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# Preliminary investigation of Late Pleistocene fauna from Ryonggok Cave No. 1, Sangwon County, North Hwanghae Province, Democratic People's Republic of Korea

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ABSTRACT: The investigation of a limestone cave on the Ryonggok-ri of Sangwon County, North Hwanghae Province, DPRK, has yielded many faunal remains including Late Pleistocene deer, brown bears and horses. Uranium series dating of fossil teeth yielded dates of ~72ka at the base of Layer 2 – the bone-bearing unit – and ~44ka at the top. The rich and diverse mammal remains of Ryonggok Cave No. 1 are indicative of warm and humid temperate conditions during the Late Pleistocene, and reflect the presence of both dense forests and open grassland. In addition, pollen and spores from the site include two families and 24 genera of trees, six families and a genus of grasses and herbs, and two families and six genera of ferns, corroborating the environments inferred from the faunal remains.


KEYWORDS: DPRK; fauna; Late Pleistocene; mammal; Ryonggok Cave No. 1

## Introduction

Investigation of sedimentary fills deposited in limestone caves along the Munpho stream of Ryonggok-ri in Sangwon County, North Hwanghae Province, Democratic People's Republic of Korea (DPRK), has yielded floral and faunal data useful for the reconstruction of the Late Pleistocene environmental history of the region. Faunal remains, stone tools, human remains and fireplaces recovered from Ryonggok Cave No. 1 enable the investigation of palaeoenvironmental and human occupation. Here, we perform a preliminary analysis of the fossils collected to date, and provide a palaeoenvironmental interpretation of the Late Pleistocene of the Ryonggok-ri region in Sangwon County.

### *Study area*

Ryonggok Cave No. 1 (RCN1) (38°47′N, 126°03′E) is a limestone cave rich in fossil bones and was formed in the limestone of the Ectasian (Proterozoic) Sadangu Group. The cave is located in Ryonggok-ri, about 45 km southeast of Pyongyang City. It is approximately 5 km from Munpho stream, a tributary to the River Taedong, and located halfway up the eastern slope (100 m above sea level) at the bottom of Mt Hojang.

Most of the remains were discovered in areas within 40 m of the entrance. The initial dimensions of the cave were 3 m high, 6 m wide and 16 m long. The dimensions of the excavation itself were 40 m long, 21.05 m deep and 6–12 m wide. In 1980–1981, a research group from Kim Il Sung University discovered the cave deposits and conducted fieldwork. The remains are stored at the Institute of Human Evolution and Development History, Faculty of History, Kim Il Sung University.

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## Methods

The cave deposit was excavated in 20 4 $m^2$ (2×2 m) squares, and in 10 cm spits. The sediments were removed using trowels and brushes, according to their stratigraphy. The sediments surrounding large bone materials were dissolved in water and removed using brushes. Small fossil specimens included in the bulk sediment were wet-sieved with a 2 mm mesh and then immersed in acetic acid at 10% concentration and washed with water. Some 8200 mammalian remains were collected in total. Of these, the specimens of extinct and extant species were identified using published references (Young, 1932; Pei, 1934, 1936, 1940; Colbert and Hooijer, 1953; Beden and Guérin, 1973; Zheng, 1984; Jin, 1984; Jin *et al.*, 1984; Zong and Huang, 1985; Zheng *et al.*, 1998; Tong *et al.*, 2004, 2008; Merceron *et al.*, 2004; Billia, 2014; Fu, 2008; Kierdorf *et al.*, 2012; Ledevin *et al.*, 2012; Marciszak *et al.*, 2015), and modern skeletal specimens in the National Natural Museum and the Natural Museum of Kim Il Sung University. Following von den Driesch (1976), we took linear measurements of the specimens using AIRAJ ARZ-150 mm digital calipers to aid in identification.

For pollen and spore analysis, samples were processed following Faegri and Iversen (1989) and were identified under a light microscope using 400× magnification. The pollen analysis was performed only for Layer 2 where the majority of faunal remains were found. We identified three pollen zones using PSIMPOLL 4.25 constrained cluster analysis (Bennett, 2005) (Fig. 5).

We focused our U-series dating efforts on Layer 2 because most of the bones were found there. For dating, we analysed dentine from six teeth (one sample from each) of *Equus ferus* and *Ursus arctos*. U-series dating was conducted at Kim Il Sung University, following Shen *et al.* (2001). We separated the uranium and thorium by ion exchange, then removed Fe, Ca and P using solvent extraction and hydroxide precipitation. A radioactive sample was made by evaporation and the

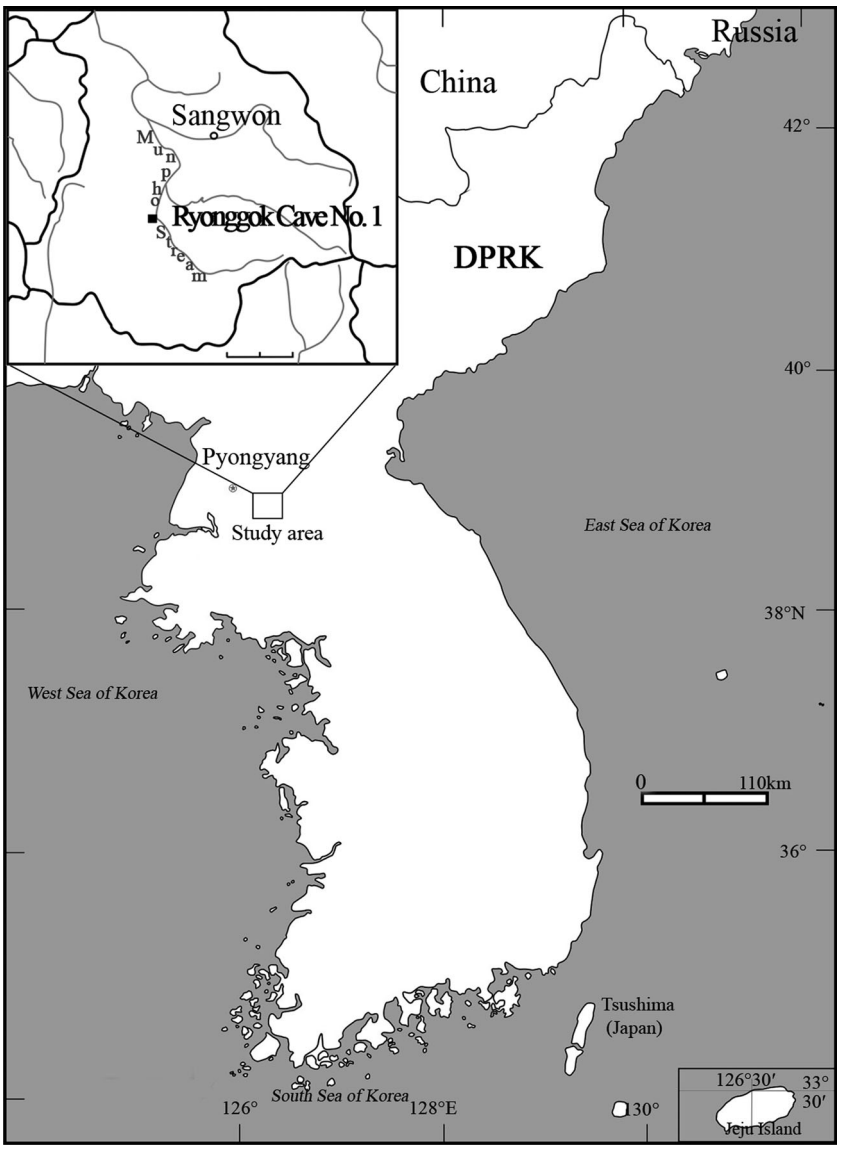


**Figure 1.** Location map of the site of Ryonggok Cave No. 1 in the River Taedong Basin in the DPRK.

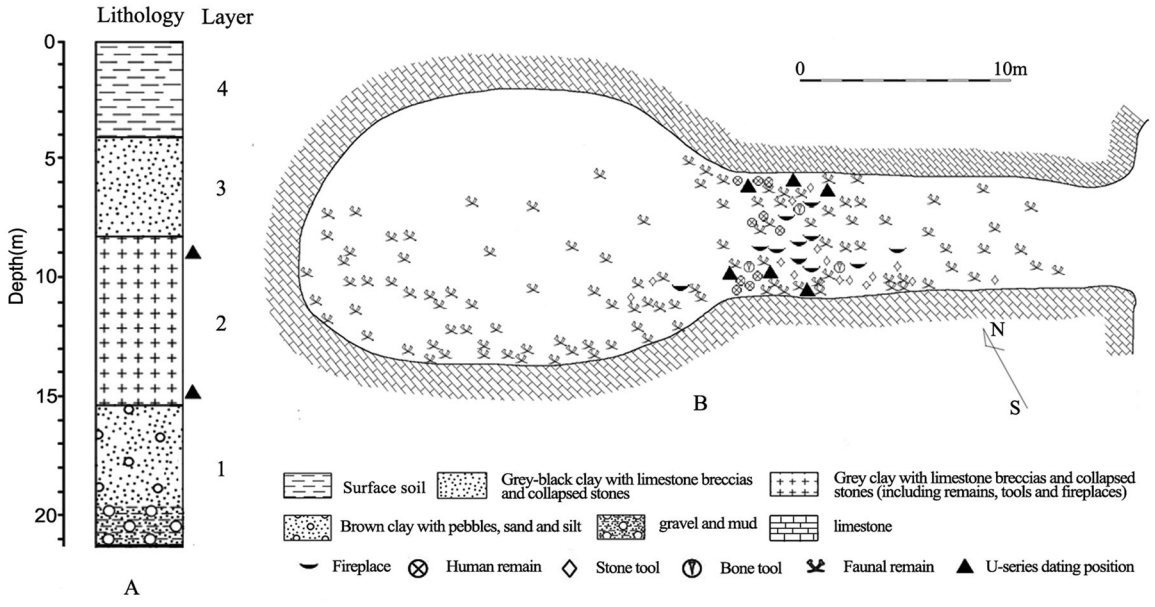


**Figure 2.** Stratigraphy section, and plan and remains distribution of the excavation area of Ryonggok Cave No. 1.

**Table 1.** Faunal species, number of identified specimens (NISP) and minimum number of individuals (MNI) from Ryonggok Cave No. 1.

| Taxon | NISP | MNI |
|---|---|---|
| Chiroptera | | |
| Vespertilionidae | | |
| *Murina leucogastor* | 20 | 8 |
| Lagomorpha | | |
| Leporidae | | |
| *Lepus europaeus* | 2 | 1 |
| Rodentia | | |
| Cricetidae | | |
| *Microtus oeconomus* | 2 | 1 |
| *Microtus fortis* | 1 | 1 |
| *Microtus* sp. | 1 | 1 |
| *Eolagurus simplicidens* | 2 | 1 |
| *Cricetulus triton* | 10 | 3 |
| *Alticola* cf. *stracheyi* | 1 | 1 |
| *Alticola* sp. | 1 | 1 |
| *Myospalax* cf. *psilurus* | 4 | 2 |
| Muridae | | |
| *Apodemus agrarius* | 1 | 1 |
| Sciuridae | | |
| *Eutamias sibiricus* | 1 | 1 |
| Carnivora | | |
| Canidae | | |
| *Canis lupus* | 14 | 3 |
| *Vulpes vulpes* | 4 | 1 |
| *Nyctereutes procyonoides* | 20 | 2 |
| Mustelidae | | |
| *Meles meles* | 6 | 2 |
| Felidae | | |
| *Panthera* sp., indet | 81 | 2 |
| *Felis microtis* | 3 | 1 |
| Hyaenidae | | |
| *Crocuta ultima* | 2 | 2 |
| Ursidae | | |
| *Ursus arctos* | 21 | 2 |
| Perissodactyla | | |
| Rhinocerotidae | | |
| *Stephanorhinus* sp., indet | 6 | 1 |
| Equidae | | |
| *Equus ferus* | 36 | 1 |
| Artiodactyla | | |
| Suidae | | |
| *Sus scrofa* | 15 | 2 |
| Cervidae | | |
| *Hydropotes inermis* | 5 | 1 |
| *Capreolus* sp., indet | 152 | 19 |
| *Cervus nippon* | 442 | 49 |
| *Cervus elaphus* | 69 | 4 |
| Bovidae | | |
| *Nemorhaedus goral* | 4 | 1 |
| *Bubalus* sp. | 28 | 5 |
| Sum | 954 | 120 |

radioactivity of $^{238}U$, $^{234}U$ and $^{230}Th$ was measured by alpha spectrometric methods.

## Results

### *Stratigraphy*

The cave sediments include four layers, and consist of fluvial, calcareous and collapsed deposits. The Late Pleistocene deposits of RCN1 comprise an approximately 21.05 m thick sequence in the section (Fig. 2).

Layer 1 was composed largely of gravel and mud in the lower portions and of brown clay intermixed with pebbles, sand and silt in the upper portion. No remains were discovered from this layer. The sediment of Layer 2 is composed of grey or grey-white clay mixed with limestone breccia and collapsed stones. This layer contained abundant faunal remains, human remains, stone tools, fireplaces and bone tools (Fig. 2). Layer 3 comprised grey clay with limestone breccia and collapsed stones, containing mammal bones, human bones, stone tools and a few pieces of unglazed pottery. Layer 4 is surface soil.

Uranium series dating of Layer 2 yielded mean ages of approximately 72.6ka at the base (depth 14.8 m) and approximately 47ka at the top (depth 10.9 m) (Table 2).

### *Faunal analysis*

The identified mammalian fauna in Ryonggok Cave Site No. 1 comprises 954 specimens, and includes 25 genera and 29 species representing 15 families and six orders (number of identified specimens (NISP) = 954, minimum number of individuals = 120) (Table 1).

RCN1 sediments include both large and small mammals, and these remains are well preserved. The diverse mammalian fauna includes carnivores (eight species), perissodactyls (two species), artiodactyls (seven species), lagomorphs (one species), bats (one species) and rodents (10 species) (Figs. 3 and 4) (macromammals identified by Choe and micromammals by Han). All the bones of sika deer, red deer and horses were discovered in Layer 2.

Artiodactyls dominate the fauna (NISP = 715, ~75%), followed by carnivores (NISP = 151, 15.8%), perissodactyls (NISP = 42, 4.4%), rodents (NISP = 24, 2.5%), bats (NISP = 20, 2.1%) and finally lagomorphs (NISP = 2, 0.2%). Descriptions of the studied specimens are in the supporting information.

## Discussion

Ryonggok Fauna No. 1 (RFN1) is a diverse and abundant Pleistocene assemblage.

Based on other fossil deposits in the region, including Locality 1 and the Upper Cave of Choukoutien in China, and localities in European Russia, we conclude that most of the extinct species from RNC1 – *Crocuta ultima, Stephanorhinus* sp., indet, *Bubalus* sp., *Microtus oeconomus, Eolagurus*

**Table 2.** U-series dating results for tooth fossils of Ryonggok Cave No. 1.

| Sample number | Depth (m) | Material | Uranium (ppm) | $^{234}U/^{238}U$ | $^{230}Th/^{234}U$ | $^{230}Th$ age (ka) |
|---|---|---|---|---|---|---|
| RG9005 | 10.9 | *Ursus arctos* | 40.6 ± 2.1 | 1.70 ± 0.05 | 0.34 ± 0.01 | 44 ± 2 |
| RG9012 | 10.9 | *Ursus arctos* | 60.0 ± 1.4 | 1.58 ± 0.07 | 0.36 ± 0.01 | 48 ± 2 |
| RG8003 | 10.9 | *Ursus arctos* | 66.2 ± 2.0 | 1.04 ± 0.17 | 0.37 ± 0.10 | 49 ± 6 |
| RG8010 | 14.8 | *Equus ferus* | 90.7 ± 1.8 | 1.13 ± 0.03 | 0.50 ± 0.01 | 76 ± 4 |
| RG8002 | 14.8 | *Equus ferus* | 70.2 ± 1.3 | 1.11 ± 0.04 | 0.47 ± 0.01 | 70 ± 3 |
| RG8005 | 14.8 | *Equus ferus* | 99.1 ± 1.8 | 1.28 ± 0.06 | 0.49 ± 0.04 | 72 ± 7 |

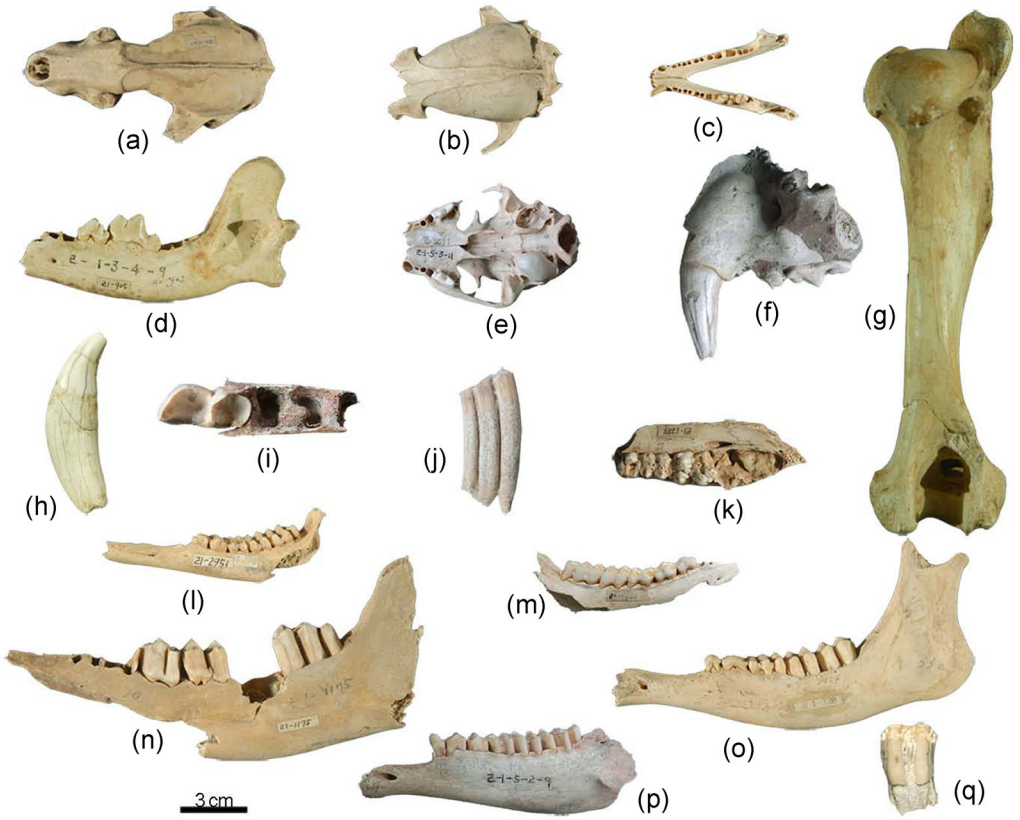


**Figure 3.** Specimens of Carnivora, Perissodactyla and Artiodactyla from Ryonggok Cave Site No. 1. (a) Dorsal view of cranium of *Meles meles* (R1-1120); (b) Dorsal view of cranium of *Vulpes vulpes* (R1-3555); (c) Occlusal view of mandible ($M_1$–$M_2$) of *Nyctereutes procyonoides* (R1-2300); (d) Lingual view of right mandible ($P_4$–$M_1$) of *Canis lupus* (R1-905); (e) Ventral view of cranium of *Felis microtis* (R1-3211); (f) Buccal view of left maxilla of *Panthera* sp., indet (R1-1402); (g) Caudal view of right humerus of *Crocuta ultima* (R1-193); (h) Lingual view of left upper canine of *Ursus arctos* (R1-9); (i) Occlusal view of left mandible of *Stephanorhinus* sp., indet (R1-183); (j) Buccal view of right $M_3$ of *Equus ferus* (R1-200); (k) Occlusal view of right maxilla ($P^4$–$M^2$) of *Sus scrofa* (R1-1259); (l) Buccal view of left mandible ($P_3$–$M_3$) of *Hydropotes inermis* (R1-2951); (m) Buccal view of right mandible of *Capreolus* sp., indet (R1-0466); (n) Buccal view of left mandible ($P_2$–$M_2$) of *Cervus nippon* (R1-330); (o) Buccal view of left mandible ($P_4$, $M_1$, $M_3$) of *Cervus elaphus* (R1-1175); (p) Buccal view of left mandible of *Nemorhaedus goral* (R1-1014); (q) Lingual view of left $M^3$ of *Bubalus* sp. (R1-1190). [Color figure can be viewed at wileyonlinelibrary.com]

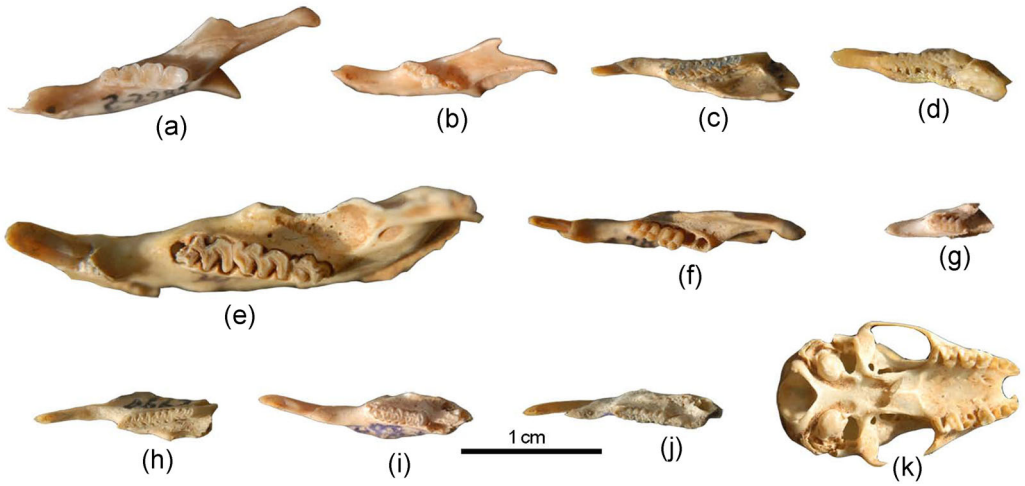


**Figure 4.** Specimens of Rodentia and Chiroptera from Ryonggok Cave Site No. 1. (a) Occlusal view of right mandible ($P_4$–$M_3$) of *Eutamias sibiricus* (R1-2985); (b) Occlusal view of right mandible ($M_1$–$M_2$) of *Apodemus agrarius* (R1-2986); (c) Occlusal view of left mandible (I, $M_1$–$M_3$) of *Alticola* cf. *stracheyi* (R1-2987); (d) Occlusal view of left mandible ($M_1$–$M_3$) of *Alticola* sp. (R1-2991); (e) Occlusal view of right mandible (I, $M_1$–$M_3$) of *Myospalax* cf. *psilurus* (R1-2995); (f) Occlusal view of right mandible ($M_1$–$M_2$) of *Cricetulus triton* (R1-2980); (g) Occlusal view of right mandible ($M_1$) of *Eolagurus simplicidens* (R1-2993); (h) Occlusal view of left mandible (I, $M_1$–$M_3$) of *Microtus fortis* (R1-2990); (i) Occlusal view of right mandible (I, $M_1$–$M_2$) of *Microtus* sp. (R1-2989); (j) Occlusal view of right mandible (I, $M_1$–$M_3$) of *Microtus oeconomus* (R1-2998); (k) Ventral view of cranium of *Murina leucogastor* (R1-2999). [Color figure can be viewed at wileyonlinelibrary.com]

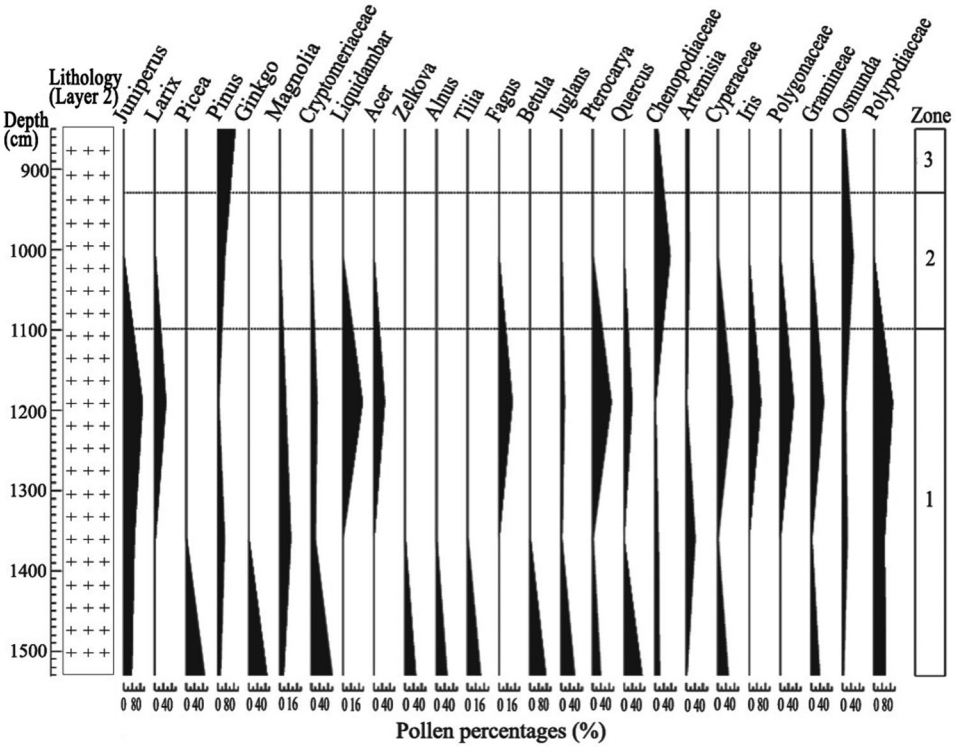


**Figure 5.** Pollen percentage diagram of the site of Ryonggok Cave No. 1 (all taxa which are >1.24% of the total counts).

*simplicidens, Alticola* cf. *stracheyi*, etc. – are characteristic of the Pleistocene in North China and Russia (Young, 1932; Pei, 1940; Billia, 2014).

*Panthera* sp., *Ursus arctos, Meles meles, Equus ferus, Stephanorhinus* sp., *Sus scrofa, Cervus nippon, Capreolus* sp., *Hydropotes inermis, Cervus elaphus, Bubalus* sp., *Apodemus agrarius, Microtus oeconomus* and *Murina leucogastor* were found at the Chongphadae Cave Site of the Late Pleistocene in DPRK (Choe *et al*., 2020), and from the Early Pleistocene to the Late Pleistocene sites in China (Pei, 1936, 1940; Qiu, 2006). *Equus ferus* and *Sus scrofa* are typical species of the Late Pleistocene in North China (Qiu, 2006).

The most striking feature of the RFN1 is the high diversity of artiodactyls, represented by numerous mandibles and phalanges and at least seven species. Also abundant are the rodents, represented by 10 species. Forest-dwelling artiodactyls and carnivores of RFN1, such as *Cervus nippon*, *Panthera* sp., *Sus scrofa*, *Ursus arctos*, etc., are abundant and diverse (Michael *et al*., 2004). The predominance of these suggests that the cave was located in or near a forest environment at the time of bone deposition. The presence of *Equus ferus* and *Crocuta ultima* indicates an open environment such as grassland, while *Microtus oeconomus*, *M. fortis, M.* sp. and *Alticola* cf. *stracheyi* indicate wet and moist areas. *Stephanorhinus* is associated with hot and humid tropical and subtropical forests in China (Wu *et al*., 1989), but occurs commonly in temperate contexts in Europe (Stuart, 1982).

All of the species in RFN1 are associated with the temperate regions. The rich and diverse mammal remains of RCN1 indicate that the Late Pleistocene environments were warm and humid temperate habitats, with both dense forest and open grassland. Analysis of palynological remains provides information on the palaeoenvironment and regional palaeovegetation of the Late Pleistocene (Fig. 5).

The dominant floral elements are trees (*Pinus*, *Juniperus*, *Quercus*, *Betula*, etc.) and herbs (Chenopodiaceae, *Artemisia*), together constituting greater than approximately 80% of the total. *Quercus*, *Pinus* and *Juniperus* dominate identified tree pollen, together constituting about 39% of the flora. Also represented are riparian species including *Alnus*, *Juglans*, a few ferns (*Osmunda*, Polypodiaceae) and moss (Bryaceae). The dominant floral elements associated with the temperate climate include *Pinus*, *Juniperus*, Chenopodiaceae, *Osmunda*, *Artemisia*, etc. Also represented was the subtropical species *Magnolia* and Cryptomeriaceae.

In concordance with the faunal evidence, the palynoflora of Ryonggok Cave Site No. 1 indicates that during the Late Pleistocene, a warm and humid environment existed in this region.

Both the RFN1 and the Chongphadae fauna are composed of the typical species of the Late Pleistocene; however, *Coelodonta antiquitatis*, which is adapted to cold weather, is also represented at the latter (Choe *et al*. 2020). This suggests that the palaeoenvironment of the Chongphadae Cave Site region was colder than that of the Ryonggok Cave Site.

U-series dating of teeth from RCN1 gives dates ranging from 47 to 72.6ka. Our research represents a first step toward the settlement of a reliable chronology for the RCN1.

The human remains, stone tools and fireplaces from RCN1 provide evidence of human presence and a potential role in the taphonomy of the site. Research on these components of RCN1 is ongoing. Future work on the palaeoenvironment is also planned.

## Conclusions

Our preliminary investigations of RFN1 have produced a diverse faunal assemblage allowing inference about Late Pleistocene environmental conditions in the Ryonggok-ri region. The species composition of the mammalian fauna and flora of RCN1 suggests that in the Ryonggok-ri region during the Late Pleistocene, forests and grasslands associated with many trees and herbs were widespread, and coexisted with riparian zones in a warm and temperate environment. The Late Pleistocene environment inferred from the mammalian fauna in and around Ryonggok Cave Site No. 1 is

consistent with that of the palynoflora, and suggests that it was slightly warmer at RCN1 than at the Chongphadae Cave Site (Choe *et al*. 2020). The research indicates that the palaeoenvironments of the Ryonggok Cave Site No. 1 area were adequate to support a rich mammalian fauna during 44–72ka, as well as human existence and activity. Future work on RCN1 may provide a more comprehensive image of the Late Pleistocene environments of this area.

## Supporting information

Additional supporting information can be found in the online version of this article.This article includes online-only Supplemental Data.

Supporting information.

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## References

Beden M, Guérin C. 1973. Le Gisement de vertébrés du phnom Loang (Province de Kampot, Cambodge)-Faune pléistocéne Moyen Terminal. (Loangien).O.R.S.T.O.M. Paris 51–63.

Bennett KD. 2005. Documentation for Psimpoll 4.25 and Pscomb 1.03: C programs for plotting pollen diagrams and analyzing pollen data. Retrieved from http://chrono.qub.ac.uk/psimpoll/psimpoll.html.

Billia EME. 2014. *Stephanorhinus kirchbergensis* (Jäger, 1839) (Mammalia, Rhinocerotidae) from European Russia: A new, detailed inventory of sites and referred material. *Central European Geology* **57**(2): 165–195.

Choe RS, Han KS, Kim SC *et al*. 2020. Late Pleistocene fauna from Chongphadae Cave, Hwangju County, Democratic People's Republic of Korea. *Quaternary Research* **97**: 42–54.

Colbert EH, Hooijer DA. 1953. Pleistocene mammals from the limestone fissures of Szechwan, China. *Bulletin of the American Museum of Natural History* **102**: 102–105.

Faegri K, Iversen J. 1989. *Textbook of pollen analysis*. Wiley: Chichester.

Fu RY. 2008. Preliminary report on 2007's excavation at the Mashandong Cave in Chaoyang, Liaoning Province, China. *Proceedings of the Eleventh Annual Meeting of the Chinese Society of Vertebrate Paleontology* 85–91.

Jin CZ. 1984. The Quaternary stratigraphy and mammalian fossils of Weixian. *Shandong. (In Chinese with English summary) Vertebrata PalAsiatica* **22**(1): 54–59.

Jin CZ, Xu QQ, Li CT. 1984. The Quaternary mammalian faunas from Qingshantou site. *Jilin Province. (In Chinese with English summary) Vertebrata PalAsiatica* **22**(4): 314–323.

Kierdorf U, Bahelkova P, Sedlacek F *et al*. 2012. Pronounced reduction of fluoride exposure in free-ranging deer in North Bohemia (Czech Republic) as indicated by the biomarkers skeletal fluoride content and dental fluorosis. *Science of the Total Environment* **414**: 686–695.

Ledevin R, Quéré JP, Michaux JR *et al*. 2012. Can tooth differentiation help to understand species coexistence? The case of wood mice in China. *Journal of Zoological Systematics and Evolutionary Research* **50**(4): 315–327.

Marciszak A, Stefaniak K, Mackiewicz P *et al*. 2015. *Ursus arctos* L., 1758 from Bukovynka Cave (W Ukraine) in an overview on the fossil brown bears size variability based on cranial material. *Quaternary International* **357**: 136–148.

Merceron G, Viriot L, Blondel C. 2004. Tooth microwear pattern in roe deer (*Caprolus capreolus* L.) from Chizé (Western France) and relation to food composition. *Small Ruminant Research* **53**: 125–132.

Michael H, Devra GK, Valerius G *et al*. 2004. *Grzimek's Animal Life Encyclopedia*. Second edition. Volumes 12–16. Mammals. Farmington Hills, MI: Gale Group.

Pei WC. 1934. On the Carnivora from Locality 1 of Choukoutien. *Paleontologia Sinica, Ser.C* **8**(1): 7–164.

Pei WC. 1936. On the mammalian remains from Locality 3 at Choukoutien. *Paleontologia Sinica, Ser.C* **7**(5): 7–108.

Pei WC. 1940. The Upper Cave fauna of Choukoutien, Palaeont. *Paleontologia Sinica, New Ser. C* **10**(125): 1–84.

Qiu ZX. 2006. Quaternary environmental changes and evolution of large mammals in North China. *Vertebrata PalAsiatica* **44**(2): 109–132.

Shen GJ, Wang W, Wang Q *et al*. 2001. U-series dating of hominid site Ganqian cave at Tubo, Liujiang, Guangxi in South China. *Acta Anthropologica Sinica* **20**(3): 238–244.

Stuart AJ. 1982. *Pleistocene vertebrates in the British Isles*. London and New York: Longman.

Tong HW, Liu JY, Zhang SQ. 2004. Large mammal fossils from the Tianyuan cave, a human fossil site of End-Pleistocene age recently discovered near. *Zhoukoutien Acta Anthropologica Sinica* **23**(3): 213–223.

Tong HW, Zhang SQ, Li Q *et al*. 2008. Late Pleistocene mammalian fossils from the Xitaiping Cave, Shidu, Beijing. *Vertebrata PalAsiatica* **46**(1): 51–70.

von den Driesch A. 1976. A guide to the measurement of animal bones from archaeological sites. *Peabody Museum Bulletin 1*. Harvard University, Peabody Museum of Archaeology and Ethnology.

Wu RK, Wu XZ, Zhang SS. 1989. *Early humankind in China*. Academic Press: Beijing.

Young CC. 1932. On the Artiodactyla from the Sinanthropus site at Choukoutien. *Paleontologia Sinica, Ser.C* **8**(2): 1–100.

Zheng SH, Zhang ZQ, Dong MX *et al*. 1998. Quaternary mammals from the fissure filling of Pingyi County. *Shandong and its ecological significance. Vertebrata PalAsiatica* **36**(1): 32–46.

Zheng SH. 1984. Revised determination of the fossil Cricetine (Rodentia Mammalia) of Choukoutien district. *Vertebrata PalAsiatica* **22**(3): 179–197.

Zong GF, Huang XS. 1985. Note on some mammalian fossils from the Latest Pleistocene of Xialatuo, Luhuo, Sichuan. *Vertebrata PalAsiatica* **23**(4): 287–294.