A NEW LOWER MIocene SMALL MAMMALS SITE AT THE CLOISTER OF THE LISBON ACADEMY OF SCIENCES AND MAMMALIAN IMMIGRATION INTO WESTERNMOST EUROPE

Un nuevo yacimiento de pequeños mamíferos del Mioceno inferior en el claustro de la Academia de Ciencias de Lisboa y la inmigración de mamíferos hacia Europa occidental

Miguel Telles Antunes1, 2, 3 and Pierre Mein4

1Academia das Ciências de Lisboa, R. da Academia das Ciências, 19/ 1249-122 Lisboa, Portugal
2European Academy of Sciences, Arts and Humanities, Paris.
3CICEGE, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa. migueltellesantunes@gmail.com
4U.M.R. 5125 « Paléoenvironnement & Paléobiosphère », Université Claude Bernard Lyon 1/ Campus de La Doua, Bâtiment Géode/ F69622 Villeurbanne Cedex France. pierre.mein@univ-lyon1.fr

Abstract: Excavations in the 133 grave at the Cloister of the former ‘Convento de Jesus’ monastery (granted in 1834 to the ‘Academia Real das Sciencias de Lisboa’) exposed green expansive clays from the lowermost, 1 unit of Lisbon Miocene series. Besides victims of the Great 1755 Lisbon Earthquake, the site unexpectedly yielded Lower Miocene fishes, crocodilian and small mammals. This is noteworthy since localities of this kind are very rare and nearly impossible to prospect again in Lisbon.

For the Cloister’s mammalian fauna see Table 1. Eucricetodon aquitanicus is identified for the first time in the Lisbon area, Lower Tagus basin. Other features are the lack of Eomyidae and the uncommon predominance of Cricetidae over Gliridae.

According to its stratigraphic position, the Cloister Miocene site may be grouped with two more or less synchronous mammal sites at Horta das Tripas (that yielded some large mammals which may be somewhat older than it was believed) and km 10 (small mammals), all ca. 22 Ma after 87Sr/86Sr dating, but anyway less than 23 Ma.

The Cloister mammals indicate quite the same age as that of the Km 10 site (MN2b zone, upper Aquitanian), and are older than Universidade Católica and Avenida do Uruguay ones (both MN3a, lower Burdigalian).

As more or less synchronous sites in Spain, France and Switzerland are rather scarce, it could be expected that Portuguese occurrences would be rare as they indeed seem to be. Even so, they represent a lot of progress of our knowledge on lowest Miocene mammalian faunas.

The Cloister Miocene assemblage points out to warm and moist environments compatible with a lagoon connected to the sea but protected by a coral barrier of the hermatypic corals’ rich, Venus ribeiroi limestones. This area would be surrounded by rather dry, terrestrial environments.

Key words: Small mammals, lower Miocene, Biostratigraphy, Lisbon, Portugal.
A NEW LOWER MIocene SMALL MAMMALS SITE AT THE CLOISTER OF THE LISBON ACADEMY OF SCIENCES AND MAMMALIAN IMMIGRATION INTO WESTERNMOST EUROPE

The Academia das Ciências de Lisboa (Academia Real das Ciencias de Lisboa before 1910) was granted in 1834 by Queen Maria II the building of the former Jesus Monastery - the Convento de Nossa Senhora de Jesus or simply Convento de Jesus. The building is since then the Academy’s headquarters (Antunes, 2010).

Building begun in 1585 during Philip I’s reign as king of Portugal (II as king of Spain) after the site was granted to the ‘Ordem Terceira de S. Francisco’. The main structures were more or less complete by the 1630’s. The Sacristy’s vault was under construction in 1661, when a disaster (July 8th) took the lives of three workers. A gravestone records this event asking for a Pater noster and an Ave Maria for their souls. A male monastic community thrived there. Among its activities were teaching, the support of the population and health care at the adjacent Hospital.

Works were complete at the cloister by 1712, including the construction of graves in all its wings. A very large reservoir was concluded 1725.

Unfortunately, a major disaster occurred November 1st, 1755 – the great Lisbon earthquake with subsequent fires and tsunami. A period of anarchy ensued. Bandits, deserters, and seamen robbed and often murdered the terrified survivors. Destruction of stores and break of food supplies resulted into starvation and not uncommon cannibalism. This went on until troops arrived and enforced order under the leadership of Pedro, the first Duke of Lafões and cousin of King Joseph I. Harsh measures included the hanging of many criminals.

The priest that was celebrating mass at the Jesus church, his acolyte and 19 women were crushed to death, plus a friar at the monastery. Buildings were severely damaged.

Rebuilding begun soon afterwards. A very rich Library, inaugurated in 1795 by Prince João (later King João VI) and his wife Carlota Joaquina, was added. It was used to support teaching, especially on Natural History at the ‘Aula Maynense’ created by father Joseph Mayne (1723-1792) in his last year of life and under the administration of the Academy of Sciences.

After the earthquake, unoccupied spaces in the cloister’s graves were used for inhumation of human remnants recovered elsewhere together with coins, religious medals, animal bones, shells (Callapez et al., 2011), ashes, coal fragments, etc. as shown by excavations in 2004 at the southern wing. Hundreds of victims are represented. Their number would perhaps attain a few thousands.

We (M.T.A.) decided (2010) to open the grave 133 at the northern, unexploited wing to ascertain if it also contained remnants of 1755 victims – as at the excavated southern wing and the eastern one that had been prospected with positive results.

After the removal of the gravestones, the substratum i.e. the underlying green, expansive clays became exposed, along with more of the same reworked when the grave was dug. Unlike the southern wing, graves were not delimited by walls.

Expansive clays belong to the lowermost, I unit of the Lisbon Miocene series, the “Argilas e Calcários com Venus ribeiroi dos Prazeres”, ca. 20 to 23 Ma (stages: Aquitanian to basal Burdigalian). V. ribeiroi and other fossils had been collected at the southern wing (Balbino et al., 2011).

Excavation of grave 133 was carried on by Paulo Alexandre Correia, who did most of the preparation work at the Academy’s laboratory. It yielded the skeleton of a middle-aged woman with a chaplet in her right arm; the partial skeleton of an adult man that had been slain through a sword slash that cut the maxillaries until the rear part of the palate; and that of a child. Further remnants of humans and other mammals, an ivory ring, coins and tokens, seeds, etc. were recovered. Clays’ volume changes with dryness or moisture and tree roots displaced and broke bones.

 Bones are fragile and shells scarce. Alkalinity did not seem to attain the ideal 7.8-7.9 pH for bone’s hydroxyapatite preservation (Reitz & Wing, 2001). The local environment seems to have displaced Ca$^{++}$ (see chemical analysis).

About 175 kg of clays were washed, sieved and tried by Eduarda Ferreira at the Departamento de Ciências da Terra/Science and Technology Faculty of the New University of Lisbon to obtain modern rodent teeth, fish bones, teeth and scales, etc. Clays have been analysed by Carlos Galhano

Palabras-clave: Pequeños mamíferos, Mioceno inferior, Biostratigrafía, Lisboa, Portugal.

(same Department), who kindly carried on this work on samples forwarded by one of us (M. T. A). Results are as follows:

- Expansibility attains values between 12 and 15%. When drying slowly, the clay sample retracts to beyond the initial state and opens broad fissures. If it becomes wet again, it expands without attaining the first expansion values. Our comment: large fossils could easily tend to be mechanically destroyed, but this did not happen to smaller ones like small mammals’ teeth.

- X Ray Diffraction from the < 2 granulometric fraction (2 scanning between 5 and 60 degrees, Cu Kα radiation) shows Beidellite, Micas, Quartz, Kaolinite and a little K Feldspar. Beidellite and some Mica Group minerals are expansible and account for the expansibility.

- The chemical analysis (in oxides) is: Na₂O, 3.98%; Al₂O₃, 32.74%; SiO₂, 54.02%; H₂O, 9.26%. The sample seems devoid of Ca.

Something really new happened, the unexpected discovery of lower Miocene small mammals, a crocodilian and fishes in clays at the grave’s proximal left side. Its importance is even greater because ancient Miocene levels are nearly impossible to search elsewhere in Lisbon.

Lower Miocene mammalian sites in Lisbon and isotopic age

Studies on the Miocene series in the Lisbon/ Setubal Peninsula place the mammalian localities in their stratigraphic context. Age is known after planktic foraminifera, K-Ar from glauconites and mostly through Sr isotopes in oyster and pectinid shells (Antunes et al., 1999).

Collecting at Horta das Tripas yielded but macro mammals (Roman, 1907). In his work, he was influenced by the Burdigalian age that had been ascribed after the malacological fauna. As for the lower units, nothing could be added except a few sirenian bones.

Small mammals from the unit I of the Miocene series were described (Antunes, 1961, Antunes & Mein, 1971) from:

- the lowermost level at the km 10 trench of the A1/IP1, Lisbon-Oporto highway (Antunes & Mein, 1992), ca. 22 Ma Sr age. However nothing seems against a somewhat older age, albeit younger than that of the Laugnac site.

- the Lisbon sites at Horta das Tripas now at the Academy’s cloister, maybe more or less synchronous of the preceding one; no available isotope ages.

The results of the small mammals’ study are as follows (measurements in millimetres): One lagomorph, rodents and a small artiodactyl have been found.

Upper teeth are labelled with capital letters (for molars, M), and the lower ones with small letters (idem, m). All are housed at the Museum of the Academy of Sciences of Lisbon.

**Description**

**Class** LAGOMORPHA Brandt, 1855

**Family** Ochotonidae Thomas, 1897

**Genus** Lagopsis Schlosser, 1884

**Species** Lagopsis cadeoti Viret, 1930 ssp. spiracensis

Baudelot & Crouzel 1974

**Material:** a fragment of a molariform tooth; an m3.

A fragment of a typically hypsodont tooth seems to belong to a juvenile. It is curve in lateral view; hence it seems to be the talonid of a left m2. Measurements: occlusal width, 1.2; basal width, 1.6; height as preserved, 3.8.

The other specimen seems to belong to the same individual. It is a left m3. The crown’s shape is elliptical, its width being 0.6 and the length 0.4. The occlusal surface is oblique relatively to the maximum height. The height of the crown is 2.8. Another interesting feature is a round small fossetid in the middle of the occlusal surface.

Both specimens have been directly compared to a mandible from Estrepouy described by Viret as the holotype of Lagopsis cadeoti (Roman & Viret, 1934: 26; see also Schlosser, 1884). No meaningful differences were noticed.

The Cloister site teeth are tentatively ascribed to the ssp. spiracensis, even if the lack of the p3 does not allow us to distinguish it for sure from the typical L. cadeoti.

**Class** RODENTIA Bowdich, 1821

**Family** Sciuridae Gray, 1821

**Genus** Heteroxerus Strehlin & Schaub, 1951

**Species** Heteroxerus rubricati Crusafont & Villalta, 1955

(in Crusafont, Villalta & Truyols, 1955)

**Material:** a fragment of a right lower incisor (antero-posterior diameter, 1.70 ; transverse diameter, 1.09).

Enamel is not smooth, but there are no longitudinal ridges. Comparisons enable us to recognize Heteroxerus rubricati, the only species of this genus known at those levels.

On the other hand, Black (1965) named the large Heteroxerus from Estrepouy as Heteroxerus vireti. However, as Cuena (1988) has shown, it is but a junior synonym of H. rubricati. Hence we had to modify our previous classification as H. vireti for some Avenida do Uruguay and Universidade Católica specimens (see Table 1).

**Family** Cricetidae Fischer, 1817

**Subfamily** Eucricetodontinae Mein & Freudenthal, 1971

**Genus** Eucricetodon Thaler, 1966

**Species** Eucricetodon aquitanicus Baudelot & De Bonis, 1968

(Figures 1-3)
Material: left M2 (length, 1.92; width, 1.60); right M2 (Fig. 1; length, 1.72; width, 1.52); right M3 (Fig. 2; length, 1.30; width, 1.38); right m1 (length, 2.24; width, 1.60); another right m1 (Fig. 3; length, 2.24; width, 1.54); still another right, slightly incomplete m1 (length, ; width, 1.30); a broken left m3 (length, ; width, 1.52); two incisor fragments of a cricetodontid whose position could not be ascertained.

The genus Eucricetodon had been collected at Universidade Católica and Avenida do Uruguay (Antunes & Mein, 1971). The concerned material was ascribed to E. infralactorensis Viret, 1930. We still subscribe this classification, even if we remarked the smaller than the mean size of the teeth as known in infralactorensis. This points out to an early representative of the same species.

On the other hand, the distinction between infralactorensis and the earlier aquitanicus is subtle: Hugueney (1999) studied the variation of all Eucricetodon species and concluded that it is difficult to ascribe a species name unless a really numerous material is available.

As far as upper teeth are concerned, the M2 are rectangular in shape with mesial and distal borders that are orthogonal relatively to the lingual and labial borders. There are four main cusps in two rows: the first one, comprising the protocone and paracone, is followed by a second row with the hypocone and metacone. The longitudinal wall is oblique; at its middle part, a bulge represents the mesocone. On the tooth’s border there is an anterocone that is connected to the buccal side to an anteroloph, and lingually to a lingual cingulum that extends down to the crown’s base. The sinus is very oblique forwards. The metaconid is smaller and lower than the paracone. A longitudinal crest issued from the metacone closes on the posteroloph until the metacone base and thus isolates a posterosinus. The abrasion of the protocone forms an oblique surface. The sinusoid is transversal. There is a small ectostylid at its end in one tooth in each three.

In comparison with Universidade Católica’s teeth, the m1 from the Cloister is elongated and triangular in shape. It presents a simple anteroconid from which a labially descending cingulum is issued; it reaches the protoconid base. This anteroconid is otherwise connected to the metaconid. The metaconid is placed a little more mesially than the protoconid. The metaconid shows a posterior lingual crest. The longitudinal crest is nearly not inflated. The tooth has no mesolophid; however there is a well-developed entoconid which is transversally connected to the longitudinal crest. Some morphological differences as well as the smaller size of the only comparable tooth (the M3) present at both the Cloister and the Universidade Católica, seem to point out to two different species. This reason led us to ascribe the Cloister’s Eucricetodon to E. aquitanicus.

Family Gliridae Muirhead, 1819
Genus Peridyromys Stehlin & Schaub, 1951
Species Peridyromys murinus (Pomel, 1853)
(Figures 4 and 5)
Material: fragment of a right maxillary comprising the masseteric tubercle and the three alveoli for the P4 roots; left D4 (length, 0.80; width, 0.87); right m1 (length, 1.08, width, 1.04); an incomplete and probably digested, maybe left m3.

The D4 is triangular in shape. The protocone is shorter and higher than its labial side. The anteroloph is round and expanded forwards. There are five crests; the second one is the protoloph. This irregular crest continues until the lingual border, where it joins the metaloph at the centre of the tooth and the posteroloph at its lingual border. Labially, just before the metaloph, there is a thin and short centroloph (in a posterior position).

The five-crested m1 is trapezoid in occlusal view. The trigonid presents three crests: the anterolophid, the metalophid and the centrolophid. The metalophid crest is connected to the anterolophid both labially and lingually. The centrolophid is transverse and ends at the middle part of the tooth. The two last crests make up the talonid; the first and longest one is the metalophid. These two distal crests are connected labially. No accessory crests occur.

This species had been identified before in the Lisbon region.

Order CETARTIODACTYLA Agnarsson & May-Collado, 2008
Suborder ARTIODACTYLA Owen, 1848 (new range)
Superfamily Anoplotherioidea Gray, 1821
Family Cainotheriidae Cope, 1881
Genus Cainotherium Bravard, 1828
Species Cainotherium sp.

Material: a fragment of an upper molar (no useful measurements can be taken).

A very incomplete specimen can undoubtedly be reported to Cainotherium. As for Universidade Católica, Avenida do Uruguay and km 10 (Antunes, 2000), the available material is not enough for identification at the species’ level.

Baudelot & Crouzel (1974) described a more or less synchronous new subspecies, Cainotherium miocaenicum lintillae. According to Ginsburg & Bonneau (1995), the type locality, Les Beillaux, is older than the oldest levels of the Loire valley (no numerical dating).

The Cloister faunule and other very low Miocene Lisbon occurrences

The Cloister mammalian faunule is presented together with the earliest one (km 10) and that from Horta das Travessas, as well as the later ones from Universidade Católica and Avenida do Uruguay (Table 1). Account is taken of a previous list (Antunes, 2000).

A few modifications concerning the Lagopsis and Heteroxerus from the other referred sites are included. Stages, Lower Tagus basin depositional sequences and isotope age results are given according to Antunes et al. (1999).

The number of specimens is given.

Paleontological dating, a discussion

The Cloister faunule seems older than MN3, whose beginnings would be about 20 Ma (Steininger et al., 1996) or 19.3 Ma (Daams et al., 1999). MN 2b age would be comprised between 20.0 and 21.8 Ma (Sen, 1997).

The same may be reported to the MN 2b mammal-zone and to the upper part of the Aquitanian stage, as the km 10 fauna. According to the International Stratigraphic Chart (2009), MN 2 would be older than 20.43 Ma (Gradstein et al., 2009); its lower limit has not been given, but it anyway is above the Miocene/Oligocene boundary at 23.03 Ma (International Stratigraphic Chart, idem).

However these ages may look a little too young if account is taken of the reliable Lisbon sites’ Sr dating (Antunes et al., 1999). Anyway the Cloister fauna seems a little younger than the Km 10 one.

Comparisons between mammalian associations from Avenida do Uruguay/ Sr age 21.5 ±0.5-0.3 Ma, and Universidade Católica/ Sr age, 20.5 ±0.3-0.2 Ma age show that they do not differ much as far as taxa are concerned. Both may therefore be regarded as a single association despite a rather small age difference as shown by Sr isotopes.

It does not seem possible to reach more accurate conclusions about relative age by paleontological means only. A further argument can be added, i.e. the size of Eucrictodon teeth, the Cloister’s ones being smaller than those from Universidade Católica. Taking this into account (with some reserve as uncontrollable factors as individual variation may also have played a role), we regard the Cloister faunule as somewhat older than the associations from both Avenida do Uruguay and Universidade Católica. It would be ca. 21 to 22 Ma, which is also in agreement with stratigraphic data because Avenida do Uruguay and Universidade Católica marine sands distinctly overlie expansive clay layers that can be correlated to Cloister’s.

The lowermost Miocene mammalian sites of the Lisbon region may therefore be arranged chronologically:

(1) Km 10 is the oldest site, but probably is not much older than (2);
<table>
<thead>
<tr>
<th>Sites</th>
<th>Km 10</th>
<th>Horta das Tripas</th>
<th>Cloister Acad. Cl. Lisboa</th>
<th>Av. do Uruguay</th>
<th>Universidade Católica</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN Zones</td>
<td>MN2b</td>
<td>MN2b?</td>
<td>MN2b?</td>
<td>MN3a</td>
<td>MN3a</td>
</tr>
<tr>
<td>Stages</td>
<td>Upper Aquitanian</td>
<td>idem</td>
<td>idem</td>
<td>Lower Burdigalian</td>
<td>idem</td>
</tr>
<tr>
<td>Basin depositional sequences</td>
<td>A</td>
<td>A?</td>
<td>A?</td>
<td>BO</td>
<td>BO</td>
</tr>
<tr>
<td>$^{87}$Sr/$^{86}$Sr ages (Ma)</td>
<td>22.3+0.4-0.7 (other sites)</td>
<td>–</td>
<td>–</td>
<td>21.5+0.5-0.3</td>
<td>20.5+0.3-0.2</td>
</tr>
<tr>
<td>Glauconite K-Ar ages (Ma)</td>
<td>19.6 to 24 (other sites)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

### CARNIVORA
- Pseudaelurus transitorius

### PERISSODACTYLA
- Protaceratherium minimum
- Diaceratherium cf. aurelianensis

### ARTIODACTYLA
- Brachyodus intermedius
- Diacceratherium cf. aurelianensis

### SIRENIA
- Cf. Halitherium sp. Number?

### INSECTIVORA
- Galerix sp.
- Crocidosorex antiquus
- Soricinae indet.
- Amphechinus sp.
- Cf. Paratalpa sp.
- Dimylidae indet.

### LAGOMORPHA
- Lgopis cadeoti spiracensis
- Lgopis cadeoti
- ?Prolagus vasconiensis

### RODENTIA
- Heteroxerus cf. paulhiacensis
- Heteroxerus rubricati
- Palaesocius fissurae
- Blackia miocaenica
- Sciuridae indet.
- Glirinae indet. (Myoglis sp.)
- Glirinus modestus
- Microdyromys legidensis
- Peridyromys murinus
- Pseudodyromys ibericus
- Pseudodyromys simplicidens
- Armantomys sp. (parsani ?)

### Table 1.- Lisbon Lower Miocene localities with mammals, MN zones, Stages, Depositional sequences, $^{87}$Sr / $^{86}$Sr and K-Ar ages, Taxa and Number of specimens.
(2) the following are the Cloister of the Lisbon Academy of Sciences and probably (3) Horta das Tripas, a site in the same clayey succession that yielded but large mammals;

(4) Avenida do Uruguay and (5) Universidade Católica, by that order and although not distinguishable on their small mammals’ contents, are the latest according to their $^{87}\text{Sr}/^{86}\text{Sr}$ age.

**Similar Iberian, French and Swiss faunas / Immigration into westernmost Europe**

Comparisons can be made with several lowermost Miocene localities in Spain. A very complete account has been presented (Daams et al. 1997). The Cloister fauna is older than the chronostratigraphic zone Z, whose magnetostratigraphical age span is 17.0 to 19.3 Ma. Comparable Spanish sites seem to be Navarrete del Río (Adrover, 1978) and other MN 2 ones: Ramblar 3, Loranca do Campo, Colmenar Viejo, Moheda, Valquemado and Cetina de Aragón. These localities were reported to local zones Y2, approximately 19-20 Ma, and Y1, from 20 to near 22 Ma (Daams et al., 1997).

In France there is a well-known locality at Estrepouy (lower MN3) besides those of Espira-du-Conflent (Baude-lot & Crouzel, 1974; Ginsburg & Bonneau, 1995), and Crémat-0 (basal MN3). There is a somewhat older site at Laugnac (MN 2b) plus a few minor ones (Hürzeler, 1945, 1962).

In Switzerland there are MN 2b localities at Vully and La Mèbre (Engesser & Mödden, 1997).

As far as French sites are concerned, let us pay a special attention to a synthesis by Ginsburg (2000) dealing with several localities from the Blésois to the Bretagne:

A-1. The age of the oldest miocene formation, the “Calcaire de Beauce”, is MN2b. Among its mammals there are *Eucricetodon aquitanicus*, *Peridyromys cf. prosper*, *Protaceratherium minutum*, *Dia ceratherium cf. aginensis* and *Aurela choerus aurelianensis*. This is very close to the Km10 – Horta das Tripas association.

A-2. Sands at Chitenay, Les Beilleaux, Mauvières and La Brosse contain a closely similar to (and a little older than) the Wintershof-West fauna in Bavaria, which comprises some new elements and is the reference fauna for MN3. Among its elements let us underline *Brachyodus intermedius* (also collected at Horta das Tripas), *Protaceratherium minutum* (H. das Tripas), *Eucricetodon infra lactorensis* and *Pseudaelurus turnauensis* (H. das Tripas). This supports an MN2b age for Km10, the Cloister and Horta das Tripas.

A-3. There are higher levels with *Brachyodus onoideus*, but these are not of interest here.

All the lower Miocene mammalian species found in Lisbon are known elsewhere in Europe in localities of nearly the same age. As the Lisbon localities are placed in the extreme, westernmost part of Europe, their approximately synchrony means once again that mammalian migrations took place quite quickly, geologically speaking. No barriers as the Pyrenees and other mountain chains, rivers, etc. prevented mammalian immigrations.

**Palaeoecological remarks**

The small mammal specimens from the Cloister are characteristic enough for paleontological dating, as shown in the preceding chapter.

On the other hand, the rather restricted number of specimens could cast some reserves on their real value as far as quantitative data are concerned, and the latter are needed for palaeoecological interpretation. Nevertheless faunal comparisons can be made.

Two characters from the Cloister’s small mammals association can be remarked: (a) the abnormal lack of Eomyidae, which often predominate among the lowermost Miocene faunas; and (b) the uncommon predominance of Cricetidae over Gliridae. One could think that the observed differences could happen by fortuitous, sheer chance. Let us analyze them:

a) The sole Eomyidae so far known in Lisbon’s lower Miocene is *Ligerimys antiquus*. Its occurrence ratios among the whole rodent’s associations are as follows for the concerned sites:

- at Km 10, there are 5 *L. a.* teeth among 48 rodent teeth or 10.4%;
- for Avenida do Uruguay, 7 in 107, or 6.5%;
- and for Universidade Católica, 6 in 71, or 8.5%.

If we try to transpose this to the Cloister association using a percentage mean value of (10.4+6.5)/2= 8.45%, more than one Eomyid tooth would be expected to occur but there is none. Although this is not a definite proof, it suggests that Eomyids’ absence is not just a matter of chance.

b) Another character of the Cloister’s rodent association concerns Cricetids (*Eucricetodon, Melissiodon*) vs. Glirids (several genera) ratio:

\[
\begin{array}{cccc}
\text{Km 10} & \text{Cloister} & \text{Av. Uruguay} & \text{U. Católica} \\
\text{Cricetids} & 4 & 9 & 6 & 6 \\
\text{Glirids} & 32 & 4 & 90 & 53 \\
\% & 12.5 & 225 & 6.6 & 11.3 \\
\end{array}
\]

If we try to transpose this to the Cloister association using a percentage mean value of (10.4+6.5)/2= 8.45%, more than one Eomyid tooth would be expected to occur but there is none. Although this is not a definite proof, it suggests that Eomyids’ absence is not just a matter of chance.

Hence this result does not suggest either that such differences are just a matter of chance.

The small mammals’ association from the Cloister seems uncommon because of a) and b). This will be taken into account. The ecological interpretations have been based on Neogene small mammals from Spain, mostly from continental deposits (Daams et al., 1997).

The Cloister small mammals underwent some transportation. Salt (or brackish?) water fish teeth are common, and a crocodilian tooth was found. Expansive clays must have been accumulated in a quite large, flat, more or less flooded lagoon connected to the sea, probably protected by a barrier-reef. Floods would bring in terrestrial elements. A small crocodile points out to warm enough conditions to ensure crocodilian reproduction.

---

**Table:** Ratios are nearly the same for Km 10 and Universidade Católica, and somewhat less for Avenida do Uruguay. On the contrary, there is a very marked contrast between these three and the Cloister. Differences are much too high. Hence this result does not suggest either that such differences are just a matter of chance.

The small mammals’ association from the Cloister seems uncommon because of a) and b). This will be taken into account. The ecological interpretations have been based on Neogene small mammals from Spain, mostly from continental deposits (Daams et al., 1997).

The Cloister small mammals underwent some transportation. Salt (or brackish?) water fish teeth are common, and a crocodilian tooth was found. Expansive clays must have been accumulated in a quite large, flat, more or less flooded lagoon connected to the sea, probably protected by a barrier-reef. Floods would bring in terrestrial elements. A small crocodile points out to warm enough conditions to ensure crocodilian reproduction.
Close by terrestrial environments around were inhabited by cricetodontids, glirids and other mammals; both the prevailing *Eucricetodon* and *Peridyromys murinus* lived in rather dry terrestrial environments.

**Conclusions**

1. Excavations held in 2010 at the number 133 grave at the northern wing of the former ‘Convento de Jesus’ monastery Cloister exposed the building’s foundations: green expansive clays from the lowermost, I unit of Lisbon Miocene series (“Argilas e Calcários com *Venus ribeiroi* dos Prazeres”).

2. Besides victim’s remnants of the Great 1755 Lisbon Earthquake, the same clays unexpectedly yielded Lower Miocene vertebrates including salt or brackish water fishes, a crocodilian and small mammals. This is a noteworthy occurrence since localities of this kind are very rare and nearly impossible to prospect and exploit again in Lisbon.

3. The composition of the Cloister’s mammalian fauna is shown Table 1. *Eucricetodon aquitanicus* is identified for the first time in the Lisbon area, Lower Tagus basin. Even with some reserve owing to the scarcity of the material, we may recognize as peculiar features the lack of Eomyidae and the uncommon predominance of Cricetidae over Gliridae.

4. According to its stratigraphic position, the new Miocene Cloister site may be grouped with the more or less synchronous mammal localities of Horta das Tripas (some large mammals that are somewhat older than it was thought before) and km 10 (small mammals), both ca. 22 Ma but anyway less than 23 Ma.

5. The Cloister small mammals’ assemblage indicate an age that is quite alike that of the Km 10 site and Horta das Tripas, MN2b zone (upper Aquitanian), and older than that of Universidade Católica and Avenida do Uruguai ones, MN3a (lower Burdigalian).

6. As there are rather scarce more or less synchronous sites in such a very large area of Spain plus France and Switzerland, it could be expected that Portuguese occurrences would be rare as they indeed are. Anyway they represent a lot of progress in our knowledge on lowest Miocene mammal faunas.

7. All mammal species found are known elsewhere in Europe in localities of the same or closely similar age. As the Lisbon localities are placed in the extreme, westernmost part of Europe, they show once again that mammalian migrations happened rather quickly, geologically speaking; no barriers as mountain chains, rivers, etc. were enough to prevent immigrations to this land’s end.

8. As a whole, the Cloister fossil assemblage points out definitely to a warm environment compatible with a lagoon connected to the sea but protected by a barrier of hermatypic corals’ rich, *Venus ribeiroi* limestones. This area would be surrounded by rather dry terrestrial environments.

As a last comment, it is quite curious that when searching for two and a half century’s fossils we unexpectedly found other, 220 000 centuries’ ones. Hazards may count in Science!

**Acknowledgements**

Miguel Telles Antunes presents his best thanks to Mrs. Marie-Thérèse Mein for her help, Paulo Legoinha for stratigraphic and age data, and Carlos Galhano, who studied clay samples. We also recognize the contributions by the Main Editor, Luis Miguel Nieto Albert, and the anonymous referees for constructive suggestions. The drawings have been made by M.T. Antunes after photos by Marie-Thérèse Mein and sketches by Pierre Mein.

**References**


Bowdich, T. E. (1821): *An analysis of the natural classification of...*