

Skeletal Element Distribution and Metrical Analyses of Cave Bear Remains from Križna jama (Slovenia)

by

Martina Pacher¹⁾

PACHER, M., 2014. Skeletal Element Distribution and Metrical Analyses of Cave Bear Remains from Križna jama (Slovenia). — Mitt. Komm. Quartärforsch. Österr. Akad. Wiss., 21:85–96, Wien.

Zusammenfassung

Križna jama im slowenischen Karst ist eine reiche Höhlenbärenfundstelle. Jedoch war ein Teil der Funde, die HOCHSTETTER (1881) aufzählt, nicht auffindbar. Das vorhandene Material besteht aus 4745 Knochen- und 520 Zahnresten. Kleine Skelettelemente sind im Material der der älteren Grabungen unterrepräsentiert. Das von Hand durchsuchte Material der neuen Grabungen 1999 und 2001 weist deutlich mehr kleinere Elemente auf.

Die metrische Auswertung von Eckzähnen, Schädeln, Unterkiefern und Langknochen belegt ein Überwiegen von männlichen Tieren im Fundmaterial der Križna jama. Die Masse einiger Stücke übertreffen jene der Vergleichsmaterialien aus dem genetisch eng verwandten Material aus der Gamssulzenhöhle, Österreich und der Potočka zijalka, Slowenien. Generell sind die Größenverteilungen für beide Geschlechter in allen drei Fundstellen ähnlich und kleinere Unterschiede auf die teilweise geringe Anzahl messbarer Stücke zurückzuführen.

Schlüsselwörter: Elementverteilung, Metrik, Höhlenbär, Križna jama, Slowenien

Abstract

Križna jama in the Slovenian karst area is a rich cave bear site but part of the material listed by HOCHSTETTER (1881) is missing. The available assemblage consists of 4745 bones and 520 teeth remains. Small elements are clearly underrepresented in the material of the older excavation campaigns. The hand screened material from the new 1999 and 2001 campaigns shows a better representation of small elements.

Metrical analyses on canines, crania, mandibles, and long bones indicate a male dominated cave bear assemblage at Križna jama. In long bones, some specimens from Križna jama are larger than the comparative material from the genetically closely related sites Gamssulzen-cave, Austria and Potočka zijalka, Slovenia. In general, size ranges of both sexes are similar at all three sites and observed differences may be explained by partly low sample size.

Keywords: element distribution, metrical analyses, cave bear, Križna jama, Slovenia

Izvleček

Križna jama s slovenskega Krasa je bogato najdišče ostankov jamskega medveda. Vendar del najdb, ki jih omenja HOCHSTETTER (1881) nismo našli. Pri izkopavanju zbran material predstavlja 4745 kosti in 520 zob. Manjše kosti skeleta so slabše zastopane. V letih 1999 in 2001 smo pri izkopavanjih zbrali neprimerno več manjših delov okostja.

Meritve podočnikov, lobanj, spodnjih čeljustnic in dolgih kosti kažejo na prevlado moških osebkov (samcev) med najdbami iz Križne jame. Velikost nekaterih delov okostja presega enake najdbe iz genetsko sorodnega materiala iz jame Gamssulzenhöhle v Avstriji in iz Potočke Zijalke v Sloveniji. V glavnem je porazdelitev velikosti obeh spolov podobna v vseh treh najdiščih. Majhne razlike so deloma posledica premajhnega števila merljivih kosov.

Ključne besede: porazdelitev najdb, meritve, Križna jama, Slovenija

1. Introduction

Die Križna jama or Kreuzberghöhle is situated near Bloška Polica in the Slovenian karst area. Its main attractions are over 40 underground lakes flowing over sinter cascades. Besides important bat colonies it is famous for over 40 troglobiontic species.

¹⁾ Dr. Martina PACHER, Institute of Palaeontology, University of Vienna, Althanstraße 14, A-1090 Vienna, Austria, e-mail: martina.pacher@univie.ac.at

Element	Hochstetter (Listed)	NHMW (stored)	IPUW	NML	New Excav.
Crania	35	11	—	42	149
Mandibulae	90	36	1	56	56
Atlas	59	17	1	4	12
Epistrophei	28	6	1	5	8
Vertebrae cerv.	194	27	—	13	—
Vertebrae thor.	455	31	1	51	28
Vertebrae lumb.	221	14	2	11	31
Vertebrae caud.	49	1	—	—	7
Costae	732	—	3	200	148
Sterna	65	8	—	—	12
Scapulae	48	2	—	13	26
Humeri	89	61	2	19	27
Radii	115	98	1	13	40
Ulnae	125	94	4	54	37
Carpals	169	101	—	11	103
Metacarpals	453	319	4	55	106
Pelvis	27	18	2	17	26
Sacrum	49	6	2	—	5
Femora	125	88	—	37	40
Tibiae	157	115	—	16	30
Fibulae	75	50	—	19	39
Astragali	—	15	2	10	21
Calcanei	—	22	3	13	21
Tarsals	194	21	3	2	—
Metatarsals	483	369	7	49	107
Phalanges	349	2	—	—	—
Phalanx 1	—	186	2	12	192
Phalanx 2	—	3	—	1	115
Phalanx 3	110	24	—	—	117
Patellae	50	6	—	2	18
Sesamoids	—	—	—	—	112
Hyalia	61	2	—	—	15
Bacula	21	—	—	2	3
Vertebrae	—	7	—	13	6
Metapodials	—	21	—	1	—
Total	4628	1928	39	741	2037

Table 1: Skeletal element distribution of the Križna jama material according to collections (NHMW ... Museum of Natural History Vienna, IPUW ... Institute of Paleontology Vienna, NML ... National Museum Ljubljana).

In addition, finds of cave bear remains were long known. They were also collected by local farmers as medical treatments and various other visitors. First scientific excavations were undertaken by Hochstetter from the Natural History Museum in Vienna from July, 19th–22nd 1878. From August, 1st–9th 1879 J. Szombathy and E. Kittl accompanied him. His finds came from two ter-

aces, the Monumentenhügel and mainly the Bärenwirtschaus. The material housed at the Narodni muzej BTC Ljubljana comes from the investigations from BRODAR & GOSPODARIČ (1973).

Finally, the Institute of Paleontology in Vienna in cooperation with the Oddelek za geologijo excavated in the bear's cave in 1999 and in the Kittl's bear cave in 2001.

2. Chronology

Samples of cave bear bones from the new excavations were taken for AMS radiocarbon dating and aDNA analyses. Four samples gave consistent ages from 44,800 up to 46,700 yrs BP (RABEDER & WITHALM, 2001). One sample indicates a younger occupation phase at Križna jama around 32,550 yrs BP. For details of the chronology see RABEDER (this volume). Uran-Thorium dating of flowstone remains at the site Medvedji rov resulted in six ages ranging from 126 ka until 173 ka (BOSAK et al., 2010), which indicate complex site formation processes as can be expected in a cave frequently affected by water torrents until today.

3. Material

The studied material comes from the excavation by Hochstetter and Kittl housed in the Natural History Museum in Vienna. Altogether 4600 bones of various age classes were collected and probably the same amount could not be collected due to bad preservation. Based on tibia 80 individuals are represented according to HOCHSTETTER (1881). Hochstetter mentioned about 2000 bones collected in 1878. Among them were also some complete skeletons, from which he mounted two complete skeletons that were on display in the Natural History Museum of Vienna. Unfortunately only parts of it could be found at the collection. Altogether 1928 bones out of 4628 listed by HOCHSTETTER (1881) were found at the museum's collection (Table 1). In addition 144 isolated teeth are preserved (Table 2). The new excavations in 1999 and 2001 yielded 2037 determined cave bear bones and 371 teeth remains. This material will be stored at the Oddelek za Geologijo in Ljubljana. The third larger collection is stored at the Narodni muzej BTC Ljubljana and comprises 741 determined cave bear remains. Three teeth come from this collection. A small collection at the Institute of Palaeontology in Vienna contains 41 bones and teeth. The finds listed in HOCHSTETTER (1881) came from two terraces, the "Monumentenhügel" and mainly the "Bärenwirthshaus" in an area called "Hochstetter's Schatzkammer" (Medvedji rov, bear gallery). There a 0.7 to 0.8 m thick layer of loam was excavated in around 25 m². Beneath the loam followed a flowstone layer. The loam was searched through by hand. Kittl excavated in a small area called Kittl's Bärenhöhle (Kittlovo brezno). Beneath a 0.2 to 0.3 m flowstone layer was 0.5 to 1 m humid sticky loam package with bones, among them eight skulls and associated skeletons. Hochstetter reported of one individual above the other and even neonate skeletons completely preserved. Unfortunately their preservation was so poor that most of the remains could not be collected. Both sites lay at the same level, about 10 to 12 m below the cave entrance. The material from Brodar and Gospodarič came also from the area of Medvedji rov. The large cave bear assemblage of Križna

Element	IPUW	NHMW	Excav.	NML
Deciduous teeth			68	
I1 inf.			21	
I2 inf.			9	
I3 inf.			22	
C inf.		2	28	
P4 inf.			26	
M1 inf.		34	31	
M2 inf.		19	28	
M3 inf.	1	15	29	
I1+2 sup.			30	
I3 sup.			25	
C sup.	1	6	7	1
P4 sup.		12	25	1
M1 sup.		19	22	
M2 sup.		22	28	
Canines			33	1
Molars				
Incisors		12	7	
Total	2	144	371	3

Table 2: Quantitative distribution of cave bears teeth from Križna jama (no isolated teeth mentioned by HOCHSTETTER, 1881), abbreviations as in Table 1.

jama shows a biased preservation of remains, which is due to recovery techniques and preservation. Already HOCHSTETTER (1881) mentioned the poor state of preservation of certain specimens that could not be collected. A comparison of the inventory list given by Hochstetter and the available remains at the Natural History Museum in Vienna indicate a loss of remains later on. For measurements see Appendices 1–3.

4. Metrical Analyses

A comprehensive metrical analysis was undertaken on crania, mandibles, and long bones. To the extent possible, specimens were determined as males or females. In order to compare size ranges, the material was then compared to measurements obtained on bones from Gamssulzen-cave and Potočka zijalka. Gamssulzen-cave lies at 1,300 m a.s.l. in the Totes Gebirge, Upper Austria and is regarded as type locality of the so-called *U. ingressus* (RABEDER et al., 2004). Several direct dates place the remains into the time span of approx. 38 ka to 25 ka BP (FRANK & RABEDER, 1997). Potočka zijalka is a high Alpine cave site at 1,700 m a.s.l. in northern Slovenia. The rich cave bear assemblage covers a similar time span from 36 ka to 26 ka BP (RABEDER & POHAR, 2004). Sexing of skulls and mandibles is best undertaken by measuring the crown width of the canines, that is the

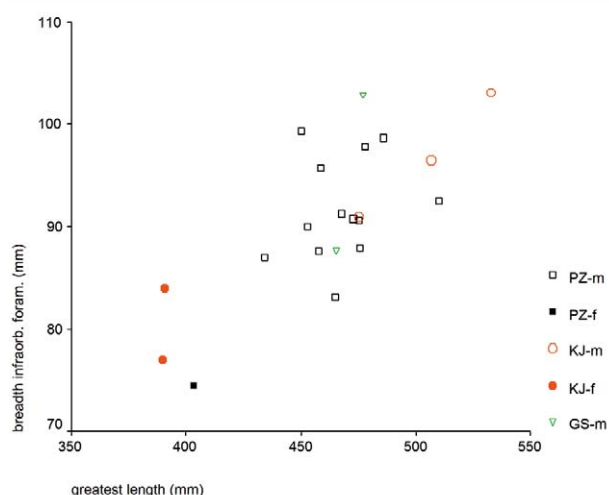


Figure 1: Comparison of cranial total length and snout width (between infraorbital foramina) of adult crania between sexes and sites (PZ ... Potočka zijalka, KJ ... Križna jama, GS ... Gamssulzen-cave), m ... male, fem ... female

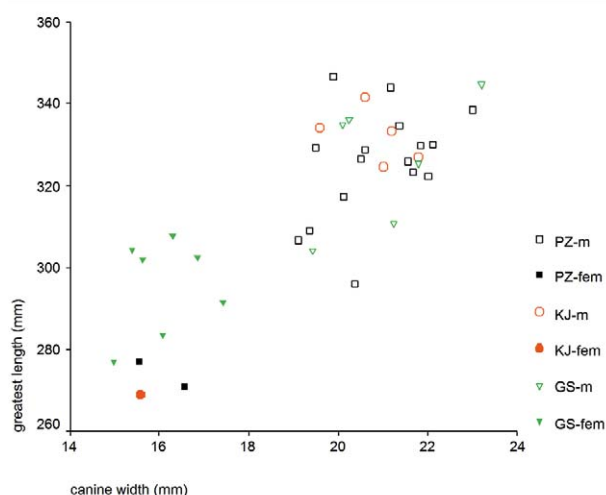


Figure 2: Comparison of canine width and total length of adult mandibles between sexes and sites (PZ ... Potočka zijalka, KJ ... Križna jama, GS ... Gamssulzen-cave), m ... male, fem ... female

transversal diameter at the base of the enamel. Although upper canines are slightly less reliable in sexing than lower ones (KURTÉN, 1955:12), it was possible to attribute all specimens from Križna jama to sexes. The bimodal distribution observed in canines is commonly concluded to represent females and males. However, the classification of specimens within an intermediate size range will always remain tentative. In case of cave bear canines the possible error is very low.

Potočka zijalka and Križna jama are male dominated while in Gamssulzen-cave females outweigh (see also PACHER & QUÍLES, 2013). The classification of the three sites into male respectively female dominated assemblages is in accordance with the approach by RABEDER (this volume).

The assemblage from Križna jama contains six completely preserved skulls, three come from the collection Hochstetter and three from the new excavation. HOCHSTETTER (1881) mentioned eight complete skulls, but only three were found at the museum's collection. The available specimens belong to four males and two females and are compared to crania from Potočka zijalka and Gamssulzen (see PACHER, 2004a). One specimen from Križna jama is missing in Fig. 1.

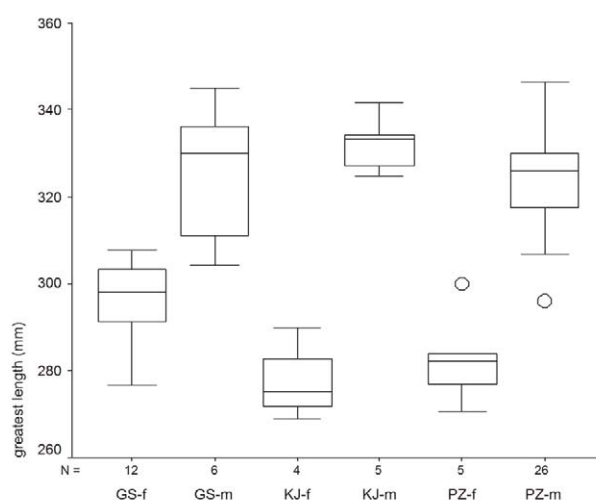


Figure 3: Comparison of greatest length of mandibles between sexes and sites (PZ ... Potočka zijalka, KJ ... Križna jama, GS ... Gamssulzen-cave), m ... male, fem ... female

In mandibles, sexual dimorphism in size is also expressed especially in the total length, the height of the mandible and the diameter of the condylus mandibularis (KURTÉN

Site	Sex	n	Min.	Max.	Mean	SD	D
KJ	F	4	269.0	290.0	277.37	8.93	1.20
	M	5	324.76	341.62	332.10	6.62	
GS	F	12	276.8	307.9	296.23	9.18	1.15
	M	5	304.2	345.0	326.08	15.74	
PZ	F	5	270.8	300.0	282.8	10.9	1.15
	M	26	295.8	346.6	325.42	11.84	

Table 3: Statistics and sex-ratios calculated on greatest length of mandibles from Križna jama (KJ), Gamssulzen-cave (GS) and Potočka zijalka (PZ), F ... female, M ... male, D ... dimorphism calculated as the ratio of the male mean to the female mean (VAN VALKENBURGH & SACCO, 2002).

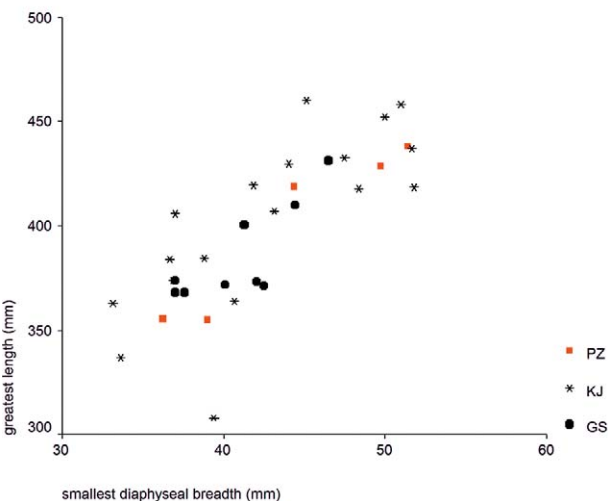


Figure 4: Greatest length and smallest diaphyseal breadth of humeri from Križna jama (KJ), Potočka zijalka (PZ) and Gamssulzen-cave (GS)

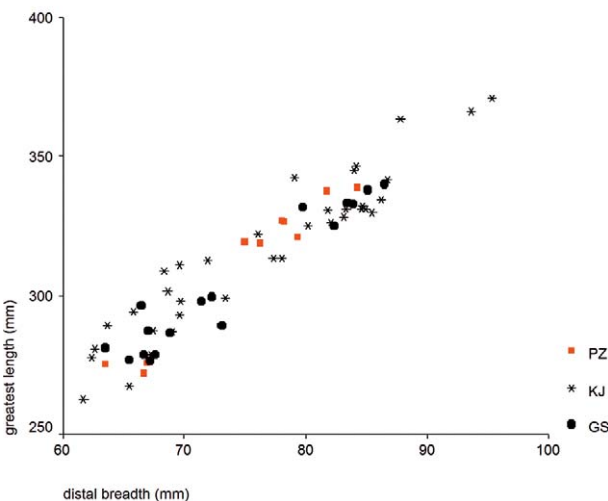


Figure 5: Greatest length and distal breadth of radii from Križna jama (KJ), Potočka zijalka (PZ) and Gamssulzen-cave (GS)

1958; PACHER, 2004b). At Križna jama nine mandibles are completely preserved. They fall into four females and five males. The total length of the specimen is in accordance with values obtained from Gamssulzen-cave and Potočka zijalka. While the few females from Potočka zijalka and Križna jama lie at the lower range of values (Fig. 2, Fig. 3, Table 3), the males from Križna are within the observed distribution ranges.

Long bones of the Križna jama bears were sexed by comparison of length and breadth measurements (greatest length, proximal breadth, smallest breadth of the diaphyses, distal breadth). Using various univariate and bivariate plots it was possible to determine most of the complete specimens according to gender (Table 4). The classification of some specimens though stays ambiguous. Charts that gave the clearest results are shown.

At Križna jama 21 humeri were completely preserved. They are classified as ten females and eleven males. The segregation into two groups is best shown in the greatest length and the smallest breadth of the diaphyses (Fig. 4) when compared to the assemblage from Potočka zijalka

and Gamssulzen-cave. Numerous measurable radii from Križna jama fall into 17 females and 20 males. Compared to values from Potočka zijalka and Gamssulzen-cave, three males are considerably larger than the samples from the latter two sites (Fig. 5). 42 ulnae from Križna jama fall into two clear size groups resulting in 18 females and 24 males. They cover the range of values shown by the samples from Gamssulzen-cave and Potočka zijalka with some larger male individuals (Fig. 6). The rather small number of measurable femora from Križna jama consists of seven females and four males. The more numerous tibiae from Križna jama consist of 29 females and 15 measurable specimens from males. The males from both, femora and tibiae lie again on the upper range of the size distribution shown by the assemblage from Gamssulzen-cave and Potočka zijalka (Fig. 7, Fig. 8).

The total length of fibulae shows a bimodal distribution (Fig. 9). The segregation of males and females was based on the results obtained by REISINGER & HOHENEGGER (1998) but stays ambiguous due to lack of additional measurements.

KJ	Female				Male					D
	min	max	mean	SD	min	max	mean	SD	F:M	
Humerus	308.0	348.0	350.2	27.21	406.0	460.0	430.8	19.26	10:11	1.23
Radius	263.0	312.5	290.2	14.27	313.0	370.7	336.2	15.92	17:20	1.15
Ulna	308.0	367.0	338.8	16.61	372.0	425.0	391.1	11.9	18:24	1.15
Femora	364.5	416.0	387.8	19.36	441.0	494.5	468.9	22.6	7:4	1.21
Tibia	237.4	282.3	266.4	11.66	283.1	340.4	308.2	13.41	29:15	1.16
Fibula	225.0	260.0	240.0	11.66	265.0	300.0	277.3	15.16	10:4	1.16

Table 4: Comparison of the greatest length (mm) in long bones from Križna jama (KJ), Gamssulzen (GS), and Potočka zijalka (PZ) for males and females. D ... dimorphism calculated as the ratio of the male mean to the female mean (VAN VALKENBURGH & SACCO, 2002).

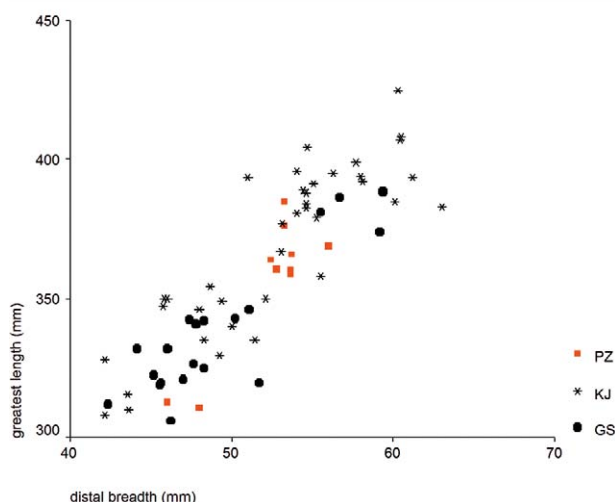


Figure 6: Greatest length and distal breadth of ulnae from Križna jama (KJ), Potočka zijalka (PZ) and Gamssulzen-cave (GS).

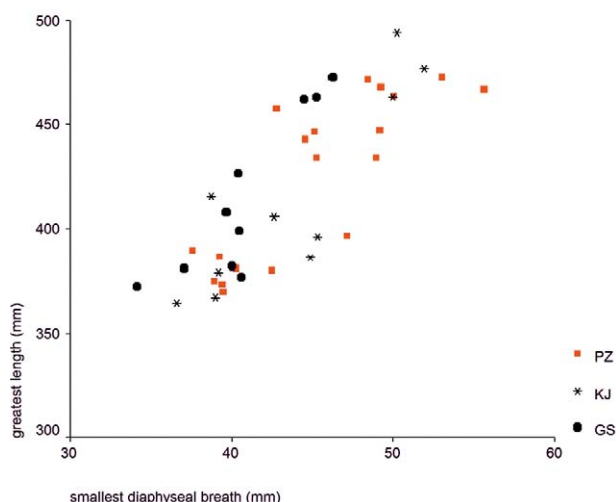


Figure 7: Greatest length and smallest diaphyseal breadth of femora from Križna jama (KJ), Potočka zijalka (PZ) and Gamssulzen-cave (GS).

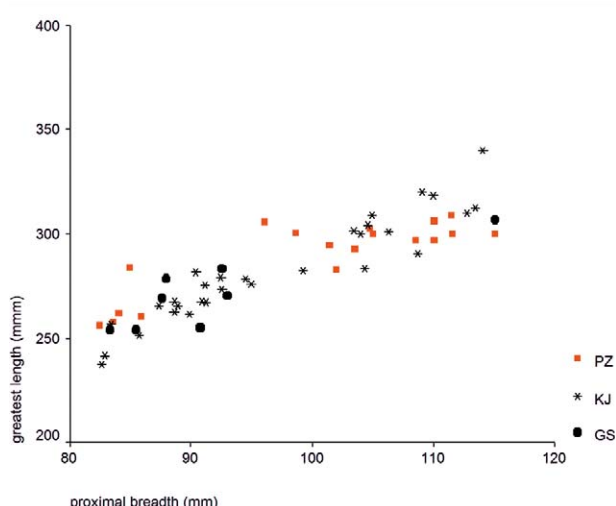


Figure 8: Greatest length and proximal breadth of tibiae from Križna jama (KJ), Potočka zijalka (PZ) and Gamssulzen-cave (GS).

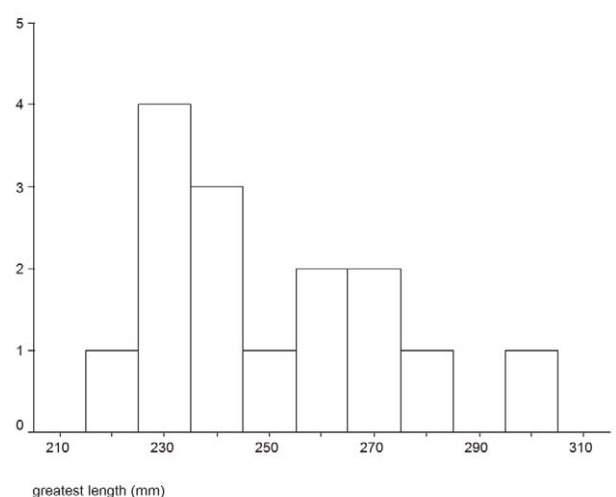


Figure 9: Greatest length (mm) of fibulae from Križna jama.

5. Summary

The available cave bear material from Križna jama is a clearly male dominated assemblage. The size ranges for crania, mandibles and long bones are in good accordance with ranges observed at Gamssulzen-cave, Austria and Potočka zijalka, Slovenia.

Single larger specimens are observed at Križna jama, especially in long bones. The values obtained from the Križna jama bears lie within ranges observed at Late Pleistocene cave bear assemblages (see PACHER & QUILES, 2013).

6. References

- BOSAK, P., PRUNER, P., ZUPAN HAJNA, N., HERCMAN, H., MIHEVC, A. & WAGNER, J., 2010. Križna jama (SW Slovenia): Numerical- and correlated-ages from Cave bear-bearing Sediments. — *Acta Carsologica* 39 (3):529–549, Postojna.
- BRODAR M. & GOSPODARIČ, R., 1973. Medvedji rov v Križni jami in tamkajšnji ostanki jamskega medveda. — [in:] Mladinski raziskovalni tabori (1971–1972), Republiški koordinacijski odbor gibanja “Znanost mladini”, pp. 30–46, Ljubljana.

- FRANK, C. & RABEDER, G., 1997. Gamssulzenhöhle — [in:] DÖPPES, D. & RABEDER, G. (eds.) 1997. Pliozäne und pleistozäne Faunen Österreichs. Ein Katalog der wichtigsten Fossilfundstellen und ihrer Faunen. — Mitt. Komm. Quartärforsch. Österr. Akad. Wiss., 10:171–176, Wien.
- HOCHSTETTER, F. von, 1881. Die Kreuzberghöhle bei Laas in Krain und der Höhlenbär. — Denkschriften kaiserl. Akad. Wiss., math-nat. Cl., 43:293–310, Wien.
- KURTÉN, B., 1955. Sex dimorphism and size trends in the cave bear, ROSENEM. & HEINR. — Acta Zoologica Fennica, 90:1–48, Oslo.
- KURTÉN, B., 1958. Life and death of the Pleistocene cave bear. — Acta Zoologica Fennica, 95:199–207, Oslo.
- PACHER, M., 2004a. Metrical and Palaeobiological Investigations of Cave Bear Crania from Potočka zijalka (Slovenia). — [in:] PACHER, M., POHAR, V. & RABEDER, G. (eds.). Potočka zijalka – palaeontological and archaeological results of the excavation campaigns 1997–2000. — Mitt. Komm. Quartärforsch. Österr. Akad. Wiss., 13:115–122, Wien.
- PACHER, M. 2004b. Metrical and palaeobiological investigations of cave bear mandibles from Potočka zijalka (Slovenia). — [in:] PACHER, M., POHAR, V. & RABEDER, G. (eds.). Potočka zijalka – palaeontological and archaeological results of the excavation campaigns 1997–2000. — Mitt. Komm. Quartärforsch. Österr. Akad. Wiss., 13:115–122, Wien.
- PACHER, M. & QUILS, J., 2013. Cave bear paleontology and paleobiology at Peștera cu Oase: Fossil population structure and size variability. — [in:] CONSTANTIN, S., TRINKAUS, E. & ZILHÃO, J. (eds.): Life and Death at the Peștera cu Oase: A Setting for Modern Human Emergence in Europe. p. 127–146. Oxford University Press, New York.
- RABEDER, G., this volume. Metrics and Evolutionary Level of Teeth of the Bears from Križna jama (Slovenia). — Mitt. Komm. Quartärforsch. Österr. Akad. Wiss., 21:57–63, Wien.
- RABEDER, G., WITHALM, G. & WILD, E.M., this volume. Stratigraphy and Chronology of the Fossiliferous Layers from Križna jama (Slovenia). — Mitt. Komm. Quartärforsch. Österr. Akad. Wiss., 21:131–136, Wien.
- RABEDER, G. & WITHALM, G., 2001. Die Križna jama bei Lož im Klassischen Karst. The Križna jama near Lož in the classic karst. — Exkursion guide to the 7th International Cave Bear Symposium, Trieste.
- RABEDER, G., HOFREITER, G., NAGEL, D. & WITHALM, G., 2004. New Taxa of Alpine Cave Bears (Ursidae, Carnivora). — Cahiers scientifiques, Hors série 2: 49–67, Lyon.
- RABEDER, G. & POHAR, V., 2004. Stratigraphy and chronology of the cave sediments from Potočka zijalka (Slovenia). — [in:] PACHER, M., POHAR, V. & RABEDER, G. (eds.). Potočka zijalka – palaeontological and archaeological results of the excavation campaigns 1997–2000. — Mitt. Komm. Quartärforsch. Österr. Akad. Wiss., 13:235–245, Wien.
- REISINGER, C. & HOHENEGGER, H., 1998. Sexual dimorphism in limb bones of Late Pleistocene cave bear (*Ursus spelaeus*, Carnivora, Mammalia) from three caves in Eastern Alps (Austria and Italy). — Bolletino della Società Paleontologica Italiana, 37:99–116.
- VAN VALKENBURGH, B. & SACCO, T., 2002. Sexual dimorphism, social behavior, and intrasexual competition in large Pleistocene carnivorans. — Journal of Vertebrate Paleontology, 22:164–169.

APPENDIX 1

Measurements (in mm) of cave bear crania from Križna jama (tl ... total length, bl ... basal length, gmb ... greatest mastoid breadth, gbo ... greatest breadth of the occipital condyles, gbf ... greatest breadth of the foramen magnum, gzb ... greatest zygomatic breadth, lbt ... least breadth of the temporalia, gfb ... greatest frontal breadth, lbo ... least breadth between the orbits, lpb ... least palatal breadth, ld ... length of diastema, cw ... crown width of upper canine, bif ... breadth between the infraorbital foraminae, gpb ... greatest palatal breadth)

No.	tl	bl	gmb	gbo	gbf	gzb	lbt	gfb	lbo	lpb	ld	cw	bif	gpb
A5335	390	347	203.5	73	31	226	71.3	110		64.1	43.7		77	
A5330	391	356	215	70	32		79.5	117.4	82.2	67.4	45.7	17.1	83.9	92.8
no.	475	425		83	34	292	84.5	133.8	103.9	67.7	49.3	21.5	91	
KJ 216	506.6	445.9	265.2	92.25	42.1	300.5	90.5	148.9	105.94	76.0	59.6	25	96.5	116.5
KJ 215	532.6	466.2	266.3	93.5	40.1					81	59.5	22.4	103.2	
KJ 214														

APPENDIX 2

Measurements (in mm) of cave bear mandibles from Križna jama (tl ... total length, ld ... length of diastema, hmp4 ... height of mandible below p4, hmm1 ... height of mandible below m1, hmm3 ... height of mandible below m3, wmp4 ... width of corpus mandibulae anterior of p4, wmm3 ... width of corpus mandibulae anterior of m3, lct ... length of cheek teeth row, bcm ... breadth of condylus mandibularis, dcm ... diameter of condylus mandibularis, cw ... crown width of lower canine, cl ... crown length of lower canine, th ... total height of mandible, ha ... height from processus angularis)

No.	tl	ld	hmp4	hmm1	hmm3	wmp4	wmm3	lct	bcm	dcm	cw	cl	th	ha
NHMW	269	52.1	54.5	53.1	63	21.7	27.3	91.7	62.9	23	15.6	20	141	118.4
KJ 189	275	46.4	54.9	56.6	62.7	20.6	23.8	99.3						
NHMW-9	290	52.5			62.2			106						
KJ 228	324.76	62.6	73.2	76.1	82	23.4	32	103			21	28.3	175.8	147.86
NHMW	327	59						102	76.8	30	21.8		188	155
KJ 4	333.14	56.3	74.8	72	78.6	28.3	31.5	104.8			21.2	25	166.8	149.04
NHMW-1	334	55.9	69.7	68.2	72.3	24.3	33.7	101	70	29.2	19.6	26.2	160	181
KJ 231	341.62	63.5	80.6	80	86.4	25.5	29.2	105.8	81.3	27.6	20.6	28	183.4	143.27

APPENDIX 3

Measurements (in mm) of cave bear long bones from Križna jama (gl ... greatest length, pl ... physiological length, pb ... proximal breadth, pd ... proximal depth, sd ... smallest diaphyseal breadth, db ... distal breadth, bt ... breadth of trochlea, bda ... breadth distal articulation, hpat ... height proc. anconaeus to tuberculum, dpa ... depth across proc. anconaeus, bpc ... breadth processus coronarii, dc ... depth of caput femoris, 1 ... sin., 2 ... dext.)

No.	Side	gl	pl	pb	pd	sd	db	bt	bda	hpat	dpa	bpc	dc
HUMERUS													
KJ-197	2	320											
NHMW-sub	2	328		65			109.3						
NHMW-15	1	337	332	67.9	83.4	33.7	99.4	71.08					
NHMW-22	2	340	330				98.95	74.12					
NHMW-7	1	363	355	67.7	68.2	33.2	100.5	66.97					
NHMW-2	1	364	361	79		40.7	100.7	78.9					
NHMW-21	2	374	366	72.1	93.7	36.9	101.7	73.3					
NHMW-19	2	384	375	80.7		38.8		83.5					
NHMW-1	2	406	398	80	104	37	117	80.7					
NHMW-18	1	407	397	84.4	104	43.12	125.7	82					
NHMW-rek	1	418	409	94.7	110	48.4	127.5	87.2					
NHMW-rek	1	418	409	94.7	110	48.4	127.5	87.2					
NHMW-rek	2	418.5	409	90.09	111.3	51.8	126.5	88					
NHMW-rek	2	419	409	90.09	111.2	51.8	126.5	88					
NHMW-12	2	419.5	410	88.6	108.5	41.8	134	87.4					
NHMW-14	1	430	420.5	92.7	107.9	44	127.6	85.9					
IPUW	2	432.8	425.3	89.42	107.85	47.5	122.08	90.9					
IPUW	1	437.22	426.4	112.9	112.85	51.66	137.36	96.95					
NHMW-17	2	452	444	99	124.4	50	134	86.5					
NHMW-20	2	458	446.5	98	116.3	51		102.6					
NHMW-13	2	460	450	97.5		45.2	135.3	93					
RADIUS													
NHMW-14	1	263	248.7	56.5		24.5	61.8		42.3				
NHMW-9	1	267.6	257.8			28.7	65.5		46.5				
NHMW-31	2	277.5	262.4			28	62.4		47.1				
NHMW-8	2	279	253.9	43.3		29.9	67.3		50.3				
NHMW-31	2	280.5	265	54.1		30.7	62.7		47.6				
NHMW-26	2	283.2	266.5			30.0			46				
NHMW-11	2	287	270	56.6		31.9	69		54.4				
NHMW-12	1	287.5	268.5	44.9		33.6	67.5		48				
NHMW-38	2	289.2	266.6	43.1		30.7	63.7		46				
NHMW-35	2	292.8	276.3	45.8		30.9	69.6		49.4				
NHMW-15	2	294.2	278.2	38.6		28.5	65.9		50.7				
NHMW-7	1	297.9	275.8	44.4		19.7	69.7		48.5				
NHMW-16	2	299	282.9	42.9		26.6	73.4		51.9				
KJ-171	1	301.5	278.29	48.19	35.4	32.13	68.68		50.9				
NHMW-23	2	309	283.7			32.5	68.4		49.3				
NHMW-34	2	310.9	292.9	47.8		31.5	69.6		51.8				
NHMW-4	1	312.5	287.6	44.8		29.9	71.9		49.4				

No.	Side	gl	pl	pb	pd	sd	db	bt	bda	hpat	dpa	bpc	dc
KJ-47	1	312.99	287.14	47.8	39.4	32.35	77.27		54.7				
NHMW-6	1	313	286	48.6		33.8	78		53.6				
NHMW-2	1	314.5	309	59.3		27.3	86.7		64.6				
NHMW-22	2	321.9	301			36.7	76		58.5				
NHMW-1	2	325	296.7	51.4		40.2	80.2		54.9				
KJ-187	1	326.34	296.73	52.91	42.44	35.86	82.05		55.09				
NHMW-20	2	328.5	301.8	59.4		37.5	83.2		61.7				
NHMW-17	1	330.2	302	42.4		36.5	85.5		59.7				
NHMW-37	2	330.5	310.2	51.4			81.8		61				
NHMW-10	1	330.9	303	43		41.2	84.6		60				
NHMW-3	1	331	294.8	55.2		3.9	83.3		60.3				
NHMW-rek	1	331	308	53.1	38.6		84.9						
NHMW-18	2	332.1	313.7	53.9		38.2	84.7		60				
NHMW-24	1	334.7	308.1	44.9		40.6	86.2		63.4				
NHMW-5	1	342.2	318.3	52.9		35.7	79.1		58				
NHMW-36	2	345	322.4			44	84		63				
NHMW-32	2	346.5	324.8	56		34.4	84.1		61.7				
NHMW-33	1	363.5	335.7	55		38.5	87.8		60.3				
NHMW-13	1	366.1	338.5	48.3		36.8	93.6		62.9				
NHMW-19	2	370.3	349.3	53.7		38.4	95.3		65.4				
ULNA													
NHMW-35	1	308		72.7			42.2			68.8	70		
NHMW-37	2	310		72.97			43.7			75.6	67.4		
NHMW-46	2	315.5		63.5			43.6			71.7	59	55.5	
NHMW	1	327											
NHMW-34	1	328		69			42.2						
NHMW-33	1	329.5		57.4			49.3			80.24	69.3		
NHMW-19	1	335		71			48.3						
NHMW-32	1	335		79.7			51.4			83.95	74.7		
NHMW-41	2	340		72.1			50			81.94	70	59.4	
NHMW-43	1	346		76			48			85.4	70.8	61.7	
NHMW-30	2	347		67.9			45.8			63	63.6	51	
NHMW-29	1	349		74.05			49.4			89.4	73.2	57	
NMLj-113-1	1	350		72.5			45.9						
NHMW-6	1	350.05		81			46.1			80.3	72.5		
NHMW-16	1	350.05		71.06			52.1			83.8	68.07		
NHMW-27	1	354		80.7			48.7			80.4	78.5		
NHMW-12	2	358		80.67			55.6			74.76	89.4		
NHMW-8	1	367		81.9			53			88.96	80.4	66.2	
NHMW-23	1	372		96.6						104.96	89.3		
NHMW-18	1	377		88.6			53.1			57.6		63.67	
NHMW	1	377											
KJ-176	1	379		90.6			55.27			83.4		65.4	
NHMW-20	1	380.5		90.3			54			99.1	85.6		
NHMW-15	1	382.5		93.7			54.6			99.5	90.4		
NHMW	1	383		94.6			63			98	89.5	68.3	
NHMW-31	2	384		98.6			54.6			86.5	84.2	39.4	

No.	Side	gl	pl	pb	pd	sd	db	bt	bda	hpat	dpa	bpc	dc
NHMW	2	385		91.5			60.08			99	85	65.3	
NHMW-1	2	388		87.6			54.6			101.5	84.05	69.2	
NHMW-21	2	389		89.5			54.4			92.1	81.06	70.2	
NHMW	2	391		84.95			55.1			87.4	77.6	61.3	
KJ-219	1	391.76		89.72			58.14			88.52	85.3	75	
NHMW-45	2	392		87.6									
NHMW-11	1	393.5		89.7			61.2			97.1	89.7	73.67	
NHMW-4	2	393.5		84.8			51			89	77.8	60.1	
NHMW	2	394		96.9			58			95.5	87.4		
NMLj-113-1	2	395		97.9			56.3					63.4	
NHMW-25	2	396					54			93			
KJ-76	1	399.15		93.86			57.7			97.5	86.6	70.9	
KJ-181	1	404.57		92.2			54.76			90	81.8	69.7	
IPUW	1	406.98		90.86			60.54			90.5	76	71.53	
NHMW-44	2	408		90.2			60.5			98	82	71	
NMLj-113-1	1	425		96.1			60.3			104.2	97	75.2	
FEMUR													
NHMW-10	2	364.5	345	93.7		36.6	80.6						46.3
KJ-136		366.48				27.52							
NHMW-11	2	367	337	97.5		39	81						47.5
NHMW-5	1	379	356	96.8		39.2	84						
NHMW-7	2	386	357	104.3		44.9	86.5						50.8
NHMW-2	1	396	368	110.5		45.4	95.9						
NHMW-3	1	406	384	113.8		42.6	96.9						54
NHMW		416		111			94						
NHMW-1	1	441	422	131			102.8						59.04
NHMW-4	1	463	430.15	137		50	108.5						62.9
NHMW-8	2	477	440	142		51.9	110.7						62.8
KJ-217	1	494.47	458.24	140.9		50.22	116.56						66.57
TIBIA													
NHMW-39	1	237.4		82.7		26.1							
NHMW-35	2	241.5		82.9		25.5	63.2		62.4				
NHMW-22	2	246.5				24.6							
NHMW-28	1	250.6				28.8	66.8		65				
NHMW-27	1	251.4		85.8		28.5	66.4		66.1				
NHMW-37	1	256.4		83.5		28.4	70.4		66.8				
NHMW-41	1	261.5		89.9		27.7	72.2		69.2				
KJ-187	2	262.43		88.68		30.87	68.78		65.89				
NHMW-46	2	263.5				29.6							
NHMW-14	1	265.2		87.4		27.7							
IPUW	2	265.84		88.89		32.22	70.69		62.7				
NHMW-19	2	266.8		91.2		34	74.4		69.2				
NHMW-50	2	267.3				31.3	68.2		67.9				
NHMW-15	2	267.4		88.6		29.3	72.8		65.7				
NHMW-5	2	267.7		90.9		32.1							
NHMW-49	1	270.2				31.1	70.5		70				
NHMW-12	2	271.2				31.3	70.5		65.3				

No.	Side	gl	pl	pb	pd	sd	db	bt	bda	hpat	dpa	bpc	dc
NHMW-21	1	271.8				31.4	72		66.8				
NHMW-25	1	272.2				28.2	68.1		60.9				
NHMW-16	2	273.1				30.9	69						
NHMW-20	2	273.3		92.6		30.9	72.5		69.1				
NHMW-34	2	273.6				34	72.4		69.4				
NHMW-3	1	275.5		91.1		28.4	74.3		61				
NHMW-45	1	275.9		95		32	71.6		70.4				
NHMW-40	2	277				30.2							
NHMW-13	2	278.7		94.5		34.1	77.5		74.4				
NHMW-44	2	279.1		92.5		30.5	70.8		70.8				
NHMW-2	1	281.4		90.45		31	71.4		60.2				
NHMW-29	1	282.3		99.2		34.3	76.7		71.4				
NHMW-1	1	283.1		104.3		35.3	83.1		67				
NHMW-47	1	290.9		108.7		38.2	86.3		80.4				
NHMW-10	2	300.3		104		36.7	84.8		80.5				
NHMW-7	1	301.27		106.3		35.4							
NHMW-18	2	301.4				33.12	81.8						
NHMW-8	2	301.8		103		40.1	88.7		79.3				
NHMW-36	1	304.5		104.6		23.4	76.8		71.8				
NHMW-11	1	309.3		104.9		33.2	80		77.9				
KJ-181	2	309.9		112.73		36.32	87.03		78.87				
NHMW-48	1	312.6		113.4		31.2							
NHMW-30	1	313.5				34.6	85.2		80.3				
NHMW-33	2	315				38.2	81						
NHMW-9	1	318.6		109.9		39	83.4		84.9				
NHMW-38	1	319.8		109		37.4	81		82.6				
NHMW-4	2	340.4		114		37	91.2		83				
FIBULA													
NHMW	2	225		26.7			31.2						
NHMW	1	230.0		21.6			27.2						
NHMW	1	230.0		22.0			29.4						
NHMW	1	233					28.1						
NHMW	2	235					30.7						
KJ-210	1	241.55					26.7						
NHMW	2	243		26			29.5						
NHMW	1	245.0		26.3			30.3						
NHMW	1	257		28.54			34.4						
NHMW	1	260		27.4			33.9						
NHMW	1	265		31.2			35.1						
NHMW	2	270					35.4						
NHMW	2	275		31.4			30.1						
KJ-6	1	299.2		31.8			41.3						