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Pliocene lagomorphs and rodents from Udunga, Transbaikalia, eastern Russia

Yoshinari Kawamura[1*] and Masanaru Takai[2]

[1]*Department of Earth Sciences, Aichi University of Education, Kariya 448-8542, Japan*
[2]*Primate Research Institute, Kyoto University, Inuyama 484-8506, Japan*
**Corresponding author. e-mail: yskawamr@auecc.aichi-edu.ac.jp*

Abstract

Hundreds of lagomorph and rodent fossils from the Middle Pliocene of Udunga are stored in the Southern Scientific Center, Russian Academy of the Sciences. They have been studied taxonomically. The lagomorph fossils include three forms of ochotonids such as *Ochotona* cf. *gromovi*, *Ochotona* sp. (large form) and *Ochotonoides complicidens*, and two forms of leporids such as *Hypolagus* sp. and Leporidae, gen. and sp. indet. The rodent fossils include one castorid species (*Castor anderssoni*), one siphneid form (*Prosiphneus* cf. *praetingi*) and one arvicolid form (*Villanyia* sp.). Among them, *Castor anderssoni* is highly predominant, and attains to more than 50 % of all the lagomorph and rodent specimens identifiable at the family, genus or species level. These fossils provide additional knowledge to the small mammal fauna of Udunga already reported.

Introduction

Udunga is a well-known fossil locality of Pliocene mammals in Transbaikalia (Figure 1). The sediments of the locality are only 8.5–9.5 m in total thickness, and are divided into the lower, middle and upper units (Alexeeva *et al*., 2001). The middle unit consisting of loam and sandy loam yields abundant mammal fossils, which are considered to be Middle Pliocene age by their faunal characters (Erbajeva and Alexeeva, 2000). The fossils from this units stored in the Southern Scientic Center, Russian Academy of the Sciences, in Rostov-on-Don, Russia, have been studied as the Japan-Russia Collaborate Research Project titled "Paleontological study on the evolution of the Tertiary primates in the northern Eurasian continent." This fossil collection includes a number of lagomorph and rodent fossils, which were allotted to us to study as a part of the work of the project. This paper presents the results of our study on these fossils.

Studied material

The fossils were tentatively identified and given numbers with the prefix Udg by Japanese members of the project who visited the Southern Scientific Center in 2007 and

Figure 1. Locations of Udunga and the other fossil localities mentioned in the text.

2008. Among the fossils, those identified as lagomorphs and rodents were transported to Japan (Primate Research Institute, Kyoto University and Aichi University of Education) for the present study. They were already returned to, and are now stored in the center.

The fossils transported are 377 in total specimen number, and have been reidentified as listed in Appendix 1. Most of the fossils are lagomorphs and rodents, but few of them are regarded as indeterminate or misidentified ones.

Among the fossils of lagomorphs and rodents, 246 specimens are upper and lower jaws (maxilla and/or premaxilla and mandible) which are identifiable at the family, genus or species level. They are allocated to five families (Table 1). Of the families, Castoridae (beavers) is the most abundant, and Ochotonidae (pikas) is the next. On the other hand, Leporidae (hares and rabbits), Siphneidae (zokors) and Arvicolidae (voles) are few.

Measuring method and terminology

In the present material, the size difference is one of important characters which distinguishes the lagomorph and rodent forms included. Thus the lengths and widths of the cheek teeth were measured on their occlusal surfaces, because the cheek teeth are abundant in the material and generally suitable for taxonomic work. The measuring methods for representative cheek teeth of lagomorphs and rodents (Castoridae, Siphneidae and Arvicolidae) are shown in Figures 2 and 3 respectively. These figures also show the terminology of the teeth used in the following taxonomic chapters.

Before measuring the cheek teeth, we fixed each of them as its occlusal surface was horizontal. Then the teeth of the lagomorphs, siphneid and arvicolid were measured with a measurescope (Nikon: MM-11) with an electoric disital counter (Nikon: CM-6S). On the

Table 1. Number of the maxillae (including premaxillae), mandibles and isolated cheek teeth identified at the family, genus or species level with confidence in the Southern Scientific Center collection from Udunga.

Taxon	Number of specimens identified		
	Maxilla and premaxilla	Mandible	Isolated cheek teeth
LAGOMORPHA			
Ochotonidae			
Ochotona cf. *gromovi*	–	–	6
Ochotona sp. (large form)	–	1	1
Ochotonoides complicidens	–	1	6
Ochotona or *Ochotonoides* sp.	2	15	38
Leporidae			
Hypolagus sp.	–	4	18
Leporidae, gen. and sp. indet.	–	1	3
RODENTIA			
Castoridae			
Castor anderssoni	2	10	119
Siphneidae			
Prosiphneus cf. *praetingi*	–	3	11
Arvicolidae			
Villanyia sp.	–	1	4

other hand, those of the castorid were photographed with a scale, and were measured on the photographs taken.

Taxonomy of the lagomorph fossils

Most of the lagomorph fossils can be classified into Ochotonidae and Leporidae by mandibular and dental morphology. The fossils assigned to Ochotonidae are further divided into a larger-sized and smaller-sized groups. In the larger-sized group, isolated P_3 and mandibles with P_3 are referable to *Ochotona* sp. (large form) and *Ochotonoides complicidens* on the basis of the enamel pattern of P_3, because the pattern is generally regarded as the most important character for generic and specific distinction of lagomorph fossils. The remaining fossils of the larger-sized group are referred only to *Ochotona* or *Ochotonoides* sp., because ochotonid genera known from the Pliocene and Pleistocene of eastern Eurasia are restricted to *Ochotona* and *Ochotonoides*. On the other hand, all the fossils of the smaller-sized group are referred to *Ochotona* cf. *gromovi*, because P_3 of this group shows the *Ochotona*-type enamel pattern which distinguishes them from *Ochotonoides*, and resembles that of *O. gromovi*.

The fossils assigned to Leporidae can be classified into a large-sized and small-sized forms. The fossils of the large-sized form include P_3, and are referable to *Hypolagus* sp. on the basis of the P_3 pattern. Those of the small-sized form lack P_3, and are referable only to Leporidae, gen. and sp. indet.

The measurements of the cheek teeth of all the lagomorph forms are given in Appendices 2 to 9 which show the size differences among the forms mentioned above.

***Ochotona* cf. *gromovi* Erbajeva, 1976** (Pl. 1, fig. 1):

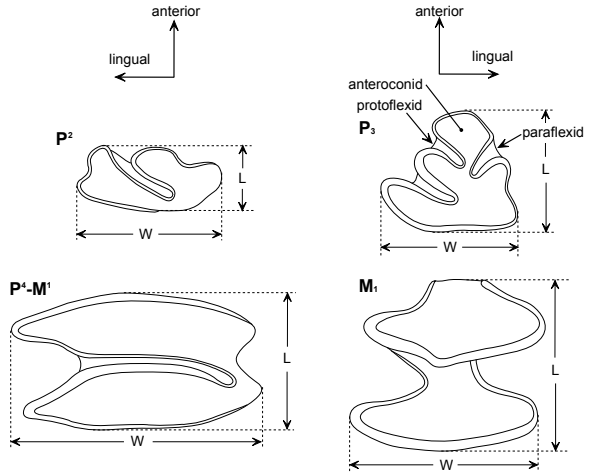

Figure 2. Measuring method for cheek teeth of lagomorphs, and terminology used in the text.

Six specimens are allocated to the smaller-sized group, but include only one P_3 which has no flexid on the anterior wall of the anteroconid. Thus the fossils of this group are referred to *Ochotona*. In the same tooth, the enamel walls of the protoflexid and paraflexid are not plicated. The measurements of the fossil species known from the Pliocene and Lower Pleistocene of Transbaikalia and Mongolia are given in Erbajeva (1970, 1988), Bazarov *et al*. (1976), and Agadjanian and Erbajeva (1983). They show that the cheek teeth of the group are larger than those of *O. dodogolica*, *O. gureevi*, *O. intermedia*, *O. bazarovi* and *O. sibirica*, but are smaller than those of *O. zasuchini*. P_3 of the present fossils seems to be most similar to that of *O. gromovi*. The present fossils are referred to *O.* cf. *gromovi*, because of the scarcity of the available material. Erbajeva *et al*. (2003) already reported the occurrence of *O.* aff. *gromovi* from Udunga.

***Ochotona* sp. (larger form)** (Pl. 1, figs. 2–3):

The fossils assigned to this form are only one mandible with P_3–M and one isolated P_3. This form is much larger than *Ochotona gromovi*, *O. tologoica*, *O. zazhigini*, *O. dodogolica*, *O. gureevi*, *O. intermedia*, *O. bazarovi* and *O. sibirica*, judging from the data given by Erbajeva (1970, 1988), Bazarov *et al*. (1976) and Agadjanian and Erbajeva (1983). It is nearly as large as *Ochotonoides complicidens* mentioned below (Appendices 3 and 4), but differs in P_3 without any flexid on the anterior wall of the anteroconid. Its P_3 also lacks placation on the enamel walls of the protoflexid and paraflexid. Erbajeva *et al*. (2003) described *Ochotona* aut *Ochotonoides* from Udunga, which is as large as the present form and lacks any flexid on the anterior wall of the anteroconid, but has plicated protoflexid and paraflexid. The present form seems to be different from the known *Ochotona* species from Transbaikalia, but is referred only to *Ochotona* sp. (large form), because of the scarcity of the examined material.

***Ochotonoides complicidens* (Boule and Teilhard de Chardin, 1928)** (Pl. 1, figs. 4–7; Pl. 2, fig.1):

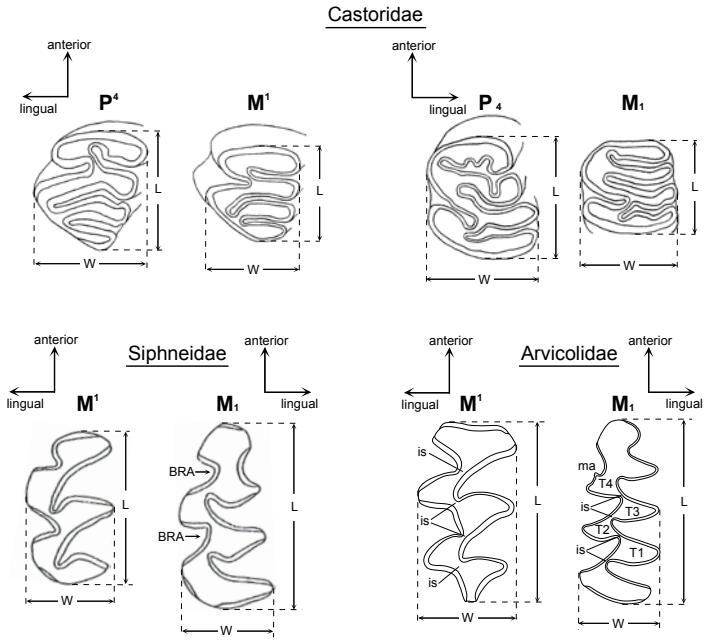

Figure 3. Measuring method for cheek teeth of rodents (castorids, siphneids and arvicolids), and the terminology used in the text. BRA: buccal reentrant angle, is: isthmus, L: Length of occlusal surface, ma: *Mimomys* angle, T: triangle, W: width of occlusal surface.

In the isolated P_3 and mandible with P_3 of the ochotonids, those assigned to *Ochotonoides complicidens* are the most abundant, and comprise seven specimens. P_3 of this species is characterized by one or two flexids on the anterior wall of the anteroconid. Of the seven, five specimen have one flexid on the anterobuccal wall of the anteroconid (Pl.1, figs. 4, 5, 7). The remaining two (Udg 523 and 584) have anterobuccal and anterolingual flexids (Pl.1, fig. 6). The enamel walls of the protoflexid and paraflexid are sometimes plicated. Of the seven, both or one of the walls are plicated in three specimens (Udg 523, 563, 584; Pl.1, fig. 6), but the walls are not plicated in the remaining specimens.

Ochotonoides complicidens is an extinct species, and was already recorded from Udunga (Erbajeva *et al.*, 2003 and others). This species is also known from the Pliocene of Beregovaya (Bazarov *et al.*, 1976), and of Tologoi 1 (Alexeeva *et al.*, 2001) in Transbaikalia (Figure 1). Furthermore *O.* cf. *complicidens* was recorded from the Pliocene of Shamar in Mongolia (Zazhigin, 1989). *O. complicidens* has occurred from many localities of Pliocene to early Middle Pleistocene age in northern China (Boule *et al.*, 1928; Teilhard de Chardin and Piveteau, 1930; Teilhard de Chardin and Young, 1931; Teilhard de Chardin, 1940, 1942; Chow and Li, 1965; Ji, 1976; Hu and Qi, 1978; Zheng *et al.*, 1985; Erbajeva and Zheng, 2005; Cai *et al.*, 2008).

***Ochotona* or *Ochotonoides* sp.** (Pl. 2, fig. 2):

The ochotonid fossils of the larger-sized group other than the isolated P_3 and mandibles with P_3 attain to 55 in specimen number (Table 1), and are collectively referred to *Ochotona* or *Ochotonoides* sp. Most of them seem to be derived from *Ochotonoides complicidens*, because P_3 of *O. complicidens* are much more than those of *Ochotona* sp. (large form) in the larger-size group of the ochotonids.

***Hypolagus* sp.** (Pl. 2, figs. 3–5)

The large-sized form is much more abundant than the small-sized form in the leporid fossils (Table 1), and is referred to the genus *Hypolagus*. Its P_3 shows the simple occlusal pattern characteristic to *Hypolagus*, where no reentrant fold is observed on the enamel wall of the anterior and lingual sides, and one or two reentrant folds are present on the buccal enamel wall (protoflexid and/or hypoflexid). Erbajeva *et al*. (2003) recorded two species of *Hypolagus* from Udunga (*H. transbaikalicus* and *H. multiplicatus*). These species were originally allocate to the genus *Pliolagus* by Bazarov *et al*. (1976). Their measurements and figures indicate that the present fossils are near to both of the species in size and cheek tooth pattern. In northern China, *Hypolagus* is represented by *H. schreuderi*, which occurs from Pliocene and Early Pleistocene localities (Teilhard de Chardin, 1940; Cai, 1989; Zheng *et al*., 1997). The cheek teeth of *H. schreuderi* is also similar to those of the present fossils. Owing to the limited material, we refer the fossils to *Hypolagus* sp. herein.

Leporidae, gen. and sp. indet.:

The small-sized form of the leporids (Leporidae, gen. and sp. indet.) is few in specimen number (Table 1), and is much smaller than *Hypolagus* sp. (Appendices 7–9).

Taxonomy of the rodent fossils

The rodent fossils in the collection are easily classified into three forms by striking difference in size. They are very large, medium and small forms, which are assigned to a form of castorids, siphneids and arvicolids respectively. The size difference is well represented in Appendices 10 to 13.

***Castor anderssoni* (Schlosser, 1924)** (Pls. 3–6):

Castorid fossils are 158 in specimen number (including isolated incisor), and are referable to a single species. In his study on Chinese fossil castorids, Xu (1994) recognized three categories in cheek tooth patterns (*Asiacastor* dental pattern, *Castor* dental pattern and *Castoroides* dental pattern), and four categories in root formation of cheek teeth (cheek teeth with strong root, cheek teeth with weak roots, closed cheek teeth and open cheek teeth). He concluded that castorid fossils from the Chinese Neogene and Quaternary belonged to seven genera, such as *Youngofiber*, *Anchitheriomys*, *Trogontherium*, *Eucastor*, *Dipoides*, *Steneofiber* and *Castor*. The cheek teeth of the present fossils show *Castor* dental pattern, and are high crowned and very weakly rooted or closed. These features distinguish the present remains from *Youngofiber*, *Anchitheriomys*, *Trogontherium*, *Eucastor*, *Dipoides* and *Steneofiber*. The cheek teeth of the remaining genus *Castor* are well coincident with those of the present fossils. Additionally, the incisors of the present fossils have weakly convex and smooth enamel surfaces, and their edge angles are apparently observed. These features also agree

with those of *Castor*.

Judging from the descriptions of Schlosser (1924), Teilhard de Chardin and Young (1931), Teilhard de Chardin (1942), Xu (1994), and Qiu and Storch (2000), the present fossils are referable to *Castor anderssoni* known from the Upper Miocene to Pleistocene of northern China, which is distinct from the living *Castor* species, *C. fiber* and *C. canadensis* as shown by Xu (1994), because the size, and dental and mandibular morphology of the present fossils are well coincident with those of *C. anderssoni*. Furthermore, the present fossils are different from *C. canadensis* in larger size and somewhat more primitive condition in root formation of cheek teeth.

Additionally we compared the fossils with the mandible assigned to *C. anderssoni* from the Upper Pliocene (= Lower Pleistocene in Chinese sense) of Longdan, Gansu (Figure 1). This mandible (V 13572.1) was described by Wang (2005) and has been stored in the Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing. It shows no basic difference in morphology from the present fossils, although it is somewhat smaller.

The other extinct species *C. zdanskyi* is known from the Pliocene and Pleistocene of northern China (Young, 1927; Teilhard de Chardin, 1942; Zhang *et al*., 1986). All the examined cheek teeth except one M^1 (Udg 447) are different from those of *C. zdanskyi* in having simpler enamel fold, but Udg 447 shows the complicated enamel fold which recalls that of *C. zdanskyi*. As pointed out by Xu (1994), *C. zdanskyi* is a problematic species, and its diagnostic characters may be attributable to intraspecific variation. We regard Udg 447 as a variant in the cheek teeth of *C. anderssoni*.

***Prosiphneus* cf. *praetingi* Teilhard de Chardin, 1942** (Pl. 7, figs. 1–4):

Fossils showing siphneid or myospalacine dental characters are relatively few in the present material, and comprise three mandibles with molars and 11 isolated molars (Table 1). The fossils are assignable to the genus *Prosiphneus*, because the molars are rooted. The crown heights of the molars are moderate, and the occlusal outlines of the molars are somewhat elongated antero-posteriorly. These characters distinguish the fossils from late Miocene and early Pliocene primitive species such as *P. quianensis*, *P. qiui*, *P. haoi*, *P. licenti*, *P. murinus*, *P. tianzuensis*, *P. ericksoni*, *P. truncates*, *P. sinensis* and *P. lyratus*, on the basis of the descriptions and figures by Schlosser (1924), Teilhard de Chardin and Young (1931), Teilhard de Chardin (1942) and Zheng *et al*. (2004). In the present fossils, the roots of the molars are divided in old individuals (for example, M_1 with three roots). The buccal reentrant angles of the lower molars (BRA in Figure 3) are shallow so that they easily become enamel islands on the occlusal surface in earlier stage of wear. Judging from Teilhard de Chardin and Young (1931) and Teilhard de Chardin (1940) , these characters distinguish the present fossils from late Pliocene and Early Pleistocene advanced species *P. intermedius* and *P. pseudarmandi*. On the other hand, the present fossils are similar to *P. youngi*, *P. praetingi*

and *P. paratingi* described by Teilhard de Chardin (1940, 1942) in the crown height and root morphology of the molars. These species are intermediate between the above-mentioned primitive and advanced species in geological age as well as molar morphology. The size of the present fossils seems to be nearest to that of *P. praetingi*, although sufficient dental measurements of these three species are not available. Thus the fossils are referred to *P.* cf. *praetingi*. Additionally Erbajeva *et al.* (2003) already recognized *P. praetingi* in the Udunga fauna.

***Villanyia* sp.** (Pl. 7, figs. 5-8):

Fossils allocated to arvicolid rodents comprise a mandibular fragment with M_2 and four isolated molars (Table 1). The molars are rooted and have no cementum in their reentrant angles. Their salient angles are pointed and isthmuses are not closed. The enamel of the molars is not differentiated in thickness. M^1 has three roots, while M_1 and M_2 has two roots. The lagurine structure and enamel islet are absent in M^1 and M_1 respectively, but *Mimomys* angle is present on the anterior wall of T4 of M_1. These characters indicate that the fossils are allocated to *Villanyia*, according to Zhang *et al.* (2008) and Kawamura and Zhang (2009) who provided differential characters distinguishing it from the allied genus *Borsodia*. They included eight species in the genus, such as *V. exilis*, *V. petenyii*, *V. eleonorae*, *V. novoasorica*, *V. steklovi*, *V. betekensis*, *V. hengduanshanensis* and *V. fanchangensis*. The examined specimens are larger than *V. exilis*, but smaller than *V. petenyii*, *V. novoasovica*, *V. betekensis*, *V. henduanshanensis*, judging from the measurements given by Gromov and Polyakov (1977), Zazhigin (1980), Zong (1987). On the other hand, *V. eleonorae*, *V. steklovi* and *V. fanchangensis* have similar sizes to the present fossils, and the former two resemble the fossils in the M_1 pattern, on the basis of the descriptions and figures given by Erbajeva (1976), Gromov and Polyakov (1977), Zazhigin (1980) and Zhang *et al.* (2007). Erbajeva *et al.* (2003) already reported the occurrence of *V.* gr. ex. *eleonorae* from Udunga, but the determination at the species level is reserved here, owing to the insufficiency of the examined fossils.

Discussion

Erbajeva *et al.* (2003) already presented the relative abundance of the small mammal forms which had been collected from the middle unit of Udunga by washing the sediments with screens of 0.5 and 1 mm meshes. They listed five forms of ochotonid lagomorphs (*Ochotona* aut *Ochotonoides*, *Ochotona* aff. *gromovi*, *Ochotona* sp. with middle size, *Ochotona* aff. *sibirica*, and *Ochotonoides complicidens*), two species of leporid lagomorphs (*Hypolagus transbaikalicus* and *H. multiplicatus*), one form of castorid rodents (*Castor* sp.), one form of murid rodents (*Orientalomys* cf. *sibirica*), three forms of cricetid rodents (*Cricetinus* cf. *varianus*, *Gromovia daamsi*, *Kowalskia* sp.), four forms of arvicolids (*Promimomys* cf. *gracilis*, *P.* cf. *stehlini*, *Mimomys* cf. *minor*, *Villanyia* ex. gr. *eleonorae*) and

two forms of siphneid rodents (*Prosiphneus praetingi* and *Prosiphneus* sp.). Among these, *Ochotonoides complicidens* and *Prosiphneus praetingi* are predominant. In comparison with the fossils examined here, the following differences are recognized between them:

1) Murids and cricetids are present in the material of Erbajeva *et al*. (2003), while they are absent from the examined fossils. The isolated molars of these families are generally smaller than those of arvicolids, which are exceeded by lagomorphs, castorids and siphneids in size.
2) Arvicolids are more diversified in the material of Erbajeva *et al*. (2003).
3) Fossils assigned to castorids are much fewer in the material of Erbajeva *et al*. (2003). They are the largest in the lagomorph and rodent forms from Udunga.

These differences are attributable to the difference between the collecting method for the material of Erbajeva *et al*. (2003) and that for the fossils examined here. The former fossils well represent smaller forms in the fauna of Udunga, while the latter fossils well represent larger forms. Thus the fossils examined here supplement knowledge on the small mammals with relatively large size to the data provided by Erbajeva *et al*. (2003).

The predominance of the castorid species, *Castor anderssoni*, is the most remarkable feature in the fossils examined here. It attains to more than 60 % of all the specimens identifiable to the family, genus or species level. The morphological characters of the fossils indicate that this species is very similar to the living beaver species, and thus it probably enjoyed semiaquatic life in forested riverine areas as they do today. Such habitat is well coincident with the depositional and vegetational environments of Udunga already suggested by Vislobokova *et al*. (1995), Erbajeva and Alexeeva (2000) and Erbajeva *et al*. (2003), who inferred the deposition of an ancient river in a forested area under warmer climate.

Such warmer and forested environments were also inferred in the middle Pliocene of northern China, which was represented by the Yunan Fauna of Shandong Province (Jin *et al*., 1999; Figure 1). It seems to be correlative with the fauna of Udunga. Rather warm and humid climate possibly prevailed in East Asia during rather short period of the middle Pliocene (around 3.5 Ma).

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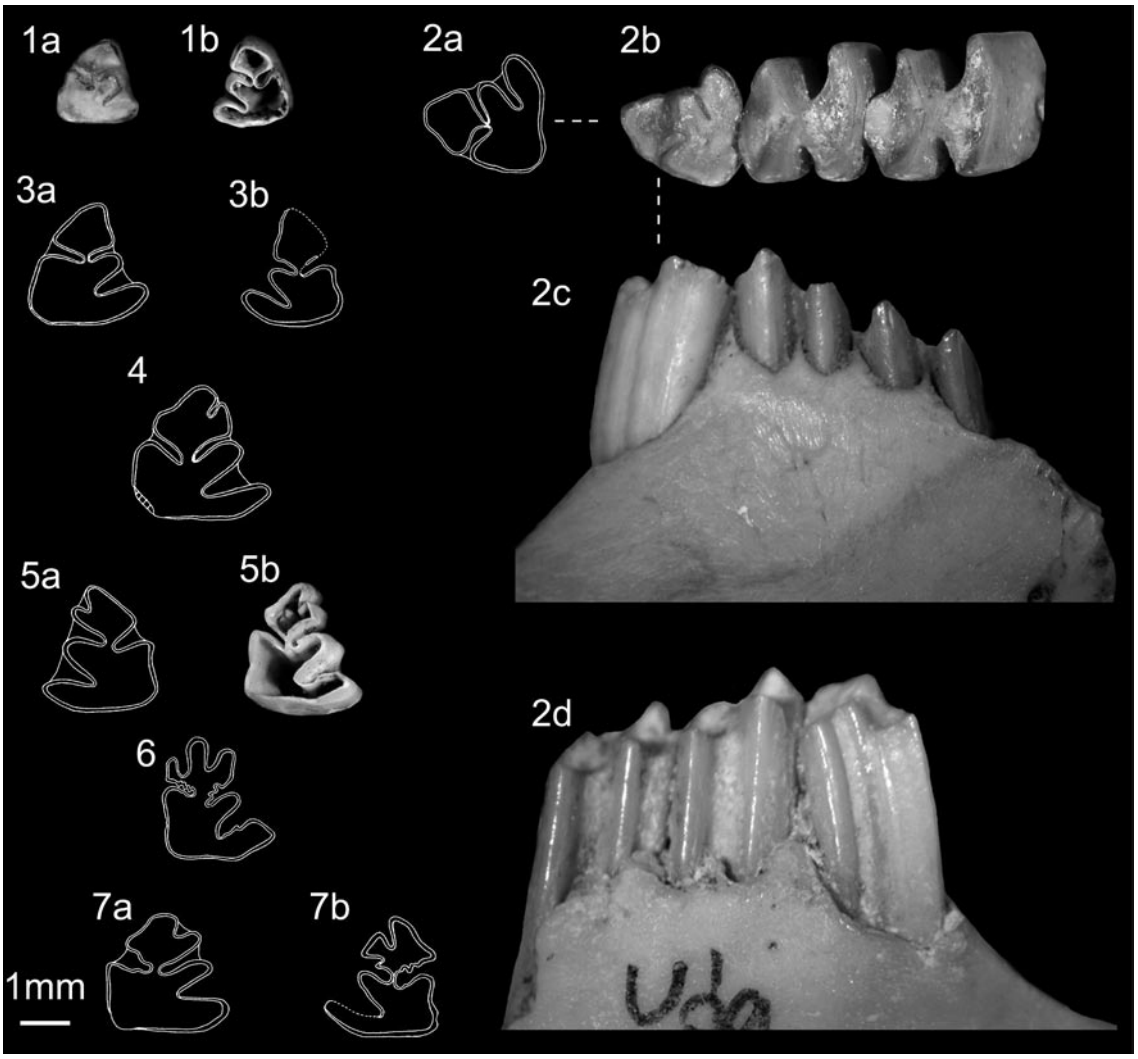

Plate 1.

Ochotona cf. *gromovi*
1: Right P_3 numbered Udg 565 (1a: occlusal view, 1b: radical view)

Ochotona sp. (large form)
2: Right mandible with P_3–M_1 numbered Udg 475 (2a: occlusal pattern of P_3, 2b: occlusal view of tooth row, 2c: lingual view, 2d: buccal view)
3: Right P_3 numbered Udg 561 (3a: occlusal pattern, 3b: enamel pattern in radical view)

Ochotonoides complicidens
4: Right P_3 numbered Udg 516 (occlusal pattern)
5: Left P_3 unnumbered (5a: occlusal pattern, 5b: enamel pattern in radical view)
6: Left P_3 numbered Udg 523 (enamel pattern in radical view)
7: Right P_3, nmbered Udg 563 (7a: occlusal pattern, 7b: enamel pattern in radical view)

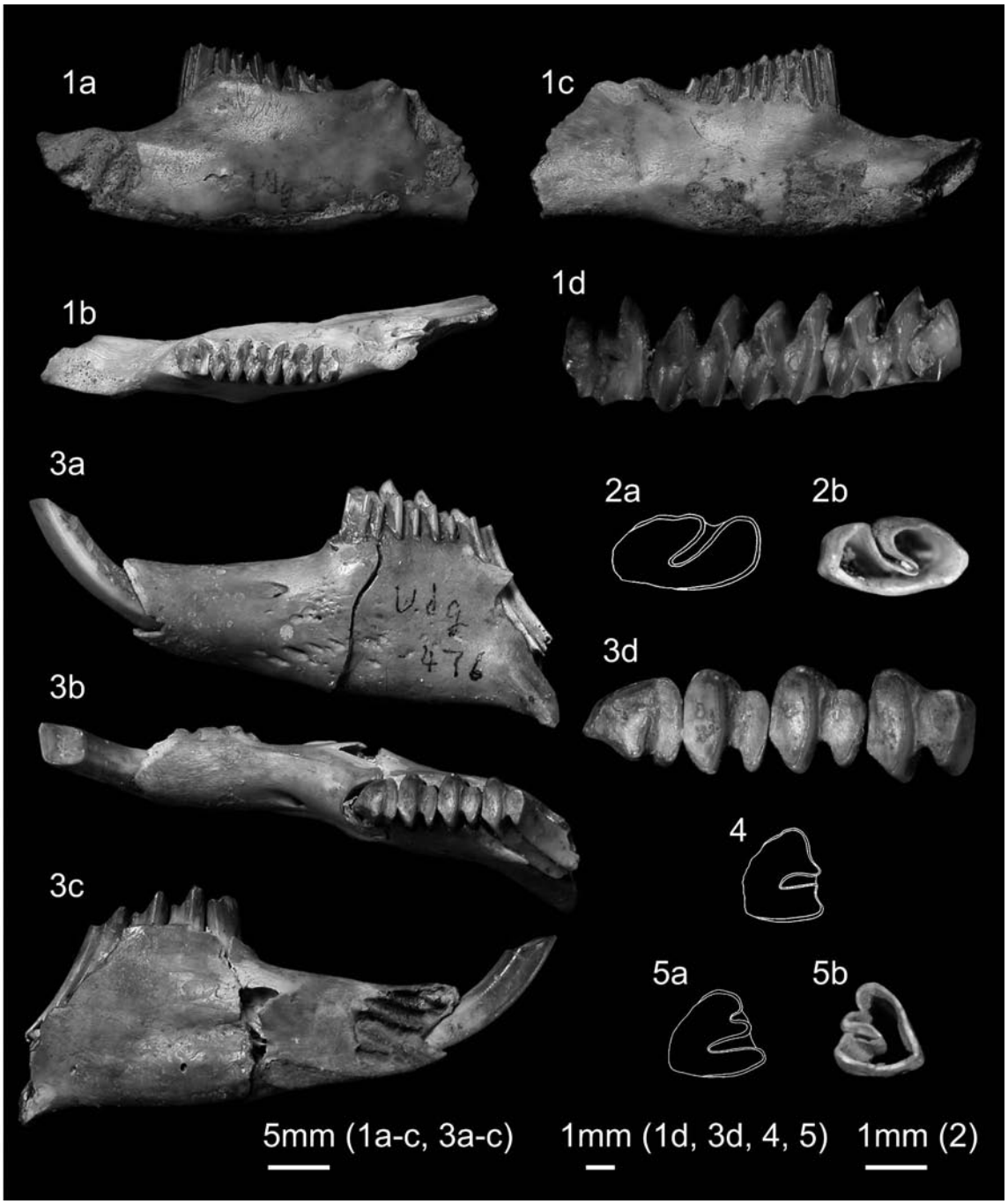

Plate 2.

Ochotonoides complicidens
1: Right mandible with P_3–M_3 numbered Udg 584 (1a: lingual view, 1b: dorsal view, 1c: buccal view, 1d: occlusal view of cheek tooth row)

Ochotona or *Ochotonoides* sp.
2: Right P^2 numbered Udg 519 (2a: occlusal pattern, 2b: radical view)

Hypolagus sp.
3: Left mandible with I and P_3–M_2 numbered Udg 476 (3a: buccal view, 3b: dorsal view, 3c: lingual view, 3d: occlusal view of cheek tooth row)
4: Right P_3 numbered Udg 517 (occlusal pattern)
5: Right P_3 numbered Udg 592 (5a: occlusal pattern, 5b: radical view)

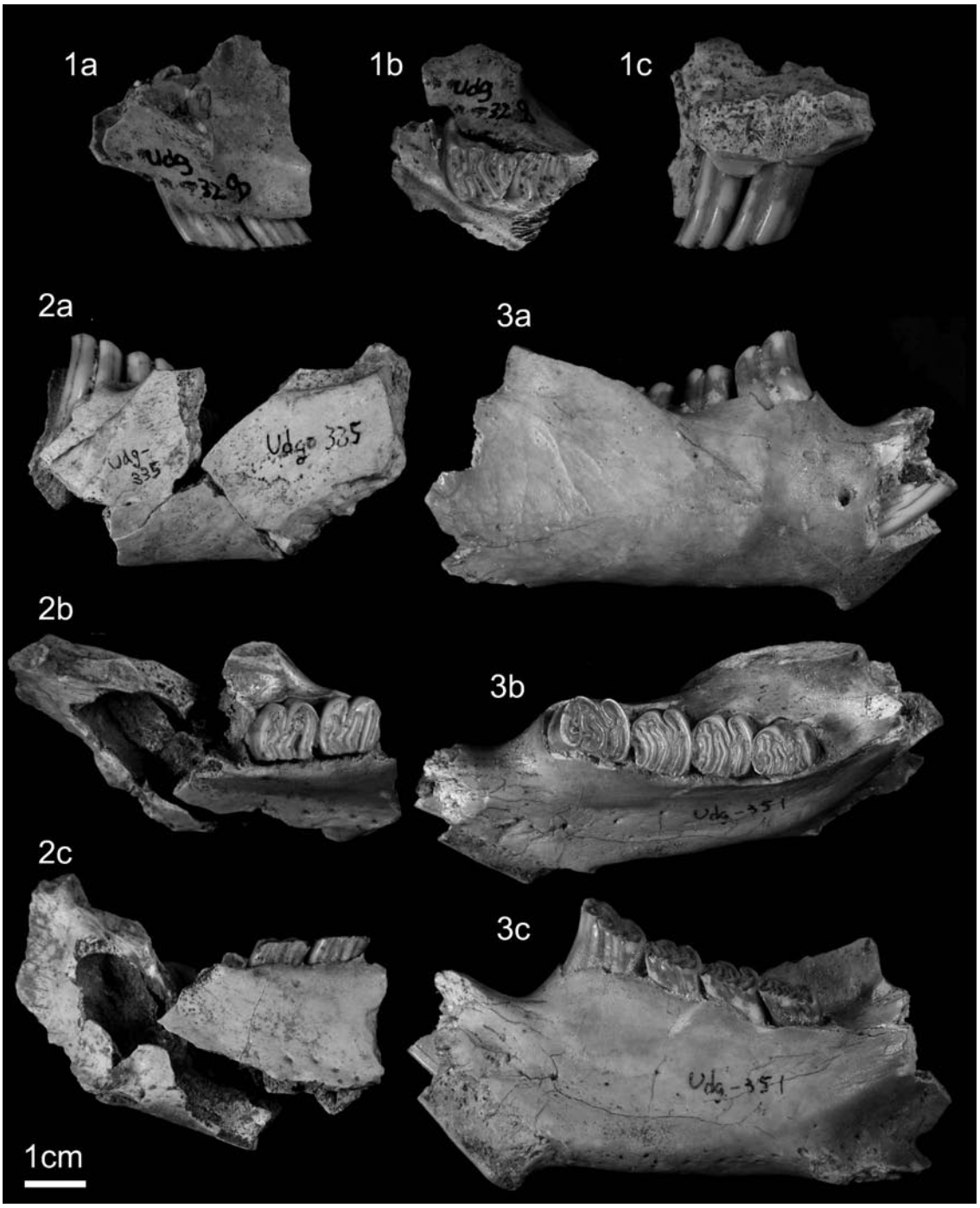

Plate 3.

Castor anderssoni
1: Left maxilla with P^4 and M^1 numbered Udg 328 (1a: buccal view, 1b: palatal view, 1c: lingual view)
2: Left mandible with M_1 and M_2 numbered Udg 335 (2a: buccal view, 2b: occlusal view, 2c: lingual view)
3: Right mandible with I and P_4–M_3 numbered Udg 351 (3a: buccal view, 3b: occlusal view, 3c: lingual view)

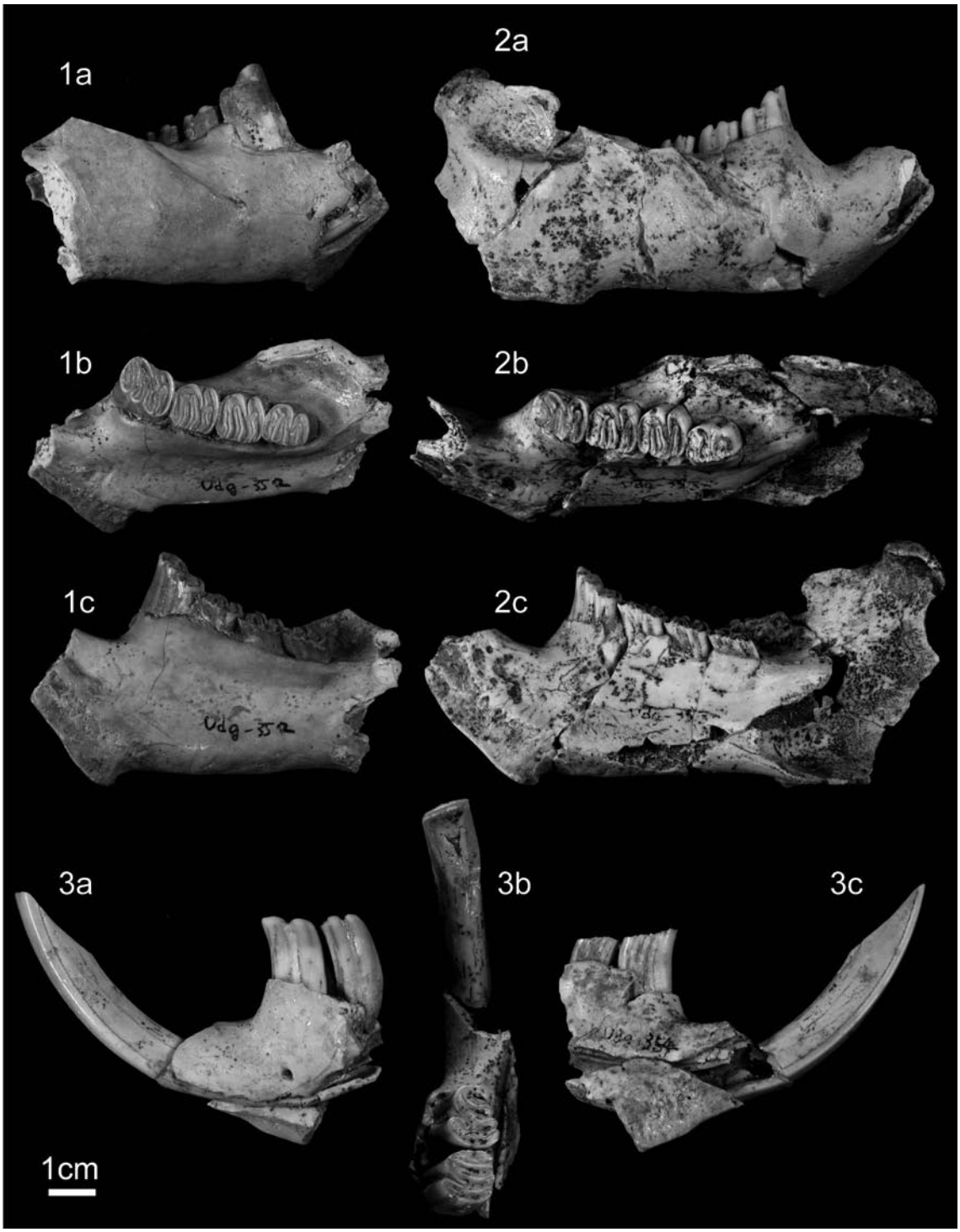

Plate 4.

Castor anderssoni
1: Right mandible with I and P_4–M_3 numbered Udg 352 (1a: buccal view, 1b: occlusal view, 1c: lingual view)
2: Right mandible with P_4–M_1 numbered Udg 353 (2a: buccal view, 2b: occlusal view, 2c: lingual view)
3: Left mandible with I, P_4 and M_1 numbered Udg 354 (3a: buccal view, 3b: occlusal view, 3c: lingual view).

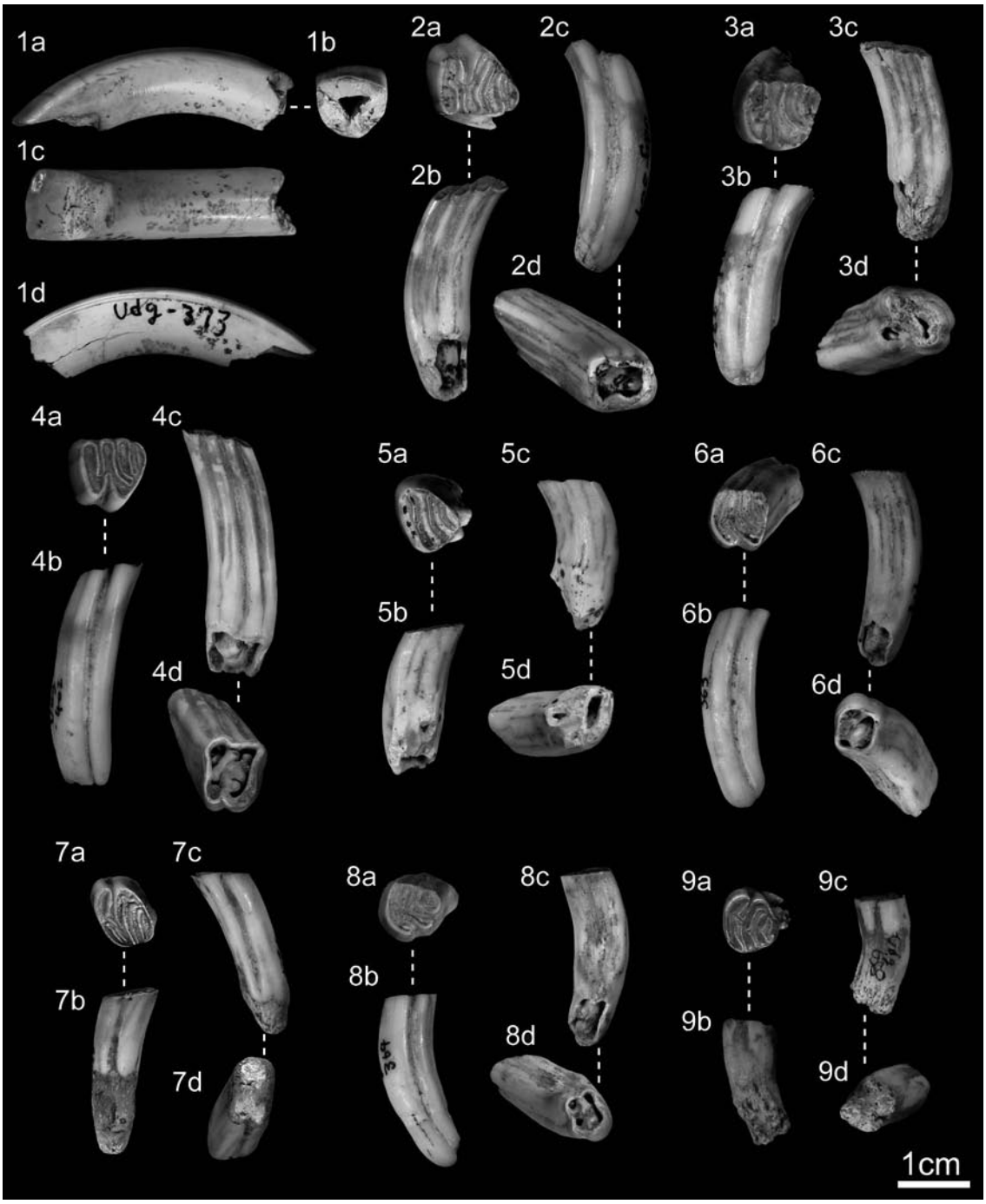

Plate 5.

Castor anderssoni
1: Left upper incisor numbered Udg 373 (1a: mesial view, 1b: posterior view, 1c: palatal view, 1d: distal view)
2: Right P^4 numbered Udg 309 (2a: occlusal view, 2b: buccal view, 2c lingual view, 2d: radical view)
3: Left P^4 numbered Udg 336 (3a: occlusal view, 3b: lingual view, 3c buccal view, 3d: radical view)
4: Left M^1 numbered Udg 402 (4a: occlusal view, 4b: lingual view, 4c buccal view, 4d: radical view)
5: Right M^1 numbered Udg 339 (5a: occlusal view, 5b: buccal view, 5c lingual view, 5d: radical view)
6: Left M^2 numbered Udg 363 (6a: occlusal view, 6b: lingual view, 6c buccal view, 6d: radical view)
7: Right M^2 numbered Udg 434 (7a: occlusal view, 7b: buccal view, 7c lingual view, 7d: radical view)
8: Left M^3 numbered Udg 364 (8a: occlusal view, 8b: lingual view, 8c buccal view, 8d: radical view)
9: Right M^3 numbered Udg 658 (9a: occlusal view, 9b: buccal view, 9c lingual view, 9d: radical view)

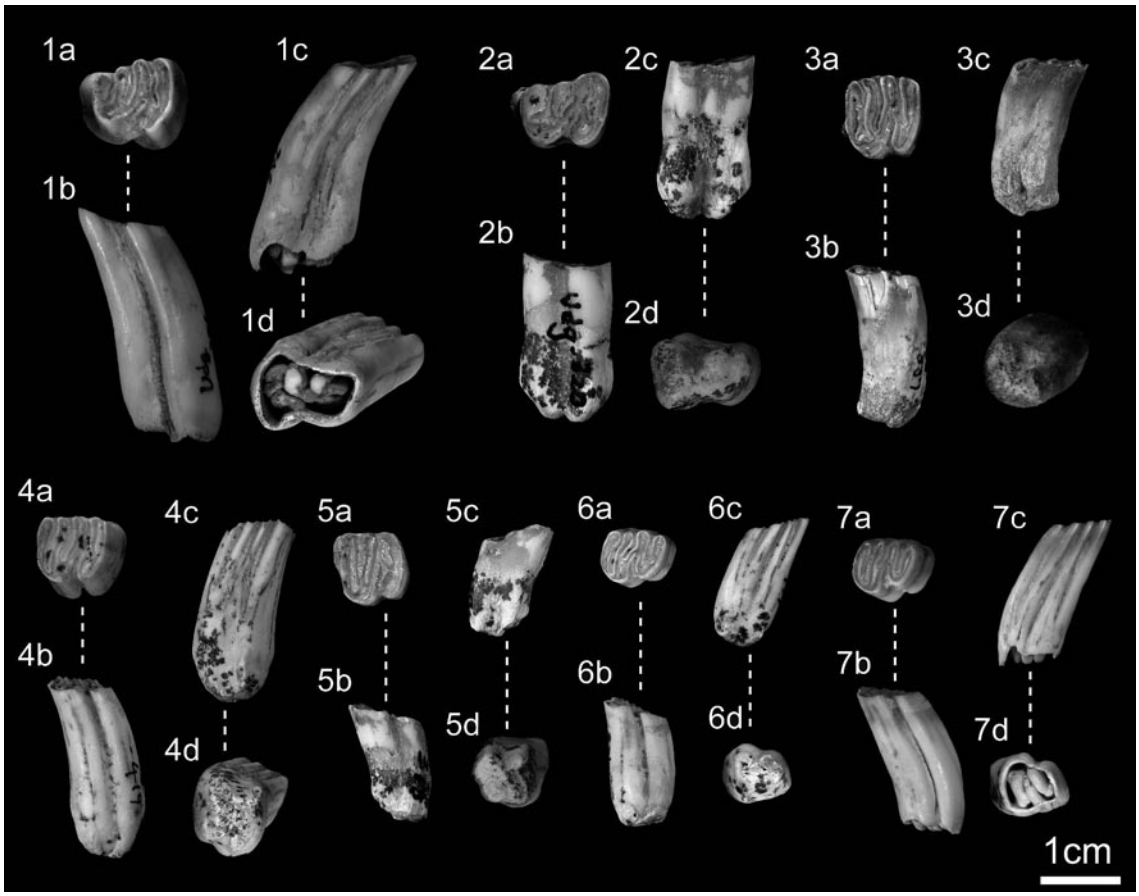

Plate 6.

Castor anderssoni
1: Left P_4 numbered Udg 346 (1a: occlusal view, 1b: buccal view, 1c lingual view, 1d: radical view)
2: Left P_4 numbered Udg 320 (2a: occlusal view, 2b: buccal view, 2c lingual view, 2d: radical view)
3: Left M_1 numbered Udg 337 (3a: occlusal view, 3b: buccal view, 3c lingual view, 3d: radical view)
4: Left M_2 numbered Udg 419 (4a: occlusal view, 4b: buccal view, 4c lingual view, 4d: radical view)
5: Left M_2 numbered Udg 313 (5a: occlusal view, 5b: buccal view, 5c lingual view, 5d: radical view)
6: Left M_3 numbered Udg 426 (6a: occlusal view, 6b: buccal view, 6c lingual view, 6d: radical view)
7: Left M_3 numbered Udg 322 (7a: occlusal view, 7b: buccal view, 7c lingual view, 7d: radical view)

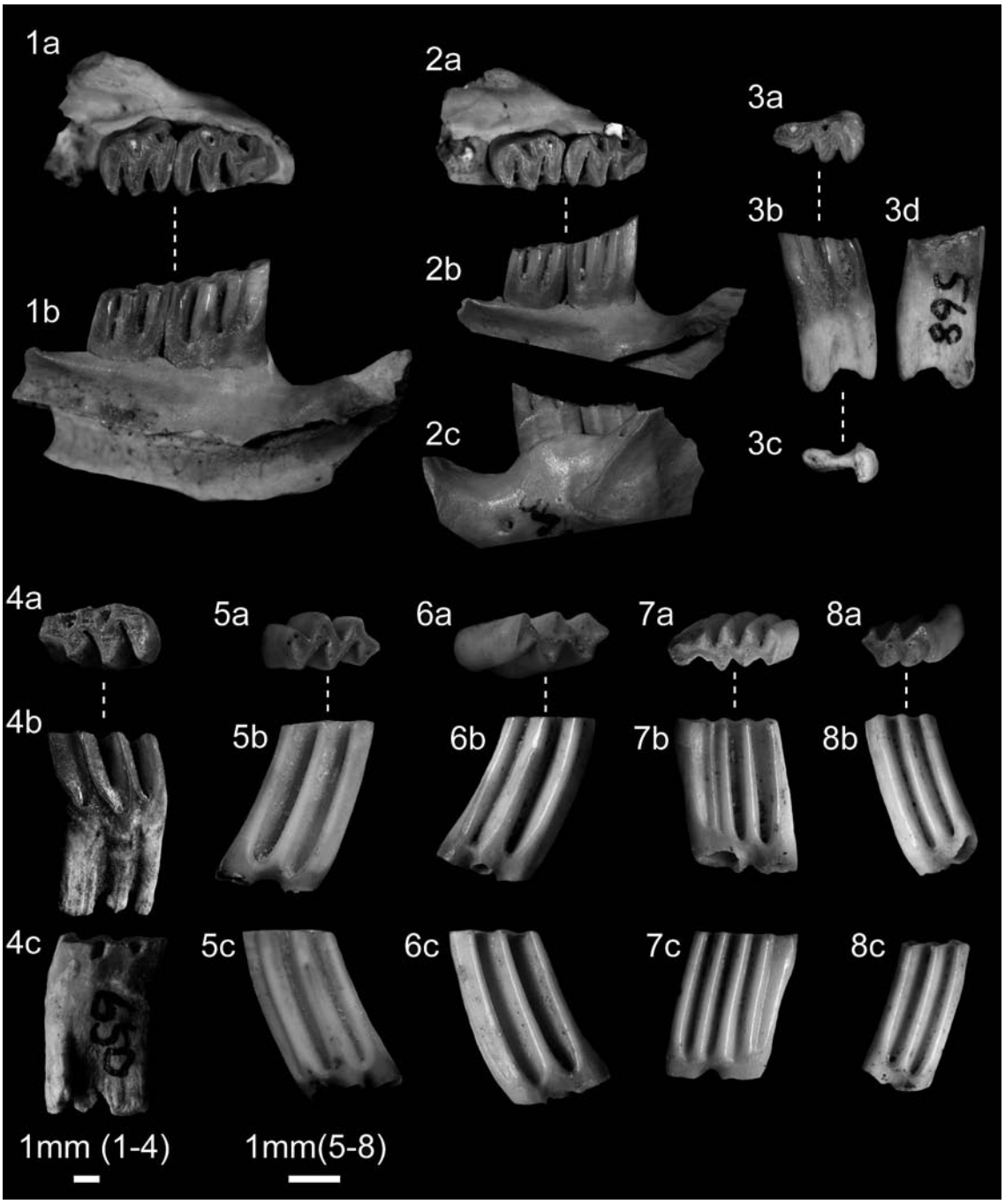

Plate 7.

Prosiphneus cf. *praetingi*
1: Left mandible with M_1 and M_2 numbered Udg 536 (1a: occlusal view, 1b: lingual view)
2: Left mandible with M_1 and M_2 numbered Udg 602 (2a: occlusal view, 2b: lingual view, 2c: buccal view)
3: Right M_1 numbered Udg 568 (3a: occlusal view, 3b: lingual view, 3c: radical view, 3d: buccal view)
4: Right M_1 numbered Udg 650 (4a: occlusal view, 4b: lingual view, 4c: buccal view)

Villanyia sp.
5: Right M^1 numbered Udg 645 (5a: occlusal view, 5b: buccal view, 5c: lingual view)
6: Left M^1 numbered Udg 645 (6a: occlusal view, 6b: lingual view, 6c: buccal view)
7: Left M_1 numbered Udg 645 (7a: occlusal view, 7b: buccal view, 7c: lingual view)
8: Right M_2 numbered Udg 645 (8a: occlusal view, 8b: lingual view, 8c: buccal view)

Appendix 1. List of the fossil specimens examined.* Udg means Udunga. ** The same Udg number was given.

Specimen no.*	Identification		Part	Remarks
Udg 301	*Castor anderssoni*		Right M^2	
Udg 302	*Castor anderssoni*		Right P^4	
Udg 303	*Castor anderssoni*		Left P_4	Juvenile
Udg 304	*Castor anderssoni*		Left P_4	
Udg 305	*Castor anderssoni*		Left M_3	
Udg 306	*Castor anderssoni*		Right M^2	
Udg 307	*Castor anderssoni*		Left M^3	
Udg 308	*Castor anderssoni*		Left M_1	
Udg 309	*Castor anderssoni*		Right P^4	Pl. 5, fig. 2
Udg 310	*Castor anderssoni*		Right M_1	
Udg 311	*Castor anderssoni*		Left M^2	
Udg 312	*Castor anderssoni*		Right M_1	
Udg 313	*Castor anderssoni*		Left M_2	Pl. 6, fig. 5
Udg 314	*Castor anderssoni*		Left M^3	
Udg 315	*Castor anderssoni*		Left M^2	
Udg 316	*Castor anderssoni*		Right M_1	Considerably worn
Udg 317	*Castor anderssoni*		Right P_4	Juvenile
Udg 318	*Castor anderssoni*		Left M^2	
Udg 319	*Castor anderssoni*		Left P^4	
Udg 320	*Castor anderssoni*		Left P_4	Considerably worn; Pl. 6, fig. 2
Udg 321	*Castor anderssoni*		Right M^1	
Udg 322	*Castor anderssoni*		Left M_3	Pl. 6, fig. 7
Udg 323	*Castor anderssoni*		Right P^4	
Udg 324	*Castor anderssoni*		Right M_3	Considerably worn
Udg 325	*Castor anderssoni*		Right P_4	Considerably worn
Udg 326	*Castor anderssoni*		Right M_2	Considerably worn
Udg 327	*Castor anderssoni*		Left M^1	
Udg 328	*Castor anderssoni*		Left maxilla with P^4 and M^1	Pl. 3, fig. 1
Udg 329	*Castor anderssoni*		Right P_4	
Udg 330	*Castor anderssoni*		Right M_2	
Udg 331	*Castor anderssoni*		Left lower incisor	
Udg 332	*Castor anderssoni*		Right M^2	
Udg 333	*Castor anderssoni*		Right M_2	
Udg 334	*Castor anderssoni*		Right P^4	Fragmentary
Udg 335	*Castor anderssoni*		Left mandible with P_4–M_3	Pl. 3, fig. 2
Udg 336	*Castor anderssoni*		Left P^4	Pl. 5, fig. 3
Udg 337	*Castor anderssoni*		Left M_1	Pl. 6, fig. 3
Udg 338	*Castor anderssoni*		Left M^1	
Udg 339	*Castor anderssoni*		Right M^1	Considerably worn; Pl. 5, fig. 5
Udg 340	*Castor anderssoni*		Left M^1	
Udg 341	*Castor anderssoni*		Left upper incisor	
Udg 342	*Castor anderssoni*		Right lower incisor	
Udg 343	*Castor anderssoni*		Right lower incisor	Fragmentary
Udg 344	*Castor anderssoni*		Left lower incisor	Fragmentary
Udg 345	*Castor anderssoni*	?	Right upper incisor	Fragmentary
Udg 346	*Castor anderssoni*		Left P_4	Pl. 6, fig. 1
Udg 347	*Castor anderssoni*		Left P^4	
Udg 348	*Castor anderssoni*		Left upper incisor	
Udg 349	*Castor anderssoni*		Right lower incisor	

Appendix 1. Continued.

Specimen no.*		Identification		Part		Remarks
Udg 350		*Castor anderssoni*		Right mandible with fragmentary I and P_4–M_2		
Udg 351		*Castor anderssoni*		Right mandible with I and P_4–M_3		Pl. 3, fig. 3
Udg 352		*Castor anderssoni*		Right mandible with I and P_4–M_3		Pl. 4, fig. 1
Udg 353		*Castor anderssoni*		Right mandible with P_4–M_3		Pl. 4, fig. 2
Udg 354		*Castor anderssoni*		Left mandible with I, P_4 and M_1		Pl. 4, fig. 3
Udg 355		*Castor anderssoni*		Right mandible with M_1–M_3		
Udg 356		*Castor anderssoni*		Right maxillary fragment with P^4		
Udg 357		*Castor anderssoni*		Left mandible with fragmentary P_4		
Udg 358		*Castor anderssoni*		Left P_4		Considerably worn
Udg 359		*Castor anderssoni*		Right femur		
Udg 360		*Castor anderssoni*		Left femur		
Udg 361		*Castor anderssoni*	?	Left pelvis		
Udg 362	?	Leporidae		Left tibia		
Udg 363		*Castor anderssoni*		Left M^2		Pl. 5, fig. 6
Udg 364		*Castor anderssoni*		Left M^3		Pl. 5, fig. 8
Udg 365		*Castor anderssoni*		Left M_2		
Udg 366		*Castor anderssoni*		Left M^2		
Udg 367		*Castor anderssoni*		Right M^3		
Udg 368		*Castor anderssoni*		Right M^2		
Udg 369		*Castor anderssoni*		Right M^2		
Udg 370		*Castor anderssoni*		Right lower incisor		Fragmentary
Udg 371		*Castor anderssoni*		Left M^1		
Udg 372		*Castor anderssoni*		Left M_1		
Udg 373		*Castor anderssoni*		Left upper incisor		Pl. 5, fig. 1
Udg 374		*Castor anderssoni*		Left P^4		
Udg 375		*Castor anderssoni*		Right upper incisor		Fragmentary
Udg 376		*Castor anderssoni*		Right P^4		
Udg 377		*Castor anderssoni*		Right M^2		
Udg 378		*Castor anderssoni*		Left M^2		
Udg 379		*Castor anderssoni*		Right M^2		
Udg 380		*Castor anderssoni*		Left M^1		
Udg 381		*Castor anderssoni*		Right M^3		Fragmentary
Udg 382		Indeterminate	?	Costa		
Udg 383		Indeterminate	?	Metapodial		
Udg 384	?	Rodentia		Left femur		Smaller than *C. anderssoni*, but larger than arvicolids
Udg 385		*Castor anderssoni*		Left M^1		Considerably worn; otherwise numbered 987/242
Udg 386		*Castor anderssoni*		Right M^2		Otherwise numbered 987/252-1
Udg 387		*Castor anderssoni*		Left P^4		Considerably worn; with massive roots; otherwise numbered 987/252-2
Udg 388		*Castor anderssoni*		Right P^4		Considerably worn; with massive roots; otherwise numbered 987/252-3
Udg 389		*Castor anderssoni*		Left M^3		Otherwise numbered 987/252-4
Udg 390		*Castor anderssoni*		Left M^2		Otherwise numbered 987/252-5
Udg 391		*Castor anderssoni*		Right upper incisor		Otherwise numbered 987/252-6
Udg 392		*Castor anderssoni*		Right upper incisor		Fragmentary; otherwise numbered 987/252-7
Udg 393		*Castor anderssoni*		Right M^1		Otherwise numbered 987/252-8
Udg 394		*Castor anderssoni*		Left M^2		Otherwise numbered 987/252-9
Udg 395		*Castor anderssoni*		Right M^3		Otherwise numbered 987/252-10
Udg 396		*Castor anderssoni*		Right M^2		
Udg 397		*Castor anderssoni*		Right M^3		
Udg 398		Indeterminate		Metapodial	?	Mammal

Appendix 1. Continued.

Specimen no.*	Identification	Part	Remarks
Udg 399	? Rodentia	Left humerus	
Udg 400	Indeterminate	Fragmentary left scapula	Mammal
Udg 401	*Castor anderssoni*	Right M^2	
Udg 402	*Castor anderssoni*	Left M^1	Pl. 5, fig. 4
Udg 403	*Castor anderssoni*	Right M^1	
Udg 404	*Castor anderssoni*	Left M^2	
Udg 405	*Castor anderssoni*	Left M^2	
Udg 406	*Castor anderssoni*	Right M^2	
Udg 407	*Castor anderssoni*	Right M^3	
Udg 408	*Castor anderssoni*	Right lower incisor	
Udg 409	*Castor anderssoni*	Right upper incisor	
Udg 410	*Castor anderssoni*	Right upper incisor	
Udg 411	*Castor anderssoni*	Right upper incisor	
Udg 412	*Castor anderssoni*	Left P^4	
Udg 413	*Castor anderssoni*	Left P^4	
Udg 414	*Castor anderssoni*	Right P^4	With massive roots
Udg 415	*Castor anderssoni*	Left P_4	
Udg 416	*Castor anderssoni*	Right P_4	
Udg 417	*Castor anderssoni*	Right M^2	
Udg 418	*Castor anderssoni*	Left P^4	With massive roots
Udg 419	*Castor anderssoni*	Left M_2	Pl. 6, fig. 4
Udg 420	*Castor anderssoni*	Right M^1	Otherwise numbered 162
Udg 421	*Castor anderssoni*	Right M_1	Considerably worn; with massive roots
Udg 422	*Castor anderssoni*	Right P_4	Considerably worn
Udg 423	*Castor anderssoni*	Left M^1	Considerably worn; with massive roots
Udg 424	*Castor anderssoni*	Left M^1	
Udg 425	*Castor anderssoni*	Right M^1	
Udg 426	*Castor anderssoni*	Left M_3	Considerably worn; Pl. 6, fig. 6
Udg 427**	*Castor anderssoni*	Right M_2	Considerably worn; with massive roots
Udg 427**	*Castor anderssoni*	Right M^2	Otherwise numbered 987/378-4
Udg 428	*Castor anderssoni*	Right M^2	Otherwise numbered 987/378-2
Udg 429	*Castor anderssoni*	Left M^2	Otherwise numbered 987/378-3
Udg 430	*Castor anderssoni*	Right lower incisor	
Udg 431	*Castor anderssoni*	Right upper incisor	Fragmentary
Udg 432	*Castor anderssoni* ?	Right lower incisor	Fragmentary
Udg 433	*Castor anderssoni*	Left M^2	
Udg 434	*Castor anderssoni*	Right M^2	Pl. 5, fig. 7
Udg 435	*Castor anderssoni*	Right M^2	
Udg 436	*Castor anderssoni*	Left M^3	
Udg 437	*Castor anderssoni*	Right M^2	
Udg 438	*Castor anderssoni*	Left M^1	
Udg 439	*Castor anderssoni*	Right M^2	
Udg 440	*Castor anderssoni* ?	Right M^1	Extremely worn
Udg 441	*Castor anderssoni*	Right M^3	
Udg 442	*Castor anderssoni*	Right P^4	Otherwise numbered 161
Udg 443	*Castor anderssoni*	Left P^4	
Udg 444	*Castor anderssoni*	Right P^4	
Udg 445	*Castor anderssoni*	Right M_2	
Udg 446	*Castor anderssoni*	Right M_1	

Appendix 1. Continued.

Specimen no.*		Identification		Part	Remarks
Udg 447		*Castor anderssoni*		Left M^1	Strong enamel folds on the occlusal surface, which recall the molar pattern of *C. zdanskyi*.
Udg 448		*Castor anderssoni*		Left M_2	
Udg 449		*Castor anderssoni*		Right P^4	
Udg 450		*Castor anderssoni*		Right lower incisor	Fragmentary
Udg 451		*Castor anderssoni*		Left upper incisor	Fragmentary
Udg 452		*Castor anderssoni*		Right P_4	Considerably worn
Udg 453		*Castor anderssoni*		Left upper incisor	Otherwise numbered 9871782
Udg 454		*Castor anderssoni*		Right mandibular fragment	Coronoid process
Udg 455		Indeterminate		Left calcaneum	
Udg 456		*Castor anderssoni*		Left lower incisor	Fragmentary
Udg 457		*Castor anderssoni*		Left P_4	Considerably worn
Udg 458		*Castor anderssoni*		Left M^1	
Udg 459		*Castor anderssoni*		Left M^2	
Udg 460		*Castor anderssoni*		Left P_4	
Udg 461		*Castor anderssoni*		Right M_2	
Udg 462		Indeterminate		Indeterminate	
Udg 463		*Castor anderssoni*		Left lower incisor	
Udg 464	?	*Castor anderssoni*		Left lower incisor	
Udg 465		*Castor anderssoni*		Left mandibular fragment with P_4	
Udg 466		Rodentia		Right upper incisor	Small-sized form
Udg 467		Rodentia		Left ulna	Small-sized form
Udg 468		*Prosiphneus* cf. *praetingi*		Right mandible with M_1–M_3	
Udg 469		Indeterminate		Phalanx	
Udg 470		Indeterminate	?	Calcaneum	
Udg 471		Indeterminate		Humerus	
Udg 472	?	Sciuridae		Left mandible with P_4–M_3	Cheek teeth strongly worn
Udg 473		*Ochotona* or *Ochotonoides* sp.		Left mandible with M_1–M_3	
Udg 474		*Hypolagus* sp.		Left mandible with P_4–M_3	
Udg 475		*Ochotona* sp. (large form)		Left mandible with P_3–M_1	Pl. 1, fig. 2
Udg 476		*Hypolagus* sp.		Left mandible with I and P_3–M_2	Pl. 2, fig. 3
Udg 477	?	Lagomorpha		Left femur	Distal part
Udg 478		Indeterminate	?	Phalanx	
Udg 479		Indeterminate		Indeterminate	
Udg 480		Rodentia		Right lower incisor	
Udg 481		Rodentia or Lagomorpha		Right lower incisor	
Udg 482		Rodentia or Lagomorpha		Right lower incisor fragment	
Udg 483		Indeterminate		Cheek tooth fragment	Small- or medium-sized mammal
Udg 484	?	Rodentia		Right lower incisor fragment	
Udg 485		Indeterminate	?	Cheek tooth	Columnar shape; small- or medium-sized mammal
Udg 486		*Ochotona* or *Ochotonoides* sp.		Left premaxilla with I^1 and I^2	
Udg 487		*Ochotona* or *Ochotonoides* sp.		Left P^4 or M^1	
Udg 488		*Ochotona* or *Ochotonoides* sp.		Right mandibular fragment with M_2	Anterior half of M_2 preserved
Udg 489		*Ochotona* or *Ochotonoides* sp.		Left P^3	
Udg 490		*Ochotona* or *Ochotonoides* sp.		Left P^4 or M^1	
Udg 491		*Ochotona* or *Ochotonoides* sp.		Left P^4 or M^1	
Udg 492		*Ochotona* or *Ochotonoides* sp.		Left M^2	
Udg 493		*Ochotona* or *Ochotonoides* sp.		Left mandible	Detached cheek teeth also preserved
Udg 494		Lagomorpha		Right tibia	Distal part
Udg 495		Lagomorpha		Right lower incisor	

Appendix 1. Continued.

Specimen no.*	Identification	Part	Remarks
Udg 496	Rodentia	Right lower incisor	Small-sized form
Udg 497	*Hypolagus* sp.	Left P^4 or M^1	
Udg 498	*Hypolagus* sp.	Left P^4 or M^1	
Udg 499	*Ochotona* or *Ochotonoides* sp.	Left P^4 or M^1	
Udg 500	*Hypolagus* sp.	Left P^3	
Udg 501	*Hypolagus* sp.	Left P^4 or M^1	
Udg 502	*Hypolagus* sp.	Left P_3	
Udg 503	*Ochotona* or *Ochotonoides* sp.	Right P_4	
Udg 504	? Rodentia	? Right upper incisor fragment	
Udg 505	*Ochotona* or *Ochotonoides* sp.	Left mandible with P_4 and M_1	
Udg 506	*Ochotona* or *Ochotonoides* sp.	Left mandible	
Udg 507	Indeterminate	? Skull fragment	Small mammal
Udg 508	*Ochotona* or *Ochotonoides* sp.	Left maxilla	
Udg 509	*Ochotona* or *Ochotonoides* sp.	Right M_1 (fragmentary)	Anterior half
Udg 510	*Ochotona* or *Ochotonoides* sp.	Right M_1 (fragmentary)	Posterior half
Udg 511	*Hypolagus* sp.	Left P_4 (fragmentary)	Anterior half
Udg 512	*Ochotona* or *Ochotonoides* sp.	Right P^4 or M^1	
Udg 513	*Ochotona* or *Ochotonoides* sp.	Left P^3	
Udg 514	*Ochotona* or *Ochotonoides* sp.	Right P^3	
Udg 515	*Ochotona* or *Ochotonoides* sp.	Right P^4 or M^1	
Udg 516	*Ochotonoides complicidens*	Right P_3	Pl. 1, fig. 4
Udg 517	*Hypolagus* sp.	Right P_3	Pl. 2, fig. 4
Udg 518	*Ochotona* or *Ochotonoides* sp.	Right M_2	
Udg 519	*Ochotona* or *Ochotonoides* sp.	Right P^2	Pl. 2, fig. 2
Udg 520	*Ochotona* or *Ochotonoides* sp.	Left M^2	
Udg 521	*Ochotona* or *Ochotonoides* sp.	Right P_4	
Udg 522	*Ochotona* or *Ochotonoides* sp.	Left P^4 or M^1	
Udg 523	*Ochotonoides complicidens*	Left P_3	Pl. 1, fig. 6
Udg 524	*Hypolagus* sp.	Right P_4	
Udg 525	*Ochotona* or *Ochotonoides* sp.	Left M_1	
Udg 526	*Hypolagus* sp.	Right P_4	
Udg 527	*Hypolagus* sp.	Right M_2	
Udg 528	*Ochotona* or *Ochotonoides* sp.	Left M_2	
Udg 529	*Ochotona* or *Ochotonoides* sp.	Left M_3	
Udg 530	Rodentia	Left lower incisor	Small-sized form
Udg 531	Rodentia	Left lower incisor	Small-sized form
Udg 532	Rodentia	Left lower incisor	Small-sized form
Udg 533	? *Hypolagus* sp.	Left upper incisor	
Udg 534	*Ochotona* or *Ochotonoides* sp.	Left upper incisor	
Udg 535	*Ochotona* or *Ochotonoides* sp.	Right M_3	
Udg 536	*Prosiphneus* cf. *praetingi*	Left mandible with M_1 and M_2	Pl. 7, fig. 1
Udg 537	*Prosiphneus* cf. *praetingi*	Right M^1	
Udg 538	*Prosiphneus* cf. *praetingi*	Right M^2	
Udg 539	*Ochotona* or *Ochotonoides* sp.	Right I^1	
Udg 540**	? *Prosiphneus* cf. *praetingi*	Left humerus	Distal part
Udg 540**	*Hypolagus* sp.	? Left P_4	Psterior half
Udg 540**	Lagomorpha	Upper incisor fragment	
Udg 540**	Lagomorpha	Upper incisor fragment	
Udg 540**	Lagomorpha	Upper incisor fragment	

Appendix 1. Continued.

Specimen no.*	Identification	Part	Remarks
Udg 540**	Lagomorpha	Upper incisor fragment	
Udg 540**	Lagomorpha	Maxillary fragment	
Udg 540**	Lagomorpha	Maxillary or mandibular fragment	
Udg 540**	Rodentia	Lower incisor	
Udg 541	*Ochotona* or *Ochotonoides* sp.	Right mandible	
Udg 542	*Ochotona* or *Ochotonoides* sp.	Right mandibular fragment	
Udg 543	*Ochotona* or *Ochotonoides* sp.	Right mandible	
Udg 544	*Ochotona* or *Ochotonoides* sp.	Right mandible with P_4–M_3	
Udg 545	Leporidae, gen and sp. indet.	Left P^4 or M^1	Considerably smaller than *Hypolagus* sp.
Udg 546	Leporidae, gen and sp. indet.	Right M^2	Considerably smaller than *Hypolagus* sp.
Udg 547	*Hypolagus* sp.	Right P^2	
Udg 548	*Ochotona* or *Ochotonoides* sp.	Right M_2 (fragmentary)	Posterior half
Udg 549	*Ochotona* or *Ochotonoides* sp.	Right M_2 (fragmentary)	Anterior half
Udg 550	*Ochotonoides complicidens*	Left P_3	
Udg 551	*Ochotona* or *Ochotonoides* sp.	Right P_4	
Udg 552	*Ochotona* or *Ochotonoides* sp.	Left P_4	
Udg 553	*Ochotona* or *Ochotonoides* sp.	Left M_2	
Udg 554	*Ochotona* or *Ochotonoides* sp.	Right M_1	
Udg 555	*Ochotona* or *Ochotonoides* sp.	Left M_1	
Udg 556	Rodentia	Right lower incisor	
Udg 557	Rodentia	Right lower incisor	
Udg 558	*Ochotona* cf. *gromovi*	Right M_2 (fragmentary)	Posterior half
Udg 559	*Ochotona* cf. *gromovi*	Right M_2 (fragmentary)	Anterior half
Udg 560	*Ochotona* or *Ochotonoides* sp.	Right M_2 (fragmentary)	Anterior half
Udg 561	*Ochotona* sp. (large form)	Right P_3	Pl. 1, fig. 3
Udg 562	*Ochotona* cf. *gromovi*	Right P_4	
Udg 563	*Ochotonoides complicidens*	Right P_3	Pl. 1, fig. 7
Udg 564	*Ochotona* cf. *gromovi*	Right M_1	
Udg 565	*Ochotona* cf. *gromovi*	Right P_3	Pl. 1, fig. 1
Udg 566	*Ochotona* cf. *gromovi*	Right M_3	
Udg 567	Rodentia	Right lower incisor	Small-sized form
Udg 568	*Prosiphneus* cf. *praetingi*	Right M_1	Pl. 7, fig. 3
Udg 569	Indeterminate ?	Tibia (distal epiphysis) ?	Small mammal
Udg 570	Indeterminate ?	Caudal vertebra ?	Small mammal
Udg 571 ?	Lagomorpha	Right calcaneum	
Udg 572	Indeterminate	Right pelvis	Small mammal
Udg 573	Indeterminate	Left ulna	Small mammal
Udg 574	Indeterminate	Left calcaneum	Small mammal
Udg 575	Indeterminate	Long bone ?	Aves
Udg 576	Indeterminate ?	Left humerus ?	Small mammal
Udg 577	Indeterminate ?	Left humerus ?	Small mammal
Udg 578	Indeterminate ?	Metapodial ?	Small mammal
Udg 579	Indeterminate ?	Metapodial ?	Small mammal
Udg 580	Indeterminate	Indeterminate	Bone fragment
Udg 581 ?	Lagomorpha	Left humerus	Distal epiphysis
Udg 582	Indeterminate ?	Phalanx ?	Aves
Udg 583 ?	Lagomorpha ?	Left tibia	
Udg 584**	Indeterminate	Long bone fragment ?	Small mammal
Udg 584**	*Ochotonoides complicidens*	Right mabdible with P_3–M_3	Pl. 2, fig. 1
Udg 585	*Ochotona* or *Ochotonoides* sp.	Right mabdible with P_4 and M_1	
Udg 586	*Hypolagus* sp.	Right mabdible with P_4	
Udg 587	*Ochotona* or *Ochotonoides* sp.	Left mandible	
Udg 588	*Ochotona* or *Ochotonoides* sp.	Right mabdible with M_3	

Appendix 1. Continued.

Specimen no.*		Identification		Part		Remarks
Udg 589	?	*Ochotona* or *Ochotonoides* sp.		Right mandibular fragment		
Udg 590		*Ochotona* or *Ochotonoides* sp.		Left P^3		
Udg 591		*Ochotona* or *Ochotonoides* sp.		Left P^4 or M^1		
Udg 592		*Hypolagus* sp.		Right P_3		Pl. 2, fig. 5
Udg 593		*Hypolagus* sp.		Right M_2		
Udg 594		*Hypolagus* sp.		Right P_4		
Udg 595		*Ochotona* or *Ochotonoides* sp.		Right M_1		
Udg 596		*Ochotona* or *Ochotonoides* sp.		Left P_4		
Udg 597		*Ochotona* or *Ochotonoides* sp.		Left I^1		
Udg 598		*Ochotona* or *Ochotonoides* sp.		Right I^1		
Udg 599		Lagomorpha		Right lower incisor		
Udg 600		Rodentia		Left lower incisor		Small-sized form
Udg 601		Rodentia		Left lower incisor		Small-sized form
Udg 602		*Prosiphneus* cf. *praetingi*		Left mabdible with M_1 and M_2		Pl. 7, fig. 2
Udg 603		*Prosiphneus* cf. *praetingi*		Right M_1		
Udg 604		*Prosiphneus* cf. *praetingi*		Right M_3		
Udg 605		*Prosiphneus* cf. *praetingi*		Right M_1		
Udg 606		*Prosiphneus* cf. *praetingi*		Right M_2		
Udg 607		*Prosiphneus* cf. *praetingi*		Right M_1		
Udg 608		*Prosiphneus* cf. *praetingi*		Right M_2		
Udg 609		*Prosiphneus* cf. *praetingi*		Left M_1		
Udg 610		Rodentia		Right lower incisor		Small-sized form
Udg 611		*Villanyia* sp.		Left mandible with M_2		
Udg 612		Rodentia		Left lower incisor		Small-sized form
Udg 613		Lagomorpha		Left lower incisor		
Udg 614	?	Rodentia	?	Right upper incisor		
Udg 615	?	Lagomorpha or Rodentia	?	Phalanx (fragmentary)		
Udg 616	?	Lagomorpha or Rodentia		Proximal phalanx		
Udg 617	?	Lagomorpha or Rodentia	?	Humerus		
Udg 618	?	Lagomorpha or Rodentia	?	Metapodial		
Udg 619	?	Lagomorpha or Rodentia	?	Humerus		
Udg 620	?	Lagomorpha or Rodentia	?	Tibia		
Udg 621	?	Lagomorpha or Rodentia	?	Ulna		
Udg 622		Lagomorpha		Left lower incisor		
Udg 623	?	Rodentia	?	Upper incisor fragment		
Udg 624		*Castor anderssoni*		Right upper incisor		
Udg 625		*Ochotona* or *Ochotonoides* sp.		Left mandible		
Udg 626		*Hypolagus* sp.		Right P_4		
Udg 627	?	Lagomorpha or Rodentia	?	Left femur		
Udg 628	?	Lagomorpha or Rodentia		Proximal phalanx		
Udg 629	?	Lagomorpha or Rodentia		Metapodial		
Udg 630		Indeterminate		Vertebra	?	Anura
Udg 631		Indeterminate	?	Scapula	?	Anura
Udg 632		Indeterminate		Long bone	?	Anura
Udg 633		Indeterminate	?	Epiphysis of a long bone	?	Small mammal
Udg 634		Indeterminate		Long bone	?	Small mammal
Udg 635		Indeterminate	?	Pelvis		
Udg 636		Indeterminate	?	Pelvis		
Udg 637		Indeterminate		Long bone	?	Anura
Udg 638		*Ochotona* or *Ochotonoides* sp.		Left mabdible with P_4–M_2		
Udg 639		*Ochotona* or *Ochotonoides* sp.		Right P_4 (fragmentary)		Posterior half
Udg 640		*Ochotona* or *Ochotonoides* sp.		Right P_4 (fragmentary)		Anterior half
Udg 641		*Ochotona* or *Ochotonoides* sp.		Left M_3		
Udg 642		*Ochotonoides complicidens*		Right P_3		
Udg 643		Rodentia		Right lower incisor		Small-sized form
Udg 644		Rodentia		Left lower incisor		Small-sized form

Appendix 1. Continued.

Specimen no.*	Identification	Part	Remarks
Udg 645**	*Villanyia* sp.	Right M^1	Pl. 7, fig. 5
Udg 645**	*Villanyia* sp.	Left M^1	Pl. 7, fig. 6
Udg 645**	*Villanyia* sp.	Left M_1	Pl. 7, fig. 7
Udg 645**	*Villanyia* sp.	Right M_2	Pl. 7, fig. 8
Udg 645**	Rodentia	Right lower incisor	Small-sized form
Udg 646	Leporidae, gen. and sp. indet.	Right mandible with P_4–M_2	Considerably smaller than *Hypolagus* sp.
Udg 647	Leporidae, gen. and sp. indet.	Right P^2	Considerably smaller than *Hypolagus* sp.
Udg 648	*Hypolagus* sp.	Right M^2	
Udg 649	*Hypolagus* sp.	Right P^4 or M^1	
Udg 650	*Prosiphneus* cf. *praetingi*	Right M_1	Pl. 7, fig. 4
Udg 651	Indeterminate	? Cheek teeth	? Small mammal
Udg 652	Rodentia	Left lower incisor	*Villanyia* size
Udg 653	Rodentia	Left lower incisor	*Villanyia* size
Udg 654	? Lagomorpha	Proximal phalanx	
Udg 655	? Lagomorpha or Rodentia	Proximal phalanx	
Udg 656	Indeterminate	Indeterminate	Bone fragments
Udg 657	*Castor andessoni*	Left M^3	
Udg 658	*Castor andessoni*	Right M^3	Pl. 5, fig. 9
Udg 2440	*Castor andessoni*	Right M_2	
Udg 2441	*Hypolagus* sp.	Right mabdible with P_4–M_2	Otherwise numbered 99/283
Unnumbered	Rodentia	Left lower incisor	Small-sized form
Unnumbered	*Ochotonoides complicidens*	Left P_3	Pl. 1, fig. 5
Unnumbered	*Ochotona* or *Ochotonoides* sp.	Right M_2	

Appendix 2. Measurements of the cheek teeth of *Ochotona* cf. *gromovi* in mm. L: length of crown, W: width of crown. For the measuring method see Figure 2.

	P_3		P_4		M_1		M_3	
Specimen no.	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**
Udg 562	–	–	1.71	1.85	–	–	–	–
Udg 564	–	–	–	–	1.77	1.93	–	–
Udg 565	1.71	1.69	–	–	–	–	–	–
Udg 566	–	–	–	–	–	–	0.81	1.57

Appendix 3. Measurements of the cheek teeth of *Ochotona* sp. (larger form) in mm. L: length of crown, W: width of crown. For the measuring method see Figure 2.

	P_3		P_4		M_1	
Specimen no.	**L**	**W**	**L**	**W**	**L**	**W**
Udg 475	2.52±	2.49	2.43	2.71	2.63	2.88
Udg 561	2.33	2.32	–	–	–	–

Appendix 4. Measurements of the lower cheek teeth of *Ochotonoides complicidens* in mm. L: length of crown, W: width of crown. For the measuring method see Figure 2.

	P_3		P_4		M_1		M_2		M_3	
Specimen no.	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**
Udg 516	2.62	2.88	–	–	–	–				
Udg 523	2.80	2.75	–	–	–	–	–	–	–	–
Udg 550	2.62	2.43	–	–	–	–	–	–	–	–
Udg 563	2.39	2.45	–	–	–	–	–	–	–	–
Udg 584	2.57	2.62	2.55	2.96	2.75	3.02	2.69	2.92	1.10±	1.58±
Udg 642	2.46	2.47	–	–	–	–	–	–	– –	– –
Unnumbered	2.57	2.40	–	–	–	–	–	–	– –	– –

Appendix 5. Measurements of the upper cheek teeth of *Ochotona* or *Ochotonoides* sp. in mm. L: length of crown, W: width of crown. For the measuring method see Figure 2.

	P^2		P^3		P^4 or M^1		M^2	
Specimen no.	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**
Udg 487	–	–	–	–	2.01	3.89	–	–
Udg 489	–	–	1.92	4.23	–	–	–	–
Udg 490	–	–	–	–	2.18	4.42	–	–
Udg 491	–	–	–	–	2.25	4.93	–	–
Udg 492	–	–	–	–	–	–	2.42	4.08
Udg 499	–	–	–	–	2.34	4.78	–	–
Udg 512	–	–	–	–	2.21	4.56	–	–
Udg 513	–	–	1.88	4.13	–	–	–	–
Udg 514	–	–	1.90	4.02	–	–	–	–
Udg 515	–	–	–	–	2.19	4.46	–	–
Udg 519	1.31	2.50	–	–	–	–	–	–
Udg 520	–	–	–	–	–	–	2.47	3.37
Udg 522	–	–	–	–	2.13	–	–	–
Udg 590	–	–	2.04	3.72±	–	–	–	–
Udg 591	–	–	–	–	2.27	–	–	–

Appendix 6. Measurements of the lower cheek teeth of *Ochotona* or *Ochotonoides* sp. in mm. L: length of crown, W: width of crown. For the measuring method see Figure 2.

	P_4		M_1		M_2		M_3	
Specimen no.	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**
Udg 473	–	–	2.55	3.08	2.60	2.94	1.19	2.01
Udg 503	2.55	3.23	–	–	–	–	–	–
Udg 505	2.47	2.76	2.86	–	–	–	–	–
Udg 518	–	–	–	–	2.63	2.78	–	–
Udg 521	2.50	3.26	–	–	–	–	–	–
Udg 525	–	–	–	–	2.58	2.66	–	–
Udg 528	–	–	–	–	2.62	–	–	–
Udg 529	–	–	–	–	–	–	1.15	2.01
Udg 535	–	–	–	–	–	–	1.17	2.00
Udg 544	2.25	2.37	2.38	2.52	2.32	–	1.03	1.77
Udg 551	2.37	2.72	–	–	–	–	–	–
Udg 552	2.30	2.66	–	–	–	–	–	–
Udg 553	–	–	–	–	2.35	2.99	–	–
Udg 554	–	–	2.36	3.30	–	–	–	–
Udg 555	–	–	2.38	3.06	–	–	–	–
Udg 585	2.38	2.98	2.59	2.88	–	–	–	–
Udg 588	–	–	–	–	–	–	1.17	2.15
Udg 595	–	–	2.59	–	–	–	–	–
Udg 596	2.40	2.85	–	–	–	–	–	–
Udg 638	2.52	3.04	2.60	3.10	2.60	2.94	–	–
Unnumbered	–	–	–	–	2.57	2.96	–	–

Appendix 7. Measurements of the upper cheek teeth of *Hypolagus* sp. in mm. L: length of crown, W: width of crown. For the measuring method see Figure 2.

	P^2		P^3		P^4 or M^1		M^2	
Specimen no.	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**
Udg 497	–	–	–	–	2.27	–	–	–
Udg 498	–	–	–	–	2.52	4.30	–	–
Udg 500	–	–	2.14	4.12	–	–	–	–
Udg 501	–	–	–	–	2.32	4.24	–	–
Udg 547	1.60	3.10	–	–	–	–	–	–
Udg 648	–	–	–	–	–	–	2.13	–
Udg 649	–	–	–	–	2.46	–	–	–

Appendix 8. Measurements of the lower cheek teeth of *Hypolagus* sp. in mm. L: length of crown, W: width of crown. For the measuring method see Figure 2.

	P_3		P_4		M_1		M_2		M_3	
Specimen no.	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**
Udg 474	–	–	2.99	3.66	3.10	3.47	3.21	3.51	2.00	1.87
Udg 476	3.05	2.92	2.89	3.55	3.17	3.46	3.17	3.49	–	–
Udg 502	3.17	2.94	–	–	–	–	–	–	–	–
Udg 517	3.11	2.73	–	–	–	–	–	–	–	–
Udg 524	–	–	3.08	3.61	–	–	–	–	–	–
Udg 526	–	–	2.84	3.37	–	–	–	–	–	–
Udg 527	–	–	–	–	–	–	2.82	3.34	–	–
Udg 586	–	–	2.98	3.63	–	–	–	–	–	–
Udg 592	3.06	3.43	–	–	–	–	–	–	–	–
Udg 593	–	–	–	–	–	–	2.96	3.24	–	–
Udg 594	–	–	2.96	3.29	–	–	–	–	–	–
Udg 626	–	–	2.88	3.60	–	–	–	–	–	–
Udg 2441	–	–	3.16	3.55	3.11	3.62	3.43	3.35	–	–

Appendix 9. Measurements of the cheek teeth of Leporidae, gen. and sp. indet. in mm. L: length of crown, W: width of crown. For the measuring method see Figure 2.

	P^2		P^4 or M^1		M^2		P_4		M_1		M_2
Specimen no.	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**	**L**
Udg 545	–	–	1.63	2.79	–	–	–	–	–	–	–
Udg 546	–	–	–	–	1.54	–	–	–	–	–	–
Udg 646	–	–	–	–	–	–	1.97	2.14	1.90	2.22±	1.83
Udg 647	1.23	–	–	–	–	–	–	–	–	–	–

Appendix 10. Measurements of the upper cheek teeth of *Castor anderssoni* in mm. L: length of crown, W: width of crown. For the measuring method see Figure 3.

	P^4		M^1		M^2		M^3	
Specimen no.	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**
Udg 309	11.6	9.2	–	–	–	–	–	–
Udg 328	11.9	11.0	9.1	8.9	–	–	–	–
Udg 336	11.7	10.4	–	–	–	–	–	–
Udg 363	–	–	–	–	8.8	8.8	–	–
Udg 364	–	–	–	–	–	–	–	–
Udg 402	–	–	9.3	8.7	–	–	–	–
Udg 434	–	–	–	–	8.1	9.4	–	–
Udg 658	–	–	–	–	–	–	8.0	7.8

Appendix 11. Measurements of the lower cheek teeth of *Castor anderssoni* in mm. L: length of crown, W: width of crown. For the measuring method see Figure 3.

	P_4		M_1		M_2		M_3	
Specimen no.	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**
Udg 313	–	–	–	–	9.3	9.5	–	–
Udg 320	11.8	9.4	–	–	–	–	–	–
Udg 322	–	–	–	–	–	–	7.7	6.7
Udg 335	–	–	10.4	10.2	10.7	10.0	–	–
Udg 337	–	–	9.6	10.8	–	–	–	–
Udg 346	10.6	9.3	–	–	–	–	–	–
Udg 351	12.0	10.7	9.9	9.7	10.3	10.1	9.9	7.9
Udg 352	11.8	9.6	9.2	9.5	9.5	9.7	9.6	7.8
Udg 353	12.1	9.4	10.9	9.9	10.6	9.8	11.3	7.6
Udg 354	12.2	10.5	10.9	10.8	–	–	–	–
Udg 419	–	–	–	–	8.9	9.1	–	–
Udg 426	–	–	–	–	–	–	8.5	7.1

Appendix 12. Measurements of the cheek teeth of *Prosiphneus* cf. *praetingi* in mm. L: length of crown, W: width of crown. For the measuring method see Figure 3.

	M^1		M^2		M_1		M_2		M_3	
Specimen no.	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**
Udg 536	–	–	–	–	4.00	2.50	3.10	2.56	–	–
Udg 537	–	2.20	–	–	–	–	–	–	–	–
Udg 538	–	–	2.56	2.62	–	–	–	–	–	–
Udg 568	–	–	–	–	3.48	1.86	–	–	–	–
Udg 602	–	–	–	–	3.86	2.18	3.06	2.20	–	–
Udg 603	–	–	–	–	3.23	1.97	–	–	–	–
Udg 604	–	–	–	–	–	–	–	–	2.41	2.00
Udg 605*	–	–	–	–	2.73	1.60	–	–	–	–
Udg 606	–	–	–	–	–	–	2.91	2.15	–	–
Udg 607	–	–	–	–	3.50	2.37	–	–	–	–
Udg 608	–	–	–	–	–	–	2.96	2.51	–	–
Udg 609*	–	–	–	–	–	1.79±	–	–	–	–
Udg 650	–	–	–	–	3.96	2.26	–	–	–	–

Appendix 13. Measurements of the cheek teeth of *Villanyia* sp. in mm. L: length of crown, W: width of crown. For the measuring method see Figure 3.

	M^1		M_1		M_2	
Specimen no.	**L**	**W**	**L**	**W**	**L**	**W**
Udg 611	–	–	–	–	1.96	1.27
Udg 645	–	–	2.45	0.98	–	–
Udg 645	1.96	1.12	–	–	–	–
Udg 645	1.92	1.07	–	–	–	–
Udg 645	–	–	–	–	1.50	0.85