

Systematic paleontology

Eomyops noeliae sp. nov., a new Eomyidae (Mammalia, Rodentia) from the Aragonian of Spain

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Abstract

A new species of *Eomyops*, *Eomyops noeliae*, is described from the locality MT-20A (Morteral section, Magro basin, eastern Spain). It is intermediate in size between the large eomiid, *E. hebeiseni*, and the small species of the group *E. catalaunicus*, *E. bodvanus* and *E. opligeri*. The age range is Lower Aragonian. MT-20A is located between deposits that contain *Megacricetodon primitivus* and *M. collongensis*. Morphologically, *E. noeliae* sp. nov. is clearly different from the rest of species of the genus, due to an important reduction of the lingual anteroloph of $M^{1,2,3}$ and the labial anterolophid of M_3 . The lower incisor shows two parallel ridges along the enamel like the type species of the genus, *E. catalaunicus*. This character is basic for the distinction between *Eomyops* and the North American genus *Leptodontomys*. **To cite this article:** F.J. Ruiz-Sánchez et al., C. R. Palevol 8 (2009).

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Résumé

***Eomyops noeliae* sp. nov., un nouveau Eomyidae (Mammalia, Rodentia) de l'Aragonien de l'Espagne.** Une nouvelle espèce d'*Eomyops*, *Eomyops noeliae*, est décrite de la localité MT-20A (Morteral section, bassin du Magro, Est de l'Espagne). Cette espèce a des dimensions intermédiaires entre le grand éomiidé, *E. hebeiseni*, et le groupe d'espèces de petite taille, constitué par *E. catalaunicus*, *E. bodvanus* et *E. opligeri*. L'âge de cette espèce est Aragonien inférieur. MT-20A est localisé entre des dépôts qui contiennent *Megacricetodon primitivus* et *Megacricetodon collongensis*. La morphologie d'*E. noeliae* sp. nov. est différente du reste des espèces du genre, due à une réduction importante de l'antérolophe lingual des $M^{1,2,3}$ et de l'antérolophide labial de la M_3 . L'incisive inférieure de cette nouvelle espèce montre deux rides parallèles tout au long de l'émail, comme chez l'espèce type, *E. catalaunicus*. Ce caractère est très important pour la distinction entre *Eomyops* et le genre américain, *Leptodontomys*. **Pour citer cet article :** F.J. Ruiz-Sánchez et al., C. R. Palevol 8 (2009).

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Keywords: *Eomyops*; Eomyidae; Rodentia; Lower Miocene; Spain

Mots clés : *Eomyops*; Eomyidae; Rongeurs; Miocène inférieur; Espagne

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Version française abrégée

Introduction

Eomyops est un éomiidé assez rare dans le registre fossile. Il apparaît en peu de localités européennes, et, quand il le fait, ce n'est pas l'élément majoritaire de la faune. Le genre *Eomyops* fut créé par Engesser [10], pour distinguer le matériel européen d'éomiidés jusqu'à ce moment inclu par Huguenev et Mein [18] dans le genre *Leptodontomys* Shotwell, 1956. La présence de deux rides parallèles dans les incisives inférieures d'*Eomyops* et quelques autres caractéristiques de la mandibule sont la base pour la distinction entre ces deux genres.

Le genre comprend quatre espèces: *E. catalaunicus* [17], *E. bodvanus* [19], *E. oppligeri* [9] et *E. hebeiseni* [20]. La distribution temporelle du genre est comprise entre le Miocène moyen et le Pliocène, zones MN 5/6 à MN 17 [11]. Le registre le plus ancien de ce genre qui est connu avec certitude totale en Europe, correspond à la zone MN5 ou MN6 [20]. Le registre le plus récent correspond à celui de la localité de Schernfeld (MN17) [7,13]. Il existe, néanmoins, quelques données qui semblent indiquer la présence de ce genre dans les localités de Theobaldof (Allemagne) [22] et de Sankt Gallen (Suisse) [2]. L'âge attribué à ces localités serait compris entre les zones MN2 et MN3.

Dans la coupe de Morteral (bassin du Magro, Valence, Espagne), nous avons découvert le gisement Morteral-20A, où il y a des restes du genre *Eomyops*. Le tamisage de plusieurs milliers de kilogrammes de sédiment a fourni une des plus importantes collections connues dans le monde de restes fossiles de ce genre.

Paléontologie systématique

Ordre: Rodentia Bodwich, 1821.

Famille: Eomyidae Winge, 1887.

Genre: *Eomyops* Engesser, 1979.

Eomyops noeliae sp. nov. (Fig. 1).

Derivatio nominis: cette espèce est dédiée à Noelia Ruiz.

Holotype: MT20A-323, molaire supérieure isolée, conservée au Musée de Géologie de l'université de Valencia.

Hypodigme: 1 Iinf., 3 P₄, 18 M_{1,2}, 6 M₃, 3 P⁴, 12 M^{1,2}, 3 M³.

Localité-type: Morteral-20A (MT-20A), Aragonien inférieur, dépression du Magro, Valencia, Espagne. Coordonnées UTM 30SXJ933608.

Diagnose: *Eomyops* de taille moyenne, avec un mésolophide mi-long, généralement disposé transversalement. Antérolophide de la M₃ absent ou court. Antérolophe lingual des M^{1,2} absent (54 %) ou très court. Jusqu'à un 35 % des M^{1,2} possède un mésolophe légèrement divisé.

Diagnose différentielle: *E. noeliae* diffère de toutes les autres espèces du genre par les antérolophes et antérolophides moins développés. En plus, *E. noeliae* diffère de *E. hebeiseni* par son mésolophe des M^{1,2} bilobé. Cette nouvelle espèce diffère de *E. oppligeri* par sa taille supérieure et par le mésolophide des molaires inférieures, moins développé. *E. noeliae* diffère de *E. catalaunicus* principalement par sa taille supérieure, par le mésolophe bilobé des M^{1,2} et par les mésolophides des molaires inférieures moins développés. Finalement, *E. noeliae* diffère de *E. bodvanus* par sa taille supérieure, son mésolophe bilobé des M^{1,2} et par les mésolophides des M_{1,2,3} moins développés.

Mesures: voir Tableau 1.

Discussion et conclusions

La distribution temporelle des espèces connues du genre *Eomyops* jusqu'à présent reste comprise entre les zones MN5 et MN17. Il existe quelques rapports sur la présence possible du genre dans la zone MN2/3 [7,13]. *E. noeliae* se trouve à la localité Morteral-20A, niveau situé entre les gisements contenant *Megacricetodon primitivus* et *M. collongensis* dans la section de Morteral. C'est pourquoi, l'âge de Morteral-20A et de sa faune associée correspondrait à la transition entre les zones MN4 et MN5.

Fig. 1. *Eomyops noeliae* sp. nov. from MT-20A, Magro Basin. A. Left P₄, MT-20A 342. B. Right D₄, MT-20A 344. C. Right M_{1,2}, MT-20A 312. D. Right M_{1,2}, MT-20A 316. E. Left M_{1,2}, MT-20A 318. F. Left M₃, MT-20A 319. G. Right M₃, MT-20A 320. H. Left M₃, MT-20A 321. I. Left P⁴, MT-20A 326. J. Right P⁴, MT-20A 327. K. Left P⁴, MT-20A 359. L. Left M^{1,2}, MT-20A 322. M. Left M^{1,2}, MT-20A 323 (holotype). N. Right M^{1,2}, MT-20A 324. O. Right M^{1,2}, MT-20A 325. P. Right M³, MT-20A 368. Q. Right M³, MT-20A 369. R. Crenulation I inf, MT-20A 373, external view. S. Crenulation I inf, MT-20A 373, external view. T. Crenulation I inf, MT-20A 373, external view. Scale=1 mm.

Fig. 1. *Eomyops noeliae* sp. nov. de MT-20A, bassin de Magro. A. P₄ gauche, MT-20A 342. B. D₄ droite, MT-20A 344. C. M_{1,2} droite, MT-20A 312. D. M_{1,2} droite, MT-20A 316. E. M_{1,2} gauche, MT-20A 318. F. M₃ gauche, MT-20A 319. G. M₃ droite, MT-20A 320. H. M₃ gauche, MT-20A 321. I. P⁴ gauche, MT-20A 326. J. P⁴ droite, MT-20A 327. K. P⁴ gauche, MT-20A 359. L. M^{1,2} gauche, MT-20A 322. M. M^{1,2} gauche, MT-20A 323 (holotype). N. M^{1,2} droite, MT-20A 324. O. M^{1,2} droite, MT-20A 325. P. M³ droite, MT-20A 368. Q. M³ droite, MT-20A 369. R. Crénulation I inf, MT-20A 373, vue latérale. S. Crénulation I inf, MT-20A 373, vue latérale. T. Crénulation I inf, MT-20A 373, vue latérale. Échelle = 1 mm.

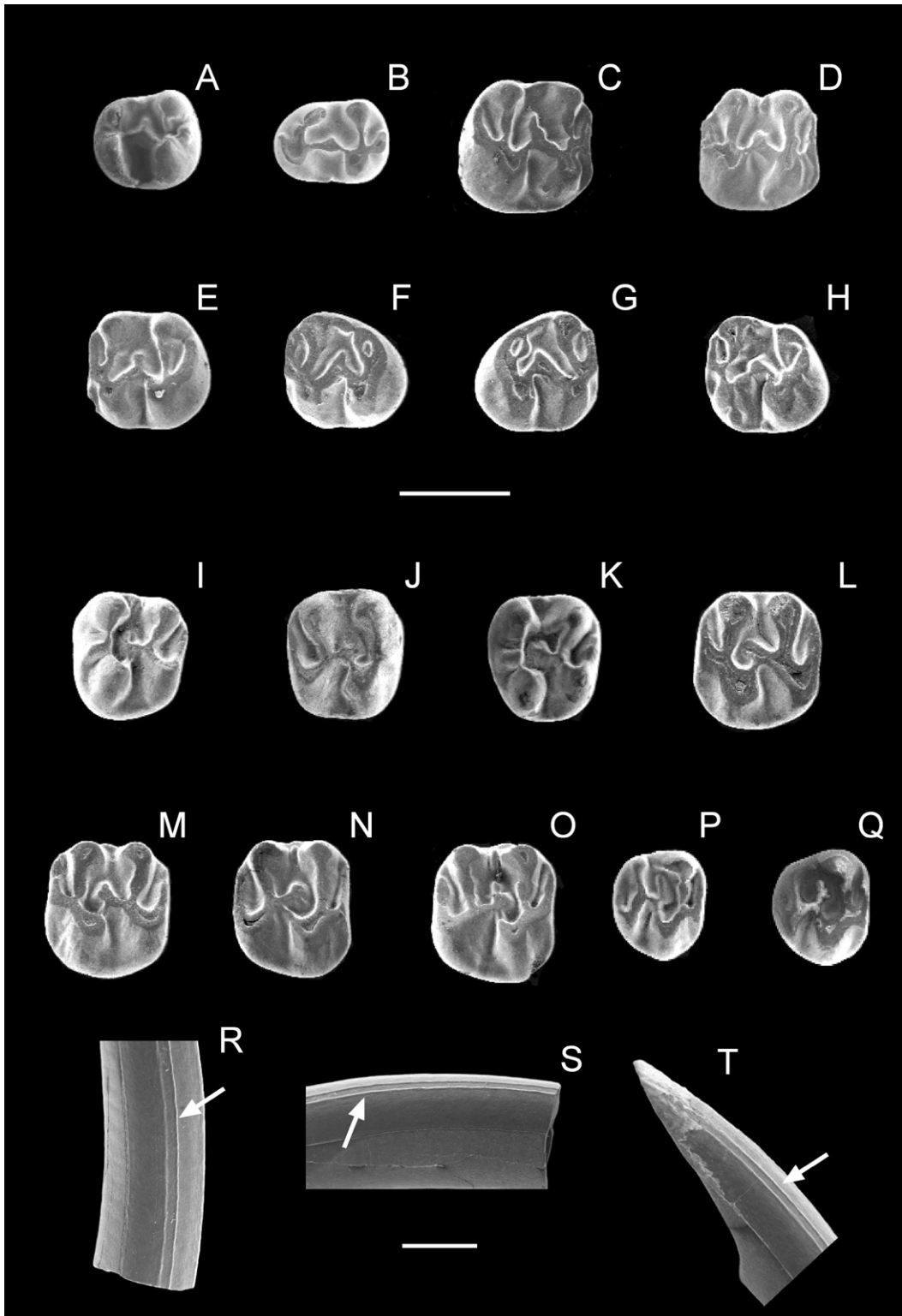


Table 1
Measurements (tenths of millimeters) of the lower and upper teeth of *Eomyops noeliae* sp. nov. from Morteral-20A.

Tableau 1. Mesures (en dixièmes de millimètres) des dents inférieures et supérieures d'*Eomyops noeliae* sp. nov. de Morteral-20A.

Element	Parameter	n	Minimum	Mean	Maximum
D ₄	L	1		9.50	
	W	1		7.20	
P ₄	L	2	8.80	8.95	9.10
	W	2	8.00	8.30	8.60
M _{1,2}	L	17	9.10	10.17	10.90
	W	18	9.60	10.34	11.00
M ₃	L	6	9.10	9.50	9.90
	W	6	8.50	9.42	10.00
P ⁴	L	3	8.90	9.00	9.10
	W	3	10.00	10.26	10.40
M ^{1,2}	L	12	8.60	9.68	10.40
	W	12	10.70	11.04	11.40
M ³	L	3	7.50	7.60	7.70
	W	3	8.80	9.23	9.50

La taille du matériel d'*E. noeliae* est intermédiaire entre celle d'*E. hebeiseni* de la MN5/6 et le reste d'espèces du groupe distribuées entre la MN7 et MN17. La morphologie d'*E. noeliae* est distincte du reste d'espèces du groupe. Il faut remarquer, entre autres, la forte réduction de l'antérolophe lingual des molaires supérieures et celle de l'antérolophe labial de la M₃. Une seule incisive inférieure possède deux minuscules crêtes qui courent en parallèle tout au long de l'émail et qui s'accordent avec celles qui sont décrites par Engesser chez *E. aff. catalaunicus* de La Grive [10].

Selon Engesser [10], le caractère ridé des incisives inférieures, avec d'autres caractéristiques de la mandibule, est utile pour faire la distinction entre le matériel européen de petits éomyidés bunodontes et le matériel du genre américain *Leptodontomys*. La présence de ce même caractère en *E. noeliae* du Miocène inférieur de l'Espagne apporte une importante information pour approfondir l'étude sur l'origine d'*Eomyops* en Europe.

Faute d'une caractérisation plus précise du matériel d'éomyidés initialement assigné au genre *Eomyops* des localités de Theobaldof et de Sankt Gallen, la présence d'*E. noeliae* dans la localité de Morteral-20A représente la mention la plus ancienne du genre en Europe.

1. Introduction

Eomyops is a rather uncommon eomyid in the fossil record. It appears in some European localities, but never constitutes the main element of the fauna. The

genus *Eomyops* was created by Engesser [10] to distinguish the European material of eomyids that Huguency and Mein [18] had included in the genus *Leptodontomys* Shotwell, 1956. The distinctive features in the mandible and the ridges of the lower incisors of *Eomyops* allowed Engesser to distinguish both taxa. The genus *Eomyops* comprises four species: *E. catalaunicus* [17], *E. bodvanus* [19], *E. oppligeri* [9] and *E. hebeiseni* [20]. The temporal range of distribution of the genus extends between the Middle Miocene and the Pliocene (zones MN5/6 to MN17) [7]. Nevertheless, this range could be wider (MN2 or MN3) if we consider the presence of the genus in the localities of Theobaldshof [22] and Sankt Gallen [2].

In this article, the assemblage of *Eomyops* from the locality of Morteral-20A is described. The material described here shows distinctive features that allow the definition of a new species, *E. noeliae*.

The section of Morteral, where Morteral-20A is located, is situated in the southeastern part of the Magro Basin (eastern Spain), an intramontane basin established in the Late Cretaceous [25]. All sediments of this basin are continental [25]. In the section of Morteral 12 fossiliferous beds have been found, ranging in age from Lower to Middle Aragonian. The preliminary faunal list of Morteral-20A includes the following taxa: *Megacricetodon* sp. 2, *Fahlbuschia* sp., *Eumyarion* sp. and *Glirudinus modestus* [24]. Morteral-20A is situated between beds with *Megacricetodon primitivus* (Freudenthal, 1963) and *M. collongensis* (Mein, 1958) [25]. The relative position of this locality and the preliminary faunal list allow us to assign Morteral-20A to the Early Aragonian (in the transition between zones MN4/MN5, probably in the MN4 zone).

The nomenclature used in the descriptions of the teeth is that of Fahlbusch [12]. Lengths and widths have been measured as defined by Álvarez-Sierra [1]. Specimens are kept in the "Departamento de Geología" of the University of Valencia, Spain.

2. Systematic Palaeontology

Order: Rodentia Bodwich, 1821.

Family: Eomyidae Winge, 1887.

Genus: *Eomyops* Engesser, 1979.

Eomyops noeliae sp. nov. (Fig. 1).

Derivatio nominis: this species is named after Noelia Ruiz.

Holotype: MT20A-323, isolated upper molar housed in the Geology Museum of Valencia University.

Referred material: 1 *Iinf.*, 3 *P*₄, 18 *M*_{1,2}, 6 *M*₃, 3 *P*⁴, 12 *M*^{1,2}, 3 *M*³.

Type locality: Morteral-20A (MT-20A), Lower Aragonian, Magro basin, Spain. Coordinates UTM 30SXJ933608.

Diagnosis: medium-sized *Eomyops*, with a medium-sized, generally transverse mesolophid. Anterolophid of *M*₃ absent or short. Lingual anteroloph absent in about half the *M*^{1,2}, very small in the rest. About one third of the *M*^{1,2} have a split mesoloph.

Differential diagnosis: *E. noeliae* differs from the other species of the genus by the poor development of the lingual anteroloph of the upper molars and of the labial anterolophid of the *M*₃. It is smaller than *E. hebeiseni* and larger than the other species. It differs from *E. hebeiseni* by the split mesoloph of the *M*^{1,2}. It differs from *E. oppligeri* by the more reduced mesolophids in the lower molars. It differs from *E. catalaunicus* by the split mesoloph of the *M*^{1,2} and the lesser development of the mesolophid of *M*_{1,2,3}. Finally, it differs from *E. bodvanus* by the split mesoloph of the *M*^{1,2} and the lesser development of the mesolophids of the lower molars.

Measurements: see Table 1.

3. Description

Iinf: only one specimen is available. The most characteristic feature of this element is the presence of two little ridges along the enamel of the tooth. They are parallel and run from the top to the base of the tooth. Between the two crests a small channel is developed. These crests are slightly displaced toward the right side of the tooth.

*D*₄: this element is much longer than wide, subrectangular. The only tooth shows a very small labial anterolophid. Lingual anterolophid absent. The mesolophid is strongly reduced, nearly absent. Posterolophid very much reduced. It does not reach the entoconid. Hypolophid continuous, connecting the hypoconid and the entoconid.

*P*₄: this element is longer than wide, subquadratic. One out of four specimens shows a very small labial anterolophid. This specimen lacks a lingual anterolophid, whereas the rest lack both the lingual and the labial anterolophid. The mesolophid is very short (1), medium (1) or medium-long (1). The posterolophid is short and thin. It reaches the entoconid in one out of three cases. The crest is partially interrupted near the entoconid in two cases. In one specimen the hypolophid

is strongly interrupted and in another two cases it is partially interrupted.

*M*_{1,2}: these teeth are wider than long. Lingual anterolophid strong and well developed, labial anterolophid long (4) or medium sized (12). Mesolophid short (4), medium-sized (11) or moderately long (3). The mesolophid is directed forwards (1), transversally (15) or backwards (2). The posterolophid joins the hypolophid at a sharp (11) or right angle (6).

*M*₃: posterior side strongly or slightly (2) rounded (4). Length and width are more or less equal, so the teeth seem square except for the reduction of the posterolingual side. The anterolophid is well developed on its lingual side. On its labial side it is very short (3), even absent in three specimens. Mesolophid short or very short (3), medium sized (2) or moderately long (1). The mesolophid is directed forwards (2), transversally (2) or backwards (2). Hypolophid continuous (3) or partially interrupted (3). This causes the extreme reduction of the fourth syncline, which in three cases nearly joins the third syncline.

*P*⁴: this element is much wider than long. The lingual part is shorter than the labial part. Mesoloph short (2) or very short (1), directed forwards (2) or transversally (1). The longitudinal crest is continuous (1), partially interrupted (1) or absent (1). In this last specimen the lingual syncline connects with the second syncline. Mesoloph split into two or more crests, much directed forward. Paracone and metacone slightly displaced to the lingual side, thus forming a small platform in front of the second and third synclines on the labial side.

M^{1,2}: rectangular outline strongly wider than long. Lingual anteroloph absent (7), very weakly developed (5) or well developed (1). The longitudinal crest joins the protocone nearly transverse, so the second syncline is longer than the third syncline. The longitudinal crest is thin and in most cases partially interrupted. Mesoloph short (7), very short (2) or medium sized (5) and directed forward (12) or transversely (2). The mesoloph is slightly forked (5) or simple (9).

*M*³: shape strongly wider than long. Protocone and paracone are the highest cusps. Lingual anteroloph absent (1) or very short (1). First syncline long and narrow. Mesoloph of medium size (1) or medium-long (3) and directed forward. The mesoloph takes up nearly all the space of the second and third synclines. Longitudinal crest nearly transverse. Lingual syncline directed forwards. Second syncline much longer than third syncline. Fourth syncline reduced and open at the postero-labial side.

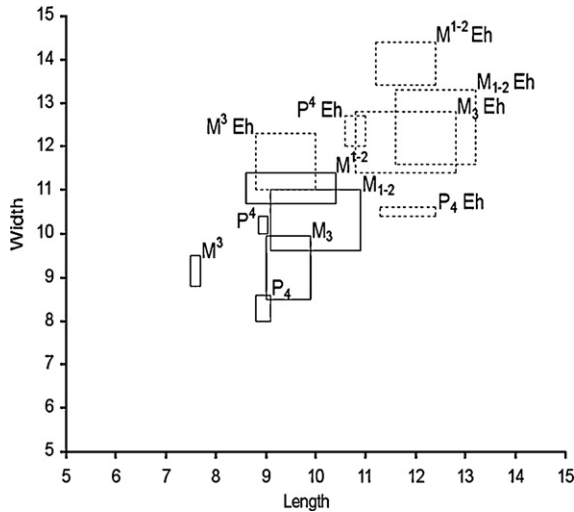


Fig. 2. Compared measurements of the dental elements of *Eomyops noeliae* from Morteral-20A and *Eomyops hebeiseni* [20] from Chatzloch.

Fig. 2. Mesures comparées des éléments dentaires d'*Eomyops noeliae* de la localité Morteral-20A et *Eomyops hebeiseni* [20] de la localité Chatzloch.

4. Discussion

The dental characters of the genus *Eomyops* described by Engesser [10] are: “The upper molars show a well-developed lingual anteroloph and the second and fourth synclines extend lingually past the middle of the teeth. The M3/3 are little reduced, M₃ generally having a hypolophid. The fourth syncline of the lower molars is well developed in most species. The mesoloph of the upper molars is mostly short, sometimes bifurcated, and anteriorly directed. The lower incisors are crenulated”.

The length/width scatter diagrams of *E. noeliae* indicate that all elements have a similar size, except the M³ (Fig. 2). This also happens in *E. hebeiseni* from Chatzloch, where the M³ is the smallest element of the dentition [20]. Fig. 2 shows the range of measurements of the elements of *E. hebeiseni* and *E. noeliae* nov. sp.. The M3/3 are not very much reduced, especially the M₃. The latter is longer than the M³ in *E. hebeiseni* and in *E. noeliae*, while both the M³ from Morteral-20A and from Chatzloch [20] are, more or less, as wide as the M₃.

The lingual anteroloph in *E. noeliae* is not as well developed as described in Engesser’s characterization of the genus [10,11]. While the lingual anteroloph is mostly well developed in *E. hebeiseni*, *E. opligeri*, *E. catalaunicus* and *E. bodvanus*, in *E. noeliae* the lingual anteroloph is mainly absent.

The development of the second and fourth synclines, extending lingually past the middle of the teeth, is very common in *E. noeliae*.

The development of the hypolophid of the M₃ is variable. At least in three specimens (50%) this crest is partially interrupted. The rest has a weak and continuous hypolophid.

Engesser figured a fragment of a lower incisor of *E. aff. catalaunicus* from La Grive that presents two ridges in the underside of the tooth [10]. He distinguished this character as representative of European populations of *Eomyops*. Among the remains of *E. noeliae* from Morteral-20A there is a lower incisor with this morphology (Fig. 1R, S, T). The lower incisor from Morteral-20A is complete, so this character can be studied. The two ridges extend throughout the enamel all along the tooth. It consists of two small parallel crests. The highest of these two crests is very small and draws a small channel from the base of the tooth until its apex. This character is not commonly mentioned in the literature, but may be an excellent feature to distinguish the genus *Eomyops*. After the revision of all the rodent incisors in Morteral-20A, no other incisor with two ridges has been found. Although important in some cases, as can be observed in *Eomyops*, incisors are usually not studied in fossil collections. Therefore, diagnostic characters based on incisors are seldom utilized for the distinction between taxa at the generic level. Nevertheless, in *Eomyops* they can be helpful to distinguish the material of this genus from the rest of rodents.

Throughout the chronological range of distribution, the morphology of the teeth of *Eomyops* is very conservative [8]. The four described species of the genus show great similarities in the morphology. Biometrically, the species of *Eomyops* are clearly distributed in two groups. A first one is composed by small-sized species: *E. catalaunicus*, *E. bodvanus* and *E. opligeri* and *E. noeliae*. The other one comprises only *E. hebeiseni*, of larger size.

The temporal distribution of *E. hebeiseni* covers zones MN5 and MN6; *E. opligeri* occurs in zones MN7 and probably MN6, MN8 and MN14; *E. catalaunicus* occurs in zone MN9 and MN10, and probably in MN13 and MN14, and *E. bodvanus* in MN14 and perhaps MN15. In the German locality of Schernfeld (MN17 a few teeth that represent the youngest record of this genus [8] have been found.

Based on the published literature, we have compared the material of *Eomyops* from Morteral-20A with that from the type localities of the different species of the genus. For the morphological and biometrical comparison of our material, we follow the chronological order of

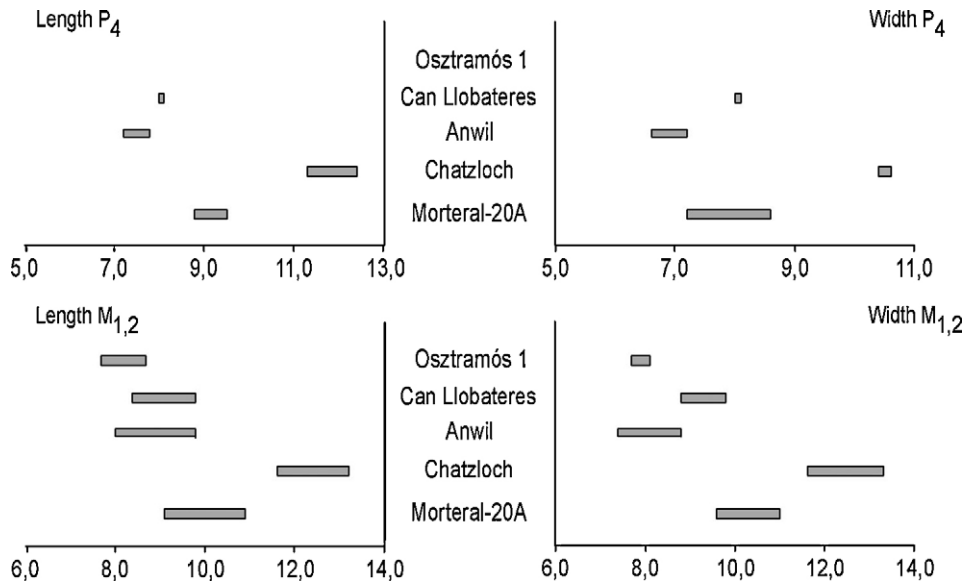


Fig. 3. Ranges of variation of several parameters of the lower molars of *Eomyops noeliae* from Morteral-20A, *Eomyops hebeiseni* from Chatzloch, *Eomyops opligeri* from Anwil, *Eomyops catalaunicus* from Can Llobateres and *Eomyops bodvanus* from Osztramós 1.

Fig. 3. Variation de quelques paramètres des molaires inférieures de la dentition de *Eomyops noeliae* de Morteral-20A, *Eomyops hebeiseni* de Chatzloch, *Eomyops opligeri* d'Anwil, *Eomyops catalaunicus* de Can Llobateres et *Eomyops bodvanus* d'Osztramós 1.

the different species of the genus *Eomyops* (*E. hebeiseni* – *E. opligeri* – *E. catalaunicus* – *E. bodvanus*).

Figs. 3 and 4 represent the ranges of several parameters of the dentition of *Eomyops* species from various European localities. The size of *E. noeliae* is intermediate between the larger *E. hebeiseni* and the smaller *E. opligeri*, *E. catalaunicus* and *E. bodvanus*.

There is no overlap of the measurements with *E. hebeiseni*, only the maximum length values of the $M^{1,2}$ and the $M_{1,2}$ of *E. noeliae* are near the minimum values of *E. hebeiseni*. This does not happen with lower and upper P_4 , but those elements are less numerous.

E. opligeri from Anwil is smaller than *E. noeliae*, but the biometrical differences are not always evident. The length of lower and upper P_4 and width of first and second lower and upper molars do not overlap. In these cases *E. noeliae* is clearly larger than *E. opligeri*. On the contrary, minimum length values of first and second lower and upper molars of *E. noeliae* overlap with maximum values of first and second lower and upper molars of *E. opligeri*, and the values for the width of P_4 come very close. In the case of the upper molars, the values are clearly separated for all the measured parameters, except for the length of the $M^{1,2}$. In this case, the extreme length values of the $M^{1,2}$ of *E. opligeri* match with the minimum ones of *E. noeliae* from MT-20A.

The material of *E. catalaunicus* from the type locality, Can Llobateres, is very scarce. So, the comparison of measurements between both populations is difficult.

While all parameters of the upper molars in *E. noeliae* have quite higher values than in *E. catalaunicus*, the size of the lower molars is more similar. In the $M_{1,2}$ the maximum values of *E. catalaunicus* overlap the minimum values of *E. noeliae*. In the P_4 , the only specimen from Can Llobateres has the same width value as medium-sized specimens from MT-20A.

As in the case of *E. catalaunicus*, the material of *E. bodvanus* from its type locality is very scarce. Only the first and second lower and upper molars can be compared biometrically. There is no overlap between the populations of *E. bodvanus* and *E. noeliae*. Only the lengths of the first and second lower and upper molars of both species are similar (the maximum values of *E. bodvanus* are close to the minimum values of *E. noeliae*).

In the $M^{1,2}$ of *E. noeliae* the lingual anteroloph is absent (54%), very weak (38%) or of short-medium size (8% = 1 specimen). The M^3 of *E. noeliae* is represented by two teeth. One specimen lacks the lingual anteroloph and the other one has a weak anteroloph. On the contrary, in the $M^{1,2}$ of *E. hebeiseni* from Chatzloch predominate morphotypes with well-developed lingual anteroloph (50%) [20]. In Chatzloch, all specimens (4) of M^3 have anterolophs [20]. The other species have a well-developed lingual anteroloph in all upper molars.

The mesoloph of the $M^{1,2}$ of *E. noeliae* is short or very short in 64% of the teeth, and of medium size in the rest. The length of mesolophs in the other species of the genus is similar. Only in *E. hebeiseni*, this crest is

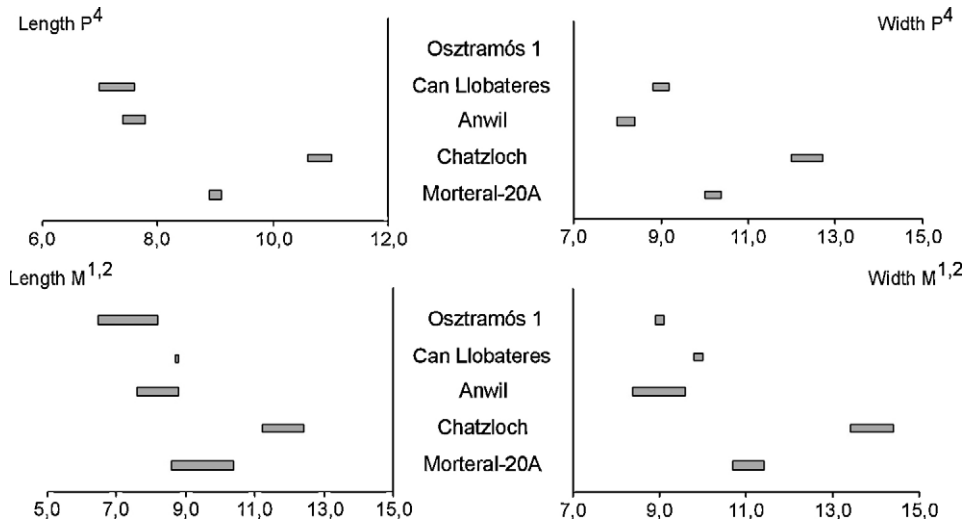


Fig. 4. Ranges of variation of several parameters of the upper molars of *Eomyops noeliae* from Morteral-20A, *Eomyops hebeiseni* from Chatzloch, *Eomyops opligeri* from Anwil, *Eomyops catalaunicus* from Can Llobateres and *Eomyops bodvanus* from Osztramós 1.

Fig. 4. Variation de quelques paramètres des molaires supérieures de la dentition de *Eomyops noeliae* de Morteral-20A, *Eomyops hebeiseni* de Chatzloch, *Eomyops opligeri* d'Anwil, *Eomyops catalaunicus* de Can Llobateres and *Eomyops bodvanus* d'Osztramós 1.

moderately long and simple [20]. A remarkable fact is the bifurcation of the mesoloph of $M^{1,2}$. While *E. noeliae* and *E. opligeri* have specimens with a clear division of the mesoloph (36% in *E. noeliae*), in the rest of the species this crest is always single.

Another important morphological difference between *E. noeliae* and the other species is the development of the labial anterolophid of M_3 ; in *E. noeliae* it is weak in three specimens and absent in the other three; this crest it is well developed in *E. hebeiseni* [20], *E. opligeri*, *E. catalaunicus* and *E. bodvanus*.

On the another hand, the development of the mesolophid of the lower molars of *E. noeliae* is clearly different from the other species. In *E. noeliae* this crest is short or medium sized in 83% of the $M_{1,2}$ and in all M_3 , *E. opligeri*, *E. catalaunicus* and *E. bodvanus* have a long or moderately long mesolophid. In the $M_{1,2}$ of *E. noeliae* the mesolophid is directed forwards (1; 6%), transversally (15; 83%) or backwards (2; 11%) and in the M_3 directed forwards, transversally or backwards in the same proportion. In the rest of species of the genus, this crest is directed backwards or transversally.

Kälin [20] lists all localities that have yielded *Eomyops* in western and central Europe. Four of these localities are located in the Iberian Peninsula (Can Llobateres, Las Planas 5K, Manchones and Arroyo del Val 6). Can Llobateres is the type locality of *E. catalaunicus*, and the rest of the localities contain a material determined as *Eomys* sp. [8], *Leptodontomys* (*Eomyops*) sp. [13] or *L. (Eomyops) aff. catalaunicus*

[14] in Manchones and *Leptodontomys (Eomyops) sp.* [13] or *L. (Eomyops) aff. catalaunicus* [14] in Arroyo del Val 6 [14]. Posteriorly, the material from Las Planas 5K and Manchones is attributed to *E. catalaunicus* [5,6]. Las Planas 5K, Manchones and Arroyo del Val 6 contain *M. crusafonti* and are assigned to the Aragonian biozone G2 (MN6) [5,6]. On the other hand, in Can Llobateres *M. ibericus* [15,16] has been identified, so this site has been assigned to biozone MN9. In spite of the scarcity of material of these localities, the morphological differences of these populations as compared with *E. noeliae* are based on the same features described before for the type localities of each species. Recently, in the section of "Abocador de Can Mata", near Can Llobateres (Vallés-Penedés basin), new localities with *Eomyops* material, provisionally determined as *E. cf. opligeri* [4] have been found.

So far, the oldest species of the genus *Eomyops* was *E. hebeiseni* from Chatzloch [20] and the youngest *E. bodvanus* from the Pliocene of central Europe [19]. Nevertheless, there are some data indicating the probable presence of this genus in older deposits of central Europe [2,22]. The presence of *Eomyops* in deposits earlier than zone MN5 is uncertain. The best known *Eomyops* assemblages correspond to an age range between MN5 and MN17 (Middle Miocene to Late Pliocene).

During many years, the small bunodont eomyids known from some Middle and Upper Miocene localities of Europe had been considered to belong to the North American genus *Leptodontomys* [18,23]. Some differ-

ences in morphology lead Engesser [10] to assign the European material of *Leptodontomys* to the new genus *Eomyops*. These differences are the presence of two ridges in the lower incisors and other slight differences in the mandible.

Some authors have considered the differences between *Eomyops* and *Leptodontomys* not significant enough to justify the existence of two separate genera [3,7,23]. The decision of creating a new genus ultimately depends on the importance assigned to the diagnostic characters distinguishing each genus. The morphological similarities between *Leptodontomys* and *Eomyops* are evident. If we accept the fact that the description of the *Eomyops* material in Europe has been based on the study of each one of the dental elements, including incisors, the difference between *Leptodontomys* and *Eomyops* in the lower incisors is also undeniable.

The presence of two ridges in the lower incisor is now known in two assemblages: La Grive [10] and MT-20A (in the other assemblages the lower incisor is not known) and this enforces Engesser's view that *Eomyops* and *Leptodontomys* are different genera. So far no crenulation has been described in the lower incisors of *Leptodontomys*. The North American record of *Leptodontomys* extends between the Arikarean (Upper Oligocene) [3,21] and the Clarendonian (Upper Miocene) [26].

In China, Qiu [23] reports the occurrence of *Leptodontomys* aff. *gansus* and *Leptodontomys* sp. nov. 2 in the Middle Miocene locality of Tunggur, *Leptodontomys* sp. nov. 1 in the Lufeng site and *L. gansus* in Harr Obo, Ertemte and Songshan. These last three localities and Lufeng have been attributed to the Upper Miocene. No crenulated incisors have been described in any of the Chinese assemblages studied [23]. According to Qiu, the presence of *Eomyops* (*Leptodontomys* selon Qiu) in Europe would be due to the migration of *Leptodontomys* from North America to Europe through Asia. If this hypothesis is true, *Leptodontomys* should be present in the basins of the Asiatic migratory route proposed by Qiu in the Lower Miocene or earlier. However, the first record in China of *Leptodontomys* in the locality of Tunggur is younger than the first *Eomyops* record in Europe.

The *Leptodontomys* record in the Chinese continental basins is fragmentary and probably still incomplete [23]. If *Eomyops* is a descendant of *Leptodontomys*, and if the latter migrated to Europe through the Asiatic route, new occurrences of *Leptodontomys* in the Asiatic basins in deposits older than Tunggur are to be expected. If, on the contrary, the *Leptodontomys* record in China and other possible continental areas connecting Europe and North America were not older than Middle Miocene, the presence of *E. noeliae* in Lower Miocene deposits in southern

Europe would support Engesser's hypothesis about an independent evolution of *Eomyops* and *Leptodontomys* in the European and American continent respectively.

5. Conclusions

The *E. noeliae* assemblage from the locality of Morteral-20 A contains the greatest collection of fossil remains of the genus *Eomyops* in the Iberian Peninsula and represents the first true report worldwide of this genus in zone MN4.

The size of this new eomyid species is intermediate between the large *E. hebeiseni* and the group of small species composed by *E. catalaunicus*, *E. oppligeri* and *E. bodvanus*. Thus, there is no clear trend of size increase or decrease among the species assigned to the genus.

The degree of development of the lingual anteroloph of the upper molars and the lingual anterolophid of the M₃ represents a significant difference with the rest of *Eomyops* species. The conservative character of the *Eomyops* morphology made the distinction between species of the group particularly difficult. So far, few or no differences could be established between the representatives of the genus.

The presence of two ridges in the lower incisors of *E. noeliae* makes this morphological character one of the most important to distinguish between *Eomyops* and *Leptodontomys*.

The presence of *Eomyops* in paleontological sites of zone MN4 adds new information to the analysis of the origin of the genus in Europe and extends the temporal range of the distribution of *Eomyops*.

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References

- [1] M.A. Álvarez-Sierra, Estudio sistemático y bioestratigráfico de los Eomyidae (Rodentia, Mammalia) del Oligoceno superior y Mioceno inferior español, Scripta Geológica 86 (1988) 1–207.

- [2] T. Bolliger, Kleinsäugerstratigraphie in der miozänen Hörlichschüttung (Ostschweiz), in: H.J. Gregor and H.J. Unger (Eds.), Kleinsäuger aus der Miozänmolasse der Ostschweiz, Documenta naturae, München, 1992, pp. 1–296.
- [3] J.J. Burke, New Duchesne River rodents and a preliminary survey of the Adjidaumidae, *Annales Carnegie Museum* 23 (1934) 391–398.
- [4] I. Casanovas-Vilar, The rodent assemblages from the Late Aragonian and the Vallesian (Middle to Late Miocene) of the Vallès-Penedès basin (Catalonia, Spain), PhD, Autonomous University of Barcelona, Spain (2007) (282 p.).
- [5] R. Daams, M. Freudenthal, A.J. van der Meulen Ecostratigraphy of micromammal faunas from the Neogene of Spain, *Scripta Geológica Spec. Issue 1* (1988) 287–302.
- [6] R. Daams, M. Freudenthal Synopsis of the Dutch-Spanish collaboration program in the Aragonian type area, 1975–1986, *Scripta Geológica Spec. Issue 1* (1988) 3–18.
- [7] R. Dehm, Altpleistozäne Säuger von Schernfeld bei Eichstätt in Bayern, *Mitt. Bayer. Staatsslg. Paläont. Hist. Geol* 2 (1962) 17–61.
- [8] H. de Bruijn, Gliridae, Sciuridae y Eomyidae (Rodentia, Mammalia) miocenos de Calatayud (provincia de Zaragoza, España) y su relación con la biostratigrafía del área, *Bol. Inst. Geol. Min. España* 78 (1967) 187–373.
- [9] B. Engesser, Die obermiozäne Säugetierfauna von Anwil (Basel-land), *Tätigkeitsber. Natf. Ges. Basell* 28 (1972) 37–363.
- [10] B. Engesser, Relationships of some insectivores and rodents from the Miocene of North America and Europe, *Bull. Carnegie Mus. Nat. Hist.* 14 (1979) 1–68.
- [11] B. Engesser Family Eomyidae, in: G.E. Rössner and K. Heissig (Eds.), *Land Mammals of Europe*, Verlag Dr. Friedrich Pfeil, München, 1999, pp. 319–335.
- [12] V. Fahlbusch, Populationsverschiebungen bei tertiären Nagetieren, eine Studie an oligozänen und miozänen Eomyidae Europas, *Bayerische Akademie Der Wissenschaften Mathematisch-Naturwissenschaftliche Klasse, Neue Folge* 145 (1970) 1–136.
- [13] V. Fahlbusch, Die stammesgeschichtlichen Beziehungen zwischen den Eomyiden (Mammalia, Rodentia) Nordamerikas und Europas, *Mitt. Bayer. Staatsslg. Paläont. Hist. Geol* 13 (1973) 141–175.
- [14] V. Fahlbusch, Die Eomyiden (Rodentia, Mammalia) der Oberen Süßwasser-Molasse Bayerns, *Mitt. Bayer. Staatsslg. Paläont. Hist. Geol* 15 (1975) 63–90.
- [15] J.L. Hartenberger, Les Cricetidae (Rodentia) de Can Llobateres (Néogène d'Espagne), *Bull. Soc. Geol. France* 7 (1965) 487–498.
- [16] J.L. Hartenberger, Contributions à l'étude de l'anatomie crânienne des Rongeurs. I.- Principaux types de Cricétodontinés, *Palaeovertebrata* 1 (1967) 47–64.
- [17] J.L. Hartenberger, Les rongeurs du Vallésien (Miocène supérieur) de Can Llobateres (Sabadell, Espagne): Gliridae et Eomyidae, *Bull. Soc. Geol. France* 8 (1966) 596–604.
- [18] M. Hugueney, P. Mein, Les Eomyidés (Mammalia, Rodentia) néogènes de la Région lyonnaise, *Geobios* 1 (1968) 187–204.
- [19] D. Jánossy, Middle Pliocene Microvertebrate Fauna from the Osztramos Loc. 1 (Northern Hungary), *Ann. Hist. Natur. Mus. Nat. Hungar* 64 (1972) 27–52.
- [20] D. Kälín, *Eomyops hebeiseni* n. sp., a new large Eomyidae (Rodentia, Mammalia) of the Upper Freshwater Molasse of Switzerland, *Eclogae Geol. Helv.* 90 (1997) 629–637.
- [21] W.W. Korth, B.E. Bailey, Additional specimens of *Leptodontomys douglassi* (Eomyidae, Rodentia) from the Arikareean (Late Oligocene) of Nebraska, *J. Mammal.* 73 (1992) 651–662.
- [22] E. Moayedpour, Geologie und Paläontologie des tertiären "Braunkohlenlagers" von Theobaldshof/Rhön (Miozän, Hessen), *Geologische Abhandlungen Hessen* 76 (1977) 1–135.
- [23] Z. Qiu, Eomyidae in China, in: Y. Tomida, C.K. Li, T. Setoguchi (Eds.), *Rodent and Lagomorph Families of Asian Origins and Diversification*, National Science Museum Monographs, Tokyo, 1994, pp. 49–55.
- [24] F.J. Ruiz-Sánchez Estudio paleontológico de los roedores fósiles del Mioceno inferior de la cuenca del río Magro (Valencia), PhD thesis, University of Valencia, Spain (1999). (395 p., unpublished).
- [25] F.J. Ruiz-Sánchez, C. de Santisteban, J.I. Lacombe Nuevas faunas de roedores fósiles (Mammalia, Rodentia) de edad Aragoniense inferior y medio en la serie del Barranco de Morteral (cuenca del río Magro, prov. De Valencia, España), *COL-PA* 1 (2003) 579–594.
- [26] K.S. Smith, First Record of *Leptodontomys* (Rodentia: Eomyidae) in the Clarendonian (Miocene) of the Southern Great Plains, *Proc. Okla. Acad. Sci.* 85 (2005) 47–53.