

Original Study

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Two micromammal faunas from archaeological contexts in Türkiye

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Abstract: In the interaction between Man and his environment, the role of small mammals is often overlooked. Although micromammals are used as an indicator for palaeoenvironments of the Palaeolithic, the role of synanthropic species, from the Holocene is, particularly for Anatolia, insufficiently documented and not well understood. This study reports the discovery of micromammal remains from two archaeological sites in northeastern Türkiye: Niksar Castle and Pulur Höyük. So far, the newly discovered fauna consists of a rat (*Rattus rattus*), a murine (*Mus musculus*), and a hare (*Lepus europaeus*) in Niksar Castle, whereas the Macedonian mouse (*Mus macedonicus*), a mole rat (*Spalax leucodon*), a hamster (*Mesocricetus brandti*) and an arvicoline (*Microtus* sp.) were found in Pulur Höyük. The difference between the two assemblages lies in Niksar Castle yielding mostly synanthropic species, whereas the Pulur Höyük assemblage has an indigenous wild small mammal fauna.

1 Introduction

With the Neolithic Revolution, the relation between man and the animals around him changed drastically (Arbuckle et al. 2014; Scanes 2018). Hunted prey made way for livestock as the main protein source, and large carnivores became increasingly less of a competition or even a threat for the human population (Shimelmitz et al. 2023). Of course, humans remain dependent on natural resources, and animal remains found in archaeological sites will tell us a lot about the way they used these resources. In addition, animals can tell us a lot about the environment, since each species has its own natural distribution based on available and suitable habitat, which may have changed over time. Particularly in Paleolithic sites, we may get a good impression of the natural fauna that inhabited an area (e.g., Van Kolfschoten 2014). In Neolithic and later sites, we are more likely to find the remains of the animals that were traded into the settlement, either as livestock, pets, and -more rarely-trophies or ritualistic remains.

When considering the relationship between man and animals, we tend to think of the larger mammals, birds, and fish first. These are the ones that provide the resources, be it the hunted deer, the herded goats, or the dog as a pet. Among birds, (wild) fowl is the first to spring to mind, as these are the ones most likely to be used for their eggs or end up as a meal. However, these represent only a small part of the fauna, as most mammal and bird species tend to be much smaller. The largest order among the mammals are the rodents, whereas the passerines are the most speciose order in birds. They tend to escape our attention, not only because of their size, but of their limited economic use. That being said, rodents can be a threat to humans, not only as pests but also as carriers of diseases (e.g., *Rattus*, McCormick 2003). Moreover, some species only obtained their current distribution as commensals and are therefore inseparably

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connected to human settlements (e.g., *Mus musculus*, Cucchi et al. 2020).

Despite receiving less attention, the small mammals from excavations can carry a wealth of information. In Paleolithic sites, small mammal species are often regarded as better environmental indicators than their large mammal counterparts, as they often have more narrow niche requirements. As settlements grow, we are less likely to obtain a view of the natural micromammal fauna. Instead, commensal species such as the house mouse, *M. musculus*, and the black and/or brown rat (*Rattus rattus* and *Rattus norvegicus*) appear in archaeological sites (see, e.g., Cucchi et al. 2020; Yu et al. 2022).

Despite the region's rich history in archaeological excavations, the micromammals from the human settlements in Anatolia are very poorly documented. The few studies dealing with this have primarily focused on either taxonomic or environmental aspects. Emra et al. (2022) used *Castor fiber* and some unidentified rodents with other mammals from Körtiktepe in order to reveal drastic climate change between the Late Pleistocene and Early Holocene, while Demirel et al. (2011) discussed the relationship between the predator fauna and environmental changes based on the taphonomy of small mammals from Karain Cave. Suata-Alpaslan (2011) described a latest Pleistocene fauna from Üçağızlı Cave, with a composition that is no different than the current Anatolian wild fauna. Erdal et al. (2019) focused on the taxonomy of the small mammal fauna and environment from the Neolithic settlement Tepecik-Çiftlik. These studies paid limited attention to small mammal-human interactions. Jenkins (2012a, 2012b) did discuss the micromammal fauna that inhabited Çatalhöyük and how it affected the human occupants, and Bailey (2018) did the same for Aşıklı Höyük. In turn, however, these papers addressed the taxonomy of the finds in less detail.

In this paper, we present the micromammal findings of two archaeological sites from different periods (Niksar Castle and Pular Höyük). In doing so, we aim to show and discuss how little critters are part of the human narrative and to what extent they can contribute to our knowledge of the respective settlements.

1.1 Localities

1.1.1 Niksar Castle

Niksar Castle (40°35'31" N, 36°57'31" E) is located in Niksar-Tokat (Figure 1I) and it has served as a strategically important settlement for eight distinct civilizations throughout its

history. Initially significant during the Pontus Kingdom (1st century BCE), it transformed into the Roman city of Neokaisareia after its conquest by Pompeius in 63 BCE. The castle later became a religious center in the Early Christian period (3rd century CE) and maintained its relevance under the Byzantine Empire (4th–15th century). Following the Danishmend dynasty (11th century), it was fortified and continued to be used by the Seljuk Empire (11th–13th century). After the Mongol invasions, it became part of the Ilkhanate (13–14th century) and ultimately remained significant within the Ottoman Empire (15th–20th century) (Yazar et al. 2022).

Throughout its history, Niksar has become a strategic center by being located at the intersection of important trade routes. In this context, the road from Sulusaray to Samsun stands out as one of the oldest and largest trade routes in Anatolia, while the route reaching Ünye via Niksar formed a critical part of the historical Silk Road. In addition, other routes such as the Eupatoria-Kabeira (Niksar) Road, the Amasia-Neokaisareia (Kabeira = Niksar) Road, and the Amaseia-Komana-Neokaisareia Road strengthened Niksar's economic relations. These roads contributed significantly to the development of trade and cultural interactions in the region (Uyanık 2020).

Based on the castle's historical importance, the Tokat Museum Directorate began excavations in 2015 under the coordination of Dr. Turgay Yazar, of the Department of Art History at Ondokuz Mayıs University. After a temporary pause, these excavations resumed in 2021 (Yazar et al. 2022). During these excavations *R. rattus*, *M. musculus* and *Lepus europaeus* remains were recovered from Niksar Castle, dating to the Late Ottoman Period. The micromammal specimens were obtained from a grayish-colored clay sediment layer at a depth of 1.5 m from the surface. While *Lepus* was found next to a water cistern, *Mus* and *Rattus* were found near a mosque, which is considered a dump area, with a leather shoe, some coins, and 48 pipes (Figure 2A).

1.1.2 Pular Höyük

The second studied site, Pular Höyük (39°54'20" N, 41°7'50" E) (Figure 1II) is a 15-meter-high, mound-type archaeological site where researchers have uncovered a total of seven cultural layers. It is located approximately 20 km west of Erzurum and covers an extensive area of approximately 30 ha (Akarsu 2023). The stratigraphy reveals a rich historical timeline, reflecting the various periods of human activity at the site. The uppermost layer corresponds to the Medieval period, followed by the Late Bronze Age/Early Iron Age, Early Bronze Age III/Middle Bronze Age, Early Bronze Age II,

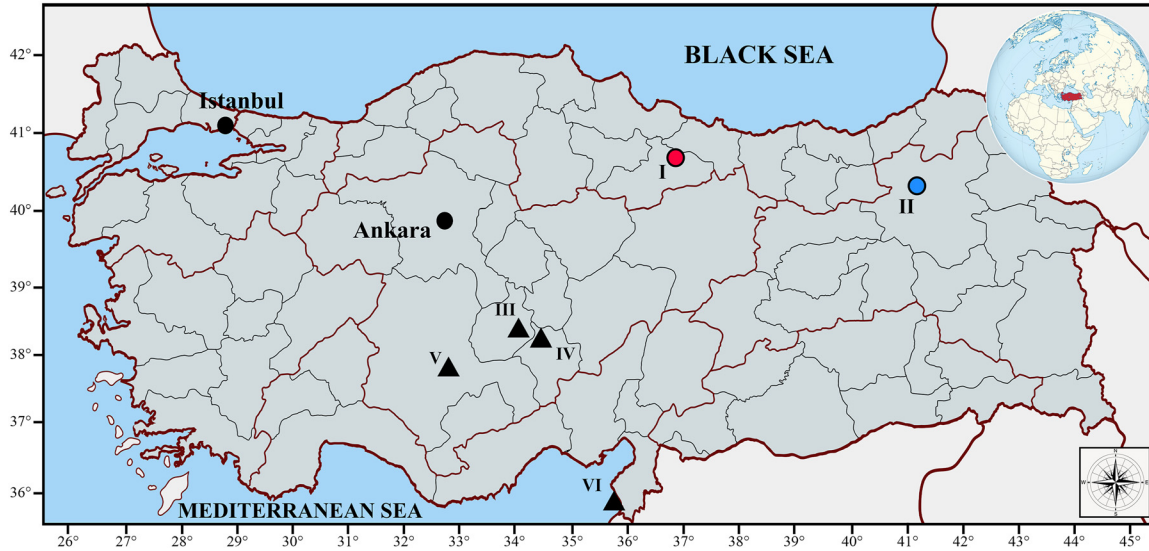


Figure 1: Location of archeological sites discussed in this paper: I, Niksar Castle; II, Pulur Höyük; III, Aşıklı Höyük; IV, Tepecik-Çiftlik; V, Çatalhöyük; VI, Uçağızlı Cave.

Early Bronze Age I, Late Chalcolithic period, and finally, the Middle Chalcolithic period layers. Based on radiocarbon dating of the stratigraphic layers, the oldest settlement at Pulur Höyük dates back approximately 7,000 years (Akarsu et al. 2025).

The site was initially excavated in 1960 by Dr. Hamit Zübeyr Koşay and Dr. Hermann Vary, and excavations resumed in 2021 after a 61-year hiatus. This revival was conducted under the auspices of the Erzurum Museum and the scientific direction of Dr. Rabia Akarsu from the Department of Archaeology at Atatürk University. This fieldwork yielded a number of micromammal remains, namely *Microtus* sp., *Spalax leucodon*, *Mesocricetus brandti*, and *Mus macedonicus*. The latter was found in the Middle Chalcolithic Age layer, *M. brandti* was found in the Late Chalcolithic Age layer, and *Microtus* sp. and *S. leucodon* were found in Early Bronze Age-Middle Bronze Age layers. Small mammal remains were found in brown soil and ashy sediments. The *Spalax* samples found in the brown compact soil structure are together with Maraz ceramics, animal bone fragments, obsidian tools, polishing stones, and grinding stones. The *Microtus* remains were found on a round stove's floor together with other burnt animal bones, obsidian tools, and Karas pottery. This space is an interior room with a ceramic stove. The *M. brandti* find came from a terracotta object next to a wall, which is considered the exterior side of a house. The *Mus* findings were found at the bottom of two 80 cm high ceramic storage vessels. Also, in the layer below, hundreds of burned grain seeds were unearthed (Figure 2B).

2 Materials and methods

Erzurum-Pulur Höyük material was collected from the site during ongoing excavations between 2021 and 2023. Niksar Castle micromammals were retrieved in 2022 by taking approximately 500 kg of sediment from the excavation sites and left to dry under the sun. The dried material was divided into batches of 3 kg, which were inundated in water in washing basins. Material for study was obtained by screenwashing these soaked sediments on a cascading sieve set with mesh sizes of 2 cm, 1.5 mm, and 0.5 mm, respectively. The washed material was dried and sorted-out under a binocular microscope (Euromex dissection).

All the teeth in the extracted material were fixed in plasticine with the occlusal surfaces facing upwards. Molars were measured with a Leica 16Z stereomicroscope and associated software (LAS V4. 13), and measurements are given in mm. The tooth dimensions are the greatest length in the direction of the tooth row and the largest width perpendicular to the largest length. SEM photos were taken with a Jeol Jsm-6480 SEM at Naturalis Biodiversity Center. The map in Figure 1 was produced using Google Earth Pro. The graphics and tables have been produced in Microsoft Excel. All figures were edited in Adobe Photoshop version 26.8.

All material is stored in Istanbul University's Anthropology Department laboratory.

The nomenclature for part of molars and measurement methods follow van de Weerd (1976) for Muridae; Mein and Freudenthal (1971) and Sarıca and Şen (2003) for Spalacidae;

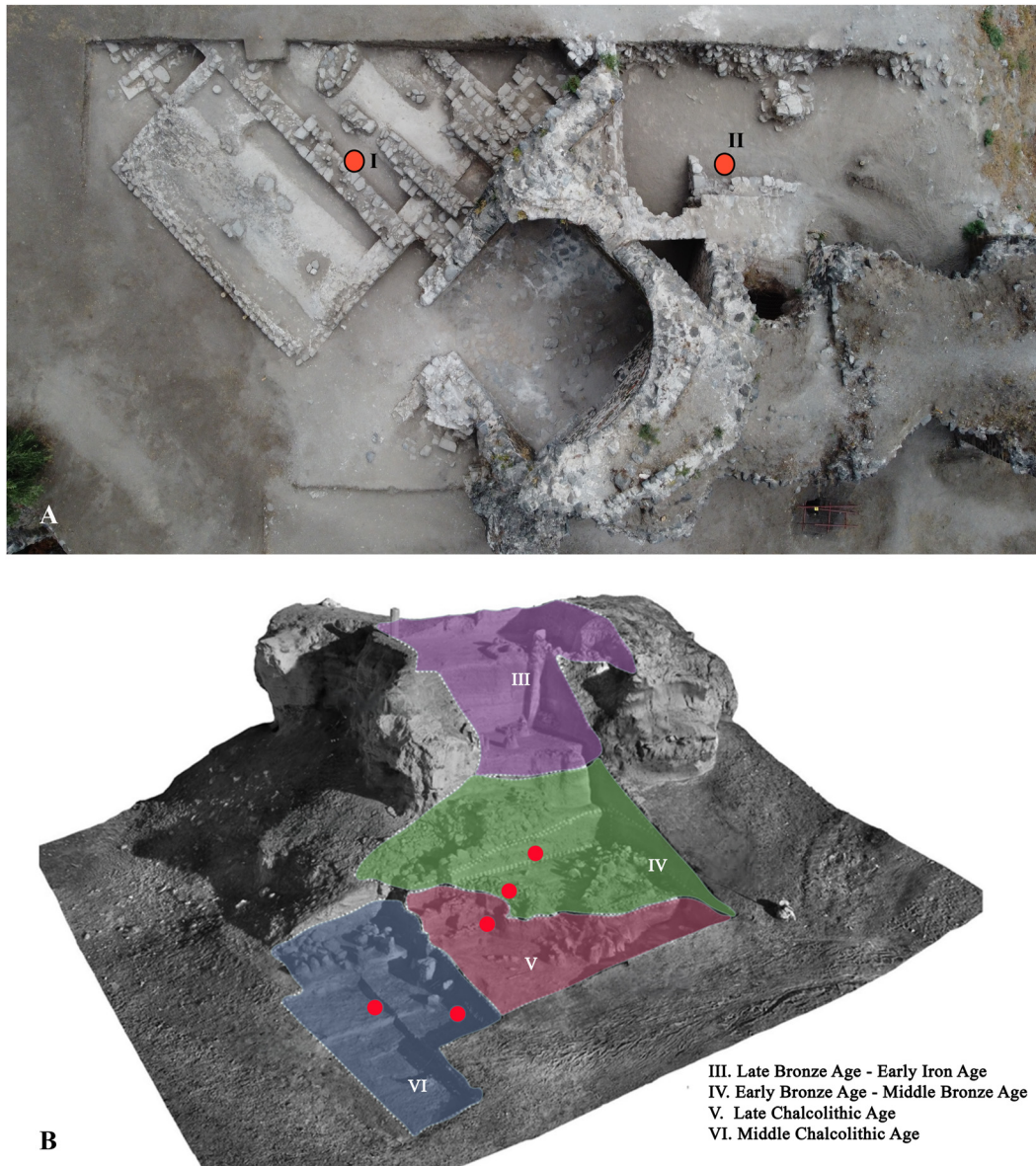


Figure 2: Photograph of Niksar Castle excavation area and stratigraphic profile of Pular Höyük. (A) Panoramic view of the finding spots of Niksar Castle I, *Lepus europaeus* teeth; II, *Mus musculus* and *Rattus rattus*; (B) stratigraphic photography of Pular Höyük with the material (red dots) shown. IV, *Microtus* sp. and *Spalax leucodon*; V, *Mesocricetus brandti*; VI, *Mus macedonicus*.

van der Meulen (1973), Rekovets and Nadachowski (1995), Hordijk and de Bruijn (2009), and Erdal et al. (2018) for Arvicolidae; Palacios and López-Martínez (1980) for Leporidae.

We measured for comparison tooth rows of ten skulls and associated mandibles from the collection of Naturalis Biodiversity Center; three of them (RMNH 5643, 5696, 5644) from Amsterdam (the Netherlands), four specimens (RMNH 28535, 28536, 28533, 28522) from Hérault and one (RMNH 28542) from Corsica (France), and one (RMNH 6035) from Samos (Greece).

Abbreviations: NK, Niksar Castle; PL, Pular Höyük; PPNB, Pre-Pottery Neolithic B; SEM, Scanning Electron Microscope; BCE, Before Common Era; BP, Before Present; CE, Common Era; TRL, Tooth Row Length; L, Length; W, Width; c1; posterior accessory cuspid; c4, an accessory cuspid between labial anteroconid and protoconid; t1-t12, numbered cusps from 1 to 12 in murid molars; M1, first upper molar; M2, second upper molar; M3, third upper molar; m1, first lower molar; m2, second lower molar; m3, third lower molar; p3, third lower premolar; and p4, fourth lower premolar.

3 Systematics

3.1 Locality Niksar Castle

Family **Muridae** Illiger, 1811

Subfamily **MURINAE** Illiger, 1811

Genus **Rattus** Fischer, 1803

Rattus rattus (Linnaeus, 1758) (Figure 3)

Type locality: Uppsala, Sweden.

Material examined: Seven lower mandibles with m1-m3 (NKm 2, NKm 38, NKm 35, NKm 45, NKm 48, NKm 51, NKm 54); TRL: 5.84–6.52 mm. Four upper maxillas with M1-M3 (NKm 19, NKm 22, NKm 29, NKm 32); TRL: 6.19–6.8 mm. One mandible fragment with m1 and m2 (NK 45), three maxilla fragments with M1s and M2s (NKm 1415, NKm 2627, NKm 2425), one maxilla fragment with m2 and m3 (NKm 1617), and one maxilla fragment with m1 (NKm 13).

Measurements: See Table 1.

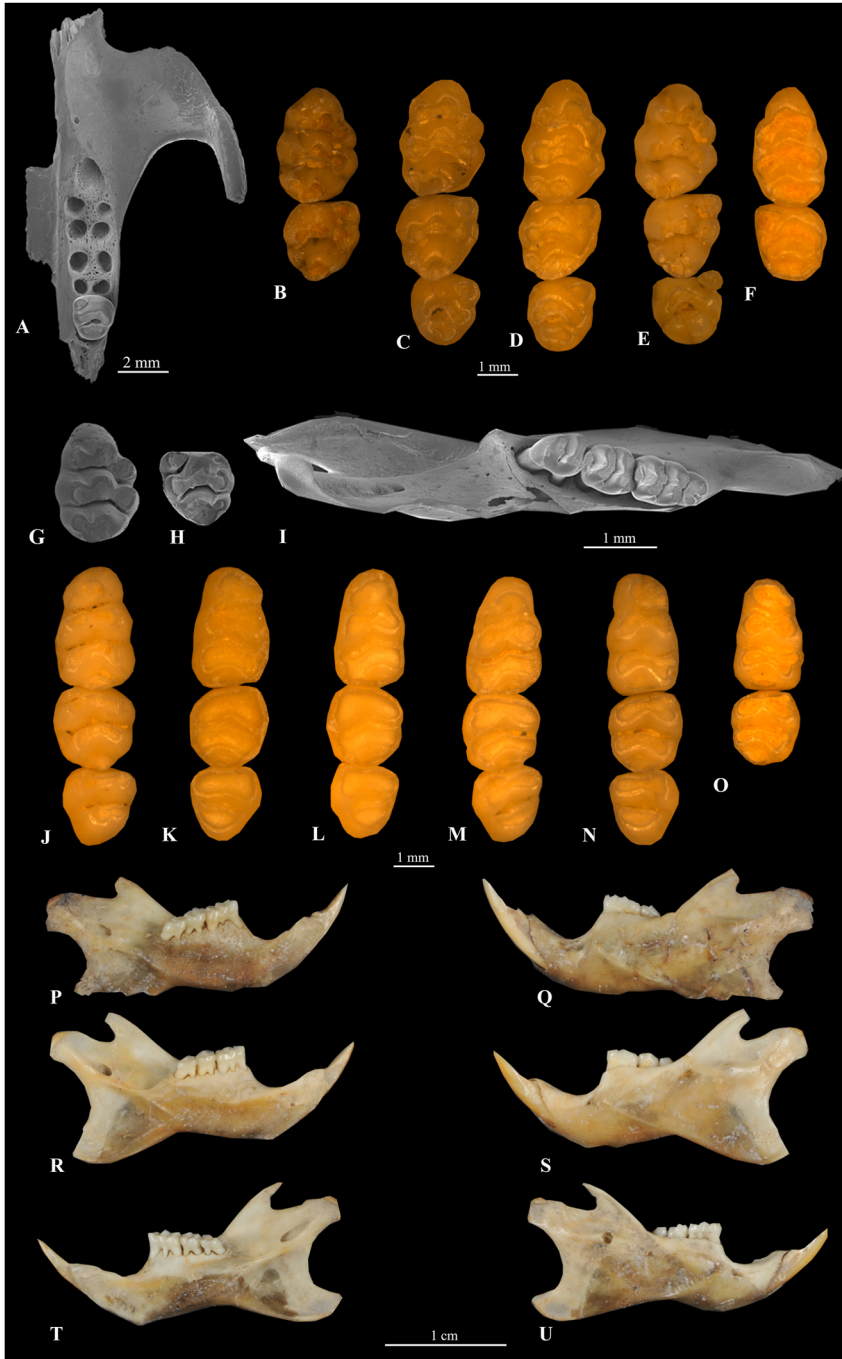


Figure 3: The material of *Rattus rattus* from Niksar Castle. (A–F) SEM picture of *Rattus rattus* maxilla: (A) left upper jaw: (B) (NK 14–15), (C) (NK 18–19–20), (D) (NK 28–29–30); right upper jaw: (E) (NK 21–22–23), (F) (NK 24–25). (G–H) SEM pictures of *Rattus rattus* molars: (G) M1 and (H) M2. (I–O) SEM picture of *Rattus rattus* mandible: (I) left lower jaw: (J) (NK 53–54–55), (K) (NK 44–45–46), (L) (NK 37–38–39); right lower jaw: (M) (NK 50–51–52), (N) (NK 1–2–3), (O) (NK 35–36). (P, R and S) Medial view of *Rattus rattus* mandibles. (Q, T and U) Lateral view of *Rattus rattus* mandibles. The molars are ordered sequentially from m1 (M1) to m3 (M3) from top to bottom. 1 mm scale for (A, B, C, D, E, F, K, L, M, N, O, H, I and G); 2 mm scale for (J); 1 cm scale for (P, R, Q, S, T and U).

Table 1: Measurements of micromammal molars from Niksar Castle and Pulur Höyük in mm.

Locality	Taxon	Measurement	N	Length (mm)		Width (mm)	
				Range	Mean	Range	Mean
Niksar Castle	<i>Rattus rattus</i>	M1	8	2.78–2.92	2.86	1.90–2.03	1.94
		M2	8	1.92–2.18	2.03	1.75–1.88	1.81
		M3	5	1.49–1.70	1.59	1.44–1.56	1.49
		m1	8	2.57–2.93	2.72	1.62–1.77	1.70
		m2	8	1.82–2.04	1.89	1.69–1.81	1.75
		m3	6	1.58–1.69	1.63	1.52–1.61	1.56
	<i>Mus musculus</i>	m1	3	1.26–1.32	1.29	0.77–0.81	0.78
		m2	3	0.81–0.86	0.83	0.76–0.80	0.78
	<i>Lepus europaeus</i>	p3	1		2.49		2.21
		p4	1		2.15		2.49
Pulur Mound	<i>Mus macedonicus</i>	M1	2	1.85–1.89	1.87	1.13–1.22	1.17
		M2	2	1.04–1.09	1.06	0.97	0.97
		M3	2	0.59–0.61	0.60	0.63–0.70	0.66
		m1	6	1.58–1.68	1.63	0.91–0.99	0.95
		m2	6	0.95–1.12	1.03	0.90–0.97	0.94
		m3	1		0.63		0.67
	<i>Spalax leucodon</i>	M1	6	2.62–2.81	2.75	2.34–2.51	2.42
		M2	5	2.47–2.57	2.51	2.33–2.54	2.47
		M3	1		1.95		1.80
	<i>Microtus</i> sp.	m1	1		2.45		0.9
		m2	1		1.37		0.85
		m3	1		1.31		0.75
	<i>Mesocricetus brandti</i>	m1	1		2.31		1.35
m2		1		2.07		1.53	
m3		1		2.45		1.64	

Description: M1s have an elliptical outline. They are composed of three laminae, which are separated by deep transverse valleys. The two anterior laminae include three cusps; t1, t2, and t3. The t1 is positioned slightly more posterior than t2 and t3. The t2 is only somewhat larger than t1 and t3; the connection between these cusps is well developed. The second lamina consists of t4, t5, and t6. The t4 is positioned slightly posterior with respect to the t6. The t4, t5, and t6 cusps are almost of equal size. The posterior laminae consist of two cusps; the t7 is reduced to an inconspicuous ridge directed towards t4. The t12 is fused with t8 (hypocone). The latter is significantly larger than t9. There are no accessory tubercles. The molars have five roots.

M2s are somewhat longer than wide and taper towards a rounded posterior end. The t1 is very large compared to t3 and drop-shaped. The t3 is present in all teeth but it is tiny. The connection between t4-t5 is slender and narrower than the connection between t5-t6. The t7 is reduced to a narrow ridge. The t8 is much larger than the t9. In five specimens out of eight, t8 is connected to t9 by a crest from the labial side. The M2 has four roots.

M3s have a large and drop-shaped t1, positioned anterolingually of the t5. Only one of the five specimens has a tiny

t3 (NK 30, Figure 3D). The t4-t5 and t6 form a “V” shaped complex. The t5 has more labial position compared to that of M2. t8 and t9 are fused and the connection between these two forms an posterior indentation. The t8 lies directly adjacent to the t4. The M3 has three roots.

m1s have an elongated outline that widens from the anterior towards the posterior side of the molar. The three laminae are separated by deep valleys. In four specimens, there is a lateral connection between the lingual anteroconid and the metaconid. The rest of the molars lack the connection between the anteroconid pair and the metaconid-protoconid pair. Six molars have the c1 fused with the hypoconid. The posterior cingulum has a compressed elliptical shape.

m2s have a sub-square outline. The small anterolabial cusp is incorporated with the protoconid. The c1 is generally fused to the hypoconid, but is relatively small and only isolated in unworn specimens (Figure 3J). The m2 has an elliptical, transversely elongated posterior cingulum, as in the m1.

m3s are composed of two laminae separated by a deep transverse valley. Antero-labial cusp is as in the m2. Hypoconid and entoconid fused totally, forming a semicircular

complex. In one specimen, there is a posterior indentation between the hypoconid and entoconid.

Remarks: At present, two *Rattus* species are in the region, *R. norvegicus* and *R. rattus* (Demirsoy 1996). Based on size, identification as *R. norvegicus* can be excluded for the Niksar Castle finds. The total length of the lower toothrow in our material is 6.24 mm, while this length is between 7.0 and 7.6 mm for *R. norvegicus* (Islam et al. 2021). The total length range of the lower molars for *R. rattus* is between 6.2 mm and 6.66 mm (Islam et al. 2021; Yigit et al. 1998). Moreover, the length and width measurements of each molar from Niksar Castle overlap with these measurements from our comparative *R. rattus* material. In addition, the Niksar Castle material shows morphologically similar characteristics. In both specimens; the outline is elliptical, t1 and t4 are located on the anterior and second lamina respectively, slightly posteriorily, t7 is absent, there is a large t8 mesially (all M1s in the collection have a small t9 fused with t8). The t8 is much larger than t9. The t3 is either absent or very small compared to t1. In addition to morphological similarities, overlapping

measurements of the M1 and m1 (Figure 4A and B) support that the Niksar Castle specimens can be confidently identified as *R. rattus*.

The question of when *R. rattus* started living with humans is still controversial. Initially, the commensal relationship between *Rattus* and humans was dated to 40,000 years ago based on finds in Israeli caves (Tchernov 1968). However, due to the stratigraphic uncertainty in these caves, the first commensal relationship is not clear. Later, the first human-*Rattus* synanthropic relationship was dated to 19,400 years ago by *Rattus* findings from Ohalo 2 (Jordan) (Belmaker et al. 2001). Thanks to this synanthropic relationship proven by Ohalo 2, *Rattus* and *Mus* finds recovered in archaeological sites provide information about human migrations, trade, and settlement types (Cucchi et al. 2020; Yu et al. 2022). Later research shows that it reached Palestine around 3000 years BP (Martin et al. 2000; Tchernov 1986). Other evidence of rats in the western Mediterranean dates to 2400 before present (Martin et al. 2000; Vigne and Valladas 1996).

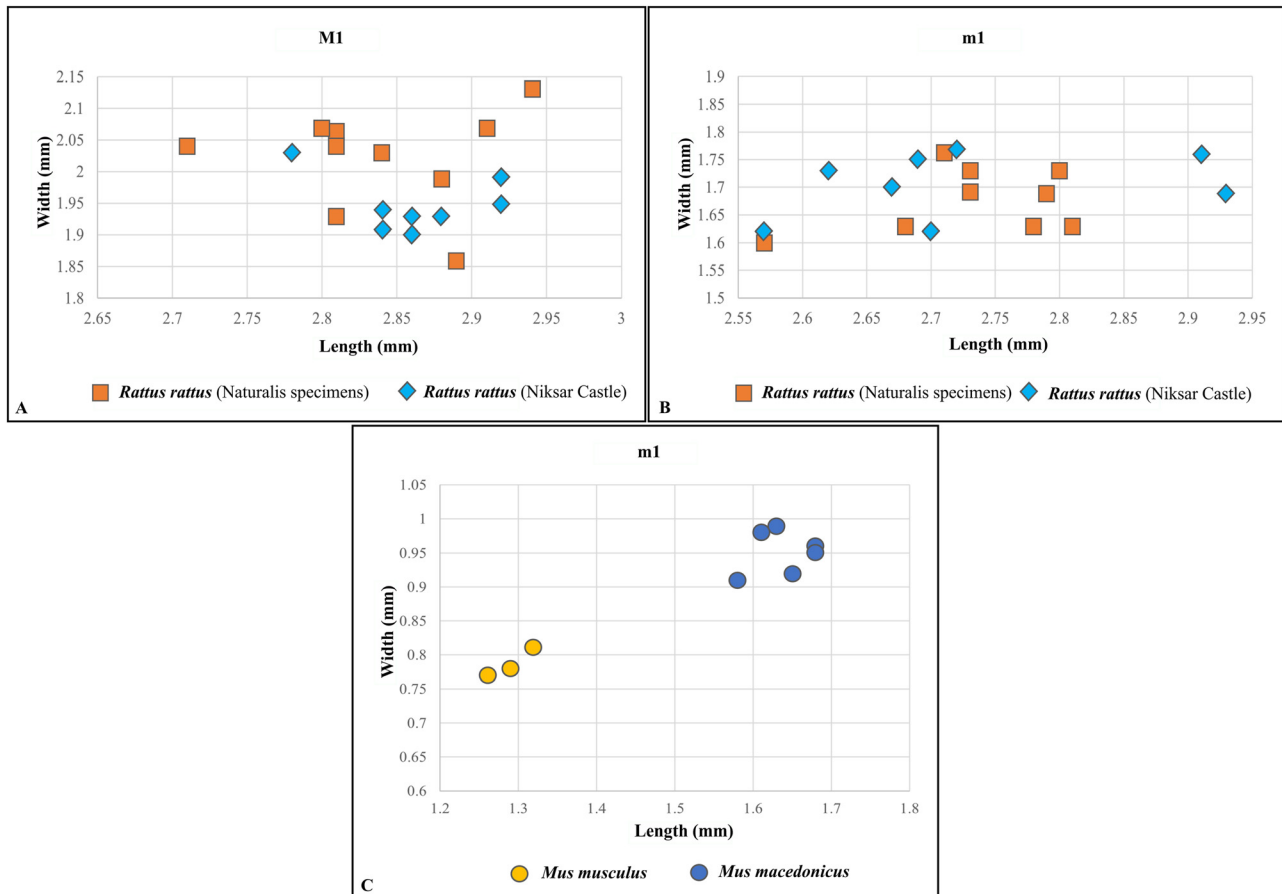


Figure 4: Diagrams comparing the archeological material of *Rattus* and *Mus* with recent specimens. (A–B) Length-width distribution diagram of M1 and m1 of *Rattus rattus* from Naturalis Biodiversity Center and NK collection; (C) m1 length-width distribution diagram of *Mus macedonicus* from Pulur Höyük with *Mus musculus* from Niksar Castle.

Genus *Mus* Linnaeus, 1758

Species *M. musculus* Linnaeus, 1758 (Figure 5F–H)

Type locality: Dublin, Ireland.

Material examined: Three mandibles with m1s-m2s (Nkm 76, 89, 1011).

Measurements: See Table 1.

Description: Three mandible fragments from Niksar Castle preserve m1s and m2s and parts of the mandibular

body. Incisors are preserved in two of the mandibles only. None of the m3s are preserved.

The elongated m1 consists of six tubercles. The two anteroconids are connected to the protoconid and metaconid, forming an “X” that is narrower in its anterior part. The lingual anteroconid is much larger and situated more anterior than the labial anteroconid. The protoconid and metaconid are aligned and of the same size. The entoconid and hypoconid are separated from these four anterior tubercles by a deep valley. The entoconid and hypoconid are almost the same size and aligned. These two tubercles form an inverted “V” with the pointed end anteriorly. It has an oval-shaped, well-developed posterior cingulum. The m1 is two-rooted.

The m2 have the protoconid and metaconid forming an inverted “V” with the pointed end anteriorly. The hypoconid and entoconid complex forms a similar shape. The protoconid-metaconid and hypoconid-entoconid pairs are separated by a deep valley. There are no accessory cusplets. There is a well-developed posterior cingulum. The m2, two-rooted (Figure 5F).

Remarks: One of the most important features to distinguish the two Anatolian species of *Mus*, *M. macedonicus* and *M. musculus*, is considered to be the thickness of the zygomatic arch (Maul et al. 2011), which is not available in our material. However, there are also characteristics in the dentition: the anterior part of *M. musculus* m1 is trilobed while *M. macedonicus* is tetralobed (Cucchi et al. 2002). Since the labial anteroconid is quite small in the Niksar Castle specimens, the anterior part of the m1 has rather taken a trilobed form.

In addition, the dentition of the two species also seems to differ in size, as can be deduced from Kryštufek and Vohralík (2009; fig. 119), who indicated that the M3 of *M. macedonicus* is less reduced than that of *M. musculus*. However, the measurements they provide do not seem to match with the minuscule size of the M3 and even surpass our dimensions for the M2 of *M. macedonicus* from Pular Höyük. Nevertheless, the differences in size are undeniable. Csanády and Mošanský (2018) included in their paper the length of the m1 of both males (1.25–1.45 mm) and females (1.23–1.63 mm) of *M. musculus*. Given, however, that the average lengths of males and females are exactly the same, they seem to have a single female outlier that accounts for the incredible overall range of 1.23–1.63 mm, with an average of 1.34 mm. Ignoring that outlier by only considering the measurements for the males, the range for our Niksar Castle sample (1.26–1.33 mm) falls neatly in the range of *M. musculus*, whereas the measurements (Figure 4C) for *M. macedonicus* from Pular Höyük are well above it. Thus, despite their similar body size Kryštufek and Vohralík (2009), there seems to be indeed a

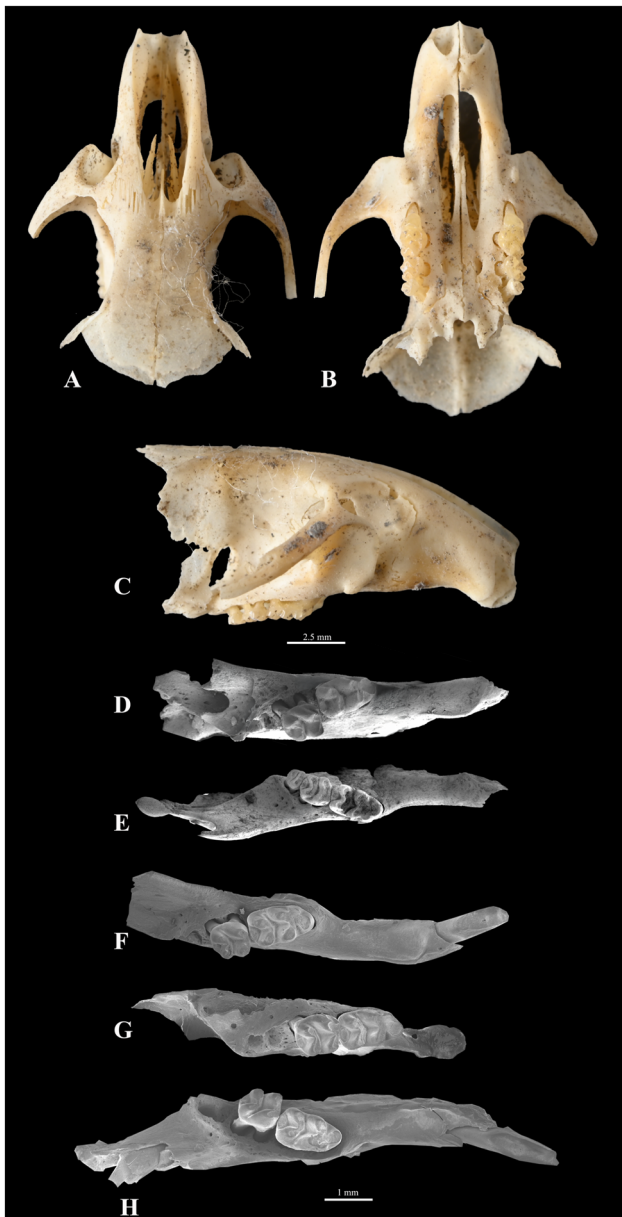


Figure 5: *Mus* specimens from Pular Höyük and Niksar Castle. (A–C) Photographs of *Mus macedonicus* skull from Pular Höyük: (A) dorsal view; (B) ventral view; (C) lateral view. (D–E) SEM pictures of *Mus macedonicus* mandibles: (D) (PLm 19); (E) (PLm 20). (F–H) SEM pictures of *Mus musculus* mandibles from Niksar Castle: (F) (Nkm 76); (G) (Nkm 89); (H) (Nkm 1011). 1 cm scale for (A, B and C); 1 mm scale for (D, E, F, G, H).

size difference in the dentition of the two Anatolian *Mus* species, with *M. macedonicus* being the more macrodont.

Mus musculus appears to have already been present in Neolithic settlements. The earliest find recovered from Türkiye came from Cafer Höyük, belonging to the Middle PPNB (8200-7500 BC) period (Cauvin and Aurenche 1982; Cucchi et al. 2020). Jenkins (2012a) listed *M. musculus* from

Çatalhöyük, but classified most of her material as *Mus* sp. Given that the two Anatolian species of *Mus* only exceptionally live syntopic (Kryštufek and Vohralík 2009), it is, however, very unlikely that more than one species is present in the material. Jenkins (2012a) did not provide any measurements, descriptions, or pictures showing the occlusal surface by which her identifications could be checked.

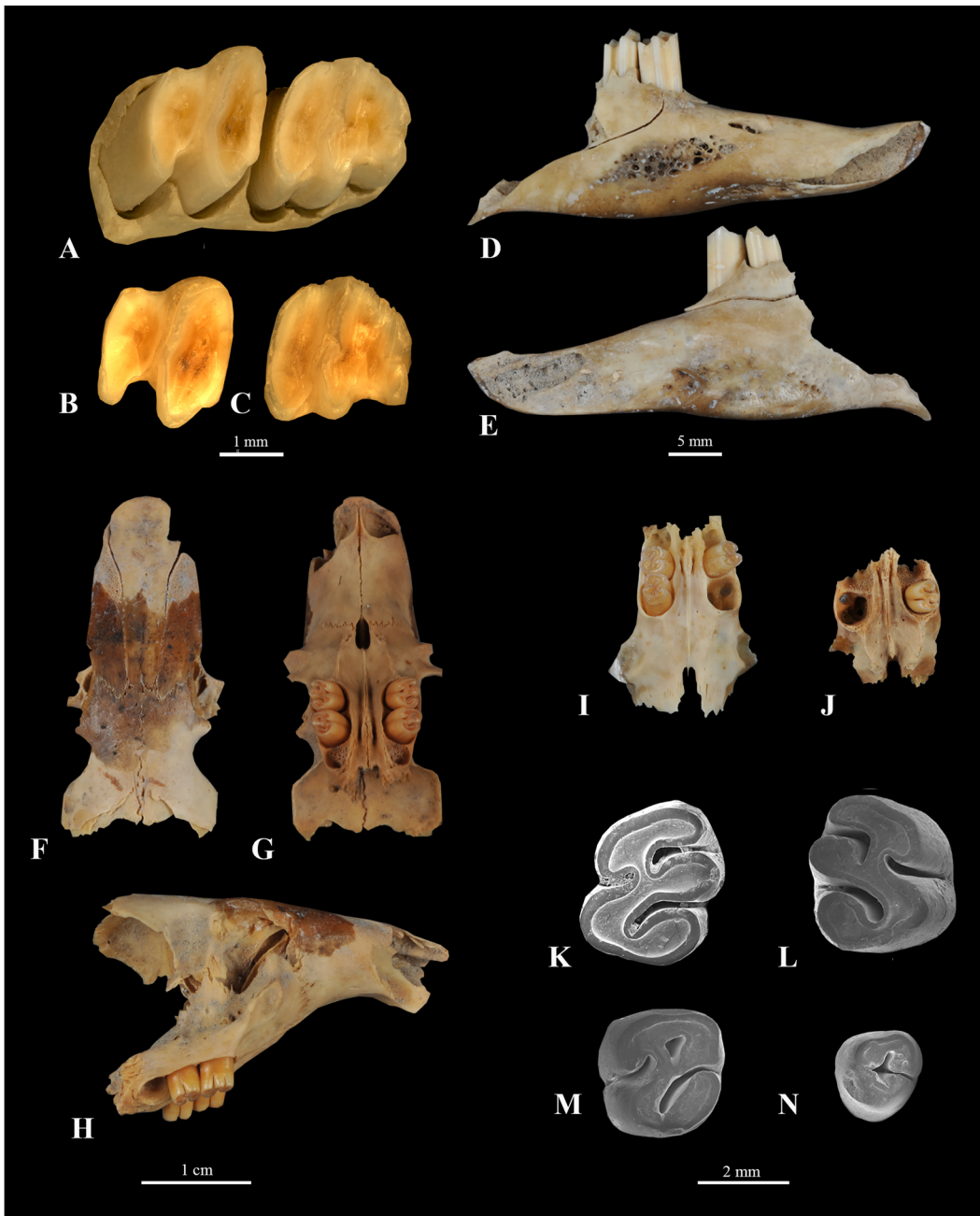


Figure 6: Material of *Lepus* and *Spalax* recovered from Niksar Castle and Pulur Höyük. (A–E) *Lepus europaeus* specimens from Niksar Castle: (A) occlusal surface of p3 and p4 on the mandible; (B) p4; (C) p3; (D) mandible in lateral view; (E) mandible in medial view. (F–J) *Spalax leucodon* specimen: (F) dorsal; (G) ventral; and (H) right lateral view of PL 1–4 skull; (I) and (J) maxilla specimen of (PLm 8910; PLm 7) found in Pulur Höyük. (K–N) SEM pictures of *Spalax leucodon* specimen found in Erzurum-Pulur Höyük: (K) M1 (PL 6); (L) M1 (PL 12); (M) M2 (PL 7); (N) M3 (PL 5). 1 mm scale for (A, B, C); 2 mm for (K, L, M and N); 5 mm scale for (D and E); 1 cm scale for (F, G, H, I and J).

However, the material from Çatalhöyük was included in a geometric morphometrics analysis of *Mus* species from archaeological sites by Cucchi et al. (2020), and they confirmed that the material can be allocated to *M. musculus domesticus*. Erdal et al. (2019) described *M. cf. musculus* from Tepecik-Çiftlik, but we consider this material to likely belong to *M. macedonicus* (see discussion below).

Order **Lagomorpha** Brandt, 1855

Family **LEPORIDAE** Gray, 1821

Genus **Lepus** Linnaeus, 1758

Lepus europaeus Pallas, 1778 (Figure 6A–E)

Type locality: Poland.

Material examined: One mandibular fragment with the p3 (NK 56) and p4 (NK 57).

Description: The single mandible fragment from Niksar Castle preserves the p3-p4 and parts of the mandibular body. The posterior parts of the mandibular ramus and the coracoid process are not being preserved. The mandibular symphysis is visible, and the anterior part of the mandible remains intact. The diastema is relatively long and slender. The incisor is not preserved. The mental foramen is relatively large, oval-shaped, and situated posteriorly, approximately 1/3 of the diastema's anteroposterior length. The labial surface of the body is fenestrated.

The p3 has two prominent anteroconids, separated by a relatively deep and narrow anteroflexid. The anteroconids are not equal in size, with the labial anteroconid being larger than the lingual. The protoflexid is wide, U-shaped, and lacks visible undulation. The enamel of the hypoflexid shows slight undulations on both the anterior and posterior parts. The hypoconid has an ellipsoidal shape, and its most exterior parts are at the same level as the protoconid. On the lingual side, the paraflexid is very slightly marked and appears to be almost nonexistent. According to the terminology by Čermák et al. (2015), the studied leporid shows the A1/Pa0/PR3 morphotype of p3, typical for the species of *Lepus* and *Oryctolagus* (Figure 6A and C).

The p4 exhibits two cylindrical shafts united by a small bridge at the lingual side, a characteristic of the p4 that is common to the majority of leporid species. Both p3 and p4 do not show any prominent enamel crenulations (Figure 6A–C).

Remarks: The two extant species of the Leporidae residing in Türkiye are *L. europaeus* and *Oryctolagus cuniculus* (Demirsoy 1996). *Lepus* and *Oryctolagus* show the so-called leporine type of p3, by featuring a p3 with a trigonid and talonid connected by a narrow lingual isthmus (Averianov 1999; Lopez-Martinez 2008).

The morphology of the lower third premolar (p3) is crucial for identifying families, genera, and species of the order Lagomorpha, thus, most of the literature has focused on the characteristic features of p3 morphology (e.g., Callou

1997; Hibbard 1963; Pelletier et al. 2015). However, for extant leporids, diagnostic features also depend significantly on skeletal elements, as tooth-based identification can be more restricted and prone to variability in some cases (Callou 1997). It must be noted that the size of dental and skeletal elements by itself is not a reliable measure for species identification, as it can vary significantly and is often influenced by local environmental conditions (Pelletier 2021).

Callou (1997) notes that the lower p3 is a key diagnostic point between *O. cuniculus* and *L. europaeus*. In rabbits, the lingual and labial anteroconids on the lower p3 are generally similar in size and shape, whereas in hares, they tend to be more asymmetrical. As reported above, the Niksar p3 shows these *Lepus* characteristics. Additionally, features such as the proportions of the diastema and the position and shape of the mental foramen can also aid in identification. The mental foramen in our specimen, like in the case of p3, closely resembles that of *Lepus*. Although, the morphological characteristics of the p3 align with those of *L. europaeus*, the size of the p3 in this specimen falls within the accepted range of *Oryctolagus cuniculus*. Based on the measurements from De Marfà (2009) and Chatzopoulou (2014), *O. cuniculus* has a noticeably smaller p3 than *L. europaeus*. It is unusual to come across such a small-sized *Lepus* specimen, but, as previously stated, relying solely on metric data is insufficient for accurate leporid species identification (Pelletier 2021). Considering all of this, the Niksar leporid is identified as *Lepus*.

The taxonomic status of hares in Türkiye has historically been a source of considerable confusion, centered on distinguishing the European hare (*L. europaeus*) from the smaller Cape hare (*L. capensis*). Hongo (1997) listed *L. capensis* from the Islamic layers of Kaman-Kalehöyük. However, *L. europaeus* is prevalent across Türkiye, where it is represented in Anatolia by the subspecies *L. europaeus syriacus* (Demirbaş and Albayrak 2014; Sözen and Çolak 2025). It has been suggested that the *L. europaeus* and *L. capensis* could be part of one species complex, although this is still a matter of debate (Bock 2020 and references therein). A species complex may account for the substantial morphological variation among *L. europaeus* population in warmer regions like Türkiye (Demirbaş and Erat 2015), also bearing Bergmann's rule in mind. Until such matters have been resolved, we consider the Niksar find best classified as *L. europaeus*, the species that also inhabits the region at present.

3.2 Location Pulur Höyük

Family **Muridae** Illiger, 1811

Subfamily MURINAE Illiger, 1811

Genus *Mus* Linnaeus, 1758

Mus macedonicus Petrov et Ružić, 1983 (Figure 5A–E)

Type locality: Near Valandovo, North Macedonia.

Material examined: Five mandibles (PLm 19, PLm 20, PLm 21, PLm 22, PLm 23) and one skull with all molars (PLm 24).

Measurements: See Table 1.

Description: The M1 is elongated and strongly asymmetrical because of the labial position of the anterior complex. The small t3 is directly adjacent to the very prominent t2. The t1 is posteriorly displaced and lies directly lingual of the t5. The latter is only somewhat larger than the t6. The t4 is somewhat smaller than the t1 and lies directly behind that cusp, somewhat anterolingual of the t8. There is no t7 and the small t9 occupies the posterolabial corner of the molars.

The M2 is longer than wide and tapers somewhat posteriorly (Figure 5B). There is a narrow anterior ridge in which the t3 is completely incorporated. This ridge connects to the t1, which lies fairly isolated on the anterolingual side of the molar. The t5 is somewhat smaller than the t8. The t6 is small and lies posterolabially to the t5 while being broadly connected to that cusp. The t4 is developed as a long, narrow ridge, connecting the t8 to the t1. By contrast, the t7 developed as a somewhat broader but clearly shorter ridge.

The M3 is a simple, semicircular element (Figure 5B). The t1 is isolated. The rest of the molar consists of a complex made up of a large t4 with an adjacent small t5 and connected to a broad posterior ridge.

The m1 is elongated (Figure 5D). There is no separate tma, but a large anterolingual cusp that may well be a fusion of the tma and lingual anteroconid. The anterolabial anteroconid is well developed but can only be recognised as a separate cusp in one unworn specimen. In all the other specimens, it fuses with the wear surface of the protoconid-metaconid and anterolingual anteroconid, although it remains identifiable by a bulge in the outline of the wear facet. The prism formed by the entoconid and hypoconid is similarly sized to that of the protoconid-metaconid but is somewhat lower. There is an elliptical posterior cingulum in central position and no accessory cusplets.

The m2 is longer than it is wider, slightly tapering posteriorly (Figure 5D). The labial anteroconid is very small, and the anterior prism is larger than the posterior one. The posterior cingulum is ridge-shaped, connecting the bases of the hypoconid and entoconid.

The only preserved m3 is moderately worn (Figure 5E). It has a subtriangular outline and consists of a wide, transverse anterior prism and a narrow posterior one.

Remarks: The relative thickness of parts of the zygomatic arch is considered to be a distinguishing characteristic

between *M. macedonicus* and *M. musculus*, according to Maul et al. (2011) and Kryštufek and Vohralik (2009; fig. 118). However, when we calculated the zygomatic indices for the skull from Pular Höyük, the right side gave a value indicative of *M. musculus*, whereas the index for the left arch fell clearly into the *M. macedonicus*. We therefore rely on dental characteristics instead.

As we noted under the remarks on *M. musculus*, the molars of *M. musculus* have smaller dimensions than those of *M. macedonicus*. In addition, there is a well-developed labial anteroconid on the m1, which leads to a tetralobed (Cucchi et al. 2002) or, in other words, clover-shaped (Suata-Alpaslan 2011) anterior complex. Also, *M. macedonicus* has a developed t3 on the M2 (invariably absent in *M. musculus*). These same characteristics were also noted for the *Mus* finds from Tepecik-Çiftlik. However, Erdal et al. (2019) classified this material tentatively to *M. musculus*, since it is somewhat smaller than the specimens of *M. macedonicus* described by Suata-Alpaslan (2011) from Üçağzılı Cave. Though smaller than other *M. macedonicus* assemblages, the material still seems larger than the values for *M. musculus* as given by Csanády and Mošanský (2018). The morphological data lead to the deduction that the Tepecik-Çiftlik assemblage is most likely to represent *M. macedonicus*.

Subfamily SPALACINAE Gray 1821

Genus *Spalax* Güldenstaedt 1770

Spalax leucodon (Nordmann 1840) (Figure 6F–N)

Type locality: Near Odessa, Ukraine.

Material examined: One skull fragment, two maxillary fragments and eight isolated upper molars. Total 12 M including six M1 (PL 2, PL 4, PL 6, PL 11, PL 10, PL 12), five M2 (PL 1, PL 3, PL 7, PL 8, PL 9) and one M3 (PL 5).

Measurements: See Table 1.

Description: The two maxilla fragments and one almost complete skull from Pular Höyük preserve the M1s. Besides these skull fragments; isolated M1s, M2s and one M3 are also preserved. All molars are hypsodont.

The length of M1 is greater than its width. Anterocone, paracone and metacone are separated by deep valleys. Anterocone and protocone are completely fused and there is an anteroloph perpendicular to them. Mesoloph is not seen. The developed connection between protocone and anterocone is parallel to the connection between paracone and hypocone. Posteroloph and metacone are completely fused with each other and take the form of a curved drop. Anterosinus, mesosinus and sinus form a ‘W’-shaped pattern. It has three roots.

M2 is almost equal in length and width. The anterocone-protocone, hypocone, and metacone merge to form an ‘S’ shape. In the worn tooth, the anterocone curved and merged with the paracone and formed an islet in the center. In one

specimen, the anteroloph is absent. Metacone and posteroloph are completely fused, as in M1 (Figure 6L).

The outline of M3 is almost rounded. Anteroloph, protolophule and protocone are connected. Mesosinus and sinus are connected. Posteroloph is well developed (Figure 6N).

Remarks: According to Kryštufek and Vohralík (2009), the *Spalax* species in Türkiye are *S. leucodon*, *S. xanthodon*, and *S. ehrenbergi*. However, the taxonomy of extant Spalacidae is complicated and largely based on genetic evidence. Here, we follow the morphological characteristics as given by Kryštufek and Vohralík (2009).

The Pulur Höyük skull lacks a mesial cleft-like structure on the nasal bone, as does *S. leucodon*. Our M1 is three-rooted, which also concurs with that species mostly having three or four roots (Kryštufek and Vohralík 2009). Only one isolated islet is found on the M3. By contrast, the M3 of *S. ehrenbergi* has two isolated enamel islets. *Spalax xanthodon* features a mesial cleft-like structure on the nasal bone, and its M1 typically has one or two roots, although three roots are very rare. Considering all of this, specimens from Pulur Höyük were identified as *S. leucodon*.

Our identification, however, does hold one major problem. According to Kryštufek and Vohralík (2009), *S. leucodon* is in Türkiye restricted to Thrace. *Spalax xanthodon* is the species that inhabits most of Anatolia, *S. ehrenbergi* being restricted to the southeast. Notably, the *Spalax* finds from the Neolithic site of Tepecik-Çiftlik (Erdal et al. 2019) were identified as *S. xanthodon*. Although this does throw some doubt on our identification, taxonomy should be based on morphological characters. These, for now, support an identification as *S. leucodon* for Pulur Höyük. However, once again we caution that *Spalax* taxonomy is notoriously difficult, and we cannot rule out that ultimately the specimens from Tepecik-Çiftlik and Pulur Höyük could belong to the same species.

Subfamily **Arvicolinae** Gray 1821

Genus ***Microtus*** Schrank 1798

Species *Microtus* sp. (Figure 7A–F)

Material examined: Three molars including one m1 (PL 13), one m2 (PL 14) and one m3 (PL 15) (A/L = 51).

Measurements: See Table 1.

Description: In arvicolid species identification, morphological characteristics of molars m1 and M3 are based on morphometric distinctions (Rekovets and Nadaschowski 1995). As the M3 is missing in our material, we will focus our description on the single m1 found.

The m1 is hypsodont and rootless. On the occlusal surface, the synclines are filled with cement. PL is composed of five prismatic closed triangles (T1, T2, T3, T4 and T5) and the anteroconid complex includes AC3, T6, T7, and weakly

developed T8 and T9. AC3 has an anterior part that is rounded. The T6-T7 complex is broadly confluent. Enamel on the mesial margins of AC3 and on the labial and lingual margins of PL is absent. In addition, the enamel on the posterior edges of the triangles is very thin (positive differentiation). Five LRAs and four BRAs are well developed. Lingual angles are more symmetrical and deeper than labial angles. A small protrusion is formed between T6 and T8 (Figure 7A).

Remarks: *Microtus* is a highly speciose and widely dispersed genus, with twelve extant species in Türkiye. These are *M. subterraneus*, *M. majori*, *M. daghestanicus*, *M. arvalis* (including *M. obscurus*), *M. levis* (*rossiaemerdionalis*), *M. socialis*, *M. irani*, *M. anatolicus*, *M. schidlovskii*, *M. guentheri*, *M. hartingi*, and *M. dogramaci* (Kryštufek and Vohralík 2009). Pulur Höyük specimens differ from *Microtus subterraneus* in the absence of a confluence between T5 and T4 (Erdal 2018). Although the A/L ratio fits with the minimum and maximum range of the *Microtus guentheri* species, the length of m1 is smaller than *Microtus guentheri* (Maul et al. 2011). In *Microtus majori*, the confluent space between T4 and T5 on m1 and AC3, is morphologically different from our sample in that it is mushroom-shaped. *Microtus daghestanicus* also shows a wide confluence between T4 and T5, which differs from our specimen (Kryštufek and Vohralík 2005). Thus, *Microtus* sp. found at Pulur Höyük could be *M. daghestanicus*, *M. arvalis*, *M. rossiaemerdionalis* or *M. socialis* based on the genus's geographical distribution. However, for lack of comparative material and descriptions of the m1 of the various species, it is at present not possible to come to a closer identification. The vole from Pulur Höyük seems slightly smaller than the one from Tepecik-Çiftlik, which was classified as *M. cf. arvalis* by Erdal et al. (2019). Notably, their discussion focuses around the same *Microtus* species as are under consideration for the Pulur Höyük specimens. Given the small size difference, and morphological similarity, it is possible that the material from the two settlements belongs to the same species. However, we consider our material too limited to come to an identification at the species level.

Subfamily **CRICETINAE** Fischer, 1817

Genus ***Mesocricetus*** Nehring, 1898

Mesocricetus brandti (Nehring, 1898) (Figure 7G and H)

Type locality: Georgia, near Tbilisi.

Material examined: One left mandible with m1-m3 (PL 16, PL 17, PL 18); TRL equals to 6.8 mm.

Measurements: See Table 1.

Description: The mandible is very well preserved. It has a high mandibular body with a deep diastema. The lowest

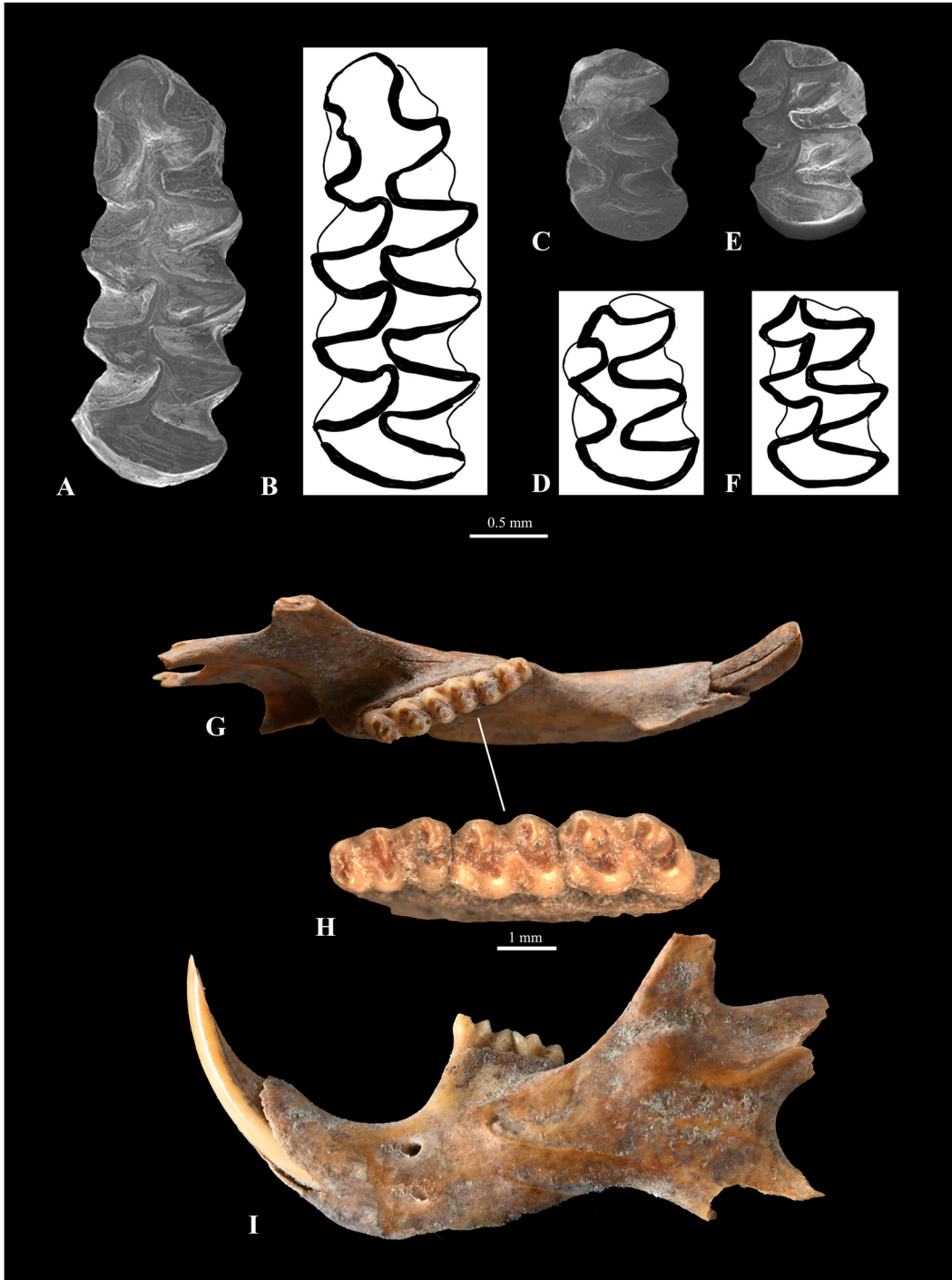


Figure 7: Arvicolids and cricetids recovered from Pulur Höyük. SEM pictures and drawings of *Microtus* sp. from Pulur Höyük: (A–B) occlusal surface of M1 (PL 13); (C–D) occlusal surface of M2 (PL 14); (E–F) occlusal surface of M3 (PL 15); (G, H) superior view of left mandible with m1–m3 (PLm 17); (I) lateral view of *Mesocricetus brandti*. 0.5 mm scale for (A–F); 1 mm scale for H.

part of the mandible is below the steep posterior end of the diastema, at the level of the front of the m1. The foramen mentale is positioned in line with the posterior end of the diastema. The coronoid process is rather low and wide (Figure 7H).

The $m1 > m2 < m3$, with the m3 being somewhat longer and clearly wider than the m1. The m1 is elongated and slender, with the opposing cusp forming three lobes. The anterior lobe is formed by the anteroconid and is slightly bilobated. The second and third lobes, formed by the

protoconid/metaconid and hypoconid/entoconid, are somewhat larger and slightly more oblique. A narrow posterolophid closes the molar at the back. The cusps of the m2 and m3 are more alternating, with the metaconid and entoconid being somewhat anterior with respect to the protoconid and hypoconid, respectively. Still, the opposing cusps form a transverse loph with a combined wear surface. The two lophs are connected by a well-developed ectolophid; there is no mesostylid. The anterolophids are small, and the posterolophid is well developed, particularly in the m3.

Remarks: At present, two species of *Mesocricetus* inhabit Anatolia. *M. brandti* is found in most of inland Anatolia as well as in the Transcaucasus and in north-western Iran. By contrast, *M. auratus* only occurs in a small area in southeastern Türkiye, adjacent to its home range in northern Syria. The most extensive description of the *Mesocricetus* dentition was provided by Hır (1992), who described the dentitions of a subfossil assemblage found near the village of Meydan in southern-central Türkiye. At the time, there was a discussion whether or not *M. brandti* should be considered a synonym of *M. auratus*. In the absence of literature on differences in the dentition between the two species, Hır decided to classify his material as *M. auratus*. In the meantime, a synonymy of the two species has been rejected on the basis of genetic grounds (e.g., Yiğit et al. 2006). As Meydan is one of the sampling localities of Neumann et al. (2017) in their genetic study of *M. brandti*, it is clear that the subfossil assemblage described by Hır (1992) should be assigned to this species. For the same reason, we consider that the find from Aşıklı Höyük listed by Bailey (2018) as *M. auratus* is better classified as *M. brandti*.

The specimen from Pular Höyük falls metrically in the upper part of the variation as described by Hır, and, with a TRL of 6.8 mm, is larger than the length recorded in that assemblage, whereas the only *M. auratus* tooth row he compared with is smaller (5.8). Thus, also on the basis that the Pular Höyük is in the middle of the current range of *M. brandti*, we can be reasonably sure that the mandible should be referred to that species.

4 Discussion

This study identified seven species collected from two archaeological excavations: Niksar Castle and Pular Höyük. Here, the primary goal was to contribute to the knowledge of micromammal fauna of human settlement centers. So far, micromammal remains were mainly recorded from Neolithic sites, such as Aşıklı Höyük (Bailey 2018), Çatalhöyük (Jenkins 2012), and Tepecik-Çiftlik (Erdal et al. 2019) and Epipaleolithic sites such as Üç Ağızlı Cave (Suata-

Table 2: Micromammal faunas from Niksar Castle and Pular Höyük.

Species	NISP	Localities		Cultural layers
		Niksar castle	Pular Höyük	
<i>Rattus rattus</i>	17	X		Late Ottoman Period
<i>Mus musculus</i>	3	X		Late Ottoman Period
<i>Lepus europaeus</i>	1	X		Late Ottoman Period
<i>Microtus</i> sp.	3		X	Early Bronze Age
<i>Spalax leucodon</i>	7		X	Early Bronze Age
<i>Mus macedonicus</i>	6		X	Middle Chalcolithic
<i>Mesocricetus brandti</i>	1		X	Late Chalcolithic

Alpaslan 2011) (Table 3). Pular Höyük and Niksar Castle are both of younger age, representing the Middle Chalcolithic to Early Bronze Age and Late Ottoman Period, respectively (Table 2). As such, it is clear that the micromammal record associated with human settlements is far from complete, particularly concerning the Bronze and Iron Ages.

The first thing that stands out when comparing our two sites is that they do not have a single species in common. Niksar Castle yielded *R. rattus*, *M. musculus*, and *L. europaeus*. These three species exhibit notable relationships with humans: *R. rattus* and *M. musculus* species are in synanthropic relationships with humans. Although *L. europaeus* is not a commensal species, its significance to human activity is documented: hares were known to be hunted in the Ottoman Empire (Artan 2011) and *Lepus* remains were also found at the Ottoman settlement of Kaman-Kalehöyük (Hongo 1997).

By contrast, Pular Höyük yielded only native Anatolian species: the mole-rat *S. leucodon*, the vole *Microtus* sp., the murid *M. macedonicus*, and the hamster *M. brandti*. The species of Pular Höyük have all been found in older localities, albeit that the species of *Microtus* have been identified at the species level there and that Tepecik-Çiftlik has a different species of *Spalax* (Table 3). Arguably the most interesting taxa, however, are the species of the genus *Mus* for three reasons. Firstly, *M. musculus* is, apart from the species of *Rattus*, the most iconic example of a synanthropic species. Secondly, in Anatolia, there is a very close indigenous species of the genus, *M. macedonicus*. And finally, these two species have a tantalizing distribution, being sympatric but never found syntopic. This merits special attention for this murid.

Whereas Üçağızlı Cave, Tepecik-Çiftlik, and Pular Höyük yielded *M. macedonicus*, the Çatalhöyük murid was firmly identified as *M. domesticus* by Cucchi et al. (2020). Thus, a pattern emerges in which some archaeological sites have

Table 3: Small mammal findings from some archaeological sites of Anatolia.

Species	Üç Ağızlı Cave	Aşıklı Höyük	Çatalhöyük	Tepecik-Çiftlik	Pulur Höyük	Niksar Castle
<i>Apodemus mystacinus</i>	X					
<i>Apodemus flavicollis</i>	X					
<i>Apodemus witherbyi</i>	X					
<i>Apodemus sylvaticus</i>		X				
<i>Apodemus agrarius</i>		X				
<i>Apodemus</i> sp.		X				
<i>Mus macedonicus</i>	X			X	X	
<i>Mus musculus</i>			X			X
<i>Rattus rattus</i>						X
<i>Chionomys nivalis</i>	X					
<i>Arvicola amphibius</i>		X	X	cf.		
<i>Microtus guentheri</i>	X		X			
<i>Microtus arvalis</i>				cf.		
<i>Microtus</i> sp.					X	
<i>Mesocricetus brandti</i>	X	X		X	X	
<i>Meriones</i> sp.		X	X			
<i>Spalax leucodon</i>		X			X	
<i>Spalax xanthodon</i>				X		
<i>Spalax</i> sp.		X				
Gliridae indet.	X					
<i>Spermophilus xanthoprimum</i>				X		
<i>Lepus</i> sp.	X					
<i>Lepus capensis</i>		X				
<i>Lepus europaeus</i>						X

Data from: Üç Ağızlı Cave from (Suata-Alpaslan 2011); Aşıklı Höyük (Stiner et al. 2022); Çatalhöyük (Jenkins 2012); and Tepecik-Çiftlik (Erdal et al. 2018).

M. musculus, whereas others have the native *M. macedonicus*. Cucchi et al. (2020) explained this pattern by suggesting that *M. musculus* only took over from the indigenous species in the more populated settlements. As such, *M. musculus* appears to be truly synanthropic. We note, however, that both in the case of Pulur Höyük and Tepecik-Çiftlik, *M. macedonicus* was found in conjunction with grain storage, so that at the very least it seems to have benefited from the human presence.

The Üç Ağızlı assemblage is strongly dominated by wood mice of the genus *Apodemus*, both in number of specimens and by the presence of three different species. *Apodemus* is also the dominant rodent in Aşıklı Höyük, a pre-pottery Neolithic site dated between 10,440 and 9400 BP (Bailey 2018; Stiner et al. 2022). Bailey (2018) listed different species of *Apodemus* than Suata-Alpaslan (2011), but provided no descriptions or photographs to back up the identifications. Notably, the genus is not found in Pulur Höyük or Tepecik-Çiftlik. Apparently, the anthropogenic environments of these settlements were shunned by wood mice, and agricultural activity near them would certainly not have favored their habitat.

The species of *Mus* found is not the only aspect of the assemblages that may be controlled by the density of the population. Also, the overall faunal composition, or rather, the likelihood that indigenous species can be found within

the settlement, seems to be dependent on the type of habitation. The Üç Ağızlı Cave microfauna, dating from the Upper Paleolithic to Epipaleolithic, aligns remarkably with the modern faunal community, a point highlighted by Suata-Alpaslan (2011). As such, we can take it as a baseline for Holocene archeological assemblages. We note, however, that, as the author herself already indicated the occurrence of the East Asian genus *Glirulus* in the assemblage is problematic, as it extirpated in Europe in the Early Pleistocene. So we prefer to classify this single molar as Gliridae indet., pending comparison to local genera, and in particular *Dryomys*. In addition, we note that *Chionomys nivalis* is a typical Pleistocene element, which now has its relict area in European mountain ranges.

Spalax, *Mesocricetus*, and the voles *Arvicola* and *Microtus* are regular components of the Neolithic to Chalcolithic assemblages. The common aspect of these genera is that they all are small burrowing rodents. As such, small, open human settlements would have a relatively minor impact on their habitat, and they would be able to sustain their burrows between and near habitation. In two of the settlements, Aşıklı Höyük and Çatalhöyük, remains of the gerbil *Meriones* were found as well. Gerbils also live in burrows, but are sometimes indicated as pests (Yeszhanov et al. 2020). As such, it could be considered to fall into the

same category as *M. macedonicus*, an indigenous species that would also have benefitted from the human presence. In the first place, these species benefitted from the increased food sources due to agricultural activity, but in addition, the presence of humans may have contributed to a safe haven from a number of predators. However, this is only true to a certain extent, as Anatolia was one of the first regions where cats may have contributed to pest control (Cucchi et al. 2020). *Spermophilus*, which was found in Tepecik-Çiftlik (Erdal et al. 2019), is also a burrower. However, it seems unlikely that a colony of ground squirrels would have lived within a settlement, as their burrows are extensive and the animals themselves are quite large. *Spermophilus* remains from a Bronze Age site in Russia show signs of snaring (RLHO, pers. obs.) and this may well be the same way that the Turkish finds found their way into a settlement. In this respect, it may be meaningful that the Tepecik-Çiftlik finds were made in an area with ashes as well as a possible trash pit (Erdal et al. 2019).

Where smaller settlements seemed to have had little effect on small mammal diversity, this was different for the larger settlements. In this respect, Niksar Castle may be a bit of an unfortunate example, given that our finds there are already from a far more recent history. But nevertheless, it is telling that no indigenous species were found. The house mouse in Niksar Castle is *M. musculus*, and Cucchi et al. (2020) already indicated that in its distribution, this species favored more densely populated settlements. As noted, the species were also found in the Neolithic site of Çatalhöyük. Our faunal list of that settlement indeed shows a limited diversity, but we need to bear in mind that Jenkins (2012a) did not provide a comprehensive species list and that much of the material in her graphs is lumped under the heading “Rodents”. So more research would be needed to see if the decline of diversity in human settlements already took place in the larger settlements from the Neolithic onwards.

The material of *R. rattus* and *M. musculus* in Niksar Castle was found at a possible dumpsite amidst refuge. Surely, in the same way rats flourish in modern waste dumps, this site would have provided ample food for the rodents. On the other hand, it would also have been a logical place to dump the bodies of rats or mice killed elsewhere in the castle. Notably, our rat specimens show advanced stages of dental wear, suggesting they lived to a relatively high age and may have been able to roam the castle quite freely. Thus, although the diversity is low, the inhabitants of the castle probably had regular encounters with the micromammals living there.

The hare jaw was the only micromammal specimen from Niksar Castle not found at the dump site. The castle may have functioned as a refuge, providing protected

habitats that align with the hares’s adaptability to peri-urban environments as shown in recent studies (Mayer and Sunde 2020; Pagh et al. 2025). Whether pet, meal, or feral, the find underscores that the hare, like the other inhabitants of Niksar Castle, is very much part of the human influence on the micromammal fauna.

5 Conclusions

When considering the Holocene micromammal history of Türkiye as a whole, the main change is probably the introduction of synanthropic species over time. Ultimately, this leads to a faunal such as that from the Late Ottoman period of Niksar Castle, which, with the exception of a single find of *L. europaeus*, solely consists of species with established synanthropic relationships with humans: *R. rattus* and *M. musculus*.

By contrast, the Chalcolithic settlement of Pular Höyük features a faunal list mirroring the indigenous fauna, with *M. macedonicus*, *M. brandti*, *S. leucodon*, and *Microtus* sp. (the latter from the Early Bronze Age sediment of the site). Minor settlements, such as Pular Höyük, apparently provided sufficient habitats for particularly small burrowing rodents. Additionally, the settlements may have offered relative safety from various predators, while agricultural activities provided increased food resources. Pular Höyük resembles in this respect a site like Tepecik-Çiftlik, but we know from other sites (Çatalhöyük) that *M. musculus* had already taken over the role of the local house mouse, *M. macedonicus*. The presence of indigenous fauna inside settlements seems to be related to the density of the human occupation. The joint history of humans and micromammals in Türkiye is far from completely told, as in particular data from the (Late) Bronze Age and Iron Age are missing, and we were only able to compare our findings with Neolithic/Early Chalcolithic sites.

Moreover, descriptions, measurements, and illustrations of the material needed to facilitate comparisons between sites were not always provided. As such, this paper is only a step in recording how our relationship with small mammals developed. But, in our opinion, the study of micromammals from archaeological sites can be a source for fascinating stories for zoologists and archaeologists alike.

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