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Morphodynamic analysis of some cave-bear teeth from Petralona cave (Chalkidiki, North-Greece)

Morphodynamische Analyse einiger Höhlenbären-Zähne aus der Petralona-Höhle auf Chalkidike (Nord-Griechenland).

by

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Abstract

From the first excavation campagne some skulls, lower jaws and teeth of *Ursus* were found mainly lying on the surface, partly in sinter and got analyzed with the morphodynamic method. As from the morphotypes of the P_4^4 the bears from Petralona belong to the intermediate state between *Ursus deningeri* and *Ursus spelaeus*.
From the morphodynamic indices the chronological age of Middle Pleistocene seems reasonable. (The age of the hominid skull is 200.000 years).

Zusammenfassung

Von der ersten Grabungscampagne, bei der vor allem oberflächlich am Höhlenboden liegende und z.T. eingesinterte Wirbeltierreste geborgen worden waren, stammen einige Schädel, Kiefer und Einzelzähne von *Ursus*, die nach morphodynamischen Methoden analysiert wurden. Nach den Morphotypen der P_4^4 gehören die Bären von Petralona dem Übergangsbereich von *Ursus deningeri* zu *U. spelaeus* an.
Die morphodynamischen Indices machen eine chronologische Einstufung in das mittlere Mittelpleistozän wahrscheinlich. (Der aus gleicher Fundlage stammende Menschenschädel ist dem gleichen Zeitabschnitt zuzuordnen.)

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Introduction

The mammal fauna from the Petralona cave does not only represent one or more parts of the Pleistocene fauna-history of Greece but has also a key-position in the problematic of the hominid skull also found in this cave. The chronological assignment of this hominid-finding has set the discussion on fire as the supposed (?) existence of human artefacts has (compare POULIANOS 1989; KRETZOI 1977; TSOUKALA 1989).
New methods have been discovered since 1960, the year of the discovery of the archaic Homo sapiens to time-order the Pleistocene so that nowadays we can deal completely different with the problem age of the Petralona skull.
The uran-series method allows an absolute dating of bones far back into the Middle Pleistocene. This method demands, on the one hand, bones from the chosen stratigraphic layer of the human skull and on the other hand financial aid for the expensive preparations and measures of these bones. A much easier way of dating represents the evolution of the ursid teeth: as we know from the comparison of many cave-bear faunas of Middle- Europe they had an extraordinary fast evolution and this can be used to subdived the Middle and Upper Pleistocene (RABEDER 1983, 1989; HILLE & RABEDER 1986).

M a t e r i a l

During a visit to the Petralona cave, on March of 1990, both authors decided to involve the bear-remains of that cave into the project "Evolution and

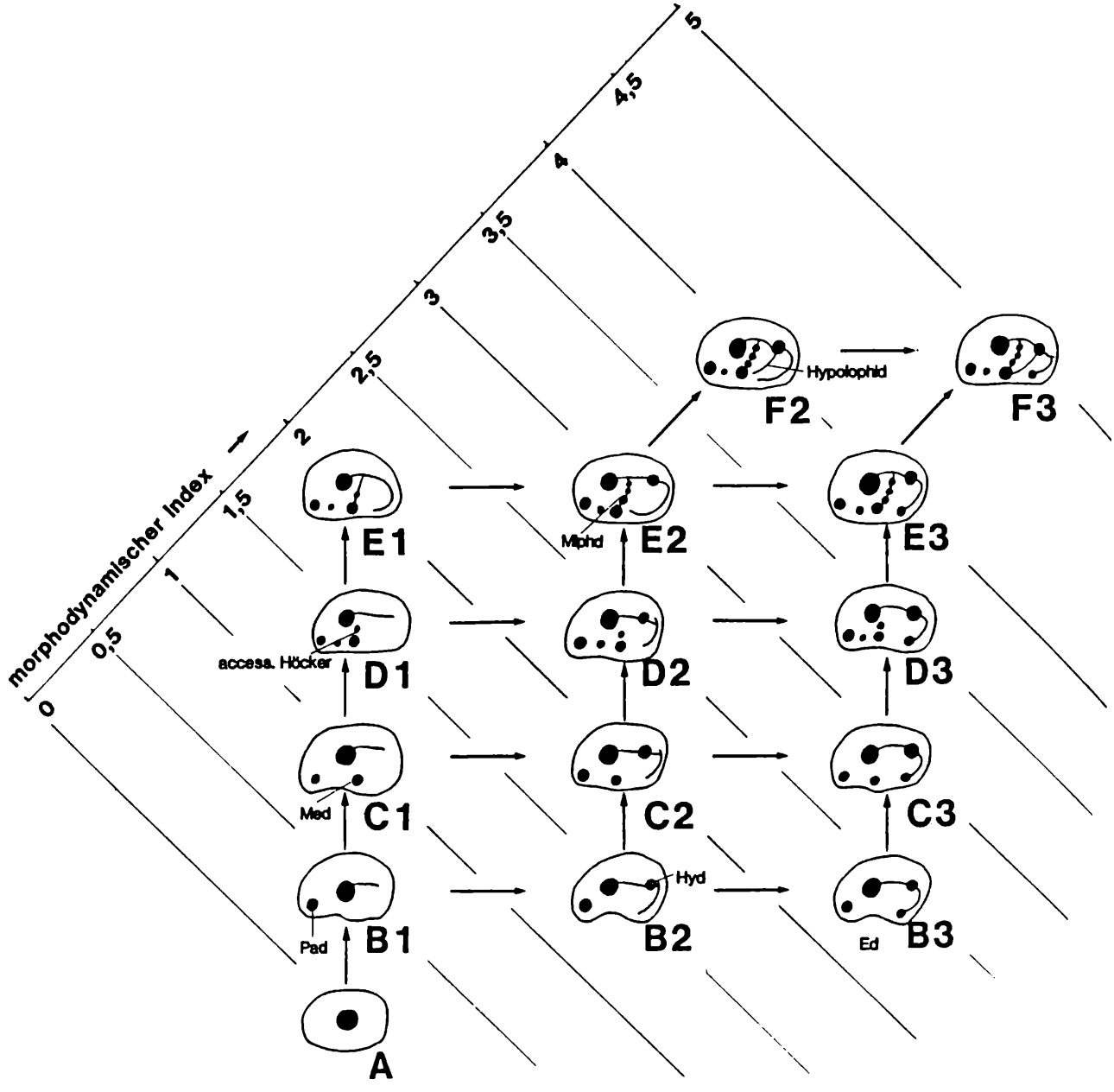

Fig. 1. Morphodynamic scheme of P_4-surface.
Abbr.: A, B1, C1... = morphotypes; access. Höcker = accessory cusp; Ed = entoconid; Hyd = hypoconid; Med = metaconid; Mephd = metalophid; Pad = paraconid; arrow = evolutionary trend.

chronology of the cave-bear" (project-number 6514 E) which gets its financial support from the Austrian "Fonds zur Förderung der wissenschaftlichen Forschung"

The study of about 300 bones, bone-fragments, skulls, mandibles and isolated teeth, mostly well preserved, has been established the presence of the bears in the Petralona cave (TSOUKALA, 1989).
This material is now in the Palaeontological Museum of University of Thessaloniki.

Method

The method used in this case has already been described lately (RABEDER 1989) so that a short review should be enough: The evolution of the cave-bear teeth can best be recognized at the last premolars P_4 and P^4). Starting with the primitive occlusal plan of *U. deningeri* (P_4: one cusp; P^4: three main susps); all additional insertion (accessoric cusps, cutting edges) can be seen as an adaption to behaviour nourishment.
The results as we have so far prove that this quick evolution of the cave-bear teeth is connected with a wide ranged variability: the complex of features of

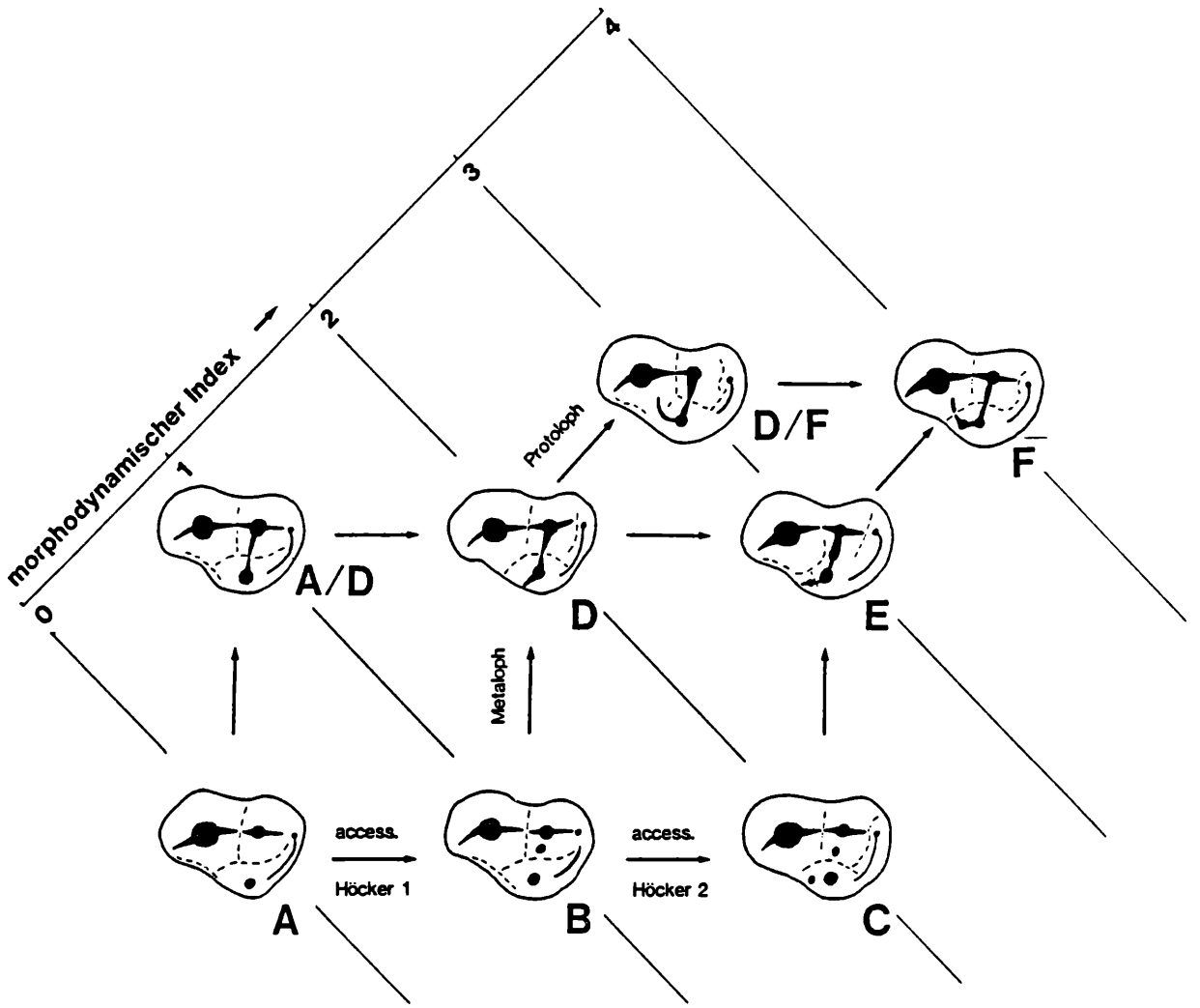

Fig. 2. Morphodynamic scheme of P^4-surface. Abbr.: A, B, C... = morphotypes.

these teeth is highly polymorph. We find similar results on the molars of arvicolids. Also here the great variability of the occlusal plan of these teeth is the source or/and the result of a dynamic evolution.

The morphodynamic analysis of teeth from *Ursus* is done as follows:

1. Registration of the morphotypes.
2. The ordering of the morphotypes following the morphodynamic scheme (Fig. 1-2).
3. Morphotype frequencies: comparison with other cave-bear associations.
4. Determination of the morphodynamic indices (Fig. 1-2, tab. 1).

These four steps were first of all done on praemolars where we already have many results for comparison. Besides the morphological also a metric shifting took place.

Results:

- Morphotypes of the P_4:
  The spectrum starts with morphotype A (one cusp), typical for *U. deningeri* and ends with morphotype C1 (three cusps) which is dominating even the Wurmian *U. spelaeus* association. But all morphotypes with talonid cusps are missing (e.g. B2 or C2).

- Morphotype B (only proto- and paraconid) is dominating. The intermediate forms as there are morphotype A/B1, B1/C1 and A/C1 dedicate a homogeneous chronological association.

- Morphotype of the P^4:
  The main part of the P^4 belongs to the primitive type A, just one example shows morphotype B with its typical metaconulus. All three praemolars have hints of accessoric cusps at the protocon = intermediate state A/C. Due to the

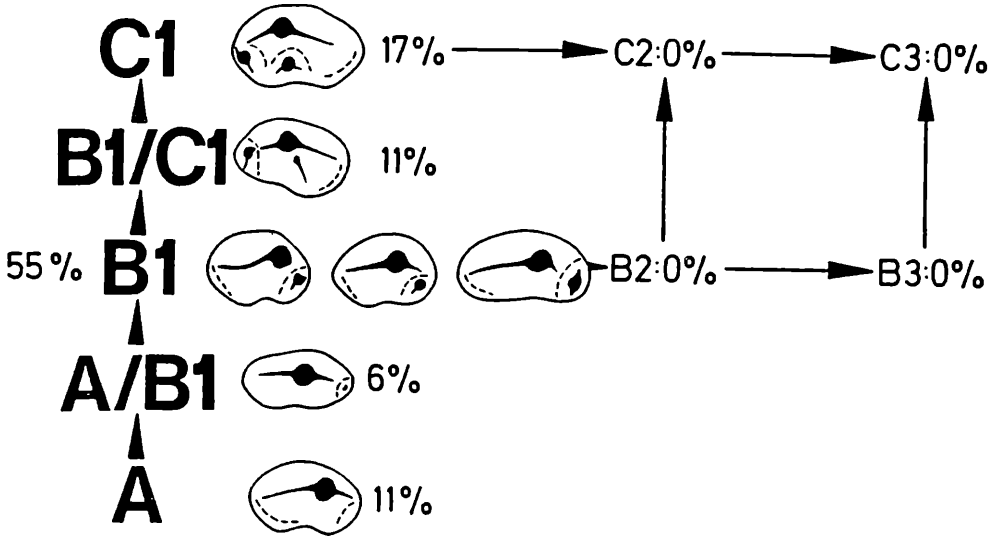

Fig. 3. Frequencies of P_4-morphotypes from Petralona.

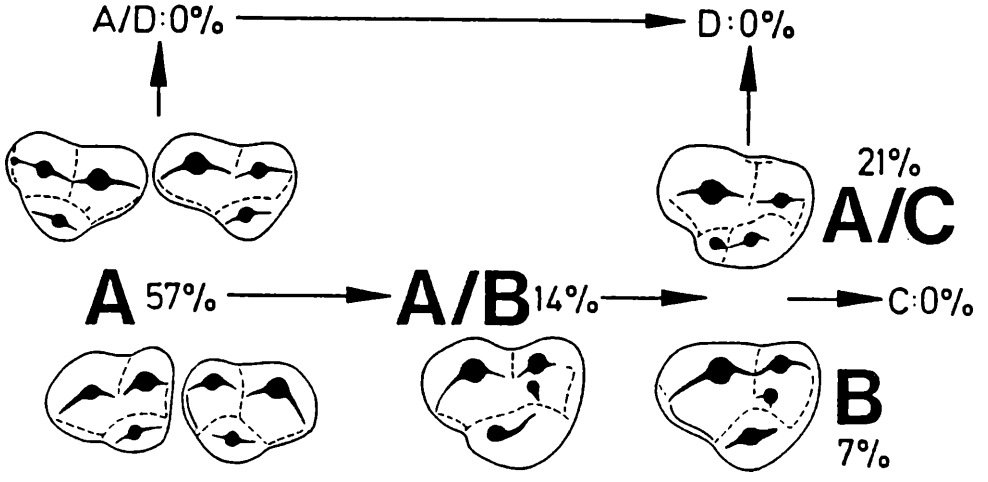

Fig. 4. Frequencies of P^4-morphotypes from Petralona.

intermediate forms A to B and A to C we can subsume a homogeneous association also from the results of the P^4.

- Morphotype-frequences:
  The frequences graphically demonstrated in Fig. 3-4 indicate a quite primeval state of evolution in the chronology of the cave-bears as it has been known only from Middle Pleistocene *U. deningeri* faunas. The domination of the characteristic *U. deningeri* morphotypes is obvious.

- Morphodynamic indices:
  The evolutionary progress in the development of morphotypes of praemolars can easily be quantized by adding each morphotype a factor (Fig. 1 and 2) which gets multiplied by the frequency. But the amount of these products (= morphodynamic index) can easier be determinated:

In the diagram (Fig. 5) are the morphodynamic indices of the P^4 (abszisse) and of the P_4 (ordinate) of about 30 cave-bear faunas listed. It is important to be aware that these indices are not only the average horizontal variability but also the summary of chronological successive finding layers. There are very few caves with distinguishable layers each carring an amount of teeth big enough to watch the

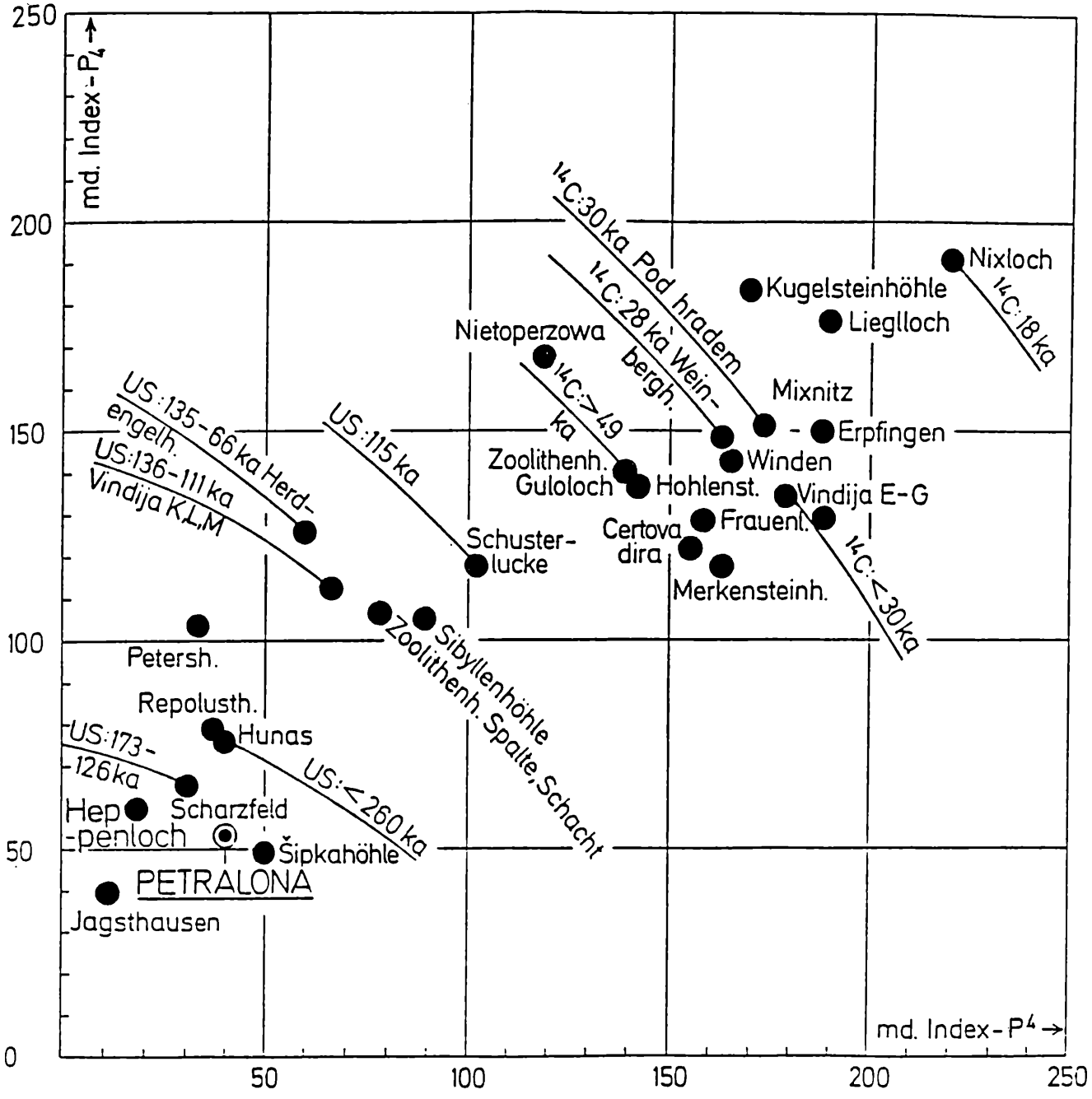

Fig. 5. Diagram of the morphodynamic indices of P_4^4.

evolution within the profil (e.g. Vindija, Herdengelhöhle). Though some inaccuracies due to the problem described above the combinding line between the indices form s-line whose time-line is dedicated from the listed absolute datas.

The s-form of this line is a product of the heterogen evolution of the upper and lower praemolars. Starting with the Early–Pleistocene niveau, niveau near point zero, the P_4 develops quicker than the P^4. In this part of the graph we find the results of Petralona quite in the neighbourhood of the Sipka cave (Mähren, VALOCH 1965), the Heppenloch (Schwäbische Alb, ADAM 1975) and the Einhornhöhle (Harz, old findings, RODE 1935, SCHÜTT 1968).

The Petralona bears are clearly higher developed than the *U. deningeri* from Jagsthausen but more primitive than the bears from Hunas (Fränkische Alb, HELLER 1983).

Tab.1. Valuation of morphodynamic indices of P_4^4 from Petralona cave.

P^4				
Morphotype	Amount	Factor	Product	Frequency
A	8	0	0	57.2 %
A–A/B	1	0.25	0.25	7.1 %
A/B	1	0.5	0.5	7.1 %
B/	1	1	1	7.1 %
A/C	3	1	3	21.4 %
total	14		4.75	99.9 %

P^4 md-index = $\frac{4.75 \times 100}{14} = 33.9$

P_4				
Morphotype	Amount	Factor	Product	Frequency
A	2	0	0	11.1%
A/B1	1	0.25	0.25	5.6%
B1	8	0.50	4	44.4%
B1/C1	2	0.75	1.50	11.1%
C1	3	1	3	16.7%
A/C1	2	0.5	1	11.1%
total	18		9.75	100.0%

P_4 md-index = $\frac{9.75 \times 100}{18} = 54.2$

Conclusion

According to the evolutionary level of the bears at least the superficial collected faunal remains (like the hominid skull) are attached to the middle part of the Middle-Pleistocene.

From the so called "old excavation" the bear remains belong to the intermediate state between *U. deningeri* and *U. spelaeus* and are therefore called *U.* cf. *deningeri* REICHENAU.

The associated fauna of macromammals (recently revised by E. TSOUKALA) on the other hand indicates two heterochrone sedimentation-phases. The taxa *Xenocyon* cf. *lycaonoides, Pliohyaena perrieri* and *Praemegaceros* sp.) are elements of a Villafranchian fauna whereas the rest of the macromammals (compare TSOUKALA 1989) and micromammals from deeper layers of the cave-filling (KRETZOI 1977) are of Middle Pleistocene age. The here studied ursid remains belong to the second (Middle Pleistocene) group.

Ergebnis

Nach dem Evolutionsniveau der Bären-Reste sind zumindest die oberflächlich aufgesammelten Faunenreste (darunter auch der Hominiden-Schädel) dem mittleren Abschnitt des Mittelpleistozäns zuzuordnen. Die aus der sog. „alten" Grabung stammenden Bären-Reste gehören taxonomisch in den Übergangsbereich von *Ursus denin-geri* zu *Ursus spelaeus* und werden als *Ursus* cf. *deningeri* REICHENAU bezeichnet. Aus dem Vergleich mit anderen Höhlenbären-Faunen wird geschlossen, daß weder zwei oder mehrere Bären-Arten vorliegen, noch ein grösserer Zeitraum angenommen werden muß, um die Variabilität zu erklären.

Literature

ADAM, K. D., 1975. Die mittelpleistozäne Säugetierfauna aus dem Heppenloch bei Gutenberg (Würtemberg). — Stuttgarter Beitr. Naturkde. Ser. B, **3**:1–247, Stuttgart.

HELLER, F. (ed.), 1983. Die Höhlenruine Hunas bei Hartmannsdorf (Landkreis Nürnberger Land). — Quartär-Bibliothek 4, Bonn.

HILLE, P. & RABEDER, G. (eds.), 1986. Die Ramesch Knochenhöhle im Toten Gebirge. — Mitt. Komm. Quartärforschung, österr. Akad. Wiss., **6**:1–77, Wien.

KRETZOI, M., 1977. The fauna of small vertebrates of the Middle Pleistocene of Petralona. — Anthropos, **4/1–2**:131–142, Amsterdam.

POULIANOS, N., 1989. Petralona cave within Lower–Middle Pleistocene sites. — Palaeogeography, Palaeoclimatology, Palaeooecology **73**:287–29, Amsterdam.

RABEDER, G., 1983. Neues vom Höhlenbären. Zur Morphogenetik der Backenzähne. — Die Höhle **34**/2:67–85, Wien.

RABEDER, G., 1989. Modus und Geschwindigkeit der Höhlenbär-Evolution. — Schrift. Ver. Verbr. naturwiss. Kenntnisse Wien, **127**:105–126, Wien.

RODE, K., 1935. Untersuchungen über das Gebiß der Bären. — Monogr. Geol. Paläont. II, **7**:1–162, Leipzig.

SCHÜTT, G., 1968. Die cromerzeitlichen Bären aus der Einhornhöhle bei Scharzfeld. — Mitt. Geol. Inst. TH Hannover, **7**:1-21, Hannover.

TSOUKALA, E., 1989. Contribution to the study of the Pleistocene fauna of large mammals (Carnivora, Perissodactyla, Artiodactyla) from Petralona cave, Chalkidiki (N.-Greece). — Thesis, Aristotle Univ. Thessaloniki, School. Geol. Sci. Ann., 1, **8**:1–360, LXII pl.,Thessaloniki.

VALOCH, K., 1965. Die Höhlen Šipka und Certova Dira bei Stramberk. — Anthropos, **17**:1–179, Brno.