A REAPPRAISAL OF THE “EAST CARPATHIAN TEMPERATE CLIMATE REFUGIUM” DURING THE LAST GLACIAL MAXIMUM

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Abstract. The concept of “East Carpathian Refugium” is largely based on reports on temperate-climate species from the Late Paleolithic sites of Moldova. The present report proposes new faunistic data from the key Paleolithic sites of Moldova that question the presence of some temperate species in the East Carpathian Region during the Last Glacial Maximum. The revision of archaeozoological material from Cosăuţi did not confirm the presence of *Capreolus capreolus* and *Alces alces* in this palaeolithic site. Osteological remains previously ascribed to *Cervus elaphus*, according to new data, belong to *Cervus canadensis* and *Ovibos moschatus*.

Introduction

The Quaternary fauna of Europe was deeply influenced by the glacial cycles that started 2.58 million years ago and caused important faunal turnovers, extinctions, dispersals and retractions of cold- or temperate-adapted species [1]. The alternations of glacial and interglacial periods, as well as their duration greatly affected the evolution of European biota, speciation, and intraspecific diversification [2, 3, 4, 5]. During the Quaternary period, the southern regions of Europe (the Iberian, Italian, and Balkan Peninsulas) played an important role of glacial refugia for a large number of animals and plants that then recolonized northern parts of Europe during interglacial climate warmings [1, 6]. The problem of Quaternary refugia is of great interest to palaeontologists, palaeoecologists, population geneticists and conservation biologists and attracted great attention from the scientific community during the last decades [1, 4, 5, 7]. Special importance in the rapid interglacial recolonizations by temperate plants and animals is given to the so-called cryptic glacial refugia, which represented particular restricted biogeographic areas with the relatively mild local climate that permitted the isolated survival of temperate biota during glaciation peaks [5]. The East Carpathian area, including the territory of the Republic of Moldova, is often regarded as one of such northern cryptic refugium. The notion of the East Carpathian temperate climate refugium was introduced by Sommer and Benecke [8] based on the presence in the northern part of Moldova of subfossil remains of *Ursus arctos* and several forest-bound species (mostly cervids) during the Last Maximum Glaciation (LMG) dated back to 23 000–16 000 years BP (before present). The list of forest temperate climate species from the Late Paleolithic sites includes *Alces alces*, *Capreolus capreolus*, and *Cervus elaphus* that coexisted with such typical tundra-steppe faunal elements as *Rangifer tarandus*, *Mammuthus primigenius*, *Coelodonta antiquitatis*, *Bison priscus*, etc. [7, 9, 10]. Here should be also mentioned *Megaloceros giganteus* reported from the second “Magdalenian” layer of Duruitoarea Veche [10] that represented an exceptional isolated case of persistence of the giant deer during LGM in Europe. Stewart et al. [11] regarded the East Carpathian refugium as one of the cryptic northern refugium of temperate-adapted taxa. The present study presents results of the revision

of cervid remains that supposedly were ascribed to the temperate-climate species and proposes to reconsider the concept of the East Carpathian cryptic glacial refugium.

Materials and methods

The material involved in the present study includes the archaeozoological Paleolithic material from Duruitoarea Veche, Raşcov-7, Cosouţi, Climăuţi II (curated at the Institute of Zoology, Chişinău), Raşcov-8, and the collection of Paleolithic artefacts from Cosăuţi (curated at the National Museum of History of Moldova, Chişinău). The systematic revision of the archaeozoological material is based on the cranial, dental, and postcranial morphological characters of cervid and bovid species [12, 13, 14].

Results and discussions

The presence of giant deer remains in layer II of Duruitoarea Veche reported by David [9] conflicts with the data of Stuart et al. [15] that indicate a conspicuous absence of *Megaloceros giganteus* in Western and Central Europe during the time interval around 20–12.5 kyr. N.A. Chetaru (personal communication, 2008) believed that the older bones of giant deer from Duruitoarea Veche could be admixed during the material sorting and the preliminary study of the osteological remains [16]. This suggestion was recently confirmed by Lister and Stuart [17] who obtained the date 37050 ± 450 years BP for the giant deer molar sample said to be from the second layer of Duruitoarea Veche. Thus, the available data do not support the persistence of *M. giganteus* in the East Carpathian area.

Figure 1. Reindeer (*Rangifer tarandus*) antlers from the Palaeolithic site of Cosăuţi (Soroca District, Moldova): A, the fragment of distal palmed part from layer VII; B, the antler of a reindeer male from Cosăuţi (redrawn from a protograph kindly provided by Dr. S. Covalenco) with a shaded part that corresponds to the antler fragment from layer VII; C, the juvenile antler of reindeer that shows the *Capreolus*-like bauplan

The reported occurrences of elk (*A. alces*), roe deer (*C. capreolus*) and red deer (*C. elaphus*) in the Late Paleolithic of Cosăuţi [10] served as an important argument in favour of the concept of East Carpathian refugium of temperate species [7]. Cultural layers of Cosăuţi were

accumulated during the relatively short period between ca. 19 000 BP and 17 000 years BP, i.e. shortly after the peak of the LGM [10, 18]. Unfortunately, David et al. [10] did not provide any description or indications to specimens ascribed to temperate climate cervids. The single specimen of *A. alces*, according to David et al. [10], comes from layer VII of Cosăuți. There is only one specimen from this layer that could be ascribed to elk, a processed fragment of large palmated antler [19: fig. 5-5]. However, unlike *A. alces*, the specimen in question is characterised by an oval cross-section of antler beam below the palmation (not subrectangular as in *A. alces*) and its palmed part is not bowed as in elks [14: fig. 13]. According to the present study, the palmed fragment of antler from layer VII belongs to a very large specimen of reindeer, as is demonstrated in fig. 1, A-B.

The revision of the archaeozoological collections from Cosăuți did not reveal any specimen that belongs to *C. capreolus*. Nonetheless, it is necessary to indicate that some juvenile antlers of *R. tarandus* from Cosăuți are characterized by bauplan that reminds the structure of antlers of roe deer (fig. 1, C). Thus, according to our opinion, the faunal assemblage from Cosăuți has a typical tundra-steppe character [19].

Figure 2. The reconstruction of antler of *Cervus canadensis* (A) based on a distal portion of antler (B) from the Palaeolithic site of Climăuți II (Șoldanești Discript, Moldova)

The multiple reports of the presence of red deer *Cervus elaphus* in the East Carpathian area during the LGM [9, 20, 21] represent a complex problem largely based on the taxonomic issues and species definitions of the so-called “elaphine deer” group that includes two vicarious species, *C. elaphus* and *C. canadensis* [22, 23]. The recent genetic [24, 25] and morphological [22, 23] studies revealed the dispersal of Asian wapiti (*C. canadensis*) in Europe during the LGM. During cold phases of glacial cycles, *C. canadensis* substituted *C. elaphus* in most of Europe with exception of the southern glacial refugia where populations of red deer persisted [23, 24]. The antler fragments from Climăuți II ($20\,350 \pm 230$ years BP) originally reported as *C. elaphus* [20] belong to a significantly larger form of *C. canadensis* and are characterized by typical for this species morphology of distal portion of antler [22]. The poor antler fragments with specific for “elaphines” pearly antler surface from Rașcov 8 reported by Croitor and Covalenco [21] as *C. elaphus*, most probably belong to *C. canadensis*.

Figure 3. The right talus “P-VII-62 III-4/2-12” of *Ovibos moschatus* from Rașcov 7 (Camenca District, Moldova): A, proximal view; B, medial view; C, dorsal view; D, plantar view

A part of remains from Rașcov 7 (22 000 - 17 000 years BP: [26]) ascribed to *C. elaphus* [9] belong to musk ox *Ovibos moschatus*. The musk ox talus “P-VII-62 III-4/2-12” from Rașcov 7 is characterized by the size and proportions (the maximum bone length is 59.8 mm; the distal breadth is 41.2 mm) quite similar to those of red deer, however, morphological characters of the specimen in question (Fig. 3) correspond to the diagnostic features of *O. moschatus* provided by Gromova [13]. The finding of musk ox from Rașcov 7 is the first record of this species on the territory of Moldova and the southernmost record of *O. moschatus* in Eastern Europe. The presence of musk ox in the archaeozoological material from Rașcov 7 confirms the strong cold-adapted character to the fauna from this Paleolithic site. Generally, findings of musk ox in the southern part of Eastern Europe are extremely rare. According to the broadly accepted opinion, *O. moschatus* dispersed into southern regions of Eastern Europe only during the coldest phases of glaciations [27, 28 and references therein].

The above presented data do not support the concept of “East Carpathian glacial refugium”, which, therefore, should be rejected. Nonetheless, the reports on the occurrence of temperate climate species (plants and animals) in the Late Pleistocene glacial phases of Hungary and Slovenian Karst in southern Slovenia [7] require further attention, since the Pannonian plane hypothetically could be protected from the glacial climatic influence by the Carpathian Mountains. The term “Pannonian Glacial Refugium” is more appropriate in this case.

The studies were performed within the State Program project 20.80009.7007.02.

Bibliography

1. von Koenigswald, W., 2003. Mode and causes for the Pleistocene turnovers in the mammalian fauna of Central Europe. *Deinsea*, 10 (1): 305-312.
2. O'Regan, H. J., Turner, A., Wilkinson, D. M., 2002. European Quaternary refugia: a factor in large carnivore extinction? *Journal of Quaternary Science*, 17 (8): 789-795.
3. Lister, A. M., 2004. The impact of Quaternary Ice Ages on mammalian evolution. *Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences*, 359 (1442): 221-241.
4. Randi, E., 2007. Phylogeography of south European mammals. In: Weiss, S., Ferrand, N. (Eds.): *Phylogeography of southern European refugia*. Dordrecht: Springer, pp. 101-126.

5. Stewart, J. R., Lister, A. M., 2001. Cryptic northern refugia and the origins of the modern biota. *Trends in Ecology & Evolution*, 16 (11): 608-613.
6. Hewitt, G. M., 1999. Post-glacial re-colonization of European biota. *Biological journal of the Linnean Society*, 68 (1-2): 87-112.
7. Sommer, R. S., Nadachowski, A., 2006. Glacial refugia of mammals in Europe: evidence from fossil records. *Mammal Review*, 36 (4): 251-265.
8. Sommer, R. S., Benecke, N., 2005. The recolonization of Europe by brown bears *Ursus arctos* Linnaeus, 1758 after the Last Glacial Maximum. *Mammal Review*, 35 (2): 156-164.
9. David, A. I., 1980. Teriofauna pleistocena Moldaviei. Chişinău: Ştiinţa, 185 p. (in Russian).
10. David, A. I., Nadachowski, A., Pascaru, V., Wojtal, P., Borziac, A. I., 2003. Late Pleistocene fauna from the Late Palaeolithic butchering site Cosăuţi I, Moldova. *Acta zoologica cracoviensia*, 46 (1): 85-96.
11. Stewart, J. R., Lister, A. M., Barnes, I., Dalén, L., 2010. Refugia revisited: individualistic responses of species in space and time. *Proceedings of the Royal Society B: Biological Sciences*, 277 (1682): 661-671.
12. Akaevskiy, A. I., 1939. Anatomy of the reindeer. Glavsevmorputi, Leningrad, 327 p. (in Russian).
13. Gromova, V., 1960. Opredelitel' mlekopitayushchikh SSSR po kostyam skeleta. Vypusk 2. Trudy Komissii po izucheniyu chetvertichnogo perioda, 16: 3-117 (in Russian).
14. Croitor, R., 2021. Early Evolutionary Radiation and Diversity of the Old World Telemetacarpal Deer (Capreolinae, Cervidae, Mammalia). *Neues Jahrbuch für Geologie und Paläontologie*, 300 (1): 33-67.
15. Stuart, A. J., Kosintsev, P. A., Higham, T. F., Lister, A. M., 2004. Pleistocene to Holocene extinction dynamics in giant deer and woolly mammoth. *Nature*, 431 (7009): 684-689.
16. Croitor, R., 2008. Giant deer *Megaloceros giganteus* (Cervidae, Mammalia) from Late Pleistocene of Moldova. *Oltenia, Studiile şi comunicări - Ştiinţele Naturii*, 24: 262-266.
17. Lister, A. M., Stuart, A. J., 2019. The extinction of the giant deer *Megaloceros giganteus* (Blumenbach): New radiocarbon evidence. *Quaternary International*, 500: 185-203.
18. Borziac, I. A., Covalenco, S. I., 1989. Some data on multilayered Palaeolithic settlement Cosăuţi from mid- dle Dniester area. In: *Chetvertichnyi Period. Paleontologia i Archeologia*, Chişinău: Ştiinţa, pp. 201-223 (in Russian).
19. Covalenco, S., Croitor, R., 2016. Bone, Antler and Ivory Tools and Wares from Multilayer Upper Palaeolithic Site Cosăuţi. *Revista arheologică*, 12 (1-2): 283-295 (in Russian).
20. David, A. I., Obadă, T., 1996. Fauna de mamifere din săpăturile staţiunii paleolitice Climăuţi II. *Buletinul Academiei de Ştiinţe Republicii Moldova, Ştiinţe biologice şi chimice*, 1: 42-48.
21. Croitor, R., Covalenco, S., 2011. Mammal fauna from Upper Paleolithic site of Raşcov-8 (Moldova). *Oltenia, Studiile şi comunicări - Ştiinţele naturii*, 27 (1): 231-238.
22. Croitor, R., Obadă, Th., 2018. On the presence of Late Pleistocene wapiti, *Cervus canadensis* Erxleben, 1777 (Cervidae, Mammalia) in the Palaeolithic site Climăuţi II (Moldova). *Contributions to Zoology*, 86 (4): 273-296.
23. Croitor, R., 2020. A new form of wapiti *Cervus canadensis* Erxleben, 1777 (Cervidae, Mammalia) from the Late Pleistocene of France. *Palaeoworld*, 29 (4): 789-806.
24. Stankovic, A., Doan, K., Mackiewicz, P., Ridush, B., Baca, M., Gromadka, R., Socha, P., Weglenski, P., Nadachowski, A., Stefaniak, K., 2011. First ancient DNA sequences of the Late Pleistocene red deer (*Cervus elaphus*) from the Crimea, Ukraine. *Quaternary International*, 245 (2): 262-267.
25. Parfitt, S. A., Lister, A. M., 2013. The Ungulates from the Peştera cu Oase, in: Trinkaus, E., Constantin, S., Zilhao, J. (Eds), *Life and Death at the Peştera cu Oase: A Setting for Modern Human Emergence in Europe*. Oxford: Oxford University Press, pp. 189-203.

26. Chetraru, N. A., Grigorieva, G. V., Covalenco, S. I., 2007. The Upper Paleolithic site of Raşcov VII. Chişinău: the Institute of Cultural Heritage and the National Museum of Archaeology and History, 185 p. (in Russian).
27. Gromova, V., 1935. Über die Verbreitung des Moschusochsen (*Ovibos moschatus* Zimm.) in Osteuropa und Nordasie. Bulletin de l'Académie des Sciences de l'URSS, Série VII, Classe des sciences mathématiques et naturelles, 1: 101–114 (in Russian).
28. Krakhmalnaya, T. V., Kovalchuk, O. M., 2018. Fossil *Ovibos moschatus* (Artiodactyla, Bovidae) from Buryin, with Reference to Muskox Dispersal in the Late Pleistocene of Ukraine. *Vestnik Zoologii*, 52 (6): 463-470.