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SECTIO BIOLOGICA
  incepit anno MCMLVII
SECTIO CHIMICA
  incepit anno MCMLIX
SECTIO CLASSICA
  incepit anno MCMLXXIV
SECTIO GEOGRAPHICA
  incepit anno MCMLXVI
SECTIO GEOLOGICA
  incepit anno MCMLVII
SECTIO HISTORICA
  incepit anno MCMLVII
SECTIO IURIDICA
  incepit anno MCMLIX
SECTIO LINGUISTICA
  incepit anno MCMLXX
SECTIO MATHEMATICA
  incepit anno MCMLVIII
SECTIO PEDAGOGICA ET PSYCHOLOGICA
  incepit anno MCMLXX
SECTIO PHILOLOGICA HUNGARICA
  incepit anno MCMLXX
SECTIO PHILOLOGICA MODERNA
  incepit anno MCMLXX
SECTIO PHILOSOPHICA ET SOCIOLOGICA
  incepit anno MCMLXII

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Contents

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An exceptionally rich Soricidae (Mammalia) fauna from the upper Miocene localities of Polgárdi (Hungary)

L. Gy. MÉSZÁROS[1]

(with 8 figures, 11 tables and 2 plates)

Abstract

More than 7000 shrew specimens were found in the Upper Miocene localities of Polgárdi, Hungary. The well preserved bones and teeth were deposited mainly by pit-fall accumulations. *Crusafontina kormosi* (BACHMAYER & WILSON), *Amblycoptus oligodon* KORMOS, *Kordosia topali* (JÁNOSSY), *Blarinella dubia* (BACHMAYER & WILSON), *Asoriculus gibberodon* (PETÉNYI), *Zelceina soriculoides* (SULIMSKI) and *Paenelimnoecus repenningi* (BACHMAYER & WILSON) were identified from the samples. On the basis of these occurrences, all sites belong to the Late Turolian MN 13 Zone, but locality 4 is somewhat older, and locality 2 is earlier than locality 5. The soricids suggest that Polgárdi 2 and 4 were well watered, forested areas in semiarid climate, while Polgárdi 5 might have been an open environment in a karstic grassland area.

Introduction

The richness and the state of preservation of the Polgárdi fossil fauna is particular even on a world-scale. The Polgárdi limestone quarry, as a Neogene locality, was discovered by L. LÓCZY, the first report on the sites was given by KORMOS (1911). In 1926 he described a new shrew genus and species from Polgárdi, locality 2. KRETZOI (1942, 1952) mentioned many carnivore species from this "Hipparion-fauna". KORDOS (1985, 1987) and FREUDENTHAL & KORDOS (1989) described new rodent genera and species from different sites of Polgárdi. BOLKAY (1913), FEJÉRVÁRY (1917), FEJÉRVÁRY-LÁNGH (1923) and VENCEL (1994, 1997) wrote up the reptiles and the amphibians, JÁNOSSY (1991) treated the birds. Further contributions are by KORMOS (1913, 1914) and KRETZOI (1983). KORDOS (1991 a) summarized the history and the geological background of the localities. The present author in his systematic papers already mentioned two Anourosoricini shrews from Polgárdi 4 and 5 (MÉSZÁROS 1997, 1998 b), while the whole soricid fauna is presented here.

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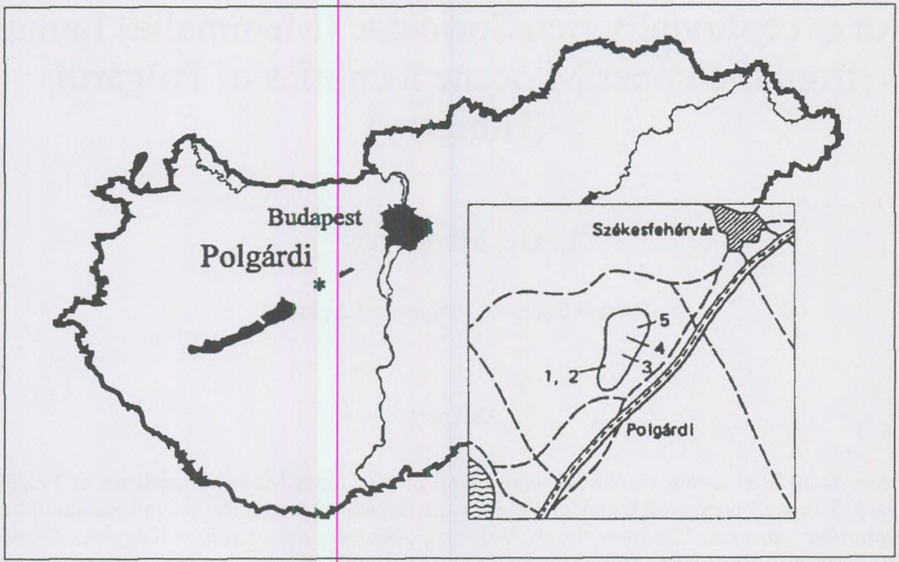

Fig. 1. Geographic situation of the Polgárdi fossil localities.

Localities

In the Devonian crystalline limestone of the Kőszár Hill, near Polgárdi (Fejér County), a great number of karstified fissures and caves were excavated by the large-scale exploitation of the rock. In the quarry, between 1909 and 1991, five localities (Fig. 1) were discovered with rich and excellently preserved fauna. The soricid remains came from locality 2, 4 and 5.

Locality 2. In the relevant literature this site is, in general, referred to as locality Polgárdi. During the excavation performed by T. KORMOS in 1910, bone remains were collected from a surface hall of a large sinkhole cave. In the profile of the cave-deposit, containing rich hipparion fauna, five beds were distinguished. Unfortunately KORMOS did not separated the fossils from these different layers. As far as we can judge now, they all represent the same biostratigraphical level (FREUDENTHAL & KORDOS 1989).

Locality 4. An inverse Y-shaped karstic fissure was discovered by I. DUNKL and S. JÓZSA in 1984 in the eastern wall at the lower level of the operating limestone quarry. L. KORDOS, with the help of the discoverers, removed all the sediments in 1984-1985. During the collecting work, the so-called "lower" and "upper" localities were distinguished. According to FREUDENTHAL & KORDOS (1989) and KORDOS (1991a), these two sites belong to the same fissure system, and they appear to be of the same age.

Locality 5. In 1985 a great number of vertebrate remains were found in the fill of a large fossil cave, at a level 15 m higher than locality 4, and about 250 m north-east of the previous site. The material was collected by L. KORDOS. This was the richest finding among the Polgárdi fossils.

KORMOS (1911 and 1926) reported three Soricidae from Polgárdi 2 site:

Sorex sp.
Crocidura sp.
Amblycoptus oligodon n. g. et n. sp.

The present study has resulted in the following list of identified species from the discussed sites:

Polgárdi 2
Amblycoptus oligodon KORMOS, 1926
Blarinella dubia (BACHMAYER & WILSON, 1970)
Paenelimnoecus repenningi (BACHMAYER & WILSON, 1970)

Polgárdi 4
Crusafontina kormosi (BACHMAYER & WILSON, 1970)
Amblycoptus oligodon KORMOS, 1926
Blarinella dubia (BACHMAYER & WILSON, 1970)
Zelceina soriculoides (SULIMSKI, 1959)
Asoriculus gibberodon (PETÉNYI, 1864)
Paenelimnoecus repenningi (BACHMAYER & WILSON, 1970)

Polgárdi 5
Blarinella dubia (BACHMAYER & WILSON, 1970)
Kordosia topali (JÁNOSSY, 1972)

Species	Polgárdi 2		Polgárdi 4		Polgárdi 5	
	A	B	A	B	A	B
C. kormosi	-	-	149	56	-	-
A. oligodon	9	2	156	61	-	-
K. topali	-	-	-	-	608	156
B. dubia	15	7	237	102	5683	2452
A. gibberodon	-	-	87	41	-	-
Z. soriculoides	-	-	7	4	-	-
P. repenningi	1	1	22	15	-	-
unidentifiable 1*	-	-	30	-	-	-
unidentifiable 2**	-	-	68	-	-	-
Isolated teeth (%)	24.00	-	8.57	-	1.84	-

Table 1. Catalogue of the Polgárdi Soricidae remains. A = number of specimens, B = minimum number of individuals, unidentifiable shrews, without the main differential characters: * = in the size of *Paenelinmoecus repenningi*, ** = in the size of *Blarinella dubia*, *Asoriculus gibberodon* and *Zelceina soriculoides*.

Material and methods

All studied specimens are stored in the collection of the Geological Museum of Hungary (GMH, in the Hungarian Geological Institute). The catalogue of the whole soricid material includes 7072 specimens (Tab. 1). The author selected the shrew remains from the Polgárdi 4 and 5 samples, washed by a team of the Hungarian Geological Institute. The Polgárdi 2 soricids were cataloguised in the collection as KORMOS determined them.

The SEM photos were made in the Microsonda Laboratory of the Geological Institute, Eötvös Loránd University.

The morphological terms and the measurements (in mm) are used after REUMER (1984) and MÉSZÁROS (1996).

Systematic palaeontology

Class Mammalia LINNAEUS, 1735
Order Insectivora BOWDICH, 1821
Family Soricidae GRAY, 1821
Subfamily Soricinae FISCHER VON WALDHEIM, 1817

Tribe Anourosoricini ANDERSON, 1879
Genus *Crusafontina* GIBERT, 1974

Type species. *Crusafontina endemica* GIBERT, 1974

Crusafontina kormosi (BACHMAYER & WILSON, 1970)

Text-Fig. 2, Pl. 2, Fig. 10

1954 - *Amblycoptus vicinus* n. sp. - KRETZOI, p. 49 (Csákvár)
1970 - *Anourosorex kormosi* nov. spec. - BACHMAYER & WILSON p. 551, figs 3-4a, 20-20a, 21-25 (Kohfidisch)
1978 - *Anourosorex kormosi* BACHMAYER & WILSON, 1970 - BACHMAYER & WILSON, p. 141 pl. 2, figs, 5-5a (Kohfidisch)
1978 - "*Anourosorex" kormosi* BACHMAYER & WILSON, 1970 - STORCH, p. 424, pl. 4, figs 29-39 (Dorn-Dürkheim)
1980 - *Anourosorex kormosi* BACHMAYER & WILSON, 1970 - BACHMAYER & WILSON, p. 361 (Kohfidisch)
1996 - *Crusafontina vicina* (KRETZOI, 1954) - MÉSZÁROS, p. 9, pl. 12, figs 5 a-b (Csákvár)
1998 a - *Crusafontina kormosi* (BACHMAYER & WILSON, 1970) - MÉSZÁROS, p. 106, pl. 1, figs 5-11 (Tardosbánya)

Holotype. Right lower jaw with the complete dentition, BACHMAYER & WILSON (1970), p. 551, Pl. 1, fig 3, Natural History Museum, Vienna (NHMV), Div. Geol. Paleont. 1970/1389. Type locality: Kohfidisch (Austria, Late Vallesian, MN 10).

Stratigraphical range. Late Miocene (Late Vallesian, MN 10 - Late Turolian, MN 13), Europe.

Studied material. Polgárdi 4: 11 fragmentary skulls, 12 left and 9 right maxillary fragments, 56 left and 39 right mandibles, 2 left and 11 right I^1, 1 left P^4, 3 left and 4 right I_1. Figured specimens: GMH, V. 20717. and V. 20718.

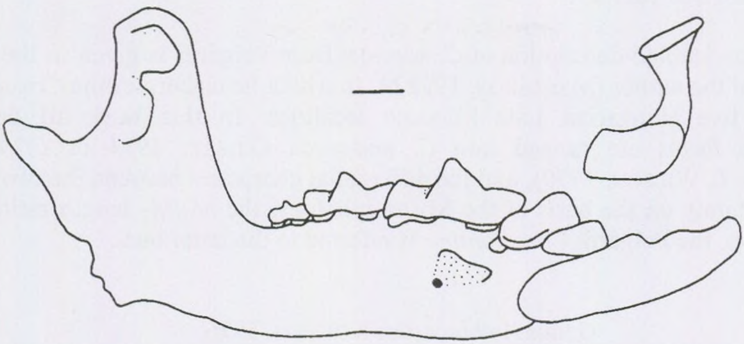

Fig. 2. *Crusafontina kormosi* (BACHMAYER & WILSON, 1970). GMH V. 20717., loc. Polgárdi 4 "upper", right mandible, lateral view and the condyle, posterior view; scale bar = 1 mm.

		min.	mean	max.	spec. nr.	standard error	standard deviation
I^1	L	2.20	2.45	2.76	12	0.1267	0.1533
	H	1.66	1.84	2.00	12	0.0653	0.0826
A^1	L	1.50	1.78	2.12	21	0.1525	0.1740
	W	1.10	1.27	1.70	21	0.0906	0.1305
A^2	L	0.95	1.05	1.20	22	0.0529	0.0673
	W	0.90	1.03	1.12	22	0.0596	0.0675
P^4	LL	1.45	1.73	1.96	44	0.0773	0.1029
	BL	2.35	2.56	2.80	44	0.0821	0.1002
	W	2.00	2.33	2.90	44	0.1773	0.2167
M^1	LL	1.45	1.82	2.28	41	0.0839	0.1258
	BL	1.90	2.15	2.56	41	0.0977	0.1239
	AW	1.90	2.22	2.58	41	0.1205	0.1478
	PW	1.70	2.01	2.36	41	0.1154	0.1462
M^2	LL	1.08	1.17	1.38	9	0.0667	0.0879
	BL	1.20	1.29	1.39	9	0.0556	0.0622
	AW	1.82	2.01	2.18	9	0.0815	0.1007
	PW	1.12	1.20	1.32	9	0.0444	0.0573
I_1	L	4.81	5.14	5.56	6	0.2356	0.2736
	H	1.10	1.28	1.52	6	0.1067	0.1332
M_1	L	2.50	2.72	3.20	87	0.0924	0.1222
	W	1.16	1.37	4.64	87	0.0567	0.0772
M_2	L	1.20	1.88	2.28	65	0.1228	0.1771
	W	0.88	1.12	1.36	65	0.0511	0.0751
M_3	L	0.90	1.04	1.34	33	0.0683	0.0932
	W	0.46	0.63	0.84	33	0.0610	0.0848

Table 2. Measurements of *Crusafontina kormosi* (BACHMAYER & WILSON, 1970) from Polgárdi 4, after MÉSZÁROS 1998 b.

Measurements. See Tab. 2.

Remarks. The detailed description of *C. kormosi* from Polgárdi is given in the special publication of the author (MÉSZÁROS, 1998 b), in which he elaborates the *Crusafontina* remains of five Hungarian Late Miocene localities. In this work all described *Crusafontina* forms are ranged into *C. endemica* GIBERT, 1974 or *C. kormosi* (BACHMAYER & WILSON, 1970), and the differential characters between the two species are given. Mainly on the basis of the M_3 morphology, the M_2/M_3 length ratio, the I^1 measurements, the Polgárdi *Crusafontina* is referred to the latter one.

Genus *Amblycoptus* KORMOS, 1926

Type species. *Amblycoptus oligodon* KORMOS, 1926.

Amblycoptus oligodon KORMOS, 1926
Text-Fig. 3, Pl. 2, Figs 4-7

1926 - *Amblycoptus oligodon* n. g. et n. sp. - KORMOS, p. 543, pl. 3. figs 1-5 (Polgárdi 2)
1980 - *Amblycoptus* cf. *oligodon* KORMOS, 1926 - KRETZOI, p. 312 (Széchenyi Hill)
1995 - *Amblycoptus* cf. *oligodon* KORMOS, 1926 - HÍR & MÉSZÁROS, p. 171, figs 4 a-l (Egyházasdengeleg)
1996 - *Amblycoptus oligodon* KORMOS, 1926 - MÉSZÁROS, p. 9, pl. 1, figs 2 a-b (Széchenyi Hill)
1998 - *Amblycoptus oligodon* KORMOS, 1926 - MÉSZÁROS, p. 104, pl. 1, figs 1-4 (Tardosbánya)

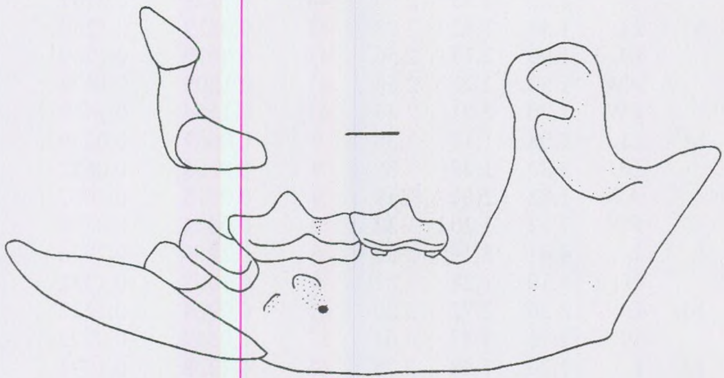

Fig. 3. *Amblycoptus oligodon* KORMOS 1926. GMH V. 20720., loc. Polgárdi 4 "upper", left mandible, lateral view and the condyle, posterior view; scale bar = 1 mm.

Holotype. Left maxilla with five teeth, Geological Museum of Hungary, OB. 5071., KORMOS (1926), p. 352, pl. 3, figs 1-5., Type locality: Polgárdi 2. (Hungary, Late Turolian, MN 13).

Stratigraphical range. Late Miocene (Turolian, MN 12-13), Europe.

Studied material. Polgárdi 4: 8 fragmentary skulls, 4 left and 3 right maxillary fragments, 53 left and 52 right mandibles, 6 left and 6 right I^1, 1 left A^1, 8 left and 13 right I_1, 1 right M_1, 1 left M_2. Figured specimens: GMH, V. 20719. and V. 20720. Polgárdi 2: 1 left maxilla (the holotype), OB. 5071., 2 mandibles, 2 M_1, 4 I_1.

Measurements. See Tabs 3-4.

Description. The saggital crest of the skull terminates between the little frontal foramina. The infraorbital fossa is very deep. The palatine foramina are situated at the middle of A^1. The palatine fossa is short and broad. The top of the coronoid process is widened in most mandibles. The upper part of the external temporal fossa is deep, the lower one is shallower, the coronoid spicule is long and high. The ascending and horizontal rami form a slightly obtuse angle, the lower margin of the horizontal one is convex. The mental foramen is placed under the re-entrant valley of M_1. A subdivided muscular depresson is situated under and before the foramen. The upper articular facet of the condyle is triangular, the lower one is mesially oblong, the interarticular area is extremely narrow. The external pterygoid fossa is deep and broad. The internal temporal fossa is oval, tight and deep, the mandibular foramen is placed under the middle or the posterior part of its lower margin. Dental formula is 142/122, the third molars are always missing. There is a buccal cingulum and conule in the basal margin of the upper incisor. A^1 is a long-crowned, big tooth with posteriorly widened cingula in both sides. There is no parastyle before the large paracone. We can see a tiny hypocone in the postero-lingual corner, and a somewhat bigger protocone before it. The second upper antemolar is triangular and far smaller than the first one. The big paracone is in central position, cingula are well-developed in the lingual and the buccal side. A^3 is tiny and unicuspid. The P^4 parastyle is protruding, it is contacted with the paracone by a weak parastylar crest. The paracone and the well-developed hypocone are separated by a deep valley. The hypoconal flange is long, a minute cuspule is rised in the lingual ridge. The posterior margin is deeply notched. The buccal edge is long and sharp. The PW of M^1 is somewhat less than AW, the parastyle is strong, the metastyle is much weaker, the mesostyle is hardly-developed. The trigone is posteriorly closed by a wide metaloph. The hypocone is well-developed, the hypoconal flange is shorter than in P^4, the posterior emargination is deeply notched. M^2 is reduced, triangular. The trigone is basined, the parastyle is long. The hypocone, the protocone and the metacone are well-identifiable. The mandibular incisor is strong and acuspulate, its apex is not up-curved. The cingulum may be present or missing in the lower antemolars and molars. The antemolars are unicuspid, A_1 is far smaller than A_2. The entoconid and the entostylid are separated by a tight walley in the mandibular molars. The entoconid crest is present in both teeth. The M_2 talonid is basined, the hypoconid and the entoconid are well-developed.

Remarks. After that MÉSZÁROS (1997) distinguished *Kordosia* from this genus, it contains only one species. All hither to known, well documented occurrences of this form are from the Carpathian Basin, thus *Amblycoptus* seems to be an endemic and monospecific group.

		min.	mean	max.	spec. nr.
A^1	L	1.93	1.75	2.10	2
	H	1.35	1.53	1.70	2
A^2	L	0.90	0.95	1.00	2
	W	1.30	1.30	1.30	2
P^4	LL	1.85	1.90	1.95	2
	BL	2.50	2.65	2.80	2
	W	2.60	2.75	2.90	2
M^1	LL	2.25	2.25	2.25	2
	BL	2.30	2.33	2.35	2
	AW	2.65	2.68	2.70	2
	PW	2.15	2.20	2.25	2
M_1	L	1.87	2.75	2.85	2
	W	1.00	1.35	1.70	2

Table 3. Measurements of ***Amblycoptus oligodon*** KORMOS 1926 from Polgárdi 2.

		min.	mean	max.	spec. nr.	standard error	standard deviation
A^1	L	1.70	1.82	2.00	9	0.0889	0.1054
	H	1.25	1.31	1.35	9	0.0346	0.0393
A^2	L	0.80	0.93	1.05	11	0.0835	0.0911
	W	0.95	1.02	1.15	11	0.0471	0.0579
P^4	LL	1.50	1.64	1.85	18	0.0852	0.0990
	BL	2.30	2.46	2.60	18	0.0722	0.0891
	W	2.25	2.38	255	18	0.0722	0.0870
M^1	LL	1.80	2.07	2.45	17	0.0834	0.1152
	BL	2.16	2.37	2.51	17	0.1179	0.1288
	AW	2.00	2.34	2.65	17	0.1219	0.1382
	PW	1.98	2.08	2.00	17	0.0580	0.0705
M_1	L	2.50	2.77	3.00	65	0.1174	0.1438
	W	1.28	1.45	1.65	65	0.0976	0.1137

Table 4. Measurements of ***Amblycoptus oligodon*** KORMOS 1926 from Polgárdi 4.

Genus *Kordosia* MÉSZÁROS, 1997

Type species. *Amblycoptus topali* JÁNOSSY, 1972.

Kordosia topali (JÁNOSSY, 1972)

Text-Fig 4, Pl. 2, Figs 1-3

1972 - *Amblycoptus topali* sp. n. - JÁNOSSY, p. 38, pl. 3, figs 7-10 (Osztramos 1)

1975 - *Amblycoptus* cf. *topali* JÁNOSSY, 1972 - RZEBIK-KOWALSKA, p. 178, fig. 4 (Zamkova Dolna)

1979 - *Amblycoptus topali* JÁNOSSY, 1972 - SULIMSKI et al., p. 387 (Mala Cave)

1984 - *Amblycoptus topali* JÁNOSSY, 1972 - REUMER, p. 110 pl. 35, figs 7-9, plate 36, figs 1-3 (Osztramos 1)

1984 - *Amblycoptus* sp. - REUMER, p. 113, plate 35, fig 10 (Osztramos 7)

1997 - *Kordosia topali* JÁNOSSY, 1972 - MÉSZÁROS, p. 72, figs 5-7 (Polgárdi 5)

Holotype. Right mandible with the incisor, the two antemolars, the first molar and the alveoli of the second one. Hungarian Natural History Museum, V. 71. 49., JÁNOSSY, 1972, p. 38, pl. 3, figs 6-10. Type locality: Osztramos 1 (Hungary, Early Ruscinian, MN 14).

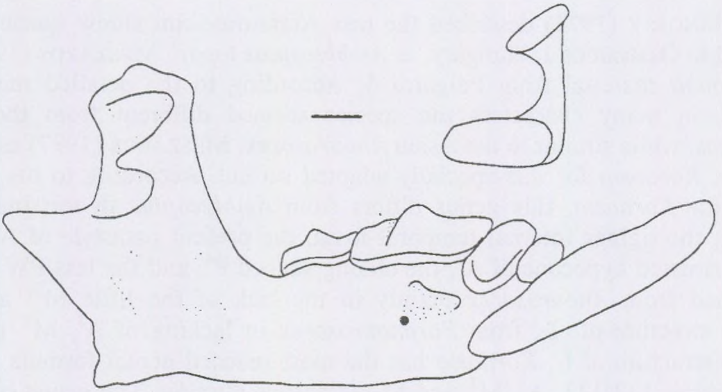

Fig. 4. *Kordosia topali* (JÁNOSSY, 1972). GMH V. 20721., loc. Polgárdi 5, right mandible, lateral view and the condyle, posterior view; scale bar = 1 mm.

Stratigraphical range. Late Miocene (Turolian, MN 13) - Late Pliocene (Villányian, MN 16), Europe.

Studied material. Polgárdi 5: 49 complete or fragmentary skulls, 39 left and 49 right maxillae or maxillary fragments, 174 left and 181 right mandibles or mandible fragments, 29 left and 40 right I^1, 4 right A^1, 2 left and 2 right P^4, 4 left and 2 right M^1, 2 left and 3 right M_1, 1 left M_2, 11 left and 16 right I_1. Figured specimens: GMH, V. 20721.

Measurements. See Tab. 5.

		min.	mean	max.	spec. nr.	standard error	standard deviation
A^1	L	1.80	2.16	2.50	87	0.1237	0.1576
	W	1.10	1.50	1.80	87	0.0986	0.1431
A^2	L	0.80	1.13	1.70	106	0.0968	0.1312
	W	0.85	1.17	1.40	106	0.0891	0.1098
P^4	BL	2.00	2.23	2.95	141	0.1464	0.2156
	LL	2.10	2.68	3.10	141	0.1424	0.1963
	W	2.10	2.51	2.90	141	0.1111	0.1479
M^1	BL	1.90	2.15	2.50	117	0.1071	0.1311
	LL	2.05	2.44	2.70	117	0.0984	0.1277
	AW	2.10	2.70	3.05	117	0.1094	0.1524
	PW	1.90	2.25	2.60	117	0.1280	0.1548
M_1	L	2.60	3.03	3.50	225	0.1064	0.1368
	W	1.05	1.54	1.80	225	0.0656	0.0870

Table 5. Measurements of *Kordosia topali* (JÁNOSSY, 1972) from Polgárdi 5, after MÉSZÁROS 1997.

Remarks. JÁNOSSY (1972) described the new Anourosoricini shrew species, what has been found in Osztramos 1, Hungary, as *Amblycoptus topali*. MÉSZÁROS (1997) studied a larger *topali* material from Polgárdi 5. According to the detailed morphological researches, in many characters the species seemed different from the European *Amblycoptus*, while similar to the Asian *Anourosorex*. MÉSZÁROS (1997) estabilished a new genus, *Kordosia* for this specially adapted soricid. According to his differencial diagnosis for *Kordosia*, this genus differs from *Amblycoptus* in missing of A^3, its larger size, the tighter internal temporal fossa, the present parastyle of A^1, the more anteriorly situated hypocone of A^2, the oblong shaped P^4, and the less PW of M^1. It is distinguished from *Anourosorex* mainly in the lack of the little M^3 and M_3 and acuspulate structure of I_1, from *Paranourosorex* in lacking of A^3, M^3 and M_3 and acuspulate structure of I_1. *Kordosia* has the most reduced dental formula in the tribe Anourosoricini: 132/122. A^3, M^3 and M_3 is always missing. The genus contains also *K. jessiae* described from Maramena (Greece) by DOUKAS (DOUKAS *et al.* 1995). *K. topali* differs from *K. jessiae* in the larger size, the L/W ratio of M_1 and the different morfology of I^1.

Tribe Soricini FISCHER VON WALDHEIM, 1817
Genus *Blarinella* THOMAS, 1911

Type species. *Blarinella quadraticauda* MILNE-EDWARDS, 1872

Blarinella dubia (Bachmayer & Wilson, 1970)
Pl. 1, Figs 1-3, Pl. 2, Figs 11-12

1911 - *Crocidura* sp. - Kormos, p. 57 (Polgárdi 2)

partim 1954 - Soricidarum g. et sp. indet. II. - Kretzoi, p. 49. (Csákvár)

1970 - *Petenyia dubia* n. spec. - Bachmayer & Wilson, p. 546. figs 6, 26, 27, 30, 31a (Kohfidisch)

1976 - *Petenyia dubia* Bachmayer & Wilson, 1970 - Kretzoi et al., p. 375 (Rudabánya)

1978 - *Petenyia dubia* Bachmayer & Wilson, 1970 - Bachmayer & Wilson, p. 138, fig. 18 (Kohfidisch)

1984 - *Petenyia dubia* Bachmayer & Wilson, 1970 - Kretzoi, p. 216 (Sümeg)

1984 - *Blarinella dubia* (Bachmayer & Wilson, 1970) - Reumer, p. 66 pl. 20 figs 5-8 (Osztramos 9)

1985 - *Blarinella dubia* (Bachmayer & Wilson, 1970) - Rabeder, p. 447 (Rudabánya)

1989 - *Blarinella dubia* (Bachmayer & Wilson, 1970) - Rzebik-Kowalska, p. 533 fig. 3 (Podlesice, Zalesiaki 1B)

1991 b - *Blarinella dubia* (Bachmayer & Wilson, 1970) - Kordos, p. 348 (Rudabánya)

1995 - *Blarinella* cf. *dubia* (Bachmayer & Wilson, 1970) - Hír & Mészáros, p. 171, figs. 3 c-d (Egyházasdengeleg)

1996 - *Blarinella dubia* (Bachmayer & Wilson, 1970) - Mészáros, p. 13, pl. 3, figs 6 a-g (Sümeg, Csákvár)

1998 - *Blarinella dubia* (Bachmayer & Wilson, 1970) - Mészáros, p. 107, pl. 2, figs 1-10 (Tardosbánya)

		min.	mean	max.	spec. nr.	standard error	standard deviation
P^4	LL	-	1.26	-	1	-	-
	BL	-	1.03	-	1	-	-
	W	-	1.45	-	1	-	-
M^1	LL	-	1.48	-	1	-	-
	BL	-	1.43	-	1	-	-
	AW	-	1.30	-	1	-	-
	PW	-	1.40	-	1	-	-
I_1	L	-	4.14	-	1	-	-
	H	-	0.88	-	1	-	-
M_1	L	1.50	1.56	1.63	8	0.0463	0.0492
	W	0.87	0.92	1.00	8	0.0349	0.0402
M_2	L	1.35	1.40	1.45	8	0.0325	0.0367
	W	0.79	0.87	0.94	8	0.0369	0.0465
M_3	L	1.05	1.09	1.15	4	0.0350	0.0394
	W	0.63	0.64	0.65	4	0.0050	0.0071

Table 6. Measurements of *Blarinella dubia* (Bachmayer & Wilson, 1970) from Polgárdi 2.

Holotype. Left mandible fragment with the three molars, NHMV, Div. Geol. Paleont., 1970/1387. (Bachmayer & Wilson 1970, p. 546, fig. 6,) Type locality: Kohfidisch (Austria, Late Vallesian, MN 10).

Stratigraphical range. Late Miocene (Early Vallesian, MN 9) - Early Pliocene (Early Ruscinian, MN 14), Europe.

Studied material. Polgárdi 2: 1 right maxilla fragment, 8 left and 6 right mandible fragments. Polgárdi 4: 12 skull fragments, 13 left and 14 right maxillary fragments, 102 left and 83 right maxillae, 3 right and 2 left I^1, 1 left P^4,
1 right P^4, 1 right I_1, 1 right A_2, 1 left and 3 right M_1. Polgárdi 5: 139 skulls, 304 left and 316 right maxillae, 2420 left and 2504 right mandibles. Figured specimens: GMH, V. 20723.

Measurements: See Tabs 6-8.

		min.	mean	max.	spec. nr.	standard error	standard deviation
I^1	L	2.00	2.23	2.52	4	0.2200	0.2256
	H	1.28	1.29	1.32	4	0.0138	0.0164
P^4	LL	0.98	1.06	1.08	4	0.0375	0.0433
	BL	1.43	1.55	1.66	4	0.0750	0.0850
	W	1.35	1.53	1.66	4	0.1150	0.1143
M^1	LL	1.35	1.45	1.53	5	0.0424	0.0588
	BL	1.40	1.52	1.63	5	0.0624	0.0763
	AW	1.39	1.50	1.55	5	0.0424	0.0557
	PW	1.45	1.56	1.66	5	0.0496	0.0673
M^2	LL	1.23	1.32	1.55	5	0.0928	0.1189
	BL	1.15	1.32	1.48	5	0.0776	0.1057
	AW	1.23	1.51	1.63	5	0.1224	0.1484
	PW	4.35	1.46	1.50	5	0.0440	0.0555
M^3	L	0.55	0.59	0.63	4	0.0400	0.0400
	W	1.28	1.34	1.39	4	0.0475	0.0482
I_1	L	3.44	3.66	3.88	4	0.1600	0.0709
	W	0.55	0.84	0.96	4	0.0438	0.1692
M_1	L	1.45	1.58	1.69	8	0.0497	0.0663
	W	0.85	1.91	0.94	8	0.0291	0.0314
M_2	L	1.35	1.42	1.53	8	0.0491	0.0586
	W	0.84	0.85	0.89	8	0.0325	0.0354
M_3	L	1.05	1.13	1 18	8	0.0312	0.0396
	W	0.60	0.67	0.98	8	0.0800	0.1196

Table 7. Meaurements of *Blarinella dubia* (BACHMAYER & WILSON, 1970) from Polgárdi 4.

Description. The skull is elongated, without saggital crest. The fossa infraorbitale is extremely deep. The external temporal fossa on the mandible usually extends ventrally to the level of the centre, but sometimes only to the top of the condyle. The spiculum coronoideum is slightly-developed. The upper articular facet of the condyle is cylinder-shaped and makes an angle of about 45° with the lower facet. The interarticular area is broad. The internal temporal fossa is triangular, high, and usually subdivided by a horizontal bar. The mandibular foramen is situated at the middle of the fossa. The mental foramen is placed under the re-entrant valley of M_1. Dental formula is

163/123. The upper incisor is not fissident. Its superior and posterior margins form a right angle. There is a broad buccal cingulum along the convex basal margin. The top of the apex and the talone are sharp and whitely coloured, the apex is long and down-curved. There are five antemolars present, decreasing in size from the first to the last, in the maxilla. All of them have a little second cusp beside the main cone, on the lingual cingulum. In P^4 the lingually placed parastyle is contacted with the paracone by a parastylar crest. The protocone forms an antero-lingual corner. The hypocone is only slightly raised from the ridge of the extended hypoconal flange. The posterior emargination is hardly notched. The M^1-M^2 trigones are posteriorly closed by a metaloph. $AW < PW$ on M^1 but $AW > PW$ on M^2. The hypocone is not developed, only the ridge is present on the deeply excavated hypoconal flange. The posterior margin is hardly concave. The very long mandibular incisor is bicuspulate, but a minute third cuspule originates behind the second one in many specimens. In the black coloured specimens the cusps are whitely pigmented. Cingulum is not appeared on the buccal side, but on the symphysal one it is present. A_1 has only one conid but A_2 seems to be two-cusped in buccal view. Broad cingulum is present on both sides of the mandibular antemolars. In M_1-M_2 the entoconid is placed very close to the metaconid and they are contacted together by a high entoconid crest. Cingula are not too broad, but the buccal one is somewhat more developed than the lingual one. The talonid of the third lower molar is not basined, it is reduced to one conid. The cingulum is weak on both sides.

		min.	mean	max.	spec. nr.	standard error	standard deviation
I^1	L	1.93	2.04	2.13	4	0.0550	0.0712
	H	1.18	1.25	1.28	4	0.0338	0.0409
P^4	LL	1.03	1.08	1.28	6	0.0389	0.0495
	BL	1.51	1.57	1.63	6	0.0367	0.0411
	W	1.50	1.61	1.68	6	0.0611	0.0670
M^1	LL	1.48	1.53	1.60	6	0.0367	0.0412
	BL	1.45	1.49	1.55	6	0.0233	0.0304
	AW	1.53	1.58	1.63	6	0.0322	0.0359
	PW	1.64	1.69	1.73	6	0.0217	0.0279
M^2	LL	1.33	1.37	1.43	6	0.0256	0.0325
	BL	1.35	1.41	1.48	6	0.0389	0.0446
	AW	1.60	1.67	1.73	6	0.0383	0.0435
	PW	1.50	1.55	1.65	6	0.0411	0.0506
M^3	L	0.65	0.70	0.75	4	0.0250	0.0354
	W	1.25	1.30	1.33	4	0.0300	0.0332
I_1	L	3.56	3.84	4.00	6	0.1344	0.1571
	H	0.84	0.86	0.91	6	0.0211	0.0243
M_1	L	1.48	1.58	1.65	10	0.0470	0.0531
	W	0.88	0.95	1.00	10	0.0360	0.0419
M_2	L	1.38	1.44	1.53	10	0.0480	0.0540
	W	0.80	0.88	0.98	10	0.0320	0.0445
M_3	L	1.13	1.14	1.18	9	0.0165	0.0445
	W	0.63	0.68	0.86	9	0.0165	0.0201

Table 8. Measurements of *Blarinella dubia* (BACHMAYER & WILSON, 1970) from Polgárdi 5.

Remarks. The living Asian *Blarinella quadraticauda* MILNE-EDWARDS, 1872 and the fossil European *Blarinella europaea* REUMER, 1984 are also ranged in this genus. *B. dubia* is one of the typical Late Miocene and Early Pliocene (Ruscinian) Soricinae shrew of Europe, but its First Appearance Date (FAD) is problematical. KRETZOI et al. (1976) and after them RABEDER (1985) and KORDOS (1991) reported this species from the Early Vallesian localities of Rudabánya (Hungary), but ZIEGLER & MÉSZÁROS (1998) who studied an other sample from Rudabánya could not find it in the site.

Genus *Zelceina* SULIMSKI, 1962

Type species. *Neomys soriculoides* SULIMSKI, 1959.

Zelceina soriculoides (SULIMSKI, 1959)

Text-Fig. 5, Pl. 2, Fig. 8

1959 - *Neomis soriculoides* n. sp. - SULIMSKI, p. 149, pl. III, figs 4 a-c, figs 5 c-d (Weze 1)
1960 - cf. *Neomys* sp. - Kowalski, p. 169 (Rebielice Królewskie)
1962 - *Zelceina soriculoides* (SULIMSKI, 1959) - SULIMSKI, p. 478, figs 2, 3a-c (Weze 1)
1964 - *Neomys soriculoides* (SULIMSKI, 1959) - KOWALSKI, p. 77 (Weze 1)
1984 - *Zelceina soriculoides* (SULIMSKI, 1959) - REUMER, p. 74, pl. 23, figs 1-7 (Csarnóta 2)
1990 - *Zelceina soriculoides* (SULIMSKI, 1959) - RZEBIK-KOWALSKA, p. 69, fig. 9 (Weze 1, Rebielice Królevskie)

Type material. 1 rostral part of a skull with the complete dentition, 1 left mandible, 1 right mandible, No 160, 700, 119, SULIMSKI 1959, p. 149 fig. 5 c-d, Type locality: Weze 1, Poland, Pliocene, MN 15.

Stratigraphical range. Late Miocene (Turolian, MN 13) - Pliocene (Ruscinian, MN 16), Middle Europe.

Studied material. Polgárdi 4: 3 right and 4 left mandible fragments. Figured specimen: GMH, V. 20724.

Measurements. See Tab. 9.

Description. The coronoid process of the mandible is high, its anterior margin is concave, the posterior one has an undulation in some specimens. The coronoid process is very short. The external temporal fossa, with deep upper part, reaches downwards to the level of the upper sigmoid notch. The undivided internal temporal fossa extends upwards to the middle of the coronoid process. The upper condylar facet is cylindrical, the lower one is elongated, the interarticular area is narrow. The mental foramen is palced under the re-entrant valley of M_1, the mandibular one under the middle or the posterior part of the internal temporal fossa.The mandibular incisor is bicuspulate, the apex is sharp and curved, both cuspules are placed far anteriorly, the posterior part of the tooth is elongated. The buccal cingulum surrounds the posterior part, the symphysial one reaches along the posterior and the inferior margins. The two-cusped A_2 has well-developed buccal and lingual cingula. The entoconid crest is moderately high in M_1-M_2, the cingulum is present on both sides. The talonid of the third molar is narrow, but slightly basined, with two conids.

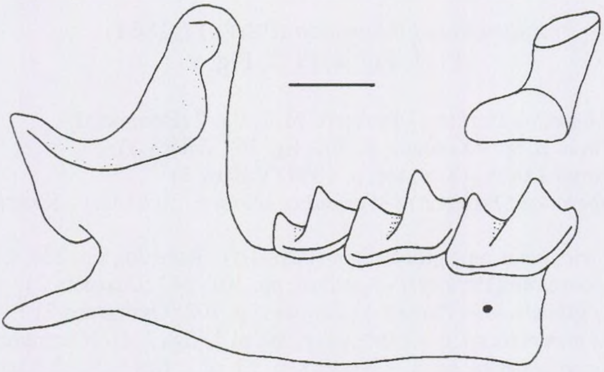

Fig. 5. *Zelceina soriculoides* (SULIMSKI, 1959). GMH V. 20724., loc. Polgárdi 4 "lower", right mandible fragment with M_1-M_3, lateral view and the condyle, posterior view; scale bar = 1 mm.

Remarks. RZEBIK-KOWALSKA (1990) described a smaller and more primitive *Zelceina* from the Early Ruscinian of Poland, as *Z. podlesicensis*. She suggested that this form could be an ancestor of *Z. soriculoides*. The recent researches extend the stratigraphical range of the studied species. The Polgárdi occurrence is the European FAD of the genus, thus the mentioned genealogy is unproved. One further species (*Zelceina kormosi*) is reported from Asia, which "seems more closely related to Z. podlesicensis" than to *Z. soriculoides* (STORCH 1995).

		min.	mean	max.	spec. nr.	standard error	standard deviation
I_1	L	2.78	2.79	2.80	2	-	-
	H	0.73	0.77	0.80	2	-	-
M_1	L	1.40	1.43	1.50	4	0.0375	0.0433
	W	0.80	0.85	0.88	4	0.0325	0.0342
M_2	L	1.23	1.28	1.33	5	0.0224	0.0319
	W	0.75	0.77	0.81	5	0.0248	0.0258
M_3	L	1.01	1.03	1.06	5	0.0192	0.0206
	W	0.58	0.61	0.63	5	0.0168	0.0185

Table 9. Measurements of *Zelceina soriculoides* (SULIMSKI, 1959) from Polgárdi 4.

Tribe Soriculini Kretzoi, 1965

Genus *Asoriculus* Kretzoi, 1959

Type species. *Asoriculus gibberodon* (Petényi, 1864).

Asoriculus gibberodon (Petényi, 1864)

Pl. 1, Fig. 4, Pl. 2, Fig. 9

1864 - *Crocidura gibberodon* Petényi - Petényi, pl. 1, fig. 7 (Beremend)
1934 - *Soriculus kubinyii* n. sp. - Kormos, p. 303, fig. 36 (Villány 3)
1937 - *Soriculus kubinyii* Korm. - Kormos, p. 1090 (Villány 3)
1956 - *Soriculus gibberodon* (Petényi) (=*Soriculus kubinyii* Kormos) - Kretzoi, pp. 61, 184 (Villány 3)
1959 - *Soriculus* (*Asoriculus* n. sg.) *gibberodon* (Petényi) - Kretzoi, pp. 238, 245 (Csarnóta 2)
1962 - *Asoriculus gibberodon* (Petényi) - Kretzoi, pp. 301, 342 (Csarnóta 2)
1973 a - *Episoriculus gibberodon* (Petényi) - Jánossy, p. 102 (Osztramos 7)
1973 b - *Episoriculus tornensis* sp. n. - Jánossy, p. 50, pl 1, figs 1, 10 (Osztramos 13)
1973 b - *Episoriculus borsodensis* sp. n. - Jánossy, p. 53, pl 1, figs 5, 9, 13 (Osztramos 1)
1974 - *Episoriculus tornensis* Jánossy - Jánossy, p. 18 (Osztramos 9)
1977 - *Episoriculus borsodensis* Jánossy - Jánossy & Kordos, p. 41 (Osztramos 1)
1977 - *Episoriculus gibberodon* (Petényi) - Jánossy & Kordos, p. 47 (Osztramos 7)
1977 - *Episoriculus tornensis* Jánossy - Jánossy & Kordos, p. 51 (Osztramos 13)
1978 - *Episoriculus gibberodon* (Petényi) - Jánossy, p. 69 (Osztramos 7)
1979 - *Episoriculus gibberodon* (Petényi) - Jánossy, pp. 23, 27, 34 (Csarnóta 2, Osztramos 7, Villány 3)
1981 - *Episoriculus borsodensis* Jánossy, 1973 - Rzebik-Kowalska, p. 236, figs 3-4 (Podlesice)
1981 - *Episoriculus gibberodon* (Petényi, 1864) - Rzebik-Kowalska, p. 245, fig. 6 (Weze 1)
1984 - *Episoriculus gibberodon* (Petényi, 1864) - Reumer, p. 92, pl. 27, figs 3-11, pl. 28, figs1-12, pl. 29, figs 1-4, pl. 30, figs 1-4, pl 31, figs 1-2 (Osztramos 1, 7, 9, 13, Csarnóta 2, Villány 3)
1994 - *Episoriculus gibberodon* (Petényi, 1864) - Rzebik-Kowalska, p. 81 (Podlesice, Zamkowa Dolna A, B, Zalesiaki 1 B, Weze 1, Rebielice Królevskie 1A, 2, Kielniki 3 B)
1995 - *Asoriculus gibberodon* (Petényi, 1864) - Doukas et al., p. 58, pl. 7, figs 1-4 (Maramena)
1998 a - *Episoriculus gibberodon* (Petényi, 1864) - Mészáros, p. 108, pl. 3, figs 1-11 (Tardosbánya)

Neotype. A skull with nearly complete dentition, GMH - OB. 3685., Kormos (1934), p. 304, fig. 36. Type locality: Beremend (Hungary, Early Villányian, MN 16), neotype locality: Villány 3 (Hungary, Late Villányian, MN 17).

Stratigraphical range. Late Miocene (Turolian, MN 12) - Pliocene (Villányian, MN 17)

Studied material. Polgárdi 4: 1 fragmentary skull, 41 left and 32 right mandibles, 6 left and 5 right maxillary fragments, 1 left I^1, 1 right M^1. Figured specimens: GMH, V. 20722.

Measurements. See Tab.10.

		min.	mean	max.	spec. nr.	standard error	standard deviation
I^1	L	-	3.88	-	1	-	-
	H	-	1.06	-	1	-	-
P^4	LL	0.80	0.87	0.93	7	0.0331	0.0406
	BL	1.26	1.40	1.50	7	0.0669	0.0792
	W	0.90	1.27	1.46	7	0.2114	0.2364
M^1	LL	1.30	1.38	1.48	7	0.0359	0.0508
	BL	1.33	1.37	1.43	7	0.0265	0.0316
	AW	1.33	1.41	1.5	7	0.0465	0.0547
	PW	1.49	1.54	1.58	7	0.0371	0.0393
M^2	LL	-	1.05	-	1	-	-
	BL	-	1.15	-	1	-	-
	AW	-	1.50	-	1	-	-
	PW	-	1.34	-	1	-	-
I_1	L	2.89	2.90	2.92	2	-	-
	H	0.80	0.80	0.81	2	-	-
M_1	L	1.15	1.46	1.58	8	0.0978	0.1304
	W	0.76	0.83	0.90	8	0.0375	0.0474
M_2	L	1.20	1.35	1.48	9	0.0630	0.0785
	W	0.68	0.79	0.95	9	0.0635	0.0789
M_3	L	0.95	1.06	1.18	8	0.0643	0.0704
	W	0.53	0.61	0.70	8	0.0338	0.0020

Table 10. Measurements of *Asoriculus gibberodon* (PETÉNYI, 1864) from Polgárdi 4.

Description. The coronoid process of the mandible is high, with concave anterior margin. The interarticular area of the condyle is narrow, the upper articular facet is cylindrical, the lower one is strongly elongated in lingual direction. The mandibular foramen is situated under the posterior part of the internal temporal fossa. The mental foramen is below the protocone of the M_1 or somewhat behind it (at the re-entrant valley). The internal temporal fossa relatively to the coronoid process is small and narow, or continues upwards as a shallow groove into the upper part of the process. The mandible is elongated, the lower margin of the horizontal ramus is concave. The upper incisor is slightly fissident. The dorsal and the posterior margins form a sharp angle. The convex posterior margin is provided with a broad cingulum. The top of the talone is sharp. The P^4 parastyle is protruding, it is connected to the high paracone by a narrow parastylar crest. The protocone is separated from the well-developed hypocone by a valley. The hypoconal flange is bordered by a high ridge, the posterior margin is deeply notched. The M^1 protocone and the hypocone are separated by a wide valley. All the cones of the trigone are well developed, the trigone basin is very deep. The talone is short, because the posterior margin is deeply notched. AW < PW, the parastyle is shorter than the metastyle. M^2 is a morphologically very similar tooth to the previous one, but AW > PW and the metastyle is about same sized as the parastyle. There are two cuspules behind the sharp, up-turned apex of the lower incisor. The anterior cuspule is slightly developed, but the posterior one is high. A buccal cingulum runs along the whole basal margin of the tooth. The lower antemolars are provided with cingula on both sides. There is only one cusp in A_1, but A_2 is two-cusped. The entoconid crest is present in M_1-M_2. The lingual end of the postcristid and the entoconid are separated by a deep valley. The cingula are present either on the buccal or the lingual sides. Weak buccal and lingual cingula are present in the third lower molar. The talonid is basined and both conids are visible on the posterior margin.

Remarks. The type material of *Crocidura gibberodon* PETÉNYI 1864 (Beremend, Hungary) has been lost. KORMOS (1934) described the same species from the Hungarian Villány 3 site as *Soriculus kubinyii*. Its type material is stored in the collections of the Geological Museum of Hungary. KRETZOI (1962) classified the species as *Asoriculus*. REPENNING (1967) ranged it in *Episoriculus* and this classification became widenly excepted. JÁNOSSY (1973) described two new species, *E. tornensis* and *E. borsodensis* from Osztramos. RZEBIK-KOWALSKA (1981) thought possible that all European *Episoriculus* forms belong to *E. gibberodon*. REUMER (1984) included all Hungarian forms in *Episoriculus gibberodon*. HUTTERER (1994) excluded all fossil forms from genus *Episoriculus*, so *Asoriculus* KRETZOI, 1959 is the valid name for *gibberodon*.

Subfamily and tribe Soricidae incertae sedis
Genus *Paenelimnoecus* BAUDELOT, 1972

Type species. *Paenelimnoecus crouzeli* BAUDELOT, 1972.

Paenelimnoecus repenningi (BACHMAYER & WILSON) 1970
Text-Fig. 6, Pl. 2, Fig. 5

1911 - *Sorex* sp. - KORMOS, p. 57 (Polgárdi 2)
1954 - Soricidarum g. et sp. indet. I. - KRETZOI, p. 49. (Csákvár)
partim 1954 - Soricidarum g. et sp. indet. II. - KRETZOI, p. 49. (Csákvár)
1970 - *Petenyiella ? repenningi* n. sp. - BACHMAYER & WILSON, p. 549, figs 7, 32, 32a, 33, 50, 50a (Kochfidish)
1978 - *Petenyiella ? repenningi* - BACHMAYER & WILSON, p. 139, fig. 3 (Kochfidish)
1984 - *Petenyiella repenningi* BACHMAYER & WILSON, 1970 - KRETZOI, p. 216 (Sümeg)
1996 - *Paenelimnoecus repenningi* (BACHMAYER & WILSON, 1970) - MÉSZÁROS, p. 15, pl. 4, figs 7 a-d (Sümeg, Csákvár)
1988 a - *Paenelimnoecus repenningi* (BACHMAYER & WILSON, 1970) - MÉSZÁROS, p. 109, pl. 4, figs 1-10 (Tardosbánya)

Holotype. Left lower jaw fragment with M_1-M_3, NHMV, Div. Geol. Paleont., 1970/1388. (BACHMAYER & WILSON 1970, p. 549, fig. 33.) Type locality: Kohfidisch (Austria, Late Vallesian, MN 10).

Stratigraphical range. Late Miocene (Early Vallesian, MN 9 - Late Turolian, MN 13), Europe.

Studied material. Polgárdi 4: 7 left and 15 right mandibles. Polgárdi 2: 1 right mandible fragment. Figured specimens: GMH, V. 20725.

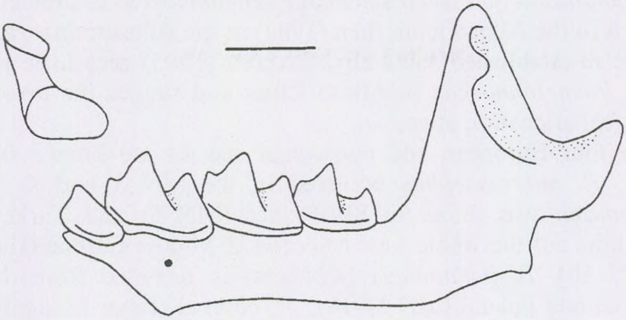

Fig. 6. ***Paenelimnoecus repenningi*** (BACHMAYER & WILSON, 1970). GMH V. 20725., loc. Polgárdi 4 "upper", left mandible fragment with A_2-M_3, lateral view and the condyle, posterior view; scale bar = 1 mm.

		min.	mean	max.	spec. nr.	standard error	standard deviation
I_1	L	-	2.30	-	1	-	-
	H	-	0.56	-	1	-	-
M_1	L	1.18	1.23	1.29	9	0.0388	0.0412
	W	0.65	0.72	0.95	9	0.0573	0.0848
M_2	L	1.06	1.18	1.26	11	0.0367	0.0507
	W	0.56	0.69	0.95	11	0.0655	0.0954
M_3	L	0.83	0.90	0.93	10	0.0284	0.0331
	W	0.48	0.58	0.70	10	0.0688	0.0767

Table 11. Measurements of *Paenelimnoecus repenningi* (BACHMAYER & WILSON, 1970) from Polgárdi 4.

Measurements. See Tab. 11.

Description. The coronoid process is high and narrow, its top is rounded, the anterior margin is concave. The coronoid spicule is small, the external temporal fossa usually extends downwards to the middle of the condyle. The upper facet of the condyloid process is oval, the interarticular area is short and narrow. The internal temporal fossa is triangular or subtriangular and higher than wide. Its lower margin is horizontal or ascending backwards. The mandibular foramen is placed under the middle or the posterior part of the fossa, the mental one under the re-entrant valley of M_1. There is no cingulum on the buccal side of the bicuspulate mandibular incisor. In buccal view a small extra conid is visible behind the main conid of the lower antemolars. A_1 is far smaller than A_2. Entoconid crest is not appeared in M_1-M_2. The buccal and lingual cingula are weak. The talonid of M_3 is reduced to a single cusp. Weak cingulids are present both on the buccal and lingual sides.

Remarks. The subfamiliar and tribal status of *Paenelimnoecus* is problematic. REUMER (1984) arranges it in the Allosoricini, then (1992) in the Allosoricinae, and gives a new diagnosis for the re-established subfamily. STORCH (1995) sees little justification for the inclusion of *Paenelimnoecus* in Allosoricines and ranges the taxon in Soricinae and leaves the tribal allocation open.

By this time four European and one Asian species are known from the genus *Paenelimnoecus. P. micromorphus* occurred in the MN 3 and 4 Zones of SW-Germany. *P. crouzeli* was found in SW-France (MN 6) and Turkey (MN 8). *P. repenningi* throughs out the whole Late Miocene of Middle Europe (Hungary, MN 9-13, Austria, MN 10). *P. pannonicus* (KORMOS) is recorded from the Pliocene of Hungary, Romania and Poland (MN 14-16). *P. obtusus* (Inner Mongolia, China, MN 13) represents the only extra-European record of this genus. On the basis of the morphology, the specimens under discussion are classified as *P. repenningi*.

Discussion

Biostratigraphy

KORDOS (1991 a), on the basis of the cricetid remains correlated the Polgárdi karstic cavity fills with the Late Turolian MN 13 Zone, but noted that locality 2 is somewhat younger than the entirely contemporaneous others. This view is supported by the shrews. The exclusive attendance of the subfamily Soricinae and the occurrences of the typical Late Miocene elements (*Crusafontina*, *B. dubia*, *P. repenningi*) in the faunas make us sure that the assemblages can be correlated with the Late Miocene (Vallesian and Turolian). The presence of *C. kormosi* indicates younger age than the Vallesian Sümeg locality (MN 10), and its measurements suggest that the faunas are later than Tardosbánya (MN 12) (MÉSZÁROS 1998 b). According to MÉSZÁROS (1998 a) the first appearance of *Asoriculus gibberodon* is in Tardosbánya, thus its Polgárdi appearance dates the sites after the MN 11/12 boundary. According to the results of the present studies *Zelceina* and *Kordosia* emerge in the MN 13 Zone.

Thus, the shrew occurrences correlate Polgárdi 4 with the MN 13 Zone. It is spearated from the MN 12 Zone by the emergence of *Zelceina*. It is older than Polgárdi 2, where *Crusafontina* is already disappeared. The appearance of *Kordosia* in Polgárdi 2 suggests somewhat younger age than Polgárdi 4, but the great difference between the two faunas seems to be rather ecological than stratigraphical. Because the stratigraphical order of locality 2 and 5 cannot be cleared by shrews, we accept the stratigraphical classification of KORDOS (1991) that Polgárdi 2 is younger than the other sites.

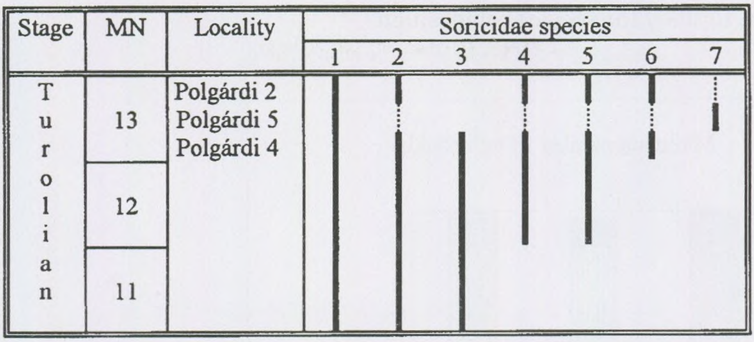

Fig. 7 Soricidae occurrences in the Polgárdi localities. 1 - *Blarinella dubia*, 2 - *Paenelimnoecus repenningi*, 3 - *Crusafontina kormosi*, 4 -*Amblycoptus oligodon*, 5 - *Asoriculus gibberodon*, 6 - *Zelceina soriculoides*, 7 - *Kordosia topali*

Taphonomy

The Polgárdi fossil assemblages enable detailed taphonomical researches, but that would require a special project. Herein only an overview of the modifications, apparent on the shrew bones and teeth, is presented.

The white and tawny tone of the bones could have been caused by siliceous and ferruginous mineralizing solutions. The black coloration of many remains indicates periodic soil-wash into the karstic cavity. Humine acids produced in-cave-corrosion on few mandibles. The material is excellently preserved, a great majority of the teeth are in situ. Digested enamel is recorded in few specimens, but their amount is negligible in the great number of the fossils. The relative frequency of isolated teeth is very low. Nearly all humeri in the microbone samples came from juvenile animals (M. ARMOUR-CHELU, pers. comm.)

The taphonomic features of the Polgárdi 4 and 5 assemblages suggest principally pit-fall accumulations. Most of the soricids were fallen alive into the fissures. The shrews could hardly escape from the deep pits: they die in the moment when they are ambushed, or - because of their remarkably fast metabolism - a short time after. Some in-cave bone movements before the fossilisation is marked by the breakage of the extraordinarily fragile bones (for example the aboral part of the skull).

KORMOS (1911), by the multitudinous occurrence of the micromammal bones, presumed predator birds to deposit the fossil assemblage of Polgárdi 2. The present studies did not find digestive corrosion caused by the bird stomach on the shrew bones and teeth from the classical site. As far as we can restore it from the sketch of KORMOS (1911), the micromammals came from a perpendicular, chimney-like branch of the cave, which would have permited pit-fall accumulation.

The way of deposition of the Polgárdi vertebrate fossils is particular not only taphonomically but also paleoecologically. The high species diversity difference between localities 4 and 5 necessitates detailed ecological analysis (see below). The pit-fall accumulations usually give unselective samples from the ancient faunas, and it is a good chance to study the species composition.

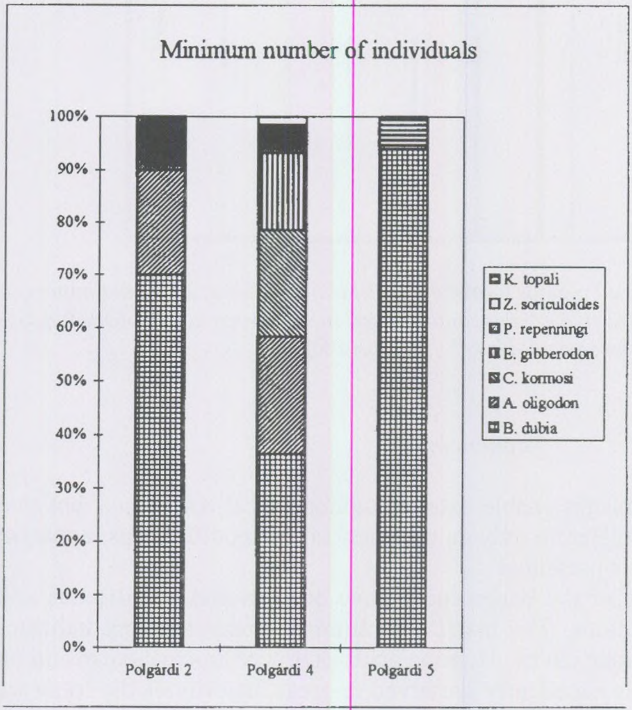

Fig. 8. Species diversity of the Polgárdi Soricidae faunas.

Palaeoecology

We apply two different methods to answer the paleoecological questions about the studied localities.

The subfamily composition of the soricid faunas gives information on the climate. The extant Crocidosoricinae and Heterosoricinae are adapted to more humid climate with balanced temperature than the recent Soricinae. The two living European subfamilies differ mainly in their preferences concerning humidity: Crocidurinae are adapted more arid conditions than Soricinae. Besides, soricines can abide colder environments and higher altitudes above sea level than crocidurines (RZEBIK-KOWALSKA, 1995).

The generic analysis of the Soricidae communities comes in useful in the determination of the biocenoses in which they lived. For the paleoecological availability of the shrew genera, if they are still living, we have to know their recent cenological preference. If the group is extinct, we need localities with known paleoecology to define its habitats.

Climate

Because of the climatic turnover, there was a great change in the Soricidae fauna of Europe during the Late Miocene (RZEBIK-KOWALSKA 1995). The somewhat colder and most arid climate caused lower diversity, then disappearance of Crocidosoricinae and Heterosoricinae shrews, with immigration of Soricinae ones. The great species number of the European soricines appears simultaneously with the coming up of the Hipparion fauna. While the larger mammals and rodents indicate mainly a steppe vegetation in the Late Miocene of the Pannonian Basin, the soricids suggest not so open environments. Their occurrences in most cases are related to somewhat more humid microclimates in mountain areas or by local water bodies.

The lack of subfamilies Heterosoricinae and Crocidosoricinae and the great diversity of the Soricinae in Polgárdi indicate herein more continental climate than in the Middle Miocene. The absence of the Crocidurinae suggest that the weather conditions were not so dry as in some periods of the Pliocene and the Pleistocene.

Habitat

On the basis of their very close relation to the extant *Anourosorex squamipes,* living in the mountain forests of SE-Asia, *Amblycoptus* and *Crusafontina* may be indices of well watered, forested environments. The very similarly evolved dentition of *A. oligodon* suggests adaptation to such malacophagous diet as the recent *Anourosorex*. *Crusafontina* is described from wooded or at least partly wooded areas. Rudabánya should have been a basin of a relatively large area with diversified vegetation, including also forests (KORDOS, 1982). STORCH (1978) mentioned Dorn-Dürkheim as a well watered, forested biotope. Although, BACHMAYER & WILSON (1970) described Kohfidisch as a largely open grassland, but with local bodies of water and restricted woodland areas.

The palaeoecology of *Kordosia*, the third recorded Anourosoricini from Polgárdi, is more problematic. While REUMER (1984) supposed this species to had been living in forested areas, by its peculiar attendance in Polgárdi 5, we should accept *Kordosia topali* as a suggestive of somewhat more open environment. Osztramos 1, from where *K. topali* was first described, was a "mixed nature with forests prevailing over the steppeic vegetation" (JÁNOSSY 1972). Its close relations to *Kordosia jessiae*, described by DOUKAS (DOUKAS et al. 1995) from the Mediterranean area, proofs that *Kordosia topali* would have prefered similar climate. However DOUKAS et al. (1995) determined Maramena, the type locality of *K. jessiae* as forested area, thus we can suppose that in its occurrence *Kordosia* insisted rather on temperature, than on vegetation. Because of its markedly southern geographical position, the Mediterranean-like warm microclimate can grow up only the south-facing, open mountain-sites in the Carpathian Basin. In this *Kordosia* can mark forests in the Mediterranean, while open fields in the northern regions. Its occurrences in the Carpathian Basin should not indicate climatic changes, but special habitat in the surroundings of the locality (see below).

Paenelimnoecus is an extinct genus, while the recent *Blarinella* lives in the mountain woods in Asia. *P. repenningi* and *B. dubia* occur in the Hipparion fauna of the European Late Miocene, but usually in local wooded areas, mentioned also for *Crusafontina*. However we can suppose that *Blarinella* could make a living also in different habitats in the Middle Miocene, because it is present even in Polgárdi 2, a locality where any forest forms are lacking.

According to REUMER (1984) *Episoriculus (Asoriculus) gibberodon* indicates the presence of open water with a good covering of wooded vegetation.

Microclimatic events

The palaeoecology of Polgárdi raises some interesting problems. KORDOS (1991 a), on the basis of the Cricetidae fauna, correlated all the three sites with the MN 13 Zone, but noted that localities 4 and 5 are from same age, while locality 2 is somewhat younger than the previous ones. However, the shrew composition of Polgárdi 4 and 2 is particularly similar (and by the *Crusafontina*, *Paenelimnoecus*, *Amblycoptus* and *Asoriculus* occurrence, indicates wooded vegetation), while the soricid community of Polgárdi 5 is significantly different. Only *Blarinella dubia* is the common form with the others and, with the here first appeared *Kordosia topali*, the number of the species is only two. The diversity of the fauna is strongly decreased from site 4 to 5 (from six to two species).

Because of the great quantity of the bones and teeth from site 5, this phenomenon could not be explained by the accidental lost of some species under the deposition, the fossilization or the collection. The dissappearance of some forest shrews could be caused by chance rather in the somewhat poorer material from site 2. The definitely different age of locality 5 from the other sites is out of the question by the stratigraphical classification of KORDOS (1991 a), based on Cricetidae, which correlated all Polgárdi localities with the Late Turolian MN 13 Zone. The taphonomical features exclude the opportunity of selective accumulation, because the little animals usually fall into the natural pits without selection and the specific composition of the fossil assemblage is the same as that of the ancient community We cannot suppose biogeographical barrier between sites 4 and 5, because they are close together, both are parts of the same cave system. Most probably, the differences between the Polgárdi Soricidae faunas are by ecological causes. These circumstances are well-marked by the palaeoecologically very useful pit-fall samples.

The differences in the shrew species composition should not indicate macroclimatic, rather - geologically very fast - microclimatic events. These changes might be caused by the disappearance of the wooded environment (site 4) from a karst region, decreasing also the shrew diversity. Appearing of a more open nature would have resulted somewhat warmer climate, where Mediterranean faunas and floras could live, as we can see in some open karst fields in southern Hungary recently as well (for example Szársomlyó Hill, Villányi Mountains). *Blarinella*, which we have to see as a very successful "opportunist" genus in the Late Miocene, is further present, the forest-preferring genera are disappeared, and the warm-adapted, Mediterranean *Kordosia* emerges (site 5). After a long (but geologically short) period, according to the general succession of the secondary grasslands, denser vegetation developed in the limestone hill, in which forest genera (*Paenelimnoecus* and *Amblycoptus*) could live again (site 2).

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PLATES

Plate 1

Figs 1-3. *Blarinella dubia* (BACHMAYER & WILSON, 1970). GMH V. 20723.; loc. Polgárdi 4 "upper", 1 = left mandible fragment with the complete dentition, a = the horizontal ramus, lateral view; x 13; b = the dentition, buccal view; x 31; 2 = complete left mandible, a = medial view; x 13; b = the dentition, medial view; x 30; 3 = right maxillary fragment with P^4-M^3, occlusal view; x 16.

Fig. 4. *Asoriculus gibberodon* (PETÉNYI, 1864). GMH V. 20722., loc. Polgárdi 4 "upper", complete left mandible, lateral view; x 20.

Fig. 5. *Paenelimnoecus repenningi* (BACHMAYER & WILSON, 1970). GMH V. 20725., loc. Polgárdi 4 "upper", left ascending ramus of the mandible, medial view; x 22.

Plate 2

Figs 1-3. *Kordosia topali* (JÁNOSSY 1972). GMH V. 20721., loc. Polgárdi 5, 1 = left horizontal ramus of the mandible with A_1-M_2, lateral view; x 14; 2 = right M^1, occlusal view; x 26; 3 = left I_1, buccal view, x 13.

Figs 4-7. *Amblycoptus oligodon* KORMOS 1926. GMH V. 20720., loc. Polgárdi 4 "upper", 4 = left mandible fragment with A_1-M_1, lateral view; x 19; 5 = right I^1, buccal view; x 22; 6 = right I_1, buccal view, x 15; 7 = right A^1, occlusal view; x 32.

Fig. 8. *Zelceina soriculoides* (SULIMSKI, 1959). GMH V. 20724.; loc. Polgárdi 4 "lower", left ascending ramus of the mandible, medial view; x 20.

Fig. 9. *Asoriculus gibberodon* (PETÉNYI, 1864). GMH V. 20722., loc. Polgárdi 4 "upper", right mandible fragment with M_2, medial view; x 30.

Fig. 10. *Crusafontina kormosi* (BACHMAYER & WILSON, 1970). GMH V. 20718., loc. Polgárdi 4 "lower", right upper incisor, buccal view; x 23.

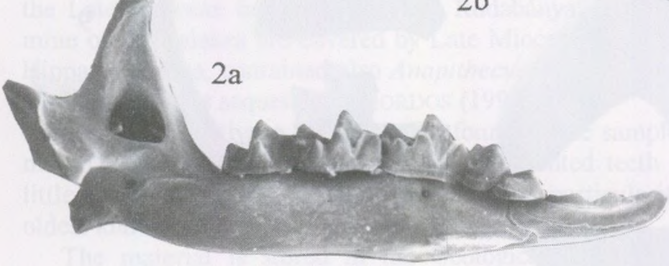
Figs 11-12. *Blarinella dubia* (BACHMAYER & WILSON, 1970). GMH V. 20723.; loc. Polgárdi 4 "upper", 11 = left upper incisor, buccal view; x 34; 12 = right M_3, occlusal view; x 70.

Plate 1


1b


1a


2b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4

Plate 2


1


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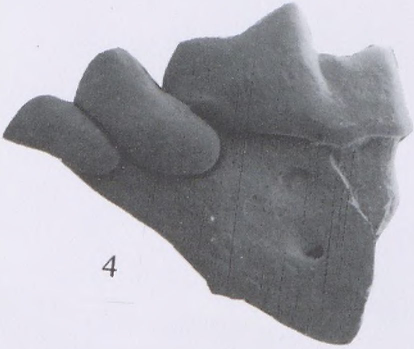
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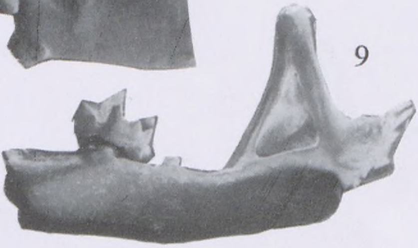
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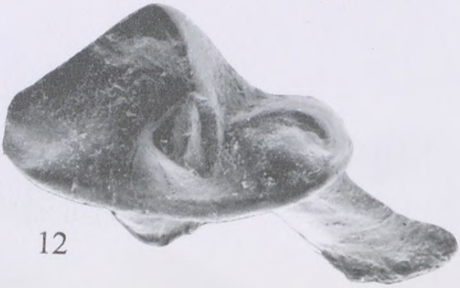
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Some insectivore (Mammalia) remains from the Late Miocene locality of Alsótelekes (Hungary)

L. GY. MÉSZÁROS[1]

(with 1 figure, 2 tables and 3 plates)

Abstract

Six Insectivora species (*Plesiosorex* sp., *Florinia* cf. *stehlini*, *Allosorex* cf. *stenodus*, *Crusafontina endemica*, *Miosorex* sp., Soricinae gen. et sp.) were found in the Alsótelekes Late Miocene fossil material. The incectivores allow for an allocation into the Early Vallesian MN 9 Zone. The fauna is indicative of humid, forested vegetation. The taphonomic features of the teeth suggest long transport by water before the lacustrine accumulation of the remains.

Introduction

Alsótelekes village (North Hungary, Borsod-Abaúj-Zemplén county) is situated at the soutwestern margin of the Rudabánya mountains, about 5 kilometres northeast of the Late Miocene hominoid locality, Rudabánya. The Triassic gipsum layers of the mine of Alsótelekes are covered by Late Miocene lacustrine and fluvial sediments. A Hipparion fauna, contained also *Anapithecus* remains, was collected in 1993 from the lower part of this sequence by KORDOS (1997).

Only 15 insectivore remains were found in the sample by the present author. The material contains mainly isolated and fragmented teeth (see Tab. 1.) However, this little and poorly preserved material has great particularity, because so far this is the oldest known insectivore fauna from Hungary.

The material is stored in the Geological Museum of Hungary (GMH) of the Geological Institute of Hungary (cat. nr.: V. 20648 - V. 20651.) The SEM photos were made in the Scanning Electronmicroscope Laboratory of the Geological Institute,. Eötvös University. The measurements are taken after REUMER (1984, Fig. 4) in millimetres. The morphological nomenclature and the abbreviations are used after REUMER (1984, pp. 5-6, Figs 1-3).

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Insectivora species	number of specimens	minimum nr. of individuals	isolated teeth
Plesiosorex sp.	2	1	2
Florinia cf. *stehlini*	1	1	1
Allosorex cf. *stenodus*	3	1	3
Crusafontina endemica	7	2	7
Miosorex sp.	1	1	0
Soricinae gen. et sp.	1	1	0
Total number	15	9	13(86.66%)

Table 1. The catalogue of the Alsótelekes insectivores

Systematic part

Classis Mammalia LINNAEUS 1735
Order Insectivora BOWDICH 1821
Family Metacodontidae BUTLER 1948
Genus *Plesiosorex* POMEL 1854

Type species: *Erinaceus soricinoides* BLAINVILLE 1838, Chaufour, France, Oligocene, Stampian.

Occurrence: Middle Oligocene - Late Miocene (MN 9), Europe, Asia and North America.

Plesiosorex sp.

Pl. 1, Figs 1-2

Studied material and measurements: 1 right M_1 fragment (TRD L = 1.60, TRD W = 1.20) and 1 left M_2 fragment (TRD L = 1.20, TRD W = 1 16).

Description

M_1 - The trigonid of this big tooth is deeply basined, it is lingually curved. The highest cusp is the protoconid, well separated from the metaconid. The paralophid is divided by a fissure. The ectocingulid is bent upwards below the protoconid.

M_2 - The trigonid is very short. The paraconid is low, the higher proto- and metaconid are same in size. A large ectocingulid is present in the anterior side of the tooth.

Family Soricidae GRAY 1821
Subfamily Crocidosoricinae REUMER 1987
Genus *Florinia* ZIEGLER 1989

Type species: *Sorex stehlini* DOBEN-FLORIN 1964, Wintershof-West, Germany, Early Miocene, Orleanian, MN 3.

Occurrence: Early Miocene (MN 3) - Late Miocene (MN 9), Europe.

Florinia cf. *stehlini* (DOBEN-FLORIN, 1964)

1964 - *Sorex stehlini* - DOBEN-FLORIN, p. 41, pl. 5, figs 1, 2, 6-8 (Wintershof-West).
1989 - *Florinia stehlini* (DOBEN-FLORIN, 1964) - ZIEGLER, p. 45, pl. 6, figs 1-3 (Petersbuch 2, Erkersthofen).
1994 - cf. *Florinia stehlini* (DOBEN-FLORIN, 1964) - Rzebik-Kowalska, p. 138, fig. 1a (Belchatów).

Holotype: lower jaw fragment with M_1-M_3, DOBEN-FLORIN (1964), p. 41, tab. 5, figs 1 a-h. Type locality: Wintershof-West (Germany, Orleanian, MN 3).

Studied material: 1 left I_1 fragment. Because of the bad preservation of the tooth, the detailed measurements could not be taken.

Description

I_1 - The apex is sharp, up-turned. The lower incisor is bicuspulate, the first cuspule is low, the second one is higher and longer. The incisor is very fragmented, but its size and the significantly shaped cuspules refer it to *Florinia* cf. *stehlini*.

Miosorex KRETZOI 1959

Type species: *Sorex pusillus* var. *grivensis* DEPÉRET 1892, Grive-Saint-Alban (Isére) (France Vindobonian, MN 4).

Occurrence: Early Miocene (MN 2) - Late Miocene (MN 9), Europe.

Miosorex sp.
Tab. 1, Figs 3 a-c

Studied material and measurements: 1 right mandible fragment with M_3 and the fragment of M_1-M_2, (M_1 L = 2.03, M_3 L = 0.97, W = 0.58), GMH - V. 20648.

Description

Mandible - The foramen mentale is situated under the M_1 protocone.

M_1 - M_2 - These molars are very fragmented. The post- and the ectocingulids are well developed. The postentoconid valley is shallow on M_1.

M_3 - The oblique crest ends between the proto- and metaconid. The talonid is basined, the hypoconid and the entoconid are present, but the postentoconid valley is absent. A well developed cingulid runs round the tooth.

Subfamily Allosoricinae FEJFAR 1966

Genus *Allosorex* FEJFAR 1966

Type species: *Allosorex stenodus* FEJFAR 1966, Ivanovce, Slovakia, Late Pliocene, Ruscinian, MN 15.

Occurrence: Late Miocene (MN 9) - Pliocene (MN 15), Europe.

Allosorex cf. *stenodus* FEJFAR 1966

Pl. 3, Figs 11-13

1966 - *Allosorex stenodus* nov. gen., nov. sp. - FEJFAR, p. 227, figs 1-9, Ivanovce.

Holotype: right mandible fragment with the lower incisor, SÚÚG, OF, No. 651 273., type lcality: Ivanovce, Slovakia, Late Pliocene, Ruscinian, MN 15.

Occurrence: Late Miocene (MN 9) - Pliocene (MN 15), Europe.

Studied material and measurements: 1 right M^1 (AW = 1.96, LL = 1.70), 1 right M_1 (L = 2.03, W = 0.98), 1 right M_2 (L = 1.68, W = 0.90).

Description

M^1 - The protocone and the metacone are strong, the paracone and the hypocone are also well developed, but somewhat lower than the previous ones. The metastyle is broken, the parastyle and the metastyle are about the same in their length. The trigon basin is deep, the the talon is emarginated. The mesostyle is not divided.

M_1 - The talonid is broken, so the entoconid crest and the postentoconid valley could not be studied. The trigonid is much longer than the talonid. Weak cingula are present on the buccal and the posterior sides.

M_2 - The trigone is very long, the talonid basin is deep, the postentoconid valley and the entoconid crest are well developed. Cingulum is preserved only on the antero-buccal part.

Remarks: The big-sized, specially adapted lower molars (the trapezoid posterior part of the long trigonid, the strong cutting edge between the proto- and the paraconid, the U-shaped valley in the lingual side of the trigonid, the deep postentoconid valley) refer the Alsótelekes *Allosorex* to the type species, described by Fejfar (1966) from the Late Pliocene of Slovakia. The Alsótelekes specimens are somewhat shorter than the Ivanovce ones (Fejfar 1966, p. 236, tab. 4.).

Subfamily Soricinae FISCHER VON WALDHEIM 1817
Tribe Anourosoricini ANDERSON 1879
Genus *Crusafontina* GIBERT 1974

Type species: *Crusafontina endemica* GIBERT 1974. Can Llobateres, Spain, Late Miocene, Vallesian, MN 9.

Occurrence: Late Miocene (Vallesian, MN 9 - Turolian, MN 13), Europe.

Crusafontina endemica GIBERT 1974
Pl. 2, figs 5-8, Pl. 3, Figs 9-10

1975 - *Crusafontina endemica* GIBERT 1974 - GIBERT, p. 118., figs 6., 7a-b. (Can Llobateres).
1976 - *Anourosorex kormosi* BACHMAYER & WILSON 1970 - KRETZOI et al., p. 375. (Rudabánya).
1984 - *Amblycoptus vicinus* KRETZOI 1954 - KRETZOI, p. 215. (Sümeg).
1984 - *Anourosorex kormosi* BACHMAYER & WILSON 1970 - KRETZOI, p. 215 (Sümeg).
1985 - *Anourosorex kormosi* BACHMAYER & WILSON 1970 - RABEDER, p. 447 (Rudabánya).
1991 - *Anourosorex kormosi* BACHMAYER & WILSON 1970 - KORDOS, p. 348. (Rudabánya).
1996 - *Crusafontina endemica* GIBERT 1974 - MÉSZÁROS, p. 10., pl. 1, figs 3a-e., pl. 2., figs 4 a-d (Sümeg).
1998 - *Crusafontina endemica* GIBERT 1974 - MÉSZÁROS, p. 147, pl. 1., fig. 1., pl. 2. figs. 6-15., (Sümeg).
1998 - *Crusafontina* aff. *endemica* GIBERT 1974 - ZIEGLER & MÉSZÁROS, in press (Rudabánya).

Holotype: left mandible fragment with P_4-M_2, Nr. 9002, GIBERT (1975), p.118. Type locality: Can Llobateres (Spain, Vallesian, MN 9).

Occurrence: Late Miocene (Vallesian, MN 9 - 10), Europe.

Studied material and measurements: 1 right I^1 (L = 2.35, H = 1,58), 1 right I^1 fragment (H = 1.75), 1 right I_1 (L = 4.50, H = 1.18), 1 right I_1 fragment (H = 1.20), 1 right P^4 fragment (H = 2.23), 1 left P^4 fragment (BL = 2.25), 1 left M_1 fragment, GMH - V. 20651.

Description

I^1 - The apex is sharp and longer than that of the close relative *C. kormosi*. The basal margin is slightly concave. Well developed conule and cingulum are present on the buccal side.

P^4 - Only the buccal part of the fragmented praemolars are present. The parastyle is protruding and turns buccally. The posterior margin seems slightly emarginated.

I_1 - The lower incisor is clearly bicuspulate, the apex is sharp and up-turned.

Remarks: The general size, the basal margin of the upper incisor, the bicuspulate lower one and the protruding P^4 parastyle make us sure that this Anourosoricini teeth belong to *Crusafontina*. Many *Crusafontina* remains came from different European localities of Late Miocene Vallesian and Turolian ages, which were ranged to two species by MÉSZÁROS (1998). Unfortunately, the main differential characters between *C. endemica* (MN 9-10) and *C. kormosi* (MN 10-13) could not be studied on the present material. However, the measurements of the upper incisor refer the Alsótelekes *Crusafontina* to the older species (Fig. 1).

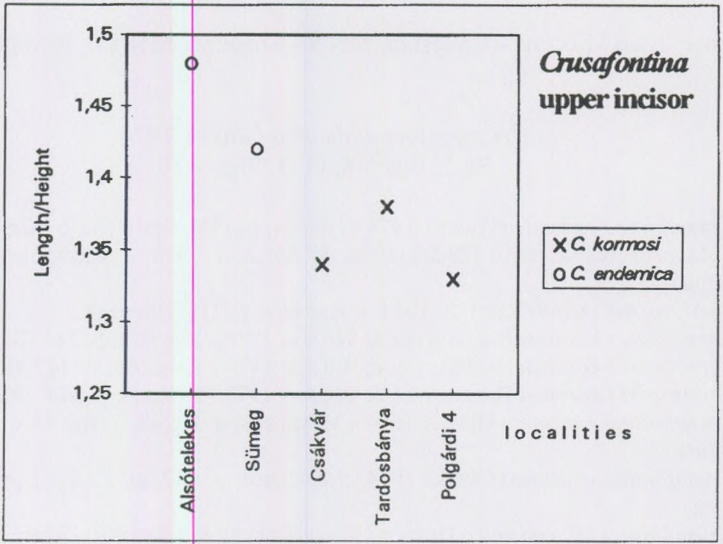

Fig. 1. Comparison of the I^1 length/height ratio of the *Crusafontina* remains from different localities. Its measurements refer the Alsótelekes incisor to *C. endemica*. (The data of the other localities are after Mészáros 1998.)

Soricinae gen. et sp.
Pl. 2, Fig. 4

1974 - *Miosorex* cf. *grivensis* (GAILLARD) - KRETZOI et al., p. 375., tab. 2 (Rudabánya).
1991 - *Miosorex* cf. *grivensis* (GAILLARD) - KORDOS, p. 348, tab. 1 (Rudabánya).
1985 - *Miosorex* cf. *grivensis* (GAILLARD) - RABEDER, p. 447 (Rudabánya).
1998 - Soricidae gen. et. sp. indet. - ZIEGLER & MÉSZÁROS, in press (Rudabánya).

Studied material and measurements: 1 left mandible fragment with M$_2$ (L = 1.20, W = 0.70) and M$_3$ (L = 0.89, W = 0.50), GMH - V. 20649.

Description

M$_2$ - The trigonid and the talonid basins are deep. The a hypo- and entoconid are clearly lower than the para-, proto- and metaconid. The hypolophid ends behind the entoconid, the postentoconid valley is wide and deep. The oblique crest runs to the lingual side of the protoconid. A low entoconid crest is present. Weak cingulid runs round the tooth.

M_3 - The talonid is much lower than the trigonid. The talonid specially weaks up forwards, the oblique crest runs to the metaconid. The talonid is basined, the hypoconid and the entoconid are present, entostylid is not separated. The cingulum is present on the buccal and the posterior sides, but absent on the lingual one.

Remarks: Not many taxonomically important detailes can be studied on this fragmented jaw. Even so, in consequence of the size and the morphology of the M_1, this form seems to be the same as the species described by ZIEGLER & MÉSZÁROS (1998) from Rudabánya quarry. By the lingual emargination of the condylus that specimen could be referred to the subfamily Soricinae.

Discussion

The relative frequency of the isolated teeth is very high (see Tab. 1). All remains are poorly preserved, but they are not digested. Many cones and most of the roots are missing. The intensive breakage pattern could have been caused by long fluviatile transport before the lacustrine accumulation of the mandible fragments and the teeth.

The resemblance between the Alsótelekes and other earliest Vallesian Soricid faunas (Rudabánya, Can Llobateres, Belchatów) make us sure that the locality is correlative with the Late Miocene MN 9 Zone (Tab. 2). This assemblage is perhaps older than the Rudabánya prehominoid localities, since *Blarinella dubia* and *Paenelimnoecus repenningi*, the typical Late Miocene shrews, here do not occur yet. However, we can not be sure about the relation of the two sites, because the Alsótelekes material is so limited, as the absence of these species can be occassional.

The MN 9 Zone is indicated by the coexistence of the early Crocidosoricinae and Heterosoricinae and the modern Soricinae. This reflects to the great change in the Soricidae fauna of Europe, caused by a climatic turnover during the Late Miocene (RZEBIK-KOWALSKA 1995). The somewhat colder and more arid climate caused the disappearance of many small-sized Crocidosoricinae and the subordination of Heterosoricinae shrews with the immigration of Soricinae and Allosoricinae ones. The subfamiliar constitution of the Alsótelekes assemblage suggests a transition between the Middle and the Late Miocene climates. The crocidosoricines prefered steady weather conditions. This is suppported by the absence of Crocidurinae, wich are adaptated to quite dry climate. On the other hand, the rife occurrence of Soricinae indicates not so warm and humid circumstances as in the Middle Miocene.

By its incidence in forested or at least partly wooded areas, we can suppose the habitat of *Crusafontina* as well-watered environment. This view is supported by its close relation to the extant *Anourosorex squamipes*, which occures in the mountain forests of SE Asia. On the basis of the *Crusfontina* occurrence, there maight have been closed vegetation in the surroundings of the lake, in which the fossiliferous layers of Alsótelekes were deposited.

INSECTIVORES	LOCALITIES				
	Alsótelekes	Rudabánya	Rudabánya	Can Llobateres	Belchatów
	this paper	Kretzoi et al. 1976	Ziegler & Mészáros in press	Gibert 1974	Rzebik-Kowalska 1993&1994
Plesiosorex	+	-	+	-	+
Limnoecus	-	-	-	+	-
Florinia	+	-	-	-	+
Miosorex	+	+	-	-	+
Oligosorex	-	-	-	+	-
Heterosorex	-	-	-	-	+
Dinosorex	-	+	+	-	+
Allosorex	+	-	-	-	-
Crusafontina	+	+	+	+	+
Blarinella	-	+	-	-	-
Paenelimnoecus	-	+	+	-	-
Soricinae gen. et sp.	+	-	+	-	-

Table 2. Insectivore faunas of the MN 9 Zone correlative localities in Europe. The Rudabánya genera, first reported by Kretzoi et al 1976, are refered here according to the taxonomical revision by Rabeder 1985, Kordos 1991, Ziegler & Mészáros 1998 and this paper

Acknowledgements

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Plate 1

Figure 1. *Plesiosorex* sp., right molar fragment, occlusal wiew, 37x.

Figure 2. *Plesiosorex* sp., left molar fragment, buccal wiew, 45x.

Figure 3. *Miosorex* sp., right mandible fragment with molars, GMH - V. 20648., a. buccal view, 21x, b. buccal view of the M_1, 53x, c. occlusal view of the M_3, 98x.

Plate 2

Figure 4. *Soricinae* gen. et sp., left mandible fragment with M_2-M_3, GMH - V. 20649., occlusal wiew, 47x.

Figure 5. *Crusafontina endemica* GIBERT 1974, right I^1, GMH - V. 20651., buccal wiew, 26x.

Figure 6. *Crusafontina endemica* GIBERT 1974, right I^1 fragment, GMH - V. 20651., buccal wiew, 32x.

Figure 7. *Crusafontina endemica* GIBERT 1974, left P^4 fragment, GMH - V. 20651., occlusal wiew, 39x.

Figure 8. *Crusafontina endemica* GIBERT 1974, right P^4 fragment, GMH - V. 20651., occlusal wiew, 36x.

Plate 3

Figure 9. *Crusafontina endemica* GIBERT 1974, right I_1 fragment, GMH - V. 20651., buccal wiew, 30x.

Figure 10. *Crusafontina endemica* GIBERT 1974, right I_1, GMH - V. 20651., buccal wiew, 21x.

Figure 11. *Allosorex* cf. *stenodus* FEJFAR 1966, right M^1 fragment, GMH - V. 20650., ventral wiew, 36x.

Figure 12. *Allosorex* cf. *stenodus* FEJFAR 1966, right M_1 fragment, GMH - V. 20650., buccal wiew, 38x.

Figure 13. *Allosorex* cf. *stenodus* FEJFAR 1966, right M_2 fragment, GMH - V. 20650., occlusal wiew, 51x.

Plate 1

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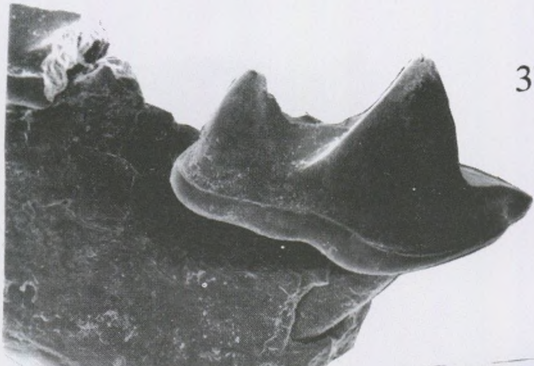

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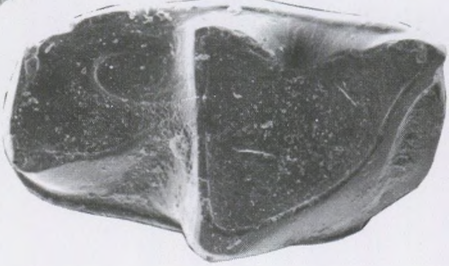

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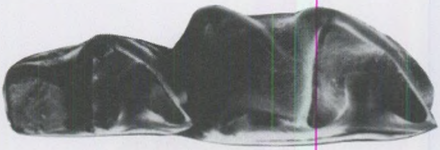
Plate 2



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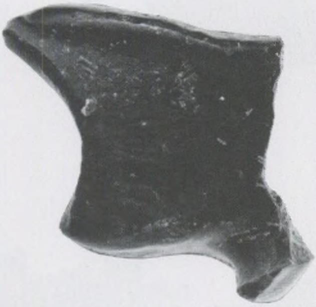

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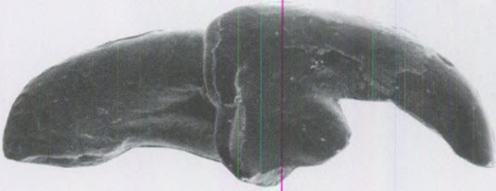

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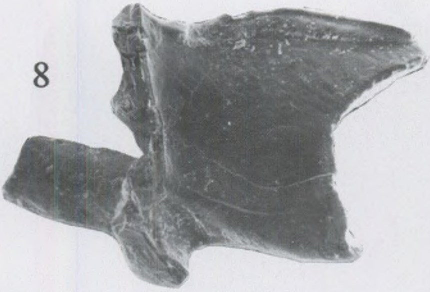

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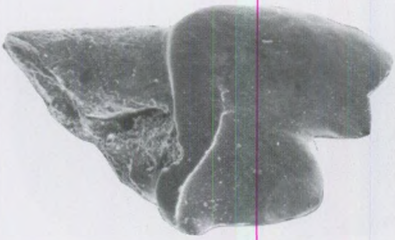

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Plate 3

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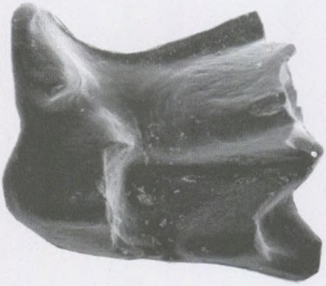

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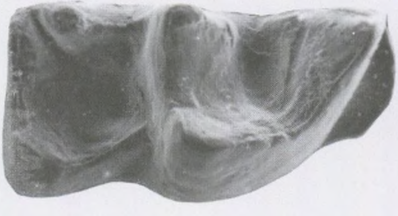

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32, 49-56 (1999) Budapest

Uppermost Pleistocene shrews (Mammalia, Soricidae) from Vaskapu Cave (N-Hungary)

L. Gy. Mészáros[1]

(with 4 figures and 4 tables)

Abstract

Three shrew species (*Sorex araneus* LINNAEUS 1758, *Sorex minutus* LINNAEUS 1766 and *Sorex alpinus* SHINZ 1837) were found in the fossiliferous sediments of Vaskapu Cave, near Felsőtárkány. The probable stratigraphical position of the sample is Upper Pleistocene, Pilisszántó Horizon (Upper Würm), about 15,000 years B.P. A cold period of the Late Pleistocene with wooded environment is indicated by the soricid assemblage.

Introduction

Palaeontological excavations were prepared under the leading of Dr. J. HÍR in the Lök-völgyi Cave, near Eger in the summer of 1994. The present author was one of the members of the researcher group. Under the preliminary field walks HÍR discovered an other fossil locality near the site of the excavations. He identified it as an unexplored part of an old locality, Vaskapu Cave. A sample of about 150 kg was removed from sediments and washed in the field that summer. The sample yielded a rich and well-preserved fossil fauna, containing also 92 shrew bones and teeth. This Soricidae finding is presented in this paper.

The Vaskapu "Cave" is a rock shelter, situated about 3.5 km NW of Felsőtárkány, by the left side of the panorama road leading from Eger to Miskolc, 350 m above see level. It was originally described as a fossil locality by M. MOTL. She correlated the deposit of the "cave" with the upper part of the Late Pleistocene (MOTL 1941).

The morphological terms and the measurements (in millimetres) are used after REUMER 1984. The material is stored in the collection of the Museum of Pásztó.

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Systematic part

Class Mammalia LINNAEUS 1735
Order Insectivora BOWDICH 1821
Family Soricidae GRAY 1821
Subfamily Soricinae FISCHER VON WALDHEIM 1817
Tribe Soricini FISCHER VON WALDHEIM 1817
Genus *Sorex* LINNAEUS 1758

Type species: *Sorex araneus* LINNAEUS 1758

Sorex araneus LINNAEUS 1758
Figs 1-2

Material. 25 left and 11 right mandible fragments, 5 left and 1 right I_1, 1 right M_3, 11 left and 9 right maxillary fragments, 1 left I^1.

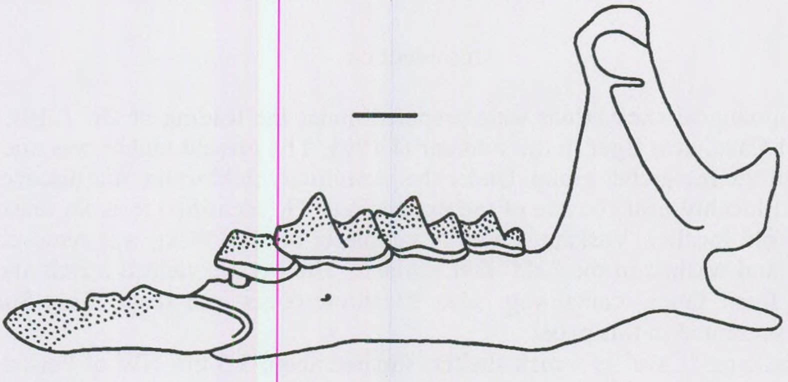

Fig. 1. *Sorex araneus* LINNAEUS 1958, left mandible with I_1 and P_4-M_3, buccal view, Vaskapu Cave, working number 6. Horizontal bar = 1 mm.

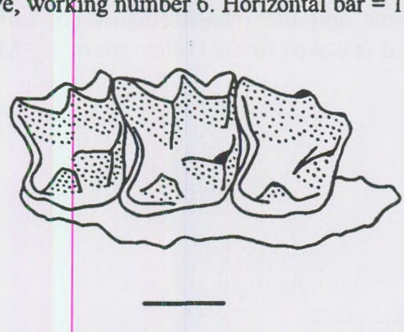

Fig. 2. *Sorex araneus* LINNAEUS 1958, right maxillary fragment with P^4-M^2, occlusal view, Vaskapu Cave, working number 22. Horizontal bar = 1 mm.

Measurements. See Tab. 1.

		min.	mean	max.	n	s. e.	s. d.
I^1	L	-	1.80	-	1	-	-
	H	-	1.36	-	1	-	-
P^4	LL	1.14	1.19	1.30	5	0.0496	0.0601
	BL	1.46	1.64	1.88	5	0.0992	0.1365
	W	1.52	1.64	1.80	5	0.0720	0.0936
M^1	LL	1.48	1.50	1.56	5	0.0288	0.0320
	BL	1.48	1.55	1.62	5	0.0384	0.0466
	AW	1.42	1.58	1.82	5	0.0944	0.1299
	PW	1.70	1.75	1.88	5	0.0528	0.0665
M^2	LL	1.24	1.31	1.36	4	0.0350	0.0436
	BL	1.32	1.36	1.40	4	0.0200	0.0283
	AW	1.56	1.65	1.84	4	0.0975	0.1135
	PW	1.28	1.45	1.68	4	0.1700	0.1752
M^3	L	0.50	0.56	0.62	2	0.0600	0.0600
	W	1.26	1.31	1.36	2	0.0500	0.0500
I_1	L	3.88	4.03	4.25	5	0.1030	0.1288
	H	1.00	1.09	1 19	5	0.0500	0.0625
A_1	L	0.93	0.99	1.05	4	0.0375	0.0451
	H	0.54	0.63	0.66	4	0.0438	0.0508
P_4	L	1,03	1,15	1,33	6	0,0979	0,1062
	H	0,80	0,90	1,00	6	0,0542	0,0665
M_1	L	1,60	1,70	1,88	12	0,0639	0,0795
	W	0,85	0,93	1,15	12	0,0559	0,0812
M_2	L	1,35	1,43	1,60	12	0,0516	0,0677
	W	0,78	0,83	0,89	12	0,0257	0,0308
M_3	L	1,05	1,11	1,15	9	0,0284	0,0323
	W	0,60	0,67	0,75	9	0,0259	0,0381

Table 1. Measurements of *Sorex araneus* LINNAEUS 1958 from Vaskapu Cave. Min. = minimum value, mean = mean value, max. = maximum value, n = number of specimens, s. e. = standard error, s. d. = standard deviation.

Description. The anterior edge of the coronoid process is slightly concave. The external temporal fossa is deep and long, the coronoid spicule is hardly developed or missing. The internal temporal fossa is high and triangular, the mandibular foramen is placed under the posterior part of its lower margin. The upper condylar facet is cylinder-shaped, mesially not protruding. Its length is less than the width of the interarticular area. The tiny mental foramen is situated under the M_1 re-entrant valley or protocone. There is a well-developed cingulum on the postero-buccal margin of the upper incisor. There are five unicuspid antemolars in the maxilla. The paracone is very strongly-built in P^4. The parastyle is protruding, it is separated from the protocone by a wide valley. There is a parastylar crest between the parastyle and the paracone. The hypocone is well-developed. The hypocone is well-developed in M^1-M^2. A ridge is running from the protocone towards the hypocone. The parastyle of M^1 is far shorter than the metastyle,

but the parastyle is the longer one in M^2. The third upper molar is triangular. Only the tricuspid talon and the parastyle are present in the tooth. I$_1$ is tricuspulate, without, or with only slight postero-buccal cingulum. It extends backwards to the half of the lower premolar. P$_4$ is bicuspulate, but there is only one cusp on A$_1$. Parastylar crest is weak and low in M$_1$-M$_2$. The M$_3$ talonid is basined with hypoconid and entoconid. The cingulum is well developed on both sides of the lower antemolars and molars. There is a dark red pigmentation on the top of the cusps.

Sorex minutus LINNAEUS 1766

Fig. 3

Material. 8 left and 8 right mandible fragments, 1 right maxillary fragment.

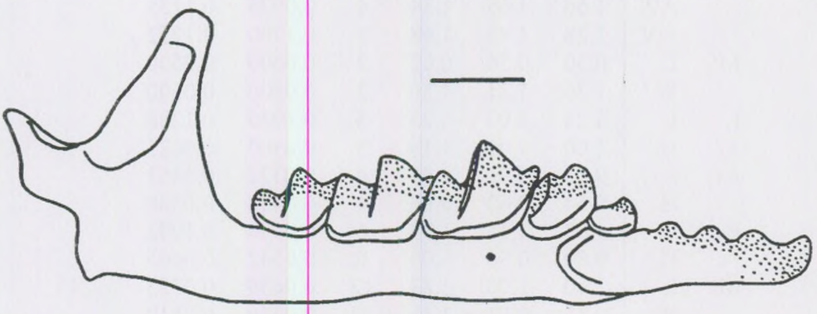

Fig. 3. *Sorex minutus* LINNAEUS 1966, right mandible with the complete dentition, buccal view, Vaskapu Cave, working number 68. Horizontal bar = 1 mm.

Measurements. See Tab. 2.

Description. The mandible is delicately built, but relatively long. The anterior edge of the coronoid process is concave. The external temporal fossa is deep and long, the coronoid spicule is absent in some specimens. The internal temporal fossa is high and triangular, continuing to the top of the coronoid in most cases. Its lower margin points to the upper facet of the condyle. The condyle is placed far backwards. The upper condylar facet is cylindrical, the lower one is protruding and widening towards the median. The interarticular area is moderately broad. The mandibular foramen is situated under the posterior corner of the fossa temporalis interna. The mental foramen is placed bellow the protocone of M$_1$. The P^4 hypocone is separated from the L-shaped protocone by a wide valley. The parastyle is connected to the paracone by a parastylar crest. The hypocone of M^1 and M^2 is only weakly developed as a cusp on the cingulum surrounding the hypoconal flange. The paracone and the protocone are separated by a wide valley. In M^1 the parastyle is significantly shorter than the metastyle, but they are equal sized in M^2. The lower incisor is tricuspulate. A weak cingulum is present along the buccal-posterior margin. The posterior part of the tooth extends backwards at the buccal side of the mandible to half-way along P_4. A_1 is unicuspid. P_4 is two-cusped, with the anterior cusp always considerably higher than the posterior one. The entoconid crest is low in M_1-M_2. The re-entrant valley opens at some distance above the buccal cingulum. The talonid of M_3 is basined and provided with both hypoconid and entoconid. The mandibular antemolar, the praemolar and the molars have well-developed cingulum both in the lingual and the buccal sides. There is a dark red pigmentation on the cusps of the teeth.

		min.	mean	max.	n	s. e.	s. d.
P^4	LL	-	0.90	-	1	-	-
	BL	-	1.10	-	1	-	-
	W	-	1.20	-	1	-	-
M^1	LL	-	1.10	-	1	-	-
	BL	-	1.18	-	1	-	-
	AW	-	1.23	-	1	-	-
	PW	-	1.25	-	1	-	-
M^2	LL	-	1.18	-	1	-	-
	BL	-	1.13	-	1	-	-
	AW	-	1.25	-	1	-	-
	PW	-	1.18	-	1	-	-
I_1	L	2.75	2.78	2.80	2	0.0250	0.0250
	H	0.78	0.78	0.79	2	0.0062	0.0062
A_1	L	0.60	0.68	0.75	3	0.0528	0.0615
	H	0.33	0.43	0.49	3	0.0667	0.0714
P_4	L	0.79	0.88	0.95	7	0.0454	0.0517
	H	0.58	0.62	0.68	7	0.0283	0.0322
M_1	L	1.15	1.31	1.40	8	0.0688	0.0788
	W	0.63	0.68	0.75	8	0.0375	0.0415
M_2	L	1.10	1.16	1.28	9	0.0506	0.0636
	W	0.61	0.65	0.70	9	0.0253	0.0293
M_3	L	0.80	0.94	1.03	9	0.0648	0.0745
	W	0.48	0.56	0.73	9	0.0515	0.0720

Table 2. Measurements of *Sorex minutus* LINNAEUS 1966 from Vaskapu Cave. For the abbreviations see Tab. 1.

Sorex alpinus SHINZ 1837
Fig. 4

Material. 1 left mandible fragment with P_4-M_2.

Measurements. See Tab. 3.

Description. The anterior edge of the coronoid process is straight. The external temporal fossa is divided by a weak coronoid spicule. The upper condyloid facet of the processus condyloideus is mesially projecting, the lower one laterally widening. The interarticular facet is quite narrow. The internal temporal fossa is low and trapezoid.

The mandibular foramen is placed under the middle of its lower margin. The mental foramen is situated slightly behind the re-entrant valley of the first lower molar. P_4 is two-cusped. The entoconid crest is low and weak in M_1-M_2. The top of the teeth are pigmented. The bucccal and the lingual cingula are well-developed in all present elements.

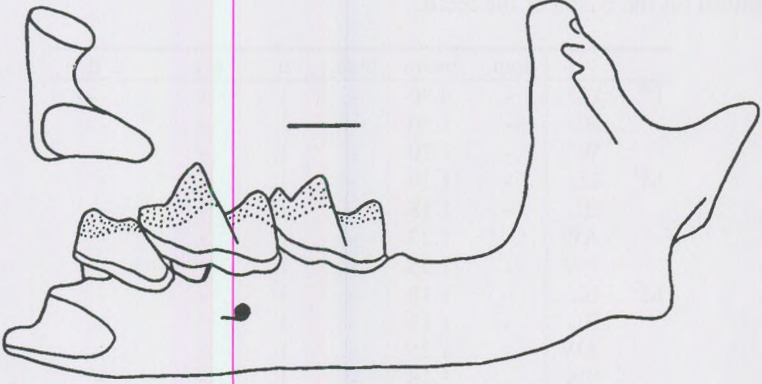

Fig. 4. *Sorex alpinus* SHINZ 1837, left mandible fragment with P_4-M_2, buccal view, and the condyle, posterior view, Vaskapu Cave, working number 92. Horizontal bar = 1 mm.

	L	H	W
P_4	1.60	0.96	-
M_1	1.83	-	1.10
M_2	1.58	-	1.00

Table 3. Measurements of *Sorex alpinus* SHINZ 1837 from Vaskapu Cave.

Discussion and conclusions

Taxonomy

The measurements of *S. alpinus* considerably overlap those of *S. araneus*. The two forms can be distinguished by the shorter I^1 talon, the bicuspid A_1, the more posteriorly situated foramen lacrimale and the mesially projecting upper condyloid facet of the Alpine species (UJHELYI 1994). Only the processus condyloideus was useful among the differential characters in the fragmented mandible of *S. alpinus* from the Vaskapu assemblage.

One hand, we have only one previous report on *S. alpinus* from the fossil fauna of Hungary (Peskő Cave, in: VÉRTES 1965). Otherwise, being two hardly distinguished species, some Hungarian *S. alpinus* occurrence might have been mentioned in the literature as the very common Quaternary shrew, *S. araneus*. This problem needs a comprehensive review in the future.

The here discussed Alpine shrew species has been recently reported in the western frontier of the country (UJHELYI 1994). By the climatic reasons its appearance in such eastern areas as the here studied locality is impossible.

Environment.

However there are also *Neomys* and *Crocidura* forms present in the Late Pleistocene of Central Europe, only *Sorex* species occur in the Vaskapu Soricidae sample. *S. araneus* is the dominant element of the fauna (Tab. 4). According to REUMER (1984) the fossil *Sorex* is indicative for a moist environment with well-developed vegetation. All the tree reported species recently have a preference for wooded or bushy areas. *S. araneus* is a very common recent shrew in most of the wet-soiled woods of Europe. *S. minutus* also occurs in humid areas with close vegetation. *S. alpinus* lives in the mountain forests of the Alps and in the lower, but wet-climated hills in the surroundings of the high mountains. We therefore assume a humid environment with a good vegetation cover in the time of the deposition of the Vaskapu sediments.

Soricidae species	Nr. of specimens	Min. nr. of individuals	Relative frequency
Sorex araneus	64	24	72.72 %
Sorex minutus	27	8	24,24 %
Sorex alpinus	1	1	3,03 %

Table 4. Catalogue of the Vaskapu soricid material.

Palaeoclimatology and biostratigraphy.

Because of the long-time coexistence of *S. araneus* and *S. minutus* (JÁNOSSY 1979, KORDOS, 1975, RZEBIK-KOWALSKA, 1991) the species composition is not enough to clear the stratigraphic position. Fortunately the special ecological character of the shrew fauna gives some information to answer this question.

During the cold episodes of the Pleistocene the shrew fauna of Europe was dominated by the genus *Sorex* (RZEBIK-KOWALSKA 1995). Such climate is marked by the exclusive occurrence of this genus in the sediments of the Vaskapu Cave as well. According to JÁNOSSY (1979) there was a cold event in the older part of the Late Würm in the Carpathian Basin. This period was characterized by a fauna reflecting the climate of the boundary zone between tundra and taiga of today. Not even arctic but also Alpine species were extremely abundant. By the occurrence of *Sorex alpinus* we can correlate the studied Vaskapu shrew sample with this period, the Upper Pleistocene, Upper Würm, Pilisszántó Horizon, about 15,000 years B.P. This stratigraphical classification is supported by the occurrence of *S. alpinus* in Peskő Cave, wich is dated to this age by MOTL (in: VÉRTES 1965).

Acknowledgements

The special thanks of the author go to Dr. J. HÍR (director of the Museum of Pásztó) for the chance to study the Soricidae material from Vaskapu Cave. The researches were supported by the FKFP 0143/1997 project.

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Sporomorphs isolated from pre-Quaternary sediments of "Barranco de Patones" (Spain)

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(with 2 figures and 4 plates)

Summary

Three levels situated in one serie established "Barranco de Patones" were investigated palynologically. The lower level (N-1) is relatively rich in early brevaxonate pollen grains of *Probrevaxones (Bolchovitinaepollenites*), and *Normapolles* such as *Complexiopollis, Verruoculopollis, Papillopollis, Longanulipollis, Interporopollenites, Nudopollis* and *Vacuopollis. Postnormapolles* are represented mostly by "myricoid forms". This is a peculiar Senonian assemblage represented by mixed *Pronormapolles* and *Eunormapolles* taxa. The second level (N-2) is poor in sporomorphs, few saccate gymnosperm pollen grains were observed. The upper level (N-3) contains gymnosperms *(Pinus, Taxodiaceae-Cupressaceae)* and evolved *Postnormapolles (Alnipollenites)* and modern angiosperm taxa *(Chenopodiipollis, Pseudospinaepollis, Tubulifloridites)*. This upper level differs palynologically from the lower one and it is similar to Tertiary assemblages.

Key words: Palynology, fossil, Upper Cretaceous, Tertiary, Spain.

Introduction

The phylogenetical stages of the angiosperm pollen grains during the Cretaceous are well established in the publication of DOYLE (1978), HICKEY and DOYLE (1977) and HUGHES (1976). The lower, first stage is characterized by the *Longaxones*, the second one by the *Brevaxonate* angiosperm pollen grains. After the appearance of the first brevaxonate pollen grains an extraordinary differentiation happened within this group. The early *Brevaxones* were classed into the stemma *Normapolles* introduced by PFLUG (1953), but the basic morphological taxa were elaborated in the monograph of

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Thomson and Pflug (1953). From morphological point of view particularly interesting and complicated pollen grains of the *Normapolles* stemma were the subject of several further investigations, e.g. Góczán (1964), Góczán, Groot, Krutzsch and Pacltová (1967), Zaklinskaya (1962), Skarby (1968). Using the TEM method cf. Kedves, Hegedüs and Párdutz (1973), Kedves (1990). Combined LM, TEM and SEM methods were first used for *Normapolles* taxa by Stanley and Kedves (1975).

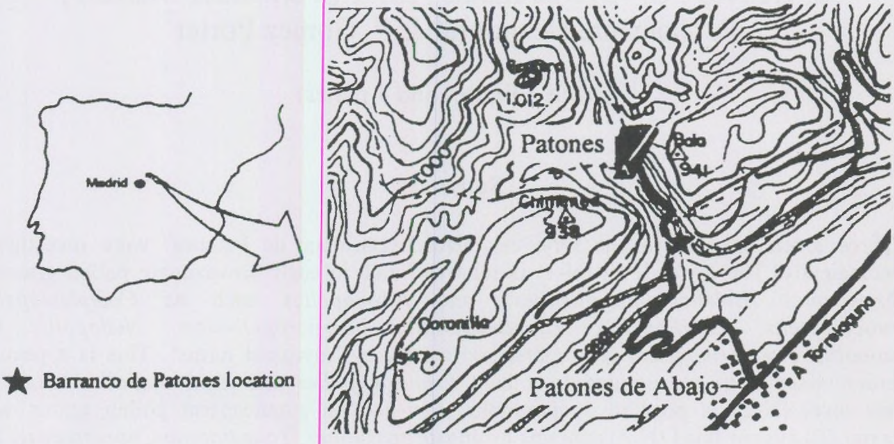

Fig. 1

The intensive differentiation process of the early brevaxonate pollen grains resulted well delineated paleophytogeographical units, cf. Zaklinskaya (1962), Krutzsch (in Góczán, Groot, Krutzsch and Pacltová 1967), Kedves (1985), etc. For the Northern Hemisphere the *Normapolles* and *Aquilapollenites* provinces were distinguished. Within these provinces further regions and sub-regions were established (Kedves and Diniz, 1983). Northern Spain was classed into the Pyrenean sub-region, the greatest part of Spain and Portugal into the Iberian sub-region.

During the last years several publications appeared dealing with Cretaceous palynomorphs of Spain and Portugal. In this way we have several assemblages for comparison.

This contribution represents one part of our palynological studies on Upper Cretaceous sediments of Spain. Several results about the macroflora and some Algae of Barranco de Patones were previously published: Alvarez Ramis, Fernández Marrón and Gomez Porter (1992), Alvarez Ramis, Kedves, Fernández Marrón, Clemente Belmonte and Gómez Porter (1996), Alvarez Ramis, Clemente Belmonte and Fernández Marrón (1996) and Clemente Belmonte and Alvarez Ramis (1996).

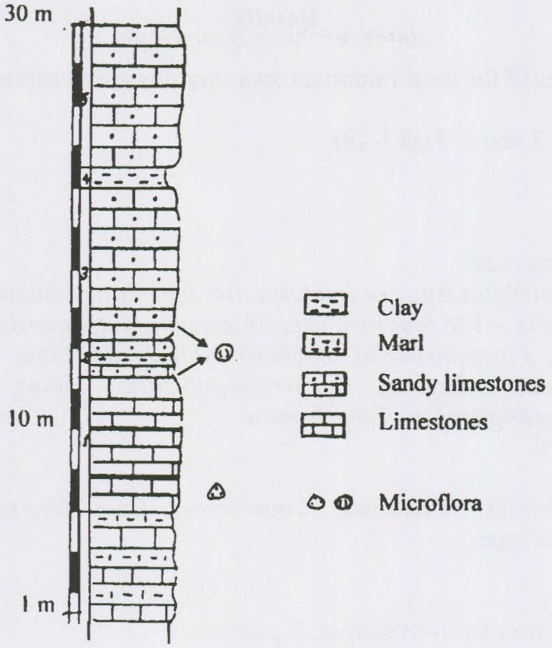

Fig. 2.

The aim of this paper is the following: based on the detailed palynological analysis of the three superposed levels we intent to meet the stratigraphical situation of Barranco de Patones series. We attempt also the reconstruction of the paleophytoassociation in the levels investigated.

Materials and methods

The samples were collected by ALVAREZ RAMIS, FERNÁNDEZ MARRÓN and KEDVES from the three horizons of Patones in October 11, 1993. Patones is at North of the Madrid community, Spain (Fig. 1). The lower level is represented by limestone and is rich in impressions of *Glyptostrobus* macroremains. The second level is limestone and sandy marl. The third level are clay and limestone (Fig. 2). Samples for micropaleobotanical investigations were treated in Madrid and in Szeged with the following basic method: HCl - H_2O - HF - H_2O. The organic remnants for LM studies were mounted in glycerine-jelly hydrated of 39.6%. Investigations and microphotographs were taken also in both laboratories. The qualitative and quantitative data were summarized by the three different levels. The slides are deposited in Madrid and in Szeged.

Results

The LM pictures of the most important sporomorphs are illustrated on plates I-IV.

Sample 1 (Plates 1, 2 and 3, Figs 1-19).

Qualitative data

Hystrichosphaeridae indet.
Pteridophyta. - *Leiotriletes* fsp., *Laevigatosporites* fsp., *Polypodiaceae.*
Gymnospermatophyta. - *Pityosporites* fsp., *Abietaceae, Pityosporites pristinipollinius, Abietaceae, Pinus, Pityosporites* cf. *minimus, Abietaceae, Pinus, Sequoiapollenites minor, Taxodiaceae, Sequoia, Inaperturopollenites hiatus, Taxodiaceae - Cupressaceae, Ephedripites* fsp., *Ephedraceae.*
Angiospermatophyta
Longaxones
Cupuliferoidaepollenites liblarensis, Cupuliferae, Cupuliferoipollenites pusillus, Fagaceae, Castanea type.
Brevaxones
Probrevaxones
Bolchovitinaepollenites miniverrucatus, B. punctatus.
Normapolles
Complexiopollis complicatus minor, C. praeatumescens, C. funiculus, C. cf. *plicatus, C. ameromii, C. microrugulatus, C. patulus, C. vilaflorensis, C. concavus, C. megagerminatus, Atlantopollis verrucosus,* Cf. *A.* fsp. *Prezaipollenites concavus tetraexitum, Plicapollis serta, P. pseudoexcelsus turgidus, P. pseudoexcelsus semiturgidus, Interporopollenites krempi, I. heteropolatus, I. stanleyi, Trudopollis granulosus,* cf. *Subtrudopollis subtrudens, Oculopollis pertrudoides, O. microoculus, Semioculopollis granulosus, S. praedicatus, S. croxtonae, S.* fsp., *Verruoculopollis skarbyae, V. pflugii, V.* fsp. 1, *V.* fsp. 2, *V.* fsp. 3, *Bohemiapollis oebisfeldensis, Convexipollis convexigerminalis, Vacuopollis orthopyramis magna,* cf. *V. microconcavus, Longanulipollis* fsp., *Krutzschipollis magnoporatus, Nudopollis terminalis cretacicus, Rocheipollenites triangulus, R.* fsp. *Minorpollis maestrichtiensis, Papillopollis pflugii, P.* cf. *weylandii, P. regulus, P. pittauae, P. rugulatus, P. krutzschii,* cf. *Aveiropollenites triangulus,* cf. *Boltenhagenipollenites aradaensis.*
Postnormapolles
Labraferoidaepollenites rurensis, L. bituitus, L. dilatus, Triporopollenites kleinoichingi,
Subtriporopollenites palaeocenicus, cf. *Chenopodiipollis* fsp.

Quantitative data

Hystrichosphaeridae 1%, Pteridophyta 1%, Gymnospermatophyta *Pityosporites* fspp. 24%, Inaperturopollenites fspp. 9%, Angiospermatophyta Longaxones 1%, Brevaxones Probrevaxones *Samoilovichaepollenites* 2%, Normapolles Pronormapolles

Complexiopollis 12%, *Papillopollis* 21%, *Oculopollis* 3%, *Verruoculopollis* 6%, *Krutzschipollis* 2%, *Plicapollis* 1%, *Vacuopollis* 15%, *Rocheipollenites* 1%, Postnormapolles formes myricoides 5%, *Subtriporopollenites* 1%.

Sample 2 (Plate 3, Figs 20-30)

It is very poor in sporomorphs: *Pityosporites* fsp., *Pinus* diploxylon type, *Podocarpidites* fsp., *Cupuliferoidaepollenites quisqualis*.

Sample 3 (Plate 4)

Qualitative data
Algae, Chlorophyta
Botryococcus braunii
Gymnospermatophyta
Pityosporites pristinipollinius, P. minutus, P. labdacus, P. insignis, Piceapollis planoides, Abiespollenites dubius, Sciadopityspollenites fsp., *Inaperturopollenites concedipites, Sequoiapollenites minor, Cupressacites insulipapillatus, Cycadopites microfollicularis, C. minimus.*

Angiospermatophyta
Longaxones

Scabratricolpites fsp., 1, *Sc.* fsp. 2, *Cupuliferoipollenites insleyanus, C. oviformis, Retitricolporites nagyae, R.* fsp. 1, *R.* fsp. 2, *Fususpollenites fusus, Cerceaupollenites* fsp., *Ilexpollenites erdtmani, Cyrillaceaepollenites* fsp., *Lanagiopollis eocaenica* type.

Brevaxones

Alnipollenites fsp., *cf. Punctioratipollis* fsp., *Chenopodiipollis multiplex, Pseudospinaepollis pseudospinus, Ulmipollenites undulosus, Celtipollenites komloensis,* cf. *Caryophyllidites* fsp.

Quantitative data

Botryococcus braunii 1.5%, *Pinus* diploxylon type 28%, *Pinus* varia 2.5%, Piceoide forms 22.5%, *Abies* 5%, cf. *Taxodiaceae* 1.5%, *Ilex* 0.5%, *Cyrillaceae* 1.5%, *Chenopodiaceae* 5,5%, *Celtis* 5.5%, *Caryophyllaceae* 1%, *Quercus* 5.5%, cf. *Pasania*, 2%, cf. *Castanea* 3%, *Juglans* 0.5%, *Alnus* 1.5%, *Betula* 0.5%, *Salix* 5%, *Ericaceae* 2.5%, *Compositae* (tricolporate) 2%, *Compositae* (fenestrate) 1%, *Gramineae* 2%, cf. *Sparganiaceae* 1.5%. Dicotyledones varia 2.5%.

Discussion and conclusions

Taking into consideration the aim of this paper we can point out the following:

1. Lower level (N-1)

1.1. The early brevaxonate pollen grains of the samples of this level are heterogeneous from palynostratigraphical point of view. *Probrevaxones (Bolchovitinaepollenites)* and *Pronormapolles* (*Complexiopollis* fspp.) were isolated from the Upper Cenomanian and Lower Turonian sediments of the *Normapolles* province. It is worth of mentioning that the *Atlantopollis* fgen. is represented by some specimens.

1.2. Pollen grains of *Papillopollis* and *Verruoculopollis, Semioculopollis* are common in the first place in the Santonian and or Campanian layers.

1.3. There are also so-called Maestrichtian-Danian forms. *Trudopollis hojrupensis, Semioculopollis daniensis, Nudopollis terminalis cretacicus.*

1.4. *Plicapollis pseudoexcelsus* is an Upper Cretaceous - Paleocene - Eocene evolved *Normapolles* type in all probability represents an early *Myricaceae* taxa.

1.5. The early Postnormapolles *(Subtriporopollenites constans, Labraferoidaepollenites)* are characteristic for the uppermost part of the Upper Cretaceous and to the Lower Tertiary.

2. Middle level (N-2)

We observed very few forms in a very bad preservation and they are not enough for any conclusions.

3. Upper level (N-3)

3.1.The great quantity of the saccate gymnosperm pollen grains indicate an open swamp paleoecologic condition. For the riparian vegetation *Salix, Castanea, Quercus, Alnus, Celtis,* forest may be presumed. We have also observed some non-arbor pollen.

3.2. It is also important that in this level contaminations of the recent vegetation are perhaps possible. In some cases it is not easy to distinguish the fossil and the recent pollen grains.

4. Based on our up-to-date knowledges as final conclusions, we can emphasize as follows:

4.1. There are important differences in the organic microremains composition between the different levels investigated. The early brevaxonate pollen grains which are characteristic for the lower level (N-1) were not observed in the middle (N-2) and the upper (N-3) levels. In general the upper part may be characterized by so-called modern angiosperm pollen grains which are characteristic till middle Tertiary levels.

4.2. The above mentioned, so-called mixed *Normapolles* flora suggests the necessity of further investigations. By the way of the palynological study of the first level (N-l) by centimeters we will have the opportunity to definitively establish whether is it really a mixed *Normapolles* assemblage, or these are different palynoassociations within the lower lithostratigraphic unit.

5. From paleophytogeographical point of view the Upper Cretaceous forms of the lower level (N-1) are characteristically of European type of the *Normapolles* province. The observed forms of the form-genus *Papillopollis* are characteristic in the first place to the assemblages of the Iberian Peninsule. But some *Normapolles* taxa of our material is

abundant in the Carpathian sub-region also, cf. *Verruoculopollis, Semioculopollis*, etc. These forms are also common in the Boreal region of the *Normapolles* province.

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Plate 1

1. *Pityosporites* fsp., *Abietaceae*.
2. *Pityosporites pristinipollinius* (TRAV. 1955) W. KR. 1971, *Abietaceae, Pinus.*
3. *Pityosporites* cf. *minimus* (ZAKL. 1957) W. KR. 1971, *Abietaceae, Pinus.*
4. *Ephedripites* fsp., *Ephedraceae.*
5. *Sequoiapollenites minor* W. KR. 1971, *Taxodiaceae, Sequoia.*
6. *Cupuliferoidaepollenites liblarensis* (THOMSON, in POTONIÉ, THOMSON and THIERGART, 1950) POTONIÉ 1960, *Cupuliferae.*
7-8. *Cupuliferoipollenites pusillus* (R. POT. 1934) R. POT. 1960, *Fagaceae, Castanea* type.
9. *Cupuliferoipollenites oviformis* (R. POT. 1931) TH. and PF. 1953 subfsp. *oviformis* (R. POT. 1931) TH. and PF. 1953, *Fagaceae, Castanea* type.
10-12. *Bolchovitinaepollenites miniverrucatus* KDS. and DIN. 1981.
13. *Bolchovitinaepollenites punctatus* KDS. and DIN. 1981.
14. *Complexiopollis complicatus* GÓCZ. 1964 f. *minor* DIN., KDS. and SICS. 1977.
15-16. *Complexiopollis praeatumescens* W. KR. 1959.
17-19. *Complexiopollis funiculus* TSCHUDY 1973.
20-21. *Complexiopollis* cf. *plicatus* KDS. 1980.
22-23. *Complexiopollis ameromii* KDS. 1980.
24. *Complexiopollis microrugulatus* KDS. 1980.
25-26. *Complexiopollis patulus* TSCHUDY 1973.
27-28. *Complexiopollis vilaflorensis* KDS. 1980.
29-31. *Complexiopollis concavus* KDS. 1980.
32. *Complexiopollis megagerminatus* KDS. 1980.
33. Cf. *Atlantopollis* fsp.

Plate 1

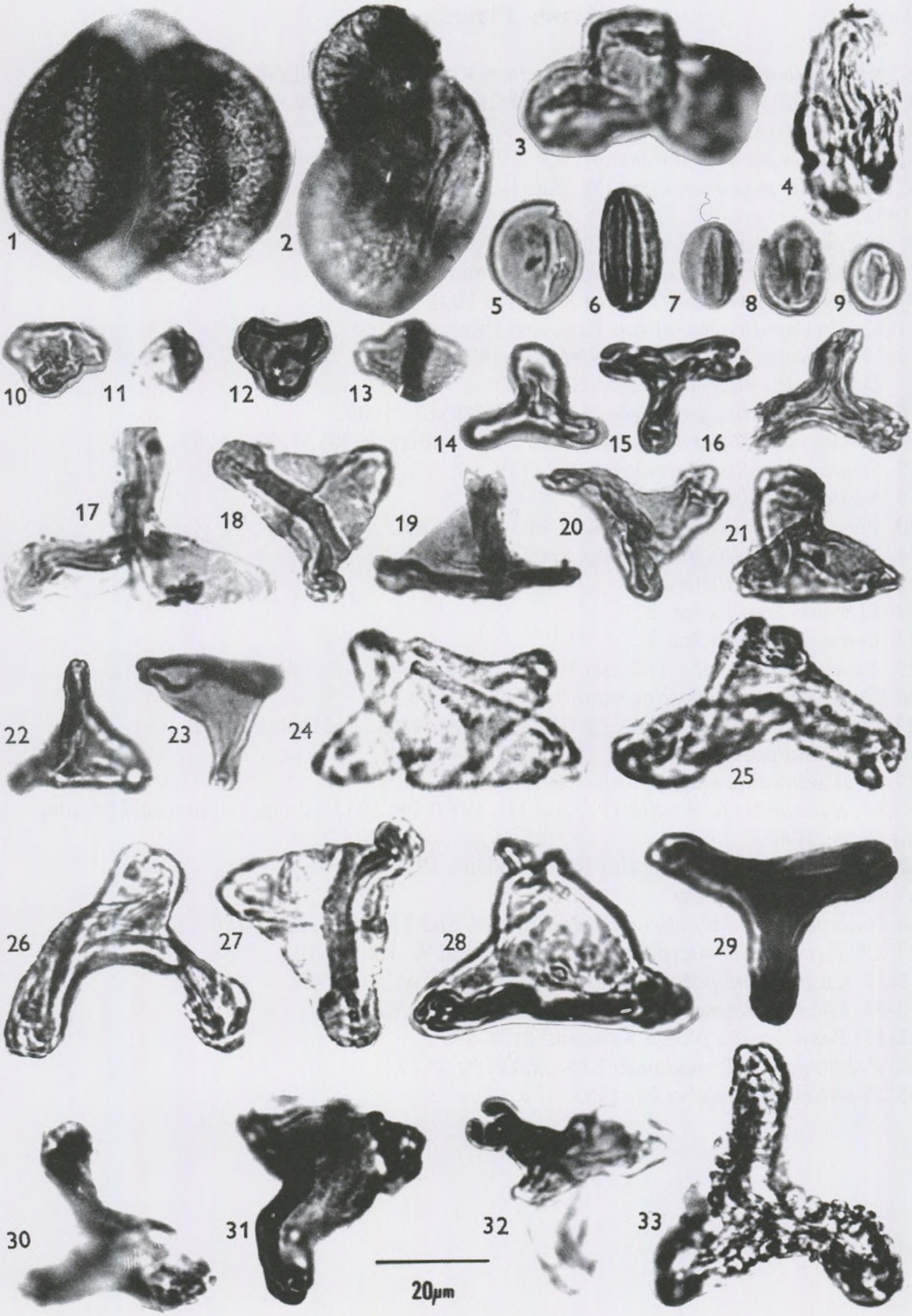
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Plate 2

1. *Prezaipollenites concavus* f. *tetraexitum* KDS. and DIN. 1980/81.
2. *Atlantopollis verrucosus* (GROOT and GROOT 1962) W. KR. 1967.
3-4. *Plicapolis serta* PF. 1953.
5. *Plicapollis pseudoexcelsus* (W. KR. 1958) W. KR. 1961 subfsp. *turgidus* PF. 1953.
6. *Plicapollis pseudoexcelsus* (W. KR. 1958) W. KR. 1961 subfsp. *semiturgidus* PF. 1953.
7. *Interporopollenites krempi* KDS. and HEG. 1975.
8. *Interporopollenites heteropolatus* KDS. and HEG. 1975.
9-10. *Interporopollenites stanley* KDS. and HEG. 1975.
11-12. *Trudopollis granulosus* KDS. and HERNGR. 1980.
13-14. *Oculopollis pertrudoides* W. KR. 1973.
15. *Oculopollis microoculus* W. KR. 1973.
16. *Semioculopollis granulosus* KDS. and HERNGR. 1980.
17. *Semioculopollis praedicatus* (WEYL. and KRIEG. 1953) W. KR. 1967.
18. *Semioculopollis croxtonae* KDS. 1979.
19. *Semioculopollis* fsp.
20. *Verruoculopollis skarbyae* KDS. and DIN. 1983.
21. *Verruoculopollis pflugii* KDS. and DIN. 1983.
22. *Verruoculopollis* fsp. 1.
23. *Verruoculopollis* fsp. 2.
24. *Verruoculopollis* fsp. 3.
25. *Bohemiapollis oebisfeldensis* W. KR. 1973.
26. *Convexipollis convexigerminalis* W. KR. 1973.
27. *Vacuopollis orthopyramis* PF. 1953 f. *magna* KDS. and DIN. 1980/81.
28. *Longanulipollis* fsp.
29. *Krutzschipollis magnoporatus* GÓCZ. 1967.
30-31. *Nudopollis terminalis* (PF. and TH. 1953) PF. 1953 subfsp. *cretacicus* KDS. and HERNGR. 1980.
32. *Rocheipollenites triangulus* KDS. and DIN. 1980/81.
33. *Rocheipollenites* fsp.
34-36. *Labraferoidaepollenites rurensis* (PF. and TH. 1953) KDS. 1980, *Myricaceae*.
37. Cf. *Vacuopollis microconcavus* PACLT. and W. KR. 1970.
38-39. Cf. *Subtrudopollis subtrudens* (PF. 1953) W. KR. 1967.
40-41. *Minorpollis maestrichtiensis* KDS. and HERNGR. 1980.
42-43. *Papillopollis pflugii* KDS. and PITT. 1979.
44. *Papillopollis* cf. *weylandii* KDS. and PITT. 1979.
45. *Papillopollis regulus* PF. 1953.

Plate 2

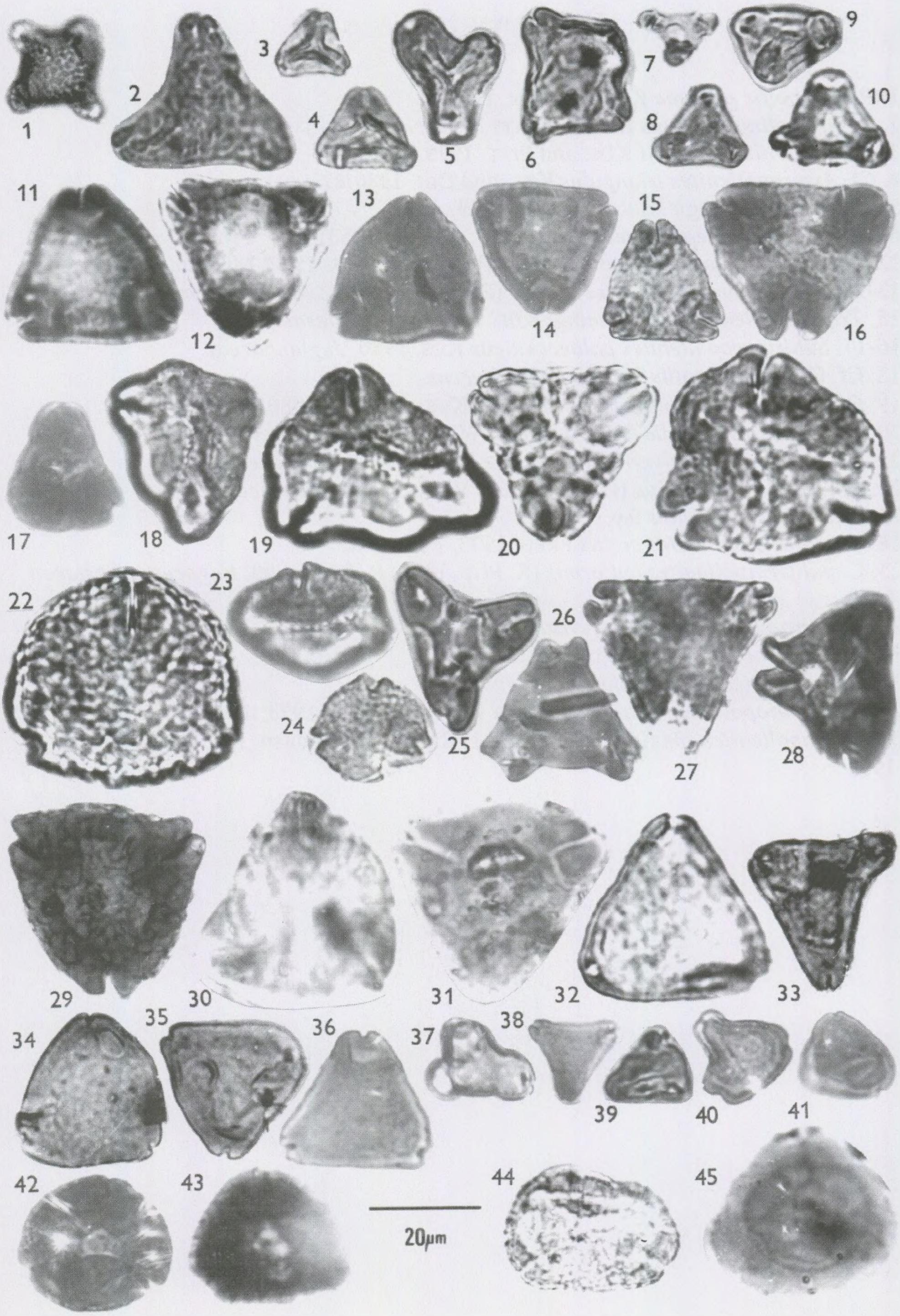
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Plate 3

1. *Papillopollis pittauae* Kds. and Din. 1983.
2. *Papillopollis rugulatus* Kds. and Pitt. 1979.
3. *Papillopollis krutzschii* Kds. and Pitt. 1979.
4. Cf. *Aveiropollenites triangulus* Kds. and Din. 1980/81.
5. *Papillopollis pflugii* Kds. and Pitt. 1979.
6-11. *Labraferoidaepolenites rurensis* (Pf. and Th. 1953) Kds. 1980, *Myricaceae.*
12. *Labraferoidaepollenites bituitus* (R. Pot. 1931) Kds. 1982, *Myricaceae.*
13-14. *Labraferoidaepollenites dilatus* (Fairch. 1966) Kds. 1982, *Myricaceae.*
15. *Triporopollenites kleinoichingi* Kds. 1980, *Juglandaceae.*
16-17. *Subtriporopollenites palaeocenicus* Kds. 1980, *Juglandaceae.*
18. Cf. *Chenopodiipollis* fsp., *Chenopodiaceae.*
19. Cf. *Boltenhagenipollenites aradaensis* Kds. and Din. 1980/81.
20. *Pityosporites insignis* (R. Pot. 1931) W. Kr. 1971, *Abietaceae, Pinus.*
21. *Podocarpidites piniverrucatus* W. Kr. 1971, *Podocarpaceae.*
22. *Abiespollenites dubius* (Chlon. 1960) W. Kr. 1971, *Abietaceae.*
23. *Sciadopityspollenites* fsp.
24. *Cupuliferoipollenites certus* Fred. 1973, *Fagaceae.*
25. *Cupuliferoipollenites oviformis* (R. Pot. 1931) R. Pot. 1960, *Fagaceae, Castanea* type.
26. *Intragranulitricolporites trevisanae* Kds. 1978.
27. *Tetracolporopollenites* fsp., *Sapotaceae.*
28. *Alnipollenites* fsp., *Betulaceae, Alnus.*
29. *Subtriporopollenites alpinus* (Wolff 1934) Tschudy 1973, *Juglandaceae.*
30. *Caryapollenites simplex* (R. Pot. 1931) Raatz 1937 subfsp. *simplex* Th. and Pf. 1953.

Plate 3

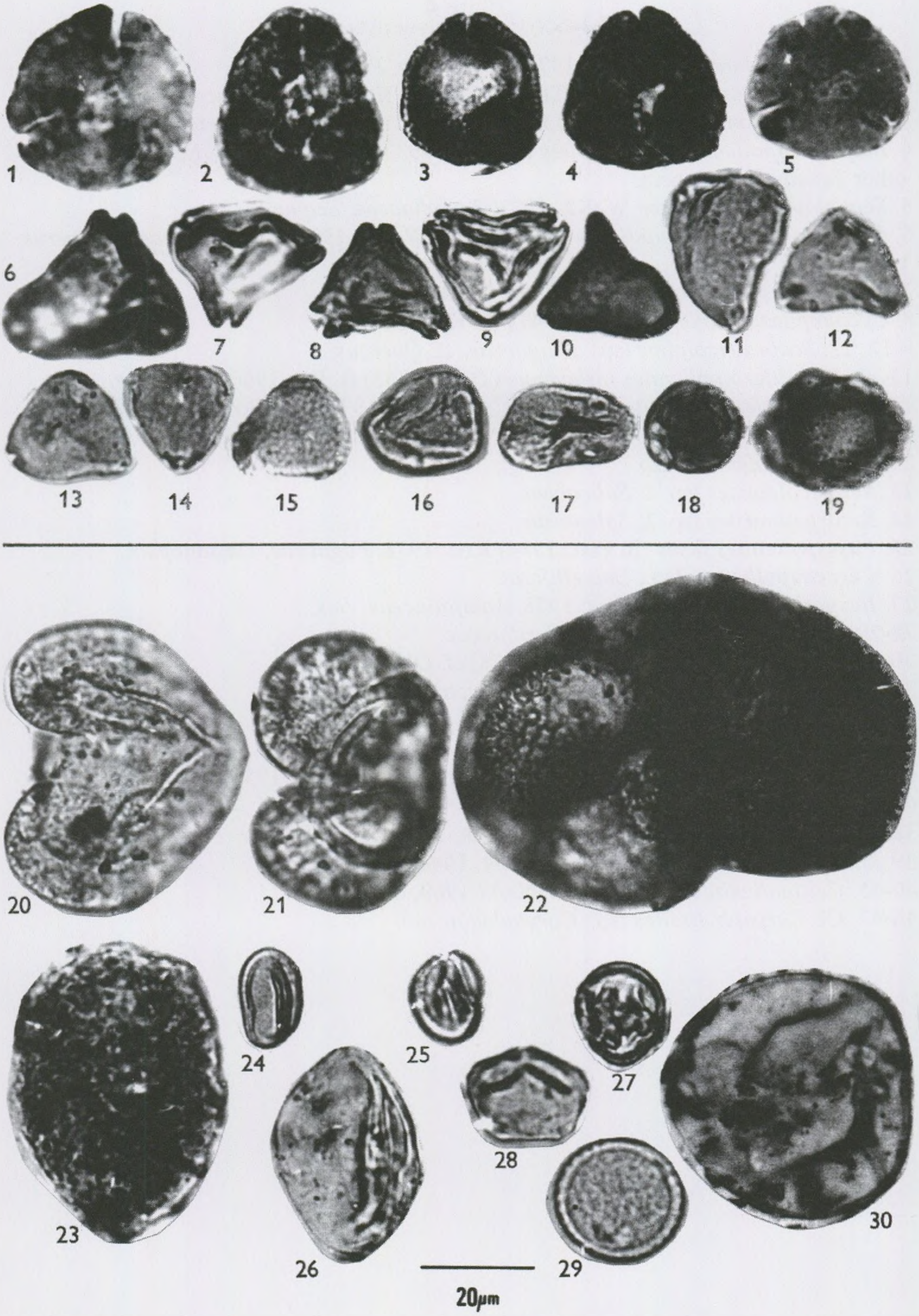
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Plate 4

1. *Piceapollis planoides* W. KR. 1971, *Abietaceae, Picea.*
2. *Pityosporites pristinipollinius* (TRAV. 1955) W. KR. 1971, *Abietaceae, Pinus.*
3. *Pityosporites minutus* (ZAKL. 1957) W. KR. 1971, *Abietaceae, Pinus.*
4. *Inaperturopollenites concedipites* (WODEH. 1933) W. KR. 1971, *Glyptostrobus* or other *Taxodiaceae* genera.
5. *Sequoiapollenites minor* W. KR. 1971, *Taxodiaceae, Sequoia.*
6. *Cupressacites insulipapillatus* (TREV. 1967) W. KR. 1971, *Cupressaceae, Juniperus* type.
7. *Cycadopites microfollicularis* W. KR. 1970.
8. *Cycadopites minimus* (COOKS. 1947) W. KR. 1970.

9-12, 22. *Scabratricolpites* fsp1., *Fagaceae,* cf. *Quercus.*

13-18. *Cupuliferoipollenites insleyanus* (TRAV. 1955) R. Pot. 1960, *Fagaceae.*

19-20. *Cupuliferoipollenites oviformis* (R. POT. 1931) R. POT. 1960, *Fagaceae, Castanea* type.

21. *Scabratricolporites* fsp.

23. *Retitricolporites* fsp. 1, *Salicaceae.*

24. *Retitricolporites* fsp. 2, *Salicaceae.*

25. *Fususpollenites fusus* (R. POT. 1934) KDS. 1978, *Fagaceae, Castanopsis.*

26. *Cerceaupollenites* fsp., *Umbelliferae.*

27. *Ilexpollenites erdtmani* KDS. 1978, *Aquifoliaceae, Ilex.*

28-29. *Cyrillaceaepollenites* fsp., *Cyrillaceae.*

30-32. *Retitricolporites nagyae* KDS. 1978, cf. *Oleaceae.*

33. *Lanagiopollis eocaenica* FRED. 1988, type.

34. *Alnipollenites* fsp., *Betulaceae, Alnus.*

35. Cf. *Punctioratipollis* fsp.

36,37. *Chenopodiipollis multiplex* (WEYL. and PF. 1957) W. KR. 1966, *Chenopodiaceae.*

38. *Pseudospinaepollis pseudospinus* W. KR. 1966, *Thymeliaceae.*

39. *Ulmipollenites undulosus* WOLFF 1934, *Ulmaceae.*

40-45. *Celtipollenites komloensis* E. NAGY 1969, *Celtis.*

46-47. Cf. *Caryophyllidites* fsp., *Caryophyllaceae.*

Plate 4


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Middle Eocene foraminifer, mollusc and ostracod fauna from the Csordakút Basin (Gerecse Mountains, Hungary): palaeoenvironments recorded in a transgressive sequence

Péter OZSVÁRT[1]

(with 6 figures and 15 plates)

Abstract

The well-preserved foraminifer, mollusc, and ostracod fauna was studied from the Midle Eocene Csordakút basin (Transdanubian Central Range, Hungary) by standard washing and by a novel acetic extraction method. Forty-two benthic foraminifer species, 17 ostracod species, and 17 mollusc species are described. Environments range from fluctuating to normal saline and from littoral to sublittoral.

Key words: Foraminifera, Mollusca, Ostracoda, palaeoenvironments, Middle Eocene, Gerecse Mts., Hungary

Introduction

The evolution of the Hungarian Paleogene Basin was understood as the product of transtensional (BÁLDI & BÁLDI-BEKE, 1986) or as retroarc flexural tectonic processes (TARI et al., 1995). Based on the biochronological and palaeoecological analysis of calcareous nannoplankton (BÁLDI-BEKE, 1972, 1977, 1984; NAGYMAROSY, 1983), planktonic foraminifer (SZTRÁKOS, 1974; HORVÁTH–KOLLÁNYI, 1983), larger foraminifer (KECSKEMÉTI, 1970, 1978, 1987), ostracod (MONOSTORI, 1972, 1985, 1996, 1998), and mollusc (BÁLDI, 1973, 1980, 1986) faunae, three main subbasins were recognized. The initiation of their subsidence displays a conspicuous west to east shift from Early Lutetian to Priabonian.

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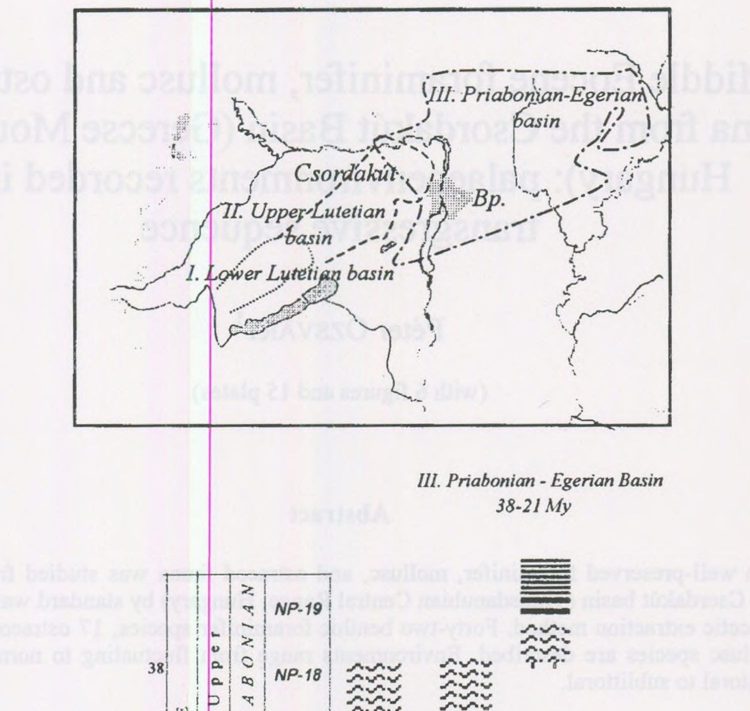

Fig. 1. Migration of the Hungarian Paleogene Basin from the Eocene to the Miocene. I. Lower Lutetian Basin (western part of the Bakony – Lutetian), II. Upper Lutetian Basin (eastern part of the Bakony, and Vértes, Gerecse, Dorog Basin – Upper Lutetian – Bartonian), III. Priabonian – Egerien Basin (Pilis, Buda Hills, northern Hungary – Priabonian – Egerian) (BÁLDI AND BÁLDI-BEKE; 1985) 1. bauxite 2: coal, 3: neritic marl, 4: limestone, 5: bathyal formation, 6: pelagic formation.

The Upper Lutetian – Bartonian Basin includes the north-western part of the Bakony, Vértes, and Gerecse Mountains and the Dorog Basin. In this basin the transgression has begun some five million years later than in the Lower Lutetian Basin (south-eastern part of the Bakony), while the end of the sedimentation is unknown. (Fig. 1).

The Lower Lutetian transgression was studied in the vicinity of Darvastó (Lower Lutetian Basin) (KECSKEMÉTI & VÖRÖS, 1975). The Upper Lutetian – Bartonian transgression sequence is well-known from Gánt (Upper Lutetian Basin) (BIGNOT et al., 1985). The Priabonian transgression was examined in Buda Hills and northern Hungary (Priabonian – Egerien Basin) by BÁLDI et al. (1986), and BÁLDI-BEKE (1972).

The littoral and shelf sediments of the Dorog Basin and the Bakony Mts. has been studied intensively due to economical (coal, bauxite) and palaeontological (outstanding subtropical shelf fauna) interest while the above mentioned areas were examined only in a few aspects. One of these less studied places is the western part of the Csordakút Basin that is situated by the southern foot of the Gerecse Mountains. It was studied within the scope of the Eocene Project which was to discover the bauxite and coal occurrences of the area (VÉGH-NEUBRANDT et al., 1978). Thanks to the technology of opencast mining excellent outcrops allow us to examine the underlying Triassic dolomite and the Middle Eocene limestone and marl. In my study I try to synthesise data got by treating the micro- and macrofossils of the area and give an explanation of the palaeoenvironmental and palaeoecological conditions.

The Csordakút Basin

The basement is Middle and Upper Triassic (Ladinian – Norian) 1500-1700 m thick lagoonal dolomite. The Jurassic and Cretaceous sediments were eroded. After the Cretaceous intensive tectonics and karst processes took part forming traps in which bauxite could be formed. The subsidence took the surface to a lower kinetic-energy level so that dolomitic breccia begun to form and bauxite influx and accumulation begun (VÉGH-NEUBRANDT et al., 1978) The accomodation and spread of bauxite was influenced by the palaeomorphology of the Triassic underlying beds and the preforming faults as well.

In the Upper Lutetian Basin on the basement (on the top of the terrigeneous sequences) paralic coal formations can be found containing epibenthonic molluscs. Next formation is 30-40 m thick marine marl, calcareous marl sequence, the subject of my work. This deposit exists also in the neighbouring basins. However, it is in 300-400 m depth in the southern and western basins (600 m in the Mány Basin), while it appears in spectacular artificial outcrops in the Csordakút Basin.

The regressive sequences of the Middle Eocene sedimentary cycle were preserved only on the eastern part of the Csordakút Basin and in the neighbouring Nagyegyháza and Mány Basins. Lithology is rather variable, on the margins dominantly sand and sandstone, that gradually changes into siltstone and clay-marl towards the inner part of the basin, and rarely limestone has been formed along the margins. (Fig. 2.)

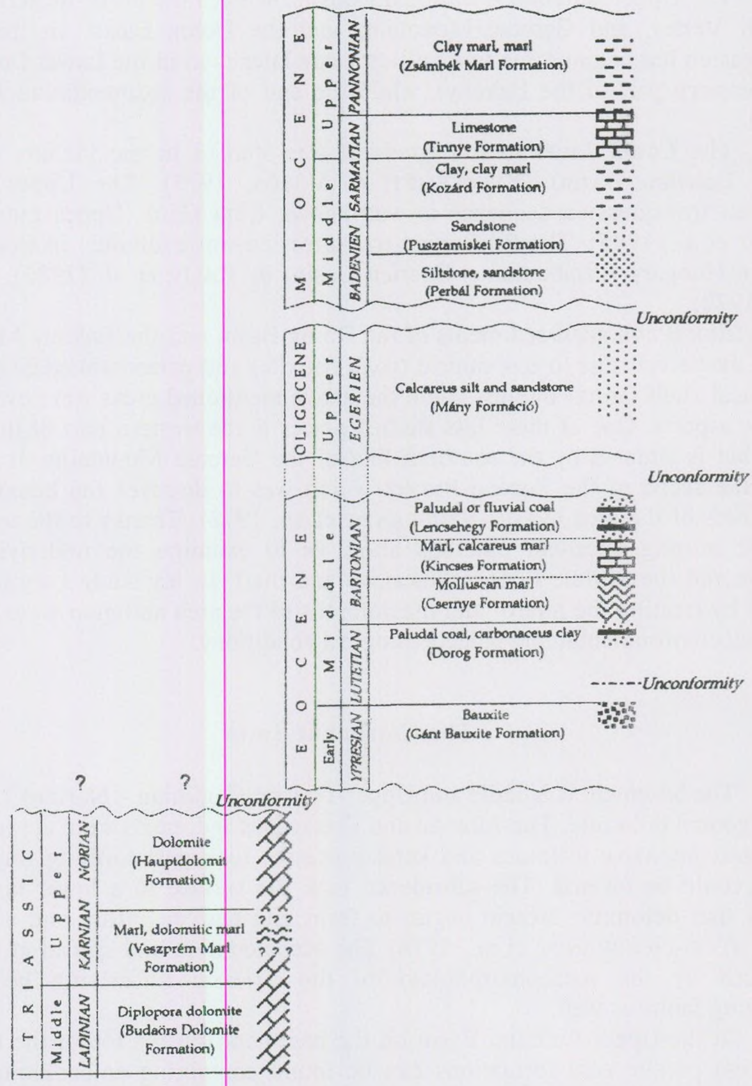

Fig. 2. Simplified synthetic stratigraphic column of the Csordakút Basin

The Upper Eocene sediments have been mostly eroded by Early Oligocene denudation (great erosion between the Upper Eocene and Upper Oligocene that eroded all formations situated to the west from the Buda Line) except in the Nagyegyháza Basin (KOPEK and TÓTH, 1977). After the denudation until the late Oigocene subaerial conditions were typical which was followed by a further transgression. The sequences of this sedimentary cycle are found only in the neighbouring basins and on the eastern margin of the Csordakút Basin (KORPÁS, 1977).

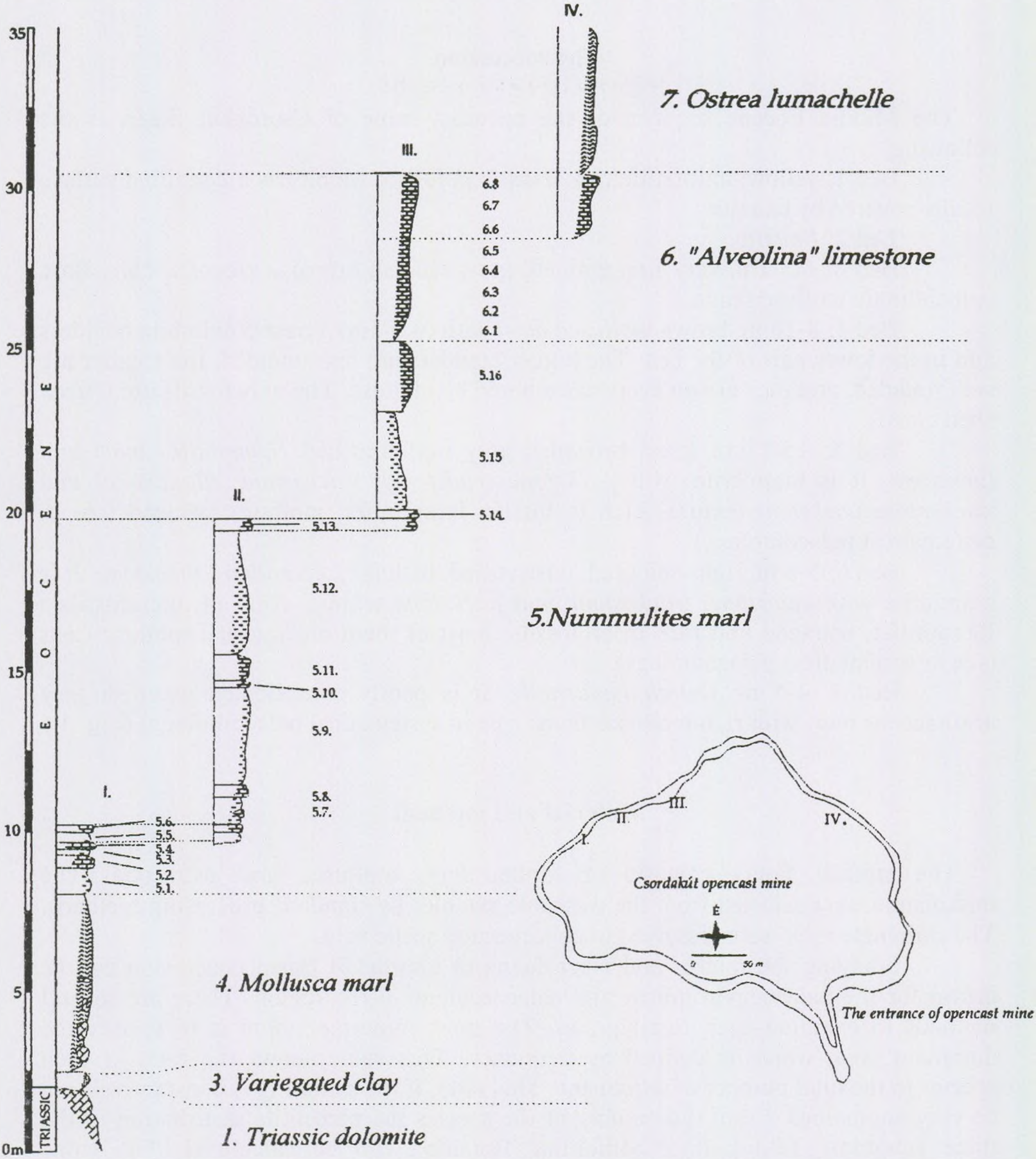

Fig. 3. The studied sequence of the Csordakút Basin

The Miocene formations are preserved in the eastern part of the neighbouring basins and on the easternmost part of the Csordakút Basin. There are Badenien clay, siltstone and fine-grained sandstone, Sarmatian shallow-marine marl, sandstone rare limestone. The uppermost part consist of Pannonian grey, silty marl. At the end of the Miocene the area has became subaerial, and intensive denudation has eroded the surface down to the Mesozoic basement.

The succession

The Middle Eocene sequnce of the opencast mine of Csordakút Basin is the following:

Bed 1: yellow, unfossiliferous *Triassic dolomite* which has a karstified surface locally covered by bauxite.

Bed 2: *Bauxite*

Bed 3: 0.5-1m, very fine-grained, grey, reddish brown *variegated clay*. Rare epibenthonic mollusc fauna.

Bed 4: 8-10 m, brown *mollusca marl* with (0.2-2m) Triassic dolomite boulders and in the lower part of the bed. The bigger boulders are less rounded, the smaller are well rounded, and they are on every cases bored by mollusc. The only fossils are *Ostrea* shell clast.

Bed 5: 15-17 m, grey, brownish grey well-stratified *Nummulites marl and limestone*. It is biomicrite with *packstone (rudstone), wackestone (floatstone)* and *wackestone/packstone* texture. Rich in fossils: foraminifer, mollusc, ostracod (see in systematical palaeontology).

Bed 6: 5-6 m, light-coloured, unstratified, nodular *„Alveolina" limestone*. It is biomicrite with *mudstone*, *wackestone* and *packstone* texture. Rich in microfossils : foraminifer, ostracod and rare macrofossils: most of them are internal mollusc casts (see in systematical palaeontology).

Bed 7: 4-5 m, *Ostrea lumachelle*. It is poorly consolidated greenish grey argillaceous marl with rich mollusca fauna (see in systematical palaeontology) (Fig. 3.)

Material and methods

The studied fauna consists of foraminifera, mollusca and ostracoda. The microfauna were selected from the washable samples by standard processing methods. The carbonate rock were dissolved in concentrated acetic acid.

Studying the micro- and macrofauna of Csordakút Basin conclusion can be drawn for the palaeoenvironment and palaeoecology of the region. There are several methods to examine each fossil group. The most important topic is to specify the dominant taxa, which is defined by frequency. This value shows the ratio of each species to the total number of specimens. This ratio, if the sampling is constant will not be very anomalous. From the number of the species the percentile distribution of the three subordos: Textulariina, Milioliina, Rotaliina can be calculated. The value represented on the triangle diagram of MURRAY (1973), gives the habitat of the species related to recent analogues. In this case due to the extreme high number of Nummulites the calculated value will be in the „Rotaliina corner" for each stratum. This indicates hypersaline or hyposaline lagoon, which is unambiguously inaccurate; possibly the Murray diagram cannot be used to interpret faunas with larger foraminifers.

Another method for explaining palaeocoenosis is the calculation of diversity parameters. The palaeoenviroment can be readly identified by using the FISHER index. Calculation of the index has proposed by MURRAY (1973): $a=n_1/x$ where x = a constant value less than one. $n_1=N(1-x)$ where N= size of population. Because of the dominant of *Nummulites* is signed hyposalinity enviroment.

Because of these problems possible different age and spatial (coeval but from different environment) resedimentation always has to be taken into account in diversity studies. The mixed ecological situation (in one stratum more than one population is represented) may cause problems in the calculation. The reason for this is that in geologically short period the ecological environment can change e.g. seasonal periodicity can occur at one time (MONOSTORI, 1972, 1975).

Discussion

Considering the problems the frequency, diversity and ecological demand of the groups and taxa in the taphocoenosis of the different strata can be summarised in the following.

Foraminifera – The dominant taxon in the fauna is the *Nummulites*. As stenohaline organism it is characteristic in normal salinity water and is very sensitive to alteration of slight changing in salinity. It is stenothermal organism, living in waters in which average annual temperature is above 22 °C. It is stenobath, its optimal depth of occurrence is 5-20 m. It lives in transparent water.

Regarding the entire stratigraphical column the most frequent species is *Nummulites subplanulatus* HANTKEN et MADARÁSZ, 1865. At some places it is extremely frequent, although the dimension of the specimens is uniform which may be caused by optimal circumstances (only for this species) or the selective effect of a high velocity current.

Miliolidae are presented in higher proportion in the fauna. The recent ecological demands of this family show marked difference to those of the *Nummulites*. They are most characteristic in the tropical hypersaline, shallow water environment (DOUGLAS, 1979) or indicate hypersaline lagoon or paludal environment (MURRAY, 1976).

In the *Nummulites* marl assemblage the two dominant groups suggest remarkably different environments. The reason for this can be the increased frequency of the Miliolidae in a short term (seasonal) arid hypersaline period that mixes the taxa of the two different environments in the sediment (MONOSTORI, 1972, 1975).

Another explanation for the presence of the two taxa with different ecological demands in the same stratum that the intensive currents could mix the stenohaline and euryhaline organisms. The evidence for this can be that the dimension of the extremely frequent forms is changing in a very narrow interval.

On the upper part of the sequence in the Alveolina limestone the proportion of *Nummulites* is decreasing while the Miliolidae and *Fasciolites* become dominant. The latter is also shallow marine vagilis benthos form. The ecological demands of these two groups are not that different as those of the previous taxa. Related to the *Nummulites* marl this assemblage by reason of the foraminifers, has been formed in shallower, oscillating salinity water (Fig. 4.).

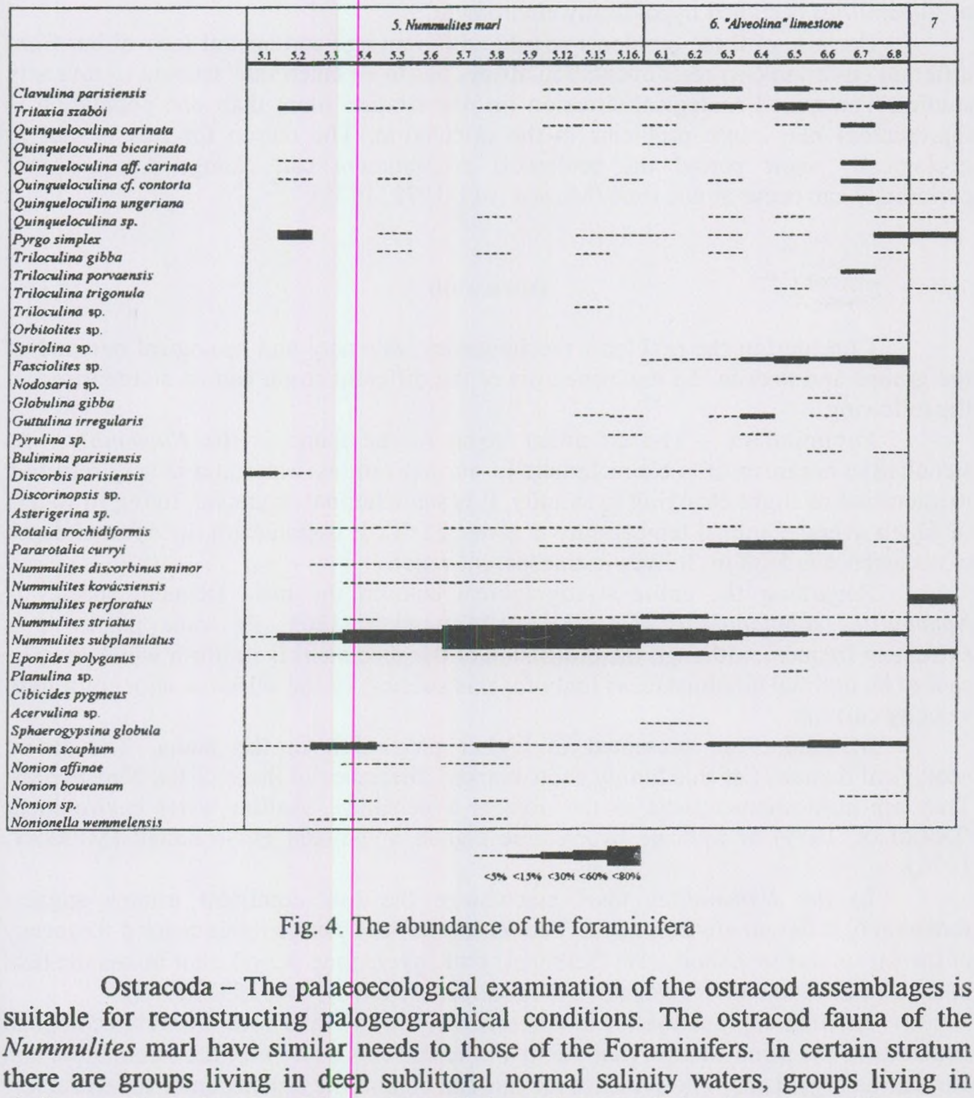

Fig. 4. The abundance of the foraminifera

Ostracoda – The palaeoecological examination of the ostracod assemblages is suitable for reconstructing palogeographical conditions. The ostracod fauna of the *Nummulites* marl have similar needs to those of the Foraminifers. In certain stratum there are groups living in deep sublittoral normal salinity waters, groups living in shallow sublittoral water with varying salinity and groups living in the transition zone. (Fig. 5).

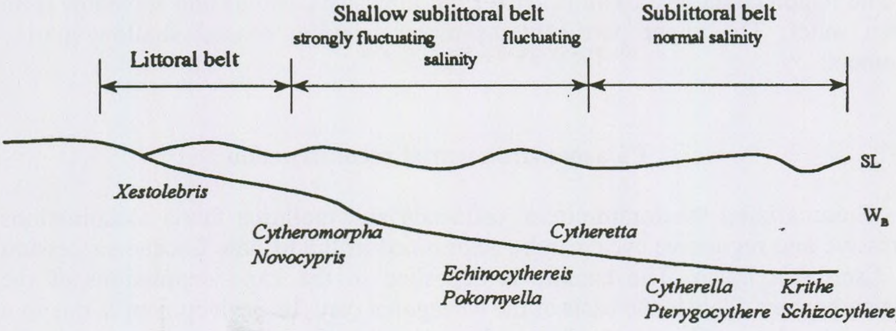

Fig.5. Ecological demands of ostracoda (after descriptions of MONOSTORI, 1972)
SL = sea level W_B = wave base

On the basis of this the problem is similar to the case of the foraminifera. By my opinion on the basement of Bed 5 the reason is the varying salinity shallow water while on the upper part the mixed taphocoenosis of groups with different ecological demands. The ecological demand of the ostracod fauna of the „*Alveolina*" limestone is almost the same. The dominant species determine a shallow littoral, sublittoral, oscillating salinity lagoon. (Fig. 6.)

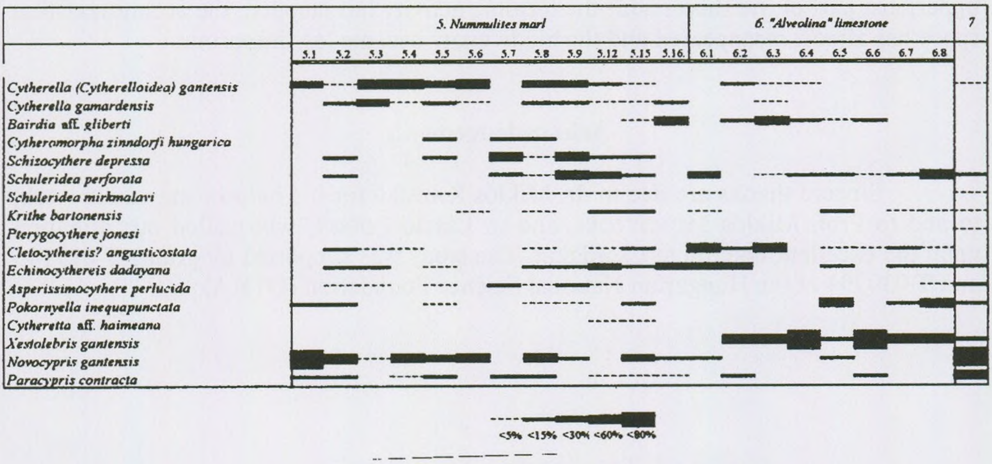

Fig. 6. The abundance of the ostracoda

Mollusca – On the basement of the sequence valuable mollusc fauna is found in *Variegated clay*, *Mollusca marl* and in the *Ostrea lumachelle*. Bed 3 contains *Brachyodontes* from the coastal mangrove swamp zone.

In Bed 4 (*Mollusca marl*) *Ostrea* is found in great amount, that sign coastal shallow marine environment especially 1-2 m deep water.

On the lower part of Bed 7 (*Ostrea* lumachelle) the characteristic genera are *Tympanotonus, Anomia, Ampullina, Turritella*. Most of these species indicate brackish water. The region could be a basin isolated from intensive currents and somehow from the open water. The upper part contains oyster, signing coastal shallow marine environment.

Palaeoenvironmental reconstruction

Summarizing the foraminifera, ostracoda and mollusca fauna examinations transgressive and regressive cycle can be determined in the Middle Eocene succession of the Csordakút Basin. The bauxite is deposited in the karst depressions of the Triassic carbonates. This is the basis of the *variegated clay*. Its development is due to a relative sea level rise. On this 8-10m thick *mollusc marl* was found. Presumably the transgression was stopped by a morphological barrier so that intensive erosion begun which is indicated by big dolomitie boulders in the marl.

The overlying marine assemblage of the *Nummulites marl* indicates that the subsidence became more and more intensive. On the basis of the *Nummulites marl* the fauna indicate frequent short period environmental change. Up the marl the deeper sublittoral zone indicating ostracod and foraminifer become dominant. Going upwards, from Bed 6 more and more sedimentary environment were typical. The rate of the subsidence has decreased so that the accommodation space has been reduced step by step. A shallow marine isolated lagoon has been developed with rich fauna dominated wide tolerance specimens (*„Alveolina" limestone*). At last with the filling up of the basin (which is signed by the shallow marine coastal *Ostrea lumachelle* in the uppermost part of the succession) the tectonic activity has stopped, the accommodation space has almost disappeared and the biodiversity became less important.

Acknowledgements

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Systematical palaeontology

Protozoa GOLDFUSS, 1818 phylum
Rhizopodea VON SIEBOLD, 1845 classis
Foraminifera EHRENBERG, 1930 ordo
Textulariina DELAGE et HÉROUARD, 1896 subordo
Lituolacea DE BLAINVILLE, superfamilia
Trochamminidae SCHWAGER, 1877 familia

Clavulina d'ORBIGNY, 1826 genus

Clavulina parisiensis d'ORBIGNY, 1826

Pl. 1, fig. 1.

1826. *Clavulina parisiensis* n. sp. – d'ORBIGNY, p. 102., Pl. 7
1865. *Clavulina parisiensis* d'ORBIGNY, – PARKER, JONES et BRADY, p. 29., Pl. I. f. 26.
1882. *Clavulina parisiensis* d'ORBIGNY – TERQUEM, p. 121., Pl. XII. f. 34.
1927. *Clavulina parisiensis* d'ORBIGNY – LIEBUS, p. 351., Pl. 12. f. 3.
1937. *Clavulina parisiensis* d'ORBIGNY – CUSHMAN, p. 18., Pl. II. f. 34.
1952. *Clavulina parisiensis* d'ORBIGNY – LE CALVEZ, p. 15., Pl. 4.
1956. *Clavulina parisiensis* d'ORBIGNY – HAQUE, p. 48., Pl. 5. f. 7–9.
1961. *Clavulina parisiensis* d'ORBIGNY – KAASSCHIETER, p. 144., Pl. I. f. 27–28.
1964. *Clavulina parisiensis* d'ORBIGNY – LOEBLICH et TAPPAN, p. C 279., f. 187/4.
1967. *Clavulina* cf. *parisiensis* d'ORBIGNY – ZILAHY, p. 401., Pl. V f. 8.
1970. *Clavulina parisiensis* d'ORBIGNY – LE CALVEZ, p. 21., Pl. I. f. 1.
1970. *Clavulina parisiensis* d'ORBIGNY – NYÍRŐ, p. 71., Pl. I. f. 1.
1983. *Clavulina parisiensis* d'ORBIGNY – SETIAWAN, pp. 104–405., Pl. VII. f. 1
1988. *Clavulina parisiensis* d'ORBIGNY – HORVÁTH KOLLÁNYI, pp. 47–48., Pl.II.f. 3–5.

Dimension: L=1.2-1.6 mm; W=0.3-0.5 mm.
Material: *5.12. bed* = 4 specimens; *5.15. bed* = 7 specimens; *6.1. bed* = 1 specimen; *6.2. bed* = 103 specimens; *6.3. bed* = 27 specimens; *6.5. bed* = 8 specimens; *6.6. bed* = 3 specimens; *6.7. bed* = 15; *6.8. bed* =2 specimens.
Stratigraphical range in Hungary: Middle and Upper Eocene (Upper Lutetian - Priabonian)

Tritaxia REUSS, 1860 genus

Tritaxia szabói (HANTKEN, 1868)

Pl. 1, fig. 2.

1868. *Rhabdogonium Szabói* n. sp. – HANTKEN, p. 9., Pl. I. f. 18.
1868. *Rhabdogonium haeringense* GÜMBEL – GÜMBEL, p. 631., Pl. I. f. 55 a–b.
1875. *Clavulina Szabói* HANTKEN – HANTKEN, p. 13., Pl. I. f. 9 a–d.
1903. *Clavulina Szabói* HANTKEN – WOJCIK, p. 498., Pl. VI. f. 20.
1932. *Clavulina Szabói* HANTKEN – PROTESCU, p. 88., Pl. I. f. 1–2.
1937. *Clavulinoides szabói* (HANTKEN) – CUSHMAN, p. 133., Pl. 18. f. 33 a–b; 34.
1937 *Clavulinoides szabói* (HANTKEN) – CUSHMAN, p. 134., Pl. 18. f. 35 a–b; 36.

1944. *Clavulina szabói* Hantken – Majzon, p. 165., f. 5.
1946. *Clavulina szabói* Hantken – Kaptarenko et Csernuszova, p. 229., Pl. II. f. 10.
1946. *Clavulinoides szabói* (Hantken) – van Bellen, p. 86., Pl. 13. f. 16.
1949. *Clavulinoides szabói* (Hantken) – Cuvillier et Szakall, p. 24., Pl. 10. f. 4.
1950. *Clavulinoides szabói* (Hantken) – Cita, p. 85., Pl. 6. f. 8.
1953. *Clavulinoides szabói* (Hantken) – Hagn, p. 39., f. 2.
1956. *Clavulinoides szabói* (Hantken) – Hagn, p. 116., Pl. 10. f. 1.
1956. *Clavulina szabói* Hantken – Kaptarenko et Csernuszova, Pl. 7. f. 9.
1972. *Clavulinoides szabói* (Hantken) – Majzon, pp. 114–115., Pl. I. f. 3–9., 11–16.,18–19., 21–23., Pl. II. 1–8., 14–20.
1977. *Tritaxia szabói* (Hantken) – Horváth, p. 42.
1979. *Tritaxia szabói* (Hantken) Sztrákos, Pl. V. f. 8.

Dimension: H=0.9-1.1 mm; W=0.5-0.8 mm.
Material: *5.2. bed* = 10 specimens; *5.4. bed* = 1 specimen; *5.5. bed* = 2 specimens; *5.8. bed* = 8 specimens; *5.9. bed* = 16 specimens; *5.12. bed* = 27 specimens; *5.15. bed* = 14 specimens; *5.16. bed* = 31 specimens; *6.1. bed* = 6 specimens; *6.2. bed* = 21 specimens; *6.3. bed* = 21 specimens; *6.4. bed* = 18 specimens; *6.5. bed* = 25 specimens; *6.6. bed* = 31 specimens; *6.7. bed* = 3 specimens; *6.8. bed* = 35 specimens.
Stratigraphical range in Hungary: Middle Eocene and Lower Oligocene (Bartonian - Kiscellian)

Miliolina Delage et Hérouard, 1896 subordo
Miliolacea Ehrenberg, 1839 superfamilia
Hauerinidae Schwager, 1876 familia
Haueríninae Schwager, 1876 subfamilia

Quinqueloculina d'Orbigny, 1826 genus

Quinqueloculina carinata d'Orbigny, 1826
Pl. 1, fig. 3.

1826. *Quinqueloculina carinata* (d'Orbigny) – Ellis et Messina, p. 302., Pl. VI. f. 1.
1905. *Quinqueloculina carinata* (d'Orbigny) – Fornasini, p. 67., Pl. 4. f. 2.
1942. *Quinqueloculina ermani* Franzn.(?) – Méhes, p. 38., Pl. XII. f. 266.
1961. *Quinqueloculina carinata* (d'Orbigny) – Kaasschieter, pp. 148–149., Pl. II. f. 9–11.
1970. *Quinqueloculina carinata* (d'Orbigny) – le Calvez, pp. 33–34., Pl. IV f. 4., Pl. V. f. 9.
1996. *Quinqueloculina carinata* (d'Orbigny) – Halupka, pp. 26–27., Pl. III. f. 6.

Dimension: L=0.4-0.7 mm; W=0.5-0.6 mm.
Material: *5.12. bed* = 1 specimen; *5.15. bed* = 12 specimens; *6.1. bed* = 13 specimens; *6.5. bed* = 1 specimen; *6.7. bed* = 15 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Quinqueloculina aff. *carinata* d'ORBIGNY,
Pl. 1, fig. 4.

Dimension: L=0.4-0.6 mm; W=0.4-0.5 mm.
Material: *5.2. bed* = 3 specimens; *6.1. bed* = 3 specimens; *6.7. bed* = 8 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Quinqueloculina bicarinata (d'ORBIGNY, 1878)
Pl. 1, fig. 5.

1878. *Quinqueloculina bicarinata* (d'ORBIGNY) – in TERQUEM, p. 68., Pl. VII. f. 10.
1902. *Quinqueloculina bicarinata* (d'ORBIGNY) – FORNASINI, p. 22., Pl. 16.
1945. *Quinqueloculina bicarinata* (d'ORBIGNY) – CUSHMAN, p. 16., Pl. 2. f. 9.
1955. *Quinqueloculina bicarinata* (d'ORBIGNY) – BHATIA, p. 671., Pl. 67. f. 12.
1957. *Quinqueloculina bicarinata* (d'ORBIGNY) – BOWEN, p. 56.
1961. *Quinqueloculina bicarinata* d'ORBIGNY – KAASSCHIETER, p. 149., Pl. II. f. 12.

Dimension: L=0.7-0.9 mm; W=0.4-0.7 mm.
Material: *6.1. bed* = 2 specimens.
Stratigraphical range in Hungary: Unknown, the species is mentioned from the Middle Eocene (Bartonian) of England.

Quinqueloculina cf. *contorta* (d'ORBIGNY)
Pl. 1, fig. 6.

1846. *Quinqueloculina contorta* (d'ORBIGNY) – in: ELLIS et MESSINA, p. 298., Pl. XX. f. 4–6.
1970. *Quinqueloculina contorta* (d'ORBIGNY) – LE CALVEZ, p. 34., Pl. V. f. 7–8.
1996. *Quinqueloculina contorta* (d'ORBIGNY) – HALUPKA, pp. 33–34., f. 5.5.

Dimension: L=0.9-1.3 mm; W=0.3-0.7 mm.
Material: *5.2. bed* = 4 specimens; *5.5. bed* = 21 specimens; *5.16. bed* = 3 specimens; *6.3. bed* = 3 specimens; *6.7. bed* = 15 specimens; *6.8. bed* = 8 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Quinqueloculina ungeriana d'ORBIGNY, 1846
Pl. 1, fig. 7.

1846. *Quinqueloculina ungeriana* n. sp. – d'ORBIGNY, p. 291., Pl. 18. F. 22–24.
1985. *Quinqueloculina ungeriana* d'ORBIGNY – PAPP et SCHMID, p. 100., Pl. 95. f. 6–8.

Dimension: L=1.0-1.2 mm; W=0.7-0.8 mm.
Material: *6.8. bed* = 5 specimens.
Stratigraphical range in Hungary: Paleogene and Neogene.

Quinqueloculina sp. indet.

Pl. 1, fig. 8.

Dimension: L=0.4-0.6 mm; W=0.4-0.5 mm.
Material: *5.8. bed* = 2 specimens; *6.3. bed* = 1 specimen; *6.5. bed* = 1 specimen; *6.7. bed* = 13 specimens; *6.8. bed* = 7 specimens.
Stratigraphical range in Hungary: Paleogene and Neogene.

Miliolinellinae VELLA, 1957 subfamilia

Pyrgo DEFRANCE, 1824 genus

Pyrgo simplex (d'ORBIGNY, 1846)

Pl. 2, fig. 1-2.

1846. *Biloculina simplex* (d'ORBIGNY) – (d'ORBIGNY), p. 264., Pl. XV. f. 25–24.
1947. *Pyrgo bulloides* (d'ORBIGNY) – LE CALVEZ, pp. 21., Pl. I.
1949. *Pyrgo simplex* (d'ORBIGNY) – CUVILLIER et SZAKALL, p. 46., Pl. XX. f. 3.
1961. *Pyrgo bulloides* (d'ORBIGNY) – KAASSCHIETER, p. 167., Pl. V. f. 18.
1970. *Pyrgo simplex* (d'ORBIGNY) – LE CALVEZ, p. 55., Pl. VIII. f. 7.
1985. *Pyrgo simplex* (d'ORBIGNY) – PAPP et SCHMID, pp. 89–90., Pl. 83. f. 1–3.
1996. *Pyrgo simplex* (d'ORBIGNY) – HALUPKA, pp. 40–41., Pl. V. f. 7–8.

Dimension: L=0.3-0.8 mm; W=0.3-0.8 mm.
Material: *5.2. bed* = 46 specimens; *5.5. bed* = 19 specimens; *5.15. bed* = 92 specimens; *5.16. bed* = 9 specimens; *6.1. bed* = 28 specimens; *6.3. bed* = 7 specimens; *6.5. bed* = 3 specimens; *6.8. bed* = 16 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Triloculina d'ORBIGNY, 1825 genus

Triloculina gibba d'ORBIGNY, 1825

Pl. 2, fig. 3.

1825. *Triloculina gibba* n. sp. – d'ORBIGNY, p. 133., Nr. 3.
1846. *Triloculina gibba* d'ORBIGNY – in ELLIS et MESSINA (1949), p. 247., Pl. 16. f. 22–24.
1882. *Triloculina gibba* d'ORBIGNY – TERQUEM, p. 163., Pl. 16. f. 31.
1947. *Triloculina gibba* d'ORBIGNY – LE CALVEZ, p. 17., Pl. 1.
1949. *Triloculina gibba* d'ORBIGNY – CUVILLIER et SZAKALL, p. 43., Pl. XIX. f. 2.
1961. *Triloculina gibba* d'ORBIGNY – KAASSCHIETER, p. 165., Pl. V. f. 13.
1970. *Triloculina gibba* d'ORBIGNY – LE CALVEZ, p. 49., Pl. VIII. f. 3–4.
1974. *Triloculina gibba* d'ORBIGNY – LUCZKOWSKA, p. 134., Pl. 23. f. 2a–c.
1985. *Triloculina gibba* d'ORBIGNY – PAPP et SCHMID, pp. 93–94., Pl. 86. f. 1–4.
1996. *Triloculina gibba* d'ORBIGNY – HALUPKA, pp. 44–45., Pl. VI. f. 6–7.

Dimension: L=0.4-0.6 mm; W=0.3-0.5 mm.

Material: *5.5. bed* = 17 specimens; *5.8. bed* = 1 specimen; *5.15. bed* = 23 specimens; *6.3. bed* = 2 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Triloculina porvaensis HANTKEN, 1875
Pl. 2, fig. 4.

1875. *Triloculina porvaensis* n. sp. – HANTKEN, p. 21., Pl. 13. f. 3.
1970. *Triloculina porvaensis* HANTKEN – LE CALVEZ, p. 52., Pl. 13. f. 12.
1970. *Triloculina porvaensis* HANTKEN – NYIRŐ, p. 71., Pl. I. f. 9.
1988. *Triloculina porvaensis* HANTKEN – HORVÁTH KOLLÁNYI, pp. 58–59., Pl. VIII. f. 4–5.

Dimension: L=1.2-1.3 mm; W=0.6-0.7.
Material: *6.7. bed* = 16 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Triloculina trigonula LAMARCK, 1804
Pl. 2, fig. 5.

1804. *Triloculina trigonula* n. sp. – LAMARCK, p. 531.
1807. *Triloculina trigonula* LAMARCK – LAMARCK, p. 9., Pl. 17. f. 4.
1882. *Triloculina trigonula* LAMARCK – TERQUEM, p. 165., Pl. 17. f. 3.
1947. *Triloculina trigonula* LAMARCK – LE CALVEZ, p. 18., Pl. 1.
1961. *Triloculina trigonula* LAMARCK – KAASSCHIETER, pp. 164–165., Pl. V. f. 8–10.

Dimension: L=0.5-0.7 mm; W=0.3-0.4 mm.
Material: *6.3. bed* = 1 specimen; *6.8. bed* = 2 specimens.
Stratigraphical range in Hungary: From Eocene to Miocene.

Triloculina sp. indet.
Pl. 2, fig. 6.

Dimension: L=0.7-0.8 mm; W=0.5-0.6 mm.
Material: *5.15. bed* = 3 specimens.
Stratigraphical range in Hungary: The genus is mentioned from the Paleogene of Hungary.

Soritidae EHRENBERG, 1839 familia
Soritinae EHRENBERG, 1839 subfamilia

Orbitolites LAMARCK, 1801 genus

Orbitolites sp. indet. LAMARCK, 1801
Pl. 6, fig. 1.

Dimension: L=0.3-0.4 mm; W=0.02 mm.

Material: The specimens is discovered for the first time in the *6.2. bed.* Up the geological column is converted into mass.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Milioliporidae BRÖNNIMANN et ZANINETTI, 1971 familia

Spirolina LAMARCK, 1804 genus

Spirolina sp. indet.
Pl. 2, fig. 7.

Dimension: L=0.55 mm; diameter of the protoconch is 0.3 mm; diameter of the older part of test is 0.2 mm.
Material: *6.8. bed* = 1 specimen.
Stratigraphical range in Hungary: Paleogene and Neogene

Alveolinidae EHRENBERG, 1839 familia

Fasciolites PARKINSON, 1811 genus

Fasciolites sp. indet. {=*Alveolina* auct. (nom. invalid.)}

Dimension: The dimenson of the test is not mesaured.
Material: The specimens is discovered for the first time in the *6. bed* and they are converted into mass in *6.3.* and *6.4. beds.*
Stratigraphical range in Hungary: Middle and Upper Eocene (Lutetian - Priabonian)

Rotaliina DELAGE et HÉROUARD, 1879 subordo
Nodosariacea EHRENBERG, 1838 superfamilia
Nodosariidae EHRENBERG, 1838 familia

Nodosaria LAMARCK, 1812 genus

Nodosaria sp. indet.
Pl. 3, fig. 1-2.

Dimension: The test has broken therefor I can not W=0.3 mm.
Material: *6.5. bed* = 2 specimens.
Stratigraphical range in Hungary: Paleogene

Polymorphinidae d'ORBIGNY, 1839 familia
Polymorphininae d'ORBIGNY, 1839 subfamilia

Globulina d'ORBIGNY in DE LA SAGRA, 1839 genus

Globulina gibba d'ORBIGNY, 1826
Pl. 3, fig. 3.

1826. *Polymorphina (Globuline) gibba* (nom. nud.) – d'ORBIGNY, p. 100., Pl. 7.
1846. *Globulina gibba* d'ORBIGNY – d'ORBIGNY, p. 227., Pl. XIII. f. 13–14.
1865. *Polymorphina (Globuline) gibba* d'ORBIGNY – PARKER, p. 29., Pl. II. f. 52.
1882. *Globulina gibba* d'ORBIGNY – TERQUEM, p. 130., Pl. XIII. f. 22–27.
1935. *Globulina gibba* d'ORBIGNY – CUSHMAN, p. 25., Pl. 9. f. 18.
1942. *Globulina gibba* d'ORBIGNY – CUSHMAN et RENZ, p. 7., Pl. 2. f. 4.
1946. *Globulina gibba* d'ORBIGNY – BELLEN, p. 37., Pl. 3. f. 4.
1946. *Globulina gibba* d'ORBIGNY – CUSHMAN, p. 18., Pl. 4. f. 16.
1948. *Polymorphina (Globuline) gibba* d'ORBIGNY – DORREEN, p. 289., Pl. 37. f. 7.
1950. *Globulina gibba* d'ORBIGNY – LE CALVEZ, p. 17.
1955. *Globulina gibba* d'ORBIGNY – KAASSCHIETER, p. 67., Pl. 5. f. 12.
1956. *Globulina gibba* d'ORBIGNY – HAGUE, p. 107., Pl. 30. f. 4.
1958. *Globulina gibba* d'ORBIGNY – BATJES, p. 121., Pl. IV. f. 9.
1961. *Globulina gibba* d'ORBIGNY – KAASSCHIETER, p. 183., Pl. VIII. f. 6–7.
1970. *Globulina gibba* d'ORBIGNY – KIESEL, p. 250., Pl. XI. f. 12; 18.
1970. *Globulina gibba* d'ORBIGNY – LE CALVEZ, p. 84., Pl. 17. f. 3–4.
1982. *Globulina gibba* d'ORBIGNY – PETTERS, p. 55., Pl. 8. f. 11.
1988. *Globulina gibba* d'ORBIGNY – HORVÁTH KOLLÁNYI, pp. 65–66., Pl.XIII. f. 1–2.

Dimension: L=0.6 mm; W=0.5 mm.
Material: *6.6. bed* = 1 specimen .
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Guttulina d'ORBIGNY, 1839 genus

Guttulina irregularis (d'ORBIGNY, 1846)
Pl. 3, fig. 4.

1846. *Globulina irregularis* d'ORBIGNY – d'ORBIGNY, p. 226., Pl. XIII. f. 9–10.
1935. *Guttulina irregularis* (d'ORBIGNY) – CUSHMAN, p. 24., Pl. 9. f. 13–16.
1946. *Guttulina irregularis* (d'ORBIGNY) – CUSHMAN, p. 16., Pl. 4. f. 12.
1950. *Guttulina irregularis* (d'ORBIGNY) – LE CALVEZ, p. 14.
1955. *Guttulina irregularis* (d'ORBIGNY) – BHATIA, p. 676., Pl. 67. f. 26.
1955. *Guttulina irregularis* (d'ORBIGNY) – KAASSCHIETER, p. 66., Pl. 5. f. 11.
1961. *Guttulina irregularis* (d'ORBIGNY) – KAASSCHIETER, p. 181., Pl. VIII. f. 2–3.
1963. *Guttulina irregularis* (d'ORBIGNY) – KÜMMERLE, p. 37., Pl. 4. f. 7.
1970. *Guttulina irregularis* (d'ORBIGNY) – KIESEL, p. 243., Pl. X. f. 21.
1970. *Guttulina irregularis* (d'ORBIGNY) – LE CALVEZ, p. 92., Pl. 20. f. 3.
1988. *Guttulina irregularis* (d'ORBIGNY) – HORVÁTH KOLLÁNYI,pp.67–68., Pl.XIII.f. 4.

Dimension: L=0.5 mm; W=0.6 mm.
Material: *5.15. bed* = 1 specimen; *5.16. bed* = 1 specimen; *6.3. bed* = 6 specimens; *6.4. bed* = 26 specimens; *6.6. bed* = 7 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Pyrulina d'ORBIGNY, 1839 genus

Pyrulina sp. indet.
Pl. 3, fig. 5.

Dimension: L=0.5 mm; W=0.25 mm.
Material: *5.16. bed* = 1 specimen; *6.4. bed* = 1 specimen.
Stratigraphical range in Hungary: The genus is mentioned from Lower Paleogene of Hungary

Buliminacea JONES, 1857 superfamilia
Buliminidae JONES, 1875 familia
Bulimininae KAASSCHIETER, 1961 subfamilia

Bulimina d'ORBIGNY, 1826 genus

Bulimina parisiensis (CUSHMAN et TODD, 1945)
Pl. 3, fig. 6.

1942. *Bulimina trigona* (CUSHMAN et TODD) – CUSHMAN et TODD, p. 17., Pl. 4. f. 6.
1946. *Bulimina trigona* (CUSHMAN et TODD) – CUSHMAN et PARKER, p. 91.,Pl.21. f. 18.
1950. *Bulimina trigona* (CUSHMAN et TODD) – LE CALVEZ, p. 37., Pl. 3. f. 35.
1961. *Bulimina parisiensis* nov. nom. – KAASSCHIETER, p. 190., Pl. VIII. f. 19., Pl. IX. f. 3–4.

Dimension: L=0.6 mm; W=0.3 mm.
Material: *6.6. bed* = 3 specimens; *6.8. bed* = 1 specimen.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Discorbacea EHRENBERG, 1838 superfamilia
Discorbidae EHRENBERG, 1838 familia

Discorbis LAMARCK, 1804 genus

Discorbis parisiensis (d'ORBIGNY, 1865)
Pl. 3, fig. 7.

1865. *Rosalina parisiensis* (d'ORBIGNY) – in PARKER, JONES et BRADY, Pl. II. f. 70.
1882. *Rosalina parisiensis* (d'ORBIGNY) – TERQUEM, p. 99., Pl. 10. f. 15–17.
1927. *Discorbis parisiensis* (d'ORBIGNY) – CUSHMAN, p. 142.
1949. *Discorbis parisiensis* (d'ORBIGNY) – LE CALVEZ, p. 16.
1961. *Discorbis parisiensis* (d'ORBIGNY) – KAASSCHIETER, p. 208., Pl. XI. f. 9–10.

Dimension: H=0.6-0.7 mm; W=0.5-0.7 mm.
Material: *5.2. bed* = 2 specimens; *5.8. bed* = 8 specimens; *5.9. bed* = 26 specimens; *5.12. bed* = 13 specimens; *5.16. bed* = 30 specimens; *6.1. bed* = 4 specimens; *6.2. bed* = 7 specimens.

Stratigraphical range in Hungary: Paleogene

Discorinopsis COLE, 1941 genus

Discorinopsis sp. indet.
Pl. 3, fig. 8, Pl. 6, fig. 2.

Dimension: H=0.3-0.4 mm; W=0.5-0.7 mm.
Material: *6.8. bed* = 5 specimens.
Stratigraphical range in Hungary: Middle and Upper Eocene (Lutetian - Priabonian)

Asterigerinidae d'ORBIGNY, 1839 familia

Asterigerina d'ORBIGNY, in de la SAGRA, 1839 genus

Asterigerina sp. indet.
Pl. 3, fig. 9.

Dimension: H=0.4 mm; W=0.6 mm.
Material: *6.2. bed* = 1 specimen.
Stratigraphical range in Hungary: The genus is mentioned from Paleogene and Neogene

Rotaliacea EHRENBERG, 1839 superfamilia
Rotaliidae EHRENBERG, 1839 familia

Rotalia LAMARCK, 1804 genus

Rotalia trochidiformis LAMARCK, 1804
Pl. 4, fig. 1.

1804. ***Rotalites trochidiformis*** n. sp. – LAMARCK, p. 184.
1882. ***Rotalina trochidiformis*** LAMARCK – TERQUEM, p. 68., Pl. VI. f. 4.
1882. ***Rotalina saxorum*** d'ORBIGNY – TERQUEM, p. 69., Pl. VI. f. 4.
1949. ***Rotalia trochidiformis*** LAMARCK – LE CALVEZ, p. 32.
1952. ***Rotalia trochidiformis*** LAMARCK – BERMUDEZ, p. 70., Pl. XII. f. 1.
1957. ***Rotalia trochidiformis*** LAMARCK – SACAL, DEBORULE et CUVILLIER, p. 40., Pl. XVI. f. 7.
1964. ***Rotalia trochidiformis*** LAMARCK – LOEBLICH et TAPPAN, p. C 607., f. 479/ 1, 480/1–3.
1970. ***Rotalia trochidiformis*** LAMARCK – LE CALVEZ, pp. 159–160., Pl. 34. f. 4–5.
1988. ***Rotalia trochidiformis*** LAMARCK – HORVÁTH KOLLÁNYI, pp. 159–160.,Pl. XVIII. f. 1–2.

Dimension: H=0.3-0.5 mm; W=0.4-0.6 mm.
Material: *5.3. bed* = 1 specimen; *5.4. bed* = 6 specimens; *5.5. bed* = 1 specimen; *5.7. bed* = 8 specimens; *5.8. bed* = 6 specimens; *5.9. bed* = 24 specimens; *5.12. bed* = 7

specimens; *5.15. bed* = 3 specimens; *5.16. bed* = 8 specimens; *6.3. bed* = 4 specimens; *6.5. bed* = 1 specimen.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Pararotaliinae REISS, 1963 subfamilia

Pararotalia LE CALVEZ, 1949 genus

Pararotalia curryi (CUSHMAN, 1928)

Pl. 4, fig. 2-3.

1928. *Rotalia canui* (CUSHMAN) – ELLIS et MESSINA, p. 55., Pl. III. f. 2.
1970. *Pararotalia curryi* (CUSHMAN, 1928) – LE CALVEZ, p. 162., Pl. XXXV. f. 1–2.
1996. *Pararotalia curryi* (CUSHMAN, 1928) – HALUPKA, pp. 63–64., Pl. X. f. 6–7.

Dimension: Diameter of the last whorl 0.4-0.6 mm; widthis 0.3-0.5
Material: *5.12 bed* = 2 specimens; *5.15. bed* = 3 specimens; *5.16. bed* = 15 specimens; *6.1. bed* = 23 specimens; *6.2. bed* = 17 specimens; *6.3. bed* = 17 specimens; *6.4. bed* = 134 specimens; *6.5. bed* = 23 specimens; *6.6. bed* = 128 specimens; *6.8. bed* = 3 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Nummulitidae de BLAINVILLE, 1825 familia

Nummulites LAMARCK, 1801 genus

Nummulites discorbinus minor DE LA HARPE, 1926

1926. *Nummulites discorbina* SCHLOTHEIM var. *minor* n. sp. – DE LA HARPE, p. 38.
1926. *Nummulites discorbina* SCHLOTHEIM var. *minor* DE LA HARPE – ROZLOZSNIK, pp. 192–193. Pl. V. f. 24.
1988. *Nummulites discorbina minor* DE LA HARPE – JÁMBOR -KNESS, pp. 289–290. Pl. XIX. f. 324–327

Material: The specimens is discovered for the first time in the *5.3. bed.* But their quantity is limited. I could find their to the *5.16. bed*
Stratigraphical range in Hungary: Upper part of Middle Eocene (Bartonian)

Nummulites kovácsiensis HANTKEN, 1865

1865. *Nummulites Kovácsiensis* n. sp. – HANTKEN, p. 414. nom. nud.
1924. *Nummulites Kovácsiensis* HANTKEN – ROZLOZSNIK, pp. 186–187.,Pl. IV.f.10 a–g.
1988. *Nummulites kovácsiensis* HANTKEN – JÁMBOR –KNESS, pp. 340–341. Pl. XXIX. f. 491–498., 500–501.

Dimension: The diameter is 1-2mm.
Material: The specimens is discovered for the first time in the *5.3. bed.* But their quantity is limited. I could find their to the *5.9 - 5.16. bed.*

Stratigraphical range in Hungary: Lower part of Middle Eocene (Lutetian)

Nummulites perforatus (MONTFORT), 1808

1803. *Nautilus lenticularis* FICHTEL et MOLL, p. 57., Pl. VII. f. H.
1808. *Egeon perforatus* nom. trans. – MONTFORT, pp. 166–167., f. 2.
1988. *Nummulites discorbina minor* DE LA HARPE – JÁMBOR-KNESS, pp. 239–244. Pl. XI. f. 183, 186–187, Pl. XII. f. 188–193. Pl. XIII. f. 194–197. (cum syn)

Dimension: Diameter of the test is 1.5 - 2 cm.
Material: The specimens is discovered for the first time in the *7. bed (Ostrea lumachella)* = 12 specimens
Stratigraphical range in Hungary: Middle Eocene (Upper Lutetian - Bartonian)

Nummulites striatus BRUGUIÈRE, 1792

1792. *Camerina striata* n. sp. – BRUGUIÈRE, pp. 399–400.
1972. *Nummulites striatus* BRUGUIÈRE – VANOVA, pp. 120–121. Pl. XXVII. f. 3–4. XXVIII. f. 3–4.(cum syn)

Dimension: Diameters of the tests are 1-2 mm.
Material: The specimens is discovered for the first time in the *5.3. bed.* Up the geological column is converted into mass in the *5.16.-6.1. beds.*
Stratigraphical range in Hungary: Upper part of Middle Eocene (Bartonian)

Nummulites subplanulatus HANTKEN et MADARÁSZ, 1865

1865. *Nummulites subplanulatus* n. sp. – HANTKEN et MADARÁSZ, p. 414–415.
1972. *Nummulites subplanulatus* HANTKEN et MADARÁSZ – BOMBITA, p. 73. f. 64–68. , f. 71–74 (cum syn)

Dimension: Diameter of the test is 1.7-2.5mm, and the widthis 0.5-1 mm.
Material: The most frequent element is in the fauna of the Csordakut Basin. The specimens is discovered for the first time in the *5. bed.* Up the geological column is converted into mass from the *5.4. bed* to the *5.12. bed.*
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Orbitoidacea SCHWAGER, 1876 superfamilia
Eponididae HOFKER, 1951 familia

Eponides de MONTFORT, 1808 genus

Eponides polyganus LE CALVEZ, 1949
Pl. 4, fig. 4.

1949. *Eponides polyganus* n. sp. – LE CALVEZ, p. 28., Pl. V. f. 90–92.
1961. *Eponides polyganus* LE CALVEZ – KAASSCHIETER, p. 210., Pl. XII. f. 1.
1970. *Eponides polyganus* LE CALVEZ – NYÍRŐ, p. 76., Pl. II. f. 1.
1970. *Eponides polyganus* LE CALVEZ – LE CALVEZ, p. 136., Pl. 37. f. 1., 9.

1975. *Eponides polyganus* LE CALVEZ – SAMUEL, p. 147., Pl. LXXXII. f. 6.
1988. *Eponides polyganus* LE CALVEZ – HORVÁTH KOLLÁNYI, p. Pl. XIX. f. 4–5.

Dimension: H=0.6-0.8 mm; W=0.7-0.9 mm.
Material: *5.3. bed* = 2 specimens; *5.4. bed* = 11 specimens; *5.5. bed* = 8 specimens; *5.7. bed* = 17 specimens; *5.8. bed* = 11 specimens; *5.9. bed* = 40 specimens; *5.12. bed* = 72 specimens; *5.15. bed* = 3 specimens; *5.16. bed* = 19 specimens; *6.1. bed* = 12 specimens; *6.2. bed* = 97 specimens; *6.3. bed* = 9 specimens; *6.4. bed* = 3 specimens; *6.5. bed* = 2 specimens; *6.8. bed* = 1 specimen.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Cibicididae CUSHMAN, 1927 familia

Planulina d'ORBIGNY, 1826 genus

Planulina sp. indet.
Pl. 4, fig. 5-6.

Dimension: Height of the last whorl is 0.7 mm, and their widthis 0.6mm.
Material: *6.5. bed* = 1 specimen.
Stratigraphical range in Hungary: Paleogene

Cibicides de MONTFORT, 1808 genus

Cibicides pygmeus (HANTKEN, 1875)
Pl. 4, fig. 7-8.

1875. *Truncatulina pygmea* HANTKEN – HANTKEN, p. 78., Pl. 10. f. 8.
1955. *Eponides pygmeus* (HANTKEN) – BHATIA, p. 683., Pl. 67 f. 7
1958. *Eponides pygmeus* (HANTKEN) – BATJES, p. 146., Pl. 7. f. 11.
1961. *Cibicides pygmeus* (HANTKEN) – KAASSCHIETER, p. 219., Pl. XIV. f. 1.

Dimension: Widthof the last whorl is 0.25mm.
Material: *5.8. bed* = 17 specimens; *5.9. bed* = 34 specimens.
Stratigraphical range in Hungary: Paleogene

Acervulinidae SCHULTZE, 1854 familia

Acervulina SCHULTZE, 1854 genus

Acervulina sp. indet.
Pl. 6, fig. 4.

Dimension: Diameter of the test is 0.13 mm.
Material: *6.3. bed* = 1 specimen.
Stratigraphical range in Hungary: Paleogene

Sphaerogypsina GALLOWAY, 1933 genus

Sphaerogypsina globula (REUSS, 1848)
Pl. 5, fig. 1-2.

1848. *Ceriopora globulus* REUSS – REUSS, p. 33., Pl. 5. f. 7.
1886. *Gypsina globulus* REUSS – UHLIG, pp. 197–200., f. 7–8.
1918. *Gypsina globulus* REUSS – TRAUTH, p. 242., Pl. III. f. 1.
1935. *Gypsina globulina* (REUSS) – CUSHMAN, p. 54., Pl. 23. f. 4–5.
1937. *Gypsina globulus* (REUSS) – SILVESTRI, pp. 156–157., Pl. VIII. f. 1.
1954. *Gypsina globula* (REUSS) – COLOM, p. 208., Pl. XV. f. 11.
1957. *Sphaerogypsina globula* (REUSS) – PURI, p. 143., Pl.14. f. 7.,Pl. 15. f. 9.
1960. *Gypsina globula* (REUSS) – TODD et LOW, p. 853., Pl. 258. f. 9.
1963. *Sphaerogypsina globulus* (REUSS) – BIEDA, pp. 45–46., Pl. III. f. 6–10.
1963. *Sphaerogypsina globula* (REUSS) – KIESEL et LOTSCH, p. 17., Pl. VI. f. 4.
1964. *Sphaerogypsina globulus* (REUSS) – LOEBLICH et TAPPAN, p. C 698., f. 569/ 1–2.
1967. *Sphaerogypsina globulus* (REUSS) – VITÁLIS ZILAHY, pp. 407–408., Pl. VII. f. 14., Pl. VIII. f. 1–2.
1969. *Sphaerogypsina globula* (REUSS) – VITÁLIS ZILAHY, p. 159., Pl. III., IV., V.
1970. *Sphaerogypsina globula* (REUSS) – NYIRŐ, p. 78., Pl. II. f. 9.
1988. *Sphaerogypsina globula* (REUSS) – HORVÁTH KOLLÁNYI, p. 85., Pl. XXV. f. 4.

Dimension: Diameter of the test is 0.45 mm
Material: *6.1. bed* = 2 specimens; *6.2. bed* = 1 specimen.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Cassidulinacea d'ORBIGNY, 1839 superfamilia
Nonionidae SCHULTZE, 1854 familia
Nonioninae SCHULTZE, 1854 subfamilia

Nonion de MONTFORT, 1808 genus

Nonion scaphum (FICHTEL et MOLL, 1978)
Pl. 5, fig. 3.

1798. *Nautilus scapha* FICHTEL et MOLL – FICHTEL et MOLL, p. 105., Pl. 19. f. d–f.
1844. *Nonionina scapha* FICHTEL et MOLL – BRADY, p. 730., Pl. 109. f. 14–15.
1846. *Nonionina communis* d'ORBIGNY – d'ORBIGNY, p. 106., Pl. V. f. 7–8.
1882. *Nonionina communis* d'ORBIGNY – TERQUEM, p. 42., Pl. II. f. 6a–c.
1939. *Nonion scaphum* FICHTEL et MOLL – CUSHMAN, p. 20., Pl. 5. f. 18–21.
1944. *Nonion acutidorsatum* TEN DAM – TEN DAM, p. 108., Pl. V. 3. f. 19.
1950. *Nonion commune* (d'ORBIGNY) – LE CALVEZ, p. 52., Pl. 3.
1951. *Nonion scaphum* FICHTEL et MOLL – MARKS, p. 49., Pl. 5. f. 16.
1955. *Nonion scaphum* FICHTEL et MOLL – BHATIA, p. 677., Pl. VI. 66. f. 3a–b.
1961. *Nonion scaphum* FICHTEL et MOLL – KAASSCHIETER, p. 204., Pl. X.f. 14., Pl. XI. f. 5.
1970. *Florilus scaphus* FICHTEL et MOLL – KIESEL, p. 282., Pl. XV. f. 6.
1970. *Nonion commune* (d'ORBIGNY) – LE CALVEZ, p. 191., Pl. 27. f. 5.
1985. *Nonion commune* (d'ORBIGNY) – PAPP et SCHMID, p.45., Pl. 34. f. 1–5.

1988. *Nonion scaphum* FICHTEL et MOLL – HORVÁTH KOLLÁNYI, p. 92., Pl. XXIX. f. 1–2.

Dimension: Height of the last whork is 0.2-0.6mm and their width i s0.2-0.4 mm.
Material: *5.2. bed* =1 specimen; *5.3. bed* = 52 specimens; *5.4. bed* = 142 specimens; *5.5. bed* = 42 specimens; *5.6. bed* = 6 specimens; *5.7. bed* = 12 specimens; *5.8. bed* = 211 specimens; *5.9. bed* = 189 specimens; *5.12. bed* = 43 specimens; *5.15. bed* = 16 specimens; *5.16. bed* = 21 specimens; *6.1. bed* = 31 specimens; *6.2. bed* = 6 specimens; *6.3. bed* = 34 specimens; *6.4. bed* = 23 specimens; *6.5. bed* = 16 specimens; *6.6. bed* = 68 specimens; *6.7. bed* = 15 specimens; *6.8. bed* = 11 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Nonion affinae (REUSS, 1851)
Pl. 5, fig. 4.

1851. *Nonionina affinis* REUSS – REUSS, p. 72., Pl. V. f. 32.
1939. *Nonion affinae* (REUSS) – CUSHMAN, p. 9., Pl. 2. f. 13.
1944. *Nonion affinae* (REUSS) – TEN DAM, p. 103.
1955. *Nonion umbilicatulum* (WALKER et JACOB) – BHATIA, p. 140., Pl. 678. Pl.66.f. 2.
1958. *Nonion affinae* (REUSS) – BATJES, p. 140., Pl. VI. f. 12.
1961. *Nonion affinae* (REUSS) – KAASSCHIETER, pp. 203., Pl. XI. f. 3–4.

Dimension: Height of the last whorl is 0.2-0.3 mm, and their width is 0.2-0.3mm.
Material: *5.4. bed* = 1 specimen; *5.5. bed* = 1 specimen; *5.7. bed* = 1 specimen; *5.8. bed* = 2 specimens.
Stratigraphical range in Hungary: Unknown, the species is mentioned from the Middle Eocene (Bartonian) of England and France

Nonion boueanum (d'ORBIGNY, 1846)
Pl. 5, fig. 5.

1846. *Nonionina boueana* d'ORBIGNY – d'ORBIGNY, p. 108., Pl. 5. f. 11–12.
1930. *Nonion asterizans* FICHTEL et MOLL – CUSHMAN, p. 6., Pl. 2. f. 5–7.
1939. *Nonion boueanum* (d'ORBIGNY) – CUSHMAN, p. 12., Pl. 3. f. 7–8.
1964. *Florilus asterizans* FICHTEL et MOLL – LOEBLICH et TAPPAN,p.C 746.,Pl.612. f. 4.
1976. *Nonion boueanum* (d'ORBIGNY) –HANSEN et LYKKE – ANDERSEN, pp. 22–23., Pl. 21. f. 24.

Dimension: Height of the last whorl is 0.4-0.5 mm, and their width is 0.3-0.4 mm.
Material: *5.12. bed* = 2 specimens; *6.1. bed* = 9 specimens; *6.3. bed* = 1 specimen.
Stratigraphical range in Hungary: Paleogene and Neogene

Nonion sp. indet.1.
Pl. 5, fig. 6., 8.

Dimension: Height of the last whorl is 0.8 mm, width 0.6 mm.

Material: *5.4. bed* = 2 specimens; *5.8. bed* = 39 specimens; *6.7. bed* = 1 specimen; *6.8. bed* = 1 specimen.
Stratigraphical range in Hungary: Paleogene

Nonionella CUSHMAN, 1926 genus

Nonionella wemmelensis KAASSCHIETER, 1961
Pl. 5, fig. 7.

1961. *Nonionella wemmelensis* n. sp. – KAASSCHIETER, pp. 205–206., Pl. XI. f. 26.

Dimension: Height of the last whorl is 0.4 mm, and their width is 0.3mm.
Material: *5.3. bed* = 10 specimens; *5.4. bed* = 11 specimens; *5.5. bed* = 1 specimen; *5.8. bed* = 17 specimens.
Stratigraphical range in Hungary: Unknown, the species is mentioned from the Middle Eocene (Bartonian) of Belgium

Cnidaria HATSCHEK, 1888 phylum
  Anthozoa EHRENBERG, 1834 classis
    Scleractinia BOURNE, 1900 subclassis
      Scleractinia BOURNE, 1900 ordo
        Faviina VAUGHAN et WELLS, 1943 subordo
          Faviicae GREGORY, 1900 superfamilia
            Rhizangiidae d'ORBIGNY, 1851 familia

Rhizangia MILNE-EDWARDS et HAIME, 1848 genus

Rhizangia sp. indet.
Pl. 5, fig. 2.

Dimension: Diameter of the corallite is 10-12 mm
Material: *8. bed* = 4 specimens

Mussidae ORTMANN, 1890 familia

Circophyllia MILNE-EDWARDS et HAIME, 1848 genus

Circophyllia sp. indet.
Pl. 5, fig. 1.

Dimension: Diameter of the corallite is 34-35 mm and their width is 23-28 mm
Material: *8. bed* = 2 specimens

Mollusca LINNÉ, 1758 phylum
Gastropoda CUVIER, 1798 classis
Prosobranchia MILNE – EDWARDS, 1848 subclassis
Archeogastropoda THIELE, 1925 ordo
Neritopsina COX et KNIGHT, 1960 subordo
Neritacea RAFINESQUE, 1815 superfamilia
Neritidae RAFINESQUE, 1815 familia
Neritinae RAFINESQUE, 1815 subfamilia

Velates de MONTFORT, 1810 genus

Velates schmidelianus (CHEMNITZ, 1786)
Pl. 5, fig. 3.

1786. ***Velates schmideliana*** n. sp. – CHEMNITZ, p. 130., Pl. 114. f. 965.
1866. ***Velates schmidelianus*** CHEMNITZ – DESHAYES, III. p. 18.
1888. ***Velates schmidelianus*** CHEMNITZ – COSSMANN, III. p 92.
1900. ***Velates schmidelianus*** CHEMNITZ – OPPENHEIM, p. 182.
1911. ***Velates schmidelianus*** CHEMNITZ – BOUSSAC, p. 269.
1913. ***Velates schmideli*** CHEMNITZ – COSSMANN et PISSARRO, Pl. VI. f. 40–1.
1925. ***Velates schmidelianus*** CHEMNITZ – SCHLOSSER, p. 82.
1930. ***Velates schmidelianus*** CHEMNITZ – CUVILLIER, p. 150.
1953. ***Velates schmideli*** CHEMNITZ – SZÖTS, p. 143., Pl. I. f. 41–56.
1957. ***Velates schmidelianus*** CHEMNITZ – MÉSZÁROS, p. 37., Pl. 6. f. 1., Pl. 21. f. 10., Pl. 22. f. 1.
1963. ***Velates schmidelianus*** CHEMNITZ – TATARIM–VLAICU, p. 163.
1966. ***Velates schmidelianus*** CHEMNITZ – STRAUSZ, p. 17., Pl. 4. f. 1; 4., Pl. 23. f. 6–9., Pl. 24. f. 1–3.
1980. ***Velates schmidelianus*** CHEMNITZ – KECSKEMÉTI – KÖRMENDY et MÉSZÁROS , p. 43., Pl. VII. f. 5.

Dimension: H = 47mm; W = 70 mm.
Material: *6.4. bed* = 1 specimen.

Mesogastropoda ordo
Cerithiacea superfamilia
Turritellidae familia

Turritella LAMARCK, 1818 genus

Turritella sp. indet.
Pl. 7, fig. 4.

Dimension: H=50; 43; 18; 35; 56 mm; H_L (height of the last whorl)= 13; 7; 3; 7; 14 mm; W=17; 12; 3; 4; 18 mm.
Material: *8.bed* = 3 specimens.

Diastomidae familia

Diastoma DESHAYES, 1861 genus

Diastoma roncanum (BRONGNIART, 1823)

Pl. 7, fig. 6-8.

1823. *Melanis costata* LAMARCK var. *roncana* BRONGNIART, p. 59., Pl. II. f. 18.
1953. *Diastoma roncanum* (BRONGNIART) – SZŐTS, p. 49., 165., Pl. III. f. 33–34.
1966. *Diastoma costellatum roncanum* (BRONGNIART) – STRAUSZ, p. 36., 119.
1972. *Diastoma roncanum* (BRONGNIART) – KECSKEMÉTI –KÖRMENDY, p. 236., Pl. XIV. f. 5–7.

Dimension: H= 18; 16mm; H_L = 6; 9 mm; W = 4; 7 mm.
Material: *8.bed* = 3 specimens

Cerithiidae familia

Cerithiinae subfamilia

Cerithium BRUGUIERE, 1789 genus

Cerithium corvinum subcorvinum (OPPENHEIM, 1894)

Pl. 7, fig. 5.

1823. *Rostellaria corvina* BRONGNIART, pp. 74–75., Pl. IV. f. 8.
1862. *Cerithium corvinum* BRONGNIART – ZITTEL, pp. 375 –376., Pl. II. f. 2.
1953. *Cerithium subcorvinum* OPPENHEIM – Szőts, p. 50., 168., Pl. IV. f. 8 –13.
1955. *Cerithium (Rinoclavis) subcorvinum* OPPENHEIM – KISS-KOCSIS BÁNYAI, p. 371., Pl. XV. f. 5a–f.
1966. *Cerithium (Rinoclavis) corvinum subcorvinum* OPPENHEIM – STRAUSZ, p. 30.
1980. *Cerithium corvinum subcorvinum* (OPPENHEIM) – KECSKEMÉTI –KÖRMENDY et MÉSZÁROS, pp., 47–48., Pl. VIII. f. 5 – 6.; Pl. IX. f. 2.

Dimension: H= 62; 53; 75 mm; H = 10; 13 mm; W = 18; 16; 15 mm.
Material: *8.bed* = 5 specimens.

Potamididae familia

Potamidinae subfamilia

Tympanotonus (KLEIN) SCHUMACHER, 1817 genus

Tympanotonus calcaratus (BRONGNIART, 1823)

Pl. 8, fig. 1-5.

1823. *Cerithium calcaratus* n. sp. – BRONGNIART , p. 69., Pl. III. f. 15.
1972. *Tympanotonus calcaratus* (BRONGNIART) – KECSKEMÉTI – KÖRMENDY, p.232., Pl. XIII. f. 6.
1980. *Tympanotonus calcaratus* (BRONGNIART) – KECSKEMÉTI – KÖRMENDY, p. 50.

Dimension: H= 20; 18; 16; 23; 15 mm; H = 4; 6; 3; 3; 4 mm; W = 7; 6; 6; 5; 8 mm.
Material: *8. bed* = 4 specimens.

Tympanotonus hungaricus (Zittel, 1862)
Pl. 8, fig. 6-7.

1862. *Cerithium hungaricum* Zittel, p. 373., Pl. II. f. 1a–b.
1953. *Tympanotonus hungaricus* (Zittel) – Szőts, p. 47., 162., Pl. II. f. 9–18.
1955. *Tympanotonus hungaricus* (Zittel) – Kiss–Kocsis Bányai, pp. 363–364.Pl. XIII. f. 3a – i.
1972. *Tympanotonus hungaricus* (Zittel) – Kecskeméti– Körmendy, p. 234., Pl. XII. f. 9–10., Pl. XIII. f. 2.

Dimension: H_L =10; 8 mm; W=15; 13 mm.
Material: *8. bed* = 2 specimens.

Strombacea superfamilia
Strombidae familia

Strombus Linné, 1758 genus

Strombus cf. *tournoueri* Bayan, 1870
Pl. 8, figs 8–10.

1870. *Strombus* (?) *tournoueri* n. sp. – Bayan, p. 480.
1871. *Strombus auriculatus* Brongniart – Hantken, p. 70.
1909. *Strombus auriculatus* Grapl. – Taeger, p. 251., Pl. 10. f. 14.
1938. *Strombus tournoueri* Bayan – Szőts, p. 188., Pl. 6. f. 9.
1966. *Strombus (Oostrombus) tournoueri* Bayan – Strausz, p. 43., Pl. 10. f. 1–2.
1980. *Strombus tournoueri* Bayan – Kecskeméti – Körmendy et Mészáros, p. 50., Pl. IX. f. 1.

Dimension: H_L = 32; 43; 15; 23; 30; 22 mm; W = 37; 41; 12; 20; 19; 14 mm.
Material: *6.4. bed* = 5 specimens; *6.5. bed* = 8 specimens; *6.6. bed* = 3 specimens.

Naticacea superfamilia
Naticidae familia

Ampullina Bowdich, 1822 genus

Ampullina perusta (Defrance, 1823)
Pl. 9, figs 1–5.

1862. *Ampullaria perusta* Brongniart – Zittel, p. 380., Pl. 3. f. 1.
1909. *Natica vulcani* Brongniart – Taeger, pp. 69; 74; 78; 80; 85; 263., Pl. 10. f. 1.
1953. *Ampullina perusta* Defrance – Szőts, p. 176., Pl. 5. f. 1–10.
1966. *Ampullina perusta* Defrance – Strausz, p. 46., Pl. 12. f. 4-5.

1980. *Ampullina perusta* DEFRANCE – KECSKEMÉTI– KÖRMENDY et MÉSZÁROS, pp. 54–55., Pl. X. f. 1–3.

Dimension: H= 31; 17; 9; 21 mm; H_L = 24; 13; 6; 17 mm; W = 25; 13; 6; 15 mm.
Material: *8. bed* = 12 specimens.

Ampullina sp. indet. 1.

Dimension: H= 72 mm; H_L = 54 mm; W=71 mm.
Material: *8. bed* = 1 specimen.

Buccinacea superfamilia
Buccinidae familia

Cantharus BOLTEN in RÖDING, 1798 genus

Cantharus brongniartianus (d'ORBIGNY, 1850)

Pl. 9, fig. 6-7.

1850. *Fusus brongniartianus* d'ORBIGNY – d'ORBIGNY, p. 317., Pl. 24. f. 362.
1862. *Fusus palygonus* LAMARCK – ZITTEL, p. 370., Pl. I. f. 4a–b; 5a–b.
1953. *Cantharus brongniarti* d'ORBIGNY – SZŐTS, p. 62–63.
1966. *Cantharus (Pollia) brongniartianus* d'ORBIGNY – STRAUSZ, p. 54.
1972. *Cantharus brongniartianus* (d'ORBIGNY) – KECSKEMÉTI – KÖRMENDY, p.58., Pl. XX. f. 3–4.
1990. *Cantharus brongniartianus* (d'ORBIGNY) – KECSKEMÉTI – KÖRMENDY, p. 90., Pl. XXX. f. 3–4.

Dimension: H= 34 mm; H_L=22 mm.
Material: *8. bed* = 2 specimens.

Bivalvia LINNÉ, 1758 classis
Pteriomorphia BEURLEN, 1944 subclassis
Mytiloida FÉRUSSAC, 1822 ordo
Mytilacea RAFINESQUE, 1815 superfamilia
Mytilidae RAFINESQUE, 1815 familia
Mytilinae RAFINESQUE, 1815 subfamilia

Brachyodontes SWAINSON, 1840 genus

Brachyodontes corrugatus (BRONGNIART, 1823)

Pl. 10, fig. 1.

1823. *Mytilus corrugatus* BRONGNIART – BRONGNIART, p. 78., Pl. V. f. 6.
1972. *Brachyodontes corrugatus* (BRONGNIART) – KECSKEMÉTI – KÖRMENDY, p. 258., Pl. XXVIII. f. 36.
1984. *Brachyodontes corrugatus* (BRONGNIART) – KECSKEMÉTI – KÖRMENDY, p. 367.

1990. *Brachyodontes corrugatus* (BRONGNIART) – KECSKEMÉTI – KÖRMENDY, p. 74., Pl. I. f. 6.

Dimension: The shell was broken and I could not measure the dimension.
Material: *4. bed* = 1 specimen.

Pterioida NEWELL, 1965 ordo
Pteriina NEWELL, 1965 subordo
Anomiacea RAFINESQUE, 1815 superfamilia
Anomiidae RAFINESQUE, 1815 familia

Anomia LINNÉ, 1758 genus

Anomia gregaria BAYAN, 1870
Pl. 10, figs 2, 4.

1870. *Anomia gregaria* n. sp. – BAYAN, p. 65., Pl. III. f. 1–2.
1892. *Anomia gregaria* BAYAN – OPPENHEIM, p. 713–716., Pl. XXXI. f. 5–8.
1953. *Anomia gregaria* BAYAN – SZŐTS, p. 88., 211.
1972. *Anomia gregaria* BAYAN – KECSKEMÉTI–KÖRMENDY, p. 260., Pl. XXX. f. 3–5.
1990. *Anomia gregaria* BAYAN – KECSKEMÉTI –KÖRMENDY, pp. 75–76., Pl. VI. f. 1–5.

Dimension: The shell was broken and I could not measure the dimension
Material: *4. bed* = 2 specimens.

Anomia tenuistriata DESHAYES, 1824
Pl. 10, figs 3, 5.

1824. *Anomia tenuistriata* n. sp. – DESHAYES, p. 377.
1837. *Anomia tenuistriata* DESHAYES – DESHAYES, Pl. LXV. F 7–11.
1861. *Anomia tenuistriata* DESHAYES – WOOD, p. 13., Pl. IX. f. 1a–e.
1864. *Anomia tenuistriata* DESHAYES – DESHAYES, p. 131.
1887. *Anomia tenuistriata* DESHAYES – COSSMANN, p. 196.
1904. *Anomia tenuistriata* DESHAYES – COSSMANN et PISSARRO, Pl. XLIV. f. 136 – 1.
1972. *Anomia tenuistriata* DESHAYES – KECSKEMÉTI– KÖRMENDY,p.261., Pl. XXX.f. 2.
1980. *Anomia tenuistriata* DESHAYES – KECSKEMÉTI – KÖRMENDY , p. 75.,Pl.VI. f. 6–8.

Dimension: L = 25; 23; 46; 16 mm; H = 24; 21; 44; 13 mm;
Material: *5.8. bed* = 9 specimens; *5.12. bed* = 4 specimens.

Ostreina FÉRUSSAC, 1822 subordo
Ostreacea RAFINESQUE, 1815 superfamilia
Ostreidae RAFINESQUE, 1815 familia
Ostreinae RAFINESQUE, 1815 subfamilia

Ostrea LINNÉ, 1758 genus

Ostrea (Cubitostrea) plicata SOLANDER, 1776

Pl. 11, fig. 1.

1887. *Ostrea plicata* SOLANDER – COSSMANN, p. 195.
1904. *Ostrea plicata* SOLANDER – COSSMANN et PISSARRO, Pl. XLIV. f. 135–31.
1964. *Ostrea (Cubitostrea) plicata plicata* SOLANDER – KARAGIULEVA, pp. 58–59., Pl. X. f. 3–7. Pl. XII. f. 1a–b.
1972. *Ostrea plicata* SOLANDER – KECSKEMÉTI– KÖRMENDY, p.261., Pl. XXXI. f.3–7.
1980. *Ostrea (Cubitostrea) plicata* SOLANDER – KECSKEMÉTI– KÖRMENDY, p. 33., Pl. IV. f.14.

Dimension: L=21mm; H=56 mm;.
Material: *8. bed* = 2 specimens.

Ostrea roncana PARTSCH in coll. (?)

Pl. 11, figs 3-7, Pl. 12, figs 1-3, Pl. 13, 1-2.

1862. *Ostrea longirostris* ZITTEL – ZITTEL, p. 393.
1870. *Ostrea roncana* PARTSCH – BAYAN, p. 484.
1900. *Ostrea roncana* PARTSCH – OPPENHEIM, p. 150.
1909. *Ostrea longirostris* ZITTEL – TAEGER, p. 59., 75.
1938. *Ostrea longirostris* ZITTEL – SZÖTS, p. 11.; 15.; 16.
1953. *Ostrea roncana* PARTSCH – SZÖTS, p. 211., Pl. 9. f. 1–4.
1972. *Ostrea roncana* PARTSCH – KECSKEMÉTI– KÖRMENDY, pp. 30–31., Pl. II. f. 5.

Dimension: L=60; 72; 62mm; H=112; 118; 109 mm;
Material: *8. bed* = in large number.

Ostrea supranummulitica ZITTEL, 1862

Pl. 11 fig. 2.

1862. *Ostrea supranummulitica* n. sp. – ZITTEL, p. 394., Pl. III. f. 7 a–c.
1972. *Ostrea supranummulitica* ZITTEL – KECSKEMÉTI– KÖRMENDY, p. 262., Pl. XXXII. f. 12.

Dimension: L=21; 32 mm; H=43; 35 mm;
Material: *8. bed* = 6 specimens.

Crassatellacea FÉRUSSAC, 1822 superfamilia
Crassatellidae FÉRUSSAC, 1822 familia
Crassatellinae FÉRUSSAC, 1822 subfamilia

Crassatella LAMARCK, 1799 genus
Crassatella sp. indet.

Pl. 13, fig. 3.

Dimension: L=115mm; H=84 mm.
Material: *6.3 bed* = 1 specimen.

Annelida LAMARCK, 1809 phylum
  Polycheatea GRUBE, 1850 classis
    Sedentaria LAMARCK, 1818 ordo
      Serpulidae BURMEISTER, 1837 familia

Serpula LINNÉ, 1768 genus

Serpula sp. indet.
Pl. 10, fig. 3.

Ditrupa BERKELEY, 1835 genus

Ditrupa sp. indet.
Pl. 6, fig. 3.

Arthropoda phylum
  Crustacea PENNANT, 1777 subphylum
    Ostracoda LATREILLE, 1806 classis
      Podocopida MÜLLER, 1894 ordo
        Platicopina SARS, 1866 subordo
          Cytherellidae SARS, 1866 familia

Cytherella JONES, 1849 genus

Cytherella (Cytherelloidea) gantensis MONOSTORI, 1977
Pl. 14, fig. 4.

1977. *Cytherella (Cytherelloidea) gantensis* n. sp. – MONOSTORI, pp.76–77., Pl.I.f. 1.
1985. *Cytherella (Cytherelloidea) gantensis* MONOSTORI – MONOSTORI, pp. 27–29., Pl. I. f. 1–3, 13.
1987. *Cytherella (Cytherelloidea) gantensis* MONOSTORI – MONOSTORI, pp.136–137., Pl. I. f. 1–3.

Dimension: L=0.65-0.71mm; H=0.39-0.41mm; L/H=1.66-1.73.
Material: *5.1. bed* = 3 specimens; *5.2. bed* = 4 specimens; *5.3. bed* = 38 specimens; *5.4. bed* = 10 specimens; *5.5. bed* = 22 specimens; *5.6. bed* = 8 specimens; *5.8. bed* = 29 specimens; *5.9. bed* = 40 specimens; *5.12. bed* = 40 specimens; *5.15. bed* = 6 specimens; *6.2. bed* = specimen; *6.3. bed* = 1 specimen; *6.4. bed* = specimen.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Cytherella gamardensis DELTEL, 1961
Pl. 14, figs 1-2.

1961 *Cytherella gamardensis* n. sp. – DELTEL, p. 16., Pl. 1., f. 18–21.
1962. *Cytherella gamardensis* DELTEL – DELTEL, p. 135., Pl. 1., f. 8–11.

Dimension: L=0.55-0.61mm; H=0.30-0.33mm; L/H=1.83-1.84.
Material: *5.2. bed* = 7 specimens; *5.3. bed* = 18 specimens; *5.4. bed* = specimen; *5.5. bed* = 12 specimens; *5.6. bed* = specimen; *5.8. bed* = 15 specimens; *5.9. bed* = 19 specimens; *5.12. bed* = specimen; *5.15. bed* = 5 specimens; *5.16. bed* = 2 specimens; *6.3. bed* = specimen.
Stratigraphical range in Hungary: Unknown

Podocopina SARS, 1866 subordo
Bairdiacea SARS, 1888 superfamilia
Bairdiidae SARS, 1888 familia

Bairdia McCOY, 1844 genus

Bairdia (Bairdoppilata) aff. gliberti, KEIJ
Pl. 14, fig. 3.

Dimension: L=1.1-1.4mm; H=0.68-0.96mm; L/H=1.46-1.61.
Material: *5.15. bed* = 6 specimens; *5.16. bed* = 7 specimens; *6.2. bed* = 2 specimens; *6.3. bed* = 6 specimens; *6.4. bed* = 2 specimens; *6.5. bed* = 2 specimens; *6.6. bed* = 5 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Cytheracea BAIRD, 1850 superfamilia
Cytheridae BAIRD, 1850 familia
Cytherinae BAIRD, 1850 subfamilia

Cytheromorpha HIRSCHMANN, 1909 genus

Cytheromorpha zinndorfi hungarica MONOSTORI, 1985
Pl. 14, fig. 5.

1985. *Cytheromorpha zinndorfi hungarica* n. sp. – MONOSTORI, pp. 37–40., Pl. III. f. 1–8.
1996. *Cytheromorpha zinndorfi hungarica* MONOSTORI – MONOSTORI, p. 28., Pl. I. f. 1–7.

Dimension: L=0.32-0.41mm; H=0.21-0.30mm; L/H=1.37-1.52.
Material: *5.5. bed* = 11 specimens; *5.7. bed* = specimen; *5.8. bed* = 33 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Schizocythere TRIEBEL, 1950 genus

Schizocythere depressa (MÉHES, 1936)
Pl. 14, fig. 6.

1936. *Eucytherura depressa* n. sp. – MÉHES, pp. 25–26., Pl. III. f. 5–8.

1977. *Schizocythere depressa* (MÉHES) – MONOSTORI, pp. 98–100., Pl. III. f. 1–4.
1985. *Schizocythere depressa* (MÉHES) – MONOSTORI, pp. 44–46., Pl. IV. f. 3–16.
1987. *Schizocythere depressa* (MÉHES) – MONOSTORI, p. 142., Pl. 3. f. 3–4.

Dimension: L=0.48-0.51mm; H=0.28-0.32mm; L/H=1.59-1.71.
Material: *5.2. bed* = 7 specimens; *5.5. bed* = 6 specimens; *5.7. bed* = 3 specimens; *5.8. bed* = 9 specimens; *5.9. bed* = 78 specimens; *5.12. bed* = 21 specimens; *5.15. bed* = 26 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Cytherideidae SARS, 1925 familia
Schulerideinae MANDELSTAM, 1959 subfamilia

Schuleridea SWARTZ et SWAIN, 1946 genus

Schuleridea (Aequacyteridea) perforata (ROEMER, 1838)
Pl. 14, fig. 7.

1838. *Cytherina perforata* n. sp. – ROEMER, p. 516., Pl. VI. f. 11.
1996. *Schuleridea (Aequacyteridea) perforata* (ROEMER, 1838) – MONOSTORI, pp. 35–36., Pl. 7. f. 7–8, Pl. 8.f. 1–8, Pl. 9. f. 1.(cum syn)

Dimension: L=0.73-0.78mm; H=0.48-0.51mm; L/H=1.52-1.53.
Material: *5.2. bed* = 13 specimens; *5.7. bed* = specimen; *5.8. bed* = 11 specimens; *5.9. bed* = 87 specimens; *5.12. bed* = 54 specimens; *5.15. bed* = 30 specimens; *6.1. bed* = 10 specimens; *6.3. bed* = specimen; *6.4. bed* = 3 specimens; *6.5. bed* = 7 specimens; *6.6. bed* = 1 specimen; *6.7. bed* = 7 specimens; *6.8. bed* = 7 specimens.
Stratigraphical range in Hungary: Middle and Upper Eocene (Lutetian - Priabonian)

Schuleridea mirkmalovi SAKINA, 1971
Pl. 14, fig. 8.

1971. *Schuleridea mirkmalovi* n. sp. – SAKINA, pp. 174–177., Pl. I. f. 1–1a.
1996. *Schuleridea mirkmalovi* SAKINA – MONOSTORI, pp. 34–35., Pl. 7. f. 1–6.

Dimension: L=0.75-0.79mm; H=0.48-0.51mm; L/H=1.54-1.56.
Material: *5.5. bed* = 3 specimens; *5.8. bed* = 2 specimens; *5.9. bed* = 7 specimens; *5.12. bed* = 6 specimens; *5.15. bed* = specimen; *6.1. bed* = specimen.
Stratigraphical range in Hungary: Middle Eocene (Bartonian)

Krithidae MANDELSTAM, 1960 familia
Krithe BRADY, CROSSKEY et ROBERTSON, 1874 genus

Krithe bartonensis (JONES, 1857) s.l.
Pl. 15, fig. 1.

1857 *Cytherideis bartonensis* n. sp. – JONES, p. 50., Pl. V. f. 2a–b., 3a–b.

1894. *Krithe bartonensis* JONES – LIENENKLAUS, pp. 252–253., Pl. XVII. f. 9.
1996. *Krithe bartonensis* (JONES, 1857) – MONOSTORI, pp. 39–41., Pl. 11. f. 4–8., Pl. 12. f. 1–8. (cum syn)

Dimension: L=0.66-0.81mm; H=0.31-0.35mm; L/H=2.12-2.31.
Material: *5.6. bed* = 2 specimens; *5.8. bed* = 9 specimens; *5.12. bed* = 21 specimens; *5.15. bed* = 21 specimens; *6.1. bed* = 1 specimen; *6.5. bed* = 3 specimens; *6.7. bed* = specimen; *6.8. bed* = 2 specimens.
Stratigraphical range in Hungary: Middle Eocene (Bartonian)

Trachyleberididae SYLVESTER-BRADLEY, 1948 familia
Trachyleberidinae SYLVESTER-BRADLEY, 1948 subfamilia

Pterygocythere HILL, 1954 genus

Pterygocythere jonesi (MÉHES, 1936)
Pl. 15, fig. 2.

1936. *Cytheropteron jonesi* n. sp. – MÉHES, pp. 22–25., Pl. III. f. 1–4.
1996. *Pterygocythere jonesi* (MÉHES, 1936) – MONOSTORI, p. 52., Pl. 19. f. 5–8. (cum syn)

Dimension: L=0.7mm; H=0.5mm; L/H=1.27.
Material: *8. bed* = specimen
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Cletocythereis SWAIN, 1963 genus

Cletocythereis? angusticostata (BOSQUET, 1852)
Pl. 15, fig. 3.

1852. *Cythere angusticostata* n. sp. – BOSQUET, pp. 91–92.,Pl. VII.f.118–119.
1998. *Cletocythereis? angusticostata* (BOSQUET, 1852) – MONOSTORI, pp.50–51., Pl. 3. f. 1–10.(cum syn)

Dimension: L= 0.6-0.8 mm; H=0.3-0.5 mm; L/H=2.0-0.16.
Material: *5.2. bed* = 7 specimens; *5.3. bed* = 2 specimens; *5.4. bed* = specimen; *5.8. bed* = specimen; *5.12. bed* = 10 specimens; *5.15. bed* = 36 specimens; *6.1. bed* = 25 specimens; *6.2. bed* = 2 specimens; *6.3. bed* = 8 specimens; *6.5. bed* = 2 specimens; *6.6. bed* = 2 specimens; *6.7. bed* = 4 specimens; *6.8. bed* = 2 specimens.
Stratigraphical range in Hungary: Middle and Upper Eocene (Upper Lutetian - Lower Priabonian)

Echinocythereis PURI, 1954 genus
Echinocythereis dadayana (MÉHES, 1941)
Pl. 15, fig. 4.

1936. *Cythereis dadayi* n. sp. – MÉHES, pp. 40–42., Pl. IV. f. 12–13.

1941. *Cythereis dadayana* nom. nov. – MÉHES, p. 43.
1996. *Echinocythereis dadayana* (MÉHES, 1941) – MONOSTORI, pp. 53–54., Pl. 20. f. 1–8. Pl. 21. f.1–7.(cum syn)

Dimension: L=0.68-0.79mm; H=0.39-0.42mm; L/H=1.74-1.88.
Material: *5.2. bed* = 9 specimens; *5.3. bed* = 8 specimens; *5.5. bed* = 4 specimens; *5.8. bed* = 16 specimens; *5.9. bed* = 15 specimens; *5.12. bed* = 44 specimens; *5.15. bed* = 32 specimens; *5.16. bed* = 9 specimens; *6.1. bed* = 10 specimens; *6.2. bed* = 4 specimens; *6.5. bed* = 7 specimens; *6.7. bed* = 7 specimens; *6.8. bed* = 5 specimens.
Stratigraphical range in Hungary: Middle and Upper Eocene (?Lutetian - Priabonian)

Asperrissimocythere MONOSTORI, 1998 genus

Asperrissimocythere perlucida (MÉHES, 1936)

Pl. 15, fig. 5.

1936. *Cythereis perlucida* n. sp. – MÉHES, pp. 43–45., Pl. IV. f. 19–22.
1985. *Hermanites perlucida* (MÉHES, 1936) – MONOSTORI, pp. 88–90., Pl. XI. f. 8–20.
1998. *Asperrissimocythere perlucida* (MÉHES, 1936) – MONOSTORI, p. 50., Pl. 1. f. 7–10., Pl.2. f.110.

Dimension: L=0.48-0.53mm; H=0.25-0.32mm; L/H=1.65-1.92.
Material: *5.2. bed* = 3 specimens; *5.3. bed* = 1 specimen; *5.5. bed* = 2 specimens; *5.7. bed* = 1 specimen; *5.8. bed* = 3 specimens; *5.9. bed* = 15 specimens; *5.12. bed* = 2 specimens; *6.8. bed* = 1 specimen.
Stratigraphical range in Hungary: Middle and Upper Eocene (Lutetian - Lower Bartonian)

Hemicytheridae PURI, 1953 familia
Hemicytherinae PURI, 1953 subfamilia

Pokornyella OERTLI, 1956 genus

Pokornyella inaequapunctata DUCASSE, 1963

Pl. 15, fig. 6.

1963. *Pokornyella inaequapunctata* n. sp. – DUCASSE, p. 229., Pl. 1. f. 7–8.
1998. *Pokornyella inaequapunctata* DUCASSE – MONOSTORI, pp.49–101., Pl. 7 f. 3–10. Pl. 8. f. 1–4. (cum syn.)

Dimension: L=0.52-0.61mm; H=0.28-0.32mm; L/H=1.85-1.9.
Material: *5.1. bed* = 1 specimen; *5.2. bed* = 11 specimens; *5.5. bed* = 4 specimens; *5.8. bed* = 3 specimens; *5.9. bed* = 2 specimens; *5.15. bed* = 14 specimens; *6.5. bed* = 15 specimens; *6.7. bed* = 8 specimens; *6.8. bed* = 9 specimens;
Stratigraphical range in Hungary: Middle and Upper Eocene (Upper Lutetian - Lower Bartonian)

Oriononinae PURI, 1973 subfamilia

Cytherettidae TRIEBEL, 1972 genus
Cytheretta G. W. MÜLLER, 1894 genus

Cytheretta aff. *haimeana* (BOSQUET, 1852)
Pl. 15, fig. 7.

1987 *Cytheretta* cf. *bambruggensis* KEIJ, 1955 – MONOSTORI, pp. 156–157., Pl. 7 f. 5–6.
1998. *Cytheretta* aff. *haimeana* (BOSQUET, 1852) – MONOSTORI, pp. 60–61.,Pl. 14. f. 9.

Dimension: L=0.84-1.01mm; H=0.48-0.52mm; L/H=1.75-1.94.
Material: *5.12. bed* = 3 specimens; *5.15. bed* = 6 specimens.
Stratigraphical range in Hungary: Middle Eocene (Upper Lutetian - Bartonian)

Xestoleberididae SARS, 1928 familia

Xestolebris SARS, 1866 genus

Xestolebris gantensis MONOSTORI, 1977
Pl. 15, fig. 8.

1977 *Xestolebris gantensis* n. sp. – MONOSTORI, pp. 113–115., Pl. IV f. 14–17.
1985. *Xestolebris gantensis* MONOSTORI – MONOSTORI, pp. 121–124., Pl. XVI. f. 1–3.
1987 *Xestolebris gantensis* MONOSTORI – MONOSTORI, pp. 158–159., Pl. 7 f. 4, 8–11

Dimension: L=0.4-0.6 mm; H=0.3-0.4 mm; L/H=1.33-1.5.
Material: *6.2. bed* = 4 specimens; *6.3. bed* = 7 specimens; *6.4. bed* = 29 specimens; *6.5. bed* = 7 specimens; *6.6. bed* = 32 specimens; *6.7. bed* = 34 specimens; *6.8. bed* = 16 specimens .
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Cypridacea BAIRD, 1845 superfamilia
Cyprididae BAIRD, 1845 familia

Novocypris DUCASSE, 1967 genus

Novocypris gantensis MONOSTORI, 1977
Pl. 15, fig. 9.

1977 *Novocypris? gantensis* n. sp. – MONOSTORI , pp. 80–81., Pl. I. f. 5–9.
1985. *Novocypris? gantensis* MONOSTORI – MONOSTORI, pp. 130–131., Pl. XVII. f. 7–21

Dimension: L=0.71-0.76mm; H=0.47-0.53mm; L/H=1.43-1.51.

Material: *5.1. bed* = 9 specimens; *5.2. bed* = 40 specimens; *5.3. bed* = 1 specimen; *5.4. bed* = 7 specimens; *5.5. bed* = 28 specimens; *5.6. bed* = 10 specimens; *5.8. bed* = 91 specimens; *5.9. bed* = 11 specimens; *5.15. bed* = 62 specimens; *5.16. bed* = 3 specimens; *6.1. bed* = 6 specimens; *6.5. bed* = 3 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

Paracypridinae SARS, 1923 subfamilia

Paracypris SARS, 1866 genus

Paracypris contracta (JONES, 1857)

Pl. 15, fig. 10.

1857. *Bairdia contracta* n. sp. – JONES, pp. 53–54., Pl. V. f. 1a–c.
1987. *Paracypris contracta* (JONES, 1857) – MONOSTORI, p. 161., Pl. 7. f. 18–19. (cum syn.)

Dimension: L=0.73-0.79mm; H=0.44-0.51mm; L/H=1.55-1.66.
Material: *5.1. bed* = 1 specimen; *5.2. bed* = 8 specimens; *5.4. bed* = 1 specimen; *5.5. bed* = 11 specimens; *5.7. bed* = 1 specimen; *5.8. bed* = 24 specimens; *5.12. bed* = 13 specimens; *5.15. bed* = 8 specimens; *5.16. bed* = 1 specimen; *6.2. bed* = 1 specimen; *6.6. bed* = 5 specimens.
Stratigraphical range in Hungary: Middle Eocene (Lutetian - Bartonian)

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Plate 1

Fig. 1. *Clavulina parisiensis* d'ORBIGNY, 1826 73×.
Fig. 2. *Tritaxia szabói* (HANTKEN, 1868) 195×.
Fig. 3. *Quinqueloculina carinata* d'ORBIGNY, 1826 108×.
Fig. 4. *Quinqueloculina* aff. *carinata* d'ORBIGNY, 143×.
Fig. 5. *Quinqueloculina bicarinata* (d'ORBIGNY, 1878) 95.5×.
Fig. 6. *Quinqueloculina* cf. *contorta* (d'ORBIGNY) 106×.
Fig. 7. *Quinqueloculina ungeriana* d'ORBIGNY, 1846. 76×
Fig. 8. *Quinqueloculina* sp. indet. 144×

Plate 2

Figs. 1-2. *Pyrgo simplex* (d'Orbigny, 1846) 101×
Fig. 3. *Triloculina gibba* d'Orbigny, 1825. 151×
Fig. 4. *Triloculina porvaensis* Hantken, 1875. 72×
Fig. 5. *Triloculina trigonula* Lamarck, 1804. 153×
Fig. 6. *Triloculina* sp. indet. 112×
Fig. 7. *Spirolina* sp. d'Orbigny, 1846 .151×

Plate 3

Figs. 1-2. *Nodosaria* sp. indet. 144× (1.), 173× (2.)
Fig. 3. *Globulina gibba* d'Orbigny, 1826. 116×.
Fig. 4. *Guttulina irregularis* (d'Orbigny, 1846). 133×
Fig. 5. *Pyrulina* sp. indet. 161×
Fig. 6. *Bulimina parisiensis* (Cushman et Todd, 1945). 179×
Fig. 7. *Discorbis parisiensis* (d'Orbigny, 1865). 94×
Fig. 8. *Discorinopsis* sp. indet. 108×
Fig. 9. *Asterigerina* sp. indet. 118×

Plate 4

Fig. 1. *Rotalia trochidiformis* Lamarck, 1804. 127×
Figs. 2-3. *Pararotalia curryi* (Cushman, 1928) 125× (1.), 112× (2.)
Fig. 4. *Eponides polyganus* le Calvez, 1949. 98.5×
Figs. 5-6. *Planulina* sp. indet. 81× (5.), 102× (6.)
Figs. 7-8. *Cibicides pygmeus* (Hantken, 1875) 236× (1.), 246× (2.)

Plate 5

Figs. 1-2. *Sphaerogypsina globula* (Reuss, 1848). 160× (1.), 162× (2.)
Fig. 3. *Nonion scaphum* (Fichtel et Moll, 1978). 161×
Fig. 4. *Nonion affinae* (Reuss, 1851). 254×
Fig. 5. *Nonion boueanum* (d'Orbigny, 1846). 145×
Figs. 6., 8. *Nonion* sp. indet. 70.5× (1.), 112× (2.)
Fig. 7. *Nonionella wemmelensis* Kaasschieter, 1961. 196×

Plate 6

Fig. 1. *Orbitolites* sp. indet. 42×
Fig. 2. *Discorinopsis* sp. indet. 42×
Fig. 3. *Ditrupa* sp. indet. 42×
Fig. 4. *Acervulina* sp. indet. 67×

Plate 7

Fig. 1. *Circophyllia* sp. indet. 2.5×
Fig. 2. *Rhizangia* sp. indet. 2.8×
Fig. 3. *Velates schmidelianus* (CHEMNITZ, 1786). 1.2×
Fig. 4. *Turritella* sp. indet. 1.2×
Fig. 5. *Cerithium corvinum subcorvinum* (OPPENHEIM, 1894). 1×
Figs. 6-8. *Diastoma roncanum* (BRONGNIART, 1823). 1.5×

Plate 8

Figs. 1-5. *Tympanotonus calcaratus* (BRONGNIART, 1823). 3×
Figs. 6-7. *Tympanotonus hungaricus* (ZITTEL, 1862). 2.5×
Figs. 8-10. *Strombus* cf. *tournoueri* BAYAN, 1870. 1.8×

Plate 9

Figs. 1-5. *Ampullina perusta* (DEFRANCE, 1823). 1.3×
Figs. 6-7. *Cantharus brongniartianus* (d'ORBIGNY, 1850). 2×

Plate 10

Fig. 1. *Brachyodontes corrugatus* (BRONGNIART, 1823). 1×
Figs. 2. 4. *Anomia gregaria* BAYAN, 1870. 1.3×
Figs. 3. 5. *Anomia tenuistriata* DESHAYES, 1824. 1.8×

Plate 11

Fig. 1. *Ostrea (Cubitostrea) plicata* SOLANDER, 1776. 2×
Fig. 2. *Ostrea supranummulitica* ZITTEL, 1862. 1×
Figs. 3-7. *Ostrea roncana* PARTSCH in coll. (?). 1.5×

Plate 12

Figs. 1-3. *Ostrea roncana* PARTSCH in coll. (?). 1×

Plate 13

Figs. 1-2. *Ostrea roncana* PARTSCH in coll. (?). 1×
Fig. 3. *Crassatella* sp. indet. 1×

Plate 14

Figs. 1-2. *Cytherella gamardensis* DELTEL, 1961. 190×(1.) 167×(2.)
Fig. 3. *Cytherella (Cytherelloidea) gantensis* MONOSTORI, 1977. 127×
Fig. 4. *Bairdia (Bairdoppilata)* aff. *gliberti*, KEIJ. 88.5×
Fig. 5. *Cytheromorpha zinndorfi hungarica* MONOSTORI, 1985. 322×
Fig. 6. *Schizocythere depressa* (MÉHES, 1936). 202×
Fig. 7. *Schuleridea (Aequacyteridea) perforata* (ROEMER, 1838). 125×
Fig. 8. *Schuleridea mirkmalovi* SAKINA, 1971. 134×

Plate 15

Fig. 1. *Krithe bartonensis* (JONES, 1857). 145×
Fig. 2. *Pterygocythere jonesi* (MÉHES, 1936). 150×
Fig. 3. *Cletocythereis? angusticostata* (BOSQUET, 1852). 131×
Fig. 4. *Echinocythereis dadayana* (MÉHES, 1941). 107×
Fig. 5. *Asperrissimocythere perlucida* (MÉHES, 1936). 204×
Fig. 6. *Pokornyella inaequapunctata* DUCASSE, 1963. 180×
Fig. 7. *Cytheretta* aff. *haimeana* (BOSQUET, 1852). 122×
Fig. 8. *Xestolebris gantensis* MONOSTORI, 1977. 182×
Fig. 9. *Novocypris gantensis* MONOSTORI, 1977. 138×
Fig. 10. *Paracypris contracta* (JONES, 1857). 115×

Plate 1

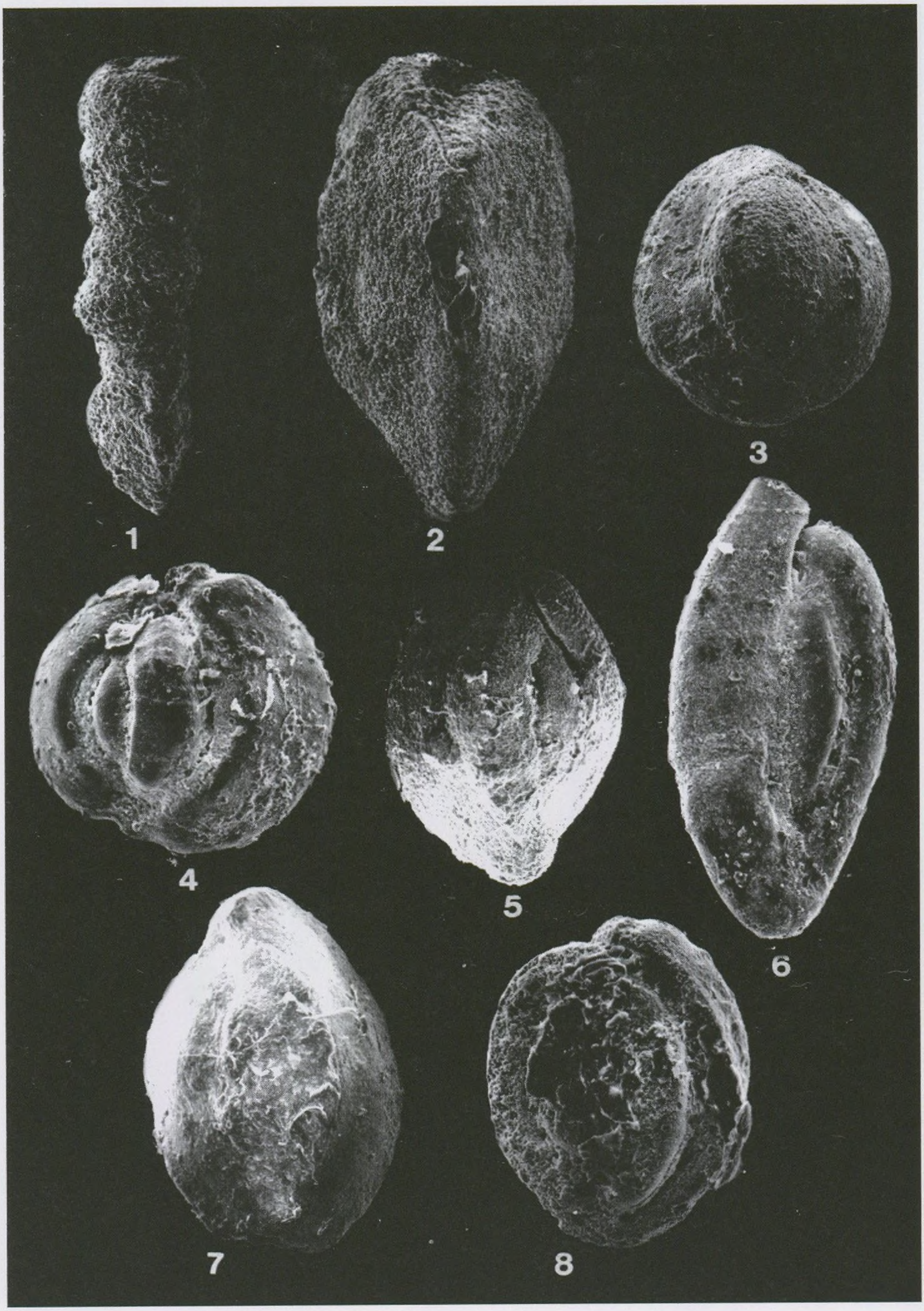

Plate 2

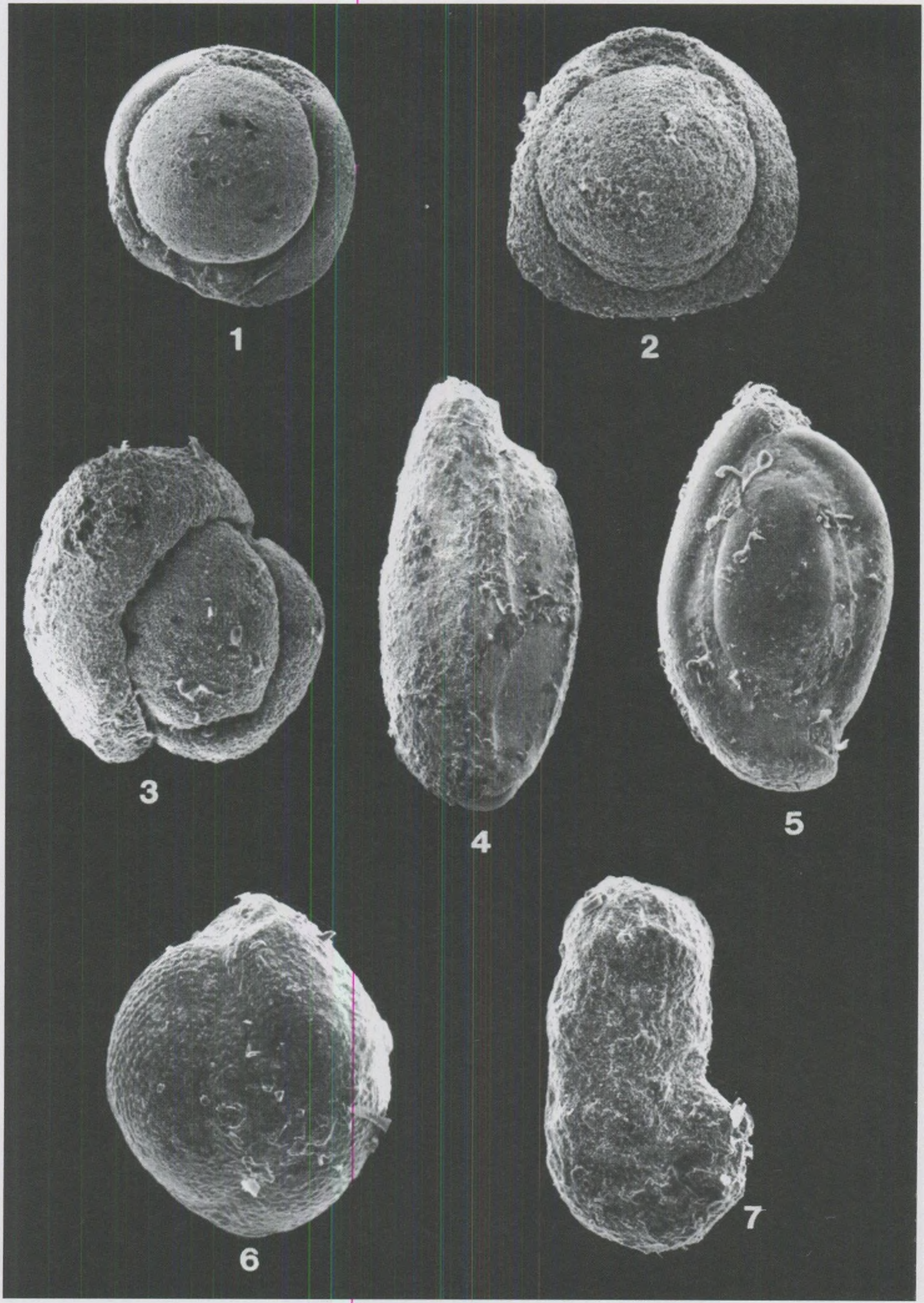

Plate 3


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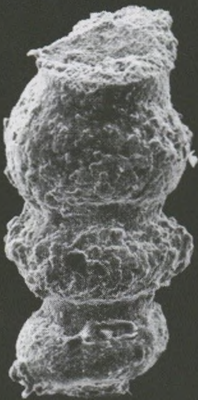
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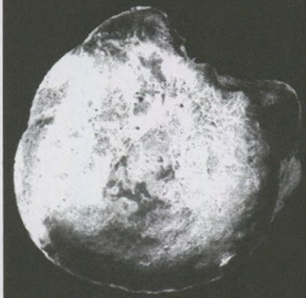
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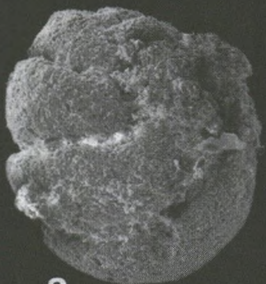
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Plate 4


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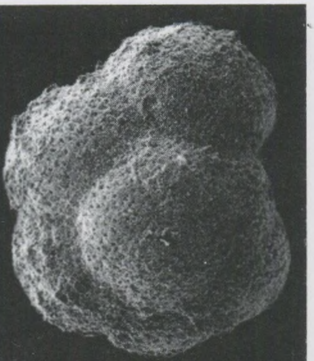
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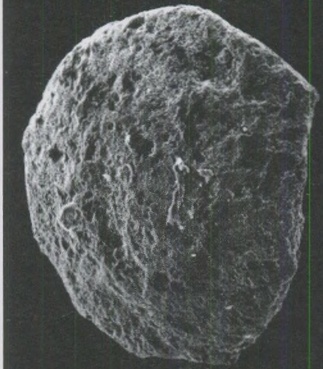
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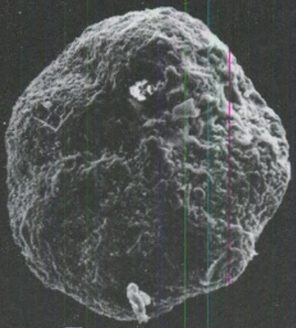
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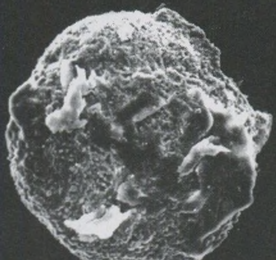
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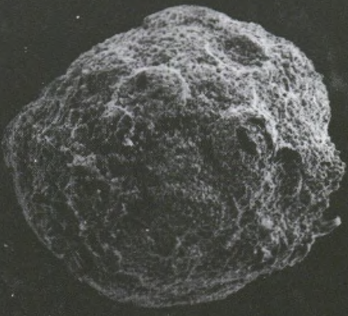
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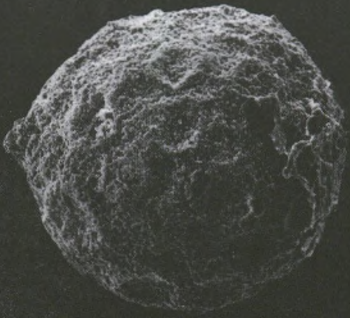
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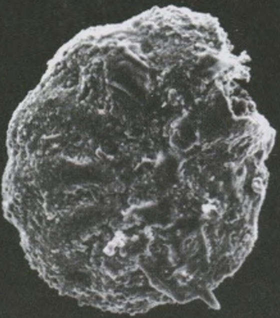
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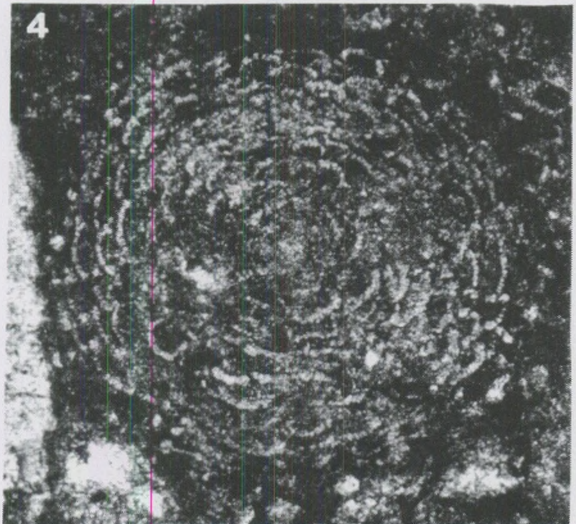

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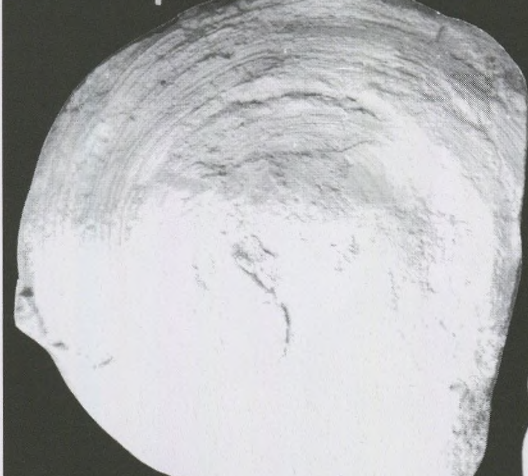

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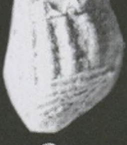

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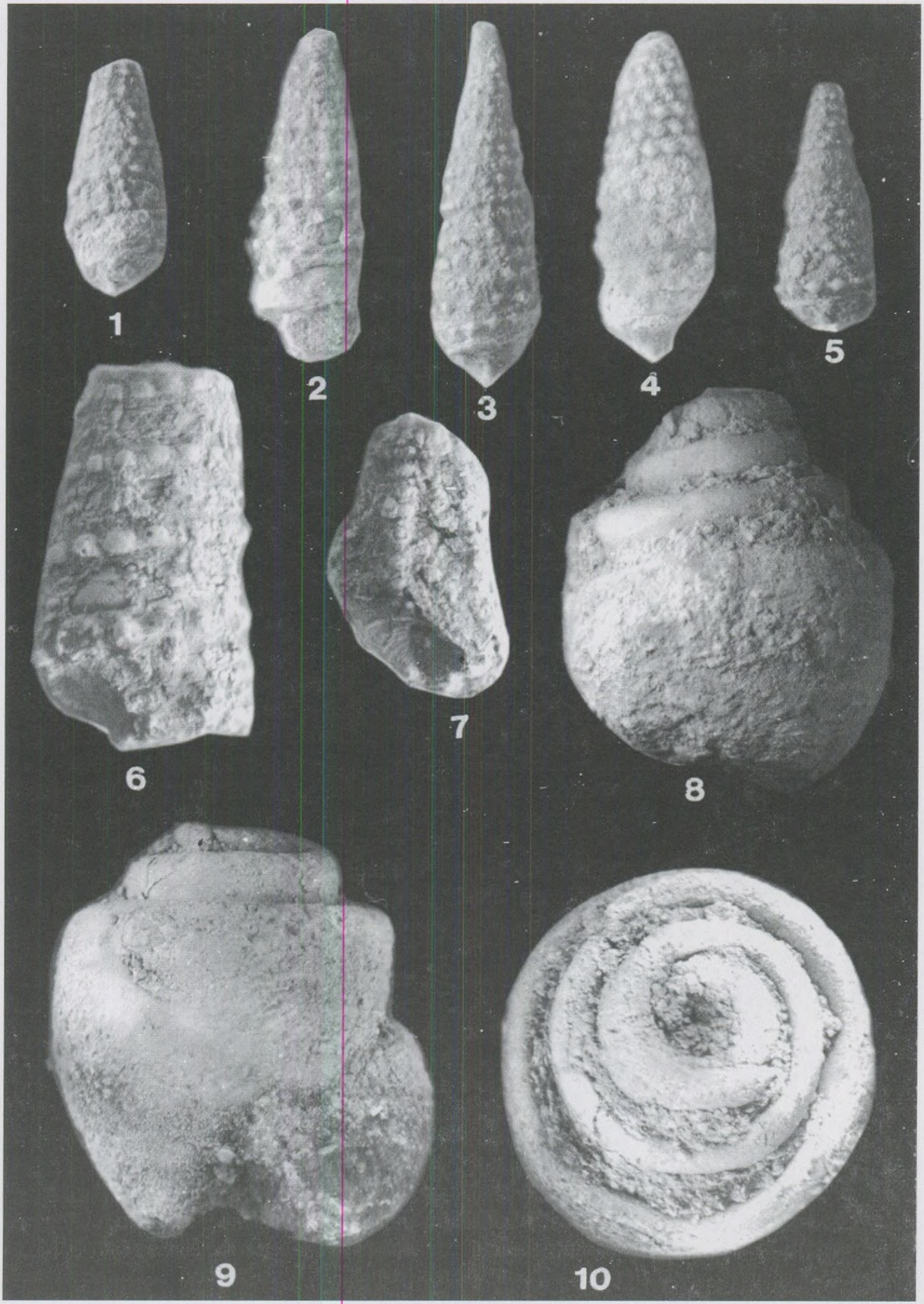

Plate 9


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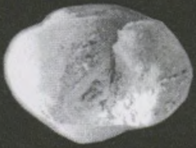
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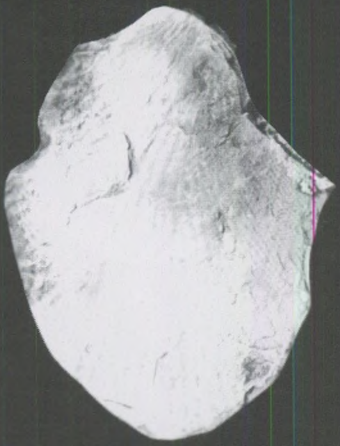

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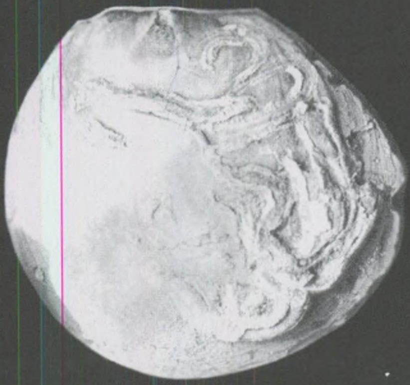

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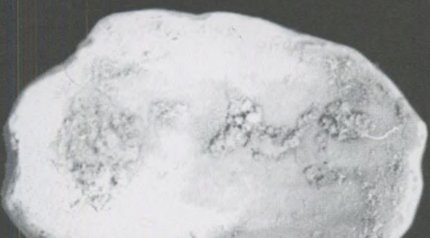

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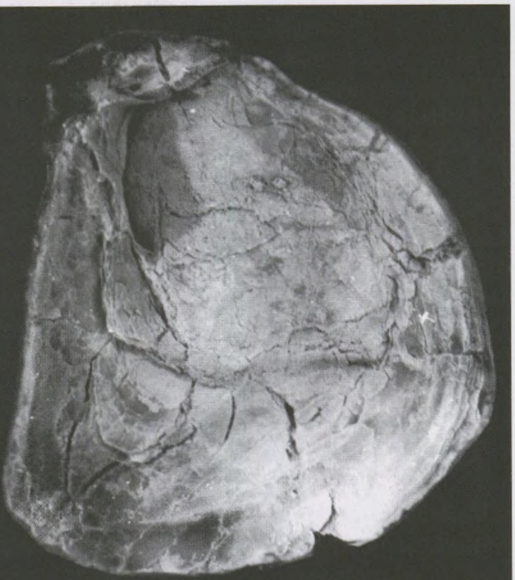

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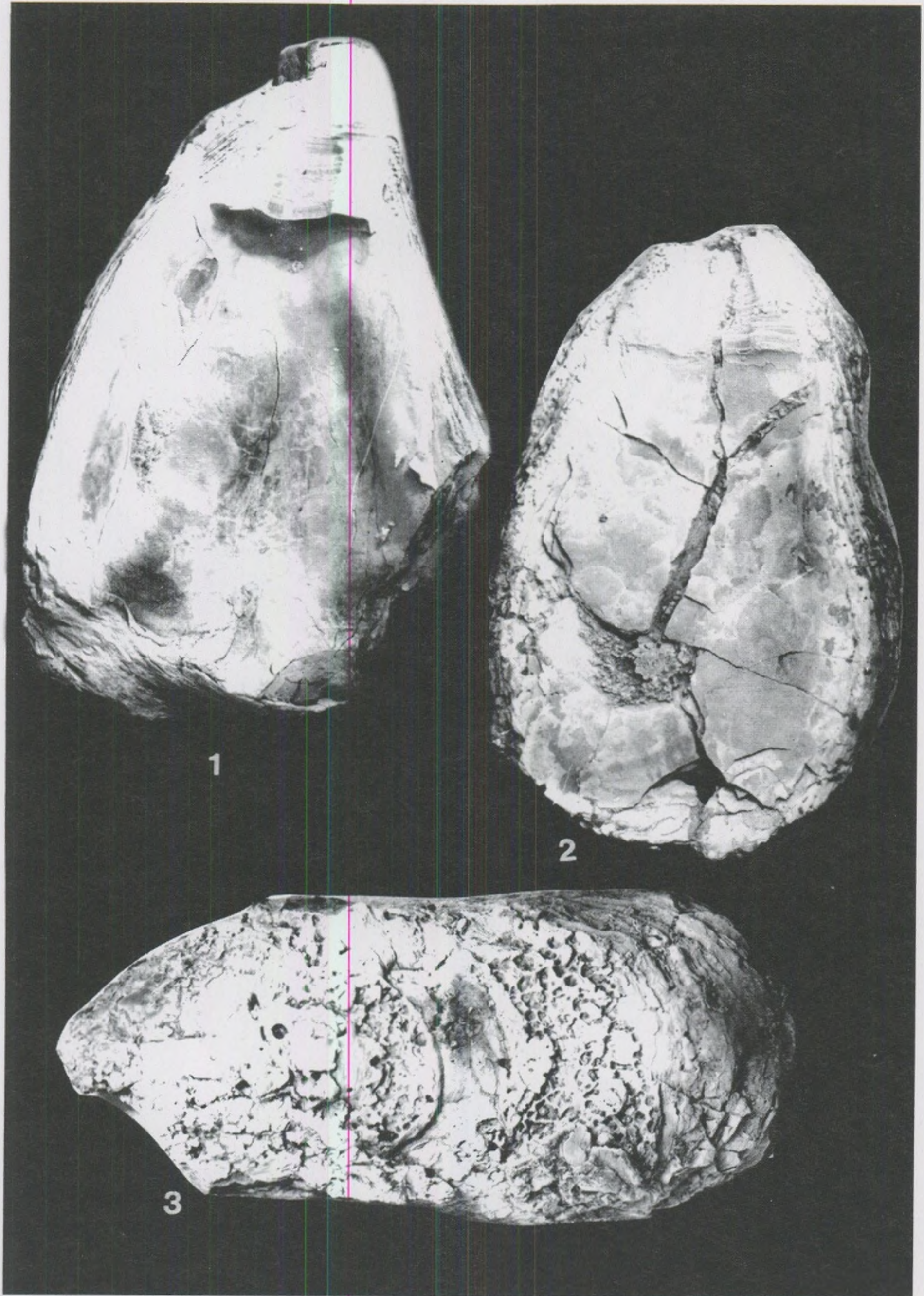

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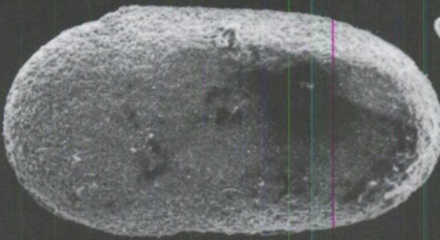

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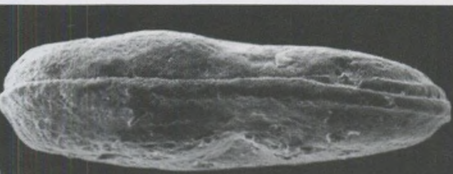

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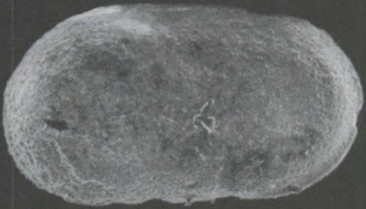

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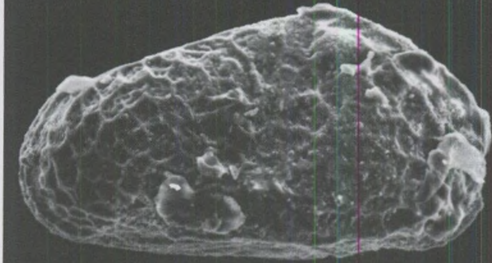

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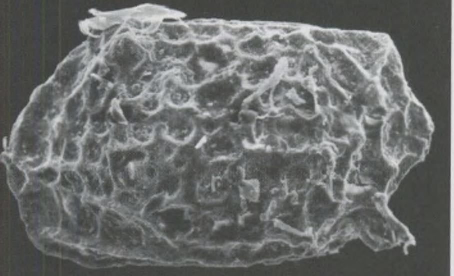

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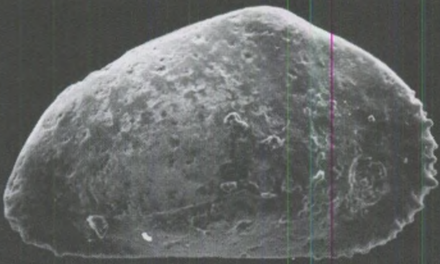

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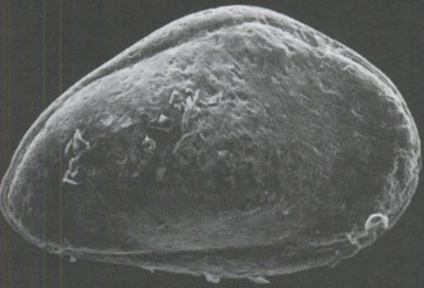

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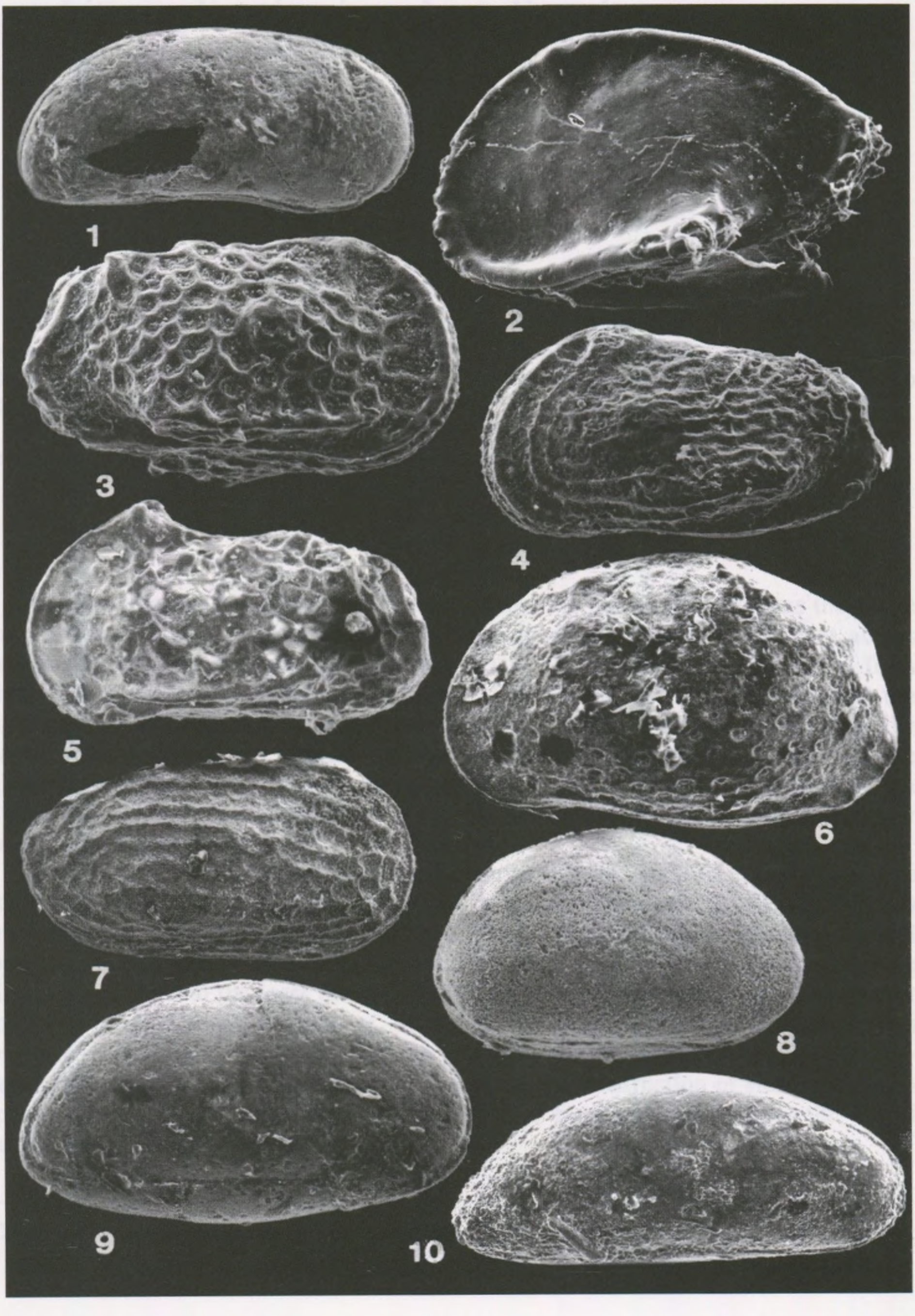
Plate 15



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32, 137–148 (1999) Budapest

The shell morpho-thermometer method and its application in palaeoclimatic reconstruction

SÓLYMOS, Péter[1] & SÜMEGI, Pál [1]

(with 3 figures and 4 tables)

Abstract

We estimated the palaeotemperature of *Granaria frumentum*-containing Upper Pleistocene layers from Katymár and Császártöltés using the shell morpho-thermometer and the malaco-thermometer method and compared the results. We tested and calibrated the two methods with recent climatic and faunistical data.

Key words: palaeoclimatology, Gastropoda, morphometry, actuopalaeontology

Introduction

Comparing terrestrial gastropods (Mollusca) to other taxons of organisms they have some preferable features: gastropod shells have good fossilization ability that allows the identification to the species level (KROLOPP, 1983), the fossil asseblages from terrestrial layers are autochtonous (EVANS, 1972), and about 80 percent of the Quaternary mollusc fauna of the Carpathian Basin have been persisting up to the present (FŰKÖH et al., 1995). Hence we can use modern analogues to reconstruct the palaeo-environment of the fossil assemblages, according to the principle of actualism (LYELL, 1833). In a statistical point of view this possibility can be used as transfer function (ROUSSEAU, 1991).

The need for a palaeotemperature reconstruction method based on the mophological properties of mollusc shells is a classical problem. ROTARIDES (1931) wrote about *Chondrula tridens* in his paper that "if we had many recent and fossil populations, their statistical comparison would enable us to draw conclusions as to the climatic conditions of the loess period", and these words are true even nowadays. Later DOMOKOS studied fossil (DOMOKOS, 1982) and recent (DOMOKOS & FŰKÖH, 1984) *Granaria frumentum* populations and he subsequently developed the shell morpho-thermometer method for local (micro) environmental reconstruction of Horváti Cave in Uppony Valley (DOMOKOS, 1985). Our aim was to carry on investigating the use of morpho-thermometer in a higher spatial scale.

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Fig. 1. Location of the stratigraphic profiles (filled circles) and sampling areas (empty circles).

Study area

We investigated *Granaria frumentum*-containing layers of the stratigraphic profiles of Katymár and Császártöltés (Fig. 1) in order to compare the estimated values of morpho- and malaco-thermometer methods. Császártöltés layer belongs to Mende Upper Soil Complex formation (5.75-6.25 m, age: 31,300 ± 330 yr BP, deb-1484) and this layer is the locus typicus of *Granaria frumentum-Vallonia enniensis zonule* (KROLOPP & SÜMEGI, 1995). Katymár I. layer belongs to Mende Upper Soil Complex formation as well as Császártöltés (9.00-9.25 m, age: 29,828 ± 554 yr BP, deb-3058) does. Katymár II. layer belongs to Dunaújváros-Tápiósüly Loess Complex, humic level 1 (6.00-6.25 m, age: 23,749 ± 360 yr BP, deb-3064). The radiocarbon age of the layers were measured with high precision radiocarbon dating system (HERTELENDI et al., 1989).

For testing the validity of the temperature estimation methods we used recent faunistical data from Szársomlyó located in the Villány Hills, S Hungary (SÓLYMOS, 1996, SÓLYMOS & NAGY, 1997), and from Uppony Valley (Simakő and Kereszteskő) located in the Mid-Mountain Range, N Hungary (FŰKŐH, 1980). We also used microclimatological data fom Szársomlyó (SÓLYMOS & NAGY, 1997), Uppony Valley (DOMOKOS & FŰKŐH, 1984), and Nagyoldal (Oltárkő) (JAKUCS, 1954) (Fig. 1).

Material and methods

Granaria frumentum is mostly a xerophilous species living in rocky and short grasslands (SOÓS, 1943, KERNEY et al., 1983). AGÓCSY (1965) considers the species as very variable with a big geographical range occuring several macroclimatic areas of Hungary.

DOMOKOS (1982) gives 30 for the minimal number of cases that is representative for the derived data of the *G. frumentum* populations. The above three layers contained enough *G. frumentum* individuals for the statistical evaluation of the morphometrical attributes (Table 1). We used full-blown and entire shells for the measuring of the height (H) and width (W) of shells in mm with 0.1 mm precision (max 5% measuring error). We calculated elongation index (H/W) for the data pairs, and arithmetic mean, mode, median, standard deviation, minimum value, maximum value, range of measuring for the *G. frumentum* populations came from the three different layers (Table 1). Fig. 2 shows the interclass distribution curves of height values came from the three layers.

The shell morpho-thermometer is based on the connection between the shell morphometry of *Granaria frumentum* and climatic factors as temperature and humidity. DOMOKOS & FŰKÖH (1984) found that higher mean temperature promoted the development of higher and wider shells within the studied temperature range (19.7-22.8 °C). The shell morpho-thermometer method was developed for local (micro) environments at Horváti Cave in Uppony Valley by DOMOKOS (1985). Here we present the application of the method in a higher spatial scale according to the postulated connection between macroclimate and shell morphometry of *G. frumentum* (SÓLYMOS & DOMOKOS, 1998). We calibrated the morpho-thermometer with recent investigations so the method combines fossil and recent data either and have to be considered as absolute estimation of the palaeotemperature. Methods without the recent calibration are have to be considered as relative estimation of the palaeotemperature (see eg. NYILAS & SÜMEGI, 1991).

Layer		AM	MO	ME	SD	Min	Max	d
Katymár I.	H	7.2	7.1	7.1	0.47	6.4	8.0	1.7
N=33	W	2.6	2.5	2.6	0.11	2.5	3.1	0.6
29,828 yr BP	H/W	2.73	2.70	2.71	0.202	2.05	3.10	1.05
Katymár II.	H	7.1	7.2	7.1	0.39	6.2	7.9	1.7
N=30	W	2.7	2.7	2.7	0.12	2.5	3.1	0.6
23,749 yr BP	H/W	2.59	2.90	2.58	0.207	2.04	3.11	1.06
Császártöltés	H	7.3	7.1	7.4	0.29	6.7	7.9	1.2
N=28	W	2.7	2.7	2.7	0.08	2.5	2.8	0.3
31,300 yr BP	H/W	2.72	2.71	2.71	0.110	2.50	2.96	0.47

Table 1. Size distribution characteristics of the measured *Granaria frumentum* populations. N: number of cases, H: height, W: width, H/W: elongation index, AM: arithmetic mean, MO: mode, ME: median, SD: standard deviation, Min: minimum value, Max: maximum value, d: range of measuring.

Palaeotemperature can be calculated using the equation of the regression line of the present time climatic data and arithmetic means of height of the recent *G. frumentum* populations (R=0.6848, R^2=0.4691, F(1.16)=14.137, p<0.0017, Standard error of estimate: 0.3932, see Fig. 3):

$$PT1 = \frac{AM - 2.1747}{0.2824}$$

where *PT*1 is the palaeotemperature calculated with morpho-thermometer method, *AM* is arithmetic mean. The connection between height and climatic factors is more detectable than the connection between width and the same climatic factors. So height values were used for the regression analysis correlated with mesoclimatic data determined after MAROSI & SOMOGYI (1990) and PÉCSI (1989).

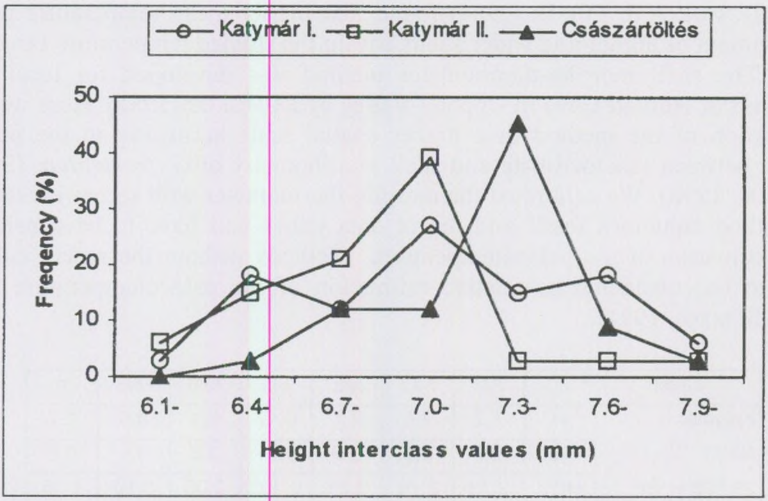

Fig. 2. Height distribution curves of the the different layers (Katymár I. and II., Császártöltés). We used 0.3 mm interclasses according to DOMOKOS (1982).

For testing the shell morpho-thermometer we used the malaco-thermometer method (SÜMEGI, 1989, 1996, HERTELENDI et al., 1992) that is based on recent arealgeographic patterns of some gastropod species dealing with a composite malacofauna. Using the data of climatic research stations, optimal climatic conditions for selected gastropod species can be determined including the minimal and maximal temperature (activity range) that these taxa tolerate (Table 2). Malaco-thermometer method is based on the following equation:

$$PT2 = \frac{\sum_{i=1}^{n} A_i T_i}{\sum_{i=1}^{n} A_i}$$

where $PT2$ is the palaeotemperature calculated with malaco-thermometer method, A_i is the abundance of a given i species in the sample, T_i is the optimum temperature of a given i gastropod species, n is the number of species used for the estimation.

Estimated palaeotemperature values are necessarily valid only for the vegetation period because the studied gastropod species are active only during certain times of the year (SÜMEGI, 1989, 1996, ROUSSEAU et al., 1994). So we compared July mean temperature values calculated by the morpho- and malaco-thermometer methods.

Results

We calculated July mean temperature values for the three layers (Table 3). In the case of Katymár I (29,828 yr BP) the morpho-thermometer underestimated the malaco-thermometer with 1.7 °C. In the case of Katymár II (23,749 yr BP) the morpho-thermometer also underestimated it with 0.5 °C. In the case of Császártöltés (31,000 yr BP) morpho-thermometer method overestimated the value of malaco-thermometer with 1.2 °C. These the differences are under 2.0 °C and 1.1 °C in average.

The estimated values and the complete malacofaunas of Katymár I and Császártöltés layer both indicate a climate similar to that of today of the Carpathian Basin at the begining of the Upper Würm period (32,000-27,000 yr BP). Katymár I and Császártöltés layer belong to the early phase of the Upper Würm *Granaria frumentum-Vallonia enniensis zonule* (KROLOPP & SÜMEGI, 1995). The xerophilous *Pupilla triplicata* is dominant with the mesophilous *Vallonia costata* and *Pupilla muscorum* in the Katymár I and Császártöltés layer. In this two layers the dominance of *Granaria frumentum* is relatively low. In the Katymár II layer the dominance of *Pupilla triplicata* is lower and *G. frumentum* is more abundant than in Katymár I. layer. The abundance of the subhygrophilous *Punctum pygmaeum*, *Euconulus fulvus*, and *Clausilia dubia* is higher indicating transitional covered vegetation and milder climate. The persistence of *Vallonia tenuilabris* indicates colder climate. The Katymár II layer shows the transitional period between the previous cold phase (*Vallonia tenuilabris zonule*, 25,000-22,000 yr BP) and the following mild and humid climatic phase (*Vallonia costata zonule*, 22,000-20,000 yr BP) with the presence of both mesophilous-subhigrophilous (*Vallonia costata*, *V. pulchella*, *Pupilla muscorum*) and frigophilous (*Vallonia tenuilabris*) species.

Using the values of the malaco-thermometer method, the cooling of the climate in the case of the Katymár layers is 1.6 °C. The values of morho-thermometer method show only 0.4 °C decrease of the July mean temperature. The cooling tendency of the climate is detectable by both methods but to a different extent.

Discussion

Before the interpretation of the results, we have to define some concept concerning climatic scales in the way we use here. Microclimate is the climate of the least ranged area that climate is different from the neighbouring microclimates (BACSÓ, 1970). Temperature is a continuous variable both in space and time so we have to use mean, minimum and maximum temperature that can be calculated from the data of a longer time period. The data of a single climate station represents a kind of microclimate on 1-2 m height. Mesoclimate temperature characteristics of a bigger area can be calculated using the data of several climate stations belonging to the area. So mesoclimate is the average of numerous microclimates of a given area and macroclimate is the average of numerous mesoclimates of a larger territory.

The Carpathian Basin has four main macroclimatic regions after Köppen: Carpathic-mountainuous climate region, moderate-warm oceanic climate region, forest-steppe steppe continental climate region, and submediterranean climate region (after DOBOSI & FELMÉRY, 1994). In a macroclimate we can find several different geomorphological features like hills and plains etc. In our oppinion, the climate of a mountain or a hill is mesoclimate with a lot of different microclimates. Microclimatic differences on the areas where from the recent *Granaria frumentum* samples were came out (Szársomlyó, Oltárkő, and Kereszteskő) are 1-4 °C according to the properties of the micro-habitat, vegetation structure (SÓLYMOS & NAGY, 1997), different exposures (STOLLÁR & ZSOLDOS, 1985, HORVÁT & PAPP, 1964), and height of themeasuring (JAKUCS, 1954, SÓLYMOS & NAGY, 1997). Micro scale temporal fluctuation of the temperature and the inertness of the measuring instruments can also reach 1-2 °C (DOBOSI & FELMÉRY, 1994).

We compared the measured microclimate data, the data of mesoclimatic research stations, and values of malaco-thermometer method dealing with the recent fauna of Szársomlyó and Uppony Valley. For Szársomlyó the malaco-thermometer method gave 20.9 °C July mean temperature, the recently observed July mean temperature is 20.8 °C (MAROSI & SOMOGYI, 1990, PÉCSI, 1989), and microclimatic measures gave 21.7 °C on 2 m height and 22.4 °C near the surface during a 24 hour period in southern exposure (SÓLYMOS & NAGY, 1997). For Uppony Valley the malaco-thermometer gave 20.7 °C July mean temperature, the recently observed July mean temperature is 18.0 °C (MAROSI & SOMOGYI, 1990, PÉCSI, 1989), and microclimatic measures gave 17.5 °C during one week quite rainy weather in different exposures (Kereszteskő is exposed to the south, Simakő is exposed to the north) (DOMOKOS & FŰKÖH, 1984).

Comparing recent time July mean temperatures of mesoclimatic research stations and estimated temperature values of malaco-thermometer at Uppony Valley, the malaco-thermometer overestimated the measured data. Contrary to the 230 km latitudinal distance between the Szársomlyó and Uppony Valley, the values of the malaco-thermometer are quite the same with 0.2 °C difference. The very similar mollusc fauna and composition could contribute to the similar estimated temperature values.

According to the above we have to ask, where the border between climatic variability and difference is. Of course it depends on the spatial and temporal scale we use in our investigations. SÜMEGI (1989, 1996, HERTELENDI et al., 1992) used the averages of July mean temperatures of several localities to estimate the palaeoenvironment of the Great Hungarian Plain. The layers were synchronized by radiocarbon dating. Averages help us to reduce the error of extreme values caused by unacquainted special micro- and mesoclimatic conditions in the past.

Comparing estimation methods of other authors using different taxa (vole thermometer, Coleoptera thermometer, and pollen thermometer) the differences of July mean temperature are between 1-6 °C or higher. The different temperatures can be explained by the different location and the types of the investigated areas (marshes, dry habitats; for detail see HERTELENDI et al., 1992). Shell morpho- and malaco-thermometer methods gave very similar outcomes in a 1-2 °C range. This range is acceptable, because the error of the estimation of malaco-thermometer method is ±1-2 °C (see Table 2). Our outcome values appertain to the same layers of the same locations. The experienced differences between malaco- and morpho-thermometer are within this 1-2 °C deviation range.

Species	Optimum (°C)	Activity range (°C)
Pupilla muscorum	16 ± 1	10 – 22
Pupilla triplicata	20 ± 2	16 – 24
Vallonia costata	17 ± 1	10 – 24
Vallonia tenuilabris	9 ± 2	4 – 14
Granaria frumentum	21.5 ± 1	17 – 26
Clausilia dubia	16 ± 1	12 – 20
Punctum pygmaeum	16 ± 1	10 – 22
Vitrea crystallina	15 ± 1	11 – 21
Trichia hispida	15 ± 1	10 – 20

Table 2. Optimum temperatures and activity ranges of gastropod species used for palaeoclimatic reconstruction (SÜMEGI 1989, 1996).

Layers	*PT*1 (°C)	*PT*2 (°C)
Katymár I.	17.7	19.4
Katymár II.	17.3	17.8
Császártöltés	18.2	17.0

Table 3. Estimated July mean temperatures for the different layers with shell morpho-thermometer method (*PT*1), and with malaco-thermometer method (*PT*2) (SÜMEGI 1989, 1996).

Conclusions

Our further aim is to make the regression model of the morpho-thermometer more precise using more recent and fossil populations. It would lead to more precise estimation of palaeotemperature what is a fundamental demand of the better comparability. Actuopalaeontological investigations provide the basis of recent calibration of the thermometer methods. We are planning the morphometrical analysis of other widespread gastropod species (eg. *Pupilla muscorum*) as well, because the appearance of *G. frumentum* is occasional during the the warm periods of the Pleistocene in the Carpathian Basin (KROLOPP & SÜMEGI , 1995). Using more kinds of estimation methods can contribute to the more precise estimation of the palaeoenvironmental variables, because the methods can confirm and complete each other.

Species	Katymár I.	Katymár II.	Császár-töltés
Cochlicopa lubrica (MÜLLER, 1774)	-	-	0.20
Cochlicopa lubricella (PORRO, 1833)	-	-	0.70
Vertigo pygmaea (O.F. MÜLLER, 1774)	-	-	11.90
Pupilla triplicata (STUDER, 1820)	78.51	21.56	5.70
Pupilla muscorum (LINNAEUS, 1758)	6.37	4.25	23.60
Vallonia costata (O.F. MÜLLER, 1774)	10.57	24.56	21.70
Vallonia pulchella (O.F. MÜLLER, 1774)	-	-	11.90
Vallonia enniensis (GREDLER, 1856)	-	-	0.80
Vallonia tenuilabris (A. BRAUN, 1843)	-	0.34	-
Punctum pygmaeum (DRAPARNAUD, 1801)	0.34	26.63	0.40
Granaria frumentum (DRAPARNAUD, 1801)	0.17	8.83	1.70
Chondrula tridens (O.F. MÜLLER, 1774)	0.51	-	2.00
Vitrea crystallina (O.F. MÜLLER, 1774)	-	0.46	-
Helicopsis striata (O.F. MÜLLER, 1774)	0.85	1.44	0.10
Euconulus fluvus (O.F. MÜLLER, 1774)	0.17	4.25	0.10
Limacidae	2.39	1.15	0.10
Clausilia dubia DRAPARNAUD, 1805	0.06	0.11	-
Nesovitrea hammonis (STRÖM, 1765)	0.06	3.21	0.40
Trichia hispida (LINNAEUS, 1758)	-	0.11	0.40
Bradybaena fruticum (O.F. MÜLLER, 1774)	-	3.10	0.10

Table 4. Relative frequencies of the gastropod species found in the three different layers.

In conclusion we adopt the words of BIRKS & BIRKS (1980) that "Numerical methods provide a common language between different biological and environmental variables: a communication link between palaeoecologist and other scientists in related fields". Interdisciplinary research is needed in order to investigate and modelling past and future climate changes and make predictions both in local and global scale.

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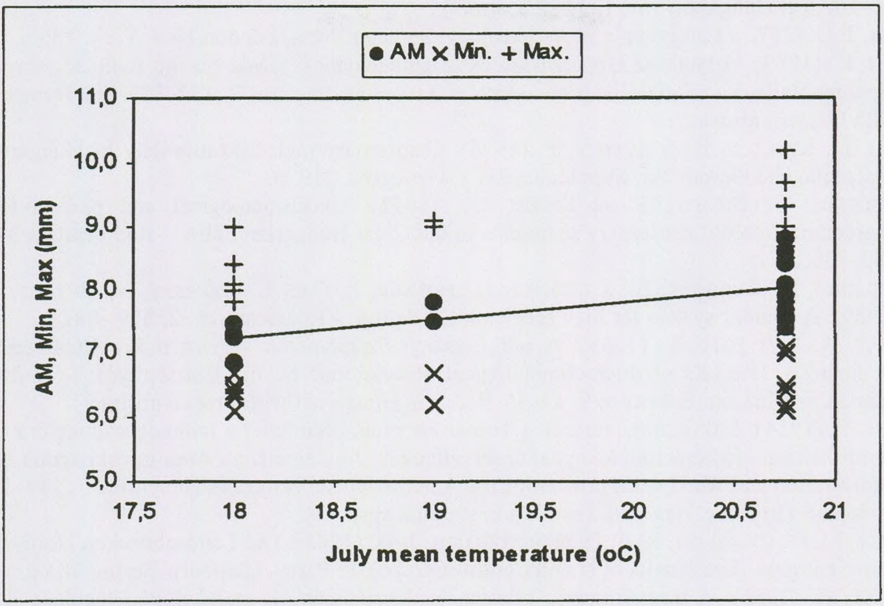

Fig. 3. Connection between macroclimatic factors and means of height (AM), mimimum (Min) and maximum (Max) values of recent *Granaria frumentum* populations from three sampling areas: Szársomlyó (July mean temperature is 20.8 °C), Oltárkõ (July mean temperature is 19.0 °C), Kereszteskõ (July mean temperature is 18.0 °C) (July mean temperatures after MAROSI & SOMOGYI 1990, PÉCSI 1989) (modified from SÓLYMOS & DOMOKOS 1998 in print).

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A héj morpho-hőmérő módszer és alkalmazhatósága őskörnyezeti rekonstrukciók során

SÓLYMOS, P. & SÜMEGI, P.

A csigák (Mollusca, Gastropoda) más élőlénycsoportokkal szemben számos előnyös tulajdonsággal rendelkeznek: jól fosszilizálódó héjuk faji szintű határozást tesz lehetővé, a héjak felépítésükből és méretükből következően az áthalmozódásra rendkívül érzékenyen „reagálnak", ezért szinte minden esetben az autochton módon, *in situ* felhalmozódott héjakat vizsgálhatunk a negyedidőszaki szárazföldi rétegekben. A Kárpát-medence belső területein található negyedidőszaki Mollusca fauna döntő része, mintegy 80%-a ma is él, ezért az aktualizmus elvének felhasználásával a recens klimatológiai, faunisztikai és biogeográfiai megfigyelések jól hasznosíthatók a kvartermalakológiai vizsgálatok során.

A morfo-hőmérő módszert DOMOKOS (1985) alkalmazta elsőként az Upponyi-szoros holocén üledékeinek vizsgálata során. Következtetései lokális vonatkozásúak voltak, mert a morfo-hőmérő „kalibrálását" az Upponyi-szoros recens faunisztikai és mikroklimatológiai adatai alapján (DOMOKOS & FÜKÖH, 1984) végezte el. A jelen dolgozatban bemutatott módszer több mikroklimatikusan is különböző területről (Upponyi szoros, Oltárkő, Szársomlyó) (1. ábra) származó recens *Granaria frumentum* populáció méretbeli változékonysága és mezoklimatikus-makroklimatikus tényezők (pl. júliusi középhőmérséklet) közötti kapcsolaton alapul (SÓLYMOS & DOMOKOS, 1998). Egy adott (fosszilis) populáció héjmagasságainak középértékét behelyettesítve a regressziós egyenes (2. ábra) egyenletébe, a júliusi középhőmérséklet becsülhető.

Három rétegsor (Katymár I., II., Császártöltés) fosszilis *G. frumentum* populációinak statisztikus elemzése után a héj morfo-hőmérő módszer segítségével becsültük az egykori júliusi középhőmérsékleteket. Az így kapott értékeket összevetettük SÜMEGI (1989, 1996) malako-hőmérő módszerével kapott eredményekkel. Az eltérések átlagban alig haladták meg az 1 °C-t (3. táblázat).

A morfo- és malako-hőmérő módszerek eredményei ugyanazokra a rétegsorokra vonatkoznak. A tapasztalt 1-2 °C eltérés elfogadható, mivel minden becslési eljárásnak van bizonyos sajáthibája, amivel a kapott eredmények értelmezése során mindenképpen számolni kell. A malako-hőmérő esetén ez a bizonytalansági tartomány 1-2 °C (ld. 2. táblázat). Más élőlénycsoportok felhasználásán alapuló őshőmérséklet becslő módszereket (pollen-, pocok-, bogár-hőmérő módszerek) összehasonlítva azok egymástól való eltérése az általunk tapasztalt 1-2 °C eltérésnek többszöröse lehet (HERTELENDI et al., 1992).

A morfo-hőmérő módszer felhasználható paleoökológiai rekonstrukciók során az őshőmérséklet becslésére, más módszerekkel kapott adatok kiegészítése, alátámasztása. A recens analógiák felhasználása lehetővé teszi a módszerek „kalibrálását", így az aktuálpaleontológiai vizsgálatok elengedhetetlenek a becslés pontosságának növelése érdekében. Minél pontosabb paleoklimatológiai módszerek állnak rendelkezésre, annál pontosabb lehet az őskörnyezeti tényezők becslése, és ezáltal több adat válik összehasonlíthatóvá. A numerikus módszerek alkalmazása kommunikációs kapcsolatot jelent a paleoökológia és más tudományterületek között, ami segítséget nyújt a környezeti és éghajlati változások lokális és globális vizsgálata és modellezése során.

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A Lower Bathonian ammonite fauna from Erice (Western Sicily)

András GALÁCZ[1]

(with 3 figures and 2 plates)

Abstract

A Lower Bathonian ammonite fauna is described from the Western Sicilian classic Jurassic locality of Monte Erice. The stratigraphic evaluation of the fauna suggests that the horizon yielding the fauna, which is very similar to those mentioned by classic works of GEMMELLARO and WENDT, represents a narrow condensation limited only to the Zigzag Zone. The main importance of the assamblage is the occurrence of "*Tulites*" *tuwaiqensis* ARKELL, 1953, which is an ammonite recorded previously only from the endemic fauna of Arabia. The here described other forms (e.g. *Oxycerites*, *Oecotraustes*, *Prohecticoceras*, morphoceratids, etc.) give an exact datation for this find of palaeobiogeographic significance.

Introduction

Monte Erice (or Monte San Giuliano in the older literature) of Western Sicily is a well-known place for Middle Jurassic ammonites. The best-known faunas are of Aalenian and Bajocian age, because Erice localities yielded the material for the classic works of GEMMELLARO (1886), DE GREGORIO (1886) and RENZ (1925). Most significant development in the Jurassic stratigraphy of the region came from the works of WENDT (1963, 1971), who recorded several Middle Jurassic faunal localities in his detailed descriptions. It is Contrada Difali, one of the Bathonian localities of WENDT, what is treated here in this paper with some more information.

The section at Contrada Difali is a series of road-cuts on the Rocce del Calderera which forms the southern slope of Monte Erice. The best exposures are along the serpentine road leading from Trapani up to the town of Erice on top of the hill. The cuts expose a sequence of well-bedded cherty limestone with marly intercalations. In 1983 a small outcrop near to the profile of WENDT (1963, pl. 6, ME 1; 1971, table 1, A) was visible, exposing the top of the siliceous, marly limestone. In this topmost part a fossiliferous horizon was discovered, possibly the same which was described in detail by WENDT (1964, pp 67-68, 1971, p.60). This locality is very near to the one what GEMMELLARO (1877) mentioned previously as Contrada Cappuccini, and where he collected a small ammonite and brachiopod fauna.

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The earlier data of GEMMELLARO and WENDT indicated the Bathonian, and our collection yielded also Bathonian forms. However this new collection made possible to restrict the age of the represented fauna. Additionally, one faunal element, the ammonite "*Tulites*" *tuwaiqensis* ARKELL, which was previously known only form the highly endemic Arabian Bathonian fauna, made possible to draw some palaeobiogeographic conclusions (GALÁCZ 1998, 1999). The aim of this paper is to document the whole fauna where this important element occurred.

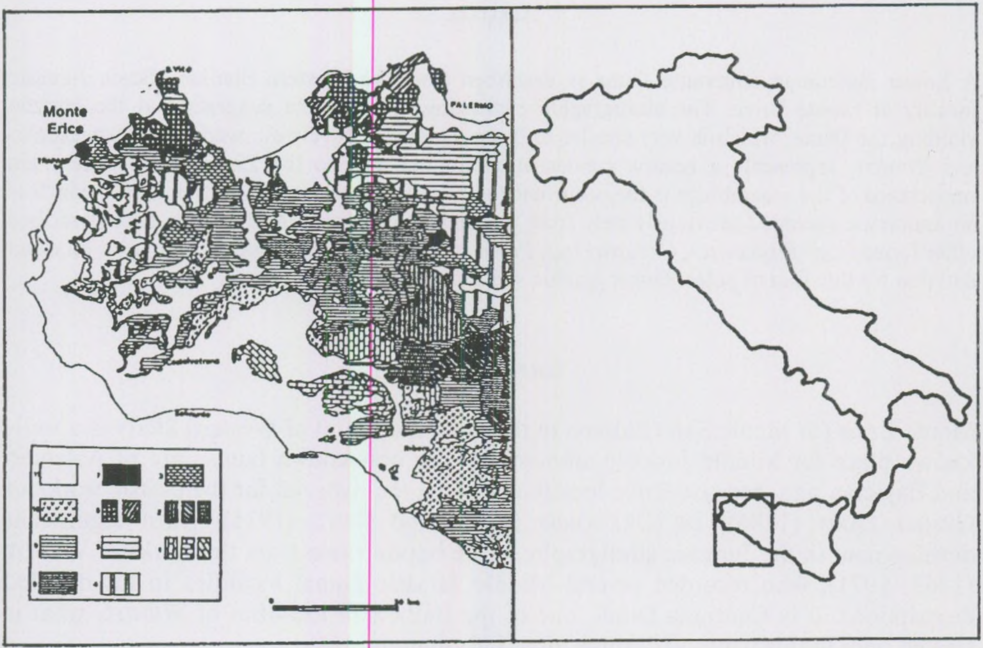

Fig. 1. Monte Erice in Western Sicily. A structural-stratigraphic map (after CATALANO & D'ARGENIO, 1981, fig.11). Legend: 1 = Saccense s.s. units; 2 = Sicanian s.s. units; 3 = Trapanese s.s. units; 4 = Numidian Flysch; 5 = Imerese units; 6 = Panormide units; 7 = Sicillidi units; 8 = Serravallian to Lower Tortonian pelagic marls belonging to the Trapanese, Sicanian and Saccense units; 9 = Upper Tortonian - Middle Messinian sediments; 10 = Upper Messinian - Lower Pliocene sediments; 11 = Middle Pliocene - Pleistocene sediments.

Stratigraphy

Monte Erice (Fig. 1), rising above the northwestern coast of Sicily, is one of the northwest Sicilian Trapanese carbonate-platform derived tectonic units (CATALANO 1997). Its allochtonous mass is built up of uppermost Triassic to Cretaceous carbonates: shallow-water dolomitic-calcareous rocks up to the Pliensbachian, intraplatform siliceous, marly limestones up to the Lower Cretaceous, then varied (deeper-water and reefoid) carbonates in the Upper Cretaceous (WENDT 1971). The

Middle Jurassic sequence is intermitted with apparent gaps of sedimentation, which are marked with marly, nodular condensation levels. These condensation levels yielded rich ammonite faunas, including the one at Contrada Difali.

The first to record Bathonian fossils from this horizon was GEMMELLARO (1877, pp.140-142). He mentioned *Phylloceras isomorphum* GEMM., "*Stephanoceras Daubenyi*" GEMM. (=*Cadomites daubenyi*) from here, and this is the type locality of his "*Haploceras*" (=*Lissoceras*) *monachum* (figured in GEMMELLARO 1886, pl.20, figs 2-3). Additionally, he described from here "*Terebratula Erycina*", "*Terebratula Phryne*" and recorded "*Rhynchonella*" *atla* OPPEL.

WENDT (1963, pp.68-69, pl.6) gave a detailed description on the Bathonian condensation horizon and the yielded fauna. He gave a list of ammonites combined from those found in the Difali and the Cappuccini sections. In his list of ammonites (some of them described and figured in the palaeontological section of his work) there is one what he interpreted as Upper Bathonian (*Prohecticoceras retrocostatum*), and another determined as *Dimorphinites dimorphus* (WENDT 1963, pl.21, fig.3), a species which is known only from the Upper Bajocian. His conclusion was that the age of the fossil bed is Upper Bathonian, though it contains mainly Lower Bathonian forms, thus in the formation of the bed reworking played a greater role. The same list of ammonites and apparently the same conclusion on the age (i.e. "strongly condensed Bathonian") is mentioned in WENDT's subsequent (1971) paper. However, these above mentioned crucial forms can be interpreted differently: ELMI (1967, p.600) excluded WENDT's form from the synonymy of *Prohecticoceras retrocostatum*, and the *Dimorphinites dimorphus* was mentioned by WENDT himself as "questionable".

In 1983, when we visited the locality, small-scale road-construction works exposed the Bathonian faunal level. It is consisted of a single layer above a hard-ground on top of the siliceous, well-bedded greyish limestone. The layer is formed by a greyish – light-brown, yellowishly weathering marly, somewhat nodular and glauconitic limestone. Thickness is variable, but generally of 20-25 cm. Fossils are common. Most frequent are ammonites preserved as internal moulds. Most common ammonites are the phylloceratids and oppeliids (*Oxycerites*, *Oecotraustes*, *Prohecticoceras*). Brachiopods are also abundant, other macrofossils are rare belemnite rostra. Above the fossil bed the grey siliceous limestone follows. In a small quarry across the road this overlying limestone gave *Euaspidoceras* sp. which indicates the Oxfordian, probably the horizon corresponding to that mentioned by CHRIST (1960, p.33).

The limited collection have yielded the following ammonites:

Phylloceras sp. indet.
Calliphylloceras disputabile (ZITTEL)
Adabofoloceras subobtusum (KUDERNATSCH)
Lissoceras (*Lissoceras*) cf. *ventriplanum* WENDT
Oxycerites yeovilensis (ROLLIER)
Oxycerites sp. indet.
Oecotraustes (*Oecotraustes*) *bradleyi* ARKELL
Prohecticoceras bisculptum (OPPEL)
Prohecticoceras sp. nov.?
Cadomites sp.
Asphinctites pinguis (DE GROSSOUVRE)
Asphinctites sp. aff. *pinguis* (DE GROSSOUVRE)

?Asphinctites sp. indet.
Morphoceras macrescens (BUCKMAN)
"*Tulites*" *tuwaiquensis* ARKELL
?Procerites (*?Siemiradzkia*) sp. indet.

This is clearly a Lower Bathonian fauna, as shown by *O. yeovilensis*, *Oe. bradleyi*, *M. macrescens* and the *Asphincites* spp. Undoubtedly higher Bathonian species did not occur. However, *Morphoceras* are practically unknown above the Macrescens Subzone, and genus *Prohecticoceras* is rare below the topmost part of the Zigzag Zone. The co-occurrence of these forms indicates a limited condensation, which resulted that the elements of the Macrescens, Yeovilensis and Tenuiplicatus Subzones are together. The Lower Bathonian age of the fauna is also supported by the occurrence of "*Tulites*" *tuwaiqensis*. This form, previously known only from Central Arabia, belongs to the so-called *Tulites* fauna (D4), which is of Early Bathonian in age (ENAY et al. 1987, ENAY & MANGOLD, 1994).

Systematic description of the important ammonites

The here described specimens are deposited in the Collections of the Department of Palaeontology of the Eötvös L. University, Budapest. The measurements were made and listed traditionally: diameter, whorl-height, whorl-width and umbilical width, the latter three with pecentages of the diameter in parantheses.

Order Ammonoidea ZITTEL, 1884
Suborder Phylloceratina ARKELL, 1950
Family Phylloceratidae ZITTEL, 1884
Genus *Calliphylloceras* SPATH, 1927

Calliphylloceras disputabile (ZITTEL, 1868)
Plate 1, fig. 1.

1852. *Ammonites tatricus* PUSCH - KUDERNATSCH, p.4, pl.1, figs 1-4.
*1868. *Phylloceras disputabile* ZITT. (=*A. Tatricus* KUD. *non* PUSCH) - ZITTEL, p.606.
1980. *Calliphylloceras disputabile* (ZITTEL, 1868) - GALÁCZ, p.37, pl.5, figs 3-6, text-figs 25-29 (*cum syn.*)

Material: Two better preserved and several fragmentary specimens.

Measurements:			
56 mm;	31 mm (55.3%);	18 mm (32.1%);	4 mm (7.1%)
83 mm;	48 mm (57.8 %);	28.5 mm (34.3%);	6.5 mm (7.8%)
58 mm;	34.5 mm (59.5%);	18.5 mm (31.9%);	4 mm (6.9%)

Description: The figured specimen is a medium-sized phylloceratid with narrow umbilicus, oblique umbilical wall, convex whorl-sides and rounded venter. There are 6 slightly prorsiradiate constrictions on the last preserved phragmocone whorl.

The suture-line is relatively simple, with high saddles. The first lateral saddle is triphyllid, other saddles have diphyllid endings.

Remarks: On the basis of the present material there is nothing to add to previous discussions on the species. The only difference what these specimens shows is in the whorl-width: this is somewhat narrower in the Contrada Difali forms then in specimens described from other Mediterranean localities.

Distribution: According to WENDT (1963, p.115) *C. disputabile* is the most common ammonite species in higher Middle Jurassic faunas of Sicily. It is true for several other Mediterranean faunas, too. The stratigraphic range of the species is wide, covering most of the Bajocian, Bathonian and Callovian (GALÁCZ 1980, p.41).

Suborder Ammonitina HYATT, 1889
Superfamily Haplocerataceae ZITTEL, 1884
Family Lissoceratidae DOUVILLÉ, 1885
Genus *Lissoceras* BAYLE, 1879

Lissoceras (*Lissoceras*) cf. *ventriplanum* WENDT, 1963
Plate 1, fig. 2.

cf.*1963. Lissoceras ventriplanum n.sp. - WENDT, p.120, pl.17, fig.4, pl.23, fig.2.
cf. 1986. Lissoceras ventriplanum WENDT - SANDOVAL, p.442, pl.1, fig.11, pl.2, figs 1-3, text-figs 5a-d.

Material: Three incomplete, fragmentary specimens.

Description: Macroconchiate *Lissoceras* with medium-wide umbilicus, rounded umbilical margin, flattened whorl-sides and nearly tabulate venter. It probably attains big sizes, because the biggest specimen (pl.I, fig.2) is wholly septate at ca. 55 mm diameter. There is no sculpture.

The suture-line (Fig. 2) is dominated by the high, well-divided lateral saddle.

Remarks: The main distinguishing feature of the species is the flattened venter, which is bordered, especially in adults, with angular ventrolateral margins (see STURANI 1964, text-fig 9, SANDOVAL 1986, pl.1, fig.11). However, the here available material of fragmentary specimens are not enough to well-based species identification. Additional material may prove that this species belongs to "*Haploceras*" *monachum* GEMMELLARO, 1877, which was based on a specimen from the nearby and stratigraphically comparable Cappuccini locality.

Distribution: WENDT (1963, p.121) mentioned Contrada Difali as one of the localities his type material came from. The few subsequent records of the species (see SANDOVAL 1986) are of Lower Bathonian.

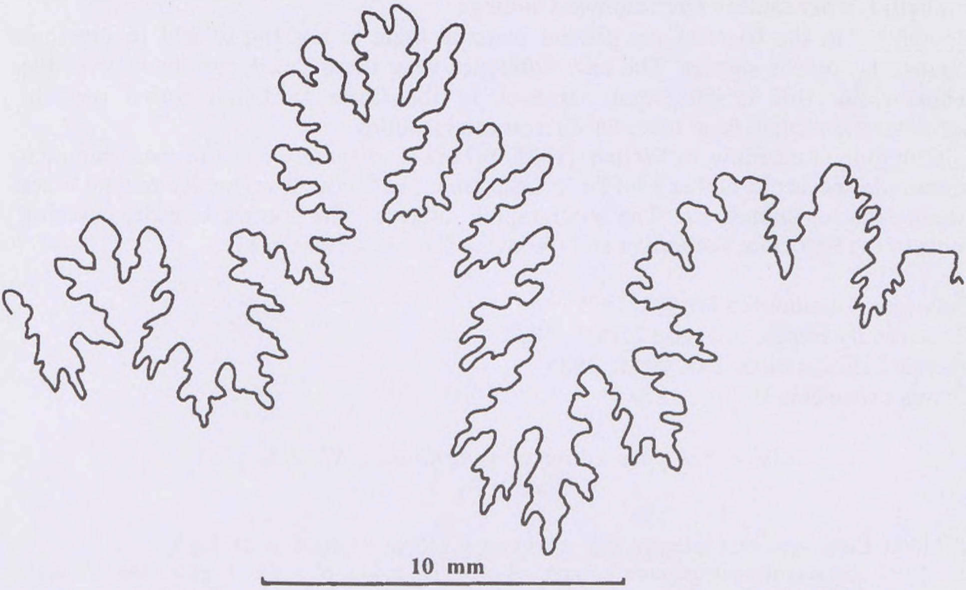

Fig. 2. Suture-line of *Lissoceras* (*Lissoceras*) cf. *ventriplanum* WENDT, 1962. ŐT 1999/41.

Family Oppeliidae BONARELLI, 1894
Subfamily Oppeliinae BONARELLI, 1894
Genus *Oxycerites* ROLLIER, 1909

Oxycerites yeovilensis (ROLLIER, 1911)
Plate 1, fig. 5.

1869. *Oppelia fusca* QUENST. sp. (var.) - WAAGEN, p.199, pl.16, fig.6.
*1911. *Oppelia yeovilensis* n. sp. - ROLLIER, p.305.
1968. *Oxycerites yeovilensis* ROLLIER - HAHN, p.29, pl.2, figs 1-4, text-fig.7 (*cum syn.*)
1987. *Oxycerites yeovilensis* ROLLIER - TORRENS, p.95, pl.1, figs 4,5,8, pl.3, fig.8.
1989. *Oxycerites yeovilensis* ROLLIER - TSERETHELY, p.36, pl.3, figs 1-10, pl.4, figs 1-4, pl.5, figs 1-7.

Material: Two better-preserved and several fragmentary specimens.

Measurements: 65 mm; 33.5 mm (51.5%); 13 mm (20%); 7.5 mm (11.5%)

Description: Large, discoidal, narrowly-umbilicated oppeliid with sharp umbilical margin and almost flat whorl-sides which converge into a sharp, keeled venter. There is a distinct raised spiral zone at mid-flanks. The ribbing on the available big specimens is developed only out of the spiral band, on the outer third of the whorls. It consists of regular, rare and low lunulate outer ribs.

The suture-line is only partially visible; it shows the high, well-differentiated 1st lateral saddle and the numerous auxiliary elements.

Remarks: The species is well-known and thoroughly studied (see ARKELL 1951-58, ELMI & MANGOLD 1966 as *O. fallax*, and HAHN 1968). The variablilty of sculpture on the inner and middle whorls is well documented in TSERETHELY (1989).

Distribution: *O. yeovilensis* is a common species in almost everywhere in Lower Bathonian faunas from Europe, North Africa, the Middle East and the Caucasus. Most data suggest that it ranges through the whole Zigzag Zone, with appearance in the topmost Bajocian and last representatives in the Tenuicostatus Subzone (see STURANI 1967, p. 25).

Genus *Oecotraustes* WAAGEN, 1869

Oecotraustes (*Oecotraustes*) *bradleyi* ARKELL, 1951.
Plate 1, fig. 6.

* 1951. *Oecotraustes* (*Oecotraustes*) *bradleyi* sp.nov. - ARKELL, p.68, pl.7, figs 1,2,9.
1963. *Oecotraustes* (*Oecotraustes*) *bradleyi* ARKELL - WENDT, p.125, pl.18, fig.5.
1966. *Oecotraustes* (*Oecotraustes*) *bradleyi* ARKELL - STEPHANOV, p.43, pl.2, figs 1,2.
1968. *Oecotraustes* (*Oecotraustes*) *bradleyi* ARKELL - HAHN, p.43, pl.4, figs 5,6,16, text-fig.8.
? 1968. *Oecotraustes* (*Oecotraustes*) *bradleyi* ARKELL - TSERETHELY, p.59, pl.5, fig.1.
non 1968. *Oecotraustes* (*Oecotraustes*) aff. *bradleyi* ARKELL - TSERETHELY, p.61, pl.5, fig.2.
1972. *Oecotraustes* (*Oecotraustes*) *bradleyi* ARKELL - KRYSTYN, p.228, pl.2, fig.5.

Material: Two incomplete specimens.

Measurements: 36 mm; 18 mm (50%); 9.5 mm (26.4%); 9.5 mm (26.5%)

Description: A small ammonite with incomplete body-chamber. Coiling is regular, without excentricity. The whorls are narrow and high, with low umbilical wall, sharp umbilical margin, gently convex flanks and narrow, acute venter. The inner half of the flanks are smooth, the outer part is sculptured with short, slightly arched rectiradiate ribs. Rib density changes with growth: on the body chamber the ribs become more distant.

The specimen is septate up to 32 mm diameter, the last sutures are crowded. Entire suture-line cannot be discerned.

Remarks: According to ARKELL's description and figures, this species is distinguished by body-chamber constriction very late, near the aperture, and by regular, distant ribs on the outer part of the narrow whorls. The Erice specimens show these features and are closest to the paratype figured by ARKELL on his pl.7, fig.2. They are very close to the specimens of HAHN (1968, pl.4, figs 5-6, 16). There are morphotypes with denser ribs (TSERETHELY 1968, pl.5, fig.1; KRYSTYN 1972, pl.2, fig.5). WENDT's specimen (1963, pl.18, fig.5) from the Bathonian of Contrada Miliada (northern side of Mount Erice) is smaller, but otherwise matches well the type and the here described forms as well.

Distribution: *Oe.* (*Oe.*) *bradleyi* is a not too common element in Lower Bathonian faunas. MANGOLD et al. (1974, p.108), HAHN (1968, p.45) and ELMI et al. (1971, p.444) gave the Yeovilensis Subzone as the characteristic level of the species.

Subfamily Hecticoceratinae SPATH, 1928
Genus *Prohecticoceras* SPATH, 1928

Prohecticoceras bisculptum (OPPEL, 1862)

Plate 1, fig. 7.

1852. *Ammonites Henrici* D'ORB. - KUDERNATSCH, p.11, pl.2, figs.9-13.
* 1862. *Ammonites bisculptus* OPP. - OPPEL, p.149.
1930. *Hecticoceras retrocostatum* DE GROSSOUVRE - ROMAN, p.24, pl.8, fig.8.
1959. *Hecticoceras*? (*Chanasia*?) *bisculptum* (A.OPPEL, 1862) - ZEISS, p.13.
1967. *Hecticoceras* (*Prohecticoceras*) *crassum* nov.sp. - ELMI, p.583, pl.4, figs 12-13, text-fig.126.
1967. *Oecotraustes subfuscus* WAAGEN - STURANI, p.26, pl.3, fig.15.
1969. *Strigoceras septicarinatum* (BUCKMAN) - MIHAJLOVIC, p.61, pl.2, fig.6. pl.3, fig.1.
p.1969. *Hecticoceras* (*Lunuloceras*) *paulowi* TSYTOWITCH - MIHAJLOVIC, p.64, pl.4, fig.2 (only)
1971. *Hecticoceras* (*Prohecticoceras*) *crassum* ELMI - ELMI, p.256, pl.20, figs 5,7,9.
1987. *Prohecticoceras bisculptum* (OPPEL) (= *P. crassum* ELMI) - TORRENS, p.97, pl.4, fig.2.
1994. *Prohecticoceras bisculptum* (OPPEL) - GALÁCZ, p.172, pl.1, fig.1, pl.2, fig.1.
1997. *Prohecticoceras bisculptum* (OPPEL) - DIETZE et al., p.7, pl.1, fig.4.

Material: One well-preserved specimen and a few fragments.
Measurements: 46.5 mm; 23 mm (49.5%); 15.5 mm (33.3%); 11 mm (23.6%)
64 mm; 32 mm (50%); 20 mm (31.3%); 18 mm (28.1%)

Description: A wholly septate specimen with medium-wide umbilicus. The smooth, vertical umbilical wall meets the slightly convex flanks in a sharp margin. The venter is wide, tectiform, with low, blunt keel. Ribbing consists of straight, prorsiradiate inner ribs and rectiradiate secondaries. There are some tubercle-like strengthenings at the bifurcation points on the inner half of the last preserved whorl. The secondaries have swollen endings on the ventrolateral margin. There are 47 secondary ribs for the 22 primaries on the last whorl.
Entire suture-line cannot be studied.

Remarks: There is nothing to add to the detailed discussion of the species by TORRENS (1987, pp.97-98) and to the revision of type material from Swinitza (GALÁCZ 1994). The here described form is closer to the strongly-ribbed morphotype described by ELMI (1967) as *P. crassum*.

Distribution: The type specimens (KUDERNATSCH 1852, pl.2, figs 9-13) came from the basal Middle Bathonian, but TORRENS (1987) demonstrated that the earliest representatives of the species appear in the Yeovilensis Subzone.

Prohecticoceras sp. nov.?

Plate 1, fig. 4.

Material: A single, incomplete, wholly septate specimen and an additional fragmentary example.

Measurements: 30.3 mm; 15 mm (49.2%); 8 mm (26.2%); 7 mm (23%)
66 mm; 36 mm (54.5%); 21 mm (31.8%); 11 mm (16.6%)

Description and remarks: A relatively big form, the available specimen being septate at 66 mm diameter. The inner whorls show wider umbilicus, narrow whorls with flattened flanks and tabulate venter with a low keel. On the last half whorl of the phragmocone the umbilicus becomes narrower, its wall is high, and the slightly convex whorl-sides become convergent. This results in a high-triangular cross-section, with tectiform venter. The sculpture consists of short, strong primaries and rectiradiate, arched secondaries on the inner whorls. The wedge-shaped outer ribs terminate abruptly, with tubercle-like endings at the ventrolateral margin. On the preserved last half whorl of the phragmocone the inner ribs and the inner parts of the secondaries fade out, only the outer quarter of the secondary ribs remain, terminating in rounded endings on the ventrolateral edge.

The suture-line (Fig.3) is typical of *Prohecticoceras*: with asymmetric saddles becoming evenly shorter toward the umbilical seam.

The characteristic feature of this form is the profound change in sculpture on the phragmocone. The ribbing of the inner whorls are very similar to that on *Prohecticoceras* sp. nov. B. of ELMI (1971, pl.20, fig.2). In this form the bigger specimen (pl.20, fig.8 in ELMI 1971) also shows the fading of the primaries at bigger size.

The here described form cannot be served as basis to designate a new species properly. However, it shows that better and richer material form the Zigzag Zone may elucidate the origin and the earliest forms of *Prohecticoceras*, this much important Bathonian genus.

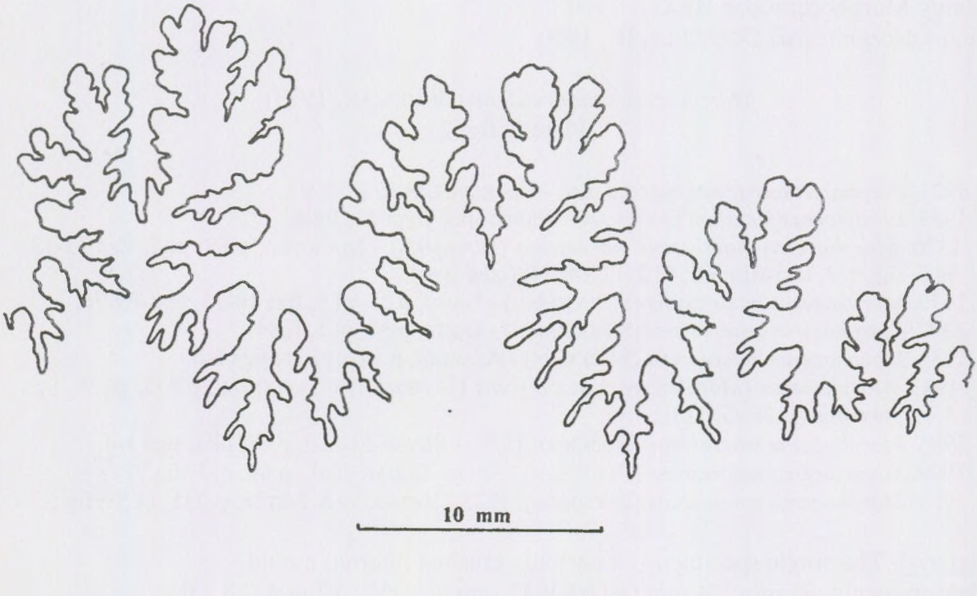

Fig. 3. Suture-line of *Prohecticoceras* sp. nov.? ÕT 1999/31.

Superfamily Stephanocerataceae NEUMAYR, 1875
Family Stephanoceratidae NEUMAYR, 1875
Subfamily Cadomitinae WESTERMANN, 1956
Genus *Cadomites* MUNIER-CHALMAS, 1892

Cadomites sp.

Plate 1, fig. 3.

Material: A single internal mould.
Measurements: 14.5 mm; 4.7 mm (32%); 7.5 mm (51%); 6.5 mm (45%).
Description: A small cadomitid with wide umbilicus, depressed whorl-section, low flanks and widely-arched venter. The primary ribs are projected forward, end in small tubercles and branch into radial secondaries. There are 14 primary and 35 secondary ribs on the last preserved half-whorl.
Suture-line cannot be seen.
Remarks: This is an inner whorls of a bigger specimen, thus cannot be determined closer. Even the subgeneric status is doubtful, but the general habit (wide umbilicus, slender whorls, slight excentricity) may suggest microconch *Polyplectites*. WENDT (1963, 1971) recorded more than one *Cadomites* species from the locality - the here described form could be inner whorls or microconch of one of them.

Superfamily Perisphinctaceae STEINMANN, 1890
Family Morphoceratidae HYATT, 1900
Genus *Morphoceras* DOUVILLÉ, H., 1880

Morphoceras macrescens (BUCKMAN, 1923)

Plate 2, fig. 2.

* 1923. *Patemorphoceras macrescens* nov. - BUCKMAN, pl.376.
1963. *Ebrayiceras jactatum* BUCKMAN - WENDT, p.135, pl.21, fig.6.
1970. *Morphoceras macrescens macrescens* (BUCKMAN) - MANGOLD, p.69, pl.5, figs 11-13, pl.6, figs 1-7, text-figs 5-6, 810, 12-14, 34. (*cum syn.*)
1970. *Morphoceras macrescens* (S.BUCKMAN) - HAHN, p.35, pl.5, figs 10-15, text-fig.7c.
1977. *Morphoceras macrescens* (S.BUCKMAN) - DIETL, p.37, pl.5, fig.4.
1982. *Morphoceras macrescens* (BUCKMAN) - AZARIAN, p.142, pl.31, figs 5-6.
1983. *Morphoceras (Morphoceras) macrescens* (BUCKMAN) - SANDOVAL, p.335, pl.28, figs 1,4,7, text-figs 112E-G, 113B.
1985. *Morphoceras macrescens* (BUCKMAN,1923) - SEYED-EMAMI, p.68, pl.4, figs 3-4.
1989. *Morphoceras macrescens* (BUCKMAN) - SEYED-EMAMI et al., p.84, pl.1, fig.7.
1993. *Morphoceras macrescens* (BUCKMAN), 1923 - BESNOSOV & MITTA, p.235, pl.53, fig.5.

Material: The single specimen is a partially crushed internal mould.
Measurements: 60 mm; 24 mm (40.0%); 17 mm (28.3%); 17 mm (28.3%)
75 mm; 22 mm (29.3%); 19 mm (25.3%); 28 mm (37.3%)
Description: A medium-size ammonite with excentrically coiled body-chamber, where the umbilicus becomes shallower and wider, and the whorl-height decreases

significantly. The whorls are compressed with flattened sides and narrow, rounded venter. Inner ribs are short, strengthened costae which branch into straight, prorsiradiate, rounded secondaries interrupted on the venter. A single constriction is visible on the penultimate whorl.

The sepcimen is septate up to about 50 mm diameter, but entire suture-line cannot be seen clearly.

Remarks: *M. macrescens* is a well-distinguished form which is characterised by the narrow, laterally flattened outer whorls, wide umbilicus of the long body-chamber and the few secondary ribs. MANGOLD (1970) gave a detailed discussion, thus only recently figured forms are mentioned here in the synonymy.

Distribution: *Morphoceras macrescens* occurs commonly in Lower Bathonian faunas in Europe and in the Middle East and North Africa - this is why STURANI (1967, p.13) suggested it as a subzonal index. The species was recorded also from Sicily (e.g. WARMAN & ARKELL 1954, p.). WENDT (1963, p.135, pl.21, fig.6) figured a *M. macrescens* from Monte Inici as *Ebrayiceras jactatum*. Stratigraphically the species is restricted to the nominate subzone (see TORRENS 1974, p.585).

Genus Asphinctites BUCKMAN, 1924

Asphinctites pinguis (DE GROSSOUVRE, 1919)
Plate 2, fig. 4.

* 1919. *Morphoceras pingue* n.sp. - DE GROSSOUVRE, p.391, pl.14, fig.7.
1956. *Morphoceras pingue* DE GROSSOUVRE - ARKELL, p.135, text-fig.49.
1967. *Morphoceras* (or *Asphinctites*) *pingue* DE GROSSOUVRE - STURANI, p.37, text-fig.3.
1970. *Asphinctites pinguis* (DE GROSSOUVRE) - MANGOLD, p.111, pl.3, figs 13-14.
1972. *Asphinctites* (*Asphinctites*) *pinguis* (DE GROSSOUVRE) - KRYSTYN, p.264, pl.8, fig.3.
1977 *Asphinctites pinguis* (DE GROSSOUVRE) - LINARES et al., p.259, pl.1, fig.2.
1983. *Asphinctites* (*Asphinctites*) *pinguis* (DE GROSSOUVRE) - SANDOVAL, p.258, pl.28, figs 3,5, text-figs 112U,V, 113.
? 1985. *Morphoceras pingue* GROSSOUVRE - ROSTOVTSEV, p.161, pl.44, figs 5-6.
1987. *Asphinctites pinguis* (DE GROSSOUVRE) - TORRENS, p.98, pl.2, figs 1-4.

Material: A single, incomplete specimen.

Measurements: 29.5 mm; 12 mm (40.6%); 14 mm (47.5%); 10 mm (33.9%)
42 mm; 12 mm (28.5%); 16 mm (38%); 15.5 mm(36.9%)

Description: A small ammonite with narrower umbilicus on the inner whorls and strongly contracted body chamber. The contraction develops as a significant decrease in the whorl-height and width, resulting in the opening of the umbilicus, while the whorl-section remains rounded. There are seemingly few constrictions of which one is visible on the penultimate whorl; this is a deep, narrow groove arching forward. The dense ribbing is built up of primaries bifurcating shortly above the umbilical seam, and slightly prorsiradiate secondaries arising mainly as intercalatories in different heights on the flanks. The secondaries cross the venter without interruption.

Suture-line cannot be seen.

Remarks: The figures of adult *A. pinguis* (e.g. in SANDOVAL 1983, pl.28, fig.3 = LINARES et al. 1977, pl.1, fig.2; TORRENS 1987, pl.2, fig.4 = STURANI 1967, text-fig.3) indicate that one specific character of the species is the narrowing body-chamber. Another feature is the "twinning" of primary ribs (see ARKELL 1951-58, p.135). Otherwise the ribbing is finer than in the *A. tenuiplicatus* group.

Distribution: The species is recorded from several localities in Europe, including Western Sicily (Monte Inici: WARMAN & ARKELL 1954). In most places it belongs to the group of stratigraphically older *Asphinctites*, occurring in the Yeovilensis Subzone (TORRENS 1987, p.98).

* * *

There is a small, incomplete specimen in the material which shows features close to *A. pinguis*: dense ribbing with non-tuberculate branchings at different heights, and constrictions. However, the ribs are denser and sharper than in typical *Asphinctites*, and the whorl-section is more depressed. The specimen is shown here as *Asphinctites* sp. aff. *pinguis* (Pl.II, fig.5)

? *Asphinctites* sp. indet.

Plate 2, fig. 3.

Description and remarks: A body-chamber fragment of a medium-size ammonite. The umbilicus is narrow, the whorl-section is high-oval with flattened flanks. The body-chamber shows a slight contraction. The ribbing consists of short primaries with stronger, tubercle-like portion on the umbilical margin, and slightly prorsiradiate, dense, weak secondaries which cross the venter without interruption.

All visible characters suggest the genus *Asphinctites*, however the specific arrangement is uncertain. The size and the style of ribbing suggests *A. tenuiplicatus*, but this species is usually more evolute and more coarsely ribbed in this stage, while other *Asphinctites* show lower whorls at this size.

? Family Tulitidae BUCKMAN, 1921

? Genus *Tulites* BUCKMAN, 1921

"*Tulites*" *tuwaiqensis* ARKELL, 1952.

Plate 2, fig. 1.

* 1952. *Tulites tuwaiqensis* n.sp. - ARKELL, p.284, pl.25, fig.3.
1999. "*Tulites*" *tuwaiqensis* Arkell - GALÁCZ, text-fig.2.

Material: A single, incomplete specimen.

Measurements: 65 mm; 23 mm (35.5 %); 30 mm (46.1 %); 21 mm (32.3 %)

Description: Because of the imperfect preservation, only the last half whorl, i.e. the body-chamber can be studied. Here the relatively small specimen shows a medium-wide umbilicus which becomes even wider as the body-chamber contracts toward the aperture. The umbilical margin is widely rounded, the flanks merge into the venter without ventrolateral margin. The whorl-section is depressed with wider venter at the end of the phragmocone, suggesting cadicone inner and middle whorls. As the body-chamber contracts, the venter becomes higher and narrower, resulting in a subtriangular cross-section near the aperture which is broken off. The sculpture is consisted of blunt, short inner ribs which appear at the umbilical margin, leaving the umbilical wall smooth. Rounded, low, slightly prorsiradiate secondary ribs appear as bifurcations or intercalations high on the flanks, and they cross the venter without interruption. The ribs persist all along the body-chamber, only the inner ribs become somewhat weaker towards the aperture. There are 13 primary and 29 secondary ribs on the last third of the preserved body-chamber.

Entire suture-line cannot be seen; only some portions of the last sutures are visible. These indicate well-differentiated, intricate suture with high saddles and thick-based lobes.

Remarks: This most interesting element of the here described fauna can be best matched with ARKELL's *Tulites tuwaiqensis*, what he described with two other congeneric species from the Central Arabian fauna. *T. tuwaiqensis* is distinguished from *T. arabicus* ARKELL by its non-tuberculate ribbing which persists on the body chamber, and from *T. erymnoides* ARKELL by its weaker ribs with furcations higher on the whorl-sides.

The generic status of the Arabian "*Tulites*" is uncertain. ARKELL (1952, p.283) relied on the ontogenetic development (i.e. strongly ribbed, cadicone inner whorls) and on the suture-line (with thick-based, two-pronged second lateral lobe, see ARKELL 1951-58, p.82) of the Arabian forms, when palced them into *Tulites*. However, he himself stressed the differences from the European species. These differences were also pointed out by French authors (ENAY & MANGOLD 1985, 1994) who studied new material from ARKELL's localities. However, most recently MANGOLD (in MANGOLD & GYGI 1997, p.506) stated, that the Arabian species are genuine *Tulites*, not homoeomorphs.

The original material of ARKELL, housed in the Sedgwick Museum, Cambridge, shows that these ammonites are significantly different from the European s.str. *Tulites* species, which are all big, never or only slightly contracted in adult stage, and their style of ribbing is also dissimilar. The differences of the Arabian "*Tulites*" are within the range of distinctions shown by many other forms described from Jebel Tuwaiq under European generic names (e.g. "*Teloceras*" and "*Stephanoceras*" in ARKELL 1952). Until detailed revision, the best approach to these forms is to regard them as a specialized branch of erymnoceratids, which - with the loss of the ventral groove - shows homoeomorphic similarity to European tulitids.

Distribution: "*Tulites*" were hitherto known only from Jebel Tuwaiq, however ENAY & MANGOLD (1994, p.162) mentioned the *Tulites* fauna as one of those of wider distribution within Central Arabia.

ARKELL (1952, p.297), and later IMLAY (1970, p.D5) correlated the Arabian *Tulites* fauna with the European Middle Bathonian. ENAY & MANGOLD (1985, p.645) suggested a correlation with the European Lower Bathonian. Later ENAY et al. (1987, fig.2) restricted the correlation of the D4 unit (yielding the *Tulites* fauna) to a part of the Lower Bathonian Zigzag Zone, and recently (ENAY & MANGOLD 1994) designated a zone (i.e. Tulites tuwaiqensis Zone) for the interval which they compared to the middle part of the Lower Bathonian. This correlation is now supported by the Sicilian record, because the here described "*T.*" *tuwaiqensis* came from a fauna containing elements from the middle to upper parts of the Zigzag Zone.

Family Perisphinctidae STEINMANN, 1890
Subfamily Zigzagiceratinae SCHINDEWOLF, 1923
Genus *Procerites* SIEMIRADZKI, 1898

?Procerites (*?Siemiradzkia*) sp. indet.
Plate 2, fig. 6.

Material: A single, incomplete, distorted and worn specimen. Because of distortion, correct measurements cannot be made.
Description and remarks: This is the only *Procerites*-like perisphinctid in the fauna, but its incomplete preservation makes its determination rather uncertain. A widely-umbilicated form with slightly high-oval whorl-section and dense ribbing. The ribs are radial and somewhat irregular in strength. The inner ribs bifurcate high on the flanks. There are indications of constrictions, two per whorls.
The suture-line is relatively simple, with short lobes and strongly retracted umbilical elements.
The specimen belongs into a species of comparatively big size, because it is wholly septate at about 60 mm diameter. The sculpture and especially the suture-line suggest *Siemiradzkia*, of which Lower Bathonian species usually have wide umbilicus, just as this poorly-preserved specimen.

Conclusions

The above descriptions suggest that the Bathonian fauna from the Contrada Difali locality belongs into a limited time interval representing only the higher part of the Early Bathonian. The importance of the assemblage is that it yielded the specimen of "*Tulites*" *tuwaiquensis* ARKELL, which was known previously only form Central Arabia, but also from the Early Bathonian. The occurence of this species in Western Sicily indicates that this unit palaeobiogeographically belonged or laid close to the migration route of Arabian ammonites along the southern margin of the Jurassic Tethys.

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Plate 1

Fig. 1. *Calliphylloceras disputabile* (ZITTEL, 1868). ÕT 1999/2. Lateral view.
Fig. 2. *Lissoceras (Lissoceras)* cf. *ventriplanum* WENDT, 1963. ÕT 1999/42. Lateral view.
Fig. 3. *Cadomites* sp. ÕT 1999/28. Lateral view.
Fig 4. *Prohecticoceras* sp. nov.? ÕT 1999/31. 4a: ventral view; 4b: lateral view.
Fig. 5. *Oxycerites yeovilensis* (ROLLIER, 1911). ÕT 1999/16. Lateral view.
Fig. 6. *Oecotraustes bradleyi* ARKELL, 1951. ÕT 1999/20. Lateral view.
Fig. 7 *Prohecticoceras bisculptum* (OPPEL, 1862). ÕT 1999/29. 7a: ventral view; 7b: lateral view.

All figures natural size

Plate 2

Fig. 1. "*Tulites*" *tuwaiqensis* ARKELL, 1952. ÕT 1999/29.1a and 1c: lateral views; 1b: ventral view.
Fig 2. *Morphoceras macrescens* (BUCKMAN, 1923). ÕT 1999/33. Lateral view.
Fig. 3. ?*Asphinctites* sp. indet. ÕT 1999/32. 3a: lateral view; 3b: ventral view.
Fig. 4. *Asphinctites pinguis* (DE GROSSOUVRE, 1919). ÕT 1999/34. 4a: ventral view; 4b: lateral view.
Fig. 5. *Asphinctites* sp. aff. *A. pinguis* (DE GROSSOUVRE, 1919). ÕT 1999/38. 5a: lateral view; 5b: ventral view.
Fig. 6: ?*Procerites* (?*Siemiradzkia*) sp. indet. ÕT 1999/37. Lateral view.

All figures natural size

Plate 1

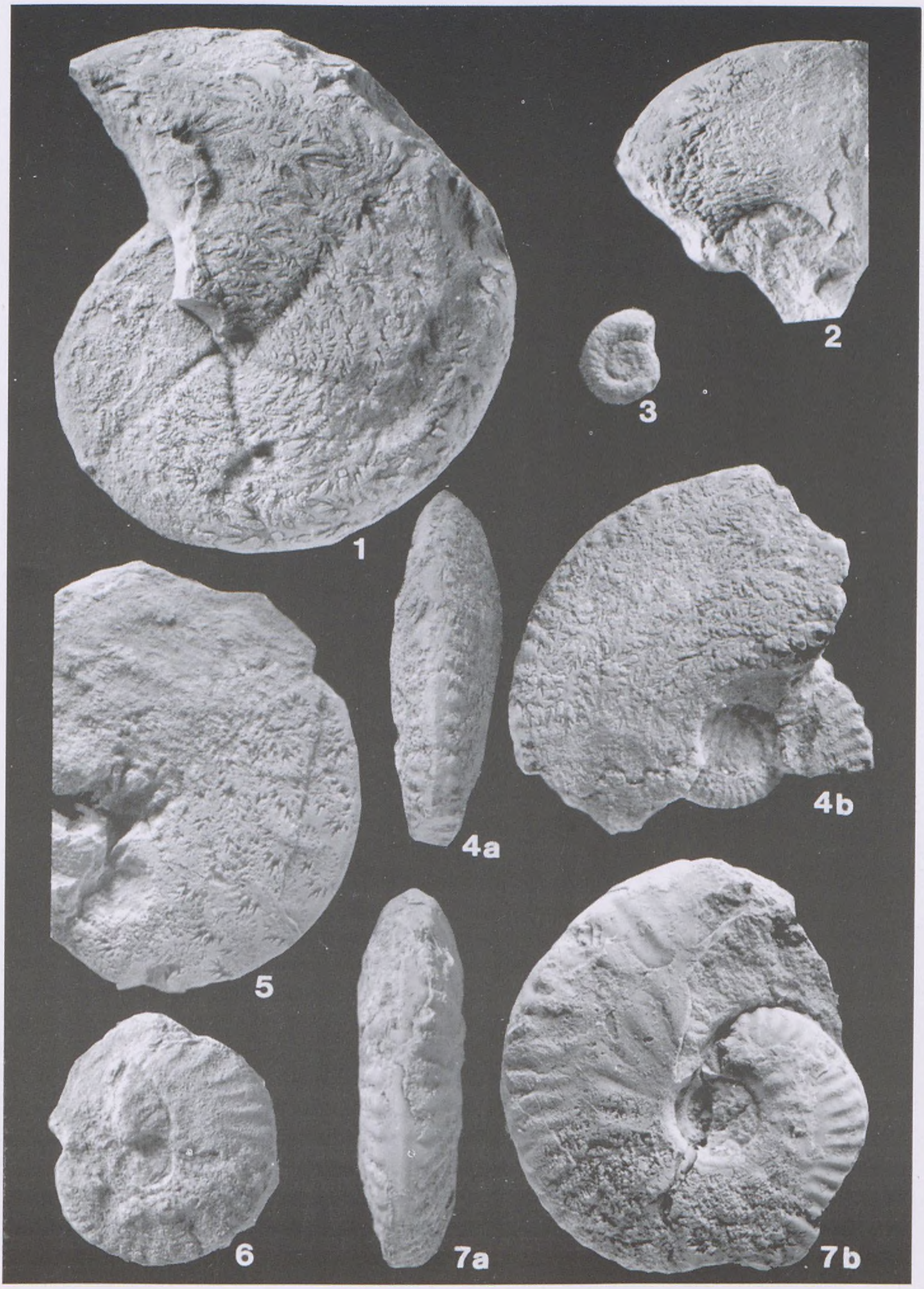

Plate 2