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The Evolution of Metapodial Bones in the Cave Bear Group and its biostratigraphical Implications

La evolución de los metápodos en el grupo del Oso de las Cavernas y sus implicaciones bioestratigráficas

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ABSTRACT

A short description of the methods is followed by some central results obtained from the analyses of metapodial bones in the cave bear group from sites in Austria and Italy. The evolution of metapodials shows, in general, a tendency towards increasing plumpness, and backs the results obtained from the morphodynamic analyses of the teeth.

Key words: **evolution, metapodials, *Ursus spelaeus*, *Ursus deningeri***

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INTRODUCTION

Since the work done by TORRES (1988) and KUNST (1989) there was not too much attention drawn to the metapodial bones of *Ursus spelaeus* and its predecessor, *Ursus deningeri*.

Torres tried to provide a range of characters to differentiate *U. spelaeus* from *U. deningeri* and *U. arctos* as well as a general description and comparison of the skeletal elements of these animals, collected in sites from Spain. Kunst tried to use the metapodial bones to exemplify differences between several cave bear sites of Austria.

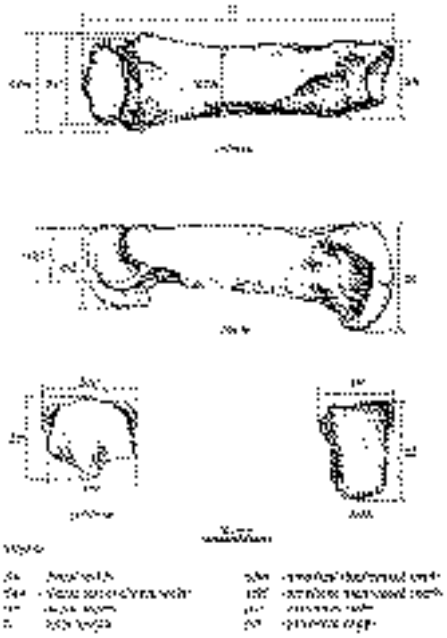

Figure 1. Measurements taken from metapodials. Graphics: from TORRES (1988), altered.

RESULTS

The current investigation is aimed at the evolutionary changes of the metapodial bones throughout time by means of morphometrics. Therefore eight different measurements were taken and five indices were calculated from 4459 metapodial bones from *U. spelaeus* and *U. deningeri* from eight different sites in Austria and Italy.

The measurements are: proximal width and depth, smallest diaphyseal width and depth, distal width and depth, distal epicondyleal width and greatest length. The indices are: proximal area, smallest diaphyseal area, distal area, index of robustness and K–index, the latter according to GUZVICA & RADANOVIC–GUZVICA (2000).

The sites from Austria and Italy are: Hundsheimer Spalte, Repolust cave, Schwabenreith cave, Ramesch cave, Conturines cave (Southern Tyrol), Herdengel cave, Windener Bärenhöhle and Gamssulzen cave.

Basic statistical analysis was carried out on this data set to see wether there is a possibility to sex a population or not, for comparison with the results from OSWALD (1999). The obtained results are totally inhomogenous and so it is not possible to sex a cave bear fauna by means of metapodials. Further investigation showed that there is a correlation between the index of robustness, the K–Index and the smallest diaphyseal area and the stratigraphic position of the site. Therefore it is not only possible to predict the age of a cave bear population by analysing the evo-

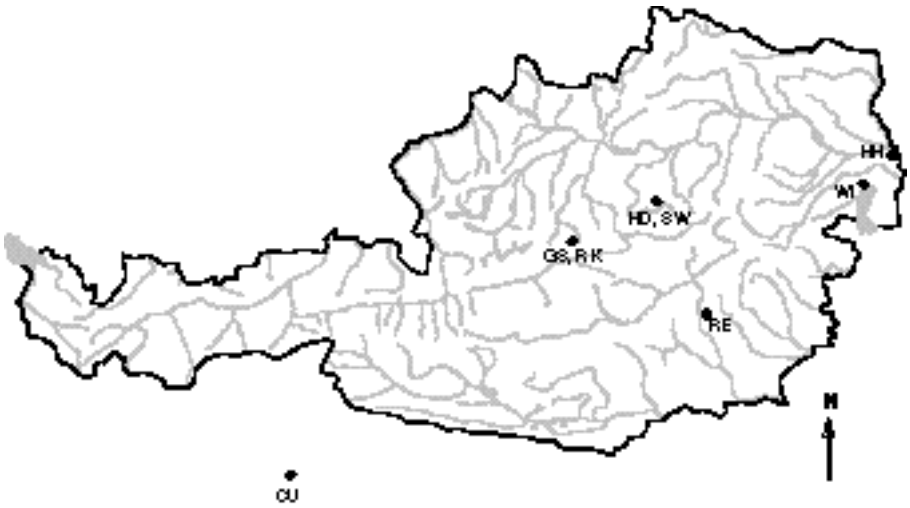

Figure 2. Map showing the distribution of the sites in Austria and Italy.

lutionary level of the teeth, but also by the analysis of the metapodial bones.

Special attention was drawn to the analysis of the material from Ramesch cave (Upper Austria), because of the long period of time this cave was inhabited by cave bears. At first this material was divided into two parts corresponding to the strata and the result was astonishing. In contradiction to the results obtained from the other sites, that is a trend towards plumper metapodial bones with a gro-

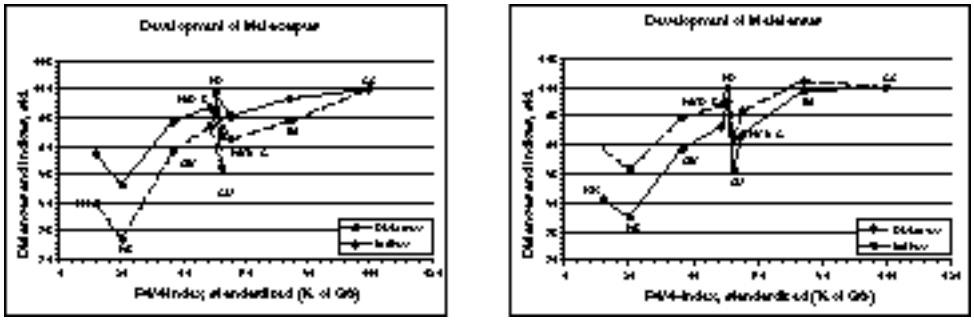

Figure 3. Development of metacarpus (left) and metatarsus (right). Please note the astonishing difference between the populations from Hundsheimer Spalte and Repolust cave as well as the decline towards Conturines cave. Abbreviations: HH- Hundsheimer Spalte, RE- Repolust cave, SW- Schwabenreith cave, CU- Conturines cave (Southern Tyrol, Italy), HD- Herdengel cave, RK- Ramesch cave, WI- Windener Barenhöehle, GS- Gamssulzen cave.

wing smallest diaphyseal area, there was a decline in the mean of the evolutionary level in the upper part of the profile for most of the metapodial bones. This decline in dimensions is a phenomenon, which was discovered first by RABEDER (pers. comm.) when he analysed the evolution of the teeth from the profile of the Ramesch cave in relation to the strata. Now it becomes more and more evident, that this trend is not only visible in the evolution of the teeth, but also in the evolution of hands and feet of this cave bear population. We assume that the reason therefore is a climatic change towards colder conditions. This reversion of the normal trend towards bigger and plumper bears implies some problems, especially for the prediction of geological age. But it seems not to be a general trend even if there seems to be a similar trend in the profile of the Herdengel cave but this can be due to a lack of material.

In figure 4, left diagram, there is a very interesting peak representing the position of the bears from Conturines cave, followed by those from Herdengel cave in Lower Austria. Despite their age these bears are plumper than one would expect. The high position of the Herdengel cave is an artefact, which is based upon the predominance of young bears in the profile, i.e. there are much more metapodial bones from the upper parts of the profile and the problem that there are not enough metapodial bones to split the material. Here it is clearly visible that plumpness is the speciality of the Conturines bear whereas the dimensions show a significant decline.

Figure 5 shows that there is neither an obvious nor a hidden correlation between average of the index of plumpness and the altitude of the site, what could have been a plausible assumption as well.

Another interesting fact is the big difference between the bears from the Hundsheimer Spalte (Lower Austria) and those of the Repolust cave in Styria. For stratigraphic and skeletal features the bears from the Hundsheimer Spalte are

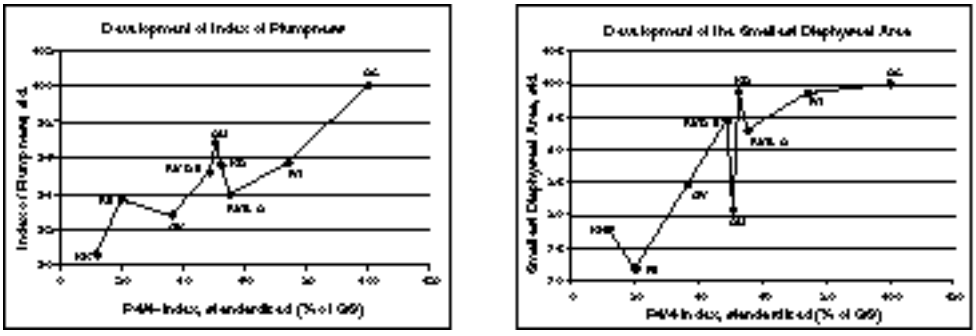

Figure 4. The left diagram shows the development of the overall index of plumpness. The right diagram shows the development of the smallest diaphyseal area. Abbreviations: HH- Hundsheimer Spalte, RE- Repolust cave, SW- Schwabenreith cave, CU- Conturines cave (Southern Tyrol, Italy), HD- Herdengel cave, RK- Ramesch cave, WI- Windener Barenhöehle, GS- Gamssulzen cave.

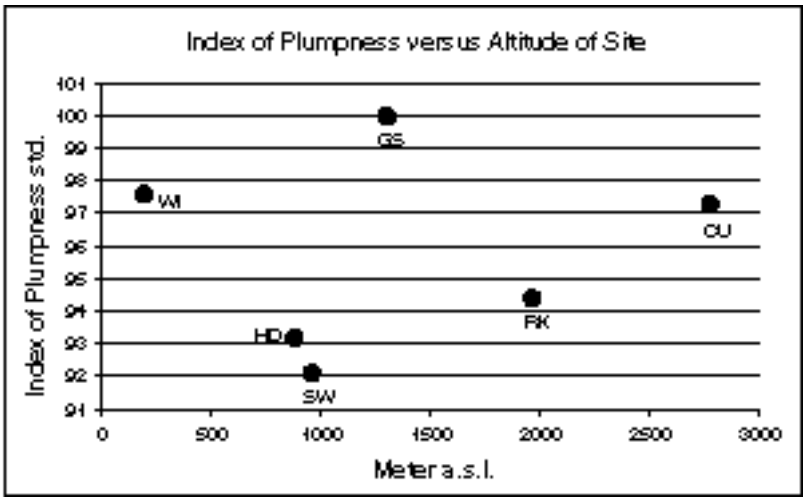

Figure 5. Index of plumpness versus altitude of site, left and index of plumpness and sex, right. This diagram shows that there is obviously no correlation between the mean index of plumpness of a cave- or deninger bear population and the altitude of the site. There is no correlation between the index of plumpness and sex too.

known as *U. deningeri*, but they do have nearly spelaeoid dimensions, and, in some cases, they become even bigger than normal cave bears do. The dimensions of the bears from the Hundsheimer Spalte differ from the deninger-bears from Repolusthöhle (Styria) in a range from 6 % until 16,6 % ! These differences could be sufficient to define a new species. The really small deninger bears from the Repolust cave are so different, that it seems to be more correct to separate this form the other deninger bears on the subspecies level. I would like to suggest the usage of the old terminus "deningeroides", which was introduced into literature by Maria MOTTL (1947). She used this term to mark the peculiarities of this bear from which she believed that it was a cave bear. Now that it is clear that this bear belongs to the species *U. deningeri* it should be used for the same purpose. But now it will be *Ursus deningeri "deningeroides"*

Furthermore, a really tiny metatarsal 5 was found in the material of the Hundsheimer Spalte, which fits perfectly well into the range of robustness of *Ursus arctos*. But it is not only the plumpness, which is responsible for the difference to those of the cave bear, it is also the morphology, showing all the features of a modern brown bear. In respect to the age of this site the metapodial in question is described as *Ursus* cf. *arctos*, which is new to the faunal list of this site as well as for the Lower Pleistocene.

Another very interesting cave is the Windener Baerenhöhle. There were two different species of bears found: a big cave bear and a very big brown bear. These

bears do not differ in greatest length of the metapodial bones but in robustness and in some morphological details of the diaphysis. The brown bear was determined by THENIUS (1956) and its name is *U. arctos priscus*. It inhabited this cave about 17 ky and was thus much younger than the cave bears. Further investigations, including new ^{14}C-datings and DNA-Analyses will shed some more light on this big brown bear.

And last but not least there is the problem of the bears from Conturines cave (Southern Tyrol, Italy) showing characters from *U. spelaeus* as well as from *U. deningeri*. The peculiarities of these bears are the significantly plumper and, in relation to the rest of the body, bigger feet, in combination with the well developed teeth and a relatively common P3 (> 25 %). Especially the metacarpal 1 and the metatarsal 1 show a tendency towards increased plumpness. We should take into account the smaller dimensions of these animals in addition to their dental status and we have a combination that makes this bear unique. There is no doubt, that further investigation in the Conturines bear will bring more interesting results. In future it could be possible to separate this bear taxonomically as a new, persisting subspecies of *U. deningeri*. See also RABEDER & NAGEL (this volume).

CONCLUSIONS

The analysis of metapodial bones is another method to determine the age of a cave bear population in a biostratigraphic way and might also shed some light on some yet unsolved taxonomical problems with diverging forms within the cave bear group.

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