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Gliridae (Mammalia, Rodentia) from the Zuurland boreholes near Rotterdam, the Netherlands

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The dormice from the Zuurland boreholes are described. Despite the scantiness of the material (there are only seven teeth available) it is possible to identify two taxa: *Eliomys briellensis* n. sp. and *Muscardinus pliocaenicus*. The finds confirm earlier suggestions that the 42-66 m depth range of the Zuurland boreholes contains a faunistic unity and that it can be dated to the Early Pleistocene.

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INTRODUCTION

Since about twenty years, mr Leen W. Hordijk has performed borings in the Zuurland polder (close to the ancient city of Brielle, province of Zuid Holland, some 30 km W of Rotterdam, The Netherlands) as a private project out of scientific curiosity. The technique employed is that of manual bailer sampling, by which means quite large amounts of sediment can be raised to the surface (Hordijk 1988 a,b). All borings have been executed in close vicinity; the longest distance between two borings is about 200 m. Preliminary results of part of the second boring (Zuurland-2) were published in a volume edited by Van Kolfschoten & De Boer (1988). Since that date much new material has been retrieved, both from the deeper levels of Zuurland-2 and from borings Zuurland-3, -4, -5, -6, and the highest levels of Zuurland-7. Not much material has so far been properly described. In an earlier paper (Reumer & Hordijk 1999) we described the Insectivora. Of the abundant rodent material, Van Kolfschoten (1998) described some *Allophaiomys* material and Van Kolfschoten & Tesakov (1998) described seven arvicolid molars belonging to an aberrant species: *Mimomys hordijki*.

MATERIAL AND METHODS

For descriptions of the boring techniques employed, we refer the reader to Hordijk (1988 a,b). The bailer sampling method employed enabled us to retrieve large amounts of sediment from certain levels that proved rich in fossils. This implies that not all levels have been equally sampled, so that there is no quantitative relationship between the levels. For example, in borings Zuurland-3, -4, -5, and -6, effort was concentrated on sampling material from depths between 14-15 m, 21-22 m, 42-44 m, 50-56 m, and between 62-65 m. The sediments recovered were sieved, and picked for the fossil content by mr Hordijk, who also selected the Gliridae from the total stock of small mammal fossils. The teeth were subsequently mounted on putty. Measurements were taken on a Leitz Ortholux microscope fitted with a movable stage and measuring clocks, at the Institute for Earth Sciences at Utrecht University. In the tables and the text, all measurements are given in millimetre units. Drawings were made on a Wild M5 binocular fitted with a drawing equipment. The material is stored in the private collection of mr Hordijk and is available for study upon request through the Natuurmuseum Rotterdam. The nomenclature of parts of the dental morphology is after Daams (1981).

In the descriptions below, the provenance of the material is indicated by the letter Z for Zuurland, the number of the borehole, followed by the depth in metres. E.g., Z4/62.85-64 means that the material originates from borehole Zuurland-4, at a depth of 62.85 to 64 m; and Z5/42-43 means borehole Zuurland-5 at a depth of 42 to 43 m.

TAXONOMY

Eliomys briellensis n. sp.

(Fig. 1 a,b,c,d)

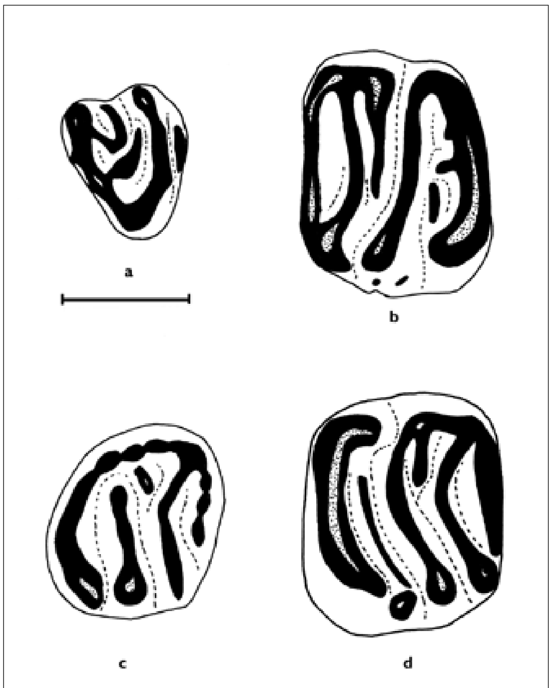

Figure 1 *Eliomys briellensis* n. sp. from Zuurland. **a** dP4 dex. from Z5/42-43, paratype; **b** m2 sin. from Z4/43-44, holotype; **c** m3 dex. from Z4/62.85-64; **d** m2 dex. from Z2/44-45, paratype. Bar = 1 mm [illustration: J.W.F. Reumer]

Material
1 dP4 dex. (Z5/42-43)
1 m2 sin. (Z4/43-44)
1 m2 dex. (Z2/44-45)
1 m3 dex. (Z4/62.85-64)

Measurements
dP4: L = 0.96, W = 1.13
m2: L = (1.55-) 1.565 (-1.58),
W = (1.87-) 1.88 (-1.89), n = 2
m3: L = 1.33, W = 1.56

Diagnosis: a large *Eliomys* species (the largest known so far) with a somewhat complicated dental pattern, with an m2 which is wider than long.

Differential diagnosis: *E. briellensis* n. sp. differs from all other continental *Eliomys* species by being larger; it differs from *E. assimilis* and *E. reductus* by having a relatively wide m2; from *E. quercinus* by having lower molars that are not notably trapezoidal.

Holotype: an m2 sin. from Z4/43-44 m (Fig. 1b).

Paratypes: an m2 dex. from Z2/44-45 m (Fig. 1d) and a dP4 dex. from Z5/42-43 m (Fig. 1a).

Type locality: Zuurland borehole number 4, at 43-44 m below surface (see Hordijk 1988a for descriptions of the locality).

Stratigraphical range: (probably Late) Tiglian.

Derivatio nominis: the new species is named after the city of Brielle (province of Zuid-Holland, the Netherlands), where mr. Hordijk lives and close to which (approx. 1.5 km SW of it) the Zuurland boreholes are located.

Description
dP4: the trigon is easily recognisable and the protoloph and metaloph are the strongest lophs. A small remnant of the anteroloph is

present halfway the anterior border. The anterior and posterior centrolophs are small and connected to the metaloph; the posterior centroloph is U-shaped.

m2: the two lower molars that are available each have six ridges/vestigial ridges. In the holotype specimen the anterolophid, metalophid and centrolophid form the anterior part of the tooth; the mesolophid and the strongly developed posterolophid form the posterior part, enclosing a small posterior extra ridge. There is no endolophid. In the other m2, the mesolophid connects to the metaconid instead of the entoconid and thus forms part of the anterior ridge complex. The posterior extra ridge is narrow but long and terminates in an accessory cuspid which is separated from the hypoconid by a narrow valley. The posterolophid thus is detached from the other ridges of the tooth.

m3: the third lower molar has five ridges, of which the centrolophid is only a small vestige. The posterolophid is connected by a lingual ridge (endolophid) to the metaconid to which also the anterolophid and the metalophid are connected. The mesolophid is a separate ridge. Both the anterolophid and the endolophid have little cuspules, giving them a bead-like appearance.

Discussion

So far, five species are known within the genus *Eliomys* (not counting the endemic Mediterranean island forms): the Pleistocene and Recent *E. quercinus* (L., 1766), *E. intermedius* FRIANT, 1953 (described from Sète, Pliocene MN15), *E. truci* MEIN & MICHAUX, 1970 (described from Hautimagne, Pliocene MN14), *E. assimilis* MAYR, 1979 and *E. reductus* MAYR, 1979 (both from Hammerschmiede, Late Miocene MN9). The latter species has an m1 and m2 with only five ridges (Mayr 1979, plate 1, figs. 9 & 10) and the illustrations show that the dental patterns are more simple in *E. reductus* than in our form. *E. assimilis* has six ridges in its lower molars (Mayr 1979, plate 13, figs. 11 & 12), but here too, as in *E. assimilis*, the teeth are longer than wide. It is unfortunate that Mayr (1979) did not provide measurements for his material, but if the statements about the enlargement of the illustrations in Mayr (1979) are correct (for which I have to reason to doubt), then the teeth of the two Miocene species are about one half smaller than our Zuurland material.

E. truci has six ridges in the lower molars (Van de Weerd 1976, plate 9, figs. 1 & 2) and its m3 has five ridges. Also, the absence of (a continuous) endoloph is a feature in common with our new species. Yet, *E. truci* is considerably smaller (Table 1) and conspecifity can be ruled out.

Table 1 Length and width of m2 of fossil *Eliomys* taxa. bold numbers = mean

taxon and provenance	L	W	reference
E. *briellensis* n. sp. Zuurland	.55-) **1.565** (-1.58)	(.87-) **.88** (- .89)	this paper
E. *intermedius* Orrios MN 15	1.30-) **.35** (-1.40)	59-) **.60** (- .61)	Van de Weerd 1976
E. *truci* Los Mansuetos MN 14	.12-) **1.187** (-1.24)	29-) **.337** (- .37)	ibid.
E. *truci* Concud 3 MN 4	.16-) **1.208** (-1.27)	27-) **.344** (- .46)	ibid.
E. *assimilis* Hammerschmiede MN9	not given, but L > W		Mayr 1979
E. *reductus* Hammerschmiede MN9	not given, but L > W		Mayr 1979

E. intermedius is also smaller, although less so than *E. truci*. The morphology of its m2 (see Van de Weerd 1976, plate 9, fig. 12) comes close to our molars: a somewhat complicated pattern, six ridges or vestiges of ridges, absence of (a continuous) endoloph. The m3 (Van de Weerd 1976, p. 144) has the same ridges as our m3, including a very short centrolophid.

E. quercinus has yet another morphology: higher cuspids, hence a more concave occlusal surface; stronger antero-posterior compression of the molars, and it is also somewhat smaller. Also, *E. quercinus* has lower molars that are narrower anteriorly than posteriorly (which gives the molars a trapezoidal shape in occlusal view). *E. quercinus* is the only living representative of the genus. Its stratigraphic distribution in NW Europe is not well known; in Poland it is reported from the Late Biharian onward (Daoud 1993), which is supposedly younger than our (Late) Tiglian material. An overview of the distribution of *Eliomys quercinus* in European Early Pleistocene localities is provided by Maul (1990). It is also shown by Maul (1990) that quite many Early Pleistocene localities have only '*E*. sp.' published; it would be interesting to see whether or not such identifications concern *E. briellensis* n. sp.

***Muscardinus pliocaenicus* KOWALSKI, 1963**
(Fig. 2 a,b,c)

Material
1 M2 sin. (Z2/54-55)
2 m1 dex. (Z5/42-43 and Z6/64.25-65)

Measurements
M2: L = 1.35, W = 1.23
m1 : L = 1.40, W = (1.02-) 1.035 (-1.05), n = 2

Description
M2: the tooth is almost square in occlusal view and has six ridges running from lingual to buccal, and two small vestigial ridges

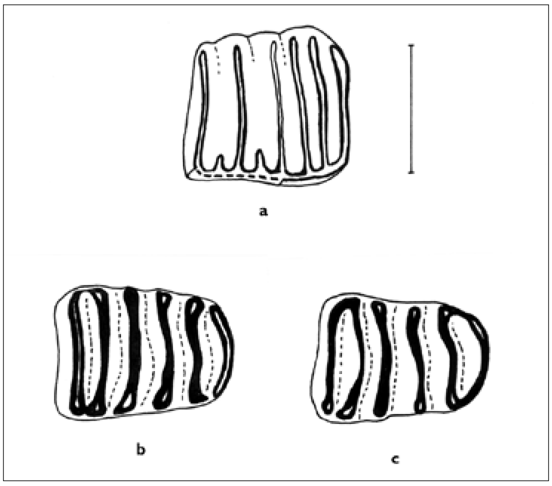

Figure 2 *Muscardinus pliocaenicus* KOWALSKI, 1963 from Zuurland. **a** M2 sin. from Z2/54-55; **b** m1 dex. from Z5/42-43; **c** m1 dex. from Z6/64.25-65. Bar = 1 mm [illustration: J.W.F. Reumer]

protruding from the lingual endoloph. The tooth has four roots.

m1: both available m1's are very similar, having six ridges running parallel across the tooth. The two most anterior ridges are joining in one specimen, thus encircling a basin.

Discussion
The morphology of the teeth does not differ significantly from that of recent *M. avellanarius*. Several species of *Muscardinus* of Pliocene and Early Pleistocene age are mentioned in the literature (see Daams & De Bruijn 1995): apart from the insular form *M. cyclopeus* AGUSTI, MOYÁ-SOLA ET PONS-MOYÁ, 1982 which needs no further consideration, these are *M. dacicus* KORMOS, 1930 (Betfia, E. Pleistocene), *M. helleri* FEJFAR ET STORCH, 1990 (Gundersheim, MN15), and *M. pliocaenicus* KOWALSKI, 1963 (Weze, MN15). The morphological differences between these taxa are vague, except for *M. helleri*.

Of these Plio/Pleistocene species, *M. dacicus* has L = 1.77 and W = 1.49 for the M2 and is thus much larger (see Table 2). *M. helleri* can be excluded due to its different morphology and larger sizes: both M2 and m1 of *M. helle* -

Table 2 Length and width of M2 of Plio/Pleistocene and recent *Muscardinus* taxa. bold numbers = mean

taxon and provenance	L	W	reference
M. pliocaenicus Zuurland	**.35**	**.23**	this paper
M. pliocaenicus Eichkogel	1.19-1.40	.17-1.45	Daxner & De Bruijn 198
M. pliocaenicus Podlesice	(17-) **.23** (- .33)	1.23-) **.27** (- .36)	Daoud 1993
M. pliocaenicus Panska Gora	(1.20-) **.27** (- .34)	(1.26-) **.30** (- .35)	ibid.
M. pliocaenicus Weze	**1.19**	**1.22**	ibid.
M. pliocaenicus Rebielice Krol. IA	**.17**	**.22**	ibid.
M. avellanarius Kozi Grzbiet	.24-) **.35** (-1.44)	1.25-) **.32** (-1.39)	ibid.
M. avellanarius Recent Poland	.24-) **.36** (- .46)	(1.25-) **.33** (- .40)	ibid.
M. helleri Gundersheim	**.40**	1.52-) **.54** (- .56)	Fejfar & Storch 1990
M. dacicus Podlesice	(1.75-) **.77** (-1.79)	1.48-) **.49** (- .50)	Daoud 1993

ri differ considerably from our material. M2 of *M. helleri* is relatively shorter (L = 1.40, W = 1.52) and it has eight ridges (Fejfar & Storch 1990) instead of six ridges plus one or two vestiges. In m1 we see a considerable widening in posterior direction and ridges that are showing greater curvature; its width (W = 1.44 and 1.48 in two specimens) is much larger than in our tooth (see Table 3).

Daoud (1993) treats his Polish material morphologically as '*M. pliocaenicus - avellanarius* group', thus emphasising the similarity between these two taxa. He describes the M2 as follows: 'four-rooted, crown built of six ridges interconnected on lingual side. Distance between three anterior ridges rather great, other ridges are placed very close to each other; one additional ridge situated lingually'. This description conforms our specimen, except for a second additional ridge placed lingually in our M2. Daoud (1993), however, distinguishes between *M. pliocaenicus* and *M. avellanarius* by the size, *M. pliocaenicus* being 'distinctly smaller' than *M. avellanarius. M. pliocaenicus* is known from Pliocene localities, *M. avellanarius* 'has lived in Europe since the Early Pleistocene, but its remains are nowhere numerous' (Daoud 1993).

We thus have to rely on the sizes of our three teeth to give them a species identification. Tables 2 (sizes of M2) and 3 (sizes of m1) clearly indicate that our Zuurland hazelmouse belongs to *Muscardinus pliocaenicus*. Only the length of M2 (mean = 1.35 mm) is somewhat large, yet it falls within the ranges of *M. pliocaenicus* from Eichkogel. The other available data unambiguously indicate *M. pliocaenicus.* The species has probably been reported from the Pleistocene before: Clot *et al.* (1976 a,b) mention *Muscardinus* cf. *pliocaenicus* from the Late Tiglian fauna of Montoussé 5 in France.

So far one record of a *Muscardinus* has been reported from the Netherlands: it concerns two teeth (m1 and M1) from Tegelen (Freudenthal *et al.* 1976). The teeth were identified as *Muscardinus* cf. *avellanarius.* Measurements were not given, only photographic illustrations of the two teeth at a 22x enlargement (Freudenthal *et al.*, plate 2, pp. 26-27). If this enlargement is correct, the measuring of the photograph of m1 gives as a result L = 1.50 mm and W = 1.07 mm. Comparison of these sizes with the data from Table 3 seems to indicate that the Tegelen material belongs to *M. pliocaenicus.* We have to await a forthcoming study of the Tegelen non-Arvicoline rodents to falsify this preliminary conclusion.

Table 3 Length and width of m1 of Plio/Pleistocene and recent *Muscardinus* taxa. bold numbers = mean

taxon and provenance	L	W	reference
M. pliocaenicus Zuurland	**.40**	(1.02-) **.035** (- 1.05)	this paper
M. pliocaenicus Eichkogel	1.30-1.50	.02-1.26	Daxner & De Bruijn 198
M. pliocaenicus Gundersheim	**.36**	**.00**	Fejfar & Storch 1990
M. pliocaenicus Podlesice	(1.36-) **.60** (- 1.69)	(0.94-) **.10** (- 18)	Daoud 1993
M. pliocaenicus Panska Gora	(1.48-) **.54** (- 1.61)	(0.95-) **.06** (- 6)	ibid.
M. pliocaenicus Weze	**.62**	**.10**	ibid.
M. pliocaenicus Rebielice Krol. 1A (	1.62-) **.67** (- 73)	1. 1-) **.13** (- 15)	ibid.
M. avellanarius Kozi Grzbiet	(1.61-) **.76** (- 1.86)	(1.08-) **.18** (- .28)	ibid.
M. avellanarius 'Late Quaternary'	(1.80-) **.85** (- 1.91)	1.20-) **.26** (- .30)	ibid.
M. avellanarius Recent Poland	(1.70-) **.80** (- 1.94)	1.20-) **.30** (- .37)	ibid.
M. helleri Gundersheim		1.44-) **.46** (- .48)	Fejfar & Storch 1990
M. dacicus Podlesice	(1.91-) **2.09** (-2.27)	1.30-) **.39** (- .47)	Daoud 1993
M. dacicus Panska Gora	**2.20**	**.56**	ibid.

GENERAL DISCUSSION

In this paper two dormouse species are reported from the Zuurland boreholes. Although the available material is extremely scanty, it can all be identified to belong to two taxa: *Eliomys briellensis* n. sp. and *Muscardinus pliocaenicus*. The first species is new and can thus not be correlated biostratigraphically; the latter species, though new for the Netherlands, is known from quite a few Pliocene localities and probably also from the Late Tiglian of Montoussé 5. It thus indicates not younger than an Early Pleistocene age. Both taxa are found in levels between 42 and 64 (*E. briellensis*), respectively between 42 and 65 (*M. pliocaenicus*) metres below surface. This is another confirmation of our earlier statement (Reumer & Hordijk 1999) that the entire range of levels between (at least) 42 and 66 m depth comprise a faunistic unity and that they should be dated to the (Late) Tiglian.

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