



General Palaeontology, Systematics, and Evolution (Vertebrate Paleontology)

First record of late middle Miocene Moschidae from Turkey: *Micromeryx* and *Hispanomeryx* from Catakbağyaka (Muğla, SW Turkey)



Premier enregistrement de Moschidae de la fin du Miocène moyen de Turquie : Micromeryx et Hispanomeryx de Catakbağyaka (Mugla, Sud-Ouest de la Turquie)

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ABSTRACT

Here, we describe remains of *Micromeryx* sp. and *Hispanomeryx* sp. from the middle Miocene locality Catakbağyaka (MN 7/8). This is the first record for Miocene Moschidae for the late middle Miocene in Turkey and verifies the importance of Turkey as a corridor for the dispersal of Eurasian mammals. Furthermore, the record from Catakbağyaka confirms that the sympatric co-occurrence of two Miocene moschid taxa in one locality appears to be a common phenomenon.

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RÉSUMÉ

Nous décrivons dans cet article des restes de *Micromeryx* sp. et *Hispanomeryx* sp. de la localité Catakbağyaka du Miocène moyen (MN 7/8). Ceci est le premier enregistrement de Moschidae miocènes de la fin du Miocène moyen en Turquie, qui confirme l'importance de la Turquie comme corridor pour la dispersion des mammifères eurasiens. En outre, l'enregistrement à Catakbağyaka confirme que la co-occurrence sympatrique de deux taxa de moschidés miocènes dans une seule et même localité apparaît comme un phénomène commun.

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1. Introduction

Moschidae are an enigmatic group of Pecora lacking cranial appendages and showing elongated upper canines in the males. Today, the family is restricted to Asia and represented by only one genus, *Moschus* (Groves, 2011). During the Miocene the family was wider spread and far more diverse with at least two genera and at least ten species described so far. The family is known with a rich record from central and western Europe (Aiglstorfer and Costeur, 2013; Aiglstorfer et al., 2014; Aiglstorfer et al., 2017; Sánchez and Morales, 2008; Sánchez et al., 2009; Sánchez et al., 2010). From the eastern part of Europe to Asia the record is far more limited, however (Alaburić and Radović, 2016; Pickford et al., 2000; Sánchez et al., 2011; Wang et al., 2015). For Turkey only tentative descriptions on moschids were given for the early middle Miocene localities Paşalar and Çandır (Gentry, 1990; Geraads, 2003; Moyà-Solà, 1986), but younger records are still unknown. Here, we describe the first record of the family for the late middle Miocene of Turkey and show the co-occurrence of both middle Miocene genera, *Micromeryx* and *Hispanomeryx*, for this area.

1.1. Historical background

During 1965 to 1970, a joint project called “Lignite Deposits Exploration in Turkey”, conducted by a group of German and Turkish geologists, led to the discovery of new fossil mammalian localities throughout western and central Anatolia (Becker-Platen, 1970; Sickenberg et al., 1975). This exploration delivered 20 Neogene localities from the Yatağan Basin (Saraç, 2003; Sickenberg et al., 1975), a SE-trending graben, ~15 km wide and ~50 km long, located near the town of Muğla (Alcicek, 2010). The Yatağan Basin is divided by a metamorphic bedrock horst (belonging to the Menderes Massif) into a larger main basin and southeast-trending sub-basins (Tınaz, Eskişehir, and Bağyaka; Bouchal et al., 2017). The Yatağan Basin is well known for its taxonomically rich record of Turolian localities. However, the late middle Miocene (MN7/8) is represented by only one single locality, Çatakbağyaka, in the sub-basin of Bağyaka.

The preliminary palaeontological field studies in the late 1960s and early 1970s at Çatakbağyaka produced quite a modest mammalian assemblage. Most of the mammal material recovered from Çatakbağyaka was transferred to museums and institutions in Germany (BGR, GPIH, SMNS, SNSB-BSPG). Although the first faunal lists given by Sickenberg et al. (1975) and Tobien (1974) included a quite diverse fauna, most of the large mammal groups recorded there (carnivores, cervids, giraffids, and equids) have not been described systematically so far. Other groups have been studied in more detail. The proboscideans were referred to *Zygodon tapiroides* and *Choerolophodon* sp. by Gaziry (1976). Recently, the latter specimen was assigned to *C. anatolicus*, a species well-known from Turkish Vallesian (MN9–10) localities, by Mayda et al. (2016). The Rhinocerotidae from Çatakbağyaka were originally described in detail by Heissig (1975) as *Brachytherium brachypus*, *Alicornops simorrensis* and

Hispanotherium grimmi. Of the ruminants only a few bovid specimens were initially studied by Köhler (1987). Based on the material she erected a new species, *Protoryx enanus*. The study on moschids, presented here, is the first since that time dealing with the fairly rich record of ruminants from the locality. Equid remains, initially reported as *Anchitherium* sp. (Sickenberg et al., 1975), are now considered to be a new species (dental morphology and metrics exhibit advanced features comparing the common *A. aureliense* from Eurasian middle Miocene (MN4–6) faunas (Mayda et al., 2016)). The carnivore material listed as *Amphicyon* sp. by Sickenberg et al. (1975) was later duly updated to *Ursinae* sp. by Schmidt-Kittler (1976). The preliminary Çatakbağyaka micromammal faunal list was given by Sickenberg et al. (1975) as *Amphilagus fontannesii* and *Stenofiber* cf. *jaegeri*. Ünay (1975) erected a new subspecies, *S. minutus ozansoyi* for the small castorids of this locality. Recently, Prieto et al. (2014) consider this taxon to be a junior synonym of *Euroxenomys minutus minutus*. So far, the mammal fauna of the Çatakbağyaka locality fits best with an age of middle to late middle Miocene.

In contrast to the studies based on mammalian remains, palynological studies at first referred the locality to an earlier age (early middle Miocene; MN5) (Biltekin, 2010; Jiménez-Moreno, 2005; Jiménez-Moreno et al., 2007). However, intense palynological investigations in South-western Anatolia, including data from the Çatakbağyaka locality, in combination with a new evaluation of the mammal fauna, find a good accordance with middle to late middle Miocene age (Bouchal et al., 2016, 2017; Yavuz-Işik et al., 2011) and will provide a better idea about the palaeoenvironment in this area during the Miocene.

1.2. Geographic and geologic setting, stratigraphy

The Çatakbağyaka mammal site is located to the South of the Yatağan Basin, near the village of Çatakbağyaka, ca. 20 km west of the Muğla town and 10 km south of the Tınaz lignite mine (Fig. 1). The sedimentary succession in the basin was first described and dated by Becker-Platen (1970), who considered it to be a single formation and divided it into four members (Turgut, Sekköy, Yatağan and Milet). Later on, Atalay (1980) revised this lithostratigraphy and distinguished three units: the Eskişehir Formation, including the Turgut and Sekköy members; the Yatağan Formation, including Madenler, Bayır and Bozarmut members; and the Milet Formation (Kaya et al., 2012; Fig. 2). The fluvio-lacustrine deposits of Çatakbağyaka which have yielded both large and small mammals were recovered from lower layers of the Sekköy Member.

2. Material and methods

The moschid material from Çatakbağyaka was excavated during the joint project “Lignite Deposits Exploration in Turkey” mentioned above.

It comprises isolated dental remains and a fragmented distal humerus. Field labels assign the material to Catak MC/2I and 3I, which comprises different finding sites in the opencast pit of Çatakbağyaka. The dental material shows a smoothed surface as it typically results from fluvial

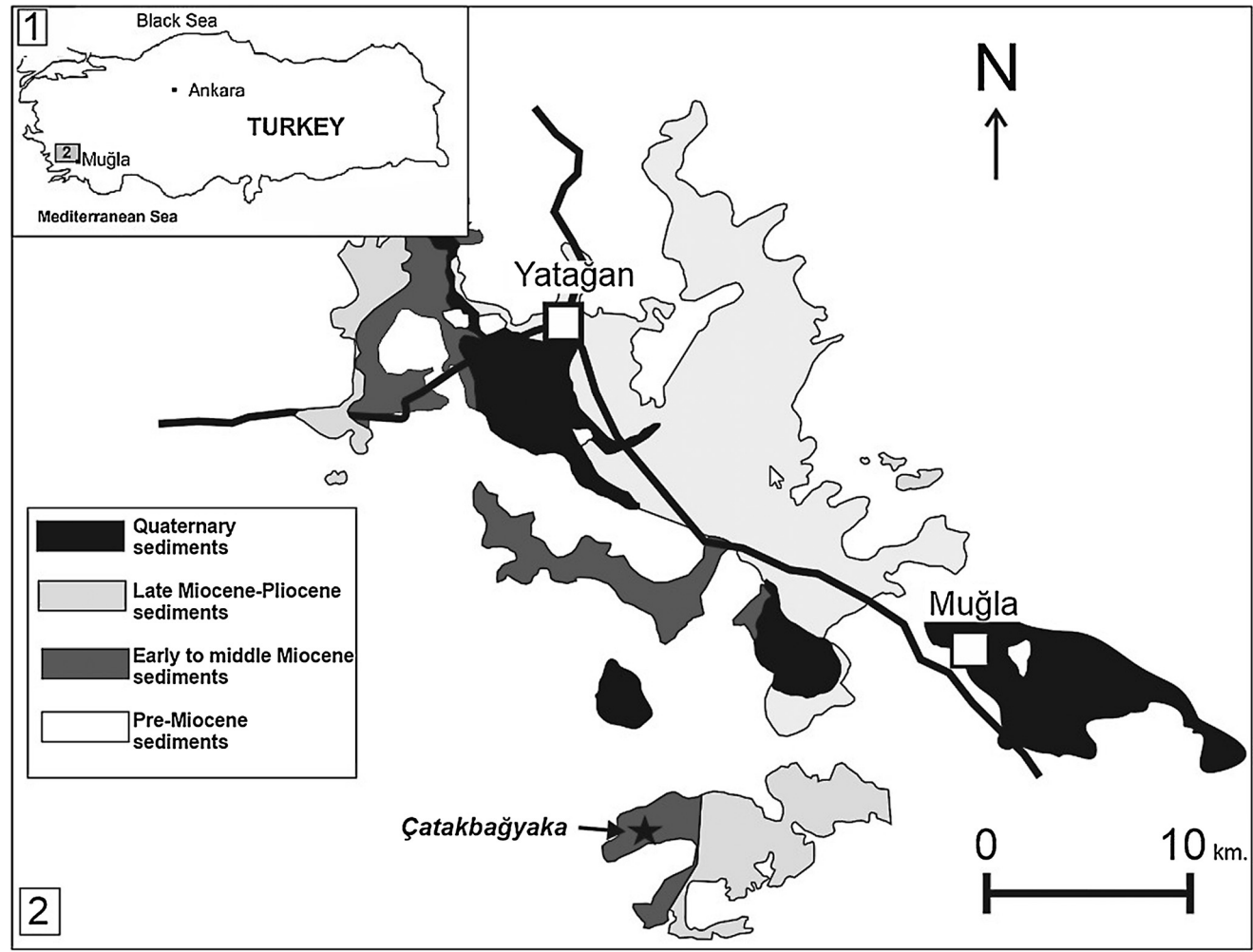


Fig. 1. Geographical (1) and regional geological map (2) of Muğla-Yatağan Basin [simplified map based on Bouchal et al. (2017)].
Fig. 1. Carte géographique (1) et géologique régionale (2) du bassin de Muğla-Yatağan [carte simplifiée basée sur Bouchal et al. (2017)].

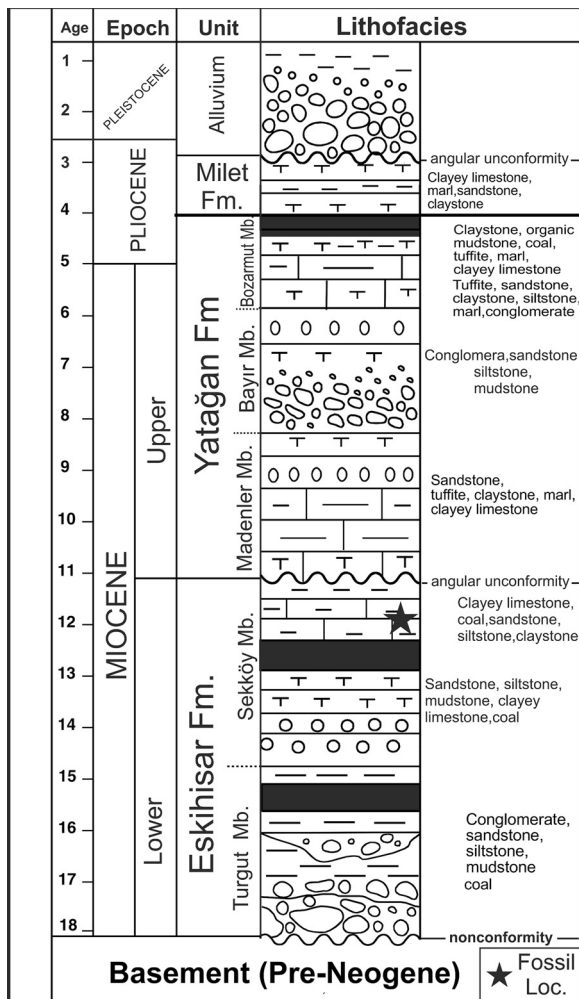


Fig. 2. Lithostratigraphy of the Muğla-Yatağan Basin with Catakbağyaka Locality (star) [modified after Kaya et al. (2012)].

Fig. 2. Lithostratigraphie du bassin de Muğla-Yatağan avec la localité de Catakbağyaka (étoile) [modifiée d'après Kaya et al. (2012)].

transport. This preservation would fit well to the main fossil horizon in Catakbağyaka, described as coarse sand and interpreted as small fluvial channels by Sickenberg et al. (1975).

The material is stored at the Staatliches Museum für Naturkunde Stuttgart at the moment and referred to with the preliminary numbers Catak-Rum for Catakbağyaka Ruminants.

Catak-Rum-1 (p4 sin. (l (max)=7.2 mm; w (max)=3.7 mm))

Catak-Rum-2 (m1? sin. (l (max)=7.7; w ant (max)=4.8 mm))

Catak-Rum-3 (P4 dex. (l (max)=5.8 mm; w (max)=6.5 mm))

Catak-Rum-4 (M2(?) dex.; l (max)=8 mm; w (max)=7.9 mm; w ant (max)=7.9 mm)

Catak-Rum-5 (M1? sin.; l (max)=7.6; w (max)=7.7; w ant (max)=7.8 mm)

Catak-Rum-6; MCI/192 (distal right humerus fragment; distal dorsopalmar width = 15.3 mm; distal mediolateral width = 18 mm)

Catak-Rum-7 (m3 dex. (l (max)=12.1 mm; w ant (max)=5 mm))

2.1. Terminology and Methods

Terminology for teeth follows Bärmann and Rössner (2011) and for bones Barone (1999) and Nickel et al. (1968). Measurements were done with digital callipers and for dental material follow modified Rössner (1995); precision is ± 0.2 mm for single tooth measurements.

2.2. Abbreviations

l (max) maximal length of tooth

w (max) maximal width of tooth (in upper molars measured perpendicular to linear from parastyle/paracone rib to mesostyle)

w ant (max) maximal anterior width of tooth

BGR Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, Germany

GPIH Institut für Geologie, Universität Hamburg, Hamburg, Germany

SMNS Staatliches Museum für Naturkunde Stuttgart, Germany

SNSB-BSPG Staatliche Naturwissenschaftliche Sammlungen Bayerns Bayerische Staatssammlung für Paläontologie und Geologie, München, Germany

3. Systematic palaeontology

Class Mammalia Linnaeus, 1758

Order Artiodactyla Owen, 1848

Suborder Ruminantia Scopoli, 1777

Infraorder Pecora Linnaeus, 1758

Family Moschidae Gray, 1821

Genus *Micromeryx* Lartet, 1851

Type species: *Micromeryx flourensianus* Lartet, 1851

Micromeryx sp.

The upper P4 dex. (Catak-Rum-3; l [max]=5.8 mm; w [max]=6.5 mm) (Fig. 3) is worn. It has a triangular to rectangular shape with a strongly rounded lingual side. The tooth has a simple tooth crown structure with a single lingual and a single labial cone, as well as a fairly pronounced anterior style, a weak rib at the labial cone, and a posterior style. There is no cingulum.

In morphology, the tooth fits well to *Micromeryx*. It is a little larger than most records for this genus, but is still in the upper part of the size range of *M. flourensianus* from Steinheim am Albuch and of *M. azanzae* (Fig. 4). The P4 of *Hispanomeryx daamsi* have a similar length as well. However, P4 of *Hispanomeryx* are usually less wide in ratio to the length, which gives them a more triangular shape than it is the case in *Micromeryx* and the tooth from Catakbağyaka. Therefore, we decided to assign the tooth to the genus

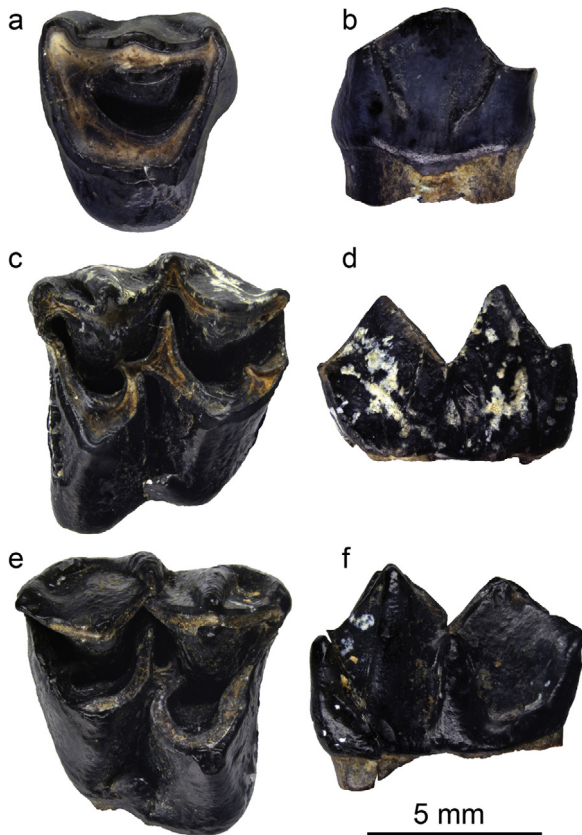


Fig. 3. *Micromeryx* sp. (a–d) and ?*Micromeryx* sp. (e–f) from Catakbağyaka: a P4 dex. (Catak-Rum-3) in occlusal view, b P4 dex. (Catak-Rum-3) in labial view, c M1? sin. (Catak-Rum-5) in occlusal view, d M1? sin. (Catak-Rum-5) in labial view, e M2(?) dex. (Catak-Rum-4) in occlusal view, f M2(?) dex. (Catak-Rum-4) in labial view.

Fig. 3. *Micromeryx* sp. (a–d) and ?*Micromeryx* sp. (e–f) de Catakbağyaka : a P4 dex. (Catak-Rum-3) en vue occlusale, b P4 dex. (Catak-Rum-3) en vue labiale, c M1 ? sin. (Catak-Rum-5) en vue occlusale, d M1 ? sin. (Catak-Rum-5) en vue labiale, e M2(?) dex. (Catak-Rum-4) en vue occlusale, f M2(?) dex. (Catak-Rum-4) en vue labiale.

Micromeryx. Due to the lack of further diagnostic characters, we leave it as *Micromeryx* sp.

An isolated upper molar (Catak-Rum-5; l (max)=7.6; w (max)=7.7; w ant (max)=7.8 mm; Fig. 3) is tentatively determined as M1? sin. due to a fairly well present anterior cingulum and anterior and posterior interdental contact surfaces fitting to that tooth position. The tooth is slightly worn, and possesses a trapezoid shape with four cones. The labial wall is strongly structured with a pronounced rib at the paracone, and a strong parastyle and mesostyle. The shape of these three structures is pyramidal. The metastyle in contrast is rather weak. There is nearly no rib at the metacone. A strong anterior and a weak and short posterior cingulum are present. The entostyle is present but short and flat. The internal structures are simple. There are, however, internal and external postprotocristae and a metaconule fold. The enamel on the labial wall of the lingual cones is rather thick. Generally, the enamel is slightly wrinkled.

While studying upper molars of *Hispanomeryx*, we observed that the enamel on the labial wall of the lingual cones in the teeth of this genus is very thin in comparison to the genus *Micromeryx*. In the upper molar from Catakbağyaka, this enamel wall is thicker than in *Hispanomeryx* and more comparable to *Micromeryx*. Furthermore, the elements of the labial wall appear more pyramidal and differ from the pillar-like structures, which can be observed in *Hispanomeryx*. The tooth is slightly larger than any *Micromeryx* species described so far, except of the just newly described *Micromeryx? eiselei* Aiglstorfer, Costeur, Mennecart and Heizmann 2017 and only just overlaps in dimensions with the lower size range of *Hispanomeryx* (Fig. 4). Due to the morphology, we think that the tooth belongs to a large *Micromeryx* rather than to *Hispanomeryx*, however.

?*Micromeryx* sp.

An isolated upper molar (Catak-Rum-4; l (max)=8 mm; w (max)=7.9; w ant (max)=7.9 mm; Fig. 3) is identified as M2(?) dex. It shows contact surfaces anteriorly and posteriorly. The anterior contact surface is too small for a contact with a P4, but fits well to the contact with another molar. The tooth is little worn, and similar in morphology to the M1? sin. described above. It differs from the latter in a slightly less inflated labial rib at the paracone, a slightly more pronounced wing-like metastyle, and a relatively longer labial side, giving the tooth a more trapezoid shape. In contrast to the tooth described above there is only a weak anterior cingulum and no posterior cingulum. The entostyle is slightly larger than in the M1? sin. and the enamel is slightly smoother.

As in the tooth described above this upper molar has more pyramidal than pillar-like structures on the labial wall and thicker enamel on the labial wall of the lingual cones than it is the case in *Hispanomeryx*. The tooth is a little larger than most *Micromeryx* species and just overlaps with *Hispanomeryx*. As the labial wall is less structured than it is usually the case in *Micromeryx* we decided to assign the tooth to *Micromeryx* with reservations only.

Genus *Hispanomeryx* Morales, Moyá-Solà and Soria, 1981

Type species: *Hispanomeryx duriensis* Morales, Moyá-Solà and Soria, 1981

Hispanomeryx sp.

We consider an isolated lower molar (Catak-Rum-2; l [max]=7.7; w ant [max]=4.8 mm; Fig. 5) to be a m1? sin. It has a relatively strong anterior cingulid, as well as a strong ectostylid. Anterior and posterior interdental contact surfaces fit to a position between p4 and m2. The tooth is strongly worn. That the lingual wall was quite flat with aligned lingual conids and that the labial walls of the labial conids were quite steep as well can still be recognized, however. There is a small mesostylid and a weak metastylid, but only a faint trace of an entostylid. The labial conids are triangular and anteroposteriorly quite narrow. Anterior and posterior fossa are narrow and deep. Although

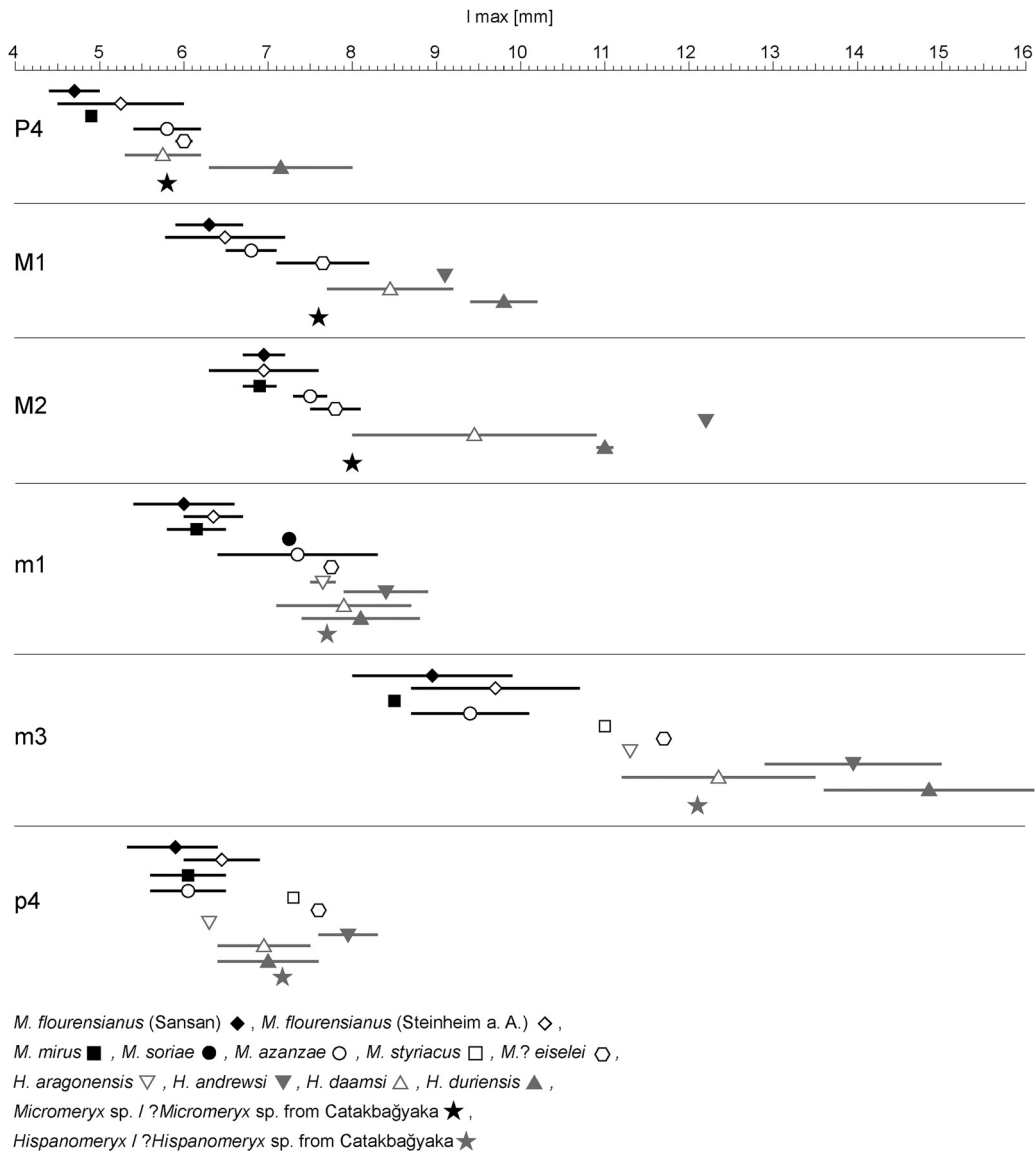


Fig. 4. Comparison of maximal tooth length of P4, M1, M2, p4, m1 and m3 for different Miocene Moschidae (data for *M. flourensianus* from Sansan and Steinheim am Albuch (Steinheim a. A.), for *M. mirus*, and for *M. styriacus* from personal observation; for *M. soriae* from Sánchez et al. (2009), for *M. azanzae* from Sánchez and Morales (2008), for *M. ? eiselei* from Aiglstorfer et al. (2017), for *H. aragonensis* from Azanza (1986), for *H. andrewsi* from Sánchez et al. (2011), for *H. daamsi* from Sánchez et al. (2010), for *H. duriensis* from Morales et al. (1981); data for Moschidae from Catakbağyaka from this publication). **Fig. 4.** Comparaison de la longueur dentaire maximale de P4, M1, M2, p4, m1 et m3 de différents Moschidae miocènes (données pour *M. flourensianus* de Sansan et Steinheim am Albuch (Steinheim a.A.) et pour *M. styriacus*, d'après des observations personnelles pour *M. soriae* d'après Sánchez et al. (2009), pour *M. azanzae* d'après Sánchez et Morales (2008), pour *M. ? eiselei*, d'après Aiglstorfer et al. (2017), pour *H. aragonensis* d'après Azanza (1986), pour *H. andrewsi* d'après Sánchez et al. (2011), pour *H. daamsi* d'après Sánchez et al. (2010), pour *H. duriensis* d'après Morales et al. (1981); données pour les Moschidae de Catakbağyaka dans cet article).

there appears to be a weak and narrow depression at the respective position, there is no clear external postprotocristid present at the posterior wall of the protoconid. All cristids are connected in this wear stage, except of the prehypocristid which is less high and touches the posterior wall of the protoconid just labial of the junction between postprotocristid, postmetacristid and preentocristid.

The lingual conids are more aligned than in *Micromeryx* and both labial and lingual walls of the tooth are quite steep and fit well to the morphology in *Hispanomeryx* (Azanza,

1986; Moyà-Solà, 1986; Sánchez et al., 2010; Sánchez et al., 2011). The tooth is smaller than the bovid teeth recorded from the locality and other bovids described from Turkey for the middle Miocene (Köhler, 1987), but overlaps with the range of *Hispanomeryx* (Fig. 4). The tooth is therefore assigned to *Hispanomeryx* sp.

A lower m3 dex. (Catak-Rum-7; l (max) = 12.1 mm; w ant (max) = 5 mm; Fig. 5) is moderately worn. It possesses a simple tooth crown structure with a well present and biconid third lobe. The lingual wall is moderately flat

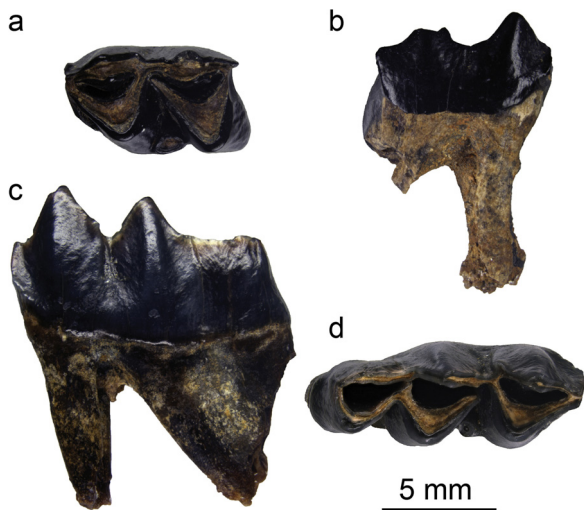


Fig. 5. *Hispanomeryx* sp. from Catakbağyaka: a m1? sin. (Catak-Rum-2) in occlusal view, b m1? sin. (Catak-Rum-2) in lingual view, c m3 dex. (Catak-Rum-7) in lingual view, d m3 dex. (Catak-Rum-7) in occlusal view. **Fig. 5.** *Hispanomeryx* sp. from Catakbağyaka : a m1 ? sin. (Catak-2um-2) en vue occlusale, b m1? sin. (Catak-Rum-2) en vue linguale, cm3 dex. (Catak-Rum-7) en vue linguale, d m3 dex. (Catak-Rum-7) en vue occlusale.

and the second and third lobe are more or less aligned. The first lobe is obliquely oriented and there is a clear metastylid present. There is no split in internal and external postprotocristid. The postprotocristid fuses with the preentocristid, while the prehypocristid is still isolated in this wear stage. Posteriorly, the posthypocristid ends in the prehypocristid. There is an anterior cingulid and a small ectostylid. Protoconid and hypoconid are triangular in this wear stage but form a more rounded shape further apically.

The tooth is less hypsodont and has more inclined labial walls as well as more rounded and less flat lingual walls than it can be observed in Bovidae. The third lobe is not turned labially and shows a high lingual wall completely fused with the postentocristid, distinguishing the tooth furthermore from the usual shape observed in bovid teeth. With the more rounded lingual walls the morphology of the m3 described here is not typical for the large moschid genus *Hispanomeryx*. However, of the middle Miocene ruminants described from Eurasia it fits best to this genus and is similar to the Asian representatives known of it. In contrast to *H. daamsi* (Sánchez et al., 2010) the tooth does not have a lingually-turned prehypocristid terminating in the preentocristid. It furthermore differs from *H. duriensis* and *H. daamsi* in less aligned and less flat lingual conoids and a clearly present metastylid. These features can be observed in m3 of *H. aragonensis* Azanza, 1986, the oldest Spanish record of the genus, and in *H. andrewsi* Sánchez, Demiguel, Quiralte and Morales 2011, the first described Asian species, as well as in *Hispanomeryx* sp. 1 in Wang et al. (2015), however. The tooth is a little larger than *H. aragonensis*, but smaller than *H. andrewsi* (Fig. 4). From *H. aragonensis* it furthermore differs in a flatter lingual wall. The tooth is therefore assigned to *Hispanomeryx* sp.

?*Hispanomeryx* sp.

A small p4 sin. (Catak-Rum-1; l (max)=7.2 mm; w (max)=3.7 mm; Fig. 6) possesses two roots and is little worn. Anteriorly, there is a split in anterior styloid conoid. Both are connected by a lingual cristid that proceeds posteriorly and is fused with the anterolingual cristid, thus closing the anterior valley lingually as it is typical in Moschidae. The mesolingual conoid is the highest conoid in the p4. It is not inflated. The posterolingual cristid is split, and the short labial branch meets the only little oblique transverse cristid, forming the posterior wall of the anterior valley. There is an anterolabial cingulid.

The labial incision posterior of the mesolabial conoid is weaker than in *H. aragonensis*, *H. daamsi* and *H. duriensis*. In *H. andrewsi* this feature seems to be more variable, though (Sánchez et al., 2011). The tooth is less bulky than *H. duriensis*, and differs from it by the presence of a transverse cristid. It is clearly smaller than *H. andrewsi* (Morales et al., 1981; Sánchez et al., 2011), but overlaps in dimensions (Fig. 4) with *H. daamsi* (Sánchez et al., 2010). It appears higher crowned than it is usually the case in *Micromeryx*. The tooth is assigned to *Hispanomeryx*, but due to the slightly ambiguous morphology with reservations only.

Of the postcranial material excavated in Catakbağyaka, only a distal fragment of a humerus dex. is tentatively assigned to *Hispanomeryx* (Catak-Rum-6; MC I/192; distal dorsovolar width=15,3; distal mediolateral width=18 mm; Fig. 6). The trochlea humeri is mediolateral wide and comprises a wide and flat medial pulley, which shows a distinct crest on its medial rim. The lateral pulley is smaller and less distinct. The capitulum humeri is only a little smaller than the lateral pulley of the trochlea humeri and meets the latter in a shallow depression. The trochlea reaches strongly proximal into the fossa coronoidea. The fossa olecrani is deep. The epicondylus medialis is strong.

The distal humerus fragment is assigned to ?*Hispanomeryx* sp. It is clearly smaller than the non-moschid ruminants from Catakbağyaka, but larger than humeri of *Micromeryx* (pers. obs. on *M. flourensianus* from Sansan and Steinheim am Albuch) and of the medium sized *H. daamsi* (see measurements in Sánchez et al. (2010)). The morphology of the specimen from Catakbağyaka is similar to *M. flourensianus* from Sansan and largely overlaps with the variability in this population. There are some minor differences, however: The medial pulley of the trochlea humeri in Catakbağyaka is wider and shallower (its medial rim extends also stronger to medial distally), the lateral pulley is less distinct, in distal view the capitulum humeri reaches as anterior as the lateral pulley of the trochlea and is not separated from it by a step as usually in *M. flourensianus*, furthermore, the trochlea stronger protrudes into the fossa olecrani. Similar features can be observed in the humeri of *H. daamsi* from Spain (Sánchez et al., 2010). Due to morphology and size the distal humerus fragment is assigned to *Hispanomeryx*, but due to the lack of clear apomorphic features with reservations only.

4. Discussion

As the small ruminant material from Catakbağyaka is sparse and does not allow an unambiguous definition we

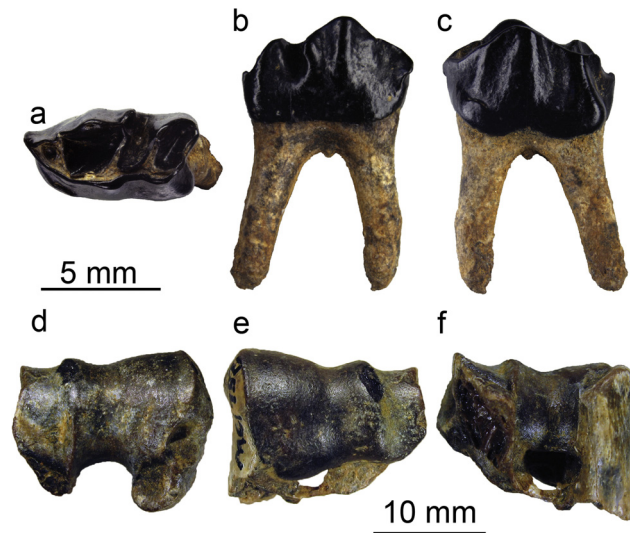


Fig. 6. ?*Hispanomeryx* sp. from Catakbağyaka: a p4 sin. (Catak-Rum-1) in occlusal view, b p4 sin. (Catak-Rum-1) in lingual view, c p4 sin. (Catak-Rum-1) in labial view, d humerus dex. (Catak-Rum-6; MC 1/192) in distal view, e humerus dex. (Catak-Rum-6; MC 1/192) in dorsal view, f humerus dex. (Catak-Rum-6; MC 1/192) in volar view; scale bar 5 mm for a–c; scale bar 10 mm for d–f?

Fig. 6. *Hispanomeryx* sp. de Catakbağyaka : a p4 sin. (Catak-Rum-1) en vue occlusale, b p4 sin. (Catak-Rum-1) en vue linguale, c p4 sin. (Catak-Rum-1) en vue labiale, d humérus dex. (Catak-Rum-6 ; MC 1/192) en vue distale, e humérus dex. (Catak-Rum-6 ; MC 1/192) en vue dorsale f humérus dex. (Catak-Rum-6 ; MC 1/192) en vue palmaire ; barre d'échelle 5 m pour a–c, 10 mm pour d–f.

cannot define particular species. However, we can assign it to the two moschid taxa, *Micromeryx* and *Hispanomeryx*, due to morphology and size.

Micromeryx was described by Geraads (2003) from the early Middle Miocene locality Çandır (Fig. 7; MN 5/6 (Mayda et al., 2015)). Unfortunately, there was no upper dentition recorded in this locality hindering a comparison with our material comprising only the latter. Gentry (1990) gave a measurement for the upper molar in ?*Micromeryx* sp. from Paşalar (MN5/6 (Mayda et al., 2015)) fitting well to the dimensions of our material. However, the here described teeth differ from the upper molar from Paşalar by a clearly present split in internal and external postprotocrista, as it also often occurs in European *Micromeryx* material. Wang et al. (2015) described some *Micromeryx* material from China; but again solely lower dentition. For the European *Micromeryx* species the upper dentition is not as diagnostic for species differentiation and not even known for all species. In any case, it can be distinguished from *Hispanomeryx* by the morphological features discussed above (general shape of P4; morphology of labial wall in upper molars and labial wall of lingual cones in upper molars). As the material described here is more characteristic for *Micromeryx*, we are confident that the genus was present in the locality.

The genus *Hispanomeryx* is mainly known from Spain (Fig. 7; Azanza, 1986; Morales et al., 1981; Moyà-Solà, 1986; Sánchez et al., 2010), but has been referred to and described from Turkey and Asia by Moyà-Solà (1986), Gentry (1990), Sánchez et al. (2011), and Wang et al. (2015). Our material comprises lower dentition showing characteristics for the genus *Hispanomeryx*. It falls into the wider dimensional range of the genus. Taken into consideration the different wear stages of the lower molars they fit well

in morphology to the dentition drawn by Moyà-Solà (1986) for *Hispanomeryx* from the locality Çandır and the specimens of *H. andrewsi* figured by Sánchez et al. (2011) from Asia; for Paşalar unfortunately only an upper molar was described by Gentry (1990). Considering morphology and size the *Hispanomeryx* material from Catakbağyaka cannot be assigned to a certain species. However, the morphology in the m3 (less aligned and less flat lingual conids and a clearly present metastylid) is very similar to the Asian *H. andrewsi* (Sánchez et al., 2010) and the material referred to as *Hispanomeryx* sp. 1 by Wang et al. (2015) from China, distinguishing all three from the western European *H. duriensis* and *H. daamsi* (Moyà-Solà, 1986; Sánchez et al., 2010). In Spain only the more primitive species *H. aragonensis* (Azanza, 1986; Sánchez et al., 2010) shares this feature. It could represent an ancestral character, which was lost in the European lineage of the genus but remained present in the Asian one.

With the description of the moschid material from Catakbağyaka, we show the sympatric co-occurrence of *Micromeryx* and *Hispanomeryx* in one locality. The co-occurrence of two moschid taxa was described for the Spanish record by Sánchez et al. (2010) and also detected in the Miocene of central Europe (see, e.g., Aiglstorfer et al., 2014 and Aiglstorfer et al., 2017). It seems to be rather a common phenomenon than an exception and could be explained by a considerable morphologic and dimensional difference between the two taxa recorded, as also indicated by Sánchez et al. (2010). In any case, it shows that the environment around Catakbağyaka provided enough ecological niches in the late middle Miocene to allow the sympatric co-occurrence of two small ruminant taxa.

The faunal interchange between Asia and Europe is an important issue for a better understanding of Miocene

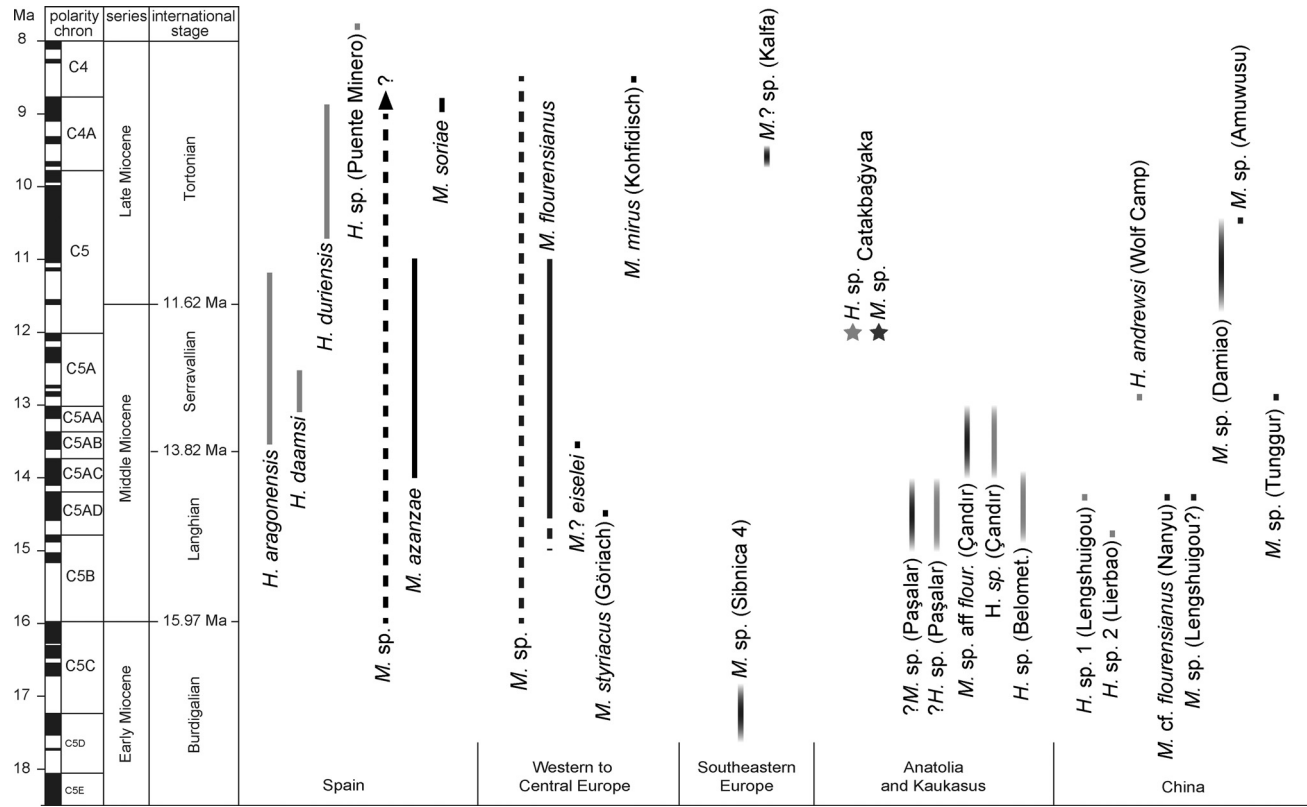


Fig. 7. Correlation of records for *Micromeryx* and *Hispanomeryx* in Eurasia (grey lines indicate range of *Hispanomeryx*, black lines the one of *Micromeryx*; dotted lines summarize the record of different localities; shaded lines indicate the possible stratigraphic range for localities with a less certain age). The record from Bulgaria described by [Nikolov \(1985\)](#) is not included here, as the age of the locality is not clear (for more information see [Aiglstorfer and Costeur \(2013\)](#)). The record of ?*Micromeryx* by [Sen et al. \(2015\)](#) is not given due to the uncertainty in the designation but is indicated with the possible wider stratigraphic dispersal of *Micromeryx* sp. from Europe. The ranges are after data from [Moyà-Solà \(1986\)](#), [Sánchez and Morales \(2006\)](#), [Vislobokova \(2007\)](#), [Sánchez and Morales \(2008\)](#), [Sánchez et al. \(2009\)](#), [Vislobokova and Lavrov \(2009\)](#), [Aiglstorfer and Costeur \(2013\)](#), [Aiglstorfer et al. \(2014\)](#), [Wang et al. \(2015\)](#), [Alaburić and Radović \(2016\)](#), [Aiglstorfer et al. \(2017\)](#), and own data.

Fig. 7. Corrélation entre enregistrements de *Micromeryx* et d'*Hispanomeryx* en Eurasie (les lignes grises indiquent le domaine d'*Hispanomeryx*, les lignes noires celui de *Micromeryx*, les lignes en pointillé résument l'enregistrement des différentes localités ; les lignes ombrées indiquent le domaine stratigraphique possible pour les localités ayant un âge moins assuré). L'enregistrement réalisé en Bulgarie, décrit par [Nikolov \(1985\)](#) n'est pas inclus ici, car l'âge de la localité n'est pas clair [pour plus d'informations, voir [Aiglstorfer and Costeur \(2013\)](#)]. L'enregistrement de ? *Micromeryx* par [Sen et al. \(2015\)](#) n'est pas donné, à cause de l'incertitude dans la désignation, mais est indiqué avec une plus grande dispersion possible de *Micromeryx* sp. à partir de l'Europe. Les domaines se fondent sur les données de [Moyà-Solà \(1986\)](#), [Sánchez et Morales \(2006\)](#), [Vislobokova \(2007\)](#), [Sánchez et Morales \(2008\)](#), [Sánchez et al. \(2009\)](#), [Vislobokova et Lavrov \(2009\)](#), [Aiglstorfer et Costeur \(2013\)](#), [Aiglstorfer et al. \(2014\)](#), [Wang et al. \(2015\)](#), [Alaburić and Radović \(2016\)](#), [Aiglstorfer et al. \(2017\)](#) et nos propres données.

Mammal Palaeogeography and strongly influenced the evolution of many groups.

Due to their geographic position, Anatolia and the Caucasus were important corridors for the dispersal of Eurasian mammals [see also discussion in Koufos et al. (2005)]. The palaeogeographic situation for the late middle Miocene in this area including possible land connections is still not fully understood. The moschid findings from Catakbağyaka are the first for the late middle Miocene of Turkey (Fig. 7) and can help to better understand the connection between Asia and Europe during this time slice and may help to shed more light on the question where and when moschids evolved and how they dispersed over Eurasia.

5. Conclusion

The record of the family Moschidae in Catakbağyaka (MN 7/8) is the first for the late middle Miocene of Turkey. The moschids are referred to *Micromeryx* sp. and *Hispanomeryx* sp. This confirms the presence of the genus *Hispanomeryx* in the middle Miocene of Turkey as proposed by Moyà-Solà (1986) and Gentry (1990) for the older localities Çandır and Paşalar. Furthermore, the moschids from Catakbağyaka verify once more that the presence of two sympatric moschids in one locality is rather a common phenomenon. With Catakbağyaka a wider dispersal over Eurasia is confirmed for Miocene Moschidae (Fig. 7). It connects the Asian and European record for the late middle Miocene and shows once more that Turkey was an important corridor for the dispersal of Eurasian Miocene mammals.

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