RADIOCARBON CHRONOLOGY FOR PREHISTORIC COMPLEXES OF THE RUSSIAN FAR EAST: 15 YEARS LATER

Yaroslav V Kuzmin

Institute of Geology & Mineralogy, Siberian Branch of the Russian Academy of Sciences, Koptyug Ave. 3, Novosibirsk 630090, Russia. Email: kuzmin@fulbrightmail.org.

ABSTRACT. The recent progress in radiocarbon dating of the prehistoric cultural complexes in the Russian Far East is discussed against the background of ancient chronologies for greater East Asia. Since 1997, the wide use of accelerator mass spectrometry (AMS) radiocarbon dating along with the continuation of conventional dating has allowed us to establish the age of several key Paleolithic, Neolithic, and Paleometal sites. It has also contributed to advancing a deeper understanding of the timing for the beginning of pottery production, maritime adaptation, and agriculture, and several other important issues in prehistoric chronology for the studied region. Reservoir age correction values for the Japan and Okhotsk seas are now used to adjust the age for samples of marine origin. Some of the cultural-chronological models for prehistoric far eastern Russian complexes put forward in the last 10 yr lack a solid basis, and are critically evaluated herein.

INTRODUCTION

The first chronological comprehensive framework for prehistoric (both Paleolithic and Neolithic) cultural complexes of the Russian Far East, including relatively extensive lists of radiocarbon dates and their critical analysis, was created in the mid-late 1990s (e.g. Kuzmin et al. 1994, 1998a). It was revised and amended until the early 2000s (e.g. Kuzmin 2006a). However, in the late 1990s it became clear that much more work is needed to construct a more reliable chronological scheme for the Stone Age and Paleometal complexes. Due to the limitation of sample size at many sites, the use of accelerator mass spectrometry (AMS) ^{14}C dating was necessary; however, as of now (August 2012) there are no AMS machines in Russia that can reliably measure ^{14}C content in samples of unknown age. Thus, in order to conduct this research, an informal agreement between the author and the NSF-Arizona AMS Laboratory (University of Arizona, Tucson, Arizona, USA) was achieved in 1997. Some other AMS laboratories in Japan, the Netherlands, and the Republic of Korea also participated in this research, as well as numerous Russian archaeologists who supplied material for ^{14}C dating. The conventional ^{14}C dating (conducted mainly in Novosibirsk laboratory, lab code SOAN; see Table 1) was continued to be employed when possible.

The main strategy was to obtain as many ^{14}C dates as possible from key sites of the Paleolithic, Neolithic, and Paleometal periods, and to supplement these with paleoenvironmental information. Also, the correlation with neighboring regions of greater East Asia was necessary to determine the place of the far eastern Russian cultural complexes in a wider context. Today, it is possible to summarize the results obtained over the last 10–15 yr and to discuss their impact on the existing chronology of the prehistoric Russian Far East. It is also timely to evaluate some models and conclusions on ancient chronology and environment of the region that have been put forward in the last decade or so and in my opinion cannot be substantiated according to modern methodological standards in geoarchaeology (e.g. Renfrew and Bahn 2004:231–74).

MAIN ACHIEVEMENTS IN PREHISTORIC CHRONOLOGY OF THE RUSSIAN FAR EAST FOR THE LAST 10–15 YEARS: AN OVERVIEW

Paleolithic Chronology

In order to understand the timing of the earliest Upper Paleolithic, dating of key sites (Figure 1, A) was performed. The ^{14}C values from the Geographic Society Cave, the oldest site in the Russian Far East with preservation of material for dating, generally fall into an interval from >40,000 to

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~31,500 BP (Kuzmin et al. 2001). The specimens most closely associated with artifacts are in the range of >38,000–40,000 BP; this age can be used as a provisional determination of the first appearance of humans in the southern part of the region. Other potentially early Paleolithic sites in the Russian Far East either have an unclear stratigraphic context (such as the Osinovka site in Primorye [Maritime] Province, see Derevianko and Tabarev 2006; the Filimoshki, Ust Tu, and Novorybachii sites in the Amur River basin, see Derevianko et al. 2006; and the Sennaya 1 site on Sakhalin Island, Vasilevsky 2008; see Kuzmin 2011:168) or were found on the surface (e.g. the Kumara cluster and Tambovka site, see Derevianko et al. 2006). Thus, their position is not secure enough to be considered as solid evidence about the human presence at a certain time, and thus, the Geographic Society Cave is the best early site so far in terms of its integrity.

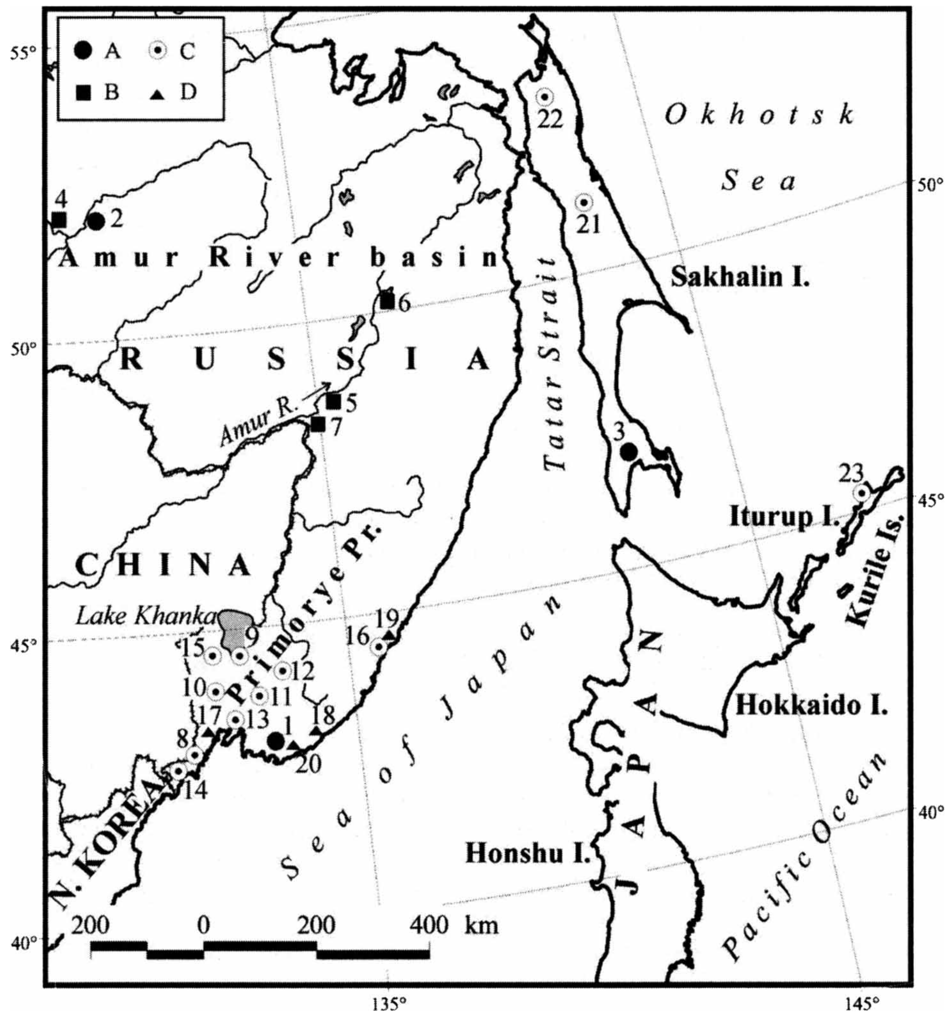

Figure 1 Key archaeological sites mentioned in the text. Epochs: A – Paleolithic; B – Initial Neolithic; C – Middle/Late Neolithic; and D – Paleometal. Sites: 1) Geographic Society Cave; 2) Ust-Ulma 1; 3) Ogonki 5; 4) Gromatukha; 5) Gasya; 6) Khummi; 7) Goncharka 1; 8) Boisman 1 and 2, Klerk 5; 9) Luzanova Sopka 2; 10) Krounovka 1 and Bogolubovka 1; 11) Mustang and Rettikhovka-Geologicheskaya; 12) Sheklyaevo 7; 13) Kirovsky; 14) Gvozdevo 4, Zaisanovka 1 and 7; 15) Novoselische 4; 16) Rudnaya; 17) Peschany; 18) Glazkovka 2, Zarya 3A and 3B; 19) Monastyrka 2 and 3; 20) Preobrazheniya 1; 21) Puzi 2; 22) Bolshaya Rechka 7; 23) Yankito.

The microblade technology in northern Asia is a clear manifestation of the late Upper Paleolithic (e.g. Kuzmin 2007). In the Russian Far East, the earliest cultural component with microblades and wedge-shaped microcores, Layer 2b of the Ust-Ulma 1 site in the Amur River basin, is dated to ~19,400 BP (e.g. Kuzmin 2007). Below it, there is another component, Layer 3, which also contains microblades but it is currently undated; the age estimate is ~24,000–20,000 BP (Derevianko et al. 2006). At another site in the Amur River region, Khodulikha 2 (not included in Figure 1; 50°40′N, 127°20′E) west of Ust-Ulma 1 site, the layer with microblades is dated to ~16,500 BP while below it the cultural component without traces of microblade technology has an age of ~22,500 BP (Kuzmin et al. 2005). The end of the Upper Paleolithic in the Russian Far East can now be dated to ~11,500–10,300 BP (Kuzmin 2003). The latest Paleolithic sites coexisted with the earliest Neolithic complexes with pottery (see below).

Recent progress in the study of microblade technology in Northeast Asia allows us to establish the age of the first appearance of microblades in Japan (~21,000 BP; Hokkaido Island) and Korea (~24,000 BP) (see Kuzmin 2007). This is similar to the Russian Far East and coincides in general with the Last Glacial Maximum (LGM). However, it would be premature to connect the appearance of microblade technology with climatic fluctuations around the LGM time (e.g. Goebel 2002). In Siberia and Mongolia, the earliest evidence of microblades (produced by pressure flaking) goes back to about 35,000–28,500 BP (e.g. Keates 2007; Kuzmin 2007; Derevianko 2009; Gladyshev et al. 2010) and definitely precedes the LGM, *contra* to Kuznetsov (2010) who still determines the age of microblade complexes in Siberia and East Asia as ~24,000–10,000 BP.

The Emergence of Pottery

Pottery in East Asia and Siberia manifests the beginning of the Neolithic (e.g. Kuzmin 2006b). For a long time, Japan was considered the "cradle of pottery-making" with the age of the Incipient Jomon pottery complexes at ~12,700–12,200 BP (e.g. Morlan 1967). However, the first final Pleistocene ^{14}C dates for pottery assemblages of the Russian Far East were obtained in the early 1980s (Okladnikov and Medvedev 1983), but they were taken into consideration with a high degree of skepticism, especially in Japan. A program of dating the cultural layers of the Initial Neolithic sites in the Amur River basin (see Figure 1B) was set up in the mid-1990s. Extensive dating of charcoal and organic-tempered pottery resulted in the determination of its age as ~13,300–12,300 BP (O'Malley et al. 1999; Kuzmin 2003, 2006b; Nesterov et al. 2006). Finally, these values have been accepted by the international scholarly community (e.g. Boaretto et al. 2009).

It seems that there were 3 major independent centers of pottery origin in East Asia and worldwide—southern China, Japan, and the Russian Far East—without clear traces of possible interaction and exchange of ideas and technology. There is no clear connection between the emergence of pottery and climatic changes in the Late Glacial (see review: Kuzmin 2010), and at the current stage of research we can only guess what was (were) the driving force(s) for the invention of pottery. This is the model of pottery emergence created by the author (see Kuzmin 2006b, 2010).

The Origin of Maritime Adaptation

The maritime adaptation of prehistoric coastal people in Northeast Asia was an important event in the economic history of the region. The increase of food resources, especially ones with predicted availability (such as shells from mollusk beds in shallow lagoons), was crucial for human survival. The first fully fledged maritime-adapted cultural complex in the Russian Far East is the Boisman culture in the southern Primorye, with Boisman 2 representing the key site (see Figure 1, C). Initial dating of this unique archaeological object was conducted in the early 1990s (Jull et al. 1994). Later on, more ^{14}C dates on charcoal, mammal bones, mollusk shells, and human bones (reservoir-corrected), generated from the shell midden with presence of bones of both terrestrial and marine mammals, fish, and mollusks, allows us to establish the age of this complex as ~5800–5400 BP (Kuzmin et al. 2002; Kuzmin 2009).

The Boisman cultural complex (or Boisman "culture" in Russian sources, see below) is divided into several stages (Moreva 2005). The proto-Boisman component with sharp-based vessels recovered from below the shell midden is dated to 7010 ± 70 BP (SNU-01378) and 7110 ± 60 BP (AA-60496). The first stage of Boisman culture is dated to 6710 ± 55 BP (AA-32671), 6635 ± 60 BP (AA-27534), 6320 ± 40 BP (AA-60497), and 5840 ± 40 BP (AA-60498); the second stage to 6150 ± 40 BP (AA-36384) and 5890 ± 110 BP (AA-60499); the third stage is placed at 5725 ± 40 BP (AA-36903), 5480 ± 40 BP (AA-36386), and 5300 ± 40 BP (AA-60500); the fourth stage is dated to 5490 ± 150 BP (AA-60501); and the fifth stage can be dated to 5860 ± 100 BP (AA-60502). Some discrepancies are due to the complicated stratigraphy of the shell midden where artifacts of stages 1–5 of Boisman culture were found. From the bottom of the cultural sequence at the Boisman 2 site with a shell midden, several other ^{14}C values were obtained: 6355 ± 60 BP (AA-9461), 6155 ± 85 BP (AA-27538), 5560 ± 50 BP (AA-27542), 5465 ± 50 BP (AA-32672), 5380 ± 50 BP (AA-27541), 5330 ± 55 BP (AA-9460), 5285 ± 55 BP (AA-27537), and 5280 ± 60 BP (AA-27543).

Two other sites of the Boisman culture (without shell middens) were also dated: Luzanova Sopka 2 at 5840 ± 40 BP (AA-60498); and Gvozdevo 4 at 5865 ± 45 BP (AA-60611), 5630 ± 40 BP (AA-60609), and 5075 ± 45 BP (AA-60610). The Boisman 1 site was previously dated using marine mollusk shell to 5690 ± 45 BP (OS-3030) (see Jones et al. 1996), and this age after reservoir correction (see Kuzmin et al. 2007) corresponds to ~4310–4030 cal BC. An additional ^{14}C value of 5640 ± 45 BP (TKa-13484) was obtained from burnt food on a potsherd (Komoto and Obata 2005); its calendar age is 4580–4360 cal BC.

As for neighboring East Asia, it seems that Japan has the earliest record for use of marine food resources and dates to the Early Holocene, ~9200–7100 BP, while in Korea and northeast China the maritime adaptation appeared approximately at the same time as in the Russian Far East, at ~6300–5700 BP (see review: Kuzmin 2009). The intensification of marine animal and invertebrate consumption may be related to the high sea level in the Middle Holocene (~6500–5000 BP) (e.g. Korotkii 1985; see also Kuzmin 2006a, 2009) and the existence of numerous coastal lagoons with mollusk beds (represented mainly by Pacific oyster, *Crassostrea gigas*).

The Beginning of Plant Cultivation

In the early 1990s, little was known about the time when agriculture was introduced in the Russian Far East. There were only 2 sites with direct evidence of Neolithic plant cultivation, i.e. seeds of cultigens: Kirovsky and Novoselische 4 (Kuzmin et al. 1998b). In 2012, we have at least 9 sites with finds of millet seeds from the Late Neolithic cultural components (Table 1, Figure 1). The general age range of the earliest sites with millet seeds is ~4700–3300 BP. The single direct ^{14}C date of millet from the Novoselische 4 site, ~3840 BP, is noteworthy, and confirms the charcoal ^{14}C values.

Regarding the origin of millet agriculture in the Russian Far East, my current model is that it initially appeared in northern and northeastern China (Cishan site, Hebei Province; and Xinglonggou site, Inner Mongolia Province; see Kuzmin et al. 2009) at around 9200–6300 BP. It then spread to the east and southeast, reaching the southern part of the Korean Peninsula (see Crawford and Lee 2003) and Primorye Province at ~4700–4600 BP.

Table 1 Radiocarbon dates associated with the earliest direct traces of millet agriculture in Primorye (Zaisanovka cultural complex).

Site, layer	Material	^{14}C date (BP)	Lab nr	Calendar age (cal BC)[a]	Reference
Krounovka 1, levels 2–3	Charcoal	4670 ± 30	NUTA2-5643	3620–3370	Komoto and Obata 2004
	Charcoal	4640 ± 40	Beta-171662	3620–3350	Komoto and Obata 2004
Mustang	Charcoal	4660 ± 60	Ki-3151	3630–3200	Kuzmin et al. 1994
	Charcoal	4050 ± 70	Ki-3152	2880–2460	Kuzmin et al. 1994
Sheklyaevo 7	Food crust[b]	4435 ± 45	AA-60053	3330–2920	This paper
	Food crust[b]	4430 ± 45	AA-60051	3330–2920	This paper
	Charcoal	4390 ± 45	AA-60058	3320–2900	This paper
Kirovsky	Charcoal	4150 ± 60	Le-193	2980–2580	Kuzmin et al. 1998b
Gvozdevo 4	Food crust[b]	4130 ± 40	AA-60612	2870–2580	This paper
Zaisanovka 1	Carbonized nut	4010 ± 45	NUTA2-5282	2840–2360	Komoto and Obata 2004
	Carbonized nut	3970 ± 30	NUTA2-5483	2570–2350	Komoto and Obata 2004
Bogolubovka 1	Charcoal	3890 ± 60	SNU07-260	2560–2150	Garkovik 2008
Novoselishche 4[c]	Charcoal	3840 ± 70	AA-13400	2480–2050	Kuzmin et al. 1998b
	Charcoal	3755 ± 35	AA-36748	2290–2040	Kuzmin 2006a
	Millet seeds	3840 ± 40	TKa-14081	2460–2150	Sergusheva 2008
Rettikhovka-Geologicheskaya	Charcoal	3390 ± 55	SOAN-4239	1880–1530	Kolomiets et al. 2002
	Charcoal	3310 ± 45	SOAN-4240	1730–1500	Kolomiets et al. 2002
	Charcoal	3280 ± 45	SOAN-4238	1670–1450	Kolomiets et al. 2002

[a]CALIB 6.0.1 software was used (Reimer et al. 2009) (± 2σ, all possible intervals combined and rounded to the next 10 yr).
[b]These ages are obtained on food adhesions on the pottery surface, and could be older than contemporaneous charcoal (see Fischer and Heinemeier 2003).
[c]Samples were collected from the floor of the dwelling.

Other Important Results

The reservoir age correction values for the Russian Far East were unknown until the mid-1990s when the first date was received (e.g. Jones et al. 1996). After that, more work was done to understand the peculiarities of the reservoir age in the Sea of Japan and Okhotsk Sea (Kuzmin et al. 2007). This was necessary for establishing the true age of the coastal population of Primorye with a heavy marine protein diet (Kuzmin et al. 2002). The reservoir ages obtained by our group are consistent with data generated by Japanese scholars (e.g. Yoneda et al. 2007; Yoshida et al. 2010).

Age determination for individual archaeological sites and cultural complexes [or "cultures" in Russian archaeological terminology; see Trigger (2006:343) and Nelson (2006:4–8)] in the Russian Far East by AMS ^{14}C dating has been conducted continuously since the late 1990s, and some results are noteworthy. The southern Primorye region, where the majority of archaeological studies are conducted, has the most abundant record of new ^{14}C dates (see Figure 1).

The Early/Middle Neolithic cultural complex initially recognized at the Rudnaya [also known as *Rundaya Pristan* and *Tetukhe*] site (e.g. Kuzmin et al. 1994:361–2) was additionally studied in the 2000s. Several ^{14}C values in the range of ~7300–6040 BP were obtained (Batarshev et al. 2010). The earliest extant textile remains in East Asia were dated to ~8215–7710 BP at another site of the Rudnaya culture, Chertovy Vorota (see Kuzmin et al. 2012a). The Middle Neolithic Vetka complex at Sheklyaevo 7 site is dated to 6045 ± 50 BP (AA-60055) and 5845 ± 100 BP (AA-60052); the Luzanova Sopka 2 site dates to 5865 ± 75 BP (AA-60504).

The Late Neolithic cultural complex of Zaisanovka was intensively ^{14}C dated in the last few years. Several values were obtained: at Sheklyaevo 7 site, ~4435–4390 BP; at Gvozdevo 4 site, ~4130 BP (Table 1); and at Luzanova Sopka 2, 4770 ± 40 BP (AA-60505) and 3905 ± 40 BP (AA-60607). The transitional Neolithic/Paleometal complex of Margaritovo [also known as *Margarita*, see Cassidy 2007] is now ^{14}C dated to 3605 ± 35 BP (AA-37114) at the Glazkovka 2 site; to ~3400 BP at the Monastyrka 2 site; ~3600–3500 BP at the Preobrazheniya 1, Zarya [Zera] 3A, and Zarya 3B sites; and ~3420–3340 BP at the Monastyrka 3 site (Cassidy 2004, 2007).

Several shell middens of the Late Neolithic (Zaisanovka and Klerk cultural complexes) and Early Iron Age were recently ^{14}C dated. The Zaisanovka 7 site of the same culture has several ^{14}C values: 4500 ± 40 BP (AA-32215); 4470 ± 40 BP (TKa-13485) (Komoto and Obata 2005); and 4450 ± 40 BP (AA-32217). The Klerk 5 site of the same complex is dated to 4750 ± 40 BP (TKa-13486) (Komoto and Obata 2005); 4585 ± 45 BP (TKa-14076) and 4125 ± 40 BP (TKa-14075) (Obata 2007). The famous Peschany site with a shell midden of the Yankovsky culture (Early Iron Age, see Okladnikov 1965) was dated to ~2455–2400 BP (Cassidy 2007).

In the Amur River basin, significant progress was achieved in the last few years. In the lower part of the Amur River course, a detailed chronological scheme was created (Shewkomud and Kuzmin 2009). In the middle part of the Amur River basin, the age of the main Neolithic complexes is now established (Kuzmin and Nesterov 2010). It is worth mentioning newly released ^{14}C dates for the Late Neolithic Osinoozerskaya culture: 3840 ± 40 BP (AA-32209) and 3520 ± 40 BP (AA-60767) at the Mikhailovka-Klyuch site (50°39′N, 127°20′E); and ~3600–3290 BP at the Gromatukha site, layer 1 (Nesterov et al. 2006).

In the insular regions of the Russian Far East (Figure 1), more ^{14}C dates from prehistoric sites came to light recently. The major chronological patterns of Sakhalin Island are now established (Kuzmin et al. 2004; Vasilevsky et al. 2009, 2010). The earliest pottery from Sakhalin dated at the Puzi 2 [also known as *Ado-Tymovo 2* site] site to ~8780–7520 BP (Kuzmin et al. 2004), and recently to 7215 ± 45 BP (AA-86215). One of the oldest sites in northern Sakhalin, Bolshaya Rechka 7, dates to 6210 ± 40 BP (AA-36905). On the Kurile Islands, the chronology of the main cultural phases has been established (Vasilevsky et al. 2009, 2010; Kuzmin et al. 2012b). The earliest occupation of the southern Kuriles is now securely dated to ~7000 BP at the Yankito site on Iturup Island (Yanshina and Kuzmin 2010).

SOLID FACTS VS. WISHFUL THINKING IN PREHISTORIC CHRONOLOGY OF THE RUSSIAN FAR EAST: AN ANALYSIS

In studying the geoarchaeology of the prehistoric sites (including chronology) and human-environment interaction in the Russian Far East, several models have been recently published (Vasilevsky 2008; Kuzmin 2009; Vostretsov 2010; Kuzmin and Rakov 2011). Some of these suffer from a wishful thinking approach, where the initial idea put forward by a researcher does not correspond to the factual data. There are discordant aspects among the different models that I would like to note: 1) unsubstantiated claims for the age of prehistoric sites; 2) the emergence of maritime adaptation; 3) the beginning of agriculture; and 4) obvious discrepancies. A critique of some of these issues was presented before (Kuzmin 2009, 2011; Kuzmin et al. 2009; Kuzmin and Rakov 2011).

In terms of unproven site ages, the most recent example is the Ogonki 5 site on Sakhalin Island (see Vasilevsky 2006). Six ^{14}C values were received for the Upper Paleolithic component of this site (strata 2b and 3), and 5 of them create a tight cluster of ~19,440–17,880 BP (Kuzmin et al. 2004). The sixth value of 31,130 ± 440 BP (AA-23138) from Stratum 3 was initially accepted (see Kuzmin et al. 1998a; Vasilevsky 2006:86), but later was found to be an outlier because of the clearly late Upper Paleolithic nature of the stone tool assemblage with the presence of microblades and wedge-shaped microcores (e.g. Vasilevsky 2006); and a second ^{14}C date of ~17,860 BP from this stratum (Kuzmin 2006a:21). It is difficult to imagine that the microblade technology appeared on Sakhalin Island much earlier than in neighboring Northeast Asia (e.g. Kuzmin 2007). However, Vasilevsky (2008) continued to consider this early ^{14}C value as the true age of Stratum 3. Also, Vasilevsky (2008) claimed that the Upper Paleolithic occupation of Sakhalin Island continued at ~16,000–12,000 BP despite the fact that no sites are dated to this timespan (see Kuzmin et al. 2004:355). The Tronnyi Grotto, which is used for this conclusion (see Vasilevsky 2008:238), has no artifacts (see Kuzmin 2011).

As for the origin of maritime adaptation, Vasilevsky (2008; see also Vasilevsky et al. 2010) claimed its beginning on Sakhalin Island at ~9000–6600/6000 BP, although no reliable evidence for this exists (see Kuzmin 2011). Vostretsov (2006, 2010) concluded that marine-based economies disappeared in southern Primorye at ~4700–4300 BP despite the fact that there are several shell middens in this region ^{14}C dated to this time period (e.g. Kuzmin and Rakov 2011:106). The model that I propose is that the first reliable traces of maritime adaptation in the Russian Far East date to ~5800 BP, although humans exploited marine resources in limited amounts even earlier, at ~7000 BP (see details in Kuzmin 2009).

Some attempts to establish the age of the earliest agriculture in Primorye are unsubstantiated by the data. For example, Vostretsov (2006, 2010) connected the beginning of agriculture in southwestern Primorye with an interval of ~5400–5200 BP. However, as was repeatedly demonstrated, the oldest site with direct evidence of millet agriculture in the region is dated to ~4700–4600 BP (e.g. Sergusheva 2007, 2008; Kuzmin et al. 2009; also see Table 1). This refutes Vostretsov's (2006, 2010) conclusion.

In some cases, there is a discrepancy in the relationship between climate change (e.g. cooling and regression of the sea) and the intensification of human activity (e.g. maritime strategies): for example, "In the north-west sector of the Japan Sea and eastern Korea, the *intensification* of maritime adaptation strategies is connected with the *cooling and regression of the sea*" (Vostretsov 1999:323; italics are mine). Later on, the conclusion was made that the cooling at ~5000 BP is correlated with a *decline* of maritime-adapted complexes (such as the Boisman culture of southern Primorye) and the appearance of agricultural populations that migrated from neighboring Manchuria (e.g. Vostretsov 2006:28). This aspect needs further study before such conclusions can be stated.

CONCLUSION

Clearly, more work is still needed to understand the patterns of the chronology of the Paleolithic, Neolithic, and Paleometal complexes of the Russian Far East and neighboring East Asia. One of the most hotly debated current issues is the relationship between cultural and natural changes—for example, the emergence of pottery, agriculture, and maritime adaptation in relation to climatic fluctuations. There is a certain trend to correlate directly the climate changes in the final Pleistocene and Holocene and features of cultural and economic history (emergence of cultural complexes; appearance of new branches of economy). As was shown for the origin of pottery-making in East Asia, there is no reliable evidence for the association between the introduction of pottery vessels and climatic fluctuations after the LGM (Kuzmin 2010). The study of chronology and environment of prehistoric Russian Far East should therefore be carried out without *a priori* assumptions and biases.

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