

# Cave bear skulls from Buco del Frate (Brescia, N. Italy) First morphometric analysis

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Published: 25.01.2023

**Citation:** INDELICATO, M.,  
ROSSI, M. & SANTI, G. (2023):  
Cave bear skulls from Buco  
del Frate (Brescia, N. Italy).  
First morphometric analysis.  
— e-Research Reports of  
Museum Burg Golling 10: 1-6.

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Published by  
Museum Burg Golling  
Markt 1  
5440 Golling a.d. Salzach  
AUSTRIA  
office@museumgolling.at  
www.museumgolling.at

Cave bears | Buco del Frate | Lombardy | skulls | morphometry analysis | Upper Pleistocene  
Höhlenbär | Buco del Frate | Lombardei | Morphometrie | Oberpleistozän

**Abstract:** The eastern area of Lombardy (N. Italy) where the Buco del Frate cave (Brescia Province) is located has not been thoroughly investigated; in order to close at least partially this gap the skulls from this cave have been preliminarily studied. With both univariate and multivariate analyses the main conclusion, after a comparison with other populations from Europe and the Urals Mountains, is that no significant difference is noted between the taxa. This investigation is only preliminary, but seems to confirm that the population from Buco del Frate could re-enter within the range of the Italian cave bears and with these results it is difficult to assign them to a precise taxon.

**Kurzfassung:** Das östliche Gebiet der Lombardei (Norditalien), in dem sich die Höhle von Buco del Frate befindet, wurde noch nie gründlich untersucht; Um diese Lücke zumindest teilweise zu schließen, wurden die Schädel aus dieser Höhle vorläufig untersucht. Sowohl bei der univariaten als auch bei der multivariaten Analyse ist die Hauptschlussfolgerung nach einem Vergleich mit anderen Populationen aus Europa und dem Ural, dass kein signifikanter Unterschied zwischen den Taxa festzustellen ist. Diese Untersuchung ist nur vorläufig, scheint aber zu bestätigen, dass die Population aus Buco del Frate in das Verbreitungsgebiet der italienischen Höhlenbären passt aber nicht einem bestimmten Taxon zugeordnet werden können.

## Introduction

In North Italy the presence of *Ursus gr. spelaeus* is surely very abundant; it inhabited all the Alpine and Prealps regions with the exception of the Valle d'Aosta region. Therefore, some areas have been thoroughly studied (i.e. Veneto and the west Lombardy), whereas others on the contrary, less or much less (the eastern part of the Lombardy, Liguria, Piedmont, Trentino A. A. and Friuli Venezia Giulia regions). In particular the eastern area of Lombardy can be considered an important zone of linkage between the western part of the same region and Veneto because it is possible that two different areas existed with the presence of one or more taxa of cave bears. In this study we present the first data of only the skulls of speleians coming from Buco del Frate in Brescia Province (East Lombardy) the fossils of which SANTI & ROSSI (2013) studied only superficially, to possibly individuate a link between the speleians from western Lombardy and its western regions and other populations from the eastern regions in N. Italy.

## Geographical setting of the Buco del Frate: a short synthesis

The Buco del Frate (Fig. 1) cave is located near Prevalle village, between Mount Budellone and Mount Paitone. It is considered the most important cave of the so-called »Carso Bresciano«. The larger and lower of the two different entrances leads to a large hall descending through a collapsed doline whose ground is occupied in its first section by huge boulders that have fallen from the vault; in the second section, towards the bottom of the cave, it is covered by a thick deposit of red clay that has given us many remains of paleontological interest, many of which belong to cave bears.

## Material and methods

The material consists of n. 11 skulls all coming from the Buco del Frate in Brescia Province, and at the present, they are preserved in the Museo Civico di Storia Naturale of Brescia (Plate 1). For them a series of measurements relating to the parameters codified by BARYSHNIKOV & PUZACHENKO (2011) were accomplished. In Fig. 2 the parameters considered and the main results of the statistical analysis are reported. The data have been elaborated with a univariate and a multivariate approach using the Past 3.2 version software (HAMMER et al., 2001) and compared with those of other of populations coming from Italian, European and Urals localities.

## Short description of the skulls

The skulls are generally well preserved, and seven specimens are still rather complete. Unfortunately the frail bones are abraded and/or lacking, like for example, the zygomatic bone (complete in only one specimen). Some skulls have also some part of condyles and the parietal bone broken or damaged. Denture is fragmentary, in some specimens premolars, molars

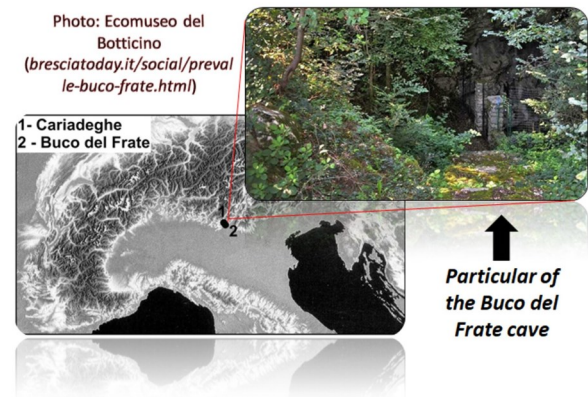


Fig. 1: Geographical position and entrance of the Buco del Frate cave (Brescia, Lombardy). | Abb. 1: Geografische Lage und Eingang der Höhle Buco del Frate (Brescia, Lombardei).

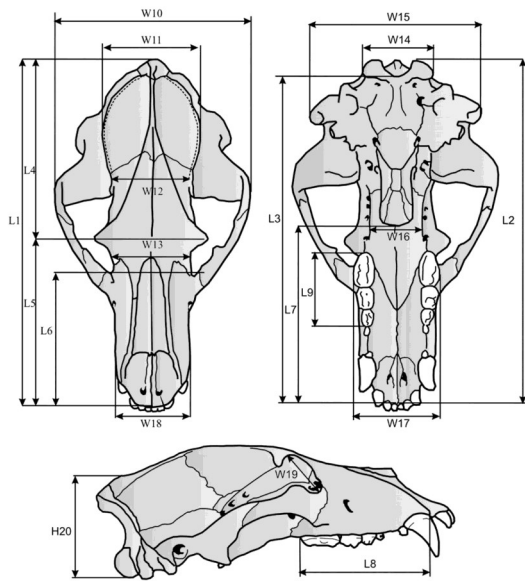
and canines (often broken or damaged), are preserved: the incisors are completely lacking. Two skulls, labelled with PA-10231 and PA-10234, have in the first, a hole (probably a bite attack) on the parietal bone and in the second specimen, some malformations of the right zygomatic bone.

## A first morphometric analysis

Preliminary univariate and multivariate analyses were elaborated. In Fig. 3 a profile of the characters of the Buco del Frate bears compared with specimens of different taxa is shown; we can note as the distribution of the medians of the specimens from Buco del Frate is similar to those of the other populations, but in particular its development is closer to that of *U. rossicus* and *U. deningeri*, the smallest in size. A first attempt to test an allometric growth (in general nonlinearity) has been defined: many parameters could support the allometry (i.e. L1-L2, L8-L9 and so on).

A comparison of some parameters of the skulls with some populations distributed in Europe (Fig. 4) shows a good correspondence with cave bears of the Late Pleistocene. A confirmation of this is shown by a report of a Correspondence Analysis (CA) elaborated with some parameters of skulls of males and females of different European caves (GRANDAL D'ANGLADE & LÓPEZ GONZÁLEZ, 2005, Fig. 5). The position of the Buco del Frate specimens is nearest to those referred to the European caves (Eirós, Liñares, Gailenreuthen, Mixnitz and Goffontaine); no difference is noted.

A dendrogram based on the median values of parameters of skulls from Buco del Frate, European and Urals taxa (Fig. 6), can be divided into many interesting parts that carry important conclusions. 1. A great similarity between *U. s. spelaeus* and *U. ingressus* is shown. 2. *U. kanevitz*, *U. s. eremus* and *U. deningeri* also compose a second block in which the first two taxa show a great similarity. In this general picture the cave bears from Buco del Frate are linked to this second rank, but rather with a higher



- L1** Total Length
- L2** Condylbasal Length
- L3** Basal Length
- L4** Neurocranium Length
- L5** Viscerocranium Length
- L6** Length of rostrum
- L7** Palatal Length
- L8** Toot-row Length C1-M2
- L9** Toot-row Length P4-M2
- W10** Zygomatic Width
- W11** Neurocranium Width
- W12** Minimal skull Width (postorbital Width)
- W13** Interorbital Width
- W14** Condylar Width
- W15** Mastoid Width
- W16** Minimal Palatal Width
- W17** Greatest Palatal Width
- W18** Width of rostrum (at canines)
- W19** Greatest diameter of orbit
- H20** Cranial Height

	<b>L1</b>	<b>L2</b>	<b>L3</b>	<b>L4</b>	<b>L5</b>	<b>L6</b>	<b>L7</b>	<b>L8r</b>	<b>L8l</b>	<b>L9r</b>	<b>L9l</b>	<b>W10</b>
Min	370	357	340	200	172	135,9	202	140	143	85,89	85,1	249
Max	483	445	423	261	243	195	255	177	178	102,5	101,57	285
Mean	429,13	408	386,63	234,88	208,44	160,11	233	158,67	157,56	91,76	91,67	270,8
Std. err.	15,39	11,35	10,69	7,25	9	6,49	7,18	4,36	4,27	1,91	1,9	6,76
Variance	1891,55	1030,57	913,41	420,13	729,53	379,51	412	170,75	164,03	32,72	32,57	228,2
Std. dev.	43,49	32,11	30,22	20,5	27,01	19,48	20,3	13,07	12,81	5,73	5,71	15,11
Median	432,5	407,5	384,5	237,5	200	159	235,5	156	155	89,97	90,78	270
Coeff. var	10,14	7,87	7,82	8,73	12,96	12,17	8,71	8,24	8,13	6,24	6,23	5,58
	<b>W11</b>	<b>W12</b>	<b>W13</b>	<b>W14</b>	<b>W15</b>	<b>W16</b>	<b>W17</b>	<b>W18</b>	<b>W19r</b>	<b>W19l</b>	<b>H20</b>	
Min	80,59	70,42	94,58	73,34	163	40,39	105,3	82,3	57,3	54,08	107,62	
Max	112,71	99,65	145,23	99,36	272	57,4	121,85	109,82	66,09	62,36	142,22	
Mean	97,43	80,89	121,94	81,15	201,83	49,24	111,03	96,68	60,52	58,12	124,06	
Std. err.	3,29	3,57	6,73	3	15,11	2,04	2,11	3,44	1,49	11,64	4,15	
Variance	97,42	101,84	408,09	71,82	1369,37	33,42	40,22	106,5	13,4	13,41	155,37	
Std. dev.	9,87	10,09	20,2	8,47	37	5,78	6,34	10,32	3,66	3,66	12,46	
Median	97,14	78,41	128,11	80,92	191,5	49,1	107,44	93,91	59,62	57,25	120,07	
Coeff. var	10,13	12,48	16,57	10,44	18,33	11,74	5,71	10,67	6,05	6,3	10,05	

Fig. 2: Parameters of the cave bears skull (BARYSHNIKOV & PUZACHENKO, 2011 mod.) and the main statistical data of the specimens from Buco del Frate. | Abb. 2: Parameter des Höhlenbärenschädels (BARYSHNIKOV & PUZACHENKO, 2011 mod.) und die wichtigsten statistischen Daten der Exemplare aus Buco del Frate.

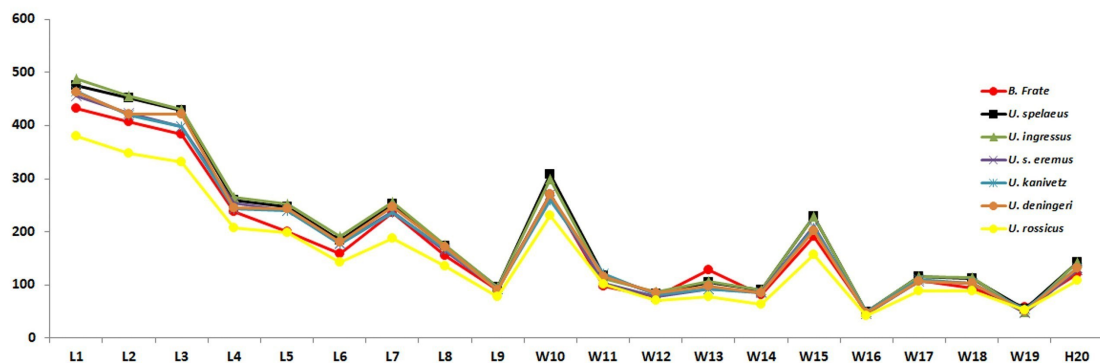


Fig. 3: Profile of the parameters of skulls from Buco del Frate and from different taxa from Europe and the Ural mountains. | Abb. 3: Profil der Parameter von Schädel aus Buco del Frate und von verschiedenen Taxa aus Europa und dem Uralgebirge.

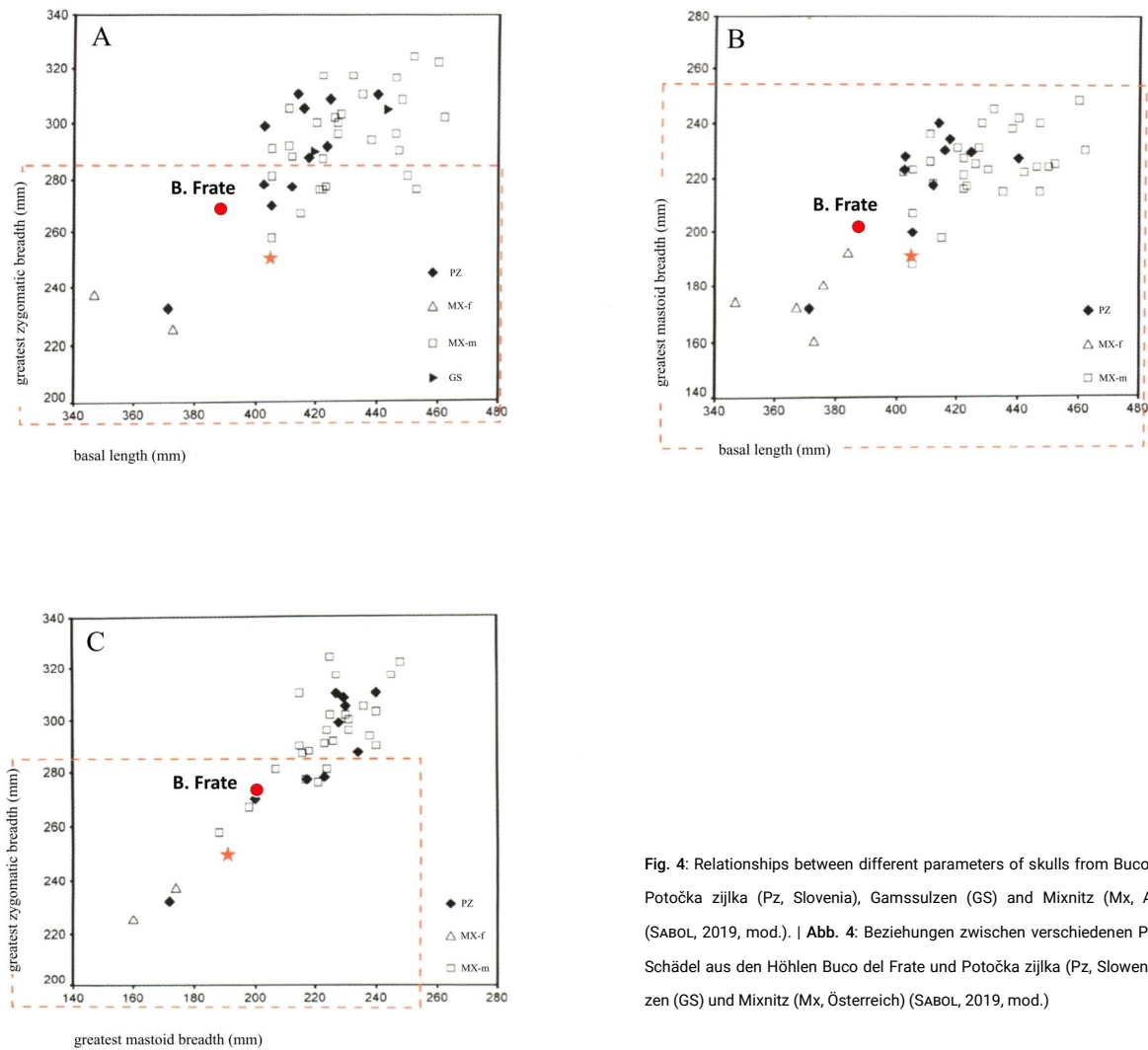


Fig. 4: Relationships between different parameters of skulls from Buco del Frate and Potočka zijka (Pz, Slovenia), Gamssulzen (GS) and Mixnitz (Mx, Austria) caves (SABOL, 2019, mod.). | Abb. 4: Beziehungen zwischen verschiedenen Parametern der Schädel aus den Höhlen Buco del Frate und Potočka zijka (Pz, Slowenien), Gamssulzen (GS) und Mixnitz (Mx, Österreich) (SABOL, 2019, mod.)

distance, while *U. rossicus* is well separated and placed to an extremity of this dendrogram. Buco del Frate speleians confirm that the Italian populations (in the past shown also for the bears from Buco dell’Orso and from some localities in Veneto region) could be effectively of a smaller size. The approach using a »similarity and distance indices« tool confirms the interpretation of the dendrogram.

### Discussion and preliminary conclusions

With the comparison between the Italian, European and Urals cave bear populations it is rather clear that after this first and preliminary analysis, the bears from Buco del Frate have a good correspondence with the *Ursus gr. spelaeus* taxa and with *U. rossicus* from the Caucasian region. As well as discussed in previous studies, focused on other Italian populations (i.e. SANTI & ROSSI, 2014; SANTI & ROSSI, 2020a; SANTI & ROSSI, 2020b), it is difficult with the actual data, to individuate the taxon/a that inhabited the Buco del Frate area. Therefore, the present important result could confirm the probable lack of *Ursus ingressus* in east Lombardy; this possibility was in the past often advanced because of the proximity of east Lombardy to other nations

(Switzerland, Austria) in which *U. ingressus* is documented (RABEDER, 1995; FRISCHAUF et al., 2017; RABEDER et al., 2017). Actually, in North Italy the possible presence of *U. s. eremus* only prudentially is advanced for the population of Mount Fenera (Borgosesia, Vercelli Province, Piedmont, SANTI et al., 2022) excluding *U. s. ladinicus* documented in the Conturines (Tyrol) population (RABEDER et al., 2004) also if TERLATO et al. (2018) documented the *U. ingressus* presence in some caves of Vicenza Province (Veneto). A question can be advanced: could Northern Italy have been isolated from the rest of Europe? With the actual data we aren’t yet able to answer this question, but the study of the cave bears from Buco del Frate carries this problem: does a real difference between the Italian populations and the European ones exist?

### Acknowledgements

We thank Dr. Paolo Schirolli (Museo Civico di Storia Naturale, Brescia) for providing an access to the museum’s collections and for their great support for this research. Dr. Nicoletta Carlo-Stella (Cleveland, Ohio, USA) is also thanked for the revision in English.

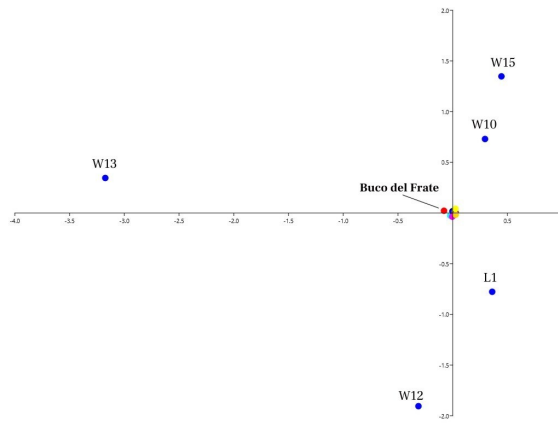


Fig. 5: Correspondence analysis with parameters of skulls from Buco del Frate and other European populations (Eirós, Liñares, Gailenreuther, Mixnitz and Goffontaine). | Abb. 5: Korrespondenzanalyse mit Parametern der Schädel aus Buco del Frate und anderen europäischen Populationen (Eirós, Liñares, Gailenreuther, Mixnitz und Goffontaine).

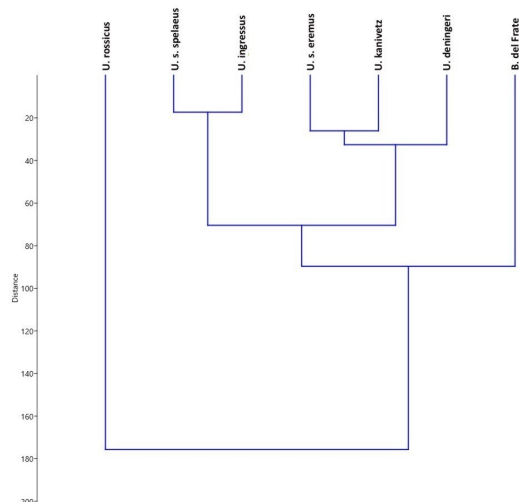


Fig. 6: Dendrogram based on the medians of parameters from Buco del Frate and populations from Europe and the Ural Mountains. | Abb. 6: Dendrogramm auf der Grundlage der Mediane der Parameter von Buco del Frate und der Populationen aus Europa und dem Uralgebirge.

## Declaration of consent

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence this work. They are not conflicts of interest.

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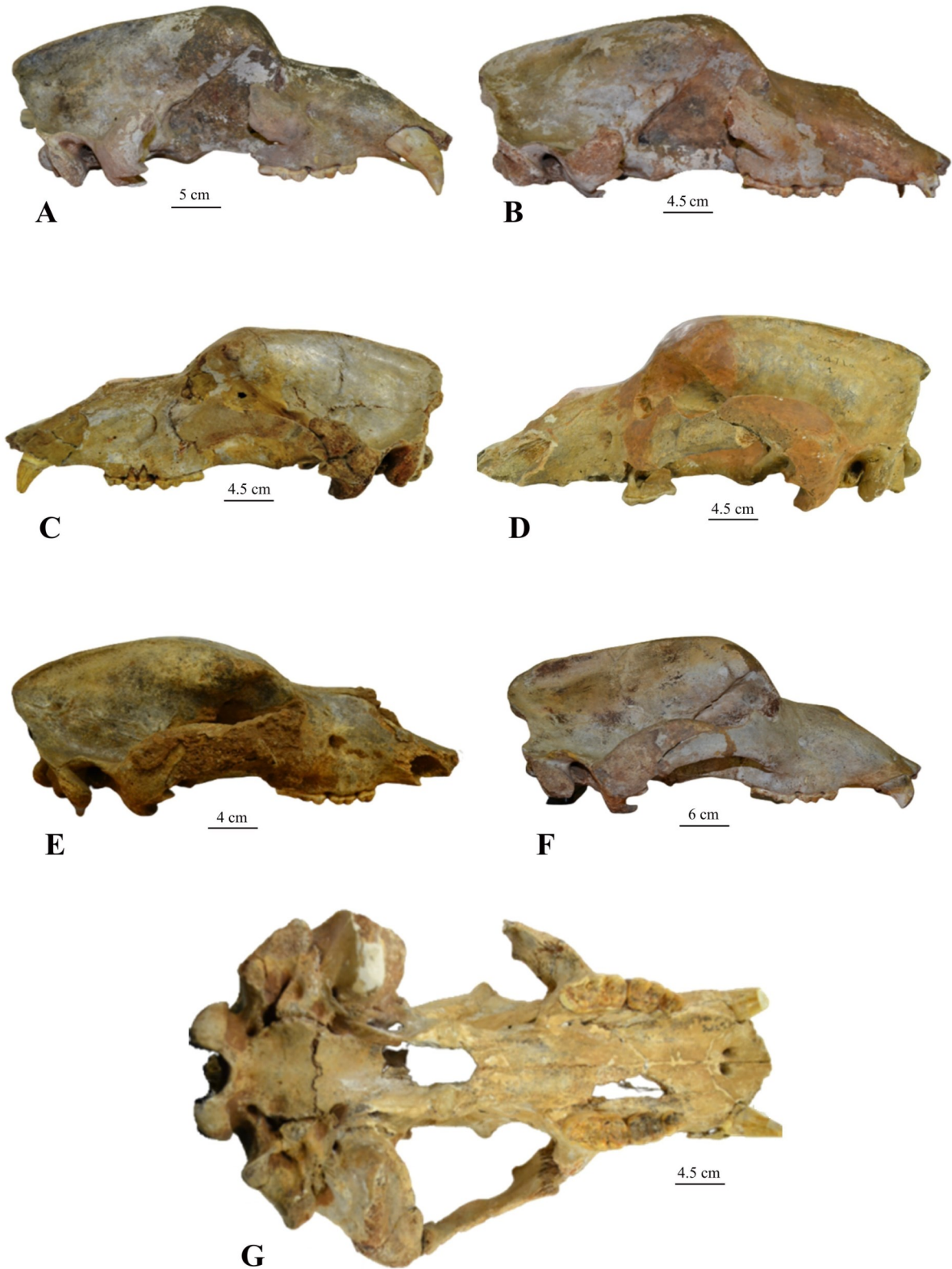


Plate 1: Skulls from Buco del Frate (Brescia Province, Lombardy). A – PA10238, lateral view, B – PA10235, lateral view, C – PA10228, lateral view, D – PA10239, lateral view, E – PA10243, lateral view, F – PA10248, lateral view, G – PA10228, ventral view. | Tafel 1: – Schädel aus Buco del Frate (Provinz Brescia, Lombardei). A - PA10238, Seitenansicht, B - PA10235, Seitenansicht, C - PA10228, Seitenansicht, D - PA10239, Seitenansicht, E - PA10243, Seitenansicht, F - PA10248, Seitenansicht, G - PA10228, Ventralansicht.