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On the karyology, morphology and biology of *Chionomys gud* (Satunin, 1909) (Mammalia: Rodentia) in Turkey

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Abstract. We examined the karyotype of *Chionomys gud* for the first time from Turkey, and found the values 2n=54, NF=58 and NFa=54. The X chromosome was found to be submetacentric and the Y chromosome acrocentric. Counts of embryos suggested a litter size range of 4 – 6 (mean 4.66, N = 3). Glans penis was stick shaped and covered by numerous microscopic papillae. The baculum had a well developed cartilaginous trifit distal process. The stalk of baculum had a well developed and broad base. The base and the shaft of the os baculum were roughly triangular in shape in dorsal view. The skull shapes of young, adult and aged specimens had distinctive features; in particular, the sagital crest became more prominent in older animals. Much variation was found in the shape of the molar chewing surfaces.

Key words: *Chionomys gud,* karyology, morphology, biology, Turkey.

Introduction

The Gudaur vole, *Chionomys gud*, is distributed only in the Caucasus Mountains and NE Turkey (Wilson & Reeder 1993, Nowak 1999, Kefelioğlu 1995). The karyotype of this species has been studied from the Caucasus (Radjabli & Grafodatsky 1977, Kurjatnikov & Tchopilashvili 1978, Kuliev 1979, Sablina et al. 1988), but the karyotype of the Turkish population, at the southernmost area of the species' distribution, is not known. The baculum of this species has also been studied from the Caucasus (Aksenova 1980), and from Turkey (Kryštufek 2005). The phallus of the Gudaur vole has been studied only from the Caucasus (Zorenko & Aksenova 1988); however, there is no phallic study from Turkey. The morphology of the skull and the teeth has been described by Kryštufek (2005). The life habits of *C. gud* are little known. Some scattered information is available about its burrowing, diet and reproduction (Gromov & Erbajeva 1995, Vinogradov & Gromov 1984, Sidlovskij 1976, Kryštufek 1999).

The purpose of this study was to describe the karyological characteristics of *C. gud* from NE of Turkey, and provide

further comparative information on the cranial, phallic and bacular morphology, as well as some aspects of general biology to fill some gaps in the knowledge about NE Anatolian isolates of *C. gud.*

Materials and Methods

Gudaur vole specimens (adult: 11, young: 4) were captured by Sherman traps from NE Turkey between 9th and 31st of July in 2003 and 2005. Localities and sample size of animals examined were as fallows: Ovit Mt Pass (40º 36´ 12.6´´ N, 2415 meters a.s.l.) (three females and two males); Verçenik Plateau (40º 45´ 47.1´´ N, 2350 meters a.s.l.) (five females and four males); and Yukarı Kavron Plateau (40º 53´ 00.1´´ N, 2100 meters a.s.l.) (one male). Sampling localities are shown in Fig. 1.

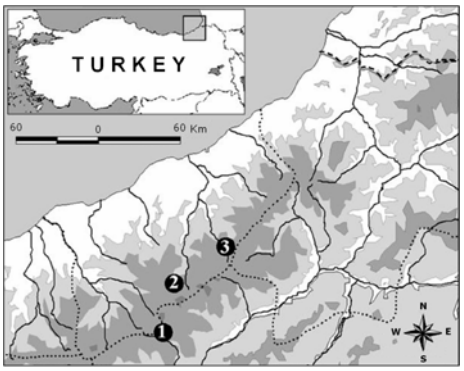

Figure 1. Map of sampling localities. 1. Ovit Mt. (Rize: İkizdere), 2. Verçenik Plateau (Rize: Çamlıhemşin), 3. Yukarı Kavron Plateau (Çamlıhemşin).

Conventionally stained chromosomes were collected from specimens deeply anaesthetized by diethyl ether and examined according to standard procedures (Ford and Hamerton 1956). We examined the photographs of about 20–30 metaphase cells of each animal and determined the diploid number of chromosomes (2n), the fundamental number of chromosomal arms (NF) and the number of autosomal arms (NFa) along with metacentrics, submetacentrics, subtelocentrics and acrocentrics with respect to centromere positions. Bacula and phalli were prepared in accordance with Lidicker (1968). Teeth terminology was used as in Kryštufek and Vohralik (2005).

Specimens were skinned in the standard museum type, and their skins, skulls and karyotype preparations have been deposited at the Department of Biology, Zonguldak Karaelmas University (N=6), Department of Biology, Ankara University (N=7), and Department of Biology, Niğde University (ZDNU) (N=2).

Results

Karyology: The karyotype of *Chionomys gud* was found to be 2n = 54, NF = 58 and NFa = 54. The X chromosome is submetacentric and is the largest chromosome in the set. The Y chromosome is acrocentric. The autosomal set consists of one small pair of metacentric and 25 pairs of acrocentric chromosomes (Fig. 2).

Skull: The skull is short, broad and slender. The rostrum is bent forward, and the interorbital region is long and quite narrow. The braincase is broad with laterally expanded occipital bones. The posterior margin of the palatine bone is U-shaped. We examined and compared the skull of young, adult and old specimens (Fig. 3, 4). Since there is no comparative study dealing with age variations of *C. gud,* we estimated the age of the young animals from our study (Fig. 4) to be about 20 – 25 days; calculations were based on age variations of *Microtus guentheri* by Sözen et al. (1999). The skull shape of the young animals had softer lines than found in the case of adults (Fig. 3). The skull of the young animals was distinctly convex in dorsal profile (see arrow in Fig. 3) with a relatively short rostrum. The braincase of the young specimens was oval in shape

while pentagonal in the case of adults, in dorsal view. Orbita were relatively larger in adults than in the young. The interorbital constriction was relatively broader in the young specimens. Tympanic bullae were not seen in the case of young but were visible in adults from dorsal view. The frontal bone formed a marked sagital crest in adults but not in the young. Postorbital tubercles of squamosum were visible in both young and adult animals, but became more pronounced in old specimens; indeed, the crest may be used to estimate the age of individuals, a more marked crested indicating a more advanced age. For example, the animal in Fig. 4d can be considered as aged (Fig. 3, 4).

Molars: The enamel on the front surface of the incisors is changing from white to yellow or orange, yellow is frequent. There is much variation in molar patterns among specimens (Fig. 5, 6). The first upper molar consists of an anterior lobe and four alternating triangles. Dental fields of loop and individual triangles are mostly closed (Fig. 5Ab). However, the dental field of the anterior lobe is confluent with the T1 in some animals (Fig 5Aa,c-e); T3 with T4 (Fig 5Aa,c,g) or T2 with T3 (Fig 5Aa,c,d,g) in some others. The 2nd upper molar has three triangles posterior to the anterior lobe. Dental fields of loop and individual triangles are mostly closed (Fig. 5Bb). However, the dental field of the anterior lobe is confluent with the T2 in the case of one animal (Fig. 5Bd), and that of T3 with T2 and T4 in some other animals (Fig. 5Ba,c). The 3rd upper molar consists of three deep re-entrant angles on either side. The posterior triangles T6 and T7 are well pronounced in the majority of specimens but their dental fields are confluent with the posterior cusp (Fig. 5Cb,c,e,g,h). T5 is not always confluent with the posterior cusp

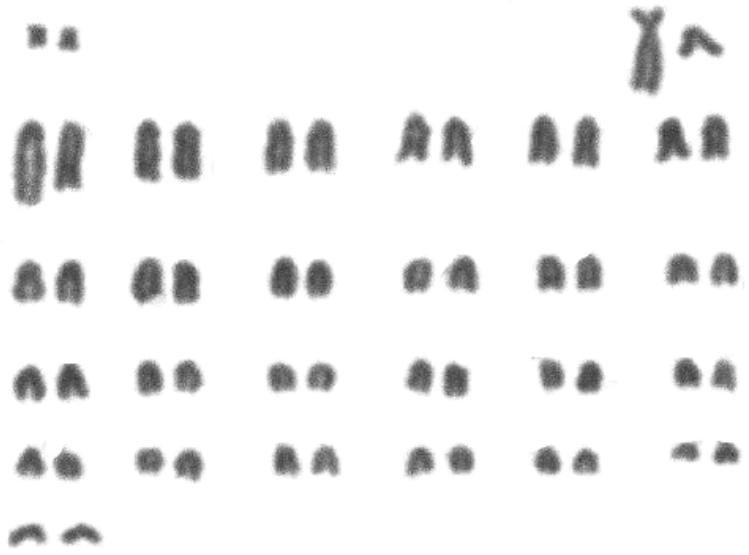

Figure. 2. Karyotype of a male *C. gud* from Ovit Mt Pass (2n =54, NF=58, NFa=54).

(Fig. 5Ce,f). The dental field of T4 is either closed (Fig. 5Cb,c,f,g,h), confluent with the posterior cusp (Fig. 5Ca,d) or confluent with the T3 (Fig. 5Ce). The dental field of T2 is either closed (Fig. 5Cb,d,e,g) or confluent with the T3 (Fig. 5Ca,c,e,f). The dental fields of all triangles, anterior lobe and posterior cusp are confluent together in the young specimen (Fig 5Ca). Dental field of T3 is confluent with the T4 in one specimen (Fig. 5Ce), and closed (5Cb,d,g) or confluent with T2 in others (Fig. 5Ca,c,e,f). The 1st lower molar mainly shows four re-entrant angles on either side; however, unlike others, buccal re-entrant angle is not deep. Dental field of T5 is mostly confluent with the anterior cusp. Dental fields of T1, T2, T3 and T4 are mostly closed (Fig. 6Ad,f,g,h,i) but sometimes communicate with the others (Fig 6Aa,b,c,e). Dental field of posterior lobe is mostly closed. Triangle tandems T1 and T2 on the 2nd lower molars either alternate (Fig. 6Bc,e,f) or are confluent (Fig. 6Ba,b,d). The dental field of T3 is mostly confluent with that of T4 (Fig. 6Ba-e) or closed (Fig. 6Cf). Dental fields of T1 and T2 are confluent, and that of T3 and T4 are also confluent in 3rd lower molar (Fig. 6C).

Phallus and baculum: We had two male specimens and only one of them was adult. The phallus and baculum of this adult specimen was examined and described here. The glans penis is stick shaped and covered by numerous microscopic papillae (Fig. 7A). The length of phallus was 11 mm; the glans penis was 5.2 mm in length and 2.9 mm in width from dorsal side. The baculum is composed of two main parts, distal and proximal. The distal part is a trifit cartilaginous process. The proximal part is

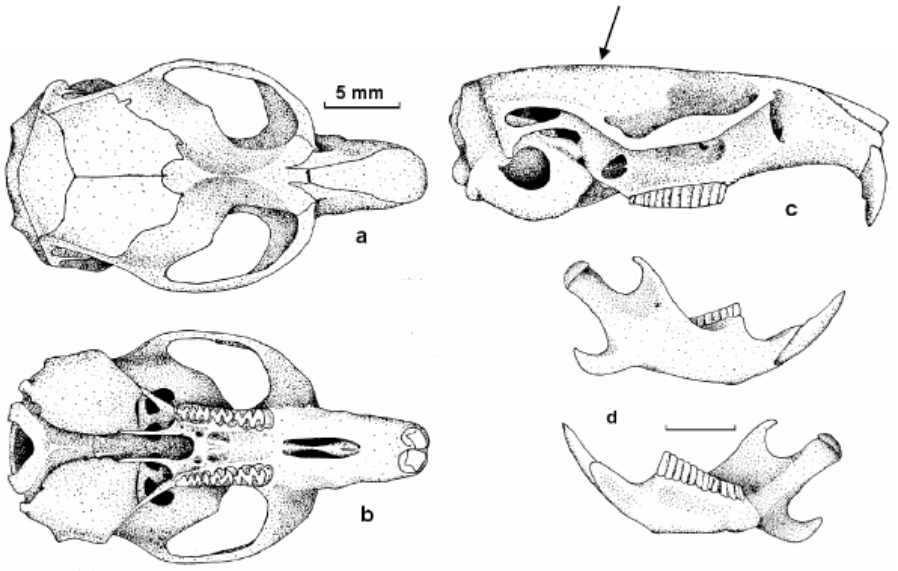

Figure 3. The skull of an adult *C. gud* from Yukarı Kavron Plateau in NE Turkey. a. Dorsal view, b. Ventral view, c. Lateral view, d. Mandible.

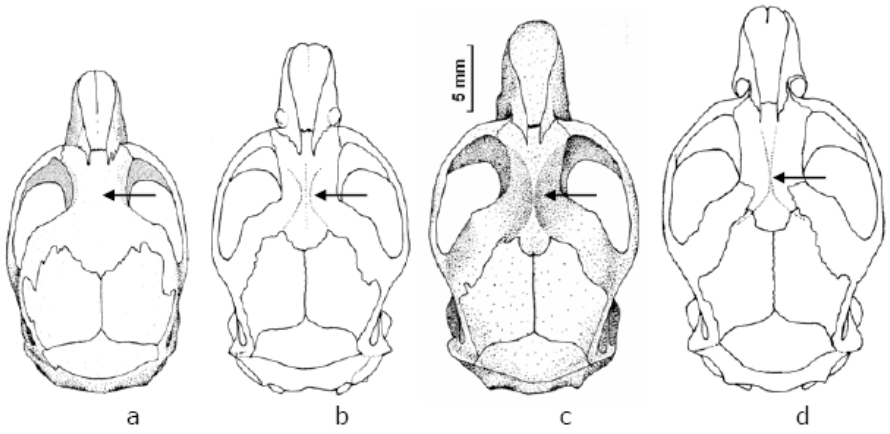

Figure 4. Age dependent variation in the dorsal skull shape in *C. gud* from NE Turkey. a. juvenile male from Ovit Mt Pass (24 g), b. adult from Verçenik (35 g), c. adult from Yukarı Kavron (35 g), and old from Ovit (43 g). Arrow shows the sagital crest.

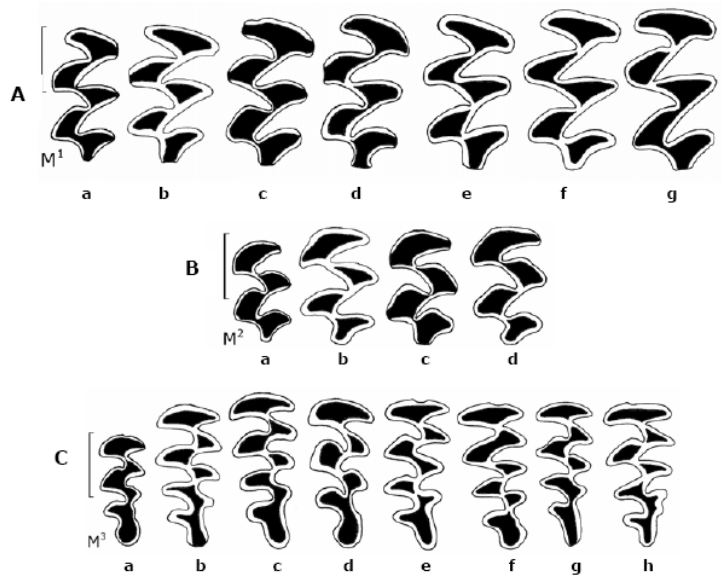

Figure 5. Variability of the upper molars in *C. gud.* A. 1st upper molars, based on specimens from: a, c–e –Ovit Mt Pass; b, f, g – Verçenik. B. 2nd uppers, based on specimens from: a, c, d – Ovit Mt Pass; b – Verçenik. C. 3rd upper molars, based on specimens from: a–d – Ovit Mt Pass; e–h – Verçenik. Scale bar: 1 mm. Lingual side is to the left, anterior side is at the top.

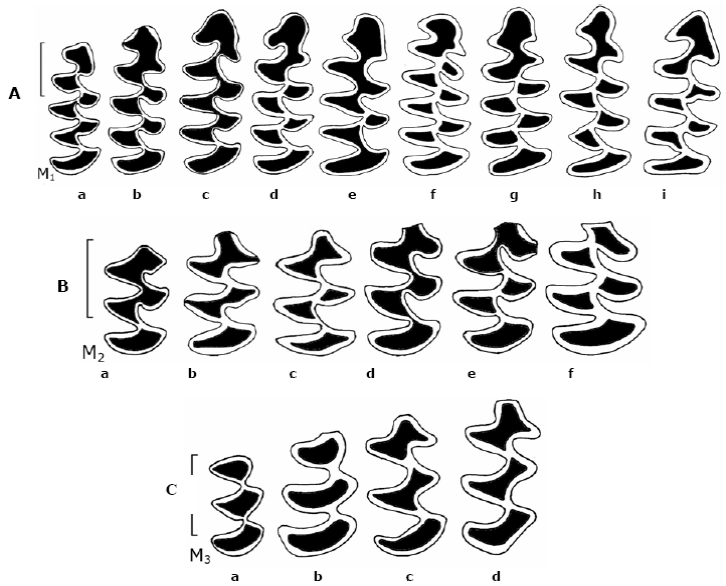

Figure 6. Variability of the lower molars in *C. gud.* A. 1st lower molars, based on specimens from: a–d – Ovit Mt Pass; e–g – Verçenik. B. 2nd lower molars, based on specimens from: a, d, e – Ovit Mt Pass; g, f – Verçenik; c – Yukarı Kavron. C. 3rd lower molars, based on specimens from: a – Ovit Mt Pass; b–d – Verçenik. Scale bar: 1 mm. Lingual side is to the left, anterior side is at the top.

osseous and also composed of two parts, the base and the shaft. The base is roughly triangular with rounded edges. There is a slight concavity on both sides, but it is deeper on the ventral side. The shaft is also triangular in both dorsal and ventral views, but it is finger-like and gets larger toward the tip in a lateral view (Fig 7B). The stalk length was 3.00 mm, and the stalk breath was 1.56 mm, while the medial process was 1.31 mm and the lateral process was 1.14 mm.

Biological note: *C. gud* prefers high elevation of alpine rocky habitats in the eastern Black Sea region and its vertical range exceeds c. 1500 m a.s.l. We collected specimens from rocky areas on mountain slopes in Ovit, Verçenik and Yukarı Kavron, from elevations ranging between 2100 and 2415 m a.s.l. In mid-July, three pregnant females were collected, and two of them had four embryos, and the other had six embryos (mean= 4.66, N= 3). The length of embryos was 11 to 12 mm (N= 14), and the width was 7 to 9 mm.

Measurements: Body and skull measurements of the adult animals were provided in Table 1.

Discussion

The karyotype of this species has been reported from Azerbaijan, Dagestan, Georgia, and Northern Osetia (Radjabli & Grafodatsky 1977, Kurjatnikov & Tchopilashvili

1978, Kuliev 1979, Sablina et al. 1988) and results of these studies are the same as those given here.

The size of phallus is similar to that given by Zorenko and Aksenova (1989). Not only the measurements but also the detailed drawings of phallus were also given here (Fig. 7A).

The skull morphology of *C. gud* was also described in detail by Kryštufek (2005). Aksenova (1980) described the baculum of two specimens from the Caucasus, and Kryštufek and Vohralik (2005) descried four specimens from Giresun Dağları in Turkey. The baculum of the animal examined in the present study from Ovit is similar in shape and size.

Body and skull measurements of the adult animals were provided in Table 1, and were found to be similar to those given by

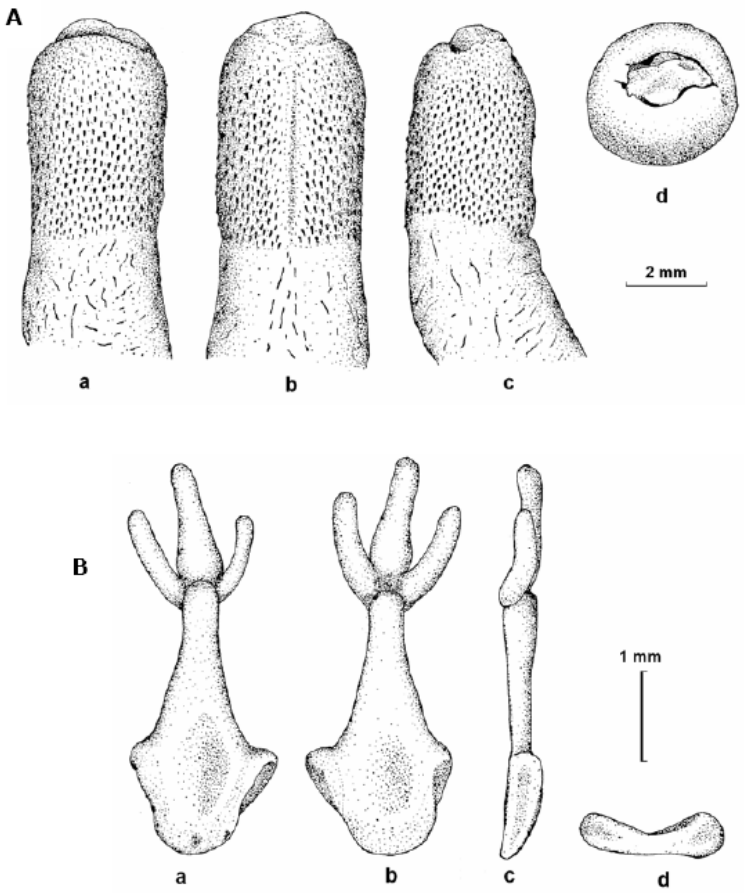

Figure 7. A. Phallus of a *C. gud* from Ovit in NE Turkey. a. Dorsal viwe, b. Ventral viwe, c. Lateral view d. Tip view. B. Baculum of a *C. gud* from Ovit in NE Turkey. a. Dorsal view, b. Ventral view, c. Lateral view, d. Basal view.

Table 1. Some basic external and cranial dimensions of *C. gud* from Turkey (The measurements of young animals is not included, measurements are in millimeters)

	N	mean	min-max
Head and body	11	120.81	114 – 130
Tail length	10	71.6	65 – 82
Hind foot length	11	21.6	20 – 25
Ear length	11	17.2	16 – 19
Body weight	11	40.8	35 – 55
Condylobasal length	9	28.7	27.1 – 30.2
Zygomatic breath	8	16.56	16.2 – 17.16
Maxillary tooth-row	9	6.34	5.9 – 6.84

Kryštufek and Vohralik (2005).

Kryštufek (1999) reported litter size as 3-4 (mean = 3.6, N = 5) for Turkish specimens. When we evaluate the results of our study and Kryštufek's study together, litter size was 3-6 (mean 4, N = 8) for Turkish specimens. Kryštufek (1999) had collected pregnant females at the end of June, and we collected pregnant and lactating females and young animals in mid-to-late July. These are the only reproductive data for Turkish specimens, and show that the reproductive period starts before July and lasts also after July. According to the studies from the Caucasus, reproduction depends on elevation and lasts from May to October (Gromov & Erbajeva 1995). Sidlovskij (1976) believes that there are 2-3 litters annually of up to six pups.

Here we provided the karyotype of Turkish specimens for the first time. More detailed phallic morphology - especially by drawings -, molar variations in larger extent, and comparative skull morphology in young, adult and aged specimens and some additional biological notes were also presented to contribute to the taxonomical data on a poorly known species, *Chionomys gud*.

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