Quaternary Science Reviews 199 (2018) 1–17

Contents lists available at ScienceDirect

Quaternary Science Reviews

journal homepage: www.elsevier.com/locate/quascirev

Presence of the Middle Pleistocene cave bears in China confirmed – Evidence from Zhoukoudian area

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ARTICLE INFO

Article history:
Received 22 April 2018
Received in revised form
6 September 2018
Accepted 8 September 2018

Keywords:
Ursus deningeri
Ursidae
Zhoukoudian
North China

ABSTRACT

For a long time, it is controversial whether cave bears have ever lived in China during the Pleistocene. Here we checked the published and unpublished bear fossils from Zhoukoudian (North China) housed in Institute of Vertebrate Paleontology and Palaeoanthropology, CAS and Zhoukoudian Site Museum, and compared them with contemporary cave bears and brown bears. Our observation confirms the existence of cave bears only in Loc. 1 of Zhoukoudian. The general morphology of cave bears in China is similar to that of the early Middle Pleistocene cave bears in Europe and this bear can be assigned to *Ursus deningeri*. The metacarpals of *U. deningeri* from Loc. 1 of Zhoukoudian are much plumper than those of the approximately contemporary *U. deningeri* from Hundsheim (Austria) and are similar to those of the Late Pleistocene *U. spelaeus/ingressus*, presumably with a good digging ability. In contrast to Europe and Caucasus, cave bears from China are much less abundant than brown bears during the Middle Pleistocene.

1. Introduction

Cave bears (herein referred to *Ursus spelaeus* s. l. and its ancestors and close relatives), known from the late Early Pleistocene, belong to typical representatives of the Middle and Late Pleistocene faunas in Europe, well known especially for their mass occurrence in many caves documented from the Ural Mountains to Spain. Despite the rich fossil record and intensive long-term research (including the aDNA analysis in the last decades), the exact taxonomic diversity, phenotypic dynamic and the distribution pattern of cave bears are still controversial and subject of many debates. Among these topics, the distribution and taxonomical status of cave bear representatives in Asia is one of the most controversial one, caused partly by the scanty fossil record of these bears in Asia, but partly also by the new and unexpected finds (Baryshnikov, 2007; Sher et al., 2011; Boeskorov et al., 2012) as well as by the results of aDNA analysis (Stiller et al., 2014).

In this paper, we contribute to this discussion and present the new data about the spelaeoid bear record in the Pleistocene of China. We checked both published and unpublished specimens of *Ursus* from Zhoukoudian housed in Institute of Vertebrate Paleontology and Paleoanthropology and Zhoukoudian Site Museum at Zhoukoudian (it is a great pity that most specimens from Zhoukoudian have been lost during World War Two) to evaluate the possible existence of cave bears in China.

1.1. Cave bears in Asia – a brief review

At present, two main morphogroups of spelaeoid bears are recognized by most authors – so-called large cave bears (incl. *U. deningeri* s. l., *Ursus kudarensis* and *Ursus* gr. *spelaeus*) and small cave bears (*U. rossicus* group). The phylogenetic relationships

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https://doi.org/10.1016/j.quascirev.2018.09.012
0277-3791/

between these two groups and within them are subject of debate, as well as the exact position of particular problematic taxa. But, at least, it was proven that representatives of both groups had been present in Asia during the Middle Pleistocene.

Baryshnikov (2007) recognized the small cave bears as a monophyletic group and all taxa included in one species – *Ursus savini* Andrews, 1922 with 3 subspecies (*U. s. savini*, *U. s. rossicus* Borissiak, 1930, and *U. s. uralensis* Vereshchagin, 1973). Later, he described the fourth subspecies – *U. s. nordostensis* Baryshnikov, 2011 (see below). *U. savini* was based on the material from the early Middle Pleistocene Cromer Forest-bed Formation (England) with the largest part of and type material originated from Bacton locality (Andrews, 1922; for review of the different taxonomical concept of this taxon see Wagner and Čermák, 2012). The exact age of the type locality is uncertain but the Early Toringian seems to be probable (cf. West, 1980). Later, Baryshnikov and Puzachenko (2017) accepted *U. savini* and *U. rossicus* (incl. *U. r. rossicus* and *U. r. uralensis*) as two valid species within this group. According to these authors, the former species shares similarities in metapodial bones also with *U. deningeri* and its exact phylogenetic position was left without a final decision. On the contrary, Spassov et al. (2017) accepted the conspecificity of *U. savini* and *U. rossicus* but excluded *U. uralensis* from this group. Based on aDNA analysis (Stiller et al., 2014), *U. uralensis* from Kizel Cave (Ural Mountains) clustered together with the large cave bears of *ingressus*-haplogroup. But this result only has a limited value from taxonomic and phylogenetic interpretation as it was based only on the mtDNA.

Within the group of small cave bears *sensu* Baryshnikov (2007), the most common species is *U. rossicus*. In Asia, this species was recorded in Southwest Siberia, ca. between the Lake Baikal and the Ural Mountains, in northern Kazakhstan, and in several caves in the Altai Mountains (for review see Baryshnikov and Foronova, 2001; Baryshnikov and Kalmykov, 2005; Baryshnikov, 2007; Boeskorov et al., 2012). These finds are of the late Middle to Late Pleistocene age (Baryshnikov, 2007).

The earlier record of bear assigned to this group originated from the Cherskiy locality (Northeast Siberia, Russia) and was described by Baryshnikov (in Sher et al., 2011) as a new subspecies *U. savini nordostensis*. The exact age of this specimen is unknown but according to Sher et al. (2011), it is very probable that it belongs to the Olyorian Mammal Complex (ca. 1.5–0.5 Ma), though a more precise determination is not possible. Baryshnikov (in Sher et al., 2011) argued the morphological similarities between this specimen and the Middle Pleistocene *U. savini*. Another mandible from Northeast Siberia was discovered at Ulakhan Sullar locality (unfortunately also without stratigraphic context), which was determined as *U. savini* spp. (Boeskorov et al., 2012). Although there are clear similarities between both finds, the latter is somewhat larger and with a more diversified molars occlusal surface (Boeskorov et al., 2012; Boeskorov and Baryshnikov, 2013). Based on its morphology, Boeskorov et al. (2012) supposed that the specimen from Ulakhan Sullar could also belong to Olyorian Mammal Complex, but probably to the later level than the specimen from Cherskiy.

With respect to the Chinese material, the large cave bears are more important and it is also more complicated from the taxonomic viewpoint. Its European Late Pleistocene representatives, traditionally determined as *U. spelaeus* Rosenmüller, 1794, were divided into more taxa by Rabeder et al. (2004) based on both morphological and mtDNA characters. Usually at least two main lineages (corresponding to *ingressus*- and *spelaeus*-haplogroup) are accepted on species level (see e.g., Münzel et al., 2011; Baca et al., 2016; Baryshnikov and Puzachenko, 2017). Because we think that this topic is still open, we use in this text only a common term *Ursus* gr. *spelaeus* for these taxa. All the Middle Pleistocene large cave bears in Europe are usually determined as *U. deningeri* von Reichenau, 1904 (sometimes separated into several (chrono)subspecies). Although a lower evolutionary level than in the previous group is common to all of these bears, the exact definition of this group (in both morphologic and taxonomic sense) is missing. We are able to define the evolutionary levels rather than the evolutionary lineages (i.e., monophyletic taxa) within this group. The last group of the large cave bears, *kudarensis*-lineage, was considered as a part of *deningeri*-group with some specific characters, restricted to the Caucasus area for a long time (see, e.g., Baryshnikov, 1998; Baryshnikov, 2007). But Knapp et al. (2009) found out that there was a rather deep splitting between this lineage and other analyzed cave bears, which led to accepting *U. kudarensis* Baryshnikov, 1985 as an independent species by many authors. The genetic (mtDNA) separation of this lineage from the Early Toringian *U. deningeri* is confirmed by Dabney et al. (2013). The relationship of *kudarensis*-lineage to the earlier forms included into *deningeri*-group (e.g., Madurel-Malapeira et al., 2009; Wagner and Čermák, 2012) stays open.

The Late Pleistocene record of large cave bears in Asia is very scanty and, leaving aside the Caucasus region (see below paragraph about *kudarensis*-lineage), it is restricted to a few isolated finds. Knapp et al. (2009) analyzed the mtDNA from two samples from the Altai caves (Strashnaya and Denisova Cave) and, surprisingly, the obtained the mtDNA belonged to *spelaeus*-haplogroup (topological position changed in Stiller et al. (2014), but with weak support and even so still within the *U.* gr. *spelaeus*). Baryshnikov (in Derevyanko et al., 2003; Baryshnikov, 2007) described a calcaneus of large cave bear from Denisova Cave. The Late Pleistocene *U. spelaeus* is also mentioned in the faunal list from several Chinese localities (e.g., Museum of Liaoning Province and Museum of Benxi City, 1986; Dong et al., 2010), but without any additional data, no taxonomical results are possible. The only exception is the material from the Upper Cave of Zhoukoudian (Pei, 1940). All Late Pleistocene large bears from this locality were described and referred to cave bear by Pei (1940), but as he stressed, these bears are intermediate forms and can be viewed as brown bears. The material from this locality is partly revised in the present paper (see below).

The record of the Middle Pleistocene *deningeri*-like bears is more frequent in Asia. In the Near East, there are two important Middle Pleistocene localities – Bear's Cave, Israel (Tchernov and Tsoukala, 1997) and Emirkaya-2, Turkey (Sen et al., 1991). The bears from the first locality were determined as *U. deningeri*, while the latter as *U.* aff. *deningeri*. More eastwards, Sel'-Ungur (Kyrgyzstan), probably of Middle Pleistocene age, yielded *U. deningeri* remains, later described as a new subspecies *U. d. batyrovi* Baryshnikov, 2007 (Baryshnikov and Batyrov, 1994; Baryshnikov, 2007; Baryshnikov and Puzachenko, 2017). The positive record of *U. deningeri* is also known from Tologoi locality (Republic of Buryatia, Russia), whose age is supposed to be similar to that of Loc. 1 of Zhoukoudian (Baryshnikov and Kalmykov, 2005). The other mandibles from this locality, previously determined as *U. rossicus* (Vereschagin and Tichonov, 1994) also belong to the large cave bear (pers. obs., Baryshnikov in verb.). On the other hand, the specimen from South Siberia determined by Alexeeva (1980) as *Ursus* cf. *deningeri* was re-determined as *U. rossicus* by Baryshnikov and Kalmykov (2005). Zhegallo et al. (1982) mentioned a few fragmentary specimens of bear from the locality Nalaikha (North Mongolia) and determined them as *Ursus* ex. gr. *deningeri*. According to Baryshnikov and Kalmykov (2005) this bear could represent *U. deningeri*. They supposed that its age is the early Middle Pleistocene, but younger than Tologoi. Somewhat earlier age is supposed by Kuznetsova and Zhegallo (2009) who assumed that most of fossiliferous layers were formed during the Jaramillo Event. Lee (2005) figured several bear specimens from the Middle