

Analysis of the Cave Bear Metapodial Bones from Križna jama (Slovenia)

by

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Zusammenfassung

Dieser Artikel beschreibt die Metapodien aus der Križna jama in Slowenien, die Teils am Institut für Paläontologie der Universität Wien und Teils am Naturhistorischen Museum Wien liegen. Es handelt sich dabei um sehr große und plumpe Metapodien, die lediglich von denen aus der Ajdovska jama, ebenfalls in Slowenien gelegen, noch übertroffen werden. Die artliche Zuordnung erfolgt zu *Ursus ingressus* RABEDER et al., 2004, wobei es auffällt, dass diese Metapodien im Mittel nur noch von denen eines *Ursus ladinicus* RABEDER et al., 2004 an Größe übertroffen werden. Eine Erklärung dafür bieten die für diese Arten unterschiedlichen ausgeprägten Anpassungsmodi an Umweltbedingungen, siehe RABEDER et al. (2008).

Schlüsselwörter: Križna jama, Slowenien, *Ursus ingressus*, Metapodien, Pleistozän

Abstract

This article describes the metapodial bones from Križna jama in Slovenia, which are housed in the collections of the Institute of Palaeontology, University of Vienna, and at the Museum of Natural History, both Vienna. These metapodial bones are very big and plump and are superseded only by those from Ajdovska jama, which is also situated in Slovenia. The bears are attributable to the species *Ursus ingressus* RABEDER et al., 2004 and it is astonishing that they are only superseded in size by a population of *Ursus ladinicus* RABEDER et al., 2004. A suitable explanation for this behaviour can be found in different modes of responses to environmental conditions.

Keywords: Križna jama, Slovenia, *Ursus ingressus*, metapodial bones, Pleistocene

Izvleček

V članku so opisani metapodiji iz Križne jame, ki so deloma shranjeni na Inštitutu za paleontologijo Univerze na Dunaju in deloma v Naravoslovnem muzeju (Naturhistorisches Museum) na Dunaju. Metapodiji so zelo veliki in čokati (masivni). Po velikosti jih presegajo samo tisti iz Ajdovske jame v Sloveniji. Pripadajo vrsti *Ursus ingressus* RABEDER et al., 2004, pri čemer vzbuja pozornost dejstvo, da jih v povprečju po velikosti prekašajo le še metapodiji vrste *Ursus ladinicus* RABEDER et al., 2004. Pojasnilo nudijo različno izražene prilagoditve teh vrst na okolje (RABEDER et al., 2008).

Ključne besede: Križna jama, Slovenija, *Ursus ingressus*, metapodiji, pleistocen

Dedication

This article is dedicated to my friend and colleague, M.A. Brigitte Kaulich, from Nürnberg (Germany) who died – much too early – in 2006.

1. Introduction

The Križna jama, its German name is Kreuzberg Höhle, is a well-known cave in Slovenia, which is famous for its impressing size, flowstone-figures and, since 1926, for its water-part, consisting of 22 lakes, separated by flowstone cascades. It is possible to visit parts of the cave in the course of a guided-tour. Nevertheless, it is also famous for the huge amount of cave bear remains, which was excavated in the second half of the 19th century by the Austrian scientist Ferdinand von Hochstetter, in collaboration with Josef Szombathy and Karl Deschmann. The fauna of Križna jama was first mentioned and roughly described by LIEBE (1879), but it was upon Ferdinand von Hochstetter to publish the first conclusive work on this cave and its bears along with a set of detailed maps of the “old part” and its position underneath Križna

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Figure 1: Measurements, taken on metapodial bones of members of the cave bear group, after WITHALM (2001:177), illustrations after TORRES PÉREZ-HIDALGO (1988), modified.

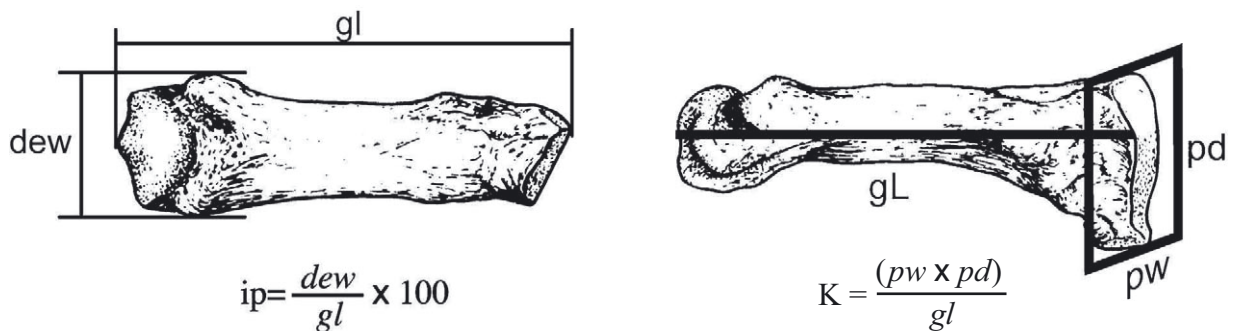
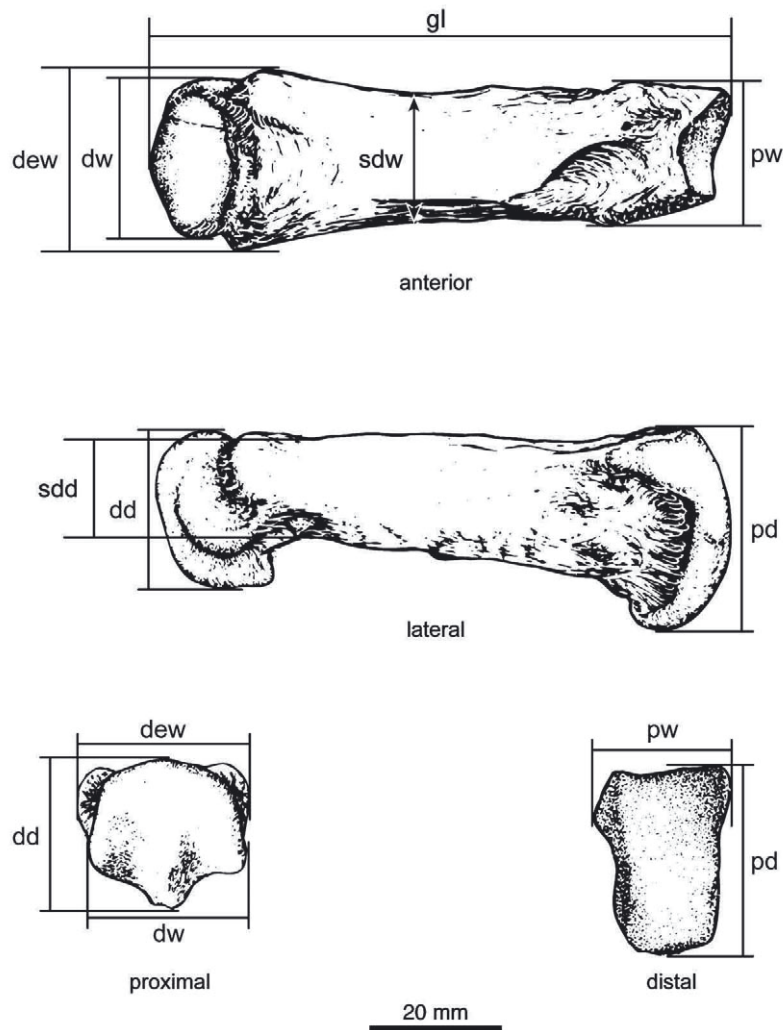


Figure 2: The most important indices for cave bear metapodial bones. Left: index of plumpness, WITHALM (2001:177), right: K-index, after GUŽVIČA & RADANOVIČ-GUŽVIČA (2000), illustrations after TORRES PÉREZ-HIDALGO (1988), modified.

gora, see HOCHSTETTER (1881). Josef Szombathy made the survey of Križna jama and drew the maps in 1879 (JUŽNIČ, 2006). Another scientist whose name has a close connection to this cave is, as mentioned above, Karl Deschmann (Karel Dežman), the former curator of the Museum in Ljubljana (Slovenia) who gave his name for a part of this cave, Dežmanova vrata. In 1999

and 2001, two excavation campaigns were made under the supervision of Prof. Gernot Rabeder (Institute of Palaeontology, University of Vienna) and Prof. Vida Pohar (Ljubljana). The main task of these excavations was to recover more and fresh cave bear material from Križna jama, with the purpose to find more teeth for morphometrical analysis and also some fresh bones for

Element	n	gl	pw	sdw	dw	dew	pd	sdd	dd	da	pa	sda	ip	K
Mc1	18	68.6	26.6	13.7	20.3	20.4	21.0	10.4	19.7	404.4	560.5	143.7	29.73	8.13
Mc2	18	81.1	21.4	18.7	24.1	27.8	31.0	13.4	22.7	559.3	675.6	252.9	34.25	8.26
Mc3	28	85.3	23.0	18.0	23.8	27.9	31.8	13.7	23.6	565.1	752.7	249.4	32.81	8.67
Mc4	19	90.3	24.9	20.4	26.8	30.3	34.0	14.2	24.5	651.0	857.7	290.0	33.49	9.45
Mc5	23	88.3	32.3	19.3	29.2	30.2	36.6	14.0	23.3	710.1	1199.0	271.3	34.14	13.42
Σ Mc	106												32.88	9.59
Mt1	14	58.0	24.9	12.6	18.3	18.2	26.6	9.9	16.8	307.5	647.9	125.6	31.41	11.09
Mt2	24	72.0	16.5	19.4	20.1	23.0	25.9	10.7	18.0	329.7	430.0	160.4	32.05	6.17
Mt3	28	80.1	21.1	16.5	20.3	24.2	32.2	11.7	18.6	374.6	693.1	196.0	30.03	8.48
Mt4	19	92.4	22.8	17.6	23.3	26.6	32.6	13.6	21.1	500.2	740.4	240.3	28.75	8.01
Mt5	22	92.4	31.4	14.2	24.5	24.7	29.5	12.7	20.2	515.7	945.0	182.4	26.74	10.09
Σ Mt	107												29.80	8.77

Table 1: Metapodial bones from Križna jama (Slovenia). Measurements taken and indices calculated according to WITHALM (2001:176–178). Abbreviations: gl – greatest length, pw – proximal width, sdw – smallest diaphyseal width, dw – distal width, dew – distal epicondyleal width, pd – proximal depth, sdd – smallest diaphyseal depth, dd – distal depth, da – distal area, pa – proximal area, sda – smallest diaphyseal area, ip – index of plumpness, K – K-index.

¹⁴C-datations. DÖPPES (2001) analysed the *Gulo*-remains from Križna jama as a part of her PhD-thesis. Eva Wild made the datations at the VERA-Laboratory in Vienna (Austria). Actually, it was not only possible to make the datations, but it was also possible to carry out aDNA-analysis on the material. Michael Hofreiter from Max-Planck-Institute in Leipzig (Germany) carried out the latter analysis on mt-DNA, (HOFREITER, oral comm.).

2. Materials and Methods

The metapodial bones dealt with herein are part of the collections of the Institute of Palaeontology, University of Vienna, Austria (IPUW) and of the Museum of Natural History in Vienna (NHMW). The state of preservation of the specimens is good, so that it was possible to take nearly all measurements in most of the metapodial bones. After the excavations of the newly recovered material, the bones were carefully prepared at the Institute. The colour varies from ebony to cream. Table 1 gives an overview on the distribution of the material from Križna jama.

The methodology for acquiring measurements and for calculating the indices is the same as is published in WITHALM (2001:176–178). Eight measurements were taken: greatest length (gl), proximal width (pw), smallest diaphyseal width (sdw), distal width (dw), distal epicondyleal width (dew), proximal depth (pd), smallest diaphyseal depth (sdd) and distal depth (dd). Four indices were calculated: proximal area (pa), smallest diaphyseal area (sda), distal area (da), index of plumpness (ip) and K-index (K), which are given in Table 1. See the measurements and indices in Fig. 1 and 2.

3. Results

It is obvious that a huge member of the cave bear group inhabited Križna jama approximately 45 ka b.p. The metapodial bones are big and plump, see Table 1 and Fig. 3–5. This is also true for the rest of the postcranial skeleton as well as for the impressively big skulls, excavated in 2001. Based on the analysis of ancient mt-DNA, the bears from Križna jama belonged to the species *Ursus ingressus*, a fact that wonderfully corresponds to what is actually known from the immigration route of this species until now.

In respect of the proportions of metacarpus and metatarsus, the bears from Križna jama are within the normal range of the cave bear group, without any significant differences.

4. Discussion

Even if it is obvious, the bears from Križna jama are big, even bigger than those from Potocka zijalka (Slovenia), compare to WITHALM (2004), the upper levels in the Vindija cave (Croatia). In respect of the greatest length, only the bears from Ajdovska jama (Slovenia) supersede them, which are, despite their size, attributable to *U. ladinicus* RABEDER et al., 2004, see RABEDER, this volume. The different morphological responses of the single cave bear species especially in respect to their habitats altitude were published in RABEDER et al. (2008). In respect to the K-index only the bears from some upper Vindija-levels, compare to WITHALM (2005), supersede the bears from Križna jama, see Fig. 6. Based on size and plumpness as well as on morphology the bears from Križna jama are clearly attributable to the species *Ursus ingressus*.

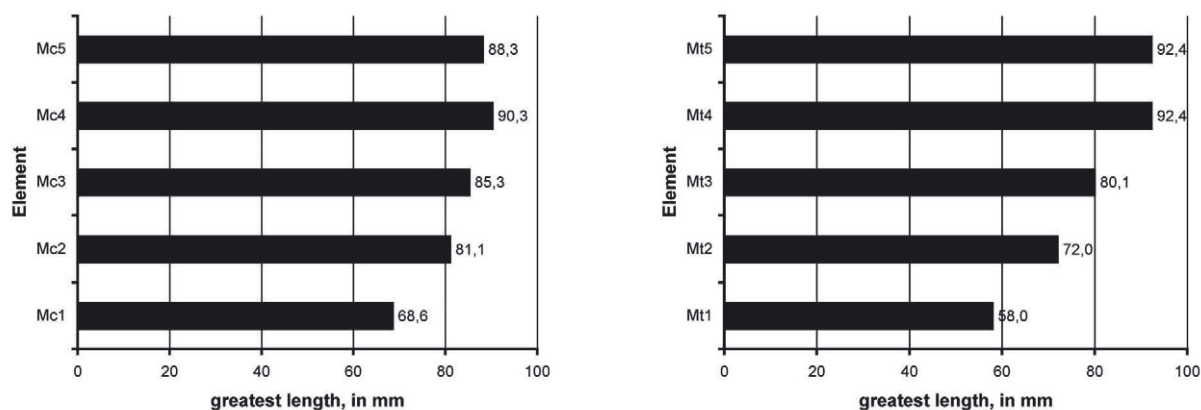


Figure 3: Proportions of metacarpus (left) and metatarsus (right) based on the greatest length.

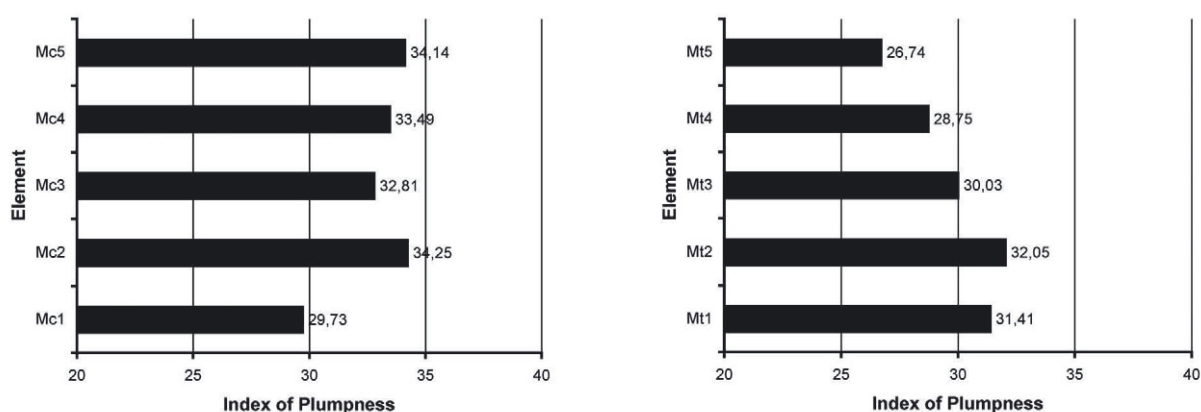


Figure 4: Proportions of metacarpus (left) and metatarsus (right) based on the index of plumpness.

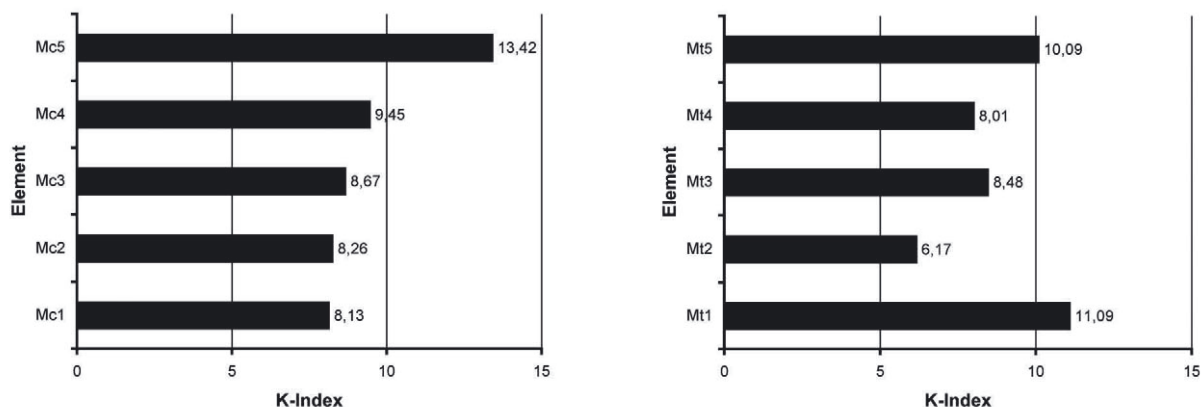


Figure 5: Proportions of metacarpus (left) and metatarsus (right) based on the K-index.

A fact that beautifully corresponds to the morphometrical analysis of teeth conducted by G. Rabeder as well as to the analysis of mt-DNA from M. Hofreiter. Moreover, it is interesting to observe the migration route of this species from east to west throughout time.

5. Acknowledgements

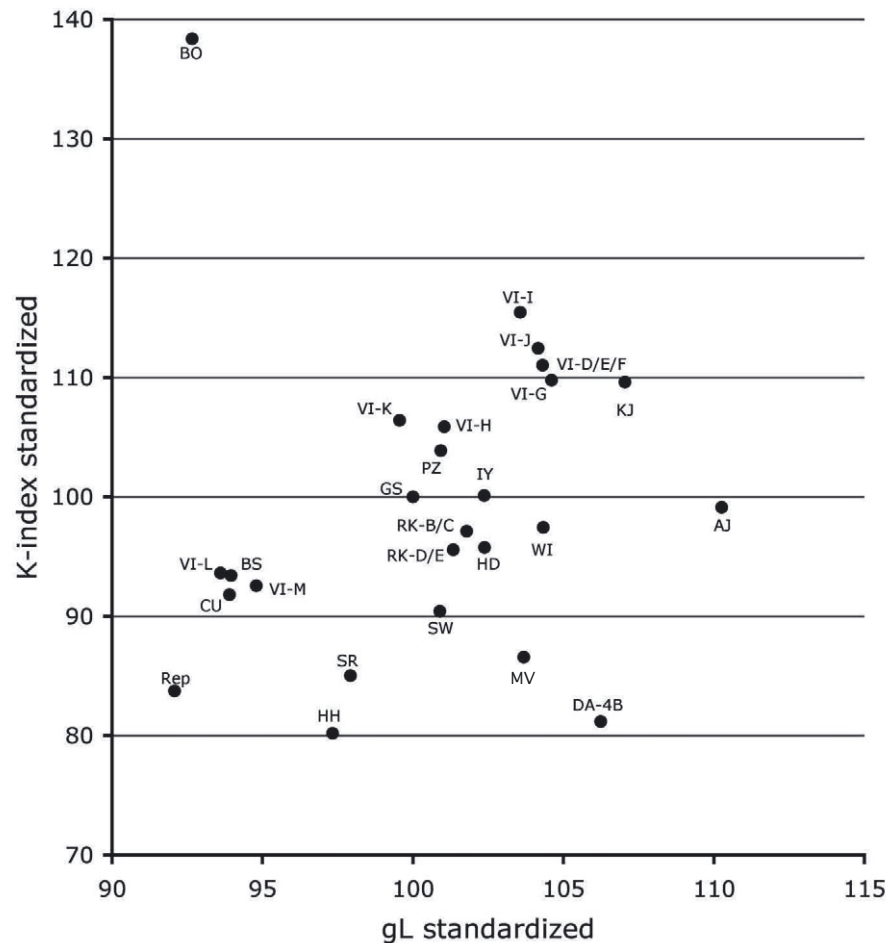
I am deeply indebted to Doz. Dr. Gudrun Höck from the Museum of Natural History in Vienna for allowing me to

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Figure 6: Scatter-plot of greatest length versus K-index of the second metatarsal bone from several studied sites, standardized on the *U. ingressus* from Gamssulzen cave in Upper Austria. Please note that the level of the K-index of the Križna-bears is one of the highest observed.



Abbreviations: AJ – Ajdovska jama (Slovenia), BO – Bucco dell'Orso (Italy), BS – Brettstein Bärenhöhle (Styria, Austria), CU – Conturines cave (South Tyrol, Italy), DA-4B – Bad Deutsch Altenburg, 4B (Lower Austria), GS – Gamssulzen-Höhle (Upper Austria), HD – Herdengel-Höhle (Lower Austria), HH – Hundsheim (Lower Austria), IY – Ilianka cave (Ukraine), KJ – Križna jama (Slovenia), MV – Grotte de Merveilleuse (France), NB – Nerubajskoe (Ukraine), PZ – Potocka zijalka (Slovenia), Rep – Repolusthöhle (Styria, Austria), VIM-D/E/F – Vindija, layers M-D (Croatia), RK D/E – Ramesch Knochenhöhle, lower layers (Upper Austria), RK B/C – Ramesch Knochenhöhle, upper layers (Upper Austria), SR – Schreiberwandhöhle (Upper Austria), SW – Schwabenreith-Höhle (Lower Austria), WI – Windener Bärenhöhle (Burgenland, Austria).

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