An abnormal enamel pattern of the first lower molar (M_1) in a field vole (*Microtus agrestis*) from the province of Zeeland, the Netherlands

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Abstract: In barn owl (*Tyto alba*) pellets, a skull from a field vole (*Microtus agrestis*) was found with an abnormal dental pattern. The enamel ridge of the first right lower molar displayed a 'capital M' outline. The rim of the root was thin (as in a regular M_1 molar), without irregularities or thickenings. Other morphs described in field voles and even the 22 morphotypes of other European and Asian arvicoline species within the genera *Alexandromys* and *Microtus* do not bear any resemblance to this specimen. The very rare abnormality in this field vole can be described as the 'syndrome of the unilateral missing lingual re-entrant angles of the anterior cap complex of M_1.' It is hypothesized that the form wasn´t caused by an infection, abnormal growth after an accident or tumour growth but most probably by an epigenetic condition.

Keywords: field vole, *Microtus agrestis*, lower first molar M_1, re-entrant angle, anterior cap complex, province of Zeeland, the Netherlands.

Amidst some 2000 skull and mandibles of field voles (*Microtus agrestis*) extracted from barn owl (*Tyto alba*) pellets from different places in the province of Zeeland, the Netherlands, one specimen immediately attracted attention. The first right lower molar (M_1) of this specimen displayed an abnormal shape: a molar without a single closed triangle and with a buccal enamel ridge forming a 'capital-M' outline (figure 1). Both middle upper molars (M^2) of NHG26739 show the characteristic postero-internal lobe ('*agrestis*-Schlinge') for field voles. The enamel pattern of M_1 of the left mandible shows a 'normal' morph (see figure 4a). The skull measurements are within the range provided by Krapp & Niethammer (1982), indicating this is compatible with a (sub)adult specimen.

The specimen originates from a pellet sample collected June 1999 in Poortvliet (Tholen); both mandibles and the cranium are preserved with the number NHG26739 and have been added to the collection of the Koninklijk Zeeuwsch Genootschap der Wetenschappen (KZWG, Royal Zeeland Scientific Society), located in the Zeeuws Museum in Middelburg, in the province of Zeeland.

The description of the elements of the occlusal surface of M_1 in this short note follows the nomenclature of Van der Meulen & Zagwijn (1974) (figure 2). Surface elements in addition to those presented in figure 2 are extended with a novel numeration.

The occlusal surface of the first right lower

Figure 1. Occlusal view of the right lower molar row of field vole NHG26739. Red arrow: first molar (M_1).

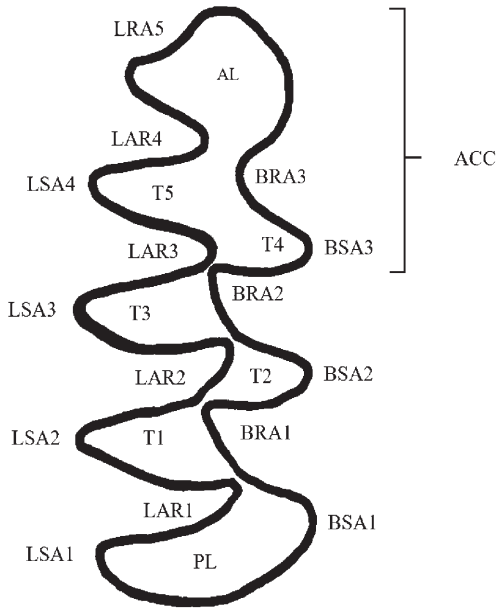

Figure 2. Elements of the occlusal surface of the right M_1 in *Microtus* (and *Alexandromys*) species (after van der Meulen & Zagwijn 1974). PL: posterior loop, AL: anterior loop, ACC: anteroconide complex, T1-T5: triangular loops of the occlusal surface, LSA2-LSA4: lingual salient angles (the lingual side of PL can be regarded as LSA1), LRA1-LRA5: lingual re-entrant angles, BRA1-BRA4: buccal re-entrant angles, BSA1-BSA5: buccal salient angles.

molar of specimen NHG26739 shows two dentine fields: the posterior loop (PL) and the anteroconid complex in which the anterior cap (AC1) is broadly linked with T1, T2 and T3. Two salient angles are present on the lingual side: LSA1 on the posterior loop and LSA2 on the basis of the anteroconid complex. On the lingual side only one re-entrant angle is present (LRA1). On the buccal side four salient angles are present: BSA1 is part of the posterior loop, while BSA2 and BSA3 originate from the anteroconid complex and BSA4 is the buccal-side bended tip of the anterior cap. All three buccal re-entrant angles, BRA1, BRA2 and BRA3, are part of the anteroconid complex with BSA2, BRA2 and BSA3 together forming the 'capital M'.

Furthermore, specimen NHG26739 shows some peculiarities:

- The lingual occlusal enamel rim of M_1 is slightly thickened (figure 3b);
- From the lingual view only one groove of the re-entrant angle is present (figure 3g);
- From the buccal view three grooves of re-entrant angles are present (figure 3h);
- The rim of the root is thin (as in a regular M_1 molar) and exhibits no signs of irregularities or thickenings (figure 3d);
- The alveolus of M_1 is slightly broadened and lacks the presence of ribs on the lingual side, which are normally present for the collagen attachment between molars and the alveolus (figure 3j).
- The occlusal length of M_1 right is slightly shorter than M_1 left, 2.50 mm as opposed to 2.90 mm.

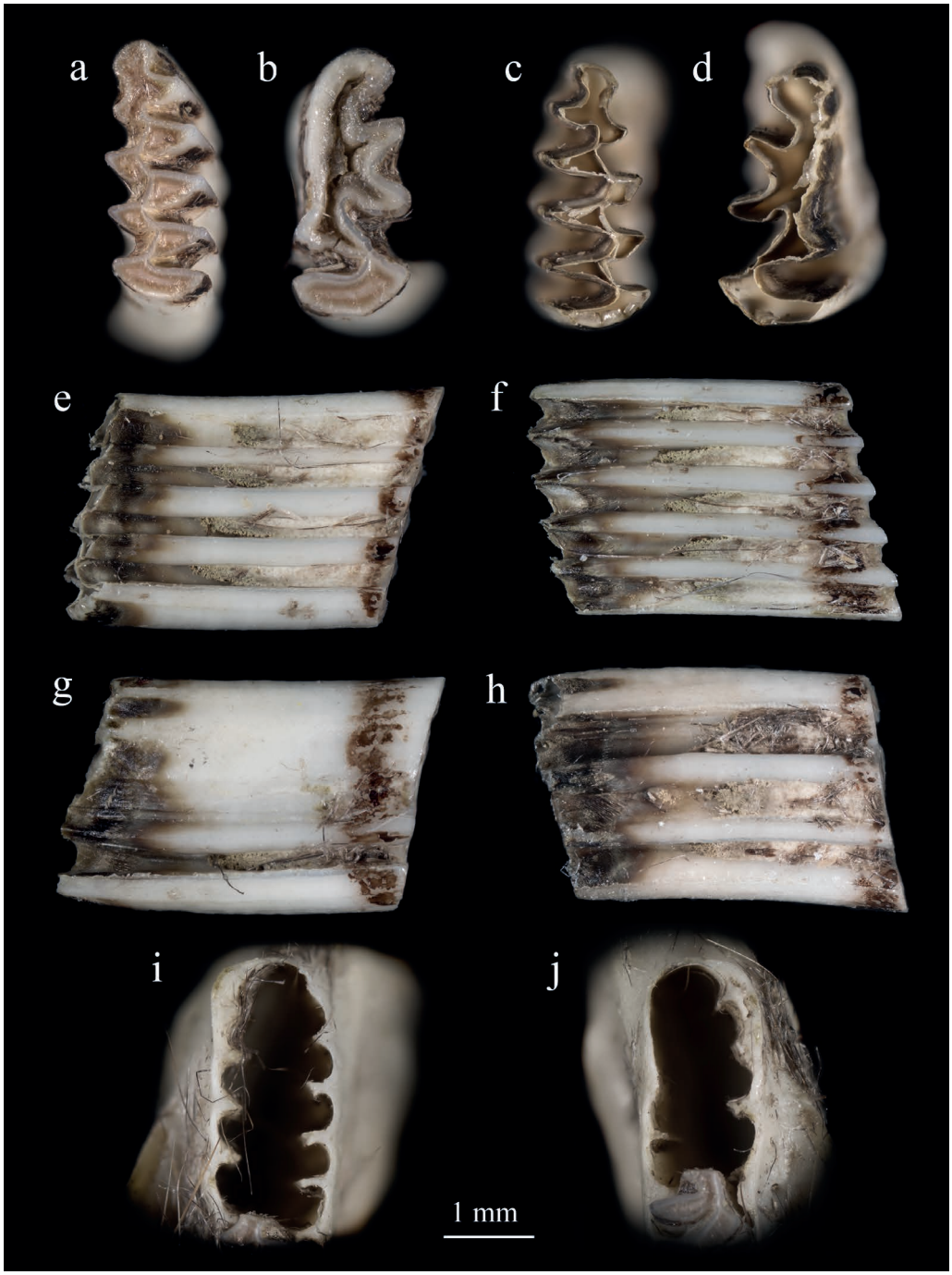

Figure 3. Views of the left (a, c, e, f, and i) and right (b, d, g, h and j) first molar (M_1) including its alveoli of field vole NHG26739. Top row: occlusal views (left), views at the rim of the root (right); second row: lingual and buccal views of left M_1; third row: lingual and buccal views of right M_1; fourth row: alveolar views. *Photos (focus-stacked images): Ben Verboom*.

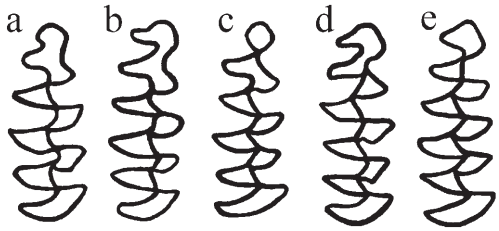

Figure 4. Schematic impression of morphs of the right first lower molar M_1 of the field vole, after Kapischke et al. (2009). a: 'normal'; b: 'oeconomus+'; c: 'maskii'; d: 'oeconomus ++'; e: 'arvalis/agrestis ++'.

- The measurements of the right and left lower molar row were 5.90 and 5.50 mm respectively.

The most common pattern of the enamel ridge of M_1 in field voles is a posterior crescent loop, an anterior loop with three lobes between five alternating triangles, three lingual and two buccal, here further described as '*normal*' (figure 4a). As early as 1905 Rörig & Börner and, later on, many other authors (e.g. Zimmermann 1956, Reichstein & Reise 1965, Reichstein 1966 and Reinwald 1967) described other morphs of the molar pattern in field voles from different German federal states. Other morphs of M_1 in field voles from Russia (Ognev 1950) and Italy (Locatelli & Paolucci 1995) have also been described. Recently Kapischke (1992), Jentzsch (2006) and Kapischke et al. (2009) described more different morphs of this molar: '*maski*', '*oeconomus*+', '*oeconomus*++' and '*arvalis/agrestis*++' (figure 4b-e). The description of these morphs starts with the variations with five closed triangles and characterized as: a. 'Normal': with anterior and posterior loop. b. 'Oeconomus +': an additional salient angle on the lingual side, mimicking the characteristic 'knight-form' (similar to the knight symbol in chess). c. 'Maskii': with a constricted and separated apical knob on the anterior loop. Patterns with six closed triangles consist of: d. 'Oeconomus ++': the enamel pattern as in b) with a buccal at a constricted salient angle. Morphs, that have been described as 'arvalis/agrestis ++' have seven closed dental triangles, shown in e). Frequencies of these morphs in field voles vary across Europe; for instance in two German federal states (Bavaria and Saxony-Anhalt) the frequencies for 'normal' molars are about 69%, and about 25% for 'oeconomus +', with the other morphs accounting for less than 5%.

Angermann (1974) depicted '*maskii*' (as in figure 4c) and '*oeconomus*', the latter with two closed triangles on the lingual buccal sides. The '*oeconomus*' morph should be presented with the cranium in a ventral view to rule out confusion with those of root voles (*M. oeconomus*); therefore this morph is not presented here.

Recently Synyavska & Peskov (2020) described 22 morphotypes of European and Asian arvicoline species within the genus *Alexandromys* and *Microtus* with depictions of the anteroconide complexes. In those depicted morphotypes two or three lingual salient angles of the anteroconide complexes are present, making four or five of these angles on the whole lingual side of the M_1. None of the described morphs in figure 4 show any similarity to the occlusal pattern of the right first lower molar of specimen NHG26739.

Bilateral asymmetry of the morphotype dental pattern has been observed in various studies. In a study of morphotype dental patterns in the narrow-headed vole (*M. gregalis*), within-individual differences among right and left molars, when present, suggests that bilateral asymmetry of the morphotype dental pattern could be regarded as an inherent characteristic of an individual (Markova et al. 2013). Polly et al. (2011), investigating contralateral M_1s from the same individual using Procrustes distance, a form of nearest-neighbour matching, found that 15 out of 24 (63%) *M. agrestis* did not match. Kapischke et al. (2009) found 'oeconomus+-morph' in field voles to be symmetrically present on both sides in most cases and just occasionally on one side only.

In the narrow-headed vole, age differences in morphotype dental patterns of specimens

of one month and older were non-significant and negligible compared to among-individual variation (Markova et al. 2013). It seems safe to assume that morphotype dental patterns in field voles older than one month remain the same and specimen NHG26739, estimated to be a (sub)adult individual, has at least had its differences in the first lower molar patterns since its first month of its life.

The buccal and lingual views as well as the aspect of the right alveolus of M_1 (see figure 3g, h and j) shows smooth molar sides and no signs of overgrowths of enamel, dentin or cementum, characteristic for odontomas (Boyd 1961) or complex odontomas (Nelson & Thompson 2010). Based on these observations the origin of this abnormal molar seems unlikely to be a (post)-infectious dental condition, an abnormal growth after an accident or of neoplastic origin. The unilaterality of the abnormality and the exclusion of other causes make an epigenetic condition most probable.

Changes towards increased complexity of the first lower molars in field voles start from the mesial part of the tooth, this is the anterior cap complex (Kapischke et al. 2009). All the variations of the described morphs of the enamel pattern in field voles in the first lower molar are expressed by the number of constrictions, resulting from salient angles originating from the lingual or buccal enamel ridges. Changes occurring in a more distal region of the molar, mostly show reductions in complexity (Kapischke et al. 2009). Several authors refer to the different frequencies of the numbers of triangles in these different morphs, depending on the longitudes. The findings of Reichstein & Reise (1965) suggest that there may be some general vegetational factors since field voles have some dental variations that are simpler (less complex) in north western Germany and Denmark than in other parts of Germany. Guthrie (1971) suggests the higher frequency of field voles that have simpler teeth in somewhat the same area as common voles, might be explained by increasing competition between these species.

A reduction of two salient angles just on the lingual side in the anterior cap complex of the (right) M_1 is not in line with the stepwise changes of morphs. In specimen NHG26739, this pattern is present on the right buccal side of M_1,; however, there is no formation of angles on the lingual side of this molar. The abnormal enamel pattern of the first lower molar (M_1) in specimen NHG26739 does not belong to the regular variations of field voles, nor of other European and Asian species of the genus *Alexandromys* and *Microtus*. Therefore the deviation described here, has to be considered as a very rare abnormality. The proposed description for the abnormal enamel pattern in this field vole is the 'syndrome of the unilateral missing lingual re-entrant angles of the anterior cap complex of M_1'.

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Samenvatting

Een afwijkend emailpatroon van de eerste onderkies (M_1) bij een aardmuis uit de provincie Zeeland

In overblijfselen van een aardmuis (*Microtus agrestis*) (specimen NHG26739) afkomstig uit braakballen van een kerkuil (*Tyto alba*) werd een opvallende afwijking vastgesteld. De emaillerand van de voorste kies in de onderkaak heeft aan de wangzijde de vorm van een hoofdletter 'M'. De rand van de wortel is dun, zonder onregelmatigheden of verdikkingen, wat er op wijst dat deze kies niet kan worden omschreven als een element na een infectie, abnormale groei na een ongeval of een van de kies afkomstige tumor. Het "normale" patroon van de voorste kies in de onderkaak van de aardmuis kenmerkt zich door een achterste halvemaanvormige lus aan de achterzijde, een lus met drie lobben aan de voorzijde en daartussen vijf driehoeken, afwisselend drie aan de tongzijde en twee aan de wangzijde. Dit "normale" patroon, de andere bekende patronen ('morphs') van de aardmuis en zelfs de 22 verschillende morphotypes van andere soorten behorende tot de geslachten *Alexandromys* en *Microtus* uit Europa of Azië vertonen geen enkele gelijkenis met specimen NHG26739.

De zeer zeldzame afwijking van de onderste eerste molaar in deze aardmuis kan worden omschreven als het 'syndroom van de unilateraal, ontbrekende, inspringende hoeken aan de tongzijde van het voorste kapcomplex'. De afwijking is hoogst waarschijnlijk veroorzaakt door een epigenetische verandering.

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