

# Middle Miocene rodents from Paşalar, Anatolia, Turkey

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Peláez-Campomanes, P. and Daams, R. 2002. Middle Miocene rodents from Paşalar, Anatolia, Turkey. *Acta Palaeontologica Polonica* 47 (1): 125–132.

Despite the importance of the Paşalar fauna for the evolution and biogeography of Miocene mammals, few studies on its rodents have been published. In this paper a taxonomic analysis of the Paşalar rodents and the possible correlation that can be based on them are presented. Several rodent taxa, previously unknown from Paşalar are described. These include the cricetids *Megacricetodon andrewsi* sp. nov. and *Democricetodon brevis* (Schaub, 1925), the sciurids *Spermophilinus bredai* (Meyer, 1848) and Sciurinae indet., and the glirid *Peridyromys lavocati* sp. nov. The taxa previously described from Paşalar are: the ctenodactylid *Sayimys* cf. *intermedius* (Sen and Thomas, 1979), the cricetid *Cricetodon pasalarensis* (Tobien, 1978), the spalacid *Pliospalax marmarensis* Ünay, 1990 and the castorid cf. *Chalicomys jaegeri* Kaup, 1832. These determinations represent a reduction of the number of taxa recorded from the locality, as previous papers listed up to five sciurids. Only two sciurids and two glirids are recognized in this study. Mainly on the basis of the new cricetid records, it is possible to correlate the Paşalar fauna to late MN6.

**Key words:** Rodentia, *Democricetodon*, *Megacricetodon*, *Spermophilinus*, *Peridyromys*, biochronology, Miocene, Anatolia.

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## Introduction

Details on the site and fauna of Paşalar were reported in the monograph by Andrews and Jungers (1990), and are not repeated herein. Hitherto, the rodents were studied only in part. Ünay (1990a, b) described *Cricetodon pasalarensis* (Cricetidae) and *Pliospalax marmarensis* (Spalacidae) respectively, and Flynn and Jacobs (1990) gave a preliminary analysis of the small mammal fauna. Most of the faunal correlations among Neogene localities in the Old World are based primarily on comparison of their rodent assemblages. The study of the rodent assemblage from Paşalar is therefore important to provide a precise biochronological position for the fauna.

Dental nomenclature for Sciuridae is after Cuenca Bescós (1988), for Cricetidae follows Daams and Freudenthal (1988), and for Gliridae follows Daams (1981). Measurements of the teeth are in millimeters.

The specimens described here are stored in the collections of the University of Ankara, Faculty of Language, History and Geology, Department of Paleoanthropology, abbreviated as UA. The PSL abbreviation denotes the collection from Paşalar. Upper cheek teeth are denoted with capital letters, lower teeth

with lower case letters: P/p, premolar; M/m molar. In case of deciduous teeth we use D/d as prefixes. In Tables: N, denotes number of specimens; s.d., standard deviation.

## Systematics

### Cricetidae Rochebrune, 1883

#### *Democricetodon brevis* (Schaub, 1925)

Fig. 1A–J, Table 1.

Table 1. Length and width of the cheek teeth of *Democricetodon brevis* (Schaub, 1925) from Paşalar.

	N	Length				Width				
		min	mean	max	s.d.	N	min	mean	max	s.d.
M1	5	1.75	1.84	1.98	0.090	7	1.06	1.19	1.31	0.081
M2	7	1.29	1.37	1.47	0.060	5	1.20	1.24	1.31	0.044
M3	9	0.96	1.05	1.12	0.059	9	0.93	1.08	1.17	0.077
m1	3	1.53	1.61	1.70		3	1.13	1.15	1.17	
m2	9	1.31	1.40	1.50	0.063	8	1.07	1.14	1.23	0.062
m3	4	1.26	1.32	1.41		5	0.98	1.06	1.13	0.057

**Description.**—M1: The anterocone is simple and kidney-shaped. The lingual and labial cingula of the anterocone descend to join the base of the protocone and paracone, respectively. A labial spur branches off the anterolophule in six out

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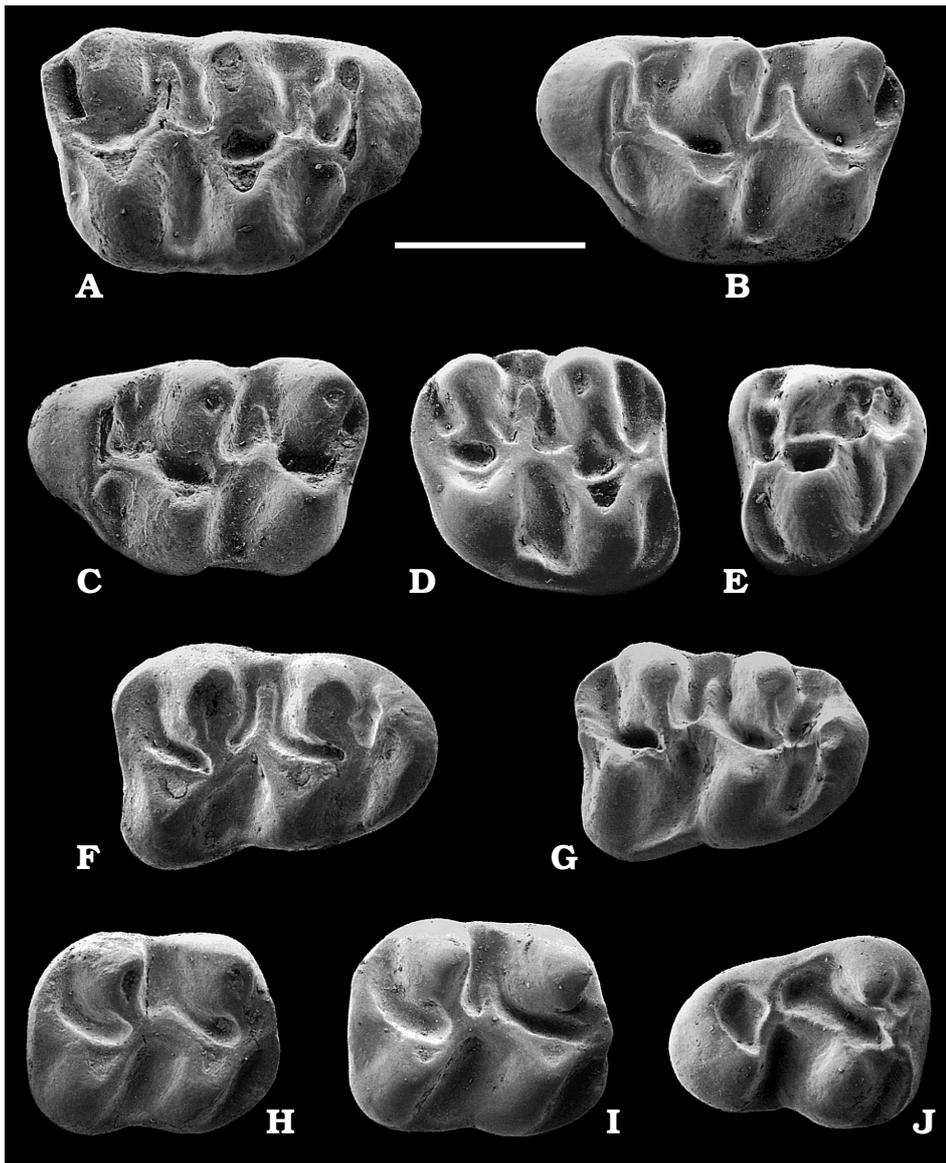


Fig. 1. **A–J.** *Democricetodon brevis* (Schaub, 1925). **A.** Right M1, AU PSL155. **B.** Left M1, AU PSL151. **C.** Left M1, AU PSL152. **D.** Right M2, AU PSL162. **E.** Left M3, AU PSL170. **F.** Right m1, AU PSL177. **G.** Right m1, AU PSL176. **H.** Right m2, AU PSL185. **I.** Right m2, AU PSL186. **J.** Right m3, AU PSL190. Scale bar 1.0 mm. Anterior is to the right in the right teeth and to the left in the left ones. All SEM micrographs.

of eight specimens. In three specimens this spur is transverse and relatively long, but does not reach the labial border. In the other three specimens the spur is short, and in one of these specimens it is oblique and apparently constitutes the anterior arm of the double protolophule. The posterior protolophule points obliquely backwards. In all eight specimens the mesoloph is relatively long, but it ends just before reaching the labial tooth border. The metalophule is absent in two cases, and it points obliquely backward in the other six. The posterosinus is narrow and labially closed.

**M2:** The lingual anteroloph descends from the middle of the anterior border to the anterior base of the protocone. The labial anteroloph encloses the anterosinus. In two specimens the paracone has an ectoloph spur which descends towards the base of the metacone without reaching it. The protolophule is symmetrically double in five specimens, and in the remaining three the anterior arm is better developed. The mesoloph is of medium length in all eight cases. The metalophule points

obliquely forward in seven specimens and it is absent in one. The posteroloph encloses the wide posterosinus.

**M3:** The lingual anteroloph descends from the middle of the anterior tooth border to the anterior base of the protocone. The labial anteroloph encloses the anterosinus. The protocone and paracone are distinct cusps, and the posterior part of the tooth forms a reticulate ridge pattern of moderate complexity.

**m1:** The anteroconid is a simple and kidney-shaped cusp. Cingular ridges descend from the cusp top towards the lingual and labial border respectively, but without enclosing the anterosinusid. The metalophulid and hypolophulid point obliquely forward. The mesolophid is relatively long, but it ends just before reaching the lingual tooth border. The posterosinusid is lingually open in two specimens; closed by the posterolophid in a third.

**m2:** The well-developed labial anterolophid reaches the base of the protoconid. The lingual anterolophid is absent in six and short in three cases. However, these short ridges dis-

appear with progressive wear. The metalophulid and hypolophulid point obliquely forward. Of ten m2s, the mesolophid is long in four, of medium length in four, short in one, and absent in one. The posterolophid reaches the base of the entoconid in all specimens.

m3: A low labial anterolophid is present. The lingual anterolophid is either short or absent and disappears with little wear. A mesolophid is present in two of four specimens.

*Comments.*—*Democricetodon brevis* from Paşalar is of similar size to the type material of *D. brevis* from La Grive (Freudenthal 1963) and the scarce material from Marktl (Fahlbusch 1964), while it is somewhat larger than *D. brevis* from MN7/8 of Giggenhausen (Fahlbusch 1964), Anwil, Ergeten 990m, and Grat 930m (Bolliger 1992). The specimens of *Democricetodon brevis* from these assemblages have a remarkably similar dental pattern, which is evident from the comparable length of the mesoloph(id)s, the labial spur of the anterolophule, the double protolophule of M2, and the length of the lingual anterolophid of m2. The only difference is the connection of the metalophule of M2. This ridge connection is anterior to the hypocone in specimens from Paşalar and Grat 930m (although less frequent in the latter, see Bolliger 1992) and posterior in *D. brevis* from Giggenhausen, Anwil, and Marktl. One of a number of general evolutionary trends in *Democricetodon* lineages is the displacement of the metalophule from an anterior to a posterior position. This would imply that the Paşalar *Democricetodon* population is somewhat more primitive than the one from Giggenhausen and Anwil, and probably also slightly more primitive than the one from Grat 930m.

*Megacricetodon andrewsi* sp. nov.

Fig. 2A–J, Table 2.

Holotype: right M1, UA PSL 217, Fig. 2A.

Etymology: *andrewsi*—in honour of Peter Andrews (Natural History Museum, London).

Type locality: Paşalar, Turkey.

Table 2. Length and width of the cheek teeth of *Megacricetodon andrewsi* sp. nov. from Paşalar.

	N	Length				Width				
		min	mean	max	s.d.	N	min	mean	max	s.d.
M1	29	1.45	1.56	1.66	0.060	33	0.91	0.99	1.08	0.040
M2	34	1.02	1.13	1.22	0.044	36	0.86	0.95	1.04	0.047
M3	15	0.72	0.81	0.93	0.055	14	0.75	0.81	0.86	0.036
m1	31	1.34	1.42	1.52	0.040	38	0.77	0.91	0.99	0.048
m2	35	1.08	1.16	1.24	0.043	34	0.84	0.93	1.01	0.042
m3	22	0.90	1.00	1.05	0.045	23	0.71	0.80	0.91	0.054

*Diagnosis.*—A *Megacricetodon* species of medium size with incompletely bilobed anterocone of M1, medium-sized to long mesolophs in M1–2 and short mesolophids in m1–2. The upper molars of *M. andrewsi* sp. nov. from Paşalar are slightly smaller than those of *M. similis* Fahlbusch, 1964 from the Upper Aragonian of Giggenhausen (south Germany), but the lower molars are of the same size and morphology. More outstanding differences between these two assemblages are: M1 of *M. andrewsi* sp. nov. never has a labial spur of the antero-

lophule, whereas this feature is frequent in *M. similis* from Giggenhausen, and the presence of a well-developed posterior spur of the paracone is rare in M1–2 of *M. andrewsi* sp. nov., while it is present in most of the specimens from Giggenhausen. *Megacricetodon andrewsi* sp. nov. differs from *M. rafaeli* Daams and Freudenthal, 1988 from the Spanish MN6 sites Armantes 7, Valalto 2B and Valalto 2C by its significantly larger size and its shorter mesolophids in m1–2.

*Description.*—M1: The anterocone is asymmetrically split into a larger labial and a smaller lingual cusp. The furrow that separates these cusps is shallow and does not reach the anterior tooth border in most of the specimens. A cingulum descends from the labial anterocone cusp to the base of the paracone to enclose a labial anterosinus. Another cingulum descends from the lingual anterocone cusp towards the base of the protocone, but does not reach it. In three out of 34 specimens the protolophule is double, although the anterior arm is incomplete. The paracone may have a small, posterior spur but disappears after slight wear. The mesoloph is short in three specimens, of medium length in 20 and long in 10 specimens. The metalophule joins the posteroloph just behind the hypocone. The posterosinus is enclosed by the posteroloph.

M2: A thin lingual anteroloph descends to the base of the protocone. The labial anteroloph joins the base of the paracone, thus enclosing the anterosinus. The protolophule is simple and anterior in nine specimens, simple and more or less transverse in 23 specimens, simple and posterior in one, double with the anterior arm better developed than the posterior one in two, and symmetrically double in two. The mesoloph is short in three specimens, of medium length in 11, and long in 21. In 10 of 36 specimens the paracone has a thin posterior spur that joins the labial end of the mesoloph. The simple metalophule is either anterior or transverse. The posterosinus is wide and enclosed by a posteroloph.

M3: A faint lingual anteroloph is visible in only three of 15 specimens. From the high paracone, the protolophule descends to join the anterior wall of M3. The protocone and hypocone fuse, thus closing the sinus. The irregular posterior part of M3 generally has a more-or-less transverse ridge, but this ridge may bifurcate. A continuous cingulum surrounds the posterior part of M3.

m1: The anteroconid is a simple, rounded cusp in 25 specimens and is slightly constricted antero-posteriorly in seven. The labial anterosinusid may or may not be bordered by a cingulum. The lingual anterosinusid is generally open. The short anterolophulid is longitudinal and reaches the labial cusp of the anteroconid when the latter structure is double. A labial spur of the anterolophulid is present in nine of 33 specimens. The metalophulid and hypolophulid point slightly forward. The mesolophid is absent in 20, short in 17, and of medium length in three specimens. The posterolophid joins the base of the entoconid, thus closing the posterosinusid.

m2. The labial anterolophid is well developed and joins the base of the protoconid. Understanding the morphology of the lingual anterolophid depends on wear, so extremely worn

specimens are not included in the following count. This ridge is absent in 13 cases, short in 14, and of medium length in five. The metalophulid and hypolophulid point slightly obliquely forward. The mesolophid is absent in 20 specimens, short in 12, and of medium length in three. The posterolophid joins the base of the entoconid, thus closing the posterosinusid.

m3: The labial anterolophid descends to join the base of the protoconid. The lingual anterolophid is absent in eight specimens and short in 14. The metalophulid points obliquely forward. The low entoconid is obliquely connected with the protoconid.

*Comments.*—The genus *Megacricetodon* contains a large number of species, which can be divided into three size groups:

(1) A small-sized group that includes *M. minor* (Lartet, 1851), *M. debruijni* Freudenthal, 1968, *M. pusillus* Qiu, 1996, *M. sinensis* Qiu et al., 1981, *M. primitivus* (Freudenthal, 1963), and *M. collongensis* (Mein, 1958). Most of these species share the presence of a deeply bilobed anterocone of M1 and generally long mesolophids on M1 and M2. More modern representatives demonstrate an anterocone that is not completely split, such as *M. debruijni* from the Spanish Vallesian (Daams and Freudenthal 1988).

(2) A medium-sized group with *M. similis* Fahlbusch, 1964, *M. rafaeli* Daams and Freudenthal, 1988, *M. daamsi* Lindsay, 1988, *M. aguilari* Lindsay, 1988, *M. sivalensis* Lindsay, 1988 and *M. lopezae* García Moreno, 1986.

(3) A large-sized group which includes *M. gersii* Aguilar, 1980, *M. crusafonti* (Freudenthal, 1963), *M. ibericus* (Schaub, 1944), *M. gregarius* (Schaub, 1925), *M. bavaricus* Fahlbusch, 1964, *M. germanicus* Aguilar, 1980, *M. fournasi* Aguilar, 1995, *M. lemartini* Aguilar, 1995, *M. roussillonensis* Aguilar et al., 1986, *M. lappi* (Mein, 1958) and *M. mythikos* Lindsay, 1988. The anterocone of M1 is clearly bilobed and anteroconid of m1 tend to be bilobed. The size of the *Megacricetodon* material from Paşalar corresponds to that of the medium-sized group, and consequently we will compare it only with these species.

The Asiatic species described by Lindsay (1988) from Sivalik have lower crowned teeth than *M. andrewsi*. The size of the latter species is similar to *M. daamsi* and slightly smaller than *M. aguilari* and *M. sivalensis*. Nevertheless, these measurement differences must be considered tentative, as the measurements published by Lindsay (1988) included a mixture of samples from different stratigraphic levels covering an extensive time period. Morphologically, *M. andrewsi* differs from *M. aguilari* by its more lophodont upper molars and the connection of the anterolophule to the lingual cusp of the anterocone. The anterolophule connects to the labial cusp of the anterocone in *M. aguilari*. *Megacricetodon sivalensis* has a set of characters that differentiates it clearly from *M. andrewsi*, such as the reduced posteroloph in the upper molars, the presence of a styler self in front of the anterocone in 50% of the M1s, and the anteroconid of m1 located in a more lingual position than in the Turkish material. *M. daamsi* has a narrower anterocone on M1 that is additionally located more

buccally than in *M. andrewsi*. In general, the molars of *M. daamsi* are more bunodont with shorter connections between main cusps than in *M. andrewsi*.

*Megacricetodon lopezae*, from the Spanish locality of Simancas 2 (Álvarez-Sierra and García Moreno 1986), differs from *M. andrewsi* by the higher frequency of bilobed anterocones and anteroconids in M1 and m1, and the presence of a styler self in front of the anterocone.

Among the species included in the medium-sized *Megacricetodon* group, only *M. similis* and *M. rafaeli* show close similarities with the Turkish material, especially the slightly bilobed anterocone, the presence of long posterolophids, and the shape and position of the anteroconid. This general pattern, similar in the three species, suggests that *M. andrewsi* should be included in the *M. rafaeli*–*M. similis* group defined by Daams and Freudenthal (1988). The size of *M. andrewsi* is intermediate between *M. rafaeli* and *M. similis*. Morphologically, *M. andrewsi* shows features that could be considered as intermediate between these two species, such as the progressive increase in bilobed anteroconids on m1 (< 5% in *M. rafaeli*, 20% in *M. andrewsi*, and > 25% in *M. similis*).

## Gliridae Thomas, 1897

### *Peridyromys lavocati* sp. nov.

Fig. 2K, Table 3.

Holotype: Left M1 or M2 UA PSL394, Fig. 2K.

Derivation of the name: In honour of Prof. Dr. René Lavocat, Montpellier.

Type locality: Paşalar, Turkey.

Table 3. Length and width of the cheek teeth of *Peridyromys lavocati* sp. nov. from Paşalar.

	N	Length				Width				
		min	mean	max	s.d.	N	min	mean	max	s.d.
P4	8	0.67	0.75	0.83	0.053	8	0.85	0.91	1.02	0.052
M1–2	10	0.93	1.02	1.06	0.041	12	1.11	1.21	1.29	0.052
M3	5	0.78	0.86	0.97	0.069	5	0.97	1.09	1.20	0.085
p4	3	0.74	0.79	0.82		2	0.78	0.79	0.79	
m1	13	1.01	1.08	1.14	0.050	13	0.95	1.04	1.13	0.056
m2	10	1.03	1.11	1.16	0.041	11	0.99	1.10	1.17	0.054
m3	9	0.88	0.97	1.05	0.051	8	0.89	0.97	1.04	0.051

*Diagnosis.*—A *Peridyromys* species of relatively small size with two-rooted lower molars, a posterior extra ridge in m1 and m2 and two centrolophids in M1 and M2. *Peridyromys lavocati* differs from *P. murinus* (Pomel, 1853) from the Lower Miocene of Western Europe by its larger size and more complicated dental pattern. It differs from *P. aquatilis* (Bruijn and Moltzer, 1974) from the Lower Miocene of Spain by its larger size and more simple dental morphology. *Peridyromys lavocati* differs from *P. columbarii* Daams, 1989 from the Upper Oligocene of Spain, from *P. turbatus* Daams and Visser, de, 1990 (in Álvarez et al., 1990) from the Lower Miocene of Spain, and from *P. jaegeri* Aguilar, 1974 from the Lower Miocene of France by its less complicated dental pattern. From *Myomimus dehmi* (Bruijn, de, 1966) from the Lower Vallesian of Spain it differs by having two roots in the lower molars in-

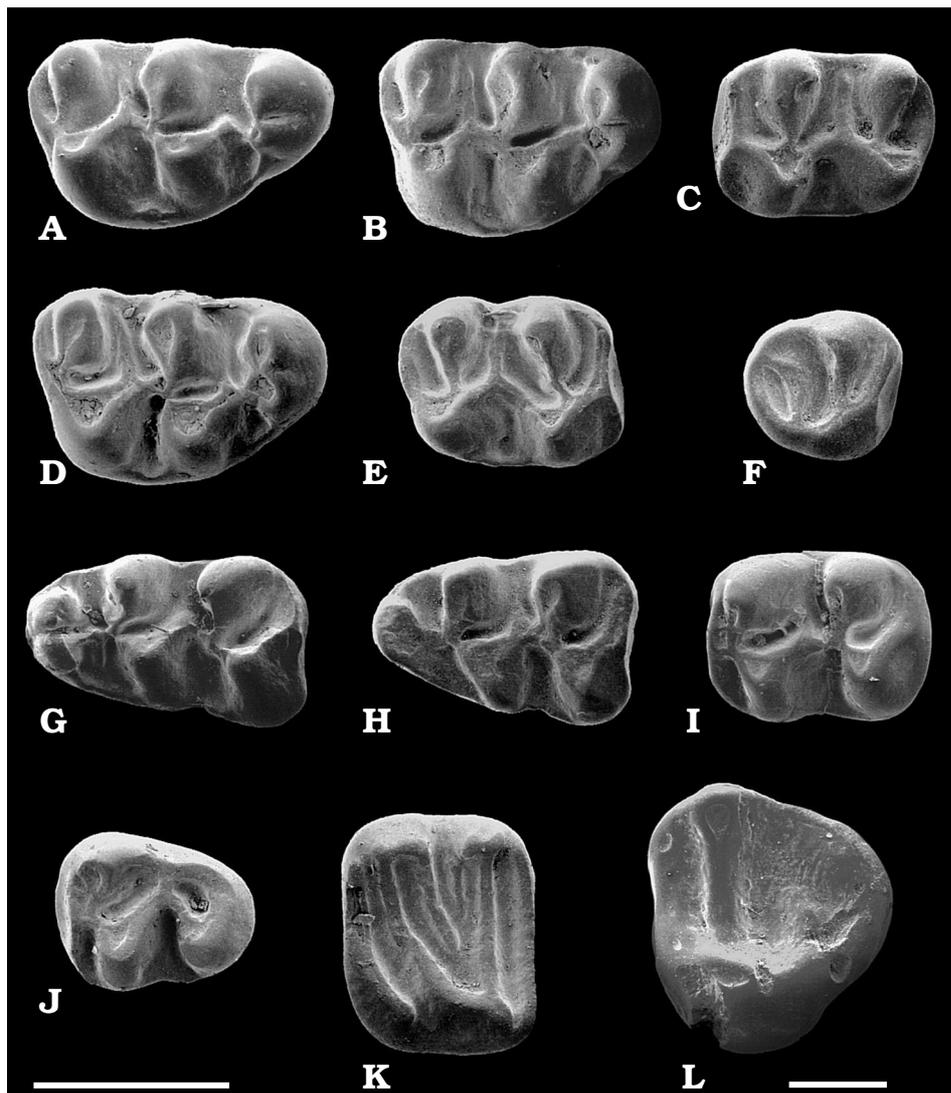


Fig. 2. A–J. *Megacricetodon andrewsi* sp. nov. A. Right M1, AU PSL217. B. Right M1, AU PSL219. C. Left M2, AU PSL226. D. Right M1, AU PSL223. E. Right M2, AU PSL246. F. Right M3, AU PSL276. G. Left m1, AU PSL293. H. Left m1, AU PSL285. I. Left m2, AU PSL330. J. Left m3, AU PSL367. K. *Peridyromys lavocati* sp. nov., Left M1, AU PSL394. L. Sciuridae indet. Left M3, AU PSL45. Scale bars 1.0 mm. Note that illustration L has another scale. Anterior is to the right in the right teeth and to the left in the left ones. All SEM micrographs.

stead of three, slightly larger size, and slightly lower number of lophs in M1 and M2.

*Description.*—P4: The anteroloph varies from short to long, and is an isolated ridge. The protoloph and metaloph join at the lingual tooth border in most specimens, although in one case these two ridges form a Y-shaped composite structure. The centroloph tends to be the posterior one and may be either connected to the metacone or isolated from this cusp. The posteroloph joins the protocone lingually.

M1 and M2: The anteroloph is an isolated ridge, although the furrow between the labial end and the paracone may be shallow and narrow. The trigon is asymmetrical since the protoloph and metaloph join the protocone near the posterolingual corner of the tooth. Most specimens have two centrolophs; the anterior one is the longest in eight specimens, the posterior one is longer in one, and in three cases these ridges meet in the centre of the tooth, thus forming a Y-shaped, composite ridge. In two of 14 specimens the posterior centroloph is lacking. One specimen has an extra ridge between the protoloph and the anterior centroloph.

M3: The tooth has a subtrapezoidal outline. The anteroloph is either connected to or separated from the protocone. Two centrolophs are present, of which the posterior one is the longest in four specimens, and the anterior one is the longest in one case. One specimen has an accessory ridge between the posterior centroloph and the metaloph. The posteroloph joins the metacone.

p4: The p4 is a subtriangular tooth, of which the anterior part consists of a short anterolophid connected to a longitudinal metalophid, thus forming a tilted T-shaped ridge. The posterior part is a U-shaped structure, formed by mesolophid and posterolophid.

m1 and m2: The anterolophid is either isolated from, or connected to, the protoconid. The metalophid does not meet the metaconid. The centrolophid is longer than half of the tooth width, but it never reaches the labial border. The mesolophid and posterolophid join each other at the entoconid. A well-developed extra ridge is present in the posterior valley. Two roots are present.

m3: Basically this tooth has the same dental pattern and number of roots as m1 and m2, but the centrolophids are shorter and the posterior extra ridge is lacking in four out of nine specimens.

*Comments.*—The dental pattern of *P. lavocati* corresponds to the general pattern of various dormouse species such as *Miodymys biradiculus* Mayr, 1979, *Myomimus dehmi* Bruijn, 1966, and *Peridyromys murinus* (Pomel, 1853). The differences are not great and our species is closest to species in the genus *Peridyromys*. *P. lavocati* differs from *M. biradiculus* from MN3/MN4 of south Germany by its somewhat smaller size, and by some M1s and M2s with fused centrolophs. In *Miodymys* centrolophs never fuse in M1 and M2 (Mayr, 1979). Our new species differs from *Myomimus dehmi* from MN9 of Pedregueras 2C (Spain) by its slightly larger size, and the somewhat more complex lower molars. Moreover, all *Myomimus*-species have two-rooted lower molars. *P. lavocati* differs from *P. murinus* from the Upper Oligocene of St. Victor (France) by its larger size and its less complex dental pattern.

### Dryomyinae indet.

*Material and measurements.*—One m2 (1.15 × 1.10) and one m3.

*Comments.*—The m2 attributed to cf. *Microdyromys koenigswaldi* by Flynn and Jacobs (1990) may belong to an undefined Dryomyinae. The d4 designated as Gliridae indet. by Flynn and Jacobs (1990: fig. 1E) is an m3 and probably also belongs to the same dryomyinine.

### Sciuridae Gray, 1821

#### Sciurinae indet.

Fig. 2L.

*Material.*—One left M3 (2.41 × 2.68)

*Description.*—M3: The outline of the robust tooth is sub-circular. The posterior part of the tooth is not expanded. The anteroloph and protoloph are well developed. A small “metaconule” is distinguishable in the flat posterior basin.

*Comments.*—The M3 assigned here to Sciurinae indet. shows a reduced posterior lobe and a metaconule that differentiate it from *Spermophilinus* and *Palaeosciurus*. The robustness and size of this specimen is comparable to those of xerine sciurids such as *Atlantoxerus*. However, no further identification can be made since the M3 is not diagnostic.

### *Spermophilinus bredai* (Meyer, 1848)

Table 4.

*Comments.*—According to Flynn and Jacobs (1990) the following five sciurid taxa are present in Paşalar: *Spermophilinus bredai*, high-crowned Tamiini, lophodont sciurine, *Palaeosciurus* sp., and cf. *Tamias* sp. (= cf. *Eutamias* sp. in fig. 2 of Flynn and Jacobs 1990). On the basis of the same material we could distinguish only two taxa: *Spermophilinus bredai* and Sciurinae indet.

Table 4. Length and width of the cheek teeth of *Spermophilinus bredai* (Meyer, 1848) from Paşalar.

	N	Length				Width				
		min	mean	max	s.d.	N	min	mean	max	s.d.
D4	5	1.45	1.56	1.64	0.072	5	1.40	1.55	1.64	0.095
P4	7	1.48	1.60	1.67	0.067	9	1.92	1.99	2.16	0.078
M1–2	24	1.60	1.78	2.03	0.099	21	2.01	2.23	2.44	0.119
M3	7	2.07	2.20	2.37	0.112	8	1.87	2.08	2.26	0.142
d4	4	1.33	1.43	1.54	0.086	4	1.15	1.29	1.39	0.101
p4	10	1.58	1.64	1.73	0.058	10	1.40	1.55	1.67	0.102
m1	15	1.68	1.80	1.95	0.076	14	1.74	1.87	1.99	0.076
m2	17	1.73	1.91	2.05	0.075	15	1.95	2.09	2.21	0.084
m3	9	2.14	2.33	2.60	0.134	9	1.92	2.21	2.40	0.161

The *Spermophilinus* population from Paşalar shows size ranges for each dental element that are comparable to other middle Miocene populations from Turkey (Bruijn 1995) and Spain (Bruijn 1967; Cuenca Bescós 1988). Flynn and Jacobs (1990) observed differences in hypsodonty as demonstrated by a low-crowned m1 (Fig. 2C) and a high-crowned one (Fig. 2H, I). Unfortunately, the low-crowned specimen appears to be an eroded tooth that is missing a considerable part of the crown. We were not able to observe any difference in hypsodonty and consider the material described as “high crowned Tamiini” by Flynn and Jacobs (1990) as belonging to *Spermophilinus bredai*. The genus *Tamias* has a set of characters that differentiates it from *Spermophilinus*, such as its smaller size, more robust dental pattern, and an M3 with a poorly developed posterior lobe. All these characters are absent in the specimens from Paşalar. The tooth figured by Flynn and Jacobs (1990: fig. 2N) as cf. *Tamias* sp. has a large metaconule and is consequently assigned to *Tamias* by these authors. However, *Spermophilinus* assemblages (e.g., *S. bredai* from the Upper Miocene of Düzyayla, Turkey, our observations; *S. besana* from the Lower Miocene of Rembach, Germany, see Ziegler and Fahlbusch 1986) have a metaconule of variable size. Therefore, this character cannot be used as distinctive for generic separation, and all material recognized by the above mentioned authors as *Tamias* is assigned by us to *Spermophilinus bredai*.

Flynn and Jacobs (1990) assigned several large sized specimens to *Palaeosciurus*, of which two are figured here (Fig. 2L; right m3, and Fig. 2M; right m3, and not m2 such as mentioned by the authors). Typical for *Spermophilinus*, however, is the size increase from p4 to m3 and therefore the m3 appears to be disproportionately large compared to the preceding elements. Therefore we consider these specimens to form part of the homogeneous *S. bredai* assemblage.

## Biochronological comments

The age assignment of the Paşalar fauna has been controversial. Sickenberg et al. (1975) considered Paşalar to be slightly older than Sansan (reference fauna for MN6) and Savage and Russell (1983) correlated Paşalar to MN5, partly based on large mammals. Flynn and Jacobs (1990) were not able to date

Paşalar more precisely and correlated it to a range of time during the MN4–MN8 interval. Bernor and Tobien (1990) correlated Paşalar to the late Langhian and early MN6, ca. 15 Ma. However, we prefer to avoid the usage of marine stratigraphic terminology since the correlation of Paşalar to late Langhian is doubtful because of the absence of correlative criteria. Other authors have correlated the Paşalar fauna to MN6 without determining its biocronological position relative to other MN6 European faunas, with the exception of Çandır and Belomechetskaya (Bruijn et al. 1992; Bernor et al. 1996; Pickford et al. 2000). On the basis of the new rodent determinations presented here, the Paşalar fauna can be more precisely sequenced within the MN scale.

After our revision, the new rodent faunal list of Paşalar is as follows: The sciurids *Spermophilinus bredai* (Meyer, 1848) (15%) and Sciurinae indet. (0.2%), the glirids *Peridyromys lavocati* (9%) and Dryomyinae indet. (0.4%), the ctenodactylid *Sayimys* cf. *intermedius* (0.2%), the cricetids *Cricetodon pasalarensis* (Tobien, 1978) (31%), *Megacricetodon andrewsi* (30%), and *Democricetodon brevis* Fahlbusch, 1964 (6.5%), the spalacid *Pliospalax marmarensis* Ünay, 1990 (7.4%), and the castorid cf. *Chalicomys jaegeri* (0.2%). The percentages shown after each taxon represent the proportion of lower and upper M1s and M2s for each species in respect to the total number of rodents M1s and M2s.

The various hamster taxa serve well to correlate the Paşalar fauna to the MN scale (Bruijn et al. 1992). *Democricetodon brevis* is a European taxon, for which the oldest record until now was MN 7/8 (Bolliger 1992), and consequently indicates that Paşalar could not be older than MN7/8. However, the material from Paşalar may represent a slightly more primitive evolutionary stage than the assemblages of the same species from the MN7/8 faunas of Grat 930m, Anwil (Bolliger 1992), La Grive (Freudenthal 1963), and Giggenhausen (Fahlbusch 1964), therefore Paşalar likely correlates with either the late MN6 or early MN7/8 intervals. *Megacricetodon andrewsi*, as discussed above, is morphologically close to the *M. rafaeli*–*M. similis* group as defined by Daams and Freudenthal (1988). It is more similar to *M. similis* from MN7/8 localities than to *M. rafaeli* from the early MN6 of Spain, and therefore we suggest that the correlation of Paşalar should be with late MN 6 localities. According to the correlation of the Aragonian with the Magnetic Polarity Time Scale proposed by Krijgsman et al. (1994, 1996) and Daams et al. (1999a, b), *M. rafaeli* has a very brief temporal range between approximately 13.8 and 13.6 Ma, while *M. similis* ranges between 13 and 11.1 Ma. Therefore, given its intermediate dental morphology, *M. andrewsi* may have an age of 13.6–13 Ma. The third cricetid recorded from Paşalar, *Cricetodon pasalarensis*, confirms the correlation of Paşalar to MN6. According to Bruijn et al. (1993) and Pickford et al. (2000), *Cricetodon pasalarensis* is less derived than *C. candirensis* from Çandır and *C. caucasicus* from Belomechetskaya, both correlated with upper MN6 (Bruijn et al. 1992; Pickford et al. 2000).

Some biochronological information can also be obtained from the sciurids. In Western and Central Europe there ap-

pears to be a trend from small to large size in the lineage of *Spermophilus besana* Cuenca Bescós, 1988 to *S. giganteus* Bruijn et al., 1970 (Bruijn 1995). The size of *Spermophilinus bredai* from Paşalar is similar to that of *Spermophilus* from MN6 assemblages from West and Central Europe (Bruijn 1995). Nevertheless, in Turkey this size trend may not be present since *S. bredai* from Düzyayla (MN11; see Bruijn 1995) is of the same size as these MN6 assemblages. The record in Paşalar of a sciurid M3 with morphology and size close to *Atlantoxerus* could confirm the correlation of this locality to late MN6, since this genus has been recorded only in Turkish localities not older than MN7/8 (Bruijn and Mein 1996). In conclusion, and based exclusively on the rodent assemblage, we propose a correlation of the Paşalar fauna to late MN6.

## Acknowledgements

Thanks are due to Dr. Peter Andrews who offered us to study the small rodent material from Paşalar. We acknowledge Dr. Hans de Bruijn for his help and discussions on the Turkish sciurids. We are very grateful to Dr. Robert A. Martin who critically read the manuscript and helped us providing linguistic corrections. Prof. Kazimierz Kowalski and an anonymous reviewer provided constructive criticism on the manuscript. Funding was provided by Dirección General de Investigación Científica y Tecnológica, projects numbers PB95-114 and PB 98-0691-C03-01.

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