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Insectivore faunas from the Lower Miocene of Anatolia

Part 2: *Dinosorex* (Heterosoricidae)

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SUMMARY

A new species of *Dinosorex*, *D.anatolicus*, is described from the Lower Miocene (MN 1–3) of Anatolia. No representatives of *Dinosorex* were found in the corresponding interval in Europe.

INTRODUCTION

This is the second in a series of papers on the Insectivore faunas from the Lower Miocene of Anatolia. These papers are expected to result in a better understanding of the stratigraphy and paleoenvironmental characteristics of the Lower Miocene of Anatolia. The material described was derived from eight Turkish localities: Kilçak 0, Kilçak 0″, Kilçak 3A, Kilçak 3B, Harami 1, Harami 2, Harami 3 and Keseköy (fig. 1).

Micromammal faunas were not known from the Anatolian Lower Miocene until some years ago. All species found thus far are new. As a consequence no (bio)stratigraphic or paleoecological conclusions can be drawn until the taxonomy has been clarified. The erinaceids from the various localities (with the exception of those from Harami 2, a locality sampled in 1992) were discussed in a previous paper (van den Hoek Ostende, 1992). In this paper we will describe the Heterosoricidae. The Dimylidae, Talpidae and Soricidae will be treated in forthcoming publications.

The localities studied all seem to be younger than Yeniköy, which is placed in the Late Oligocene. Since the evolutionary stage of cricetids in the Anatolian faunas is more primitive than that inferred from the Middle Miocene central european species, the Anatolian faunas are thought to be older than MN 4. An exact correlation of the various localities with the MN-zonation is not possible. De Bruijn et al. (1992) assigned the Keseköy faunal assemblage to MN 3 and the Harami assemblages to MN 1/2. On the basis of the rodents, the Kilçak assemblages are older than the assemblages from Harami (de Bruijn, pers. comm.). The Kilçak assemblages are tentatively placed in MN 1 and the Harami assemblages in MN 2. Preliminary results of a magnetostratigraphic study by Krijgsman et al. (in prep.) indicate an age of 22.8 my (geomagnetic polarity timescale of Cande and Kent, 1992) for the basal part of the Harami section.

The rodents of the various localities are described in the series 'Early Miocene rodent faunas from the eastern Mediterranean area', which is also published in the Proceedings of the Royal Dutch Academy of Science (de Bruijn and Saraç, 1991, 1992; de Bruijn et al., 1993; de Bruijn and von Koenigswald, 1994; Ünay, 1994).

METHODS AND COLLECTIONS

The material was collected by Dr. E. Ünay and Mr. G. Saraç of the General Directorate Mineral Research and Exploration of Turkey (M.T.A.) and by Dr. H. de Bruijn of Utrecht University during field trips in the period 1987–1992. The fossil teeth were obtained by wet-screening.

I use the nomenclature for parts of molars proposed by Reumer (1985). The elements, usually unicuspids, behind the upper and lower incisor and in front of the P4 and m1 are all called antemolars, since their homology cannot be determined. They are numbered from the front of the dentition backwards. All

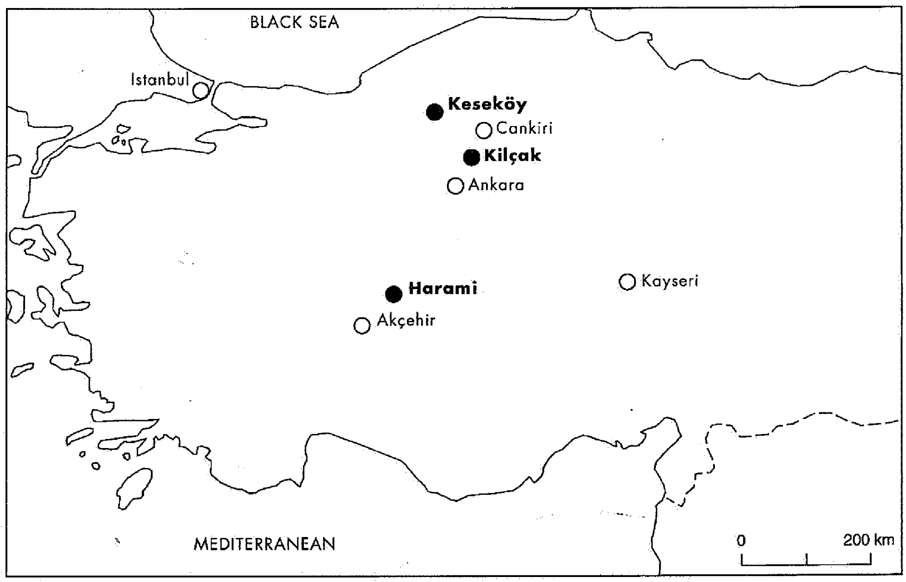

Fig. 1. Lower Miocene mammal localities in Anatolia.

elements were measured using a Reflex measuring microscope. Length and width were taken at right angles. The width given for lower molars is always the width of the talonid. All measurements are in mm. The number of specimens of a specific tooth from a particular locality is given in brackets in the descriptions.

The sizes of the m1 and m2 relative to one another is considered to be of taxonomic value. This is expressed in the ratio of the average lengths of the m1 and m2 in an assemblage.

All the elements are figured as sinistral to facilitate comparison. Underlined figure numbers on the plate indicate that a dextral element has been mirrored.

The material will be stored in the collections of the General Directorate Mineral Research and Exploration (M.T.A.) in Ankara.

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REVIEW OF THE LITERATURE ON THE HETEROSORICIDAE

Viret and Zapfe (1951) considered the Heterosoricinae a subfamily of the Soricidae. Later the group was raised to family-level by Reumer (1987), who hypothesized that the Heterosoricidae and the Soricidae originated separately from the Nycteriidae.

The Heterosoricidae are known from the Early Oligocene until the Late Miocene. The family is found both in North America and in Eurasia. Engesser (1975) revised the European representatives of the family (which he considered a subfamily). He recognized three genera: *Quercysorex*, *Heterosorex* and *Dinosorex*. Engesser's classification is primarily based on characters of the mandible, but he also gave some diagnostic features for the dentition.

Quercysorex is represented by two Oligocene species, *Q.primaevus* and *Q.herrlingensis*, each represented by one mandible only.

Dinosorex appears in the Upper Oligocene of western Europe. It is known from two Swiss localities, Boudry-Trois Rods (*Dinosorex* sp., Mojon et al., 1985) and Rickenbach (*D.huerzeleri*, Engesser, 1975). Brunet et al. (1981) mention the presence of *Dinosorex* in Cournon-Les-Soumeroux, France (MP 29). *Dinosorex* is not known from the lower part of the Lower Miocene. The genus reappears in Central Europe in MN 4 (*Dinosorex* aff. *zapfei*, Ziegler, 1989). In the Middle Miocene *Dinosorex* is represented by three species: *D.zapfei*, *D.sansaniensis* and *D.pachygnathus*.

Heterosorex is possibly also present in the Upper Oligocene. Ziegler (1989) classified some elements from the localities Ehrenstein 4 and Eggingen-Mittelhart 2 (S. Germany, MP 30) as ?*Heterosorex* sp.. The genus is represented in the Lower and Middle Miocene of Western Europe by two species, *H.neumayrianus* and *H.delphinensis*. The Lower Miocene species *H.neumayrianus* has been subdivided into several subspecies (Doben-Florin, 1964; Ziegler, 1989).

Heterosoricidae have also been found in Southeastern Europe and Anatolia. *Heterosorex* is known from the Greek Lower Miocene locality Aliveri (MN 4),

Serie	MN-Zone	Localities	Southwestern Europe	Central Europe	Southeastern Europe and Anatolia
Middle Miocene	9	Can Llobateres	*D.sansaniensis*		
	7/8	Anwil		*D.pachygnathus*	
		La Grive	*D.sansaniensis* *H.delphinensis*		
		Vermes		*D.zapfei*	
		Sariçay			*Dinosorex* sp.
	6	Sansan	*D.sansaniensis*		
		Neudorf		*D.zapfei*	
	5	Komotini			*Dinosorex* sp.
		Puttenhausen		*D.* aff. *zapfei*	
Lower Miocene	4	Erkerstshofen 2		*D.* aff. *zapfei* *H.n.* aff. *subsequens*	
		Petersbuch 2		*D.* aff. *zapfei* *H.n.* aff.*subsequens*	
		Vargas	*H.neumayrianus*		
		Aliveri			*H.ruemkae*
	3	Stubersheim 3		*H.neumayrianus subsequens*	
		Wintershof-West		*H.neumayrianus neumayrianus*	
		Keseköy			*D.anatolicus*
	2	Ramblar 1	*H.neumayrianus*		
		Ulm-Westtangente		*H.neumayrianus neumayrianus*	
		Harami 2			*D.anatolicus*
		Harami 1			*D.anatolicus*
	1	Kılçak 3A			*D.anatolicus*
		Kılçak 0"			*D.anatolicus*
		Kılçak 0			*D.anatolicus*
Oligocene		Ehrenstein 4		?*Heterosorex* sp.	
		Eggingen-Mittelhart 2		?*Heterosorex* sp.	
		Rickenbach		*D.huerzeleri*	
		Boudry Trois Rods		*Dinosorex* sp.	

Fig. 2. Stratigraphic and geographic distribution of the various representatives of *Heterosorex* and *Dinosorex*.

from which *H.ruemkae* was described (Doukas, 1986). *Dinosorex* is represented by *Dinosorex* sp. in the Anatolian Middle Miocene locality Sariçay (MN 7/8, Engesser, 1980). *Dinosorex* is also present in the Greek locality Komotini (MN 5, unpublished data).

The geographical and stratigraphical distribution of the different species of *Heterosorex* and *Dinosorex* is represented in fig. 2. The distribution of *Dinosorex* is remarkable. This genus is present in the Upper Oligocene and Middle Miocene of Central Europe, but it is completely absent in the larger part of the Lower Miocene (MN 1–3). It is not likely that this is due to lack of data, because the insectivores of Southern Germany are very well known (Ziegler, 1989, 1990a, 1990b).

SYSTEMATIC PART

Family Heterosoricidae Viret and Zapfe, 1951
Genus *Dinosorex* Engesser, 1972

Dinosorex anatolicus n.sp. (Plate I, II, III)

Derivatio nominis: The species is named after Anatolia.

Diagnosis: *Dinosorex anatolicus* is a medium-sized species of *Dinosorex*. The m1 and m2 bear well-developed entocristids. The outline of the occlusal surface of the P4 is irregularly quadrangular to sub-triangular. The m1/m2 ratio is low (ca. 1.15).

Differential diagnosis: *Dinosorex anatolicus* is larger than *D.huerzeleri* and *Dinosorex* sp. from Boudry-Trois-Rods and smaller than *D.sansaniensis*, *D.zapfei*, *D.pachygnathus* and *Dinosorex* sp. from Sariçay. Furthermore it differs from *D.zapfei* and *D.sansaniensis* by the presence of well-developed entocristids.

Type locality: Keseköy (MN 3)

Other localities with *Dinosorex anatolicus*: Harami 1 (MN 2), Harami 2 (MN 2), Kilçak 3A (MN 1), Kilçak 0″ (MN 1), Kilçak 0 (MN 1).

Type level: Lower Miocene (MN 3)

Holotype: Fragment of a mandibulum sin. with m1–m2 (Ke 6421) (m1 = 2.48 × 1.80, m2 = 2.23 × 1.64).

Description of the holotype

The mandible fragment carries the m1 and the m2; the alveoli of the m3 are preserved. The ramus horizontalis is broken off below the trigonid of the m1. The processus angularis is damaged. The ramus ascendens is broken off just above the tooth row. The condyle is not preserved.

The fragment shows that the mandible must have been robust. The foramen mentale is very large. It lies in a depression on the upper part of the mandible below the talonid of the m1.

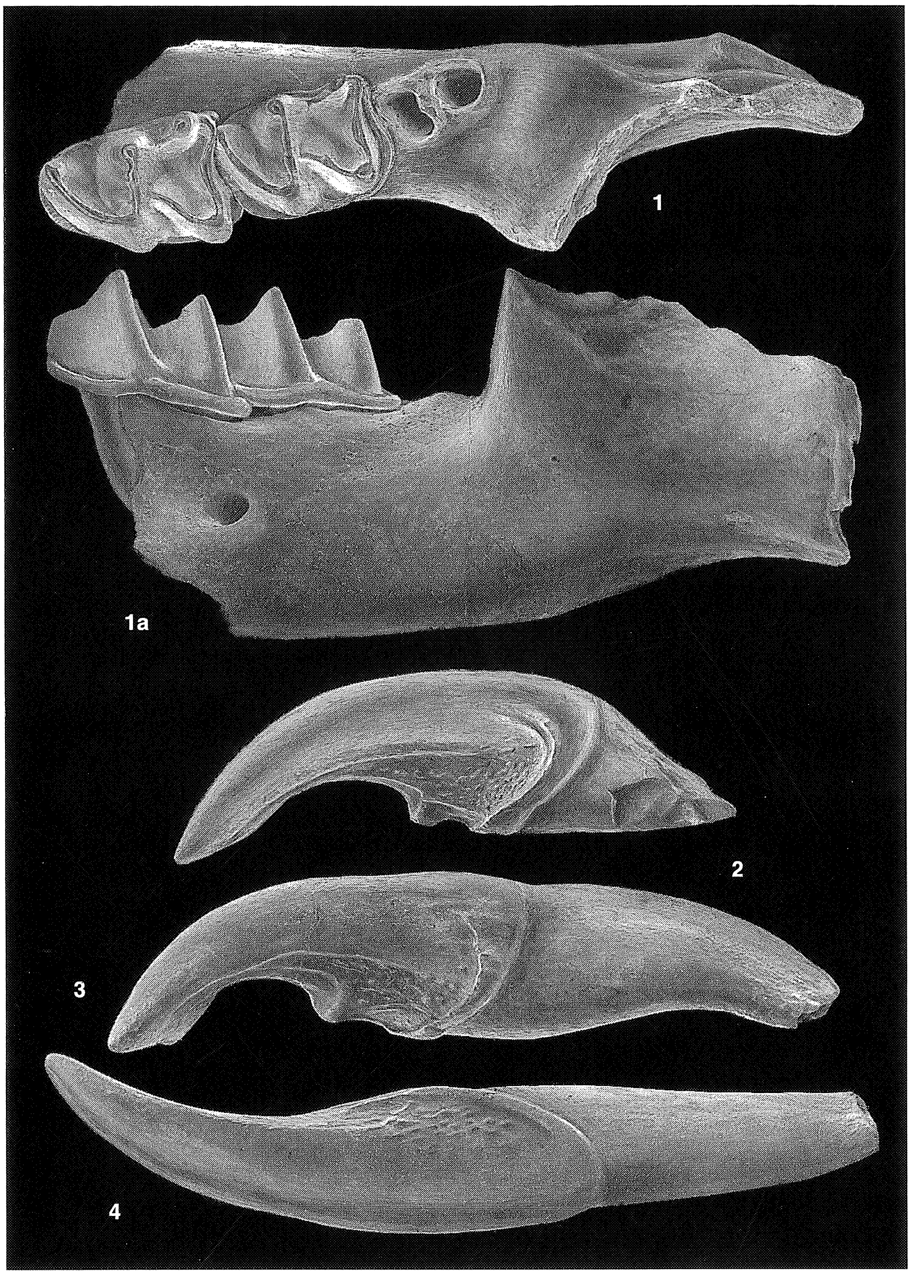

Plate I. *Dinosorex anatolicus*. 1. Holotype, mandible with m1–m2, occlusal view (Ke 6421); 1a. idem, labial view; 2. I1 (Ha 1 3489); 3. I1 (Ke 6447); 4. i1 (Ke 6413).
All fig. × 10.

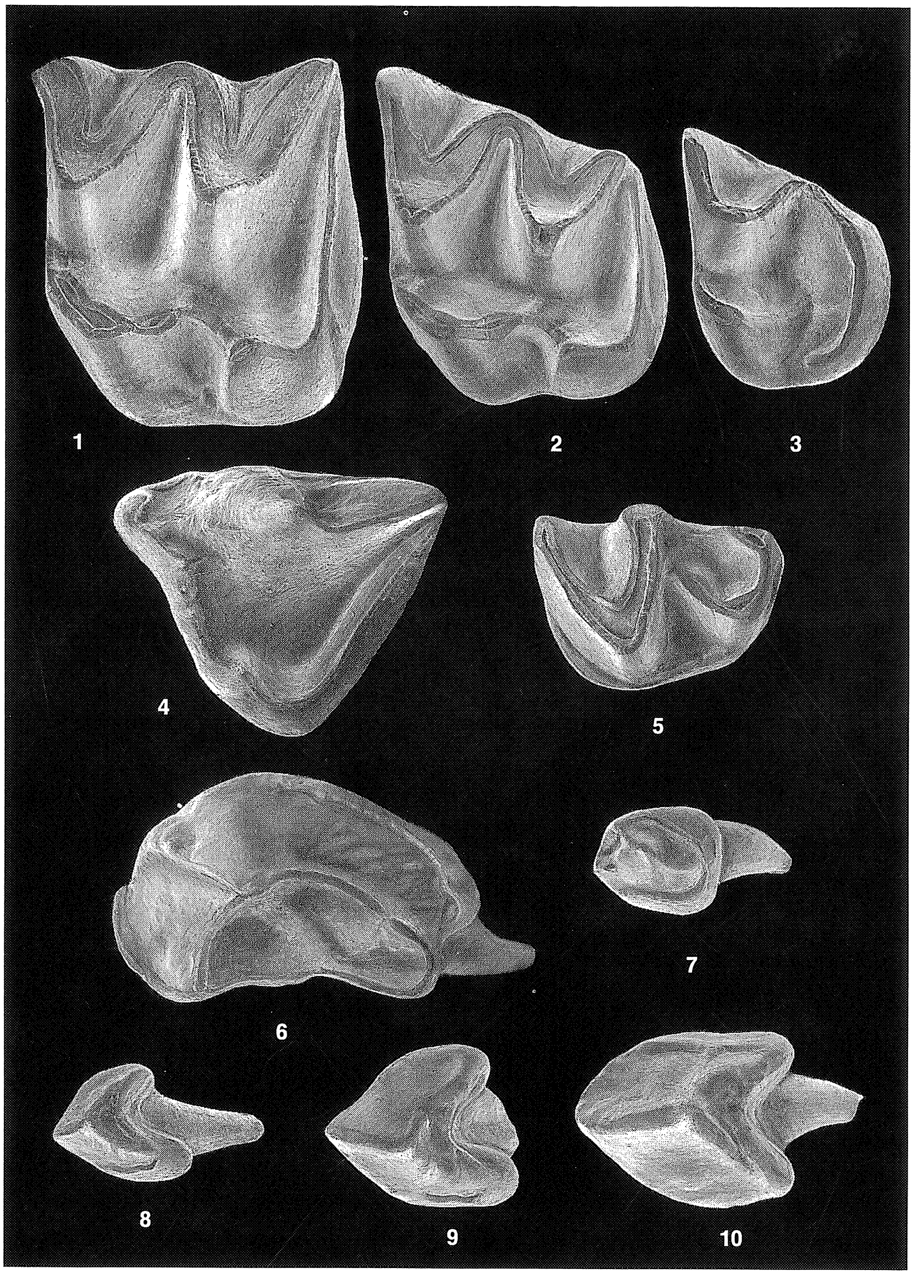

Plate II. *Dinosorex anatolicus* from Keseköy. 1. M1 (Ke 6466); 2. M2 (Ke 6476); 3. M3 (Ke 6485); 4. P4 (Ke 6454); 5. m3 (Ke 6435); 6. A1 (Ke 6861); 7. upper antemolar (Ke 6851); 8. lower antemolar (Ke 6506); 9. idem (Ke 6499); 10. idem (Ke 6495).
All fig. × 20.

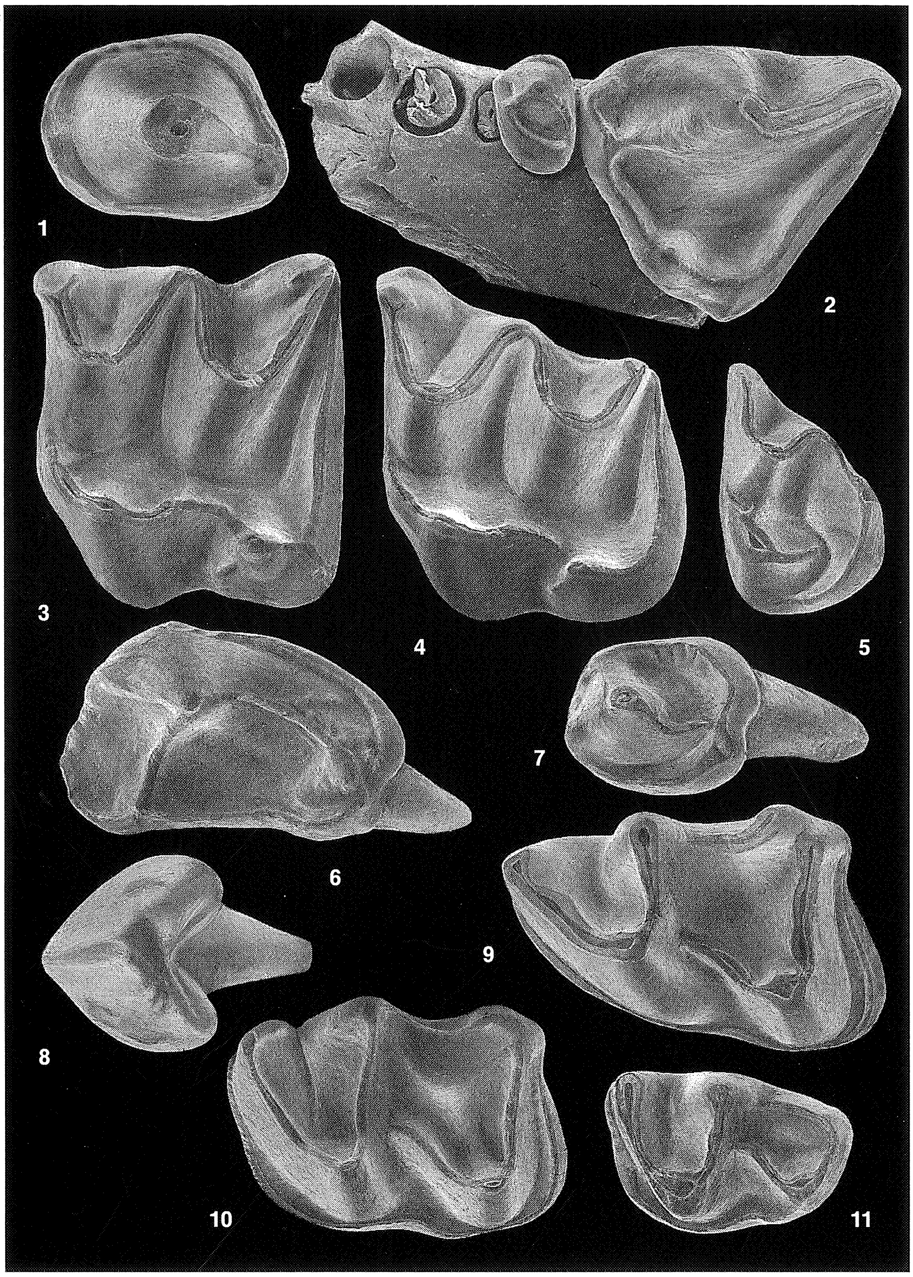

Plate III. *Dinosorex anatolicus* from Harami 1. 1. Upper antemolar (Hal 3539); *2*. mandible with P4 and upper antemolar (Hal 3500); 3. M1 (Hal 3503); 4. M2 (Hal 3512); 5. M3 (Hal 3520); 6. A1 (Hal 3491); 7. Upper antemolar (Hal 3529); 8. lower antemolar (Hal 3524); 9. m1 (Hal 3464); 10. m2 (Hal 3473); 11. m3 (Hal 3482).
All fig. × 20.

The outline of the m1 is sub-rectangular. The talonid is somewhat wider that the trigonid. The protoconid and metaconid are of the same height; the paraconid is lower than these cusps. Hypoconid and entoconid are of the same height. They are somewhat lower than the protoconid. The oblique cristid ends against the middle of the protoconid-metaconid crest. The posterior arm of the hypoconid ends against the back of the entoconid. The entocristid is well developed. The cingulum is continuous along the anterior and labial sides but interrupted at the base of the protoconid. The posterior cingulum is very well developed.

The m2 resembles the m1. The trigonid and talonid are of the same width. The trigonid is somewhat shorter than the talonid. The cingulum is continuous along the anterior, labial and posterior sides. The anterior and posterior cingulums are strongly developed. The labial cingulum is well developed.

Measurements: The measurements are listed in table 1.

Description

i1 (5). The incisor is long and has an upwards curved apex. The upper sur-

Tabel 1a. Measurements of the lower elements of *Dinosorex anatolicus*.

			Length		Width	
Tooth	Loc	N	range	mean	range	mean
i1	Ke	4	6.45–7.50	6.84		
	Ha2	–				
	Ha1	–				
	Ki3A	–				
	Ki0″	–				
	Ki0	–				
m1	Ke	2	2.48–2.50	2.49	1.66–1.80	1.73
	Ha2	–				
	Ha1	3	2.31–2.46	2.37	1.63–1.76	1.68
	Ki3A	–				
	Ki0″	–				
	Ki0	–				
m2	Ke	6	2.00–2.23	2.13	1.34–1.62	1.46
	Ha2	–				
	Ha1	8	2.01–2.36	2.21	1.39–1.61	1.53
	Ki3A	–				
	Ki0″	1		2.12		1.42
	Ki0	–				
m3	Ke	5	1.51–1.69	1.59	0.76–0.93	0.84
	Ha2	–				
	Ha1	8	1.57–1.75	1.64	0.78–0.88	0.84
	Ki3A	–				
	Ki0″	3	1.41–1.57	1.49	0.74–0.81	0.78
	Ki0	–				

Tabel 1b. Measurements of the upper elements of *Dinosorex anatolicus.*

			Length		Width	
Tooth	Loc	N	range	mean	range	mean
I1	Ke	2	4.29–5.00	4.65	2.05–2.21	2.13
	Ha2	–				
	Ha1	1		4.12		1.71
	Ki3A	–				
	Ki0″	–				
	Ki0	–				
P4	Ke	7	2.09–2.46	2.27	1.86–2.10	1.98
	Ha2	–				
	Ha1	2	2.12–2.16	2.14	1.95–2.00	1.98
	Ki3A	–				
	Ki0″	1		2.14		1.85
	Ki0	–				
M1	Ke	4	2.03–2.19	2.11	2.45–2.63	2.53
	Ha2	–				
	Ha1	1		2.08		2.36
	Ki3A	1		1.94		2.34
	Ki0″	–				
	Ki0	1		1.98		2.39
M2	Ke	6	1.77–2.05	1.87	2.20–2.44	2.31
	Ha2	1		1.98		2.41
	Ha1	3	1.82–1.91	1.87	2.21–2.25	2.23
	Ki3A	–				
	Ki0″	1		1.81		2.13
	Ki0	–				
M3	Ke	8	1.07–1.18	1.14	1.53–1.69	1.60
	Ha2	–				
	Ha1	4	1.15–1.18	1.17	1.52–1.70	1.59
	Ki3A	1		1.11		1.53
	Ki0″	–				
	Ki0	–				

face is smooth. The edge to the labial side is abrupt; the edge to the symphysal side is marked by a ridge which is well developed at the back of the tooth and becomes fainter towards the apex. A second ridge, just below the first one, is present on the symphysal side. The enamel-dentine boundary curves forwards up to halfway the length of the incisor. The edge between the symphysal side and the curved labial side is rather sharp. The enamel on the labial side is rather wrinkled. The enamel-dentine boundary lies far backwards on the labial side. It is bordered by an indistinct cingulum, which continues as a short ridge on the upper surface. The root is stout. It shows a very deep groove along the symphysal side.

m1 (2). The outline of the occlusal surface is sub-rectangular. The trigonid is somewhat wider than the talonid. The protoconid and metaconid are of the same height. The paraconid is somewhat lower than these cusps. The talonid basin is rather shallow. Hypoconid and entoconid are of the same height, and somewhat lower than the protoconid. The oblique cristid ends against the middle of the protoconid-metaconid crest. The posterior arm of the hypoconid runs in the direction of the entoconid. Halfway it bends backwards; it ends against the posterior side of the entoconid. There is no groove separating the posterior arm of the hypoconid from the entoconid. The entocristid is well developed. The cingulum is continuous along the anterior and labial sides, but interrupted at the base of the protoconid. The posterior cingulum is very well developed.

m2 (8). The m2 resembles the m1. The trigonid of the m2 is shorter than the talonid. The trigonid and talonid are of the same width. The posterior arm of the hypoconid ends against the entoconid. The anterior and posterior cingulum are strong. The labial cingulum is well developed. It is interrupted at the base of the protoconid in one of the eight specimens.

m3 (5). The m3 is clearly smaller than the m2. The trigonid resembles that of the m2. The talonid is narrow with low cusps. The anterior and labial cingulum are very well developed. The re-entrant valley is wide.

Maxillary. Two pieces of maxillary have been found. One of these carries a P4, the other the P4 and part of the M1. In the latter four alveoli of antemolars are present in front of the P4. The alveolus directly in front of the P4 and the third and fourth (counting from the P4 forwards) are of the same size. The second alveolus is clearly smaller. In the other fragment five alveoli have been preserved. In front of the alveoli as described above a fifth alveolus is present. This alveolus is very large and presumably belongs to the A1.

Tabel 1c. Measurements of the antemolars of *Dinosorex anatolicus*.

			Length		Width	
Type	Loc	N	range	mean	range	mean
A1	Ke	2	1.92–2.21	2.07	1.52–1.76	1.64
	Hal	6	2.09–2.24	2.17	1.61–1.79	1.71
I	Ke	4	1.40–1.48	1.43	0.98–1.09	1.05
	Hal	–				
II	Ke	2	1.24–1.29	1.27	0.84–0.97	0.91
	Hal	1		1.23		0.86
III	Ke	13	0.78–1.09	0.92	0.74–0.98	0.86
	Hal	3	0.89–0.91	0.90	0.94–1.01	0.97
IV	Ke	2	1.20–1.25	1.23	0.87–0.89	0.88
	Hal	6	1.26–1.33	1.28	0.88–1.03	0.96
V	Ke	5	0.83–0.99	0.93	0.65–0.80	0.73
	Hal	5	0.86–0.97	0.92	0.76–0.97	0.80
	Ki0	1		0.86		0.76
VI	Ke	–				
	Hal	1		0.66		0.79

I1 (7). The I1 is large with a moderate hook. The apex is fissident. The talon bears a small cusp. There is a shallow depression with a rather abrupt edge on the labial side of the talon. The enamel in this groove is somewhat wrinkled. The wrinkles may continue over the edge of the groove, but fade rapidly. A cingulum borders the depression. It extends halfway up the labial side. There it curves up and ends against the side of the tooth. The back of the tooth is rounded. There is an abrupt transition towards the symphysal side. The enamel-dentine boundary curves slightly forwards on the symphysal side. There is a deep groove in the root in this curve. The root is very strong.

P4 (8). The outline of the occlusal surface is sub-triangular in three of the eight specimens recovered. In the others it is irregularly quadrangular, with a labial side which is much wider than the lingual side. The paracone is high. It is the main cusp. The posterocrista curves from the tip of the paracone to the postero-labial corner of the premolar. The parastyle is an indistinct cusplet, incorporated in the anterior ridge. This well-developed ridge runs from the labial side of the tooth to the protocone. The parastyle is connected to the paracone by a short ridge. The protocone is low. It lies lingually of the tip of the paracone. A very broad ridge runs from the protocone backwards to the postero-lingual corner. It continues along the posterior side and ends against the posterocrista. These ridges border a deep basin.

M1 (6). The outline of the occlusal surface is sub-square, the tooth being somewhat wider than long. The anterior side is slightly curved. The paracone and metacone are high cusps. The anterior and posterior arms of these cusps form sharp ridges. The mesostyle is undivided. The lingual cusps are well developed. The protocone is distinctly lower than the paracone. The anterior arm of the protocone ends against the base of the paracone. The posterior arm runs in the direction of the metacone. It bends before reaching this cusp and ends against the base of the hypocone. The hypocone is rather isolated. It is a cone-shaped cusp, somewhat lower than the protocone. A well-defined posterior ridge runs from the back of the hypocone and ends low against the end of the posterior arm of the metacone.

M2 (7). The M2 differs from the M1 in the outline of the occlusal surface. It is irregularly quadrangular with an anterior side which is clearly wider than the posterior side of the tooth. This is due to the much shorter posterior arm of the metacone. In all the other features the M2 resembles the M1.

M3 (8). The outline of the M3 is sub-triangular, with a rounded postero-lingual side. The protocone is somewhat lower than the paracone. The anterior arm of the protocone ends against the base of the paracone, its posterior arm ends freely in the trigon basin. The mesostyle is slightly divided. The metacone is incorporated in a posterior ridge which runs from the mesostyle to the base of the protocone.

Antemolars

The antemolars of the Heterosoricidae can easily be distinguished from those of other insectivores. They are relatively low-cusped, have well-developed cingula and the enamel is wrinkled.

The first upper antemolar (A1) can easily be recognized. It is distinctly larger than the other antemolars. Some of the remaining antemolars are of a type that resembles the p4 of Soricidae. Their occlusal surface is heart-shaped, and they have one large root, which is directed obliquely backwards. These antemolars are considered to represent the antemolars of the lower jaw. In the Anatolian assemblages three different size categories can be recognized within these elements, so we assume that at least three lower antemolars are present.

The number of antemolars is considered to be an important character in the taxomomy of Heterosoricidae. Unfortunately, for *D.anatolicus* it is not possible to determine this number with certainty, because we cannot be sure that all antemolars are represented. Furthermore it is quite possible that two elements with different positions in the jaw are so much alike, that no determination can be made between isolated teeth.

A1 (4). The outline of the occlusal surface is sub-rectangular, the anterior side being wider than the posterior side. The enamel of the antemolar is clearly wrinkled.

The main cusp lies in the antero-labial corner of the tooth. Its tip is inclined lingually. There is a small cusplet on the postero-lingual corner of the tooth. The centrocrista runs over the tip of the main cusp and connects to the posterior cusplet. A second ridge runs from the top of the main cusp to the lingual side.

The cingulum is well-defined on the labial, posterior and lingual sides. The anterior cingulum is clearly weaker. There is one thick root, which is directed obliquely backwards.

Type I (4). The tooth is clearly longer than wide. The outline of the occlusal surface is heart-shaped. The enamel-dentine boundary slopes up high at the back of the tooth. The main cusp is pyramid-shaped. A ridge runs from its tip forwards. The cingulum is poorly developed. The tooth is the largest of the lower antemolars. Probably it represents the last of these elements (=p4?). The tooth has one root, which is directed obliquely backwards.

Type II (2). The tooth is longer than wide. It is shorter than the type I antemolar. The occlusal surface is heart-shaped. A faint ridge runs from the tip of the only cusp forward. The cingulum is poorly developed. The tooth has one root, which is directed obliquely backwards.

Type III (13). The tooth is as long as it is wide. The outline of the occlusal surface is heart-shaped. The enamel-dentine boundary slopes up high at the back of the tooth. The main cusp is very low and pyramid-shaped. The tooth is surrounded by a well-developed cingulum which is interrupted on the anterior side. The tooth has one root, which is directed obliquely backwards.

The size variation in this group is large. Possibly two different antemolars are represented. This is also suggested by the relatively large number of type III antemolars in the collection.

Type IV (2). The outline of the occlusal surface is elliptical, the tooth being only somewhat longer than wide. The main cusp is relatively high and cone-shaped. A clear posterocrista is present. The tooth is surrounded by a well-developed cingulum. The antemolar is two-rooted.

Type V (5). The outline of the occlusal surface is sub-rectangular to sub-elliptical. A low cusp lies in front of the middle of the tooth. The antemolar is surrounded by a well-developed cingulum. The tooth has one root, which is directed obliquely backwards.

Localities Harami 1, Harami 2, Kilçak 3A, Kilçak 0 and Kilçak 0″.

The material from these localities is very similar to that of Keseköy. Therefore it is not described in detail. The distribution of some characters in the various assemblages is given below. From Harami 1 a type of upper antemolar is described, which was not found in the Keseköy collection.

Harami 1

One mandibular fragment has been found in Harami 1. It carries the m3 and the alveoli of the m1 and m2. There is a very large foramen mentale lying under the posterior alveolus of the m1 on the upper half of the ramus horizontalis.

m3 (8), I1 (1), M1 (4), M2 (6), M3 (4). The morphology of these elements falls completely within the range of variation of the Keseköy assemblage.

m1 (7). Contrary to the m1 of Keseköy, the labial cingulum of this element is not interrupted at the base of the protoconid.

m2 (8) The labial cingulum is continuous in all eight specimens.

P4 (4). The outline of the occlusal surface is irregularly quadrangular in three of the four specimens. Unfortunately, the lingual side of the fourth specimen is damaged.

Antemolars

A1 (6), Type II (1), Type III (3), Type IV (5), Type V (6). These elements are similar to the various antemolars of Keseköy.

Type VI (1). (Plate III, fig. 2). The only available specimen is preserved in a maxillary. It lies directly in front of the P4. There are three alveoli in front of these elements. The maxillary is broken in front of these alveoli.

The antemolar is one-rooted. The outline of the occlusal surface is trapezoidal, the longest side lying against the P4. The low, blunt cusp lies somewhat labially of the middle of the tooth. There is a large flattening on the lingual side of this cusp, and a somewhat smaller flattening on the labial side.

Harami 2

M2 (1). The M2 from Harami 2 falls within the range of variation of the M2 from Keseköy.

Kilçak 3A

M1 (1), M3 (1). There are no major differences with respect to the material from Keseköy.

Kilçak 0

M1 (1), antemolar type V (1). These elements fall within the range of variation of the Keseköy material.

Kilçak 0″

m2 (1). The labial cingulum is not interrupted at the base of the protoconid.

m3 (3). The m3 from Kilçak 0″ falls within the range of variation of the type locality.

P4 (1). The outline of the occlusal surface of the P4 is irregularly quadrangular.

DISCUSSION

The classification of the Heterosoricidae is mainly based on characters of the mandible (Engesser, 1975). Unfortunately, we have only fragments of the jaw, so we have to rely on the morphology of the molars. The assignment of the Anatolian species to *Dinosorex* is based on the well-developed lingual cusps of the M1 and M2 and on the morphology of the M3. As in other species of *Dinosorex* the posterior arm of the protocone of the M3 ends freely in the trigon basin. In *Heterosorex* this arm continues along the posterior side of the M3 (Engesser, 1975).

All representatives of the Anatolian Lower Miocene Heterosoricidae are assigned to *Dinosorex anatolicus*. There are no significant morphological differences between the elements from the oldest (MN 1) and the youngest (MN 3) assemblages. From this we conclude that no clear evolutionary trend was present in the Early Miocene.

The absence of *D.anatolicus* in Kilçak 3B is possibly a result of the sample size. Relatively few insectivores were found in this assemblage. The absence of Heterosoricidae in the assemblage of Harami 3 is probably environmentally controlled. Differences in environment between Harami 1 and Harami 3 are also indicated by the rodent-assemblages of the localities. According to De Bruijn (1992) the absence of the muroid genus *Mirabella* in Harami 3 indicates a different habitat for Harami 3 than for Harami 1. The high relative numbers of *Democricetodon* in the Harami 3 assemblage also suggest a difference in environment (de Bruijn, pers. comm.).

D.anatolicus is regarded as one of the more primitive representatives of *Dinosorex*, because the foramen mentale is positioned under the talonid of the m1, which is even further forwards than in the Oligocene representatives of the genus. Furthermore, *D.anatolicus* has a well-developed entocristid on the m1 and m2, which is also a primitive character according to Engesser (1975).

According to Engesser one of the differences in dental morphology between *Heterosorex* and *Dinosorex* is the shape of the P4. In *Heterosorex* the outline of the P4 is sub-triangular, in *Dinosorex* it is sub-square. This observation is based on the P4 of the Middle Miocene representatives of *Dinosorex*. The P4 of the Oligocene species of *Dinosorex* is not known. However, the P4 of *D.anatolicus*

Table 2. m1/m2 ratios of *Dinosorex* species from Europe and Anatolia.

Dinosorex pachgnathus (Anwil)	1.22
Dinosorex sansansiensis (Sansan)	1.25
Dinosorex sp. (Sariçay)	1.35
Dinosorex zapfei (Neudorf)	1.33
Dinosorex aff. *zapfei* (Petersbuch 2)	1.25
Dinosorex anatolicus (Keseköy)	1.17
Dinosorex anatolicus (Harami 1)	1.13
Dinosorex huerzeleri (Rickenbach)	1.09
Dinosorex sp. (Boudry Trois Rods)	1.18

has an outline that is trapezoid or even sub-triangular rather than sub-square. Therefore the difference in shape of the P4 does not seem to furnish a diagnostic character for the older species of *Dinosorex*.

In view of the number of premolars, *D.anatolicus* is intermediate between the Oligocene and the Middle Miocene species of *Dinosorex*. *D.anatolicus* has at least three antemolars in the lower jaw. *D.huerzeleri* has five, *D.zapfei* and *D.sansaniensis* have three or four and *D.pachygnathus* has two or three lower antemolars. The m1/m2 ratio of the Anatolian species is low (see table 2).

In size and morphology the specimens of *D.anatolicus* are intermediate between those of the Oligocene and the Middle Miocene species of *Dinosorex*. The evolutionary stage is therefore in line with the evolutionary changes we see between the Oligocene and Middle Miocene species of *Dinosorex* in Central Europe. It is, however, rather surprising to find these intermediates in Anatolia and not in Europe. The genus appears even to be completely absent in Europe during most of the Early Miocene. The genus *Heterosorex*, in contrast, seems to be restricted to Europe. *H.ruemkae* from the Greek locality Aliveri (MN 4, Doukas, 1986) represents the easternmost occurrence of *Heterosorex* known thus far.

The distribution of the Heterosoricidae suggests some kind of barrier between Aliveri and Anatolian localities during the Early Miocene, which prevented faunal exchange. The existence of such a barrier is corroborated by the distribution of the Eomyidae and the Ctenodactylidae. The Eomyidae are present in Aliveri, but absent in the pre-Vallesian assemblages of Anatolia. Ctenodactylidae do occur in the Lower Miocene deposits of Anatolia, but are not present in European assemblages of comparable age.

Dinosorex re-appears in Europe in MN 4 (*D.* aff. *zapfei*, Petersbuch 2, Ziegler, 1989), probably as a result of migration, which seems to be coeval with the migration into Central Europe of the shrews *Lartetium peterbuchense* and *Miosorex* cf. *desnoyersianus* (Ziegler, 1989), the erinaceid *Galerix symeonidisi* (Ziegler, 1990a) and the hamster genera *Democricetodon* and *Megacricetodon*.

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