The Systematic Position of the Cave Bear from Potočka zijalka (Slovenia)

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The affiliation of the bone and tooth material from Potočka zijalka to the cave bear group is assured on the basis of the morphology of the molars, premolars and incisors as well as its big dimensions. Only 10 years ago this conclusion would have been satisfying. Differences in metrical and morphological data would have been regarded as the result of a different level of evolution within a phylogenetic lineage, the "Ursus spelaeus-lineage". At the most, there would have been made an intraspecific differentiation, traced back to ecological circumstances, like it is expressed, for example, by the term "high-alpine small form", which has been brought in by K. EHRENBERG (1929) for small sized cave bears of the high-alpine karst plateau.

Since the appearance of the monograph about the Gams-sulzenhöhle (RABEDER, 1991) this is seen differently. Comparative studies showed, that in two caves of the Totes Gebirge, the Ramesch-Knochenhöhle and the Gams-sulzenhöhle, which lie very close to each other, two cave bear groups, different in metrics and morphology, had been living at the same time (at least between 48.000 and 30.000 years BP) and had not intermingled (RABEDER, 1991:80-81…that leads to the hypothesis, that the bear populations of both caves lived at the same time in the same mountains, but without interbreeding, therefore they were separated in breed (hypothesis of speciation): Following this hypothesis the cave bear clade would have been split up into two lineages, into the "high-alpine form" and into the "normal form").

Studies of other Alpine bears showed, that at least a third cave bear group lived in the Alps at the same time in the Conturineshöhle in the Dolomites. A provisional family tree was drawn up in the year 2000 and presented at the cave bear symposium in A Coruña (RABEDER & NAGEL, 2001). A possibility to test this hypo-
thetic family tree arose 10 years after the termination of excavations in the Gamssulzenhöhle as it turned out, that bones of most cave bears contain “ancient DNA”. First studies showed, that the cave bears from Ramesch-Kno-
chennhöhle are actually genetically so far apart from the type of the Gamssulzenhöhle, that they have to be assigned to different species (HOFREITER et al., 2004; RABEDER et al., 2004). A phylogenetic autonomy was not only affirmed but also reinforced through the DNA studies.

Taking the present standard of knowledge, it can be assumed, that the line of the Gamssulzen bear (Ursus ingressus RABEDER et al., 2004) already split from the cave bear main line approximately 600,000 years ago, at a time when all representatives of this group still were on the evolutionary level of Ursus deningeri. The new, now genetically confirmed family tree, presented at the cave bear symposium in Kirchheim / Teck 2002 (RABEDER et al., 2002), does not correspond with the hypothesis of 2000 in one essential point: the bear from Gamssulzenhöhle (Ursus ingressus RABEDER et al., 2004) stands more far apart from the bear from Ramesch-Knochenhöhle (Ursus eremus RABEDER et al., 2004) than from the holotype Ursus spelaeus from the Zoolithenhöhle near Gaillenreuth. The holotype became also known from Alpine caves of the Préalpes (Balme à Colomb). Therefore it can be assumed at present, that at least four forms of cave bears inhabited

Figure 1: Cluster diagrams (Dendrogram 1-4) of tooth and metapodial bone data of five Alpine cave bear faunas completed by the deningeri fauna from Hunas (Franconia).
different, and partly also the same mountain ranges in Europe at the same time, namely during the late Middle Würmian (ca. 50,000 to 30,000 BP).

2. Methods

For systematic classification of the Potočka bears all available morphological data were compared to the corresponding values from other cave bear faunas, in particular to values from the faunas of the locus typicus of the new species (Gamssulzenhöhle, Conturineshöhle, Ramesch-Knochenhöhle, see Rabeder et al., 2004) on one hand, and to values from two faunas of the Middle Pleistocene (Hunas and Repolusthöhle) on the other hand. Clusteranalysis allows determining the morphological nearest cave bear form by using the principle of the smallest distance. The result is compared to the results of the DNA analysis.

3. Clusteranalysis

A clusteranalysis, based on a matrix of data with 21 variables - length and width of all molars, morphodynamic indices of p4, P4, m1, m2, and M2, also an index of length and plumpness of all metapodial bones (see Rabeder, this volume and Withalm, this volume) of five Alpine cave bear assemblages and of the Deninger bear from Hunas, was drawn up and resulted in the following dendrogram (see fig. 1): the bear population from Potočka zjalka is closely related to the cave bears from Gamssulzenhöhle and is consequently a dependant of the form with the highest evolutionary level, namely Ursus ingressus. The bear from Potočka is therefore not closer related to the other high-alpine cave bears from the Dolomites (U. spelaeus ladiniclus Rabeder et al., 2004) and from the Totes Gebirge (U. spelaeus? eremus Rabeder et al., 2004).

4. DNA analysis

Clearly identifiable tooth and bone remains from the excavation campaigns 1997 - 2000 but also fragments from artificially manufactured bone points (see Hofreiter & Pacher, this volume) were used in order to determine mtDNA-sequences. All cave bear samples from Potočka zjalka produced the same, uniform results (see phylogram, fig. 2): the Potočka samples correspond in their mtDNA sequences to the samples from Nixloch near Losenstein-Ternberg in Upper Austria and Lieglloch in Styria (see Döppes & Rabeder, 1997), as well as to samples from Gamssulzenhöhle (see Rabeder, 1995) and Vindija-cave in northern Croatia. Thus it clearly showed itself that the cave bears from Potočka zjalka are genetically closely related to these faunas.

5. Conclusion

Due to corresponding evidences of the dendrograms and the clusteranalysis obtained on morphological and metrical data as well as the phylogram based on mtDNA-sequences the cave bears from Potočka zjalka are assigned to the “Gamssulzen bear”, for which recently the nova species Ursus ingressus Rabeder et al., 2004 has been established.
The new taxonomic scheme is given in figure 3. Partly considerable differences (dimensions, evolutionary level, sexual dimorphism) between the populations from Potočka zijalka and Gamssulzenhöhle are ascribed to the more convenient living conditions on the southern exposure of the Southern Alps compared to the more rough conditions in the Northern Alps (see Rabeder, this volume). Moreover, radiometric dates show that cave bears of the *U. ingressus*-line lived at the same time in Gamssulzenhöhle, as well as in Potočka zijalka and Vindija (Croatia), which is situated approximately 100 km away from the latter. Following the present stage of data it is assumed, that *U. ingressus* immigrated into the Alps around 50,000 BP where this species replaced the other two forms of cave bears (Rabeder & Hofreiter, 2004).

6. References


