CHRONOLOGY OF LATE PLEISTOCENE HUMANS IN EURASIA: RESULTS AND PERSPECTIVES

Susan G Keates[1] • Yaroslav V Kuzmin[2] • George S Burr[3,4]

ABSTRACT. A compilation of direct age determinations for Late Pleistocene human fossils in eastern Europe and Asia is presented in this paper, and current problems with the dating of hominids in these regions are discussed. Only 25 human finds (4 Neanderthals and 21 modern humans) have been directly dated from Pleistocene eastern Europe and Asia. Indirect dating of human remains (using presumably associated organics) often is insecure, especially when information about the exact provenance of human fossils is lacking. Continuation of direct dating of Late Pleistocene humans in Eurasia, primarily with the help of the accelerator mass spectrometry (AMS) ^{14}C method, is therefore an urgent task.

INTRODUCTION

Prior to the 1990s, a few Pleistocene human fossils from Eurasia had been directly dated by radiometric methods. In the 1990s and 2000s, significant progress was achieved in the direct accelerator mass spectrometry (AMS) ^{14}C dating of Late Pleistocene humans from Europe and Siberia. This information can shed new light on the issues of the dispersal of anatomically modern humans and extinction of Neanderthals in the Old World. The results of direct AMS ^{14}C dating of some human bones (both Neanderthals and modern humans) in Europe and Asia were recently discussed (Pinhasi et al. 2011; Prat et al. 2011).

Direct dating of Pleistocene human bones using radiocarbon is being conducted mostly in western and central Europe (Richards et al. 2001; Schmitz et al. 2002; Svoboda et al. 2002; Trinkaus et al. 2003; Schulting et al. 2005; Wild et al. 2005; Higham et al. 2006a,b; Soficaru et al. 2006, 2007; Street et al. 2006; Jacobi and Higham 2008; Semal et al. 2009; Daura et al. 2010; Mannino et al. 2011; Wood et al. 2012). In eastern Europe and Asia, this practice is still rare (see Kuzmin 2009:158; Keates 2010).

It is now very clear that only the direct age determination of presumably Late Pleistocene human fossils can give us an understanding of their true antiquity. It was repeatedly demonstrated that human remains supposedly found *in situ* (e.g. Conard et al. 2004; Street et al. 2006) and some surface finds (e.g. Keates et al. 2007) are of a much younger age and therefore should be removed from the inventory of Pleistocene humans. This is especially important when the exact localization of the human fossil is uncertain, as it is quite frequently in some regions like China (see Keates 2010), or when we are dealing with surface finds (see Keates et al. 2007; Kuzmin et al. 2009). For example, direct AMS ^{14}C dating of the Wajak modern human femur from Java (Indonesia, Southeast Asia), previously believed to be of Late Pleistocene origin but whose stratigraphic position is unclear, produced an age of 6500 ± 140 BP (AA-7718) (Shutler et al. 2004).

In order to illustrate problems with radiometric ages obtained from different materials (charcoal, animal bones, flowstones, and other kinds) associated with human fossils, the recent case of Denisova Cave (Altai Mountains, Siberia) can be used. A human phalanx, with a genome different from

[1]Corresponding author. Email: archres2010@t-online.de.
[2]Institute of Geology & Mineralogy, Siberian Branch of the Russian Academy of Sciences, Koptyug Ave. 3, Novosibirsk 630090, Russia.
[3]NSF-Arizona AMS Laboratory, University of Arizona, Tucson, Arizona 85721-0081, USA.
[4]Department of Geosciences, National Taiwan University, Taipei, Taiwan, Republic of China.

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both Neanderthals and anatomically modern humans (tentative name of this hominid is *Homo sapiens altaiensis*, see Derevianko 2011:465), was apparently found in Layer 11.2 of the cave's Eastern Gallery in 2008 (Krause et al. 2010: Supplement, p 1; Reich et al. 2010: Supplement, p 85). At that time, only 2 ^{14}C dates were available and restricted to Layer 11 of the Southern Gallery of the cave, at ~48,650 BP for Layer 11.2 and ~29,200 BP for the top of the sequence, the contact of layers 10 and 11 (Derevianko 2010:9; Krause et al. 2010; Reich et al. 2010: Supplement, p 84). These values were used for the preliminary age estimate of the human bone (Krause et al. 2010:896). However, the ^{14}C-dated stratum in the Southern Gallery is not stratigraphically connected with Layer 11 of the Eastern Gallery (see Reich et al. 2010: Supplement, p 84). Later on, several ^{14}C dates were generated from Layer 11 of the eastern and southern galleries (Reich et al. 2010:1059, Supplement, p 81–6). In the Eastern Gallery, the ^{14}C ages of human-modified animal bones vary from ~15,740–23,170 BP (Layer 11, without subdivision into sublayers; see Reich et al. 2010: Supplement, p 84) to >50,000 BP (Layer 11.3); and in the Southern Gallery, 2 ^{14}C dates on non-modified animal bones from Layer 11.2 are >50,000 BP. It should be stressed again that these layers in the Eastern and Southern galleries are not stratigraphically connected; therefore, their numbers do not mean that they are contemporaneous (see Reich et al. 2010: Supplement, p 84). Unfortunately, it was not possible to date the human phalanx directly because of the small sample size (Reich et al. 2010: Supplement, p 84). Therefore, the wide range of ^{14}C dates from Layer 11 in both galleries of Denisova Cave limits our understanding of the age of the human fossils. It is suggested that the phalanx is derived from the undisturbed part of Layer 11.2 in the Eastern Gallery, but it is impossible to rule out the possibility of "major post-depositional mixing in this part of the cave" (Reich et al. 2010: Supplement, p 85).

METHODS AND MATERIAL

Two radiometric methods, namely radiocarbon (^{14}C) and uranium-series (U-series), were used for direct dating of Pleistocene humans in eastern Europe and Asia. Following recent advances in ^{14}C dating of bone, including issues of collagen yield and ultrafiltration (see Brock et al. 2007, 2010a,b; Higham et al. 2006b; Hüls et al. 2007, 2009; Higham 2011; Talamo and Richards 2011), it was found that only bones with 1% or more of collagen are reliable in terms of their preservation, and ultrafiltration seems to be a preferable step in dating the older (i.e. more than ~20,000–30,000 BP) specimens. Also, nowadays the measurement of yield, carbon and nitrogen stable isotope composition, and the C:N ratio of extracted collagen is a must to understand the degree of collagen preservation. Samples with collagen yields <1%, and/or unusual C:N ratios, beyond 2.9–3.6 as suggested by van Klinken (1999) and others (e.g. Brock et al. 2010a), should be rejected. Similarly, direct dates of Pleistocene humans reported without these parameters should be treated with extreme caution.

The reliability of U-series dating for Levantine fossil humans is hampered by the choice of the model of either early uptake (EU) or late uptake (LU) of uranium by bone (see e.g. Latham 2001:69; see also Pike and Pettitt 2003). Unfortunately, there is no comparative study for direct ages of human fossils from the Levant dated by both U-series and ^{14}C methods; at least we are not aware of it. In this case, particular care should be taken in the evaluation of U-series dates by means of comparison with the ^{14}C ages of the stratum from where human remains are recovered. As for the comparison of U-series dates with other chronometric methods (TL, ESR), information available from the Levant (e.g. Bar-Yosef 1994; Mercier and Valladas 1994; Schwarcz 1994) gives us several examples of large controversies such as with the Tabun and Skhul sites (see reviews: Pike and Pettitt 2003; Grün 2006:29–34). This most probably means that results of U-series dating of hominid fossils from Asia should be treated with some reservation, and independent evaluation of U-series ages should be conducted (e.g. Farrand 1994).

Another warning about the reliability of direct U-series dating of human fossils comes from Japan where modern humans from Mikkabi (Honshu Island) were dated to ~9100–20,900 yr by Yokoyama (1992; cited by Matsu'ura and Kondo 2001:278; see also Keates 2010:457–8). Direct ^{14}C dating of the human bones gave much younger ages, ~7450–9540 BP (Matsu'ura and Kondo 2001). Data on the physical anthropology of the Mikkabi human fossils indicated that they could be of Jomon age (Matsu'ura 1999:193; Ono et al. 1999:183), which ranges within ~2500–12,500 BP, and ^{14}C dates confirmed this. However, the same suggestion for the Negata [Hamakita] humans (see Ono et al. 1999:183) turned out to be incorrect (see Table 1).

For this study, we assembled direct radiometric dates on human remains from eastern Europe (European Russia and Ukraine) and Asia available as of April 2012; they are arranged from west to east (Table 1; Figure 1). The results of direct dating of human fossils from the Ngandong and Sambungmacan sites (Java, Indonesia) show that samples dated by U-series underwent leaching of uranium (Yokoyama et al. 2008), which contradicts one of the basic assumptions of this method. This is why we did not include these ages in Table 1.

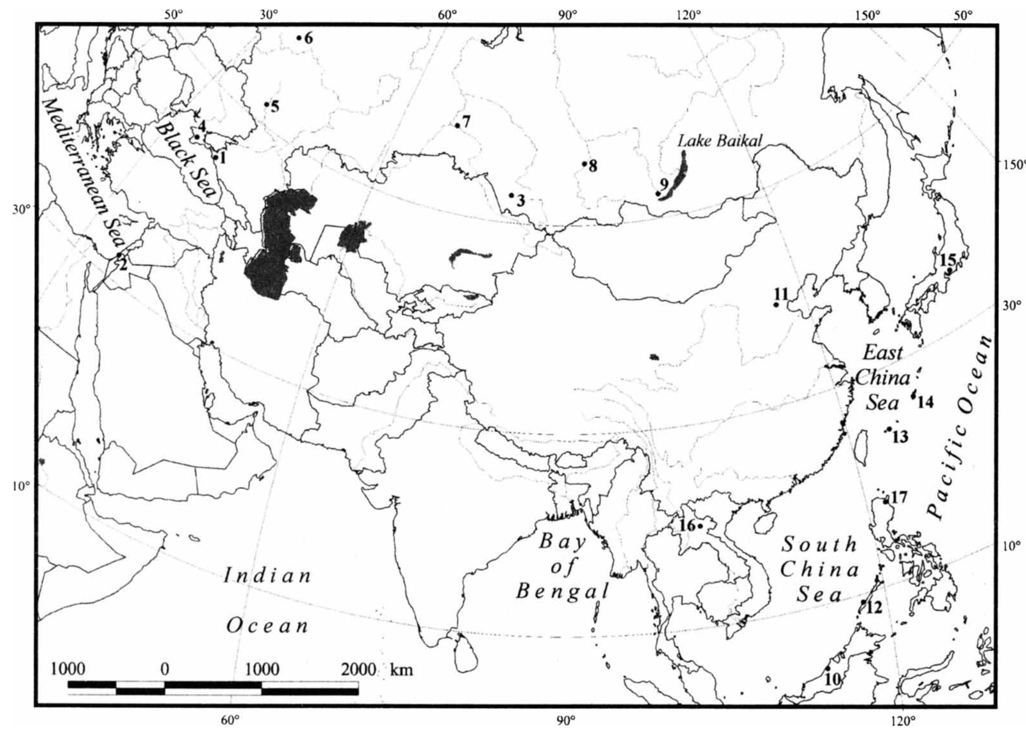

Figure 1 Location of fossil human finds in eastern Europe and Asia mentioned in the text. 1 – Mezmaiskaya Cave; 2 – Tabun Cave and Skhul Cave; 3 – Okladnikov Cave; 4 – Buran-Kaya III; 5 – Kostenki; 6 – Sungir; 7 – Baigara; 8 – Maly Log 2; 9 – Malta; 10 – Niah Cave; 11 – Tianyuan Cave; 12 – Tabon Cave; 13 – Shiraho-Saonetabaru Cave; 14 – Minatogawa; 15 – Negata; 16 – Tam Hang Cave; 17 – Callao Cave.

In the following section, short comments are given about the direct ages of Late Pleistocene humans in eastern Europe and Asia whenever necessary. Recent discussions of direct dating of human fossils in western/central Europe can be found in Benazzi et al. (2011), Higham et al. (2011), Mellars (2011), and Prat et al. (2011).

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RESULTS AND DISCUSSION

Neanderthals

For the Mezmaiskaya Cave in the northern Caucasus, Russia (Figure 1), there is a large discrepancy between the ^{14}C ages of the Mez 1 and Mez 2 individuals (Table 1). The reason for this cannot be determined at present, but the value of ~29,195 BP for the Mez 1 individual was recently rejected due to inconsistency with other lines of evidence, including the lower stratigraphic position of Mez 1 (Layer 3) compared to Mez 2 (Layer 2) (see Pinhasi et al. 2011:8612). Thus, the minimal age for Neanderthals at Mezmaiskaya Cave (see Pinhasi et al. 2011:8615) is now considered to be ~40,000 cal BP (i.e. ~34,800 BP; see Reimer et al. 2009).

At Tabun Cave in the Levant (Figure 1), the exact provenance of the Tabun C1 skeleton, which is directly dated by U-series, is unknown (Schwarcz et al. 1998). First direct age determinations of the Tabun C1 skeleton (Schwarcz et al. 1998) are contradictory and considered to be too young (Grün and Stringer 2000:610). The results of ESR dating of the Tabun C1 human fossils at 112,000 ± 29,000 to 143,000 ± 37,000 yr (Grün and Stringer 2000) are much older than the U-series age of this sample at ~47,000 yr (see Table 1). In our opinion, the issue of this discrepancy has not been resolved. Comparisons of the human bone age with the chronology of the Tabun site were made (Grün and Stringer 2000; see also Grün et al. 1991), and it was suggested that the Tabun C1 individual comes from Layer B rather than from Layer C; the U-series date for Layer B is ~90,000 yr (Grün and Stringer 2000:610) as confirmed by Coppa et al. (2005; see also Table 1).

At Okladnikov Cave in Siberia, Russia (Figure 1), 3 ^{14}C values on the same material, a subadult humerus (see Krause et al. 2007: Supplement, p 2), received from 3 different laboratories, give a wide variation, from ~37,800 to ~29,990 BP (Table 1). The reason for this is unknown, and an average value of 34,190 ± 760 BP was suggested (Krause et al. 2007: Supplement, p 1). More recently, the value of ~37,800 BP was considered as the most reliable one (see Pinhasi et al. 2011:8614, Figure 3), although the reason for this is not indicated. The adult humerus from Okladnikov Cave, ^{14}C dated to 24,260 ± 180 BP (KIA-27010), cannot be attributed to a Neanderthal because of an absence of Neanderthal-like mtDNA primers (see Krause et al. 2007: Supplement, p 4), and its species determination is unclear (Krause et al. 2007:902).

Modern Humans

At the Kostenki 1 site in eastern Europe (Russia; Figure 1), dating was performed without (Richards et al. 2001) and with (Higham et al. 2006b) ultrafiltration, and no age difference is observed (Table 1). The standard deviation (sigma) for OxA-15055 value is much smaller than for the OxA-7073 one, and this is important in understanding the calendar age of the Kostenki 1 skeleton, because the calendar timespan for the OxA-15055 value is much shorter than for OxA-7073 (see Table 1). The age of the Kostenki 18 individual is much younger, ~21,000 BP (Table 1); due to the absence of a stratigraphic connection between these 2 directly dated humans, it is impossible to evaluate the age difference. The recently dated Kostenki 14 individual is the oldest at ~33,250 BP (Marom et al. 2012; see Table 1).

The situation at another Upper Paleolithic site in eastern Europe, Sungir [also Sunghir] (Russia; Figure 1), is still not clear; a definite difference is observed between the Tucson (lab code AA) and Oxford (lab code OxA) dates (Table 1), but currently there is no convincing clue as to what may have caused it (see Kuzmin et al. 2004). Redating of 2 skeletons from Sungir at the Leibniz AMS Laboratory in Kiel (Germany; lab code KIA) did not result in clarification of the age of the Sungir 1 individual (see Dobrovolskaya et al. 2012). There are now 3 ^{14}C values, ~19,160 BP, ~22,930 BP, and ~27,050 BP for Sungir 1 (Table 1). If we take into account the ^{14}C dates of ~21,800–22,500 BP run on charcoal collected beneath the Sungir 1 skeleton (see Kuzmin et al. 2004:733), the youngest value (AA-36473) is the most reliable one. As for the double burial of the Sungir 2 and 3 individuals, the new ^{14}C date of ~26,000 BP for Sungir 3 (Dobrovolskaya et al. 2012; Table 1) fits well with the existing Tucson dates of ~26,200–27,050 BP (Sungir 2) and ~26,190 BP (Sungir 3) (Table 1). The Oxford ^{14}C values on these 2 skeletons, produced after ultrafiltration of collagen, are younger: ~24,800–25,400 BP (Table 1).

The latest ^{14}C dates of the Sungir 2 and 3 individuals (Marom et al. 2012) are older than the other values (see Table 1). Although Marom et al. (2012) are convinced that the dating of hydroxyproline amino acid of collagen from these skeletons gives the most reliable ages, the situation, in our opinion, is not as simple as that. Without knowledge of the true age for the Sungir 2 and 3 burials, it is impossible to prove that some compounds in bone collagen are more resistant against contamination or degradation. Also, no one (to the best of our knowledge) was able to disprove scientifically the statement made by van Klinken (1999:690) that amino acid analysis tends "…to be relatively unhelpful for the assessment of 'collagen' quality."

In Siberia, the oldest human find so far is from Baigara in the central West Siberian Plain (Figure 1). The minimal calendar age of the human talus bone is 44,300 cal BP (Table 1). The "true" age could be even older if we take into account the geological data for this locality, which shows the existence of forests possibly dated to a relatively warm climate that began at ~46,000 BP (see Kuzmin et al. 2009:93) or approximately 49,750 cal BP (see Reimer et al. 2009), but for this period there is no reliable calibration. Additional dating is needed to get a finite age, or at least to stretch it up to ~49,900 BP as this is the background for bone collagen at the Oxford AMS Lab (Wood et al. 2010).

More directly dated human fossils are known from insular East and Island Southeast Asia (Figure 1; Table 1). At the Niah Great Cave on Borneo [Kalimantan] Island, Malaysia, the first ^{14}C age of material associated with the "Deep Skull"—39,600 ± 1000 BP (GRO 1339) (Harrisson 1958)—was later considered to be unreliable because of the uncertain association of the hominid and the dated samples (e.g. Brothwell 1960; Wolpoff 1999:735): "Moreover this 1958 radiocarbon date really means >30 kyr, and may indicate no more than that there was insufficient carbon for an accurate age assessment" (Wolpoff 1999:735). Recently, a new dating program was set up (see Higham et al. 2009). The U-series date of ~35,000 yr on fragments of the "Deep Skull" (Barker et al. 2007; Table 1) is in agreement with the GRO 1339 value generated on charcoal collected near the skull during the excavation in the 1950s and stored (see Harrisson 1958, 1959). The U-series date is also similar to the ^{14}C dates on charcoal and from the trench next to the "Deep Skull" spot dug in the course of the later opening: 35,690 ± 280 BP (OxA-V-2076-16) and 35,000 ± 400 BP (OxA-15126) (see Barker et al. 2007:252–4). A single direct ^{14}C date on Late Pleistocene human bone is known for mainland Southeast Asia at Tam Hang Cave in Laos, 15,740 ± 80 BP (Demeter et al. 2009; no lab nr given).

In Tabon Cave on Palawan Island (the Philippines; Figure 1), the human fossils were initially correlated with ^{14}C dates of ~22,000–24,000 BP run on associated material (see Dizon et al. 2002:661), and a U-series direct dating gave an age of ~16,500 yr ago (Table 1). New discoveries of human bones allowed the continuation of the dating program (see Détroit et al. 2004); however, in this brief report no details on the stratigraphic position of the new finds are given, besides their depth in the profile for some of the human remains (Détroit et al. 2004:711). Instead, the authors refer to data such as "Square" and "S (surface)," presumably centimeters (?) below the cave's ground surface (?), and only 1 of the directly dated human bones is listed with the "S (surface)" data: Tibia fragment (IV-2000-T-197) at 16 [cm] (Détroit et al. 2004: Table 2). The new U-series dates are significantly

Table 1 Direct radiometric dates of Late Pleistocene human fossils from eastern Europe and Asia.

Site name	Method	Date[a]	Lab code and nr	Calendar age[b]	Reference
Neanderthals					
Mezmaiskaya Cave (Mez 1)	^{14}C	29,195 ± 965	Ua-14512	31,410–36,120	Ovchinnikov et al. (2000)
Mezmaiskaya Cave (Mez 2)	^{14}C	39,700 ± 1100	OxA-21839	42,190–45,310	Pinhasi et al. (2011)
Tabun C1	U-series	47,000 ± 3000		44,000–50,000	Grün and Stringer (2000)
Tabun BC7	U-series	90,000 +36,000/–16,000		80,000–126,000	Coppa et al. (2005)
Okladnikov Cave	^{14}C	37,800 ± 450	OxA-15481[c]	41,740–43,060	Krause et al. (2007)
Okladnikov Cave	^{14}C	34,860 ± 360	Beta-186881[c]	38,930–40,880	Krause et al. (2007)
Okladnikov Cave	^{14}C	29,990 ± 500	KIA-27011[c]	33,270–36,170	Krause et al. (2007)
Modern humans					
Kostenki (Kostenki 1)	^{14}C	32,600 ± 1100	OxA-7073	34,930–39,920	Richards et al. (2001)
Kostenki (Kostenki 1)	^{14}C	32,070 ± 190	OxA-15055	35,710–37,000	Higham et al. (2006b)
Kostenki (Kostenki 14)	^{14}C	33,250 ± 500	OxA-X-2395-15	36,690–38,980	Marom et al. (2012)
Kostenki (Kostenki 18)	^{14}C	21,020 ± 180	OxA-7128	24,500–26,560	Richards et al. (2001)
Sungir (Sungir 1)	^{14}C	19,160 ± 270	AA-36473	22,250–23,560	Kuzmin et al. (2004)
Sungir (Sungir 1)	^{14}C	22,930 ± 200	OxA-9036	26,880–28,250	Pettitt and Bader (2000)
Sungir (Sungir 1)	^{14}C	27,050 ± 210	KIA-27006[d]	31,090–31,590	Dobrovolskaya et al. (2012)
Sungir (Sungir 2)	^{14}C	26,200 ± 640	AA-36475	29,560–31,570	Kuzmin et al. (2004)
Sungir (Sungir 2)	^{14}C	27,210 ± 710	AA-36474	30,390–33,140	Kuzmin et al. (2004)
Sungir (Sungir 2)	^{14}C	23,830 ± 220	OxA-9037	28,080–29,280	Pettitt and Bader (2000)
Sungir (Sungir 2)	^{14}C	25,020 ± 120	OxA-15753[d]	29,520–30,240	Marom et al. (2012)
Sungir (Sungir 2)	^{14}C	30,100 ± 550	OxX-2395-6	33,310–36,240	Marom et al. (2012)
Sungir (Sungir 3)	^{14}C	26,190 ± 640	AA-36476	29,550–31,560	Kuzmin et al. (2004)
Sungir (Sungir 3)	^{14}C	26,000 ± 410	KIA-27007[d]	29,780–31,260	Dobrovolskaya et al. (2012)
Sungir (Sungir 3)	^{14}C	24,100 ± 240	OxA-9038	28,400–29,460	Pettitt and Bader (2000)
Sungir (Sungir 3)	^{14}C	24,830 ± 110	OxA-15754[d]	29,420–30,160	Marom et al. (2012)
Sungir (Sungir 3)	^{14}C	30,000 ± 550	OxX-2395-7	33,210–36,210	Marom et al. (2012)
Baigara	^{14}C	>40,300	AA-61831	44,300[e]	Kuzmin et al. (2009)
Niah Cave	U-series	35,200 ± 2600		32,600–37,800	Barker et al. (2007)
Tabon Cave	U-series	47,000 +11,000/–10,000		37,000–58,000	Détroit et al. (2004)
Tabon Cave	U-series	31,000 +8000/–7000		26,000–39,000	Détroit et al. (2004)
Tabon Cave	U-series	16,500 ± 2000		14,500–18,500	Dizon et al. (2002)
Minatogawa	U-series	19,200 ± 1800		17,400–21,000	Matsu'ura (1999)

Table 1 Direct radiometric dates of Late Pleistocene human fossils from eastern Europe and Asia. *(Continued)*

Site name	Method	Date[a]	Lab code and nr	Calendar age[b]	Reference
Shiraho-Saonetabaru Cave	^{14}C	20,415 ± 115[f]	MTC-12820	23,930–24,780	Nakagawa et al. (2010)
Shiraho-Saonetabaru Cave	^{14}C	18,750 ± 100[f]	MTC-13228	22,060–22,900	Nakagawa et al. (2010)
Shiraho-Saonetabaru Cave	^{14}C	15,750 ± 420[f]	MTC-12818	18,000–19,840	Nakagawa et al. (2010)
Buran-Kaya III	^{14}C	31,900 +240/–220	GrA-37938	35,510–36,890	Prat et al. (2011)
Skhul II	ESR/U-series	121,000 ± 29,000		92,000–150,000	Grün et al. (2005)
Skhul IX[g]	U-series	131,000 ± 2000		129,000–133,000	Grün et al. (2005)
Maly Log 2 [Pokrovka 2]	^{14}C	27,740 ± 150	OxA-19850	31,420–32,440	Akimova et al. (2010)
Malta [Mal'ta]	^{14}C	19,880 ± 160	OxA-7129	23,330–24,260	Richards et al. (2001)
Tianyuan Cave	^{14}C	34,430 ± 510	BA-03222	38,120–40,940	Shang et al. (2007)
Negata [Hamakita]	^{14}C	14,200 ± 50	Beta-160572	16,970–17,580	Kondo and Matsu'ura (2005)
Negata [Hamakita]	^{14}C	14,050 ± 50	Beta-160571	16,860–17,440	Kondo and Matsu'ura (2005)
Negata [Hamakita]	^{14}C	13,860 ± 50	Beta-160570	16,770–17,130	Kondo and Matsu'ura (2005)
Unclear *Homo* species					
Callao Cave	U-series	66,700 ± 1000		65,700–67,700	Mijares et al. (2010)

[a] ^{14}C ages are expressed in yr BP; U-series ages in yr ago.

[b] Calibration of ^{14}C ages is after IntCal09 curve (Reimer et al. 2009), with $\pm 2\sigma$ and rounded to the next 10 yr. Values are in yr cal BP; U-series ages are in yr ago.

[c] These dates were run on the same sample.

[d] Samples ultrafiltered before ^{14}C dating.

[e] Minimal age estimate (see Reimer et al. 2009:1136).

[f] Ages are rounded to the next 5–10 yr.

[g] A bone surface sample was dated (Grün et al. 2005:320).

older than the one in Dizon et al. (2002) (see Table 1). Given that 1 of the charcoal ^{14}C dates from the early excavations is ~30,100 BP (see Dizon et al. 2002:660), and the fact that the sediment sequence at Tabon Cave is quite thick, at least 1 m (S G Keates and Y V Kuzmin, personal observation, 2006), this is not surprising. Judging from the current state of dating the human bones, one can suggest that several individuals (at least 3) have been recovered from Tabon Cave, and that they lived at quite different times within the ~16,500–47,000 yr timespan, while also noting the high deviations for the latter age (Détroit et al. 2004; Table 1). Unfortunately, it is not possible to evaluate the reliability of the age for humans at Tabon Cave due to insufficient information about the provenience of some directly dated samples (see Détroit et al. 2004:711); it was suggested that the older ages, ~31,000–47,000 yr, fit better with the existing chronology of the cave (Détroit et al. 2004:710).

At the Minatogawa site (Ryukyu Islands, Japan; Figure 1), the U-series date of ~19,200 yr on a human cranium (Table 1) is scarcely known outside of Japan; see Matsu'ura (1999) who cited the original publication by Yokoyama (1992). This age is in accord with charcoal ^{14}C dates of ~18,250–16,600 BP (see Keates 2010:455), corresponding to a calendar age range of 18,960–23,410 cal BP. However, Matsu'ura (1999:185) is not certain about the U-series age of the Minatogawa cranium because of possible leaching of uranium.

The first direct ^{14}C age of fossil humans from the Ryukyu Archipelago, which is located between mainland East Asia and the Japanese Islands, was only recently obtained for the Shiraho-Saonetabaru Cave (Nakagawa et al. 2010; Figure 1). Although an earlier age (~32,000 BP and even older) was suggested for the Yamashita find from Okinawa Island (e.g. Trinkaus and Ruff 1996), which was never directly dated (see Keates 2010:456), the ^{14}C values from Shiraho-Saonetabaru Cave of ~20,400–15,800 BP (Table 1) make it possible to place the age of modern humans from the Ryukyus in a secure chronological context (Nakagawa et al. 2010). The investigation of this site is not yet finished and a new study will shed light on unresolved issues, such as for how long Paleolithic humans occupied the cave and how intensive their presence was during the Last Glacial Maximum, ~26,500–19,000 cal BP (Clark et al. 2009).

As for the Skhul site in the Levant, the recent dating campaign brought consistent ESR/U-series and U-series ages for human remains of ~121,000–131,000 yr (Table 1), although the deviation for the ~121,000 yr date is high. The results of previous studies, which gave younger ages for this cave ~32,000–100,000 yr ago, are discussed in Grün (2006:31–6).

In terms of direct ages for other Pleistocene modern humans in eastern Europe and Asia, such as Buran-Kaya III, Maly Log 2, Malta, Tianyuan Cave, and Negata (see Table 1), they are in good agreement with other radiometric data (^{14}C age of animal bones and other associated material) available for these localities, and can be accepted as secure dates.

Uncertain *Homo* Species

The recent discovery of human fossils in Callao Cave on Luzon Island (the Philippines; Figure 1) is the third only direct age determination for Pleistocene humans in the Southeast Asian region (see also Niah and Tabon caves), and this is why it is important for paleoanthropology and Paleolithic archaeology. The U-series age of a human metatarsal, ~66,700 yr (Table 1), is not consistent with another date of ~52,000 yr run on a cervid tooth from the same depth (Mijares et al. 2010:126), and the second cervid tooth age from 20 cm below the first tooth is ~54,300 yr. This shows some disturbance of the stratigraphy in Callao Cave, as suggested by Mijares et al. (2010:126). Concerning the species determination of the Callao metatarsal, more research is needed to identify the species of this find (Mijares et al. 2010).

Asian Perspectives

Several human fossils from East Asia could potentially be used for direct dating (see Keates 2010). However, due to different factors, including a reluctance to submit samples for destructive analysis and perhaps apprehension because of some potential age difference with a curators' *a priori* opinion (see e.g. Keates et al. 2007), the majority have not been dated yet. This to some extent limits the determination of the true age of Late Pleistocene humans in the region, and we can hope that in the near future the paradigm of some researchers will change, with evaluation of the age of human fossils on a scientific basis.

CONCLUSION

There are currently 4 directly dated Neanderthals and 21 modern humans from Pleistocene eastern Europe and Asia. The age of Neanderthals in eastern Europe and Asia, based on the most reliable evidence from the Mezmaiskaya and Okladnikov caves, is ~40,000–34,000 BP. Modern humans in eastern Europe are now dated to ~32,000–33,000 BP (Kostenki 1 and 14 and Buran-Kaya III); in Siberia up to ~40,000 BP and possibly older (Baigara); in East Asia to ~34,000 BP (Tianyuan Cave, China); and in Southeast Asia to ~35,000 yr (Niah Cave) (i.e. ~30,500 BP; see Reimer et al. 2009).

Indirect dating (using age determinations of presumably associated bones, charcoal, and other kinds of material) in many cases turned out to be quite unreliable, especially in situations where there is a lack of information about the exact provenance of human fossils or when these are surface finds. Thus, direct dating of Late Pleistocene humans, primarily with the help of the AMS ^{14}C method, is an urgent task.

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