matter of the environmental differences between the cooler parts of NE Hokkaido with boreal forests (spruce and birch) and the warmer SE parts with mainly deciduous forests (Mongolian oak and Japanese beech), and the impacts of those differences on the human foraging strategies employed there. Finally, improved insights into labor organization and socio-political differentiation, in part through mortuary archaeology on the abundant human remains and cemeteries, can contribute more to the current understanding of hunter–gatherer regional and temporal variation on Hokkaido.

There are two other points to make about the Hokkaido sequence; one regarding the state of habitation site archaeology, the other the state of the life history research. In Hokkaido, as elsewhere in Japan, archaeology of middle Holocene habitation sites is well advanced largely due to the intensive program of fieldwork starting in the 1970s in association with large public construction projects. The level of detail resulting from this work by far exceeds what is known about middle Holocene hunter–gatherer habitation sites in Cis-Baikal. The opposite, however, is true for the life history approach. Although population-level studies of human osteological materials from Hokkaido abound to the extent that only a small sample of this research can be referenced here (e.g., Dodo, 1974, 1986; Dodo and Ishida, 1990; Ishida, 1995, 1996; Hanihara et al., 1998, 2008; Dodo and Kawakubo, 2002; Shigematsu et al., 2004; Matsumura, 2007; Komesu et al., 2008; Hanihara and Ishida, 2009; Ishida et al., 2009; Matsumura et al., 2009), geochemical and genetic testing has been somewhat limited in scope and just beginning, respectively (Chisholm et al., 1992; Minagawa and Akazawa, 1992; Yoneda et al., 2002; Adachi et al., 2006, 2009; Sato et al., 2007, 2009a, 2009b; Kusaka et al., 2009; Naito et al., 2010). Lastly, integration of all these different lines of evidence with the mortuary record has not been yet attempted. Consequently, the contribution of the life history work to the current knowledge of Hokkaido’s Holocene hunter–gatherers is clearly incommensurate with its immense potential. Furthermore, what makes this program of work particularly attractive in the Hokkaido context is the additional knowledge that can be derived from integrating the rich data from habitation sites with the insights supplied by the life history approach in ways that are not feasible in Cis-Baikal.

3. Framing the comparative analysis: Cis-Baikal and Hokkaido

Explaining the specific patterns of culture change in Cis-Baikal’s and Hokkaido’s hunter–gatherer Holocene prehistory that were summarized in the preceding two sections can best be addressed by a comparative program of multidisciplinary research. It is, therefore, useful at this point to review some of the relevant similarities and differences between the two study areas.

As noted, Cis-Baikal and Hokkaido share a number of cultural and environmental characteristics including very long sequences of hunter–gatherer Holocene archaeology, changes in population size and distribution, as well as shifts in settlement and cemetery use, subsistence, mobility and social complexity. The available evidence suggests that the various transitional periods within each sequence were relatively quick rather than gradual. However, it remains unclear as to whether the apparently rapid nature of these shifts is merely a by-product of the typological and culture-historical approaches that were central to earlier research in the regions as
both tend to emphasize sudden changes between archaeological units (phases or cultures). Furthermore, the environmental setting in both cases is also generally boreal and coastal (Lake Baikal effectively serving as a landlocked sea) with abundant aquatic and terrestrial resources. Hokkaido’s connection to mainland Asia during the Pleistocene glaciations produced fauna and flora more closely affiliated with Northeast Asia than with the rest of the Japanese archipelago, which remained isolated from Hokkaido and from the continent. Furthermore, both regions experienced Holocene climatic shifts which may have played important roles in the processes of cultural change.

In addition to these multiple similarities between the two study areas, the existing differences inject important aspects of variability that make the comparative approach even more productive. For example, the durations of the various culture-historical phases in each region were different; Hokkaido hunter–gatherers appear to have been connected with the outside world – other foragers to the north and farmers to the southwest of the island and beyond – in a pattern much different from the Baikal region; hunter–gatherer life style on Hokkaido was more sedentary; Hokkaido’s plant and aquatic resources were more abundant and diverse than Baikal’s; the rivers of Hokkaido are very small relative to the Angara, Lena, and Selenga rivers but numerous and, nevertheless, have productive fisheries (salmon); and sea level changes and shifting oceanic circulation patterns are unique to the Hokkaido setting. Lastly, while ample ethnographic records are available from both regions, osteological collections of proto and historic hunter–gatherers (the Ainu) are only present on Hokkaido. This enables unique ‘historically-informed’ bioarchaeological analyses to be conducted in Hokkaido (Bachelor, 1927; Watanabe, 1973, 1986).

Building on these similarities and differences, the following general questions are particularly relevant to both regional archaeological sequences:

- What specific mechanisms generated the observed hunter–gathering cultural patterns?
- What role was played by the changes in population size and distribution? and
- What was the role of changing climate and environments in these processes?

The rest of this paper will address the key challenges that are involved in understanding complex human–environment interactions in both regions focusing on the last question. As research in Hokkaido is only starting, more attention will be paid to Cis-Baikal.

4. Culture, environment, and climate change: Cis-Baikal

Some aspects of the work conducted to date by the BAP are directly relevant to linking the Holocene hunter–gatherer culture change with climatic and environmental factors. This work is reviewed with the dual aim of identifying main theoretical and empirical challenges, all of which generate scope for further methodological and analytical improvement, and outlining how a similar approach could be applied to both Hokkaido and Cis-Baikal as part of BHAP. The review starts with a short description of the archaeological and environmental backgrounds of Cis-Baikal, along with a summary of the history of linking culture change with environment–climate change in the region.

4.1. Cis-Baikal archaeological background

The Holocene archaeology of the Cis-Baikal region (Fig. 2) was introduced to the Western audience by a series of generalizing works by Okladnikov (1959), Michael (1958), Tolstoy (1958), Chard (1958, 1974) and several technical contributions by Russian scholars published in English during the second half of the 20th century (e.g., Khlobovstn, 1969; Medvedev, 1969a, 1969b; Okladnikov and Konopatskii, 1974/1975). Through these publications Cis-Baikal has gained a well-deserved reputation of one of the most promising places in the boreal world to study the cultural dynamics of middle Holocene hunter–gatherers. Compared to other regions, Cis-Baikal stands out primarily because of the wealth of cemeteries and well-preserved human skeletal remains, a true rarity on a global scale. In contrast, habitation sites, while present, are not as numerous and frequently are not very well stratified, giving the archaeological record some unusual biases.

The region’s culture-history was structured by Soviet scholars based on the appearance of prehistoric technological innovations. For example, the microblade technology defined the Mesolithic; bow and arrow, ground stone tools, and ceramics the Neolithic; and objects of copper and bronze the EBA. Further chronological subdivisions, particularly those of the Neolithic, were based exclusively on the mortuary record with specific burial traditions, economic, social and political relations assigned to a different period (Okladnikov, 1950, 1955). Despite some serious initial critique (e.g., Weber, 1995); this older model remained in vogue until the 1990s when it eventually underwent fundamental revisions necessitated by the pressure from new radiocarbon evidence (Mamonova and Sulerzhitskii, 1989) and reinterpretation of other data (Lam, 1994; Weber, 1994, 1995). A new model was developed via an extensive program of radiocarbon dating implemented by the BAP (Weber et al., 2002, 2006, 2010b) which now guides research in the region.

4.2. Cis-Baikal environmental background

In the present day, Cis-Baikal (Fig. 2) is ecologically a highly complex and diverse region (e.g., Weber, 2003; Weber and Betteringer, 2010; Weber et al., 2011). It features a markedly continental boreal climate with vegetation dominated by middle and southern taiga forests. While average temperatures are regionally homogenous with effective temperatures (ET; Bailey, 1960) consistently around 11, topography, geology, hydrography, precipitation, vegetation, and terrestrial and aquatic fauna are all highly variable across Cis-Baikal resulting in a substantial mosaic of environmental conditions and in a few distinct micro-regions.

The downstream sections of the Angara and Lena River valleys feature thick taiga forests. The upper sections, however, display pockets of steppe–forest, and are connected by stretches of open vegetation that run along the Kuda River (right tributary of the Angara) and the Manzurka River (left tributary of the Lena). The Little Sea, or Ol’khon area (Ol’khon Island, the mainland across from it and all the way southwest to the mouth of the Bugul’deika River), is relatively dry with only c. 250 mm of rainfall annually. Open steppe dominates the coast there and much of the island itself. Open landscape prevails also in the middle section of the Irkut valley (i.e., the Tunka area), west of Lake Baikal.

The distribution of terrestrial food resources varies with vegetation. Roe deer and red deer favor open vegetation and would have been more plentiful in all four micro-regions than elk (moose) and musk deer, which would have favored the closed vegetation characteristic of the more densely forested parts of Cis-Baikal. The mountains along the northwest coast of Lake Baikal probably offered middle Holocene hunters some combination of these aquatic foods, although available everywhere, are very variable in distribution, abundance, and accessibility, and the three main fisheries – Angara, Lena and Baikal – are independent of each other (Fig. 2; Weber, 2003; Weber and Betteringer, 2010; Weber et al.,
2002). While the Angara and Lena fisheries are each quite consistent in these three terms along their upper courses, the Angara is vastly more productive than the Lena. The Baikal fishery, with its several distinct habitats (open coast littoral, gulfs, shallow coves and lagoons, and pelagic) is the most variable on all three accounts including also seasonality. Baikal is also the only fishery that offers the seal resource although on a seasonally limited basis. Numerous throughout entire Cis-Baikal, small rivers and streams would also offer fish but it is unlikely that they would attract as much human activity as the main fisheries.

All these niches, terrestrial and aquatic, would have afforded prehistoric populations with ample scope for developing a wide range of subsistence strategies; moreover, changes in these environmental conditions would have generated new sets of opportunities and constraints.

4.3. The archaeology of human—environment interactions in Cis-Baikal

How have archaeologists studied the role of environmental change in the region? Soviet archaeology primarily concerned itself not with adaptation, but with culture-history and ethnogenesis. For example, in Okladnikov’s model (1950, 1955), the environment and its resources were passive backdrops, and although it was known and understood that Holocene climates and environments did change somewhat, these changes were regarded as being slow, minute, and rather inconsequential from the human perspective. On the other hand, the rather limited technological and foraging prowess of the Holocene hunter—gatherers was believed, at least implicitly, to be insufficient to inflict any lasting damages upon the environment, including its food resources. This approach is best exemplified in the Okladnikov model of economic, social, and political changes which dwells exclusively on the role of internal factors, mostly technological—a rather obvious influence of the Marxist model of historical change, which was official at this time in the Soviet Union. The rest of the Baikal archaeological scholarship in Russia, including the opponents of the Okladnikov model, either followed the same tack or were entirely mute on the subject. In general then, questions pertaining to environmental adaptation saw little attention. As a result, Okladnikov’s take on hunter—gatherer culture change in the Baikal region was that of continuous progressive social evolutionary growth in complexity in every aspect from technology and economy through social and political organization to ritual and beliefs.

Starting in the 1990s, in contrast to Okladnikov and his adherents, the work conducted by the BAP has examined explicitly the role of environmental factors in structuring the archaeological record and has indicated a number of striking correlations between these cultural and environmental variables. The first pattern, found in all culture-historical periods with formal cemeteries (EN, LN, and EBA), is the coinciding spatial distributions of mortuary sites (large and small cemeteries as well as isolated graves), open landscape (steppe or parkland), and good fisheries (riverine or lacustrine). As Weber and Bettinger (2010, p. 503) note, “...mortuary sites concentrate not only in places where the best fisheries exist, but also where open landscape, with its ecotonal properties, would support sizable herbivore populations” (i.e., roe deer and red deer).

Furthermore, there are a few other more specific sets of associated variables (Weber and Bettinger, 2010, Table 6) which for the EN include:

- Uneven distribution of fish resources (i.e., diversity, abundance, accessibility, and seasonality), uneven distribution of the human population, and cultural heterogeneity; and
- Poorer overall community health, more extensive male travel and heavier workloads, and higher reliance on fishing.

For the LN and EBA the configurations of correlated variables seem to be different:

- More even distribution of terrestrial game (ungulates), more even distribution of the human population, and cultural homogeneity; and
- Better overall community health, less travel and lighter workloads with more equitable distribution of labor between males and females, and higher reliance on game hunting.

Most strikingly, the new model identified a major cultural discontinuity separating the EN from LN and EBA hunter—gatherer groups which was manifest archeologically in the lack of formal cemeteries during the Middle Neolithic (MN). According to White and Bush (2010), this cultural discontinuity seems to coincide chronologically with a period of climate change which they consider the most significant and rapid Holocene climate change affecting the broader Baikal region and describe it as transition from generally warming—wet to warmer—drier conditions. The onset of this shift is believed to occur between 7500 and 6500 cal. BP and the authors suggest a causal link between this climate change on the one side and the EN—MN culture change in Cis-Baikal on the other. However, there are several reasons why this link appears to be very tenuous at the moment.

Viewed together, these new insights emphasize highly dynamic patterns of cultural variability, both temporal and spatial, compared to what was known prior to the commencement of the BAP research as well as the noticeable correlation between cultural characteristics and the variable biophysical environment of the Baikal region. As Weber and Bettinger (2010, p. 504) also observe, “That two or more variables are correlated with each other does not, of course, imply existence of causal relationships between them. However, such associations do suggest where to look for causal mechanisms.” First, they suggest that environmental factors may have indeed played a substantive role in local culture change. Second, while sustainable terrestrial hunting appears to have been a central element enabling long-term stability in all middle Holocene forager subsistence strategies (for shelter, clothes, and toolmaking in addition to food), it appears likely that an increased, at least seasonally, reliance on fishing generated a combined strategy which, in turn, facilitated development of more complex adaptations, particularly during the EN. Third, it appears that termination of the EN and LN—EBA periods of increased hunter—gatherer complexity could have been related to the depletion of the ungulates, particularly red and roe deer, perhaps through human hunting pressures, the adverse effects of the environment—climate shift, or combined effects of the two. Either way, it is the ungulates (K-selected species) that would be more sensitive to human hunting pressure compared to the aquatic resources (r-selected). As such, it is reasonable to expect that collapse of the ungulate resource could generate the kind of socio-economic stress that would lead to the major cultural shifts observed in the archaeological record. Although corroborating evidence in the form of empirical data or models is currently lacking, such evidence is not impossible to obtain. The end of the EBA complexity may have something to do with the competition between the local foragers and herders advancing from the south, for which the forest—steppe environment would be equally inviting (Weber et al., 2010b).

Taken together, the observed correlations imply that in order to explain middle Holocene culture change in Cis-Baikal it is necessary to examine the interactions between the natural environment, subsistence strategies, and demography. This is challenging because it requires understanding of the possible causal links between these three complex agents of change, not an easy task in itself. Moreover, despite the entire new knowledge acquired since
the 1990s, it is still difficult to link the cultural discontinuity with the climate–environment change because many critical pieces of information, particularly about the changing distributions and abundances of plant and animal communities, are still lacking. This is another point to return to later in the paper.

5. Researching human–environment–climate dynamics: current challenges and opportunities

Although attempts to link culture change to climate change are nothing new to archaeology, these attempts have been frequently unsuccessful and the reasons for this rest with both archaeological and paleoenvironmental research. It may seem at first that the main difficulty has been the lack of empirical data, archaeological–behavioral and environmental–climatic, of sufficient spatial and temporal resolution, which is true. However, there are also some critical theoretical problems. They refer, in particular, to employment of an explanatory perspective that is capable of integrating the two kinds of data into conceptually consistent and coherent models.

5.1. Theoretical aspects

Although a comprehensive review is beyond the scope of this paper, it is useful to mention that most of the work on human–environment–climate dynamics among prehistoric hunter–gatherers has been conducted within the framework of the adaptationist program founded by New Archaeology (Binford, 1962, 1968). However, in this particular edition, the program is more suitable to researching how things work together (Binford, 2001) over short time intervals rather than why things exist and how they change, which is much different from the use of the adaptationist program in biology (Gould and Lewontin, 1979; Mayr, 1983). Consequently, archaeological applications of this approach have not produced encouraging results and many explanations rarely go beyond simplistic citations of such prime movers as regional or global climate change, or resource or environmental deterioration in addition to cultural prime movers such as population migrations, demographic crashes or peaks, or major technological innovations. In addition to its functionalist lean (see Bettinger, 1991; Kelly, 1995 for a more comprehensive critique of New Archaeology), there are two other weak points of this approach: (1) regardless of Binford's calls for paying more attention to variation, New Archaeology continued to operate at low spatio-temporal resolution in both archaeological–behavioral and environmental–climatic records; and (2) as such the approach all too often invoked teleological (vitalistic) explanations, which assume that humans have the ability to recognize and measure the parameters of environmental or climate change and choose the right solution from the existing repertoire of behaviors to deal with the change effectively or, in the absence of such solutions, to invent them. All these, of course, are rather weak and unrealistic assumptions.

The programs of human behavioral ecology (HBE) and cultural transmission theory (CT) – both with roots in the neo-Darwinian evolutionary theory and both particularly relevant to this research – do not operate under such assumptions and, especially, are adept at dealing with some of the shortcomings of the adaptationist program of New Archaeology (e.g., Krebs and Davies, 1981, 1991; Piana, 1981; Winterhalder and Smith, 1981, 2000; Boyd and Richerson, 1985; Stephens and Krebs, 1986; Bettinger, 1991; Smith and Winterhalder, 1992; Kelly, 1995; Boone and Smith, 1998; Shennan, 2002, 2008). Most importantly, HBE and CT schools of thought explicitly dwell on variation in the empirical record. As such, these programs are particularly suitable to integrate the details generated by the life history approach to human remains and the high-resolution environment and climate research. The approach does not deny the role of human intention or invention, population fluctuations or migrations, climate change, or resource deterioration, but sees their role differently. Instead of viewing them as ultimate causes of culture change, these factors are assigned the critical role of agents generating variation on which evolutionary forces of culture change act upon. Overall then, the approach explicitly requires that identifying and measuring spatio-temporal variation, archaeological–behavioral and environmental–climatic, employs units that are meaningful from the perspective of understanding culture change. Such units may involve, depending on the specific setting, individual, group, community, or micro-region on the one side and annual, interannual or decadal scales of measurement on the other. In other words, variation needs to be measured at spatial and temporal resolutions that are one level better than the change, whether archaeological–behavioral or environmental–climatic that is believed to have occurred.

The approaches of HBE and CT theory have been quite successful in hunter–gatherer studies in general and particularly in the examination of the dynamic interactions between behavioral and environmental variables to elucidate spatio-temporal variability in foraging strategies, and to reconstruct long-term patterns of culture change. Human behavioral ecology examines how populations adapt to changing environments, mainly to shifts in distributions and abundances of plant and animal communities (i.e., paleo-ecology), and focuses on the strategies pursued by individuals to satisfy such basic human requirements as subsistence and reproduction, both of which contribute to larger scale patterns of community health and demography (Winterhalder and Smith, 1981; Mithen, 1990; Bettinger, 1991; Smith and Winterhalder, 1992; Winterhalder and Smith, 2000). When applied to humans, the guiding idea is that individuals attempt to satisfy these needs (e.g., energy) economically but the approach does not stipulate that all human behavior is economizing. Rather it defines a standard for recognizing economizing behavior – when present – and for recognizing situations where behavior appears, with respect to the chosen currency, to be non-economizing, which requires either a different currency or a different form of explanation. Furthermore, as demonstrated by a growing number of studies, this approach is also applicable to the examination of social practices and structures, such as the evolution of inequality, ritual, and religious behavior (Bird et al., 2001; Bird and Smith, 2005; Boone, 1992, 2000; Bowles et al., 2010; Hawkes and Bird, 2002; Kennett and Kennett, 2000; McGuire and Hildebrandt, 2005; Palmer and Pomianek, 2007; Smith, 2010; Smith et al., 2010; Sosis and Bressler, 2003). Cultural transmission theory, on the other hand, examines how and why cultural behaviors – for example, making stone tools or pottery, subsistence activities, or mortuary ritual – are acquired through social learning and then passed on between individuals or groups and generations of people resulting in distinct patterns of spatio-temporal cultural variation (Boyd and Richerson, 1985; Durham, 1991; Shennan, 2002; Henrich, 2004; Eerkens and Lipo, 2005, 2007; Lipo et al., 2006; Mesoudi et al., 2006; Collard and Shennan, 2008; O’Brien, 2008; Jordan and Shennan, 2009).

Thus, these two evolutionary approaches complement each other in their focus on the roles of individuals in evolutionary processes and together provide a coherent theoretical framework from which to examine how past subsistence strategies and technologies evolved over space and time (Bettinger, 1991; Smith, 2000; Shennan, 2002; Bentley et al., 2008; Collard et al., 2008). Also, as already well-established approaches in hunter–gatherer archaeology, HBE and CT also come with a ready-made ‘tool-kit’ of questions and methods that can be applied strategically on a case-by-case basis to specific archaeological datasets in both Baikal and Hokkaido pertaining to different aspects and dimensions
of prehistoric behavioral variability. More importantly, their shared emphasis on documenting and explaining individual strategies and decision making processes means that they also provide a logical and obvious choice for a theoretical framework that is able to integrate empirical insights into human diet, health, and mobility that are derived from the individual life history approach described above. Lastly, this central focus on individuals is important at least for two reasons: (1) population-level phenomena are merely statistical abstractions but individuals, which make up populations, are real (Mayr, 1959); and (2) while it is populations that evolve, it is the individuals that are the locus of behavioral change and the object of evolutionary forces (Boyd and Richerson, 1985).

Another important strength of these two approaches (HBE and CT) is that they explicitly call for theoretical and mathematical models of interactions between relevant variables: behavioral, technological, and environmental. The value of such simulations, and other kinds of models, relates both to the improved conceptual refinement that formal modeling requires, but also to the fact that empirical data, generated by examination of archaeological collections (human remains or materials from habitation sites) or environmental proxies, always display some deficiencies regardless of the amount of field and laboratory work completed, shortcomings being qualitative, quantitative, spatial or temporal. Current bioarchaeological and paleoenvironmental knowledge clearly indicates that distributions and abundances of human groups as well as plant and animal (terrestrial and aquatic) communities were highly variable in Cis-Baikal during the entire middle Holocene, and this is sufficient to pursue such models. The goal is to explore different scenarios and outcomes of the dynamic interactions between these three variables, i.e., human groups, animal populations, and plant communities.

Modeling of this kind is important because it provides control over a number of variables that are critical players in the process of hunter–gatherer culture change but are all but impossible, or at best very difficult, to glean from empirical data. With regard to human groups the list of such variables includes primarily demographic characteristics (e.g., local group and effective population size, age and sex structure) but also migration rates, game hunting or culling rates, and culture transmission mechanisms, the latter being tightly linked to demographic variables (e.g., Henrich, 2004). Animal characteristics useful to model may also include population size, age and sex structure, resilience to predation (human and non-human), adaptability to environmental change, inter-specific competition, and replacement rates (e.g., between red deer and roe deer). Equally practical would be to simulate the tempo of changes in distribution and abundances of plant communities. Another benefit of models is that they help guide the empirical research in terms of formulating right questions to be answered either via empirical work or further simulations. While examples of successful application of this approach abound and continue to grow as demonstrated by a few recent reviews (e.g., Winterhalder and Smith, 2000; Lupo, 2007; Shennan, 2008), no such models so far have been attempted either for the Cis-Baikal or Hokkaido Holocene foragers.

5.2. Empirical aspects

Any examination of human–environment relations – regardless of the theoretical approach – requires detailed paleoenvironmental data, for example, well-dated proxy records of adequate spatial-temporal resolution. The work conducted by the research group led by D. Sandweiss (University of Maine, Orono, USA) and colleagues on the Holocene prehistory of the Peruvian coast is one example, which persuasively demonstrates empirically the connections between climate change and culture change via relatively well documented shifts affecting the aquatic and terrestrial environments (Sandweiss et al., 2007; Sandweiss, 2008). This work shows that, if the environment and climate are suspected – via correlation – to be at the root of culture change, it is necessary to examine the paleoenvironment at spatial and temporal scales that are meaningful, as mentioned earlier, from the perspective of culture changes.

Since the 1990s (e.g., Dansgaard et al., 1993), paleoclimate research has been growing consistently in the direction of high resolution records and reconstructions, a trend applicable also to Northeast Asia (Nakagawa et al., 2003; Brauer et al., 2008; Wanner et al., 2008; Stebich et al., 2009). The continuously improving spatial and temporal resolution of this work, mathematical and proxy-based (Gotanda et al., 2002; Nakagawa et al., 2002, 2003; Tarasov et al., 2009), now has the capacity to produce predictive and reconstructive models of climate and environmental change that have much better control over such critical variables as seasonal variation in temperature and insolation, precipitation and snow cover, etc. Furthermore, these parameters allow modeling distribution and changes in biome types (Prentice et al., 1992, 1996) and tree cover (Guiot, 1990; Tarasov et al., 2007b; Kleinen et al., 2011), which can be further developed into corresponding changes in abundances and distributions of food resources (mostly fauna) important for past foragers. It is specifically such models, in addition to spatial-temporal changes in past climate, that are of vital importance to the new BHAP research objectives.

In Cis-Baikal, these are the main steps to take on the way to modeling and understanding better the interactions between the likely food resources — most importantly the ungulates — their resilience to human predation, hunter–gatherer subsistence activities, and associated changes in human population size and distribution throughout the region. These tasks can take advantage of the existing proxy records for the region, quantitative climate and vegetation reconstructions (Tarasov et al., 2007a, 2009), numerical simulations already in place or in progress (Bush, 2004, 2005; White and Bush, 2010), and new proxy data of better resolution hopefully obtained from coring Lake Kotokol’ near Baikal (Fig. 2; Shichi et al., 2009; Bezrukova et al., 2010).

However, there are some rather specific challenges that compromise utility of the current paleoenvironmental work for addressing the archaeological questions, and the presence of numerous technical contributions included in this special volume allows this paper to emphasize a few broader matters that refer directly to the examination of the human–environment–climate interactions in Holocene Northeast Asia. The following issues have been identified mainly based on an understanding of the recent survey of research on Holocene climate and environment history in the broader Baikal region by White and Bush (2010). This review is of particular value here because it treats the subject matter (i.e., climate and environment history) directly from the perspective of the MN cultural discontinuity in Cis-Baikal. Each of these points invites a few comments.

- Too much attention paid to the identification of the ultimate cause of environment–climate change and not enough to the micro-regional effects

This is a valid concern because life of a terrestrial animal, including human, is not really affected by global, continental or regional climatic changes but by what happens to the environment with which animals and people interact on a daily basis. For hunter–gatherers, what really matters is the effects a climate change would have on the abundance and distribution of terrestrial, riverine, and lacustrine food resources close to home. For example, in Cis-Baikal, the understanding of what the environment
was doing in various micro-regions in response to the middle Holocene climate shift is lacking. Although, given the importance of the ungulate resource, it is reasonable to expect that areas with more open vegetation would have been more affected than areas with thick forests, details of this variation are greatly needed.

- Incompatibility of scale between archaeological and environmental spatial units of analysis

Compounding the matter further is the fact that although the middle Holocene archaeological sequences are located in Cis-Baikal (the area north and west of the lake), the most useful currently available paleoenvironmental proxy sites come from Trans-Baikal (south and east of the Lake) (White and Bush, 2010). This discrepancy perhaps would not have been as much of a factor if it were not for the enormous size and volume of Lake Baikal (c. 640 km long and c. 20% of the Earth’s freshwater reservoirs) and the impact it imparts on the ecological conditions of the broader region, effectively serving as an important environmental barrier between Cis- and Trans-Baikal. Also, while archaeologically meaningful spatial units of analysis have been rather well established for Cis-Baikal (e.g., the Angara, Upper Lena, Little Sea and Tunka micro-regions; fig. 2), the lack of proxy sites with compatible catchments limits the ability to monitor ecological history within these units.

The shortage of good proxy sites in Cis-Baikal is nothing new and this is why the attention of paleoenvironmental fieldwork driven by archaeological research agenda has shifted to the region’s stratified archaeological sites (e.g., Gorinova and Vorob’eva, 1986, 1993; Vorob’eva et al., 1992; Vorob’eva and Gorinova, 1996). Admittedly, geoarchaeology of habitation sites contributes important information about site depositional and post-depositional history which is necessary to understand, for example, compression patterns and why some archaeological periods are missing from any given location. However, such sites notoriously lack the stratigraphic and chronological resolution as well as record continuity required to understand the human–environment–climate interactions over longer periods of time (e.g., Georgievskaya, 1989; Gorinova and Khlobystin, 1992). Moreover, availability of desirable proxies is highly variable from location to location. Consequently, this research avenue is unlikely to produce useful results.

While the Trans-Baikal location of most proxy sites reviewed by White and Bush is one obvious problem, the different catchment of each is another. Some records are local or even sub-local, some are regional or sub-continental (e.g., the cores from Lake Baikal itself) and none, of course, match spatially the archaeological micro-regions in Cis-Baikal. As there is no easy and immediate solution to this difficulty, mathematical modeling might be helpful.

- Dating problems and insufficient temporal resolution

There are a few inter-connected difficulties here: some related to archaeological, other to paleoenvironmental sequences. Despite the fact that the culture–history of Cis-Baikal presented earlier has been developed on the basis of hundreds of radiocarbon dates on human skeletal remains (Weber et al., 2010b), with dozens of new dates generated recently, the model does not account for two important factors: the old carbon/reservoir effect on radiocarbon age of human bones and stochastic effects on distribution of calibrated radiocarbon dates.

Although it has been recognized that the reservoir effect, i.e., accumulation of old carbon in large bodies of water, could also apply to Lake Baikal (Colman et al., 1996; Prokopenko et al., 1999), efforts to develop methods of correcting the offset have been inconclusive (Watanabe et al., 2009a, 2009b). Recent extensive radiocarbon dating of seal bones, which represent purely aquatic diet of Lake Baikal origin, and bones of ungulates, which represent purely terrestrial diet, from the archaeological habitation site Sagan-Zaba on Lake Baikal, clearly demonstrates that the offset could be as much as 700–1000 years (Nomokonova et al., 2013), a value often surpassing that seen in marine environments (Reimer and Reimer, 2001). However, it is unclear at the moment what that offset would be for dates on human bones representing quite variable balance between terrestrial and aquatic foods, the latter coming from different sources such as Lake Baikal, Angara, and Lena Rivers (Weber et al., 2011), each likely carrying somewhat different old carbon/reservoir offset. In either case, the chronological periods of the middle Holocene culture-historical sequence established on the basis of large sets of dates on human skeletal remains (i.e., EN, LN and EBA) are all likely to be a few hundred years younger relative to what the model currently specifies. Consequently, the MN, even though it lacks such dates, will be correspondingly younger too.

Radiocarbon dating, like any other kind of measurement, is a subject of stochastic vagaries. In archaeological literature this problem has been recognized only relatively recently, that is when scholars started working with large sets of radiocarbon determinations rather than only a few dates as has been the case in the past (Buck et al., 1994, 1996; Ramsey, 2009a, 2009b). One way to correct for stochastic effects is via Bayesian statistics, an approach that results in time intervals that are usually much shorter relative to what raw or calibrated dates indicate prior to statistical processing. In Cis-Baikal, this method has been applied so far only to two EBA cemeteries and one habitation site in all cases shortening substantially the relevant time intervals (e.g., periods of cemetery use) from several to a few centuries or even shorter spans (Weber et al., 2005; Nomokonova et al., 2013; Weber, 2012). While application of the Bayesian approach to all dates from middle Holocene Cis-Baikal should wait until the question of the old carbon/reservoir effect is resolved, it is entirely reasonable to expect that the main outcome will be shorter duration of chronological periods dated primarily by dates on human bones (i.e., EN, LN and EBA) and longer duration of the MN dated essentially only by outside boundaries of the neighboring EN and LN periods. As a mere example, if the EN is dated today to 8000–6800 cal. BP, it is not unreasonable to expect that after correcting it for the old carbon/reservoir offset and stochastic effects, the EN will be shifted towards the younger half of the 8000–6800 cal. BP interval and only 200–300 years long. Moreover, applying these two corrections to the LN and EBA periods is expected to do two things: first, to extend the MN period to perhaps as much as 2000 years and, second, to open a gap between the LN and EBA periods of formal cemetery use.

While at the current stage of research this remains a hypothesis, thinking about this scenario is directly relevant to the main matter at hand: the purported link between the middle Holocene climate–environment change and the EN–MN transition. The corrected chronology of the EN–MN transition would not misalign it with the onset of the middle Holocene climate–environment change in Cis-Baikal, mainly because the latter is dated only very broadly to c. 7500–6500 cal. BP. However, the beginning of the climate–environment shift needs to be dated with much better accuracy than the one thousand year-long window in order to investigate its potential involvement in the cultural transition. It is also clear that the middle Holocene climate–environment would have nothing to do with the subsequent similar cultural shifts.

This is why precise and accurate dating of the proposed model of the middle Holocene environment–climate change is such an important task. The proxy sites discussed by White and Bush are considered the best records available, both in terms of dating and
chronological resolution. Still, the temporal controls in every case are rather poor at least from the perspective of integrating those records with archaeological ones. Not infrequently every proxy record is dated by only a handful of radiocarbon determinations with one or two dates anchoring a specific section of the entire sequence and timing of the rest of the sequence normally extrapolated from those few dates based on the assumption of constant accumulation rates. Perhaps this is why, at least in part, each record suggests a different date, not uncommonly by as much as 1000 years. Moreover, the Bayesian approach is not applicable to such small datasets. The purpose of this point is merely to demonstrate that the two fields, archaeology and paleoenvironmental studies, employ quite different strategies to date their sequences and that this makes integration of both fields not an easy scholarly pursuit.

Next, as most of the relevant proxy records are on the Trans-Baikal side of the Baikal region, it is useful to consider to what extent the middle Holocene climate change could have been time-transgressive. That is, if the climate shift was at least to some extent a result of a weakening Asiatic paleomonsoon system, the moist air masses of which did not penetrate as far inland as before, a possibility mentioned too in White and Bush’s survey, then it is reasonable to expect that the climate change would affect first Cis-Baikal on the northwest side of the lake before impacting Trans-Baikal on the southeast side. If so, the parameters of the climate shift in the two regions separated by the vast body of Lake Baikal water would be different from one another. At present the field data seem to be inconclusive to reject or to support this scenario and, if the latter, to add more details to it.

In sum then, knowing that the middle Holocene climate change impacted the Baikal region sometime over the course of 1000 years (between 7500 and 6500 cal. BP) is merely not enough to construct any realistic models of forager-environment interactions particularly in the context of poor proxy records on the Cis-Baikal side. A difference of as little as 100–200 years between the onset of the climate-environment change and culture shift would make the link between the two rather difficult, if not entirely impossible, to demonstrate.

- Poor knowledge of the tempo of environmental change

The job of linking the EN–MN transition with middle Holocene environment–climate shift faces an additional challenge in that the tempo of the latter is unknown. Thus, while this and the other middle Holocene cultural transitions appear to be quick, it is unclear whether the environmental shift was, for example, gradual and relatively quick or gradual but rather slow, or slow first and quick later or the other way around, or punctuated etc. To know this is not only interesting but also important because of at least two reasons. First, there is always a lag time between the change in long-term weather pattern and the resulting shifts in abundances and distribution of local flora and fauna. And second, adaptive responses of flora, fauna, and human groups depend not only on the extent but also on the tempo of the local climate change with large mammals, and particularly humans, adaptable to a wide range of environmental settings.

White and Bush describe the middle Holocene climate change as rapid and significant; however, to clarify the matter, it was most certainly not as rapid and dramatic (Mayewski et al., 2004) as the tempo of Late Pleistocene shifts from fully glacial to fully interglacial conditions which are believed to be taking place on the decadal scale (e.g., Dansgaard et al., 1993; Kerr, 1993; Mayewski et al., 1993). The tempo is an important factor also because decadal or interannual changes can be witnessed and experienced directly by people but not the centennial or intercentennial ones which can only be tracked indirectly via oral tradition if at all. Consequently, decadal to interannual and centennial to intercentennial shifts evoke different kinds of responses in human groups and, thus, either scenario requires a different kind of explanation. Lastly, there is very little evidence that even faster acting events, such catastrophic earthquakes, volcanic eruptions, storms, or tsunamis (as in the North Pacific, e.g., Maschner and Jordan, 2008), were an important part of Cis-Baikal’s middle Holocene environment. If field data are again of little help, perhaps mathematical tools are needed to address the matter of the tempo of middle Holocene climate change in Cis-Baikal.

- Integration of the archaeological data with paleoecological data

The last point emphasizes the need to assess the effects of climate change on the local environments not alone but in conjunction with human foraging which, from what is known, varied likely more in degree than in kind—which is important—both spatially and temporally across entire Cis-Baikal (Weber et al., 2011). The available data suggest that population size and distribution of hunting-gathering groups across entire Cis-Baikal was equally variable and that every micro-region experienced somewhat different demographic history (Weber and Bettinger, 2010). For example, while the foraging population in the Angara valley, with the exception of the MN period, seems to be relatively stable in terms of size and density, this was likely not the case in the Little Sea on Lake Baikal where it is the EBA population that appears to be an order of magnitude larger than the earlier groups. This is important because, keeping the environment constant, such large and quick changes in population density could quickly lead to depletion of food resources, particularly those involving K-selected species (ungulates). Current knowledge is quite far from understanding the interplay between climatic and cultural factors and their combined impact on micro-regional environments and their food resources.

A number of new studies have been released since the publication of the White and Bush (2010) review. All these works contribute new and important insights on middle Holocene climates and environments but not of the kind that would necessitate revision of the empirical challenges described above (e.g., Tarasov et al., 2009; Bezrukova et al., 2010, 2011; Mackay et al., 2011). Rather, they strengthen the points which, unsurprisingly, resonate well with those made recently in a broader review of interactions between middle Holocene climate change and cultural transitions (Anderson et al., 2007).

5.3. Summary of challenges and opportunities

Archaeological or any other examination of living systems, regardless of the theoretical approach employed, is a complex process that involves many steps. Research conducted from the kind of neo-Darwinian perspective advocated here emphasizes two such elements: one documents spatio-temporal variation and interactions between units as well as pattern recognition; and the other attempts explanation of spatio-temporal variation, patterns, and change via evolutionary mechanisms. The life history approach, as described above, has been applied in Cis-Baikal over the last 20 years to examine several large cemeteries dating to the EN (Lokomotiv, Shamanka) and LN–EBA (Ust’-Ida, Khuzhir-Nuge XIV, Kurma XI; Fig. 2) as well as to two stratified (Mesolithic to Iron Age) habitation sites (Sagan-Zaba and Buguldeika; Fig. 2). Examination of this material—step one—has progressed from documentation of hunter–gathering behavior (cultural) and environmental variation in space and time to pattern recognition. With these tasks completed or in progress, the focus now is shifting—step two—to toward explanation of the processes responsible for these patterns. Environmental change and its role in culture change
becomes a high priority, because of the apparent correlations listed earlier.

The broad diversity of methods and approaches employed in step one, requires equal diversity of methods and approaches to be employed in step two. It is neither necessary nor possible for us to provide specific guidelines or recommendations with regard to how this research needs to proceed in order to develop such explanations. All that is required is that it subscribes explicitly to the main tenets of the neo-Darwinian school of thought (e.g., Mayr, 1959, 1976, 1982; Dunnel, 1982) of which the following are the most important:

- Evolution of any living system is defined in terms of changes in population characteristics (biological or behavioral) over time or, in other words, as differential persistence of variation;
- Evolutionary change is cumulative rather than transformational;
- While it is the individual that is the locus of behavioral change and the main subject of evolutionary forces, it is the populations that evolve;
- Time and space are dynamic factors in the process of evolutionary change in that in addition to affecting quantitative aspects of outcomes they also affect outcomes in qualitative ways;
- Explanations are historical contingencies (things happen only once and are never repeated anywhere and anytime again) rather than ahistorical law-like statements;
- Explanations are historical contingencies also in the sense that the employed units and their properties, and the interactions between them are different in time and space.
- Explanations of cumulative changes can invoke any kind of evolutionary mechanisms as long as they are not vitalistic or teleological (i.e., people can introduce a new variant with

Fig. 3. Northern Japan and location of environmental sites mentioned in the paper.
specific goal, but they cannot control whether it is accepted or rejected by the rest of the group and, similarly, individuals can only control what variants they accept or reject, not which ones exist to choose from).

Obviously, development of such explanatory models will require much time and their impact on the scholarship is expected to be both cumulative and gradual, quick at times and slow at other times. Admittedly, understanding of the basic culture-historical sequences on Hokkaido appears to be much better relative to Cis-Baikal’s 20–30 years ago. However, datasets compatible with the life history approach are yet to be generated for Hokkaido in order to revisit its Holocene past from this new evolutionary perspective. This, very likely, will provide new insights which may require revisions to the summary presented earlier. Nonetheless, a few useful points of interest are noted. The Hokkaido cultural sequence spans shifts in climate, vegetation, ocean currents, and sea levels, but their potential effects on resource availability and foraging strategies remain to be systematically assessed. Similarly unknown are the potential effects of human hunting on the stocks of the sika deer population—the only important terrestrial game species on the island. One would also expect even more, relative to what was mentioned earlier, cultural variation related to the effects of the two prevailing gradients of environmental variability on Hokkaido that is the Pacific v. Sea of Japan coasts and the cooler northeast v. the warmer southwest.

An important advantage of bringing this research approach to Hokkaido is the availability of annual proxy records from varve lakes which are lacking in Cis-Baikal. Most relevant to this work are the cores from lake Megata (e.g., Yamada et al., 2010) and Ogawara (Ikeda et al., 1998), located on the Sea of Japan and Pacific coasts of northern Honshu, respectively (Fig. 3). As the main climatic parameters of modern Hokkaido and northern Honshu are highly correlated, it is thus possible to use the data from these two lakes to build for Hokkaido the same kind of biome and tree cover distribution models as for the Baikal region but with much better temporal resolution and accuracy. Of further assistance will be the partial varve sequences available from Lake Abashiri in Northern Hokkaido and Lake Kushu on Rebun Island (Fig. 3; Kumanou et al., 1990), the latter recently cored by scholars associated with the BHAP (Dr. H. Yonenobu, Naruto University, personal communication, February 2012). Despite Hokkaido’s much better potential for high resolution modeling of Holocene climates and environments, many of the challenges described above, particularly the theoretical ones, will need to be reckoned with too.

6. Conclusion: researching climate change and the agency of Holocene hunter–gatherers

Archaeology has tended to portray Holocene foraging groups as being rather static and lacking capacity for innovation and culture change unless triggered by the arrival of food production and the dispersal of farming colonists. More recent research is overturning these stereotypes, and is beginning to indicate that Holocene hunter–gatherer communities were highly dynamic, with unique local histories often characterized by sudden cyclical shifts in subsistence, settlement and social practices. While research is only now starting to apprehend some of these patterns, it also stands on the brink of exciting new theoretical and methodological developments in the analysis of hunter–gatherer ‘agency’ thanks to recent advances in bioarchaeology, particularly the potentials inherent to the life history approach, and the continuous growth of evolutionary approaches to hunter–gatherer anthropology and archaeology. With the right kinds of data and modeling tools, archaeologists can explore and reconstruct dynamic histories of individuals and populations and discern major spatio-temporal patterns. BHAP has identified two regions in Northeast Asia highly suitable for this approach: Cis-Baikal and Hokkaido.

As detailed above, both regions are characterized by patterns of cyclical and substantial culture change. Available evidence, at least for Cis-Baikal, points to the importance of changes in environments and climate as being behind some of the cultural shifts. To take this research agenda forward, BHAP will require high-resolution paleoenvironmental models, and it will also need to develop ways to integrate the climate change data with the bioarchaeological approach, which focuses on individuals and populations. Thus, by applying the life history approach to Cis-Baikal and Hokkaido and by conducting high resolution paleoenvironmental work in both areas, and eventually by comparing the two regions with each other, it is hoped to attain better understanding of the interactions between the changing biophysical environment and hunter–gatherer behavior in both places during the Holocene. In both regions, this combined application of a large program of comparative bioarchaeological, biogeochemical, and paleoenvironmental research framed by the HBE and CT theory is the best approach to addressing research challenges described earlier in the paper and to taking full advantage of the existing opportunity to understand better the specific mechanisms of hunter–gatherer culture change in these two particular settings. Overall, and understandably, this is a long-term research program that requires generational effort much beyond the life of the current BHAP.

In archaeology, the most telling insights into the processes generating human cultural and biological diversity are derived through exploration of meaningful parallels with other case studies. Thus, findings from the parallel examination of Baikal and Hokkaido hunter–gatherers will be relevant to the understanding of factors driving culture change in Holocene hunter–gatherers around the world, including northern North America, the North Pacific rim, coastal South America (Peru and Chile), Atlantic Europe, and south Scandinavia, all of which display conspicuous similarities with regard to cultural and population discontinuities, demographic and social complexity cycles, use of formal cemeteries, frequent redefinition of subsistence strategies, as well as the aquatic environmental settings.

Even more generally, this work promises to address a few key gaps in current hunter–gatherer archaeology. First, it will continue to generate new hunter–gatherer bioarchaeological data which, for reasons mentioned earlier, are generally rare globally. Second, new detailed paleoenvironmental data and models for Cis-Baikal and Hokkaido will be of critical importance for apprehending the causality and tempo of long-term hunter–gatherer culture change in both regions. Third, it will expand knowledge of the diversity of Holocene hunter–gatherer adaptive strategies including the factors affecting cultural complexity, behavioral variation, and differing lines of cultural and biological transmission, all of which feed into the conditions under which hunter–gatherers develop varying historical trajectories. Importantly, a recent summary of Holocene hunter–gatherer archaeology identifies the last two points as the most pressing research goals for the immediate future (Bettinger, 2001). With these archaeological research questions in place, the papers included in this special volume contribute much new knowledge on paleoenvironments in Northeast Asia to assist the assessment of human prehistory. Potentials aside, this is challenging research and good environmental data are central to all hunter–gatherer archaeological scholarship in Holocene Cis-Baikal, Hokkaido, and beyond.
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