Identifying the Beginnings of Sheep Husbandry in Western China

Part ii

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Appendix A Zooarchaeological Evidence of Caprinae in Northern, Central, and Southern Part of China

Palaeolithic (Pleistocene)

Fossils of *Ovis* were discovered from many Pleistocene sites in North China, while there seem to be very few from South China. At the early Pleistocene site Nihewan (泥河湾) in Hebei Province (ca.1,800,000-1,000,000 BP), fossils of wild Shandong sheep (*Ovis shantungensis*) were identified; in the middle Pleistocene site Zhoukoudian (周口店) (400,000-230,000 BP) in Beijing, *Ovis cf. ammon* were identified, together with close related fauna such as *Gazella*, *Nemorhaedus*, and Ovibovinae; at late Pleistocene Shandingdong (山顶洞), which is just above Zhoukoudian and dated to 10,470-18,340 BP, *Ovis sp*. was also identified (Qi 1989). Apparently, these remains represent the local wild fauna hunted by humans. In the northwest, remains of Caprini were also reported in late Pleistocene sites, such as from Xiheqiao (西河桥) at Ningxia, and Yuzhong (榆中) of Gansu, although the exact genus status was problematic (Dong and Chen 1991, Xie and Zhang 1994). The *Ovis nahoor* reported at Yuzhong might be actually *Pseudois nayaur*, rather than true *Ovis*.

It should be noted that these identifications have all been based on the morphology of the fragmentary bones and there might be errors. For example, although *Capra* sp. was identified from Late Pleistocene site Shanchengzi (山城子) in Shandong Province (Qi 1989), it should be a misidentification because *Capra* is not a fauna indigenous to this part of China, as will be discussed in Chapter 4. Besides, fossils of *Ovis* were also from a site in Southern China, in Jiande (建德), Zhejiang Province, dated to 181,000-110,000 BP (Han et al. 1989), but this status may also be doubtful because *Ovis* is hardly distributed in this region in the later periods. In addition, fossils identified as Ovinae or Caprinae have also been reported in many Pleistocene sites in Southern China, but they were not identified to more detailed taxonomical levels (Han et al. 1989).

In general, the records of the *Ovis* identified from late Pleistocene fossils in the south are far fewer than in the north, conforming to the current understanding of their distribution. Although there were errors in the early taxonomic identifications, the existence of *Ovis* in North China in upper Pleistocene is likely credible. Xie (谢成侠) (1985) thus believed that domestic sheep in North China might descend from the local wild Argali sheep (*Ovis ammon*). But there are also other opinions, which will be discussed later.



Figure A.1 Map of China showing principal regions and sites mentioned in Appendix A. 1. Xingcheng (兴城), 2.Machengzi (马城子), 3.Shuiquan (水泉), 4.Hongshanhou (红山后), 5.Shanchengzi (山城子), 6. Zhukaigou (朱开沟),7. Zhangying (张营), 8.Nihewan (泥河湾), 9.Tonglin (桐林), 10.Chengziya (城子崖), 11.Baiying (白营), 12.Xinzhai (新砦), 13.Erlitou (二里头) 14.Maiodigou (庙底沟), 15.Sanmenxia (三门峡), 16. Banpo (半坡), 17 Lingkoucun (零口村), 18. Kangjia (康家), 19.Nianzipo (碾子坡), 20.Yuzhong (榆中), 21.Xinhua (新华), 22.Zhukaigou (朱开沟), 23.Xiheqiao (西河桥), 24.Dadunzi (大墩子), 25.Caiyuanzi (菜园子), 26.Karuo (卡若), 27.Balikun (巴里坤), 28.Mulei (木垒), 29.Kongquehe (孔雀河), 30.Qugong (曲贡), 31.Jiande (建德).

Early, Middle Neolithic (8000 – 4700 BP)

Only very few caprine bones have been reported from the early and middle Neolithic sites in this region, and the taxonomy status is doubtful (Flad et al. 2007, Luo 2009, Benxiong 周本雄 Zhou 1984). Lingkoucun (零口村) was probably the earliest reported to contain a significant number of caprine bones. In the early period (7130-6500 BP), caprine has NISP=12 (3.7 percent). In Yangshao culture period (6500-5750 BP), there is a NISP of 31 (26.1 percent) of caprines, being second to pigs in abundance. In Xiwangcun period, NISP=5 (5.6 percent). All of the caprines were reported as a goat in Chinese (*Shan-Yang* 山羊), but the scientific nomenclature given was Caprinae, which include several different species in the subfamily Caprinae (IASP 2004). Thus it seems more likely that these represent wild Caprinae remains rather than domestic goat. Banpo (半坡) (6800-6300 BP) is a very famous Yangshao culture site in Xi'an, Shaanxi Province. Here three mandibles and a lower molar teeth were identified as *Ovis sp* (Li and Han 1959). But the taxonomy identification which based on several loose teeth is problematic, as will be shown in the later parts of the dissertation, teeth are among the most difficult elements to be separated between the different Caprinae and gazelle species. The status of domestication was doubted by the investigator, though it was reported that the size and character of the specimens look similar to *Ovis shang Teihardet Young*, the securely identified Chinese domestic sheep of Shang Dynasty. In addition, an image of a sheep head was found in a pottery vessel (IACSA and BMXS 1963), which may also indicate sheep were part of the animals in people's life. Apart from the above, Sanmenxia (三门峡) (4900-4800 BP) in Shaanxi Province is reported to contain some goat remains in the second phase of Miaodigou culture, and there were suggested to be domestic. But again the taxonomy status is not correctly represented, and there is no evidence for domesticated animals being presented (Zhou 1984). In other parts of China, no evidence of sheep/goat remains has been reported in this time period.

Chalcolithic – Bronze Age (4600-3000 BP)

Sheep and goat bones were identified from Longshan culture complex in Central Plain and interpreted as domestic. In some sites, more rigorous zooarchaeological work has been done. Erlitou site (3800-3500 BP) (二里头) is believed to be the capital city of the first dynasty Xia in Chinese history. The number of the sheep/goats here is large: NISP=1563 and MNI=108 (four periods altogether), and they were all identified as domestic animals based on the analysis of age structure, the species abundance, the measurement, and archaeological context. A few specimens of goats were identified (Yang 2006). At Xinzhai (4050 - 3750 BP), the caprines are identified as the second most important domestic animal (NISP=411, next to pigs). The ratio of caprines in domestic animals gradually increased through the three periods from 3.8% to 30.8%, and a specimen of goat bone was identified (Huang 2008). In Kangjia (康家) (4300-4000 BP), the amount of caprine is the third following cattle and pig (NISP=64, 8%-14% in different contexts). Based on the age structure, they were thought to be domestic (Liu et al. 2005). In the Longshan culture period of Baiying (白营) (4290 - 4028 BP) (Zhou 1983) and Miaodigou (庙底沟) (2500 BP) (IACASS 1959), sheep/goat was identified as domestic animals, but no detailed information was given. In the later stage, sheep remains

were found more abundantly, such as in Nianzipo (碾子坡) site of early Zhou Dynasty culture (JTIACSSA 1989)

Chengziya (城子崖) (4500-4000 BP) is a typical Longshan culture site in Shandong Province, east China. Sheep remains here were identified as domestic, since the morphology of the bone was found similar to that of the domestic sheep of Shang Dynasty (Benxiong 周本雄 Zhou 1984). In Zhizhushan (蜘蛛山) (4000 - 3800 BP), it was only mentioned that Inner Mongolia sheep remains were identified in the lower level of Xiajiadian Culture phase (IMTIACASS 1979). Machengzi (马城子) is a cemetery site in Liaoning Province. In the tombs of the Bronze Age (3600-3000 BP) period, a few sheep bones were buried as a grave good. Caprine remains were also found in Houshanhou (红山后) in Chifeng, but the dates of the remains are not clear. There is no direct radiocarbon dating, and some were reported from Hongshan culture (ca. 5000 BP) (Bintian and Shuiye 1936, Lv 1958, Ying 1955), and some from Bronze Age (Benxiong 周本雄 Zhou 1984). Besides, caprines were also reported in late Neolithic to Bronze Age period of Tonglin (桐林) (Zhang 2006), Shuiquan (水泉) (Zhang 1989), and Xingcheng (兴城) (ICRARJP 2001), Zhangying (张营) (ICRB and CCCDB 2007). However, in none of these reports evidence for taxonomy identification was given.

In the Northern part of China, domestic sheep remains also appeared in the late Longshan period. In Zhukaigou (朱开沟) (4000-3600), caprines have a NISP of 406, and all were identified as sheep (*Ovis*), accounting for 40.6 percent of the total faunal remains. They were identified as domestic based on the measurements and the mortality profile, which shows that most were killed at 1.5-2 years old (Huang 1996). Several bones of caprines were also reported from Xinhua (新华) (4000-3900 BP) of Shenmu (神木) in the north part of Shannxi Province, but the author is not sure about domestic or wild (Xue et al. 2005).

In Xinjiang province, several Bronze Age site in Kongque River (孔雀河) (ca. 3900-3800 BP) were reported with caprine remains which fabrics made from sheep wool (Wang 1983). After 3300 BP, sheep remains were found abundantly among in the tombs in Mulei (木垒), Hami (哈密), Balikun (巴里坤) etc. (Chang 1985, Huang and Dai 1986, Yang 1982). These seem to be related to the nomad people from central Asia since the analysis of the human bones identified some of them as European type.

The earliest site contain sheep remains in the south were from Tibet. At Qugong (曲贡) (4000-3500 BP) of Lasa, Tibet, sheep (*Ovis*) remains were identified in the ash pits from and were likely the food wastes as suggested by the author, and were found more close to the local Tibetan domestic sheep (Zhou 1999). In the early site Karuo (卡若) at Changdu (昌都) (ca. 5000-4000 BP), no caprine remains were found although *Procapra* were reported (Huang and Leng 1985). However, according to my rough examination in the summer of 2012, Caprinae remains do exist, although it was not able to identify them to a more detailed taxonomic level at that time. In the other parts of Southern China, sheep were probably imported into this region only since the Shang Dynasty (Wu and Luo 2008), although *Ovis* remains were also reported in Yunnan Province at Dadunzi (大墩子) (YPM 1977) and

Caiyuanzi (菜园子) (Dai et al. 2003) of earlier than 4000BP, but the identification of Caiyuanzi is just based on several loose teeth, and in another site no information about the material was given.

Appendix B Registry Information of Modern Ovis

Specimens

Label Name	Specimen Number	Age	Sex	Origin	Status
Ovis ammon	BMN 1	ad	-	Berlin Zoo	zoobred
Ovis ammon	BMN 5391	ad	m	Berlin Zoo	captured wild
Ovis ammon	SAPM 02238 (LMU 9)	ad	m	-	zoobred
Ovis ammon	SAPM 02235 (LMU 6)	ad	f	Munich Zoo	zoobred
Ovis ammon	SAPM 02237 (LMU 8)	ad	f	Munich Zoo	zoobred
Ovis ammon	SAPM 02236 (LMU 7)	sub	m	Munich Zoo	zoobred
Ovis ammon	SAPM 02230 (LMU 1)	sub	m	Munich Zoo	zoobred
Ovis ammon	SAPM 02232 (LMU 3)	sub	f	Munich Zoo	zoobred
Ovis ammon mongolica	MNHN 1876-524	sub	f	Mogolia	captured wild
Ovis ammon littledalii	MHJ ohne, O am ltld 1	ad	m	Altai Mountains	captured wild
Ovis ammon littledalii	MHJ 218, O am ltld 9	ad	f	Altai Mountains	captured wild
Ovis ammon alt	MHJ 217,O am alt 3	ad	f	Altai Mountains	captured wild
Ovis ammon littledalii	MHJ ohne, O am ltld 2	ad	f	Altai Mountains	captured wild
Ovis ammon littledalii	MHJ 204, O am ltld 7	ad	f	Altai Mountains	captured wild
Ovis pol hein	MHJ 216, O pol hein 1	ad	m	Xinjiang, China	captured wild
Ovis ammon littledalii	MHJ II, O am ltld 3	ad	f	Altai Mountains	captured wild
Ovis ammon altaica	MHJ 163,O am alt 2	sub	m	Altai Mountains	captured wild
Ovis ammon karelini	FMNH 25683	ad	F	Xinjiang Uygur	captured wild
Ovis ammon karelini	FMNH 25684	ad	m	Xinjiang Uygur	captured wild
Ovis ammon karelini	FMNH 25685	ad	m	Xinjiang Uygur	captured wild

Ovis ammon polii	FMNH 25676	ad	m	Xinjiang Uygur	captured wild
Ovis ammon Darwini	USNM 240688	ad	f	Shanxi, China	captured wild
Ovis ammon polii	USNM 62100	ad	f	Turkestan, China	captured wild
Ovis ammon polii	USNM 62101	ad	m	Xinjiang, China	captured wild
Ovis ammon polii	USNM 62096	ad	m	Taqdum bash Pamir, USSR	captured wild
Ovis ammon darvini	MCZ 19941	ad	m	Shanxi, China	captured wild
Ovis ammon darvini	MCZ 19940	ad	m	Shanxi, China	captured wild
Ovis ammon darvini	MCZ 19942	ad	-	Shanxi, China	captured wild
Ovis ammon darvini	AMNH 45490	ad	m	China	captured wild
Ovis ammon darvini	AMNH 45492	ad	m	Shanxi, China	captured wild
Ovis ammon darvini	AMNH 45493	sub	m	Shanxi, China	captured wild
Ovis ammon darvini	AMNH 45494	sub	m	Shanxi, China	captured wild
Ovis ammon polii	AMNH 54931	sub	m	Thai Shan Mountains	captured wild
Ovis ammon polii	AMNH 54865	ad	m	Russian Pamirs	captured wild
Ovis ammon polii	AMNH 54867	ad	m	Russian Pamirs	captured wild
Ovis ammon polii	AMNH 54873	ad	m	Russian Pamirs	captured wild
Ovis ammon polii	AMNH 54874	sub	m	Russian Pamirs	captured wild
Ovis ammon polii	AMNH 54875	ad	f	Russian Pamirs	captured wild
Ovis ammon polii	AMNH 54881	sub	m	Russian Pamirs	captured wild
Ovis ammon cycloceros	SAPM 01752 (LMU 1)	ad	f	Munich Zoo	zoobred
Ovis ammon cycloceros	SAPM 02234 (LMU 5)	ad	f	Munich Zoo	zoobred
Ovis ammon cycloceros	SAPM 01753 (LMU 2)	ad	f	Munich Zoo	zoobred
Ovis arkal	BMN 4830	ad	m	Transcaspian Region	captured wild
Ovis arkal	BMN arkal	ad	-	Central Asia	captured wild
Ovis ammon cycloceros	BMN 83438	ad	f	Berlin Zoo	zoobred

Ovis ammon cycloceros	BMN 83437	sub	m	Berlin Zoo	zoobred
Ovis ammon cycloceros	SAPM 02233 (LMU 4)	sub	m	Munich Zoo	zoobred
Ovis ammon cycloceros	SAPM 02231 (LMU 2)	ad	f	Munich Zoo	zoobred
Ovis vignei cycloceros	MHJ 153/07	ad	m	India	captured wild
Ovis vignei cycloceros	MHJ 430, O ur 26	ad	m	Calcutta: Kolkota, WestBengal, India	captured wild
Ovis vignei cycloceros	MHJ O ur 21	ad	m	India	captured wild
Ovis vignei cycloceros	MHJ 165, O ur 23	ad	m	demoplastic	captured wild
Ovis vignei cycloceros	MHJ 392, O ur 25	ad	m	India	captured wild
Ovis vignei cycloceros	MHJ 161, O ur 22	ad	m	India	captured wild
Ovis vignei/orientalis vignei	AMNH 119526	ad	m	-	captured wild
Ovis vignei vignei	AMNH 54615	ad	f	India: Punjab, Kala Chitta Range, Campbellpore	captured wild
Ovis vignei vignei	AMNH 54616	ad	f	India: Punjab, Kala Chitta Range, Campbellpore	captured wild
Ovis gmelini	MHJ 290, O gml 2	ad	f	Persien durch	captured wild
Ovis gmelini	MHJ O gml 1	ad	m	Persien	captured wild
Ovis anatolicum	MHJ 145/02	ad	m	-	captured wild
Ovis gmelini	LMU Bastam 72(1)	ad	-	Bastam, Iran	captured wild
Ovis gmelini	LMU Bastam 72(2)	ad	-	Bastam, Iran	captured wild
Ovis gmelini	LMU Bastam 78(1)	ad	-	Bastam, Iran	captured wild
Ovis gmelini	LMU Bastam 78(2)	ad	-	Bastam, Iran	captured wild
Ovis gmelini	LMU Bastam	ad	-	Bastam, Iran	captured wild
Ovis gmelini	LMU Bastam Da2	ad	-	Bastam, Iran	captured wild
Ovis gmelini	LMU Bastam 5	ad	-	Bastam, Iran	captured wild
Ovis gmelini	LMU 4 .1(*O. o. gmelini*)	sub	f	Urmiasee	captured wild
Ovis gmelini	LMU 4.2 (*O. o. gmelini*)	ad	f	Urmiasee	captured wild
Ovis gmelini	LMU 4.3 (*O. o. gmelini*)	ad	m	Urmiasee	captured wild
Ovis anatolica	BMN 16329	ad	m	-	-

Ovis orientalis	GCZ MFLN, A.J.L	ad	-	-	captured wild
Ovis orientalis	TBG CP 26	ad	-	-	captured wild
Ovis orientalis	TBG CP 115	ad	-	Mleha U.A.E	captured wild
Ovis aries gmelini	FMNH 98161	ad	m	-	captured wild
Ovis aries gmelini	FMNH 58031	ad	m	-	captured wild
Ovis aries gmelini	FMNH 152005	ad	f	-	captured wild
Ovis aries gmelini	FMNH 152006	ad	f	-	captured wild
Ovis aries gmelini	FMNH 58037	ad	m	-	captured wild
Ovis aries gmelini	FMNH 58033	ad	f	Iran Bijar, NW Iran	captured wild
Ovis aries gmelini	FMNH 58038	ad	f	Iran: Baijar	captured wild
Ovis aries gmelini	FMNH 58039	sub	m	-	captured wild
Ovis aries gmelini	FMNH 58070	ad	f	-	captured wild
Ovis aries gmelini	FMNH 58065	ad	f	-	captured wild
Ovis aries gmelini	FMNH 98162	sub	-	-	captured wild
Ovis aries gmelini	FMNH 58035	ad	m	-	captured wild
O. musimon	BMN 22773	ad	f	-	feral
O. musimon	BMN 22776	ad	m	Hrzana,Sardinia	feral
O. musimon	BMN 41394	-	f	Corsica	feral
O. musimon	BMN 22772	-	f	-	feral
O. musimon	BMN 11527	sub	m	Sardinia	feral
O. musimon	BMN 22771	sub	m	Cyprus	feral
O. musimon	MNHN 1907-579	ad	m	-	feral
O. musimon	MNHN UN 1	ad	-	–	feral
O. musimon	MNHN UN 2	ad	-	–	feral
O. musimon	MNHN 1930-468	ad	M	–	feral
O. musimon	MNHN 1872-19	ad	m	–	feral
O. musimon	MNHN 1987-058	ad	f	–	feral
O. musimon	MNHN 1909-317	sub	m	–	feral
O. musimon	MNHN 1967-924	sub	-	–	feral
O. musimon	MNHN UN 3	ad	f	–	feral
O. musimon	MNHN UN4	ad	-	–	feral
O. musimon	MNHN 1909-307	sub	f	–	feral
O. musimon	SAPM-MA-01987	ad	f	Nürnberg Zoo	zoobred
O. musimon	SAPM-MA-02000	ad	m	Nürnberg Zoo	zoobred
O. musimon	SAPM-MA-01976	ad	m	Nürnberg Zoo	zoobred

O. musimon	SAPM-MA-01990	ad	m	Nürnberg Zoo	zoobred
O. musimon	SAPM-MA-01982	sub	m	Nürnberg Zoo	zoobred
O. musimon	SAPM-MA-01998	sub	f	Nürnberg Zoo	zoobred
O. musimon	SAPM-MA-01995	ad	f	Nürnberg Zoo	zoobred
O. musimon	LMU 6	ad	f	Nürnberg Zoo	zoobred
O. musimon	LMU 28	ad	f	Nürnberg Zoo	zoobred
O. musimon	LMU 20	ad	f	Nürnberg Zoo	zoobred
O. musimon	LMU 10	ad	f	Nürnberg Zoo	zoobred
O. musimon	LMU 12	sub	m	Nürnberg Zoo	zoobred
O. musimon	BMN IIA 1502	ad	f	zoo in the US	zoobred
O. musimon	BMN 2II 1925	ad	m	zoo in the US	zoobred
O. musimon	BMN 13.VI.1924	ad	m	zoo in the US	zoobred
O. musimon	TBG CP 132	ad	-	zoo in the US	zoobred
O. musimon	TBG CP 133	ad	-	zoo in the US	zoobred
O. musimon	AMNH 6238	sub	-	zoo in the US	zoobred
O. musimon	AMNH 10261	ad	m	zoo in the US	zoobred
O. musimon	AMNH 35478	ad	m	zoo in the US	zoobred
O. musimon	AMNH 35316	ad	-	zoo in the US	zoobred
O. musimon	AMNH 35683	ad	f	zoo in the US	zoobred
O. musimon	AMNH 875CA	ad	m	zoo in the US	zoobred
O. aries	GCZ N75	ad	f	Suffolk, UK	domestic (Soay)
O. aries	GCZ G64	ad	-	Suffolk, UK	domestic (Soay)
O. aries	GCZ 315	ad	f	Suffolk, UK	domestic (Soay)
O. aries	GCZ 404	ad	f	Suffolk, UK	domestic (Soay)
O. aries	GCZ 329	ad	f	Suffolk, UK	domestic (Soay)
O. aries	GCZ 436	ad	f	Suffolk, UK	domestic (Soay)
O. aries	GCZ 394	ad	f	Suffolk, UK	domestic (Soay)
O. aries	GCZ 495	ad	f	Suffolk, UK	domestic (Soay)
O. aries	GCZ 115	sub	-	Suffolk, UK	domestic (Soay)
O. aries	GCZ 435	ad	m	UK	domestic (Soay)
O. aries	GCZ Y1	ad	-	UK	domestic
O. aries	GCZ Y2	sub	-	UK	domestic
O. aries	GCZ Y3	ad	-	UK	domestic
O. aries	GCZ Y4	sub	-	UK	domestic
O. aries	GCZ Y7	ad	-	UK	domestic
O. aries	GCZ Y5	sub	-	UK	domestic
O. aries	GCZ Y28	sub	-	UK	domestic
O. aries	GCZ Y49G6H	ad	-	UK	domestic
O. aries	GCZ DORSET SHEEP	ad	-	Dorset, UK	domestic
O. aries	MHNP 1930-159	ad	m	Quessant	domestic
O. aries	AMNH 17980	ad	f	zoo in the US	domestic
O. aries	AMNH 21528	ad	m	zoo in the US	domestic
O. aries	AMNH 35494	ad	f	zoo in the US	domestic
O. musimon aries	LMU 27	ad	m	Nürnberg Zoo	domestic
O. musimon	LMU 6	ad	f	Nürnberg Zoo	domestic

aries					
O. musimon aries	LMU 60	sub	m	Nürnberg Zoo	domestic
Rambouillet	MHJ O rb 4, 8	ad	m	Halle, Germany	domestic
Rambouillet	MHJ O rb 6, 14/75	ad	f	Halle, Germany	domestic
Rambouillet	MHJ O rb 9, 15/82	ad	m	Halle, Germany	domestic
Rambouillet	MHJ O rb 2, 1	ad	f	Halle, Germany	domestic
Rambouillet	MHJ O rb 18, 432	ad	f	Halle, Germany	domestic
Rambouillet	MHJ O rb 13, 20/75	ad	f	Halle, Germany	domestic
Rambouillet	MHJ O rb 3, 2	ad	f	Halle, Germany	domestic
Rambouillet	MHJ O rb 17,209/76	ad	m	Halle, Germany	domestic
Rambouillet	MHJ O rb 19, 433	ad	m	Halle, Germany	domestic
Rambouillet	MHJ O rb 10, 17/75	ad	f	Halle, Germany	domestic
Rambouillet	MHJ O sfrz m 1	ad	f	Halle, Germany	domestic
Rambouillet	MHJ O rb 7, 14/82	ad	f	Halle, Germany	domestic
Rambouillet	MHJ O rb 5, 13/75	ad	f	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 87, 811/92	ad	f	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 191, 1014/03	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 59,708/90	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 251,1093/02	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 246, 109/97	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 311,1148/06	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 286,1115/97	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 17, 986/06	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 281, 1100/97	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 193, 1015/95	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 126, 902/01	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 200,1030/95	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 155, 978/94	ad	f	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 259, 1093/08	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 116; 885/93	ad	f	Halle, Germany	domestic

Rambouillet× Argali	MHJ O rb/ag 143; 939/01	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 211; 1035/95	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 258; 1093/07	ad	m	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 190; 1014/00	ad	f	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 173; 986/05	ad	f	Halle, Germany	domestic
Rambouillet× Argali	MHJ O rb/ag 95;1892-1895	ad	m	Halle, Germany	domestic

ad: adult; **sub**: sub-adult; **f**: female; **m**: male;

Halle, Germany: the Museum für Haustierkunde "Julius Kühn", Martin-Luther University of Halle-Wittenberg, Germany.

Domestic (Soay): A breed of domestic sheep, which is descended from a population of feral sheep on the island of Soay in St Kilda, and thought as remaining similar to the wild ancestors of domestic sheep[1].

Note:

1. Specimens started with 'LMU' are all SAPM samples. The numbering started with 'LMU' is under the old labelling system.
2. The SAPM samples of Argali are all from zoo animals. Five of them have the record in 1966 and were imported from "Russia" over "Jugoslawia". 'BMN 6391' is a wild animal caught in Western Siberia (Southern Altai), and then sold to Berlin Zoo.
3. The samples labelled with 'LMU4' of Western Asian Mouflon contain two females and one male, which were from wild sheep in Lake Urmiasee, northwest Iran, originally labelled as '*Ovis ammon gmelini'* by Professor Boessneck. As discussed in Chapter 4, there are confusions in the use of nomenclature of the different species of *Ovis* and these specimens should be labelled as *Ovis orientalis gmelinii* instead of *Ovis ammon*.
4. The MNB specimens of Western Asian Mouflon were originated from Taurus Mountain in Turkey, which was originally labelled as '*Ovis vignei*' but this should be a mistake because *'vignei'* represent the wild sheep in central Asia.
5. Two samples from BMN collection were labelled as '*arkal*', which is a term proposed by Eversmann in 1850 for the wild sheep distribute Iran, Kirgizstan, Turkmenistan, Uzbekistan, and thus put into the group of Western Asian Mouflon.

[1]Ryder, M.L., 1981, October. A survey of European primitive breeds of sheep. In *Annales de génétique et de sélection animale* (Vol. 13, No. 4, p. 381). BioMed Central.

6. Specimen ‘GCZ MFLN, A.J.L’ is from a wild Mouflon from west Asia, belonging to Professor Tony Legge’s personal collection formally held in Grahame Clark Laboratory.
7. Zoo European Mouflons of SAPM collection are all from Nürnberg zoo, being labelled as ‘*Ovis orientalis’*. They were kept in the Zoo since long before World War2nd, and all descend from two males and three females from a forestry district near Ingolstadt (Bavaria). Documentation only started end of the 1950s, and there is no information on their origin. It is likely that these are descended from animals introduced into Europe in earlier times and are therefore considered as Europen mouflon.
8. Parts of the BMN individuals of European Mouflon have been collected in the wild in Sardinia and Corsica. The others descended from such populations but were raised in the zoo. The MNHN samples of European Mouflon are all originally from Corsica.
9. Some specimens of European domestic country sheep of unknown sources in Grahame Clark Laboratory (number started with GCZ) are old specimens and should be the normal country sheep in England. In addition, the skeletons of domestic soay sheep breeds in the collection of the Grahame Clark Laboratory were taken. Domestic soay sheep samples are from Suffolk, England, raised from the soay sheep breed. Three domestic sheep housed in the SAPM collections are from Nürnberg Zoo and were labelled as *Ovis musimon aries*, which should be the domestic sheep descended from the *Ovis orientalis musimon*.

Appendix C Registry Information of Modern non-Ovis Caprinae and Gazella Specimens

Label Name	Specimen Number	Age	Sex	Origin	Status
Pseudois nayaur	LMU 1	ad	m	zoo in Germany	zoobred
Pseudois nayaur	LMU 2	ad	f	zoo in Germany	zoobred
Pseudois nayaur	MNHN 1966-136	sub	m	zoo in Germany	zoobred
Pseudois nayaur	MNHN 1971-245	sub	f	zoo in Germany	zoobred
Pseudois nayaur	BMN 68734	ad	f	Himalaya	captured wild
Pseudois nayaur	NHML 1854	ad	m	zoo in France	zoobred
Pseudois nayaur	MNHN 1972-92	ad	f	zoo in France	zoobred
Pseudois nayaur	MNHN 1972-92a	ad	f	zoo in France	zoobred
Pseudois nayaur	MNHN 1991-641	ad	f	zoo in France	zoobred
Pseudois nayaur	MNHN 1985-055	ad	f	zoo in France	zoobred
Pseudois nayaur	MNHN 1996-2097	ad	-	zoo in France	zoobred
Pseudois nayaur	MNHN 1896-696	ad	f	zoo in France	zoobred
Pseudois nayaur	MNHN 1995-197	ad	m	zoo in France	zoobred
Pseudois nayaur	SMTD 14576	ad	f	zoo in France	zoobred
Pseudois nayaur	NHML 70-190	ad	-	zoo in France	zoobred
Pseudois nayaur	MNHN 1968-766	sub	m	zoo in France	zoobred
Pseudois nayaur	BMN 14738	sub	m	zoo in France	zoobred
Pseudois nayaur	BMN 43037	sub	m	zoo in France	zoobred
Pseudois nayaur	NHMW 32972	sub	m	zoo in France	zoobred
Pseudois nayaur	LMU 4	sub	f	Nepal	captured wild
Pseudois nayaur	BMN 68734	sub	f	Berlin zoo	zoobred
Pseudois nayaur	MNHN 2005-569	sub	-	Himalaya	captured wild
Pseudois nayaur	BMN 68737	sub	f	Himalaya	captured wild
Pseudois nayaur	BMN 68736	sub	m	Himalaya	captured wild
Pseudois nayaur	MNHN 1902-412	sub	-	zoo in France	zoobred
Pseudois nayaur	LMU 3	sub	m	Nepal	captured wild
Pseudois nayaur	LMU 5	sub	f	Nepal	captured wild
Pseudois nayaur	BMN 68735	sub	-	Berlin zoo	zoobred
Pseudois nayaur	BMN 83323	juv	f	Berlin zoo	zoobred
Pseudois nayaur	BMN 43038	juv	f	-	captured wild
Pseudois nayaur	BMN 68733	juv	-	Berlin zoo	zoobred
Pseudois nayaur	USNM 258665	ad	m	Sichuan, China	captured wild
Pseudois nayaur	USNM 258661	ad	m	Sichuan, China	captured wild
Pseudois nayaur	USNM 258662	ad	f	Sichuan, China	captured wild
Pseudois nayaur	USNM 258663	ad	f	Bhutan	captured wild
Pseudois nayaur	USNM 395251	ad	f	Ningxia,China	captured wild

Pseudois nayaur	USNM 240681	ad	-	-	captured wild
Pseudois nayaur	AMNH 22786	ad	m	zoo in the US	zoobred
Pseudois nayaur	AMNH 22787	ad	m	zoo in the US	zoobred
Pseudois nayaur	AMNH 22812	ad	-	zoo in US	zoobred
Nemorhaedus goral	BMN 83318	ad	f	Beijing zoo	zoobred
Nemorhaedus goral	BMN 14451	ad	f	Berlin zoo	zoobred
Nemorhaedus goral	BMN 70589	sub	-	Himalaya	captured wild
Nemorhaedus goral	BMN 70589 (2)	juv	-	Himalaya	captured wild
Nemorhaedus goral	BMN 70721	ad	m	Berlin zoo	zoobred
Nemorhaedus goral	BMN 70035	ad	f	Berlin zoo	zoobred
Nemorhaedus	FMNH 36788	ad	m	Sichuan, China	captured wild
Nemorhaedus	FMNH 26922	ad	-	Kashmir	captured wild
Nemorhaedus	FMNH 26921	ad	-	Kashmir	captured wild
Nemorhaedus	FMNH 36786	ad	m	Kashmir	captured wild
Nemorhaedus	USNM 259398	ad	m	Sichuan, China	captured wild
Nemorhaedus	USNM 258677	ad	f	Sichuan, China	captured wild
Nemorhaedus	USNM 259390	ad	f	Sichuan, China	captured wild
Nemorhaedus	USNM 259396	ad	m	Wenchuan, China	captured wild
Nemorhaedus	USNM 259397	ad	f	Sichuan, China	captured wild
Nemorhaedus	USNM 259023	ad	f	Sichuan, China	captured wild
Nemorhaedus	USNM 258678	ad	m	Wenchuan, China	captured wild
Nemorhaedus	USNM 20934	ad	m	Japan	captured wild
Nemorhaedus	USNM 259399	ad	f	Sichuan, China	captured wild
Nemorhaedus	AMNH 43004	ad	m	Yunnan,China	captured wild
Nemorhaedus	AMNH 43001	ad	-	Yunnan,China	captured wild
Nemorhaedus	AMNH 40995	ad	m	Yunnan,China	captured wild
Nemorhaedus	AMNH 110481	ad	m	Sichuan, China	captured wild
Nemorhaedus cinereus	MNHN 1896-693	sub	-	zoo in France	zoobred
Nemorhaedus cinereus	MNHN 1896-692	ad	-	zoo in France	zoobred
Nemorhaedus griseus	MNHN 1962-197	ad	f	Sichuan, China	wild
Nemorhaedus caudatus	MNHN 1913-728	juv	-	Sichuan, China	wild
Nemorhaedus goral	MNHN 1963-320	ad	m	zoo in France	zoobred
Nemorhaedus goral	MNHN 1962-153	ad	f	zoo in France	zoobred
Nemorhaedus goral	MNHN 1966-198	sub	f	zoo in France	zoobred
Nemorhaedus	MNHN 1877-574	sub	-	Japan	captured wild

crispus					
Nemorhaedus	AMNH 165685	ad	f	Taiwan	captured wild
Nemorhaedus	AMNH 184946	sub	-	Taiwan	captured wild
Capricornis	AMNH 165683	ad	f	Japan, Honshu Island	captured wild
Capricornis	FMNH 36783	ad	-	Sichuan	captured wild
Capricornis	FMNH 31137	ad	f	Sichuan	captured wild
Capricornis	FMNH 114389	ad	f	Nepal	captured wild
Capricornis	USNM 258653	ad	f	Wenchuan, China	captured wild
Capricornis	USNM 258670	ad	m	Wenchuan, China	captured wild
Capricornis	USNM 152165	ad	f	Gansu, China	captured wild
Capricornis	USNM 259025	ad	m	Sichuan, China	captured wild
Capricornis	USNM 259404	sub	m	Sichuan, China	captured wild
Capricornis	USNM 258671	ad	m	Sichuan, China	captured wild
Capricornis	USNM 258831	ad	m	Wenchuan, Sichuan	captured wild
Capricornis	USNM 258832	ad	m	Sichuan, China	captured wild
Capricornis	USNM 258833	ad	m	Sichuan, China	captured wild
Capricornis	AMNH 115578	sub	m	Burma, Ngawchaung	captured wild
Capricornis	AMNH 43037	ad	m	Yunnan, China	captured wild
Capricornis	AMNH 54614	ad	f	India. Kashmir Valley	captured wild
Capricornis	AMNH 54613	sub	f	India. Kashmir Valley	captured wild
Capricornis	BMN 47492	ad	-	Berlin zoo	zoobred
C. crispus (Japan serow)	BMN 7476	sub	m	Berlin zoo	zoobred
C. milneedwardsii	MNHN 1874.283	ad	-	China	captured wild
C. milneedwardsii	MNHN 1919.28	juv	-	China	captured wild
C. milneedwardsii	MNHN 1902-411	ad	-	China	captured wild
Capricornis sumatraensis	MNHN 1937-314	sub	-	zoo in France	zoobred
Capricornis milneedwardsii	MNHN 1901-1350	ad	-	zoo in France	zoobred
Capricornis marihmus	MNHN 1886-1241	ad	-	zoo in France	zoobred
C. sumatrensis	CMZ H25602	ad	-	zoo in UK	zoobred
Capra hircus	LMU 30	ad	f	Germany	domestic
Capra hircus	LMU 18	ad	m	Germany	domestic
Capra hircus	LMU 48	ad	m	Germany	domestic
Capra hircus	LMU 3	ad	f	Germany	domestic
Capra hircus	GCZ 25	ad	-	Germany	domestic
Capra hircus	LMU 7	ad	f	Germany	domestic
Capra hircus	LMU 10	sub	m	Germany	domestic
Capra hircus	LMU 8	sub	m	Germany	domestic

Capra hircus	LMU 5	sub	f	Germany	domestic
Capra hircus	LMU 2	sub	f	Germany	domestic
Capra hircus	LMU 14	juv	-	Germany	domestic
Capra hircus	LMU 51	juv	f	Germany	domestic
Capra hircus	LMU 47	juv	m	Germany	domestic
Capra hircus	LMU 31	juv	f	Germany	domestic
Capra hircus	LMU 28	juv	f	Germany	domestic
Capra hircus	LMU 39	sub	f	Germany	domestic
Capra hircus	LMU 50	juv	f	Germany	domestic
Capra hircus	LMU 17	sub	-	Germany	domestic
Capra hircus	LMU 34	ad	m	Germany	domestic
Capra hircus	GCZ we wild	ad	-	Germany	domestic
Capra hircus	GCZ 1	ad	-	Germany	domestic
Capra hircus	LMU Bastam	ad	-	Germany	domestic
Capra hircus	GC Y1	ad	-	Germany	domestic
Capra hircus	LMU 1	ad	f	Germany	domestic
Capra hircus	LMU 3	ad	f	Germany	domestic
Capra hircus	GCZ 207	juv	-	Germany	domestic
Capra hircus	GCZ 154	juv	-	Germany	domestic
Capra hircus	GCZ 167	juv	-	Germany	domestic
Capra hircus	GCZ 537	ad	-	Germany	domestic
Capra hircus	GCZ 26141	ad	-	Germany	domestic
Capra sibirica	BMN 68477	sub/ad	-	Tscholesmantal, Altai Mts., Western Siberia/UdSSR	captured wild
Capra sibirica	BMN 68437	ad	-	Teletzker Berge, Altai/Russland	captured wild
Capra sibirica	BMN 68435	juv	-	Tscholesmantal/UdSSR	captured wild
Capra sibirica	BMN 20.X. 1906	sub	-	Narynsk 4. Kriegerowski	captured wild
Capra sibirica	BMN 20.X. 1906(2)	sub	-	Narynsk 4. Kriegerowski	captured wild
Capra sibirica	fMNH 25652	ad	m	China: Xinjiang	captured wild
Capra sibirica	fMNH 134540	ad	m	Zoo in Asia	zoobred
Capra sibirica	fMNH 134541	ad	f	Zoo in Asia	zoobred
Capra sibirica	USNM 062090	juv	f	China: Xinjiang	captured wild
Capra sibirica	USNM 062089	ad	m	China: Xinjiang	captured wild
Capra sibirica	USNM 062092	ad	f	Turkestan: Taqdumbach Pamir	captured wild
Capra sibirica	USNM 0620893	ad	m	Xinjiang, China	captured wild
Capra sibirica	USNM 062091	ad	m	Xinjiang, China	captured wild
Capra sibirica	USNM 021846/A36566	ad	m	Baltistan,Pakistan	captured wild
Capra sibirica	USNM 015457/A22302	ad	m	-	-
Capra sibirica	USNM 267940	ad	m	National zoological park in US	zoobred

Capra sibirica	USNM 257969	ad	m	-	-
Capra sibirica	AMNH 54901	sub	f	Tianshan Mountains	captured wild
Capra sibirica	AMNH 54902	ad	f	Tianshan Mountains	captured wild
Capra sibirica	AMNH 54904	sub	f	Tianshan Mountains	captured wild
Capra sibirica	AMNH 54905	ad	m	Tianshan Mountains	captured wild
Capra sibirica	AMNH 54907	ad	m	Tianshan Mountains	captured wild
Capra sibirica	MNHN 1964-404	ad	m	-	-
Capra sibirica	MNHN 1974-116	ad	f	-	-
Capra sibirica	MNHN 1932-509	ad	m	-	-
Procapra gutturosa	LMU 1	ad	m	zoo in Germnany	zoobred
Procapra gutturosa	LMU 2	ad	f	zoo in Germnany	zoobred
Gazella gazella	LMU 3	ad	m	zoo in Germnany	zoobred
Gazella dorcas	LMU 3	ad	m	zoo in Germnany	zoobred
Gazella arabica	MNHN 1960-3646	ad	m	-	-
Gazella gazella	MNHN 1991-303	ad	m	-	-
Gazella gazella	MNHN 1998-222	ad	f	-	-
Gazella gazella	MNHN 1992-1844	ad	f	-	-
Gazella sub adgutturosa	MNHN 1988-158	ad	f	-	-
Gazella sub adgutturosa	MNHN 1934-368	ad	f	-	-
Gazella dorcas	MNHN 1961-997	ad	f	-	-
Gazella dorcas	MNHN 1916-22	ad	m	-	-
Gazella dorcas	MNHN 1874-124	ad	m	-	-
Gazella dorcas	MNHN 1906-108	ad	f	-	-
Gazella dorcas	MNHN 1937-1262	ad	f	-	-
Gazella dorcas	MNHN 1909-491	ad	m	-	-
Gazella dorcas	MNHN 1912-415	ad	f	-	-
Gazella arabica	USNM 240986	sub	m	-	-
Gazella arabica	USNM 282355	sub	m	zoo in US	zoobred
Gazella dorcas	USNM 328577	sub	m	Iran	captured wild
Gazella dorcas	USNM 328578	ad	f	Iran	captured wild
Gazella bennettii	USNM 329354	ad	m	Iran	captured wild
Gazella bennettii	USNM 329355	ad	m	Iran	captured wild
Gazella dama ruficollis	USNM 254440	ad	m	-	-
Gazella dama	USNM 543093	ad	m	-	-
Gazella dama	USNM 578578	ad	f	-	-
Gazella dorcas	USNM 544385	sub	f	-	-
Gazella dorcas	USNM 241500	ad	m	-	-
Gazella dorcas	USNM 395622	ad	m	-	-
Gazella dorcas	USNM 395623	ad	f	-	-
Gazella dorcas	USNM 534739	ad	m	-	-

sub: sub-adult; **juv**: juvenile; **ad:** adult; **m**: male; **f**: female

Note:

1. The sample BMN 7476 is *C. crispus*, a Japenese serow, and its size is much smaller than the other samples the originally distributed in China. Therefore it is excluded from the size analysis but still used in the analysis for the shape (ratios of the measurements).
2. 11 specimens of *Gazella* from USNM collections (from USNM 328578 to USNM 534739) were only examined for their osteomorphology of the humerus but were not taken with the measurements.

Appendix D Test of Reliability of the Newly Developed Measurements

The test of the reliability of the measurements consist of two parts: the interrater reliability and intra-rater reliability. The interrater reliability is the one that compares the reliability of measurement from several different analysts, and the intra-rater reliability is a comparison of reliability measures from one analyst performed on several occasions.

In my study, plus myself, altogether six different colleagues participated the test. These people are post-doc researchers or graduate students specialised in zooarchaeology. Each of them took the measurements on a specimen of sheep (*O. aries*), and a specimen of goat (*C. hircus*) held in Grahame Clark Laboratory following the illustrations of the measurements on pictures and descriptions provided by me. The new measurements are DBV and DpBV on distal metapodials, SDp, BFpl, and Dp on the radius, LGm on the scapula, Ddl, Bd, Dlda, Dldb, and Bd on distal tibia, LC on the proximal femur (Table D.1). In addition, I have taken these measurements on the same sheep and goat specimen for nine times, and there is a half-day interval between each time of taking the measurements (Table D.2). Due to an unexpected occasion, the measurement of Dd on distal phalanges 1 could not be used.

Specimen	Measurement	Maya	Tansy	Ningning	Preston	Roder	Yiru
Ovis mc	DBV	12.00	11.65	12.00	12.70	12.20	11.64
Ovis mc	DpBV	12.35	13.25	12.18	13.40	13.60	12.93
Capra mc	DBV	15.47	15.27	15.19	16.05	15.60	15.27
Capra mc	DpBV	18.08	17.96	16.99	17.95	17.70	18.70
Ovis mt	DBV	11.43	11.31	11.38	11.90	11.80	11.30
Ovis mt	DpBV	10.72	11.90	10.95	12.30	11.80	11.30
Capra mt	DBV	11.57	11.35	11.77	12.40	11.70	11.22
Capra mt	DpBV	13.55	13.93	13.16	14.40	19.30	14.20
Ovis scapula	LGm	23.76	24.08	23.87	23.20	22.00	24.02
Capra scapula	LGm	21.80	21.72	21.36	21.40	21.60	21.66
Ovis radius	BFpl	6.64	7.66	6.44	8.40	9.60	7.50
Ovis radius	SDp	7.60	9.38	8.51	9.70	9.10	9.69
Ovis radius	Dp	16.01	15.91	15.92	15.90	16.10	15.82
Capra radius	BFpl	6.42	6.70	6.48	10.10	7.00	7.72
Capra radius	SDp	7.96	8.04	8.20	7.70	7.70	7.61
Capra radius	Dp	15.37	14.83	15.21	14.40	15.10	15.57
Ovis femur	LC	25.69	-	24.14	23.60	25.30	26.02
Capra femur	LC	21.35	20.15	18.86	21.60	20.90	21.90
Ovis tibia	Bd	25.49	25.19	24.94	25.30	25.40	25.09
Ovis tibia	Ddl	17.10	16.86	16.99	16.60	17.00	17.28
Ovis tibia	Dlda	4.94	4.15	4.72	5.00	5.40	5.12

Ovis tibia	Dldb	4.97	7.49	7.14	6.30	6.60	7.61
Capra tibia	Bd	25.62	25.11	25.86	25.10	24.40	25.10
Capra tibia	Ddl	16.86	16.83	18.89	16.60	16.90	17.24
Capra tibia	Dlda	8.07	4.03	4.87	6.50	5.50	6.24
Capra tibia	Dldb	8.75	8.05	6.67	6.20	6.90	7.87

Table D.1 New measurements taken by six different colleagues on a sheep and goat specimen at Grahame Clark laboratory. **Ovis**: *O. aires*, a domestic sheep sample; **Capra**: *C. hircus*, a domestic goat sample; **mc**: metacarpal; **mt**: metatarsal; See Figure 6.13, pp. 156-157, volume 1, Figure H.2, p. 347, Figure J.2, p. 376, Figure L.2, p. 411, and Figure M2, p. 419, volume 2 of this dissertation for the explanation of the new measurements. **Maya, Tansy, Ningning, Preston, Roder,** and **Yiru** are the names of the different participants who took the measurements. The columns below the names show the measurements taken by the people.

Specimen	**Measurement**	**Yiru-2**	**Yiru-3**	**Yiru-4**	**Yiru-5**	**Yiru-6**	**Yiru-7**	**Yiru-8**	**Yiru-9**
Ovis mc	DBV	11.55	11.76	11.55	11.5	11.7	11.54	11.6	11.58
Ovis mc	DpBV	12.71	12.89	13.11	12.93	13.12	13.01	12.86	12.85
Capra mc	DBV	15.11	15.28	15.19	15.22	15.24	15.24	15.19	15.07
Capra mc	DpBV	18.61	19.05	18.78	18.99	19.03	19.36	19.07	19.25
Ovis mt	DBV	11.2	11.16	11.22	11.22	11.28	11.4	11.1	11.21
Ovis mt	DpBV	11.21	11.19	11.36	11.33	11.29	11.17	10.98	11.33
Capra mt	DBV	11.21	11.38	11.19	11.32	11.28	11.34	11.21	11.28
Capra mt	DpBV	14.03	14.12	13.96	13.73	14.09	14.29	13.92	13.79
Ovis radius	BFpl	7.69	7.25	7.51	7.71	7.81	7.81	7.24	7.41
Ovis radius	SDp	9.44	9.23	9.34	9.26	9.53	9.33	9.38	9.45
Ovis radius	Dp	15.88	15.89	15.88	15.85	15.87	15.9	15.66	15.88
Capra radius	BFpl	7.78	7.73	7.92	7.7	7.85	7.92	8.07	8.22
Capra radius	SDp	7.82	7.66	7.92	7.72	8.03	7.93	8.08	7.9
Capra radius	Dp	15.3	15.73	15.76	15.66	15.52	15.58	15.64	15.71
Ovis scapula	LGm	23.73	23.74	23.9	23.65	24.12	23.78	23.45	23.19
Capra scapula	LGm	21.37	21.46	22.03	22.28	22.29	21.79	22.18	21.43
Ovis tibia	Bd	24.77	24.91	25.03	25.2	25.14	25.02	25.27	25.09
Ovis tibia	Ddl	16.93	17.1	17.28	17.22	17.29	17.19	17.24	17.27
Ovis tibia	Dlda	5.35	5.46	5.24	5.46	5.4	5.39	5.25	5.59
Ovis tibia	Dldb	8.08	8.17	8.45	8.41	8.48	8.69	8.51	8.66
Capra tibia	Bd	25.4	25.23	25.05	25.34	25.29	25.34	25.17	25.37
Capra tibia	Ddl	17.28	17.38	17.31	17.35	17.34	17.32	17.33	17.38
Capra tibia	Dlda	6.37	6.34	6.69	6.16	6.17	6.19	6.16	6.01
Capra tibia	Dldb	8.49	8.55	7.44	8.26	8.4	8.06	7.96	8.05
Ovis femur	LC	25.85	25.65	25.41	25.06	25.72	25.72	25.7	25.87
Capra femur	LC	21.51	20.9	21.62	21.15	21.53	21.34	21.42	21.4

Table D.2 Eight times of measurements taken by Yiru Wang on a sheep and goat specimen at Grahame Clark laboratory.**Ovis**: *O. aires*, a domestic sheep sample; **Capra**: *C. hircus*, a domestic goat sample; **mc**: metacarpal; **mt**: metatarsal; See Figure 6.13, pp. 156-157, volume 1, Figure H.2, p. 347, Figure J.2, p. 376, Figure L.2, p. 411, and Figure M2, p. 419, volume 2 of this dissertation for the explanation of the measurements. **Yiru-2** is the second time of measurement taken by Yiru Wang. **Yiru-3, Yiru-4, Yiru-5, Yiru-6, Yiru-7, Yiru-8** are of

the same logic (e.g. **Yiru-8** is the eighth time of measurement taken by Yiru Wang).

SPSS was used to perform the intraclass correlation coefficient (ICC) to test both interrater reliability and intrarater reliability. An ICC is measured on a scale from 0 to 1. 1 represents perfect reliability with no measurement error, whereas 0 indicates no reliability.

The results are shown in Table D.3 and D.4.

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.982[b]	.969	.991	278.017	24	96	.000
Average Measures	.996[c]	.994	.998	278.017	24	96	.000

Table D.3 Information relating to the Interclass Correlation Coefficient2

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.999	.998	.999	9.203E3	25	208	.000
Average Measures	1.000	1.000	1.000	9.203E3	25	208	.000

Table D.4 Information relating to the Intraclass Correlation Coefficient3

As can be seen, the estimated reliability between the analysts is 0.982, with 95% CI (0.969, 0.991), and the reliability of myself is 0.999, with 95% CI (0.998, 0.999). Hence, there is evidence that the repeatability of the measurements between different analysts is lower than the repeated measurements by myself, which is quite high. This could be due to many factors including familiarity with those measurements. However, in general, it could be considered that the repeatability of these measurements is acceptable, especially the intrarater reliability of myself. Nevertheless, this is only one way of performing the test of reliability, and there are a lot of many others which may show different results.

[2]Two-way mixed model is selected, whereas the people effects are ramdom and measures effects are fixed.

[3]One-way random effects model is selected, where people effects are random.

Appendix E Measurements Taken on the Modern Specimens of None-Ovis Caprinae and Gazella

1. Measurements Taken on Distal Humerus

Species	Specimen number	Age	Sex	Bd	Bt	Ht	SHT	BTM	BTl	LHT
Pseudois nayaur	LMU 1	ad	m	39.50	38.33	23.68	16.00	23.14	13.69	15.30
	LMU 2	ad	f	38.00	37.20	24.70	15.50	23.05	12.90	16.30
	BMN 68734	ad	f	38.10	36.30	22.20	16.40	22.80	11.40	17.60
	NHML 1854	ad	m	37.30	35.80	-	-	-	-	-
	MNHN 1972-92	ad	f	38.20	36.20	22.60	16.70	23.30	12.00	15.50
	MNHN 1972-92a	ad	f	36.73	35.77	21.60	16.03	22.34	12.50	14.84
	MNHN 1991-641	ad	f	39.40	37.40	23.50	17.40	24.90	12.60	17.10
	SMTD 14576	ad	f	39.40	38.20	25.40	17.90	25.80	12.30	18.70
	NHML 70-190	ad	-	36.60	35.90	-	-	-	-	-
	MNHN 1995-197	ad	m	42.24	39.41	25.72	18.55	27.32	11.35	17.17
	MNHN 1996-2097	ad	-	36.62	34.77	22.18	16.49	22.05	11.53	15.14
	MNHN 1966-136	sub	m	38.50	35.99	23.30	17.20	24.20	11.20	15.30
	MNHN 1971-245	sub	m	38.06	35.85	22.02	17.10	24.20	11.60	15.10
	MNHN 1968-766	sub	m	39.50	37.30	24.20	18.30	24.90	11.30	15.70
	BMN 14738	sub	m	36.20	34.00	21.40	15.30	22.70	9.40	14.70
	BMN 43037	sub	m	-	-	17.40	14.40	19.50	9.50	13.30
	NHMW 32972	sub	m	40.50	39.20	25.00	17.90	24.80	13.30	16.80
	LMU 4	sub	f	34.20	32.70	20.10	14.30	22.60	9.40	14.70
	BMN 68734	sub	f	38.10	36.30	22.20	16.40	22.80	11.40	17.60
	MNHN 2005-569	sub	-	32.58	31.34	18.30	13.38	20.69	10.00	12.99
	BMN 68737	sub	f	36.98	35.31	23.90	17.00	23.19	10.18	15.43
	BMN 68736	sub	m	40.40	39.10	24.90	17.60	25.40	12.30	16.70

	LMU 3	sub	m	36.40	34.85	21.55	14.90	22.80	11.40	14.70
	LMU 5	sub	f	34.20	32.33	20.10	14.30	22.60	9.40	14.27
	BMN 68735	sub	-	35.10	34.90	21.70	16.60	22.80	10.60	16.10
	BMN 83323	juv	f	32.00	32.40	18.70	14.50	22.20	8.40	13.70
	BMN 43038	juv	f	32.90	32.10	19.40	15.20	21.20	9.90	14.60
Capricornis	BMN 47492	ad	m	43.07	42.03	25.38	20.25	28.00	12.91	17.34
	MNHN 1874.283	ad	m	59.39	52.90	32.06	27.27	33.47	15.99	20.58
	CMZ H25602	ad	-	-	43.97	26.14	-	-	-	-
	FMNH 114384	ad	F	51.87	47.36	30.13	23.54	30.38	13.73	17.69
	USNM 258653	ad	f	56.76	49.55	33.28	25.97	33.33	14.26	22.46
	USNM 258670	ad	m	52.77	49.52	32.40	24.70	32.76	14.33	18.90
	USNM 152165	ad	f	53.97	51.10	33.83	27.92	33.14	15.26	21.21
	USNM 259025	ad	m	58.22	50.18	31.20	24.40	31.59	15.69	20.32
	USNM 259404	ad	m	48.01	44.95	30.64	24.40	30.09	14.15	17.39
	AMNH 43037	ad	m	49.19	46.83	29.73	23.83	30.89	13.77	20.55
	AMNH 54614	ad	f	50.65	47.47	30.78	23.59	30.37	15.22	19.80
	MNHN 1937-314	sub	f	41.20	39.30	26.61	21.16	24.57	12.54	16.07
	AMNH 115578	sub	m	46.87	43.07	26.19	21.64	27.32	14.52	16.30
	AMNH 54613	sub	f	45.67	43.11	25.64	20.58	27.38	13.78	17.22
	MNHN 1919.28	juv	-	44.45	43.18	25.34	22.32	28.04	13.39	17.89
	BMN 7476	juv	m	32.96	32.00	19.55	16.03	20.44	10.74	10.96
Nemorhaedus goral	BMN 83318	ad	f	31.08	29.02	19.11	15.23	17.63	10.49	11.78
	BMN 70035	ad	f	32.01	30.72	19.95	16.37	19.76	10.08	11.63
	BMN 14451	ad	f	30.60	28.71	17.74	14.72	18.83	8.63	11.39
	BMN 70721	ad	m	36.01	30.96	19.76	16.18	20.50	9.41	13.17
	MNHN 1963-320	ad	m	30.02	28.02	18.71	14.53	17.79	9.24	12.21
	MNHN 1962-153	ad	f	31.05	29.53	17.51	15.12	18.50	9.94	10.88
	BMN 70589	sub	-	30.54	28.19	17.47	14.10	18.10	9.26	10.99
	MNHN 1966-198	sub	f	31.92	28.76	18.96	15.63	18.21	9.28	11.63
	FMNH 36922	ad	-	33.57	30.72	18.78	15.18	20.20	8.95	12.22

	FMNH 26921	ad	-	33.00	29.83	19.33	14.51	19.85	9.14	11.48
	FMNH 36786	ad	m	32.79	29.05	17.82	14.44	19.48	8.57	11.14
	USNM 259398	ad	m	34.62	31.60	20.88	15.43	20.45	9.81	11.46
	USNM 258677	ad	f	32.23	29.28	18.97	15.55	17.22	10.58	11.67
	USNM 259390	ad	f	26.68	23.64	16.39	13.30	14.48	7.88	9.28
	USNM 259396	ad	m	31.23	28.72	17.98	14.09	18.75	9.10	11.42
	USNM 259397	ad	f	31.60	29.38	17.69	13.92	18.97	9.72	11.14
	USNM 259023	ad	-	36.42	32.44	19.76	15.54	21.17	9.79	13.07
	USNM 258678	ad	m	34.79	30.22	20.10	16.70	19.69	9.60	12.93
	AMNH 43004	ad	m	33.19	31.37	19.63	15.08	20.03	9.87	12.24
	AMNH 43001	ad	-	35.45	32.96	20.87	16.43	21.01	10.48	13.32
	AMNH 110481	ad	m	34.18	31.93	20.25	15.42	20.47	10.08	11.99
	AMNH 165685	ad	f	33.92	30.68	26.65	20.14	16.08	20.83	9.32
	AMNH 184946	sub		31.17	28.78	24.52	18.49	14.65	18.73	9.01
Capra hircus	LMU 30	ad	f	34.34	30.63	19.07	14.02	19.14	10.73	13.48
	LMU 18	ad	m	36.51	35.07	21.84	-	24.73	9.65	16.15
	LMU 48	ad	m	42.70	39.07	24.41	18.13	25.67	11.98	18.89
	LMU 3	ad	f	32.82	29.59	19.25	15.35	19.05	10.04	13.73
	CBZ 25	ad	-	31.42	28.99	18.14	13.47	19.17	8.54	12.08
	LMU 7	ad	f	36.31	33.68	20.46	15.74	22.03	11.33	15.53
	LMU 10	sub	m	35.29	33.90	21.76	16.62	22.29	10.99	15.08
	LMU 8	sub	m	34.56	33.17	20.10	15.68	21.36	10.62	15.59
	LMU 5	sub	f	34.75	-	20.66	15.05	20.56	10.40	14.42
	LMU 2	sub	f	29.67	28.57	17.18	-	16.95	9.83	11.35
	LMU 14	juv	-	31.73	29.18	18.07	14.24	19.83	8.43	14.17
	LMU 51	juv	f	29.89	28.38	17.76	14.67	18.80	8.54	12.82
	LMU 47	juv	m	30.76	28.11	15.67	11.76	18.09	8.87	10.98
	LMU 31	juv	f	27.18	25.60	14.97	11.80	17.60	7.48	11.21
	LMU 28	juv	f	31.48	29.32	18.89	14.27	19.28	8.61	13.07
	LMU 39	sub	f	34.30	32.45	20.23	15.28	21.63	10.31	13.09

	LMU 50	juv	f	32.03	30.74	19.12	14.31	20.29	9.13	13.43
C. sibirica	BMN 68477	ad	-	43.56	39.67	25.42	18.59	25.20	13.35	17.38
	BMN 68437	ad	-	42.26	40.84	25.68	17.92	-	-	18.45
	BMN 20.X.1906.1	sub	-	47.04	43.69	28.95	20.31	29.58	13.15	20.40
	BMN 20.X.1906.2	sub	-	45.99	42.53	26.52	20.46	29.48	11.42	19.47
	BMN 68453	juv	-	40.03	39.63	21.65	17.05	26.70	12.32	16.15
Gazella gazella	LMU 3	sub	m	22.64	20.21	15.42	10.33	14.42	5.74	10.35
	MNHN 1960-3646	ad	m	25.57	22.55	16.97	12.69	15.56	5.92	10.64
	MNHN 1991-303	ad	m	25.20	23.65	16.82	13.04	15.87	6.70	11.80
	MNHN 1998-222	ad	f	22.19	20.50	16.37	12.26	13.49	6.35	10.96
	MNHN 1992-1844	ad	f	23.97	22.83	16.19	12.87	15.68	6.07	11.92
Gazella subgutturosa	MNHN 1988-158	ad	f	27.20	25.11	18.35	13.64	15.37	8.04	12.70
Gazella dorcas	MNHN 1961-997	ad	f	22.08	19.17	14.08	10.73	12.85	5.99	10.56
	MNHN 1916-22	ad	m	24.47	22.73	16.41	12.35	15.30	6.34	11.34
	MNHN 1874-124	ad	m	23.33	21.26	16.61	12.03	13.95	6.92	11.38
	MNHN 1906-108	ad	f	21.71	19.63	15.04	11.80	13.22	5.96	10.38
	MNHN 1937-1262	ad	f	26.36	24.41	18.04	13.34	16.39	7.15	11.87
	MNHN 1909-491	ad	m	21.32	19.94	15.01	10.69	13.75	5.55	10.83
	MNHN 1912-415	ad	f	22.89	20.73	15.75	12.25	14.35	5.78	11.66
Procapra guttorosa	LMU 1	ad	m	29.20	28.22	19.76	15.40	18.30	9.00	13.80
	LMU 2	ad	f	28.30	28.31	19.95	15.00	17.70	9.20	13.70

2. Measurements Taken on Distal Metacarpal

Species	**Specimen Number**	**Age**	**Sex**	**Bd**	**DBV**	**DpBV**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Pseudois	LMU1	ad	m	32.21	14.61	15.55	15.06	14.51	13.32	20.56	12.59	20.24	16.50	16.36
	LMU2	ad	m	30.14	13.84	14.57	14.65	14.08	13.04	19.85	12.37	19.19	16.20	15.81
	NHML 1845	ad		31.50	-	-	-	-	-	-	12.50	-	-	-

	MHNP 1896-696	ad	f	30.20	13.61	14.64	14.02	13.69	12.40	19.60	11.90	19.20	16.35	16.50
	MHNP 1972-92	ad	f	30.95	14.61	14.55	14.62	14.70	12.80	20.00	12.00	19.30	16.35	16.57
	MHNP 1972-92a	ad	-	28.71	13.17	13.92	13.55	13.02	12.82	19.61	11.53	18.67	16.04	16.07
	MHNP 1991-641	ad	f	31.10	14.23	14.50	15.08	13.92	13.00	21.00	12.00	19.20	16.91	16.09
	MNHN 1996-2097	ad	-	29.24	13.65	13.53	13.85	13.46	12.58	19.74	11.57	19.31	16.32	16.00
	SMTD 14576	ad	f	32.00	-	-	-	-	13.60	19.40	12.30	18.70	-	-
	NHML 70-190	ad	-	29.60	-	-	-	-	-	-	12.70	-	-	-
	MHNP 1995-197	ad	m	34.90	16.51	16.47	15.85	15.68	14.45	21.90	13.14	21.09	19.06	19.09
	USNM 258665	ad	f	29.87	14.02	15.08	13.80	13.62	11.75	18.74	11.72	18.44	15.82	16.14
	USNM 258661	ad	m	34.57	15.92	16.30	15.89	15.84	14.41	21.73	12.96	20.86	18.58	18.24
	USNM 258662	ad	m	33.02	15.67	16.34	14.93	15.17	13.58	21.06	13.32	20.67	17.93	18.07
	USNM 258663	ad	f	28.80	13.72	14.73	13.24	12.93	12.21	19.23	11.38	18.70	16.38	16.13
	USNM 395251	ad	f	27.76	12.81	13.64	12.93	12.69	12.15	17.98	10.87	17.31	14.87	15.25
	USNM 240681	ad	f	25.81	12.48	13.04	12.01	11.72	10.40	16.83	9.56	16.14	13.40	13.26
	MHNP 1966-136	sub	m	32.60	15.90	15.92	15.24	14.87	13.53	19.47	12.76	19.00	16.66	16.54
	MHNP 1971-245	sub	m	30.88	14.67	15.67	14.43	14.53	13.39	20.62	12.41	19.50	16.88	16.71
	MCZ 29959	sub	m	29.53	14.65	14.44	13.12	13.32	12.46	18.76	11.80	18.26	15.87	16.06
	LMU3	sub	m	29.14	13.85	14.96	13.88	13.22	11.79	18.63	10.68	17.90	15.28	15.07
	MHNP 1968-766	sub	m	33.90	15.42	15.49	14.89	14.44	13.60	21.00	12.90	20.10	17.52	17.05
	MNB 14783	sub	m	30.20	-	-	-	-	11.90	18.20	11.10	17.60	-	-
	MNB 43037	sub	m	26.00	-	-	-	-	10.60	17.20	10.00	16.30	-	-
	NHMW 32972	sub	m	32.00	-	-	-	-	13.50	20.70	12.40	20.00	-	-
	LMU 4	sub	f	28.00	-	-	-	-	12.10	17.70	11.30	17.30	-	-
	MHNP 1902-412	sub	-	30.10	12.85	13.05	12.98	13.14	12.60	18.80	11.40	18.70	15.30	15.87
	MNB 43038	juv	m	29.60	-	-	-	-	11.20	17.60	10.40	17.00	-	-
	MNB 83323	juv	f	-	-	-	-	-	11.30	17.90	10.50	17.50	-	-
Capra hircus	LMU3	ad	f	29.07	13.54	16.10	13.24	12.96	10.64	17.61	10.01	17.31	14.30	14.41
	LMU7	ad	f	30.47	13.68	17.00	14.12	13.84	11.52	18.01	10.86	18.12	15.08	15.23
	LMU 14	sub	m	27.70	11.00	15.88	13.54	13.52	10.88	17.59	10.65	17.62	14.68	15.22
	LMU30	ad	f	28.70	12.81	15.29	13.44	12.82	11.63	18.19	10.39	17.23	14.53	14.06

	LMU48	ad	m	35.61	14.98	19.00	16.32	15.93	13.77	20.58	12.62	20.19	16.74	16.87
	LMU74	-	-	-	10.50	15.24	-	-	-	-	-	-	-	-
	2G141	ad	-	27.09	11.61	14.50	12.58	12.38	10.44	16.83	9.66	16.65	13.50	13.66
	GC1	ad	-	30.00	13.80	15.32	13.72	13.82	10.97	17.96	10.47	17.87	14.75	14.95
	LMU 18	ad	m	31.18	14.01	17.49	14.06	14.21	11.88	19.45	11.50	19.35	15.70	16.42
	LMU 2	sub	f	25.90	12.25	15.28	11.79	11.28	10.03	-	9.62	16.66	14.24	-
	LMU 17	sub	-	23.69	10.52	12.81	11.05	10.49	9.17	14.78	8.54	14.55	12.36	12.49
	LMU Bastam	ad	-	35.49	16.70	18.62	16.94	16.50	14.36	-	13.16	-	17.79	-
	LMU 34	juv	m	30.87	14.06	18.01	14.56	13.68	11.19	19.11	10.94	18.66	14.89	14.86
	LMU 47	juv	m	25.36	12.18	13.84	11.41	10.95	9.26	14.91	8.32	14.56	11.73	11.75
	GC Y1	ad	-	25.08	11.31	14.13	11.53	11.38	9.22	16.20	8.57	15.92	13.23	13.35
	LMU 1	ad	f	29.36	13.41	15.56	13.15	13.05	11.46	17.28	10.89	16.76	14.65	14.69
	LMU 3	ad	f	23.97	10.92	12.73	11.19	10.68	8.79	14.76	8.24	14.53	11.79	11.91
	LMU 28	sub	f	27.41	12.62	14.24	13.01	12.44	10.37	16.61	9.51	16.02	13.32	13.12
	LMU 50	sub	f	27.14	11.99	15.91	12.82	12.31	11.28	18.64	10.09	17.60	15.24	15.11
Gazella dorcas	LMU 3	sub	m	17.47	7.76	7.45	7.80	7.99	11.09	14.42	10.53	14.27	-	-
	MHNP 1906-108	ad	f	16.42	7.92	7.44	7.72	7.79	10.49	13.97	9.90	13.88	12.00	11.97
	MHNP 1874-124	ad	m	17.56	8.30	7.14	8.23	8.02	10.65	13.93	10.25	13.76	12.44	12.90
	MHNP 1916-22	ad	m	17.88	8.58	7.56	8.13	8.28	10.74	14.45	10.52	14.28	12.74	12.74
	MHNP 1961-997	ad	f	15.06	6.98	6.46	6.94	6.89	8.87	12.29	9.44	12.40	10.96	11.05
	MHNP 1937-1262	ad	f	20.08	9.34	8.57	9.20	9.15	11.76	15.12	11.47	15.25	13.45	13.73
	MHNP 1909-491	ad	m	16.41	8.08	6.96	7.40	7.48	10.48	13.68	9.93	13.47	11.99	12.12
	MHNP 1972-415	ad	f	17.03	8.02	7.21	7.71	7.98	10.82	14.23	10.39	13.92	12.31	12.57
Gazella gazella	LMU 3	ad	m	17.61	8.11	8.00	7.70	7.87	10.43	13.30	9.82	13.27	-	-
	MHNP 1960-3646	ad	m	19.68	8.92	7.69	8.83	9.07	11.74	14.80	11.32	15.07	13.11	13.23
	MHNP 1992-1844	ad	f	19.54	9.65	7.69	9.00	8.98	10.57	13.57	10.04	13.50	11.67	11.89
	MHNP 1998-222	ad	f	17.06	7.62	7.24	7.83	8.07	9.87	13.25	9.72	13.27	11.67	11.83
	MHNP 1991-303	ad	m	19.95	9.93	7.79	8.90	8.96	11.28	14.36	10.75	14.32	12.50	12.81
Gazella subgutturosa	MHNP 1988-158	ad	f	19.67	9.86	9.10	8.94	9.01	11.99	15.34	11.28	15.15	13.88	14.03
	MHNP 1934-368	ad	f	17.74	8.68	7.33	8.12	7.96	9.78	13.30	9.25	13.11	11.62	11.67

Procarpa gutturosa	LMU 1	ad	m	21.50	10.60	10.00	10.00	9.80	14.30	17.50	13.20	17.20	16.00	16.10
	LMU 2	ad	f	21.60	10.10	9.90	10.10	9.90	13.60	16.90	12.60	16.70	15.50	15.80
Nemorheadus goral	BHM 83318	ad	-	27.54	17.92	16.31	12.28	12.12	9.74	15.37	9.23	14.98	13.64	13.48
	BHM 70589	sub	-	25.44	12.53	13.10	11.54	11.75	10.28	15.75	9.70	15.47	13.95	13.77
	BHM 14451	ad	f	26.34	12.69	13.13	11.81	11.99	9.99	15.77	9.42	15.05	13.85	13.58
	BHM 70035	ad	f	27.21	13.05	12.19	12.79	12.45	11.04	17.46	10.43	17.22	15.54	15.39
	MHNP 1896-693	sub	-	28.26	13.56	13.66	13.11	12.86	10.35	16.26	10.16	16.10	14.54	14.43
	MHNP 1896-692	ad	-	26.94	13.39	11.74	12.39	12.17	10.68	16.58	10.24	16.33	15.10	15.02
	MHNP 1962-197	ad	f	25.00	12.12	10.98	11.84	11.52	9.84	14.79	8.66	14.15	13.07	13.01
	MHNP 1913-728	sub	-	22.85	10.67	10.47	11.06	10.52	9.38	14.78	8.97	14.54	13.61	13.44
	MHNP 1963-320	ad	m	24.53	11.75	11.25	11.35	11.53	9.72	14.38	9.19	14.46	13.02	13.23
	MHNP 1962-153	ad	f	26.17	12.16	12.22	12.13	12.02	10.63	15.83	9.90	15.64	13.10	13.81
	MHNP 1966-198	sub	f	25.98	13.01	11.28	11.87	11.83	9.75	14.95	9.48	14.93	13.39	13.40
	MHNP 1877-574	sub	-	29.15	14.16	13.16	13.47	12.86	11.23	17.37	10.83	16.97	15.47	15.04
	FMNH 36788	ad	m	30.41	15.11	12.61	13.98	13.61	11.79	18.14	11.51	18.10	15.93	15.84
	FMNH 26922	ad	-	27.55	13.28	13.03	12.63	12.92	10.29	15.87	10.26	15.75	14.93	14.51
	FMNH 26921	ad	-	26.35	12.38	11.53	12.12	12.29	10.76	16.61	10.16	16.30	15.03	14.81
	FMNH 36786	ad	m	27.88	14.52	13.23	12.53	12.28	9.85	15.56	9.30	15.46	13.88	13.85
	AMNH 43004	ad	m	26.57	12.72	12.15	12.44	12.22	10.30	15.64	9.86	15.53	14.14	14.12
	AMNH 43001	ad	-	29.46	14.59	13.84	13.49	13.16	11.76	18.26	11.44	17.94	16.15	16.07
	AMNH 40995	ad	m	20.83	9.75	8.79	9.40	9.64	9.37	12.46	8.86	12.57	11.42	11.70
	AMNH 110481	ad	m	29.13	13.68	12.42	13.39	13.19	10.21	16.26	9.76	16.06	14.58	14.70
	AMNH 165683	ad	f	33.26	16.68	14.48	14.96	14.43	13.51	20.08	12.48	19.67	17.38	17.48
Capricornis serow	BHM 47492	ad	-	35.67	16.70	14.96	16.81	16.33	13.48	20.77	12.97	20.75	17.52	17.74
	HNP 1874.283	ad	-	45.64	21.58	20.76	21.13	20.70	17.80	26.28	17.76	26.20	23.77	23.71
	HNP 1919.28	sub	-	39.68	16.96	16.01	16.61	17.11	15.04	22.55	14.86	22.44	19.56	19.62
	MHNP 1902.411	ad	-	43.71	20.99	20.25	19.36	19.04	17.30	25.52	16.62	25.38	22.89	22.26
	MHNP 1937-314	sub	f	34.30	17.04	17.06	16.04	15.55	13.83	21.83	13.06	21.32	19.06	18.48
	MHNP 1886-1241	ad	-	33.01	15.24	14.50	15.48	15.28	12.41	19.52	12.37	19.83	17.43	17.71

	FMNH 36783	ad	-	43.48	22.12	20.95	20.57	20.05	15.83	24.79	14.60	24.31	22.32	21.41
	FMNH 31137	sub	f	38.10	18.30	18.33	17.39	17.23	15.89	24.06	15.50	24.09	21.20	21.38
	USNM 258653	ad	f	43.04	21.04	19.28	19.93	19.82	16.39	26.51	16.71	26.46	23.27	22.86
	USNM 258670	ad	m	40.91	19.98	17.32	18.75	18.48	16.07	23.96	15.66	23.59	22.26	22.19
	USNM 152165	ad	f	41.80	19.86	17.14	19.45	19.43	17.54	24.63	16.61	24.78	21.53	21.70
	USNM 259025	ad	m	43.05	21.89	20.36	20.41	19.84	17.39	25.90	16.74	25.67	22.78	22.81
	USNM 259404	ad	m	39.53	19.47	18.19	18.30	17.97	16.36	24.86	15.16	24.49	22.31	21.90
	USNM 258671	ad	m	42.14	21.07	16.89	19.22	19.52	15.94	24.41	16.04	24.83	21.44	21.33
	USNM 258831	ad	m	44.72	22.83	19.80	20.53	20.04	17.46	26.48	16.68	26.18	23.60	23.53
	AMNH 115578	sub	m	37.67	18.95	18.15	17.55	16.57	13.53	21.78	12.87	21.24	19.35	18.86
	AMNH 43037	ad	m	42.16	19.21	17.59	19.48	19.75	16.66	24.35	16.24	24.07	21.44	21.24
	AMNH 54614	ad	f	43.95	20.30	19.36	20.34	20.28	16.44	25.28	16.09	24.86	22.44	22.61
	AMNH 54613	sub	f	37.53	17.91	16.30	17.46	17.03	14.89	22.48	13.99	22.15	19.57	19.63
	AMNH 16583	ad	f	27.34	13.98	12.03	12.24	12.04	9.94	16.17	10.09	15.89	14.18	14.02
Capra sibirica	BHM 68477	ad	-	35.88	15.83	16.96	16.46	16.44	13.45	21.01	12.47	20.87	17.23	17.51
	MHNP 1964-404	ad	m	35.23	14.66	17.43	16.86	16.02	14.16	22.55	13.45	22.00	18.06	18.52
	MHNP 1974-116	ad	f	29.61	13.61	15.18	13.82	13.34	12.19	18.96	11.08	18.30	15.80	15.72
	MHNP 1932-509	ad	m	30.59	14.27	18.34	14.30	13.65	10.87	18.10	10.50	17.84	14.67	14.77
	FMNH 25652	ad	m	39.58	17.79	19.08	18.68	17.93	15.22	23.40	14.59	23.27	20.59	20.55
	FMNH 134540	ad	m	37.75	17.99	18.66	17.76	16.94	14.10	22.33	13.85	22.17	19.51	19.49
	FMNH 134541	ad	f	30.27	13.75	14.57	13.92	14.24	12.02	18.61	11.54	18.48	16.48	16.67
	USNM 062090	juv	f	31.70	14.06	15.33	14.50	13.84	13.42	20.67	12.58	20.21	17.52	17.36
	USNM 062089	ad	m	38.88	17.49	19.62	17.93	17.74	15.44	23.47	14.53	23.18	20.42	20.13
	USNM 062092	ad	f	34.76	15.81	18.04	16.29	15.43	14.54	22.20	13.32	21.46	18.80	19.01
	USNM 062093	ad	m	36.97	16.73	19.13	17.45	16.86	14.66	23.34	14.03	22.60	19.85	19.79
	USNM 062091	ad	m	34.12	16.00	18.95	15.60	15.14	14.12	21.64	13.41	21.20	18.09	18.26
	USNM 021846	ad	m	39.20	18.00	19.55	18.57	17.85	15.80	24.49	15.07	23.29	20.41	20.39
	USNM 015457	ad	m	34.32	16.14	16.13	16.28	15.77	12.21	20.15	11.57	19.68	16.92	16.84
	USNM 267940	ad	m	33.12	15.07	16.53	15.76	14.99	13.18	20.23	11.92	19.45	17.62	16.99

	USNM 257969	ad	m	38.43	18.04	17.39	18.10	17.52	13.09	20.32	13.07	20.10	17.28	17.07
	AMNH 54901	sub	f	33.45	15.94	15.32	15.45	14.96	13.20	20.92	12.60	20.15	17.38	17.13
	AMNH 54902	ad	f	34.93	15.86	14.82	16.33	15.97	12.99	21.11	12.15	20.55	17.61	17.40
	AMNH 54904	sub	f	32.70	14.87	15.71	15.13	14.83	12.88	20.18	11.67	19.71	16.30	16.50
	AMNH 54905	ad	m	38.67	17.76	17.56	18.00	17.62	15.69	24.37	14.98	24.17	20.70	20.53

3. Measurements Taken on Distal Metatarsal

Species	Specimen Number	Age	Sex	Bd	DBV	DpBV	1	2	3	4	5	6	7	8
	LMU1	ad	m	28.78	13.47	14.34	13.51	12.27	13.04	20.27	12.48	19.76	16.39	16.06
	LMU2	ad	f	31.10	13.12	-	15.84	14.61	12.71	19.82		19.68	16.33	16.61
	LMU3	ad	m	27.83	12.95	13.97	12.81	12.04	12.13	18.69	11.23	17.87	15.51	15.14
	MNHN1896-696	ad	f	27.68	12.89	12.67	12.96	12.23	12.10	20.00	12.20	19.30	16.21	16.66
	MNHN 1972-92	ad	f	28.33	12.96	13.84	13.32	13.20	12.60	20.20	12.00	19.40	16.48	16.46
	MNHN 1972-92a	ad	-	25.53	11.94	13.99	12.46	11.44	11.84	19.20	11.92	18.33	16.50	15.88
	MNHN 1991-641	ad	f	29.70	12.95	12.66	13.10	12.60	12.60	19.60	12.40	19.00	15.81	15.74
	SMTD 14576	ad	f	31.00	-	-	-	-	12.30	19.40	11.80	18.40	-	-
	NHML 70-190	ad	-	29.20	-	-	-	-	-	-	-	-	-	-
	MNHN 1995-197	ad	m	31.51	14.78	16.18	14.76	14.07	13.65	21.54	13.06	20.50	18.46	18.66
Pseudois	MNHN 1985-055	ad	f	28.04	12.75	13.68	13.04	12.91	12.94	20.26	12.47	19.76	16.57	16.61
	MNHN 1996-2097	ad	-	27.08	12.70	12.87	12.55	12.29	12.20	19.77	11.48	18.80	15.80	15.75
	USNM 258665	ad	f	27.45	13.25	14.24	12.66	12.26	11.16	19.07	11.79	18.78	16.14	15.88
	USNM 258661	ad	m	31.04	14.72	15.72	14.32	13.92	13.54	21.62	13.05	20.66	17.96	17.54
	USNM 258662	ad	m	30.38	14.90	14.92	13.60	13.77	12.71	21.11	13.01	20.74	17.72	17.78
	USNM 258663	ad	f	26.52	12.11	13.71	12.22	12.08	11.13	19.38	11.52	18.96	16.24	16.23
	USNM 395251	ad	f	25.10	11.86	12.62	11.82	11.18	11.63	17.90	10.82	17.20	14.72	14.87
	USNM 240681	ad	f	23.68	11.37	11.84	11.26	10.40	9.35	15.83	9.88	16.65	13.29	13.22
	AMNH 22786	ad	m	24.46	12.08	12.42	11.28	10.70	10.71	17.59	10.28	17.14	14.31	14.31
	AMNH 22787	ad	m	25.50	12.56	12.11	11.91	11.07	10.96	17.40	10.14	16.76	14.46	14.17
	MNHN 1971-245	sub	f	27.54	12.90	14.64	12.51	12.45	12.42	20.11	11.71	19.45	16.49	16.71

	MNHN 1966-136	sub	m	28.52	14.54	14.83	13.09	12.48	12.46	19.53	12.11	18.74	16.23	16.03
	MNHN 1902-412	sub	-	25.81	11.84	12.89	11.99	11.59	12.10	18.70	11.60	18.40	15.00	15.35
	AMNH 22812	juv	-	27.31	13.53	15.31	12.21	11.85	10.41	17.74	10.21	17.22	14.89	14.98
	MNHN 1968-766	sub	m	29.09	14.11	14.80	13.57	12.93	13.10	20.60	12.90	20.00	17.23	16.99
	BMN 14783	sub	m	27.80	-	-	-	-	11.40	17.90	10.80	17.00	-	-
	BMN 43037	sub	m	24.80	-	-	-	-	9.90	17.00	9.30	16.10	-	-
	NHMW 32972	sub	m	31.00	-	-	-	-	12.30	20.50	12.00	19.90	-	-
	BMN 43038	juv	f	16.80	-	-	-	-	10.40	17.60	9.90	16.50	-	-
	BMN 83323	juv	f	25.30	-	-	-	-	11.30	17.60	10.60	16.90	-	-
Capra hircus	GCZ 207	juv	-	25.04	11.15	14.02	11.90	11.38	10.17	16.17	9.20	15.38	-	-
	GCZ 154	juv	-	21.47	9.94	13.54	9.97	9.34	8.19	14.30	7.46	13.62	-	-
	GCZ 167	juv	-	25.12	11.00	14.39	12.06	11.36	10.38	16.54	9.78	16.02	-	-
	GCZ 537	ad	-	26.71	12.52	14.24	12.44	11.78	10.22	17.19	10.07	17.01	-	-
	GCZ 26141	ad	-	24.79	11.43	13.08	11.58	10.80	10.21	16.07	9.58	15.50	-	-
	we wild	ad	-	28.09	13.21	16.60	13.16	12.41	11.75	18.65	10.78	18.23	-	-
	LMU 7	ad	f	-	13.68	16.79	-	-	-	-	-	-	-	-
	LMU 3	ad	f	-	13.54	16.10	-	-	-	-	-	-	-	-
	LMU 30	sub	f	25.79	12.81	15.29	12.08	11.34	11.18	17.77	10.66	17.21	14.41	14.14
	LMU 48	ad	m	31.22	14.98	19.00	13.93	13.72	13.43	20.65	12.57	20.35	16.47	16.77
	LMU 74	sub	-	-	10.50	15.24	-	-	-	-	-	-	-	-
	LMU 5	sub	f	24.24	10.75	13.88	11.40	10.60	10.75	17.04	10.18	16.73	13.50	13.54
	LMU 8	sub	m	27.82	12.89	15.77	12.90	12.42	11.81	18.16	10.39	17.63	14.46	14.57
	LMU 18	ad	m	27.93	12.88	-	13.14	11.96	11.34	-	10.90	18.38	-	15.44
	LMU 60	sub	-	19.89	9.57	11.26	8.99	8.36	8.11	13.09	7.61	12.74	11.27	11.05
	LMU 17	sub	-	20.64	9.44	11.31	9.45	9.09	8.61	14.33	7.68	13.66	11.74	11.88
	LMU 14	sub	-	24.32	10.82	14.74	12.18	11.31	10.23	16.84	9.85	16.59	14.21	14.52
	LMU 28	sub	f	24.04	10.68	12.57	11.49	11.08	10.04	16.13	9.10	15.32	12.79	13.14
	LMU 50	sub	f	24.57	11.40	13.94	11.80	10.98	10.56	17.80	9.93	17.05	14.87	14.91
	LMU 1	ad	f	24.83	12.00	15.07	11.72	10.99	10.06	16.43	9.83	15.85	14.40	14.57

	LMU 3	ad	f	21.26	10.24	11.67	9.93	9.38	8.14	14.31	7.95	13.90	11.47	11.49
Gazella gazella	LMU 3	ad	m	18.19	8.67	7.67	8.01	7.65	10.42	13.99	9.41	13.40	12.32	12.21
	1992-1844	ad	f	21.16	10.58	8.78	9.43	9.45	10.54	14.52	9.92	13.99	11.62	11.70
	1991-303	ad	m	21.72	10.80	8.65	9.86	9.27	11.37	15.57	10.25	14.90	12.89	12.57
	1960-3646	ad	m	20.85	9.55	8.43	9.33	9.27	11.68	15.83	10.94	15.15	13.36	13.30
	1988-222	ad	f	18.13	8.55	7.66	8.32	8.18	10.25	14.17	9.63	13.68	11.87	11.86
Gazella dorcas	LMU 3	ad	m	19.48	9.23	8.31	8.63	8.45	10.96	15.43	10.41	15.02	13.07	13.09
	MNHN 1906-108	ad	f	18.75	9.15	8.12	8.50	8.36	10.65	15.40	9.86	14.69	12.61	12.62
	MNHN 1874-124	ad	m	19.23	9.24	8.25	8.61	8.62	10.59	14.74	10.07	14.31	12.54	12.74
	MNHN 1916-22	ad	m	20.05	9.11	7.77	9.01	8.84	11.06	15.38	10.10	15.00	13.05	13.28
	MNHN 1961-997	ad	f	17.12	8.16	7.18	7.92	7.55	9.63	13.42	8.84	13.06	11.35	11.52
	MNHN 1937-1262	ad	f	21.54	10.31	9.51	9.73	9.53	11.78	16.31	10.73	15.95	13.79	14.04
	MNHN 1912-415	ad	f	18.59	9.08	8.42	8.79	8.20	10.67	14.95	10.32	14.54	12.63	12.61
	MNHN 1909-491	ad	m	18.08	8.62	8.22	8.13	7.89	10.34	14.48	9.60	13.97	12.60	12.34
Procapra gutturosa	LMU 2	ad	f	22.28	10.50	10.50	10.13	9.51	13.21	17.26	12.44	16.87	15.10	15.20
	LMU 1	ad	m	21.99	10.50	10.30	9.85	9.53	13.48	17.47	12.28	16.99	15.60	15.70
Gazella sub adgutturosa	MNHN 1934-368	ad	f	17.97	8.48	7.08	7.98	7.96	9.31	13.64	8.41	13.12	11.39	11.21
	MNHN 1988-158	ad	f	21.28	10.89	10.14	9.52	8.97	11.86	16.21	10.82	15.36	13.98	13.85
Capricornis	USNM 258831	ad	m	41.75	21.33	19.92	19.16	18.03	16.20	25.73	16.16	25.24	22.58	22.58
	MNHN 1874.283	ad	-	41.45	19.49	19.15	19.37	18.76	17.60	26.23	16.56	25.89	22.78	23.21
	AMNH 54614	ad	f	40.60	19.19	17.79	18.41	18.04	15.48	24.58	14.76	23.41	20.84	20.84
	MNHN 1901-1350	ad	-	39.82	18.90	18.00	18.83	17.28	16.07	25.31	14.67	24.27	21.30	21.75
	USNM 258653	ad	f	39.32	19.73	17.53	18.38	17.23	16.42	25.73	15.59	25.54	22.29	22.22
	USNM 258833	ad	m	39.04	19.09	18.38	17.31	17.18	15.29	23.32	15.25	23.28	20.25	20.70
	USNM 259025	ad	m	38.95	19.82	18.68	18.18	17.27	16.62	24.80	16.23	24.73	22.14	21.96
	FMNH 36783	ad	-	38.47	19.78	18.02	18.33	17.40	14.62	24.77	15.18	24.22	21.03	21.15
	AMNH 43037	ad	m	38.47	18.04	16.40	17.69	17.05	15.91	24.21	15.47	24.09	20.67	21.14
	USNM 152165	ad	f	38.35	18.59	16.96	17.75	17.17	16.21	24.38	15.95	24.57	21.27	21.70
	USNM 259404	sub	m	37.60	18.35	17.37	17.70	17.09	15.60	24.82	15.06	23.96	21.85	22.04
	USNM 258671	ad	m	37.57	19.11	16.10	17.27	16.78	15.34	23.65	15.28	23.78	20.16	20.55

	USNM 258670	ad	m	37.53	18.83	16.76	17.17	16.22	15.08	22.89	14.61	22.88	20.69	20.93
	USNM 258832	ad	m	36.97	17.70	18.80	17.07	16.26	15.86	24.15	15.18	23.39	21.32	21.52
	FMNH 31137	sub	f	35.86	15.92	17.23	16.33	15.92	15.63	23.59	14.98	23.65	20.24	20.51
	AMNH 115578	sub	m	34.65	17.08	17.08	15.99	14.85	13.08	21.69	12.56	21.04	18.79	18.89
	AMNH 54613	sub	f	34.54	16.27	15.15	16.28	14.94	14.21	21.97	13.69	20.87	18.36	18.41
	BMN 47492	ad	-	32.58	15.08	15.50	15.12	14.28	12.79	20.73	12.37	19.95	17.39	17.04
	MNHN 1919-28	sub	-	31.98	15.64	15.18	15.14	14.20	14.76	22.15	13.12	21.57	18.36	18.85
	AMNH 165683	ad	f	31.07	15.91	14.46	14.54	12.88	12.41	19.82	12.11	18.99	17.02	16.77
	MNHN 1937-314	sub	f	30.95	15.09	14.59	14.34	13.67	-	-	-	-	-	-
	MNHN 1886-1241	ad	-	30.94	14.73	13.64	14.59	14.02	12.15	19.64	12.04	19.53	16.64	17.14
	MNHN 1902-411	ad	-	30.05	19.52	18.39	17.80	17.51	16.53	25.19	16.42	24.87	21.67	22.20
Nemorhaedus	MNHN 1877-574	sub	-	27.61	13.62	12.94	12.94	11.80	10.60	17.14	9.97	16.62	14.83	15.07
	FMNH 36788	ad	m	27.55	13.69	13.61	12.36	12.31	10.58	17.25	10.83	17.71	14.92	15.52
	AMNH 43001	ad	-	26.60	13.16	12.39	12.13	11.86	11.00	17.35	11.24	17.47	15.10	15.37
	AMNH 110481	ad	m	26.11	12.75	11.97	11.88	11.75	9.83	15.84	9.49	15.53	13.64	14.03
	MNHN 1896-693	sub	-	25.73	13.22	13.31	11.70	11.61	9.45	15.78	9.99	16.10	13.95	14.05
	BMN 83318	ad	-	25.51	12.22	11.94	10.66	10.81	9.24	14.84	8.83	14.50	13.03	13.10
	BMN 70035	ad	f	25.50	12.09	12.38	11.51	11.51	10.61	16.92	10.40	16.34	14.45	14.41
	FMNH 36922	ad	-	24.53	11.88	10.92	11.11	11.06	10.51	15.64	10.08	15.67	13.58	13.94
	FMNH 36786	ad	m	24.53	12.90	12.70	11.05	10.82	9.29	14.99	9.00	14.94	12.87	12.95
	MNHN 1896-692	ad	-	24.46	12.18	10.89	11.18	10.93	10.40	16.55	10.27	16.10	14.43	14.31
	BMN 70721	ad	-	24.07	12.06	12.44	11.43	11.35	10.78	16.34	10.26	16.21	14.48	14.77
	AMNH 43004	ad	m	24.00	12.07	10.87	10.95	10.80	10.38	15.17	10.01	14.75	13.47	13.43
	FMNH 26921	ad	-	23.89	11.26	10.82	10.90	10.77	10.62	16.15	9.56	15.91	13.88	14.07
	BMN 14451	ad	f	23.32	11.36	11.36	10.63	10.57	9.84	15.18	9.43	14.82	13.08	13.08
	MNHN 1966-198	sub	f	22.96	11.55	10.32	10.70	10.65	8.78	14.33	9.16	14.45	12.72	12.91
	MNHN 1962-153	ad	f	22.90	10.42	10.20	10.84	10.54	9.76	15.10	9.01	14.88	12.31	12.76
	MNHN 1963-320	ad	m	22.14	11.21	10.66	9.98	10.09	9.17	14.02	8.73	14.01	12.21	12.49
	MNHN 1962-197	ad	f	22.08	10.96	9.85	10.35	10.12	9.29	14.14	9.06	13.96	12.14	12.28
	MNHN 1913-728	sub	-	20.93	10.34	9.54	9.79	9.65	9.49	14.59	9.03	14.44	12.84	12.99

Capra sibirica	BMN 68477	ad	-	31.78	14.55	15.88	14.17	13.85	13.05	20.71	12.82	20.44	16.52	16.77
	FMNH 25652	ad	m	34.19	15.14	17.97	16.03	15.35	14.22	22.69	13.76	21.95	19.29	19.56
	FMNH 134540	ad	m	31.66	15.05	16.60	14.59	14.30	13.29	21.40	12.96	20.85	18.34	18.62
	FMNH 134541	ad	f	26.63	11.86	12.82	12.52	12.21	11.55	18.00	10.96	17.24	15.74	15.61
	USNM 062090	juv	f	29.92	14.00	15.83	13.84	12.94	14.55	21.59	13.14	20.30	17.82	17.93
	USNM 062089	ad	m	33.69	15.50	17.18	14.97	14.51	15.19	23.27	14.64	22.29	19.30	19.38
	USNM 062092	ad	f	30.78	13.71	15.28	14..58	13.48	13.44	21.99	12.84	20.95	18.06	18.15
	USNM 0620893	ad	m	32.47	14.42	16.59	15.14	14.70	14.49	22.82	13.08	21.73	18.58	18.50
	USNM 062091	ad	m	28.37	12.59	14.42	13.05	12.37	12.70	20.22	12.18	19.61	16.76	16.97
	USNM 021846/A36566	ad	m	33.80	15.38	17.74	15.81	15.26	14.67	23.74	14.19	22.43	19.35	19.35
	USNM 015457/A22302	ad		30.52	14.48	16.89	14.23	13.62	12.73	20.27	12.87	20.05	17.12	16.87
	USNM 267940	ad	m	29.17	14.04	16.25	13.65	13.00	12.72	19.84	11.87	18.82	17.21	16.99
	USNM 257969	ad	m	31.07	15.34	16.97	14.59	14.02	12.23	19.59	11.44	19.13	17.05	16.96
	AMNH 54901	sub	f	29.72	14.15	14.15	13.33	13.11	13.16	20.84	12.17	19.52	16.91	16.74
	AMNH 54902	ad	f	31.50	13.82	13.91	15.10	14.21	12.92	21.20	12.57	20.26	17.24	17.09
	AMNH 54907	ad	m	35.42	16.50	15.89	16.56	15.78	15.66	23.28	14.66	21.77	19.21	18.57

Appendix F Measurements Taken from the Modern Specimens of Ovis

1. Humerus

Species/Group	Specimen Number	Age	Sex	Bd	BT	HT	SHT	BTI	BTM	LHT
Ovis ammon (Argali, zoobred)	BMN 1	ad	-	34.66	32.03	20.39	15.35	9.30	21.40	15.86
	LMU 9 (SAPM 02233)	ad	m	39.22	36.65	23.20	17.56	10.36	24.53	17.41
	LMU 6 (SAPM 02235)	ad	f	40.95	36.10	24.43	17.96	11.04	27.02	17.30
	LMU 8 (SAPM 02237)	ad	f	37.94	36.12	25.08	18.13	9.54	23.99	18.42
	LMU 7 (SAPM 02236)	sub	m	36.89	35.16	23.29	16.69	10.35	23.99	16.66
	LMU 1 (SAPM 02230)	sub	m	39.25	37.17	23.96	17.94	11.77	24.12	17.22
	LMU 3 (SPAM 02232)	sub	f	36.98	34.58	21.04	16.07	11.20	22.52	15.85
Ovis ammon (captured wild)	MHNP 1876-524	sub	f	38.95	38.60	24.38	17.40	11.87	25.72	17.23
	MHJ 216, O pol hein 1	sub	m	52.21	50.52	33.41	23.96	15.45	34.67	22.38
	MHJ II, O am ltld 3	sub	f	41.81	40.50	27.02	19.53	12.03	27.67	18.83
	MHJ 163,O am alt 2	sub	m	46.71	43.99	27.96	21.21	13.39	28.99	19.45
	MHJ ohne, O am ltld 1	ad	m	50.09	45.03	30.39	21.94	14.47	29.71	22.12
	MHJ 218, O am ltld 9	ad	f	46.52	44.02	28.32	21.23	11.99	30.87	20.47
	MHJ 217,O am alt 3	ad	f	48.94	46.08	28.06	21.89	14.18	31.49	21.13
	MHJ ohne, O am ltld 2	ad	f	48.80	45.68	29.24	22.17	11.79	32.75	21.40
	MHJ 204, O am ltld 7	ad	f	46.13	43.85	27.00	20.83	12.82	30.17	19.94
	USNM 62100	ad	f	40.76	38.84	24.69	17.69	12.12	25.77	12.14
	USNM 62096	ad	m	52.43	48.60	31.22	22.82	11.47	12.15	21.81
	USNM 62101	ad	m	44.28	42.31	26.97	19.78	11.81	28.84	18.99
	MCZ 19941	ad	m	48.17	45.66	29.33	20.22	11.69	33.97	20.57
	AMNH 45490	ad	m	46.53	43.58	28.30	19.76	13.19	30.11	19.94

	AMNH 45493	sub	m	42.88	41.38	27.43	19.31	12.28	28.89	18.80
	AMNH 54931	sub	m	50.32	44.78	30.10	21.76	14.56	29.59	21.45
	AMNH 54865	ad	m	48.17	44.60	29.40	20.80	12.14	31.34	21.01
Ovis vignei (Urial Sheep)	LMU 1 (SAPM 01752)	ad	f	30.86	28.55	20.03	14.77	8.16	23.13	14.06
	LMU 5 (SAPM 02234)	ad	f	28.00	26.61	16.11	12.76	7.41	19.17	11.93
	LMU 2 (SAPM 01753)	ad	f	31.66	29.19	17.48	13.77	8.32	18.52	13.70
	MNB 83438	ad	f	31.68	30.77	19.49	14.91	8.83	19.44	14.49
	MNB 83437	sub	m	34.89	33.69	21.30	16.39	8.86	19.80	15.40
	LMU 4 (SAPM 02233)	sub	m	35.23	32.43	20.72	14.58	8.22	23.01	14.80
	MHJ 153/07	ad	m	30.96	29.49	19.27	14.99	9.11	18.98	13.64
	MHJ 430, O ur 26	ad	m	31.71	30.82	19.27	14.72	8.87	21.46	14.30
	MHJ O ur 21	ad	m	34.64	32.88	20.28	15.27	9.84	22.06	13.59
	MHJ 165, O ur 23	ad	m	27.85	26.57	15.04	11.54	8.30	18.04	10.71
	MHJ 392, O ur 25	ad	m	29.18	27.57	18.20	13.47	7.77	19.42	13.20
	MHJ 161, O ur 22	ad	m	31.43	28.40	18.57	14.47	8.22	18.87	13.69
	AMNH 119526	ad	m	33.66	30.76	19.42	14.62	8.79	21.66	14.17
	AMNH 54616	ad	f	33.64	32.23	19.44	15.54	9.80	22.14	15.13
Ovis orientalis (Western Asian Mouflon)	LMU Bastam	-		37.93	35.09	23.90	17.20	9.29	24.42	17.75
	LMU 4 *O. gmelini*	sub	f	34.70	32.97	20.63	-	-	21.83	14.65
	MNB 16329	ad	m	36.98	35.80	22.54	16.90	10.26	24.14	16.66
	MHJ 289, O gml 1	ad	m	30.75	29.64	19.53	14.99	9.23	19.58	14.24
	MHJ 290, O gml 2	ad	f	30.14	29.05	19.26	13.40	8.94	20.05	11.98
	MHJ Ovis anatolicum 145/02	ad	m	29.38	27.73	18.25	14.22	8.90	18.07	13.89
	FMNH 98161	ad	m	32.94	30.29	19.34	14.04	9.13	20.73	13.14
	FMNH 58031	ad	m	33.94	31.88	20.62	15.71	9.18	21.59	15.42
	FMNH 152005	ad	f	33.64	31.64	19.86	14.50	8.90	22.18	14.51
	FMNH 152006	ad	f	32.36	29.63	19.41	14.10	7.92	20.18	13.33
	FMNH 58037	ad	m	33.37	31.49	21.67	16.10	9.47	20.66	15.60
	FMNH 58038	ad	f	32.14	30.56	18.55	14.34	8.53	21.32	14.68
	FMNH 58039	sub	m	30.52	29.30	18.73	14.19	8.93	19.27	14.19

	FMNH 58070	ad	F	31.28	29.00	19.29	14.58	8.64	19.90	14.83
	FMNH 58065	ad	f	30.08	28.31	18.28	15.23	8.75	19.12	13.31
	FMNH 98162	sub	-	30.83	28.80	18.98	14.83	8.75	19.06	14.50
	FMNH 58035	ad	m	36.24	34.14	21.99	16.63	10.88	22.26	16.76
Ovis musimon (European mouflon, feral)	MNB 22773	ad	f	35.39	32.11	20.87	15.89	7.38	23.95	15.70
	MNB 22776	ad	m	29.23	27.65	18.28	13.56	7.51	18.42	13.58
	MNB 41394	-	f	28.37	27.91	18.17	13.25	7.04	18.48	13.78
	MNB 22772	-	f	36.05	33.98	20.49	15.93	9.61	22.80	13.66
	MNB 11527	sub	m	31.74	29.87	20.07	15.87	7.11	21.24	15.01
	MNB 22771	sub	m	-	-	-	-	-	-	-
	MHNP 1907-579	ad	m	34.80	33.05	21.62	15.99	9.44	22.62	16.11
	MHNP 1930-G68	ad	m	32.82	30.38	20.64	15.16	8.86	19.34	15.10
	MHNP 1872-19	ad	m	32.17	30.71	20.76	14.94	9.51	20.22	14.69
	MHNP 1987.058	ad	f	29.94	30.43	18.97	14.92	7.84	20.60	13.78
	MHNP 1967-924	sub	-	28.97	27.26	17.62	13.69	8.15	17.88	14.06
	MHNP 1909-317	sub	m	28.26	26.45	17.09	13.97	7.25	17.82	13.62
	MHNP UN4	ad	-	28.92	26.86	18.32	13.49	7.88	18.60	13.93
	MHNP UN1	ad	-	32.39	31.14	19.40	15.30	8.59	20.89	16.02
	MHNP UN3	ad	-	28.27	27.55	17.49	14.28	6.79	19.55	14.95
	MHNP 1909-307	ad	f	27.78	26.92	16.58	13.30	7.55	18.76	13.31
Ovis musimon (European mouflon, zoobred)	LMU 19	ad	f	28.27	26.40	17.60	13.54	7.19	18.45	13.42
	LMU 32	ad	-	30.18	27.61	17.79	13.33	7.83	17.56	13.27
	LMU 8	ad	m	32.49	30.98	19.67	15.13	8.52	18.53	14.92
	LMU 22	ad	-	31.53	30.19	19.28	15.51	7.67	21.02	15.39
	LMU 14	sub	m	27.29	26.34	16.54	13.13	7.55	21.50	12.90
	LMU 30	sub	f	25.67	25.16	15.37	12.08	7.33	16.61	12.02
	LMU 28	ad	f	28.06	26.88	16.94	13.34	7.25	18.48	13.44
	LMU 20	ad	f	27.22	25.45	16.45	13.14	7.29	17.52	12.62
	LMU 10	ad	f	28.98	28.29	17.96	14.33	7.14	20.44	13.94
	LMU 12	sub	m	27.46	26.54	16.69	14.15	7.28	18.17	12.83

	LMU 31	ad	f	27.21	25.75	15.98	12.53	7.33	17.79	12.70
	LMU 27	ad	f	31.07	26.85	17.07	12.72	7.24	19.46	13.13
	LMU 257	sub	m	28.44	26.89	16.78	13.49	7.28	18.95	12.76
	LMU 259	sub	m	28.30	27.35	18.03	14.39	7.60	19.16	12.33
	MNB IIA 1501	ad	f	28.07	26.91	17.18	12.85	6.21	19.68	12.36
	MNB 2II 1924	ad	m	31.99	29.12	18.79	15.43	7.23	19.05	14.45
	MNB 13.VI.1923	ad	m	33.77	31.56	19.85	15.50	7.55	22.76	14.86
	AMNH 10261	ad	m	28.54	25.37	16.31	11.91	7.44	17.64	12.89
	AMNH 35478	ad	m	35.07	32.56	22.21	16.76	9.43	22.43	15.63
	AMNH 35683	ad	f	31.45	28.39	19.27	14.10	7.74	19.92	14.50
Ovis aries musimon(Domestic sheep)*	LMU 60	sub	m	33.26	30.67	21.24	15.88	6.87	23.37	16.64
	LMU 6	ad	f	30.07	28.43	17.65	13.21	7.21	20.61	12.86
	LMU 27	ad	m	30.86	29.09	20.35	14.54	7.44	20.78	14.59
Ovis aries (Soay breed)	GCZ 394	ad	f	26.27	23.85	15.58	11.96	7.70	15.52	12.12
	GCZ 404	ad	f	25.98	24.65	16.13	12.54	6.96	16.55	12.57
	GCZ 315	ad	f	28.97	25.35	16.49	12.81	7.75	16.66	12.96
	GCZ 436	ad	f	25.86	24.25	15.64	11.58	7.51	16.24	12.17
	GCZ 329	ad	f	28.84	26.77	18.46	13.55	7.53	19.09	13.38
Ovis aries (Country domestic sheep)	GCZ 115	sub	-	23.68	23.26	15.27	11.46	7.02	15.48	12.06
	GCZ Y7	ad	-	-	26.00	16.44	12.78	7.94	16.77	12.25
	GCZ Y5	sub	-	-	27.15	17.27	14.22	7.46	17.66	13.68
	GCZ Y4	sub	-	31.13	31.11	20.72	16.62	9.06	20.50	16.10
	GCZ Y28	sub	-	28.67	27.22	17.62	13.24	7.74	19.01	13.41
	GCZ 435	ad	-	31.52	28.20	19.53	14.72	7.70	19.28	14.76
	GCZ Y1	ad	-	45.75	42.44	26.75	20.92	12.68	28.53	19.58
	GCZ Y2	sub	-	40.72	36.26	24.29	18.91	10.95	24.07	18.90
	GCZ Y3	ad	-	32.05	28.55	18.82	14.65	8.42	20.12	14.41
Ovis aries (domestic sheep, Rambouillet breed)	MHJ O rb 4, 8	ad	m	39.94	37.63	25.01	18.65	11.91	24.79	18.86
	MHJ O rb 6, 14/75	ad	f	28.63	26.65	17.08	13.29	7.78	17.83	12.43
	MHJ O rb 9, 15/82	ad	m	34.48	31.49	22.15	16.80	9.29	21.02	16.14

	MHJ O rb 2, 1	ad	f	39.68	35.99	22.35	18.08	11.36	23.24	17.42
	MHJ O rb 18, 432	ad	f	27.92	26.53	17.53	13.63	7.85	17.89	13.04
	MHJ O rb 13, 20/75	ad	f	30.13	27.77	18.90	15.35	8.46	19.01	14.86
	MHJ O rb 3, 2	ad	f	35.69	33.80	22.72	17.46	10.22	22.56	16.58
	MHJ O rb 17,209/76	ad	m	36.86	33.83	23.16	16.78	11.62	21.41	17.50
	MHJ O rb 19, 433	ad	m	41.62	36.70	26.95	19.71	10.50	25.51	18.63
	MHJ O rb 10, 17/75	ad	f	27.74	26.00	17.13	14.01	7.81	18.21	12.63
	MHJ O sfrz m 1	ad	f	29.27	27.19	18.41	14.68	7.89	18.98	14.05
	MHJ O rb 7, 14/82	ad	f	29.03	27.09	17.66	13.74	8.93	17.47	13.43
	MHJ O rb 5, 13/75	ad	f	28.35	26.74	18.22	14.20	7.97	17.62	13.79
Ovis aries (crossbreed, Argali ×sheep)	MHJ O rb/ag 87, 811/92	ad	f	27.04	26.59	17.02	13.95	7.70	18.21	13.00
	MHJ O rb/ag 191, 1014/03	ad	m	31.78	30.37	18.99	15.03	9.25	20.48	14.29
	MHJ O rb/ag 59,708/90	ad	m	30.39	28.77	18.91	15.17	8.67	19.78	13.97
	MHJ O rb/ag 251,1093/02	ad	m	-	30.05	21.12	15.27	8.91	19.70	14.30
	MHJ O rb/ag 246, 109/97	ad	m	34.44	32.68	21.90	16.10	9.93	21.93	16.20
	MHJ O rb/ag 311,1148/06	ad	m	30.81	29.28	20.02	16.24	8.53	20.10	15.06
	MHJ O rb/ag 286,1115/97	ad	m	-	30.00	19.97	14.66	8.48	19.64	14.22
	MHJ O rb/ag 17, 986/06	ad	m	30.93	30.44	18.96	14.17	8.68	20.73	14.02
	MHJ O rb/ag 281, 1100/97	ad	m	-	28.96	18.66	14.95	8.77	18.72	14.16
	MHJ O rb/ag 193, 1015/95	ad	m	32.54	30.51	21.48	17.12	10.43	19.37	16.52
	MHJ O rb/ag 126, 902/01	ad	m	33.16	31.48	20.85	16.39	10.09	20.68	15.52
	MHJ O rb/ag 200,1030/95	ad	m	32.19	29.99	18.83	14.73	8.68	20.80	13.62
	MHJ O rb/ag 155, 978/94	ad	f	29.85	28.57	18.78	14.76	8.75	18.61	13.54
	MHJ O rb/ag 259, 1093/08	ad	m	31.59	29.71	20.10	14.31	8.46	20.52	13.25
	MHJ O rb/ag 116; 885/93	ad	f	31.18	29.41	19.50	15.14	9.04	19.87	14.37
	MHJ O rb/ag 143; 939/01	ad	m	30.81	29.56	18.94	14.93	9.39	19.67	14.85
	MHJ O rb/ag 211; 1035/95	ad	m	28.09	26.72	18.56	13.71	8.13	17.15	13.60
	MHJ O rb/ag 258; 1093/07	ad	m	31.20	31.10	19.32	15.45	9.52	21.08	14.89
	MHJ O rb/ag 190; 1014/00	ad	f	28.08	25.81	17.25	13.18	8.20	16.53	12.51
	MHJ O rb/ag 173; 986/05	ad	f	30.65	28.65	19.05	13.66	8.54	19.47	13.79

	MHJ O rb/ag 95;1892-1895	ad	m	29.29	27.24	18.29	14.17	7.23	19.48	12.58

1. Metacarpal

Species/Group	Specimen Number	Age	Sex	Bd	DBV	DpBV	1	2	3	4	5	6	7	8
Ovis ammon (Argali, zoobred)	SAPM-02235(LMU 6)	ad	f	32.48	15.89	14.33	14.55	14.38	15.77	21.26	14.94	20.77	18.42	18.19
	SAPM-02237(LMU 8)	ad	f	31.02	14.73	14.35	13.89	13.77	14.26	20.37	13.38	19.66	17.58	17.35
	LMU 3	sub	f	26.98	12.87	12.57	12.51	11.94	12.45	19.52	12.50	18.83	16.30	16.53
	LMU 1	sub	m	32.66	15.77	14.73	15.35	14.81	13.65	20.73	12.94	19.93	17.78	17.31
	LMU 7	sub	m	28.08	12.91	12.77	12.85	12.78	13.64	19.29	12.85	18.99	16.64	16.75
	LMU 9	ad	m	30.52	14.44	13.01	14.12	13.73	14.49	20.48	13.66	19.93	17.48	17.36
Ovis ammon (Argali, captured wild)	MHJ O am 218 ltld 9	ad	f	36.22	17.50	17.51	16.72	16.10	18.20	25.29	17.18	24.63	22.64	21.74
	MHJ O am alt 3, 217	ad	f	37.30	17.52	17.70	17.38	16.76	18.63	26.25	17.37	25.60	22.87	23.11
	MHJ O am ltld 2, ohne	ad	f	35.89	17.27	16.55	16.51	15.90	18.50	25.44	17.46	25.02	22.44	22.28
	MHJ O am ltld 7, 204	ad	f	36.26	17.17	16.14	17.09	16.22	19.15	25.22	18.10	24.80	22.37	22.28
	FMNH 25683	ad	F	34.65	16.08	15.23	15.97	15.63	16.35	23.42	15.60	22.79	20.04	19.78
	AMNH 54875	ad	f	33.22	15.60	14.73	15.39	15.09	16.71	23.46	16.03	22.95	20.38	20.28
	USNM 240688	ad	f	31.73	15.72	13.72	14.32	14.17	15.48	21.58	15.16	21.38	18.33	18.50
	FMNH 25684	ad	M	40.56	18.40	17.80	18.68	18.67	18.78	26.53	17.46	25.60	23.26	22.75
	FMNH 25685	ad	M	38.99	18.29	17.23	17.98	17.77	18.24	25.58	17.41	24.92	22.48	22.17
	MCZ 19940	ad	m	36.51	17.90	16.03	16.61	16.60	18.26	24.71	17.22	24.08	21.69	21.95
	MCZ 19941	ad	m	38.69	18.39	16.43	17.65	17.35	18.40	25.95	17.98	25.73	22.98	22.98
	AMNH 45490	ad	m	37.02	18.39	16.43	16.75	16.08	17.64	24.67	17.08	24.18	21.33	21.14
	AMNH 45492	ad	m	38.77	18.33	17.93	17.71	17.67	17.98	24.91	17.58	24.65	22.31	22.25
	AMNH 54931	ad	m	38.61	18.39	17.11	17.81	17.26	17.92	25.35	16.47	24.47	21.99	22.06
	AMNH 54873	ad	m	37.56	17.82	16.46	17.35	16.80	17.41	24.42	16.81	24.04	21.25	21.39
	AMNH 54867	ad	m	39.24	18.42	17.14	18.31	17.67	18.87	26.82	17.75	26.10	24.07	24.10
	BHM 5391	ad	m	37.29	17.92	16.31	17.13	16.53	17.73	24.95	16.98	24.43	21.45	21.46
	MHJ O am ltld 1	ad	m	38.98	17.94	16.58	18.12	17.53	18.40	26.20	17.81	25.24	22.61	22.22
	MHJ O am ltld 3, II	sub	f	34.02	16.37	14.87	15.92	15.36	16.05	22.99	15.67	22.53	20.32	20.10
	MNHN 1876-524	sub	f	30.04	14.73	13.45	13.88	13.49	15.46	21.43	14.44	20.94	18.34	18.47

	MHJ O pol hein 1, 216	sub	m	41.93	20.10	18.66	18.80	18.76	21.02	29.13	20.16	28.99	25.21	25.87
	FMNH 25676	sub	M	36.36	17.63	16.34	16.54	16.16	17.40	23.72	16.99	23.35	20.79	21.24
	AMNH 45494	sub	m	35.50	17.02	15.64	16.38	15.84	16.80	23.82	16.10	23.59	20.40	21.02
	AMNH 54874	sub	m	38.08	17.81	16.91	17.46	17.45	18.20	25.23	17.36	25.04	22.26	22.49
	AMNH 54881	sub	m	36.14	16.87	15.67	16.83	16.52	17.32	24.32	15.72	23.60	20.44	20.43
	MHJ O am alt 2, 163	sub	m	35.86	17.65	15.66	16.16	15.72	17.07	24.06	16.30	23.38	20.50	20.26
	MCZ 19942	sub	-	32.67	15.80	14.82	15.25	14.51	16.86	22.75	16.09	22.46	20.06	20.47
Ovis vignei (Urial sheep)	LMU 1	ad	f	25.42	11.16	10.95	12.18	12.05	12.46	17.24	11.12	16.83	14.08	14.20
	AMNH 54616	ad	f	26.45	13.07	12.10	12.33	11.95	13.12	18.12	12.16	17.60	15.78	15.84
	LMU 5	ad	f	22.21	10.03	9.85	10.52	10.08	10.59	15.56	9.80	15.15	13.13	12.96
	LMU 2	ad	f	25.50	11.87	11.70	11.39	10.58	13.06	17.96	11.54	17.04	15.27	15.00
	LMU 4	sub	m	28.56	14.12	13.29	12.23	12.04	13.05	17.85	11.93	17.47	15.50	15.32
	BMH 4830	ad	m	28.24	11.68	11.61	12.89	12.46	13.60	18.59	12.98	18.24	16.50	16.49
	MHJ 153/07	ad	m	24.75	11.88	11.51	11.55	11.06	12.01	16.63	10.58	15.99	14.07	13.88
	MHJ 430, O ur 26	ad	m	26.65	12.64	11.22	12.25	12.10	13.01	17.82	12.49	17.57	15.56	15.74
	MHJ O ur 21	ad	m	27.72	13.49	11.85	12.46	12.11	12.81	18.15	12.06	17.80	15.33	15.38
	MHJ 165, O ur 23	ad	m	21.62	10.25	9.97	9.99	9.97	10.32	14.67	9.89	14.39	12.88	12.88
	MHJ 392, O ur 25	ad	m	23.11	11.03	10.63	10.60	10.51	11.58	16.36	11.25	-	14.31	14.04
	MHJ 161, O ur 22	ad	m	26.51	13.20	12.18	11.80	11.75	12.35	17.53	11.21	16.86	14.45	14.53
	AMNH 119526	ad	m	26.62	12.96	11.59	11.79	11.86	12.31	17.29	11.63	17.18	14.99	15.22
Ovis orientalis (Westeran Asian mouflon)	LMU 4.1	-	-	25.10	12.32	12.13	11.49	11.18	11.85	16.69	11.31	16.31	16.46	16.16
	LMU 4.2	-	-	25.05	12.44	12.08	11.45	11.09	11.89	16.67	11.20	16.27	15.10	14.79
	LMU Bastam 72(1)	-	-	29.43	15.22	14.64	14.36	14.09	14.41	20.80	13.55	20.31	17.86	17.63
	LMU Bastam 72(2)	-	-	30.43	14.99	14.22	13.71	13.60	13.88	19.20	13.25	18.78	17.07	16.83
	Bostam 78(1)	-	-	29.10	14.72	15.45	13.48	12.69	13.75	19.91	13.18	19.68	18.01	17.86
	Bostam 78 (2)	-	-	27.78	13.09	12.51	12.74	12.24	12.88	17.95	12.09	17.75	15.91	16.91
	GCZZ MFLN, A.J.L	-	-	26.70	12.64	12.51	12.21	12.21	11.86	16.84	11.06	16.54	-	-
	TBG 26	-	-	26.46	12.14	12.65	12.33	12.28	13.00	17.71	12.15	17.24	-	-
	TBG 115	-	-	31.51	14.98	14.79	14.68	13.99	14.66	20.03	12.74	19.21	-	-

	MHJ O gml 2	ad	f	26.35	12.75	12.53	11.82	11.68	11.55	16.84	10.72	16.47	13.99	14.52
	MHJ O gml 1	ad	m	27.65	13.98	12.68	12.31	12.19	11.89	17.59	11.27	17.04	14.73	14.68
	MHJ Ovis anatolicum	ad	m	25.13	11.63	10.37	11.89	11.45	11.45	-	10.48	15.89	13.98	13.89
	FMNH 98161	ad	m	24.94	12.43	11.74	11.50	10.89	12.29	17.18	11.62	16.80	15.32	15.34
	FMNH 58031	ad	m	26.99	12.61	12.84	12.22	11.80	12.87	19.04	12.32	18.59	16.34	16.07
	FMNH 152005	ad	f	26.10	12.66	12.98	11.94	11.65	12.84	18.33	11.91	17.78	15.64	15.55
	FMNH 152006	ad	f	25.07	12.29	11.50	11.46	10.96	12.20	17.79	11.64	17.26	15.70	15.46
	FMNH 58037	ad	m	29.27	13.83	12.29	13.78	13.37	12.86	18.65	12.02	18.12	16.45	16.30
	FMNH 58033	ad	f	27.30	13.55	13.02	12.54	12.06	12.54	17.83	11.42	16.95	15.51	15.29
	FMNH 58038	ad	f	25.89	13.26	12.53	11.85	11.33	12.18	17.59	11.38	16.77	15.52	15.41
	FMNH 58039	aub	m	25.62	12.40	12.28	11.79	11.46	12.03	16.95	10.95	16.51	14.76	14.79
Ovis musimon (European mouflon, feral)	MNHN 1907-579	ad	m	27.79	13.19	11.84	12.89	12.85	12.85	18.53	11.94	17.86	15.71	15.57
	MNHN UN1	ad	-	27.23	13.00	12.32	12.68	12.51	12.37	17.51	12.24	17.34	15.51	15.65
	MNHN 1909-317	sub	m	22.73	9.98	10.50	10.88	10.93	11.65	17.39	11.32	17.17	14.52	14.63
	MNHN UN2	ad	-	32.67	14.77	14.27	14.94	14.85	13.39	19.30	12.72	18.97	16.49	16.46
	MNHN UN3	ad	f	24.46	11.52	11.24	11.48	11.12	11.52	16.49	10.85	15.93	14.46	14.39
	MNHN 1930-468	ad	m	26.13	12.51	12.25	12.20	12.08	11.66	17.43	11.23	16.97	14.57	14.57
	MNHN 1872.19	ad	m	26.95	12.97	12.85	12.53	12.25	12.20	17.67	11.36	17.11	15.05	14.92
	MNHN 1930-468	ad	m	26.28	12.70	11.84	12.23	12.15	11.52	17.30	11.30	17.16	14.64	14.75
	MNHN 1987-058	ad	f	24.31	11.10	10.93	11.27	11.31	12.57	17.73	11.88	17.11	14.97	14.76
	MNHN 1967-924	ad	-	23.88	10.97	10.49	11.15	10.95	11.78	16.29	10.99	15.64	14.26	14.09
Ovis musimon (European mouflon, zoobred)	LMU 19	ad	f	21.58	12.51	12.97	11.54	11.11	10.77	15.62	9.69	14.77	12.88	12.76
	LMU 28	ad	f	24.04	11.57	11.87	10.89	10.71	11.00	15.75	9.72	14.96	13.08	12.85
	LMU 6	ad	f	23.68	11.30	12.47	10.95	10.59	11.24	15.80	10.22	15.29	13.35	13.17
	LMU 27	ad	f	24.13	11.34	11.76	11.27	11.27	10.82	15.70	9.93	15.09	12.79	12.58
	LMU 10	ad	f	23.37	10.65	10.26	10.93	10.48	10.84	15.74	9.93	15.03	13.18	12.89
	LMU 20	ad	f	23.11	11.12	10.92	10.96	10.38	10.73	16.09	9.77	15.41	12.89	12.74
	LMU 31	ad	f	23.56	11.61	10.81	10.95	10.46	10.53	15.08	9.46	14.60	12.72	12.58
	AMNH 35683	ad	f	23.75	11.27	11.45	11.16	10.80	11.90	16.72	11.20	16.17	14.47	14.53
	LMU orientalis 32	ad	m	25.11	12.26	10.64	11.68	11.44	10.81	16.07	9.92	15.47	13.40	13.25

	LMU 22	ad	m	26.42	12.37	12.06	12.53	12.08	11.45	17.11	10.16	16.50	14.35	14.39
	LMU 8	ad	m	26.64	12.82	13.29	12.53	12.12	12.16	17.55	10.90	16.95	14.53	14.32
	AMNH 10261	ad	m	24.36	12.09	10.80	10.96	10.81	9.66	14.91	9.28	14.45	12.68	12.81
	AMNH 35478	ad	m	27.05	13.02	12.34	12.75	12.33	12.90	18.33	11.96	17.61	15.60	15.60
	AMNH 875CA	ad	m	26.06	12.51	13.28	11.97	11.68	11.66	16.79	10.94	16.13	14.54	14.67
	AMNH 35316	ad	-	24.22	12.43	12.28	10.96	10.60	10.03	15.35	9.42	14.87	13.12	13.17
	CP132	ad	-	26.99	12.34	12.93	12.72	12.28	12.27	17.96	11.20	17.30	-	-
	CP 133	ad	-	26.89	12.60	13.38	12.45	12.18	12.21	18.02	11.21	17.35	-	-
	LMU 30	sub	f	22.06	10.41	9.79	10.49	10.18	10.16	15.23	9.01	14.55	12.21	12.25
	LMU 257	sub	m	22.64	10.51	10.81	10.82	10.38	10.50	15.65	9.80	15.09	13.04	12.92
	AMNH 6238	sub ad	-	23.51	11.68	11.13	10.83	10.40	9.07	14.31	8.64	13.93	12.26	12.33
	LMU 12	sub	m	23.71	10.85	10.90	11.27	10.81	10.97	15.96	9.57	15.48	12.99	13.12
	LMU 14	sub	m	23.40	10.87	11.11	11.05	10.53	10.80	15.59	9.53	14.82	12.48	12.48
	LMU 259	sub	m	24.25	11.44	11.02	11.44	11.03	11.29	16.61	10.53	16.08	13.65	13.85
Ovis aries (domestic country sheep)	GCZ N75	ad	f	20.98	9.48	10.24	9.64	9.34	9.70	14.40	9.01	13.93	-	-
	GCZ G64	-	-	25.59	12.15	11.85	11.91	11.99	10.97	15.96	11.48	16.31	-	-
	GCZ 315	ad	f	22.17	10.20	10.76	10.02	9.80	9.64	14.28	9.28	13.96	11.72	11.90
	GCZ 404	ad	f	21.75	9.95	10.81	9.93	9.93	10.25	14.70	9.26	14.36	12.42	12.57
	GCZ 329	ad	f	22.87	10.27	11.34	10.51	10.27	10.90	15.79	10.06	15.23	13.44	13.37
	GCZ 436	ad	f	21.30	9.56	9.83	9.87	9.53	9.41	13.97	8.78	13.51	11.71	11.60
	GCZ 394	ad	f	21.79	9.98	9.63	10.15	9.73	9.08	13.47	8.75	13.27	11.44	11.62
	GCZ 495	ad	f	24.80	11.34	12.92	11.64	11.27	10.86	15.78	10.22	15.25	12.94	12.97
	GCZ 435	ad	f	25.74	11.72	13.13	11.94	11.61	11.21	15.88	10.73	15.51	13.02	12.92
	GCZ Y1	ad	-	22.85	9.83	9.58	10.61	10.57	10.89	-	9.95	-	12.94	12.88
	GCZ G64 Y48	ad	-	25.65	11.97	11.81	11.98	11.73	11.58	16.46	11.01	15.93	13.89	13.65
	GCZ Y2	ad	-	29.10	13.47	15.47	13.73	13.16	13.29	18.80	12.35	18.06	15.98	15.98
	GCZ Y3	ad	-	24.65	11.07	11.14	11.55	11.09	11.26	15.45	10.25	14.74	13.14	13.12
	GCZ Y4	ad	-	37.80	16.85	17.43	17.22	16.32	16.36	22.22	14.87	21.21	18.85	18.72
	LMU 60	sub	m	27.10	12.23	14.01	12.74	12.25	11.75	16.89	10.88	16.28	14.13	14.55
	LMU 27	ad	m	25.18	11.14	9.98	11.53	10.81	11.95	16.36	10.36	15.40	13.85	13.63

Ovis aries (domestic sheep Rambouillet breed)	MHJ O rb 6, 14/75	ad	f	23.79	11.13	10.30	11.20	10.84	10.46	15.76	9.70	14.92	13.03	12.91
	MHJ O rb 2, 1	ad	f	31.53	14.17	14.19	14.77	13.96	16.00	22.24	14.29	20.98	18.08	17.76
	MHJ O rb 18, 432	ad	f	24.33	11.39	11.94	11.32	11.01	10.20	15.35	9.40	14.82	12.80	12.81
	MHJ O rb 13, 20/75	ad	f	24.71	10.94	12.17	11.62	11.41	11.08	16.22	10.31	15.37	13.55	13.61
	MHJ O rb 3, 2	ad	f	29.36	13.55	15.42	13.85	12.90	13.98	19.86	12.77	19.32	16.45	16.95
	MHJ O rb 10, 17/75	ad	f	23.22	10.59	10.91	10.91	10.48	10.64	15.04	9.40	14.27	12.31	12.24
	MHJ O sfrz m 1	ad	f	23.64	10.63	11.45	11.17	10.39	11.25	16.32	10.18	15.60	13.63	13.54
	MHJ O rb 7, 14/82	ad	f	24.22	11.88	12.31	10.60	10.10	10.83	15.66	9.61	14.71	13.11	13.04
	MHJ O rb 5, 13/75	ad	f	25.20	12.64	12.58	11.34	10.59	11.08	16.10	10.33	15.13	13.49	13.50
	MHJ O rb 4, 8	ad	m	33.57	15.19	14.18	15.93	15.00	15.64	21.94	13.90	21.27	18.30	18.53
	MHJ O rb 9, 15/82	ad	m	28.36	13.00	14.40	13.46	12.42	12.86	18.20	11.63	17.31	15.35	14.86
	MHJ O rb 17,209/76	ad	m	29.58	13.41	15.24	14.27	13.21	14.08	19.74	12.52	18.93	16.27	16.43
	MHJ O rb 19, 433	ad	m	31.81	14.00	15.29	15.41	13.82	15.38	20.93	13.46	19.64	17.61	17.40
Ovis aries (crossbreed, Argali ×sheep)	MHJ O rb/ag 87, 811/92	ad	f	23.47	11.15	11.08	10.70	10.33	10.46	15.83	9.79	15.30	13.09	13.08
	MHJ O rb/ag 190; 1014/00	ad	f	22.40	10.52	10.81	10.54	9.73	10.19	14.72	9.21	13.98	12.17	11.90
	MHJ O rb/ag 173; 986/05	ad	f	26.88	13.14	12.61	12.14	11.42	11.99	16.50	11.11	16.16	14.02	14.25
	MHJ O rb/ag 116; 885/93	ad	f	26.09	12.23	12.05	11.95	11.40	12.43	17.54	11.94	17.16	14.88	14.92
	MHJ O rb/ag 155, 978/94	ad	f	25.85	12.75	12.09	11.58	11.42	11.24	-	11.25	-	14.13	13.92
	MHJ O rb/ag 191, 1014/03	ad	m	26.21	12.26	11.68	12.37	11.63	12.07	17.37	10.95	16.55	14.42	14.32
	MHJ O rb/ag 59,708/90	ad	m	24.82	11.39	11.61	11.18	10.58	10.98	16.18	10.66	15.89	13.83	13.76
	MHJ O rb/ag 251,1093/02	ad	m	27.07	12.66	12.10	12.60	11.72	11.72	-	10.76	15.81	13.65	13.59
	MHJ O rb/ag 246, 109/97	ad	m	29.22	14.62	13.62	13.33	12.37	12.61	18.54	11.49	17.92	15.80	15.66
	MHJ O rb/ag 311,1148/06	ad	m	25.02	11.37	11.72	11.75	11.23	12.45	17.60	11.03	16.95	14.84	14.91
	MHJ O rb/ag 286,1115/97	ad	m	-	12.01	11.62	11.31	-	-	-	-	-	14.41	-
	MHJ O rb/ag 17, 986/06	ad	m	29.44	15.00	14.04	12.52	12.19	11.94	16.65	10.95	16.25	14.33	14.11
	MHJ O rb/ag 281, 1100/97	ad	m	25.42	11.60	-	11.54	11.47	11.39	16.42	10.73	16.01	13.78	13.95
	MHJ O rb/ag 193, 1015/95	ad	m	25.15	12.29	11.41	11.12	10.99	12.08	17.26	11.33	16.94	14.67	14.67
	MHJ O rb/ag 126, 902/01	ad	m	27.27	13.07	12.87	12.47	11.88	12.77	-	11.47	17.89	15.94	15.64
	MHJ O rb/ag 200,1030/95	ad	m	26.16	12.71	12.60	11.97	11.26	11.71	17.03	10.45	16.27	14.18	14.36
	MHJ O rb/ag 259, 1093/08	ad	m	26.64	12.22	12.31	12.18	11.57	11.96	17.51	11.10	16.91	14.60	14.43

	MHJ O rb/ag 143; 939/01	ad	m	28.29	14.97	12.27	12.44	11.54	11.40	16.52	9.95	16.16	14.60	14.87
	MHJ O rb/ag 211; 1035/95	ad	m	23.84	11.38	10.51	11.04	10.35	11.40	16.04	10.50	15.48	13.74	13.46
	MHJ O rb/ag 258; 1093/07	ad	m	27.82	12.83	12.82	12.81	12.29	12.16	17.61	10.92	17.12	14.72	14.63
	MHJ O rb/ag 95;1892-1895	ad	m	24.61	11.68	11.29	10.82	10.53	11.31	16.19	10.34	15.96	14.11	14.15

3. Metatarsal

Taxa	Specimen Number	Age	Sex	Bd	DBV	DpBV	1	2	3	4	5	6	7	8
Ovis ammon (Argali, zoobred)	LMU 6	ad	f	31.66	15.08	14.33	14.01	13.01	14.95	21.38	14.26	20.58	18.08	18.01
	LMU 8	ad	f	30.10	14.21	13.88	13.43	12.37	13.66	20.57	12.97	19.70	17.48	17.18
	LMU 9	ad	m	30.11	14.44	13.01	13.63	12.43	13.74	20.26	13.21	19.29	17.01	16.94
	BMN 1	ad	-	26.43	12.16	12.24	11.86	11.03	12.45	18.38	11.57	17.49	-	-
	LMU 7	sub	m	27.50	12.76	12.94	12.93	12.04	12.73	19.34	12.11	18.65	16.83	16.66
	LMU 1	sub	m	31.41	14.47	14.45	14.45	13.45	13.35	21.11	12.16	19.71	17.30	16.62
	LMU 3	sub	f	26.76	12.70	12.85	12.40	11.90	12.26	19.47	12.13	18.81	16.35	16.33
Ovis ammon (Argali, captured wild)	MHJ O am ltld 1	ad	m	35.00	16.25	16.65	16.55	15.18	17.57	25.70	16.04	24.29	21.70	21.59
	MHJ O am ltld 9 218	ad	f	33.82	15.99	17.05	15.91	14.65	17.05	24.91	15.84	23.80	21.18	21.05
	MHJ 217,O am alt 3	ad	f	35.20	17.02	17.49	16.44	15.02	18.18	25.82	16.92	24.72	22.01	21.74
	MHJ ohne, O am ltld 2	ad	f	34.06	16.14	17.20	15.65	14.79	17.40	25.35	16.79	24.40	21.56	21.23
	MHJ 204, O am ltld 7	ad	f	33.47	15.11	15.46	15.89	14.72	17.23	-	16.24	-	-	-
	FMNH 25683	ad	f	32.75	15.27	15.08	15.40	14.14	15.68	23.80	14.89	22.84	19.73	19.54
	FMNH 25684	ad	m	36.85	17.34	17.43	17.33	16.39	18.47	26.84	16.78	25.54	22.07	22.06
	FMNH 25685	ad	m	36.26	16.58	16.82	17.16	16.16	17.30	25.77	16.14	24.77	21.67	21.34
	USNM 240688	ad	f	29.52	14.24	13.16	13.57	12.55	14.41	21.22	13.61	20.30	17.65	17.14
	MCZ 19940	ad	m	33.00	16.12	15.20	15.43	14.50	16.62	23.97	15.94	23.09	20.55	20.07
	MCZ 19941	ad	m	35.26	16.58	15.87	16.50	15.11	17.68	25.70	16.68	24.73	22.06	21.77
	AMNH 45490	ad	m	33.02	16.31	15.78	15.03	13.97	15.68	23.35	15.80	22.85	19.99	19.89
	AMNH 45492	ad	m	34.98	16.93	16.99	16.35	15.53	17.02	24.62	16.04	23.52	21.03	20.80
	AMNH 54931	ad	m	34.58	16.62	16.21	16.30	14.79	16.59	25.53	15.74	23.99	21.32	20.57
	AMNH 54875	ad	f	31.41	15.52	15.51	14.49	13.63	15.85	23.28	14.72	22.15	20.02	19.42

	AMNH 54873	ad	m	34.63	16.38	15.93	16.35	15.15	16.65	24.30	15.75	23.20	20.29	20.25
	AMNH 54867	ad	m	35.04	17.14	16.98	16.78	15.03	17.50	26.03	16.63	25.07	22.66	22.46
	MHJ O am alt 2, 163	sub		33.94	16.55	15.44	15.35	14.63	16.53	24.11	15.64	23.05	19.76	19.82
	MHJ O pol hein 1, 216	sub	m	39.00	18.54	18.72	18.08	16.73	19.22	28.86	18.82	27.80	24.19	24.04
	MHJ O am ltld 3 II	sub	f	32.63	15.31	15.09	15.01	14.38	15.46	22.94	14.29	21.92	19.44	18.66
	AMNH 45494	sub	m	32.43	15.99	15.52	15.43	13.88	15.88	23.11	14.81	22.04	19.13	19.14
	AMNH 54874	sub	m	34.85	16.77	15.62	15.78	15.29	17.88	25.43	16.64	24.54	21.60	21.40
	AMNH 54881	sub	m	33.67	15.91	15.84	15.83	14.49	16.13	24.08	14.71	22.78	19.91	19.60
	MHNP 1876-524	sub	f	28.71	13.83	13.27	13.71	12.48	14.26	21.26	13.68	20.23	17.65	17.41
	FMNH 25676	sub	m	34.54	16.75	16.00	16.09	15.07	17.29	25.33	16.64	24.47	21.85	21.59
	MCZ 19942	sub	-	29.82	14.19	14.64	14.37	13.47	15.89	22.17	14.75	21.44	18.95	19.26
Ovis vignei (Urial sheep)	LMU 1	ad	f	25.11	11.02	-	11.61	11.14	11.67	17.35	11.10	16.76	14.29	14.17
	LMU 5	ad	f	22.04	10.03	9.85	10.25	9.23	10.20	15.65	9.11	15.26	12.75	12.76
	LMU 4	sub ad	m	28.01	13.45	13.45	11.16	11.07	12.67	18.37	11.52	17.33	-	-
	LMU 2	ad	f	25.14	11.87	11.70	10.89	9.94	12.11	17.78	11.29	16.91	14.80	14.47
	BMN 83438	ad	f	25.51	11.33	11.55	11.04	10.53	11.06	17.49	10.20	16.68	-	-
	BMN O arkal 4380	ad	m	37.77	17.66	18.68	17.74	16.87	17.34	26.28	16.77	25.27	-	-
	BMN O arkal	-	-	27.56	13.10	13.09	12.09	11.67	12.80	18.48	12.08	18.12	-	-
	MHJ 153/07	ad	m	25.09	12.39	12.35	11.68	10.67	10.89	16.50	9.71	15.26	13.44	13.21
	MHJ 430, O ur 26	ad	m	25.54	12.44	10.99	11.57	11.13	12.14	17.75	11.30	-	15.02	14.49
	MHJ O ur 21	ad	m	26.11	13.04	11.76	11.70	10.95	12.24	18.31	11.27	17.49	14.97	14.72
	MHJ 165, O ur 23	ad	m	19.88	9.57	10.23	9.36	8.81	9.72	14.69	9.32	14.14	12.61	12.54
	MHJ 392, O ur 25	ad	m	21.14	10.21	9.72	9.69	9.12	10.45	15.97	10.70	-	13.56	13.69
	MHJ 161, O ur 22	ad	m	22.14	-	-	-	-	-	-	-	-	-	-
	AMNH 119526	ad	m	23.14	12.31	11.35	11.08	10.18	11.42	17.60	10.84	16.81	14.53	14.47
	AMNH 54616	ad	f	24.14	11.98	11.97	11.78	10.65	11.84	17.95	11.43	17.17	15.06	14.93
Ovis orientalis (Western Asian mouflon)	LMU 4.2	ad	f	24.48	11.87	12.40	11.36	10.39	11.60	17.40	11.06	16.66	15.01	15.14
	LMU 4.3	ad	m	26.75	13.26	12.72	12.32	11.32	12.24	18.69	11.34	17.50	16.09	15.50
	LMU Bastam 72 (1)	-	-	26.56	12.23	12.32	11.51	11.35	12.46	18.60	11.52	17.36	15.78	15.43

	*													
	Bastam 72 (2)	-	-	29.78	13.70	14.30	13.44	12.89	14.60	20.50	13.37	-	17.18	17.44
	Bastam 78 (1)	-	-	27.96	13.34	13.48	12.98	12.37	13.26	20.34	12.63	19.37	16.68	16.55
	Bastam Da2	-	-	27.55	13.09	13.34	13.17	12.12	13.29	19.98	12.37	19.29	16.53	16.32
	BHM O 16329	ad	m	31.28	13.55	13.55	13.41	12.67	13.72	20.51	12.91	19.92	-	-
	MHJ O gml 2	ad	f	32.28	11.43	11.92	11.46	10.85	11.28	17.45	10.70	16.73	14.52	14.59
	MHJ O gml 1	ad	m	33.28	13.04	12.05	11.44	10.64	11.12	17.64	10.54	16.87	14.91	14.59
	MHJ Ovis anatolicum	ad	m	34.28	10.82	10.53	11.05	10.19	10.27	16.24	9.98	15.47	13.49	13.40
	FMNH 98161	ad	m	35.28	12.13	11.40	11.12	10.19	12.04	17.68	11.32	16.92	15.02	14.95
	FMNH 58031	ad	m	36.28	11.75	11.75	11.81	10.89	12.68	19.53	12.40	18.74	16.02	16.06
	FMNH 152005	ad	f	37.28	11.99	12.27	11.81	10.95	12.26	18.84	11.50	17.95	15.39	14.98
	FMNH 152006	ad	f	38.28	11.76	11.31	11.39	10.55	11.88	18.16	11.26	17.57	15.39	15.35
	FMNH 58037	ad	m	39.28	13.06	12.23	13.31	12.41	11.80	18.64	11.60	18.02	15.86	15.85
	FMNH 58033	ad	f	40.28	13.02	12.13	12.47	11.32	12.37	18.35	11.09	17.24	15.38	15.14
	FMNH 58038	ad	f	41.28	12.61	12.64	11.54	10.66	11.63	17.93	10.99	16.92	14.83	15.02
	FMNH 58070	ad	F	42.28	12.28	11.27	11.57	10.77	11.16	16.78	11.18	16.24	14.23	13.98
	FMNH 58065	ad	f	43.28	11.05	11.12	11.77	10.47	10.81	17.20	10.31	16.13	14.47	14.09
	FMNH 58035	ad	m	44.28	12.73	13.29	13.04	11.83	13.12	20.36	12.72	19.65	17.01	17.05
Ovis musimon (wild)	MHNH 1930-G68	ad	m	24.83	11.69	12.02	12.04	10.86	11.10	17.53	10.38	16.73	14.37	14.45
	MHNH 1907-579	ad	m	26.51	12.76	12.04	12.37	11.85	12.12	18.23	11.55	17.84	15.08	15.11
	MHNH UN1	ad	-	26.02	12.89	12.72	12.25	11.33	11.60	17.34	11.43	16.45	14.85	14.84
	MNHN UN2	ad	-	29.03	14.26	13.04	13.28	12.72	13.44	19.21	12.58	18.68	15.66	15.90
	MHNH 1967-924	sub	-	22.39	10.66	11.05	10.68	9.57	11.23	16.30	10.37	15.12	13.84	13.61
	MHNH 1987-058	ad	f	23.54	10.50	10.65	11.22	10.49	12.05	17.88	11.21	16.99	14.48	14.39
	MHNH 1872.19	ad	m	26.05	12.53	12.19	12.18	11.47	11.49	17.82	10.97	17.22	14.65	14.78
	MHNH 1909.317	ad	m	22.97	10.51	11.83	11.21	10.19	11.21	18.02	10.73	16.80	14.38	14.42
Ovis musimon (zoobred)	LMU 28	ad	f	22.39	10.76	11.55	10.22	9.67	10.22	16.03	9.29	15.02	13.20	13.04
	LMU 19	ad	f	23.28	12.22	12.52	10.25	9.39	10.30	15.95	9.29	15.07	13.10	13.00
	LMU 8	ad	m	24.74	11.93	12.36	11.85	11.03	11.48	17.75	10.00	16.71	14.16	14.29
	LMU 27	ad	m	22.15	10.01	10.21	10.82	9.45	10.26	15.98	9.09	14.99	12.91	12.82

	LMU 32	ad	m	22.68	11.10	10.88	10.67	9.59	10.07	16.28	9.26	15.46	13.40	13.36
	LMU 10	ad	f	22.52	10.27	10.47	10.83	10.03	10.98	16.39	10.06	15.13	13.75	13.03
	LMU 20	ad	f	21.66	10.13	10.59	10.50	9.35	9.89	16.33	8.93	15.39	12.89	12.93
	LMU 31	ad	f	21.52	10.44	10.95	9.97	9.15	9.88	15.34	9.01	14.74	12.76	12.74
	LMU 22	ad	m	24.45	11.72	11.89	11.89	10.84	10.75	17.54	9.61	16.55	14.14	14.12
	LMU 12	sub	m	21.94	10.07	10.73	10.59	9.82	9.64	16.10	9.06	15.51	13.10	12.91
	LMU 14	sub	m	22.38	10.18	11.11	10.96	10.07	9.75	15.72	9.17	15.10	12.84	12.48
	LMU 30	sub	f	20.62	9.42	9.82	10.18	9.02	9.60	15.54	8.43	14.45	12.31	12.34
	LMU 259	sub	m	23.42	10.94	11.88	11.21	10.29	11.24	17.06	10.24	15.86	13.61	13.29
	AMNH 6238	sub	-	22.65	11.49	10.99	10.33	9.57	9.06	15.12	8.74	14.40	12.60	12.63
	AMNH 10261	ad	m	22.41	11.29	10.49	10.46	9.62	9.42	15.48	8.88	14.65	13.09	12.98
	AMNH 35478	ad	m	26.85	12.80	13.00	12.77	11.61	11.89	18.74	11.50	17.67	15.53	15.34
	AMNH 35316	ad	-	23.77	12.31	12.18	10.81	9.87	10.33	16.04	9.55	15.23	13.44	13.38
	AMNH 35683	ad	f	22.67	10.98	11.23	10.71	9.81	11.58	16.99	10.75	15.97	14.44	14.07
	AMNH 875CA	ad	m	23.85	11.61	11.45	11.23	10.47	11.44	17.16	10.73	16.37	14.39	14.30
Ovis aries (Soay breed)	GCZ 404	ad	f	21.18	10.10	11.23	10.19	9.14	9.58	14.67	9.08	14.13	12.25	12.41
	GCZ 329	ad	f	22.38	10.23	11.27	10.55	9.92	10.43	15.94	9.95	15.17	13.65	13.26
	GCZ 394	ad	f	20.47	9.84	10.49	9.91	8.68	8.58	13.59	7.92	12.72	11.38	11.34
	GCZ 435	ad	f	24.12	11.19	11.60	11.59	10.49	10.33	15.92	9.04	14.96	12.72	12.97
	GCZ 436	ad	f	20.29	9.30	10.82	9.53	8.76	8.85	13.95	8.09	13.03	11.49	11.39
	GCZ 315	ad	f	21.38	10.70	11.39	10.23	9.08	8.99	14.07	8.28	13.50	11.57	11.58
Ovis aries (country sheep)	LMU musimon aries 6	ad	f	22.95	10.68	12.17	10.81	10.10	10.89	16.06	9.90	15.11	13.08	13.11
	GCZ 1	-	-	33.39	16.06	16.79	16.46	14.48	13.19	21.50	13.51	20.09	18.06	17.86
	GCZ 2	sub	-	28.00	13.25	13.78	13.28	11.84	12.45	18.43	11.47	17.46	15.55	15.18
	GCZ Y49G6H	ad	-	23.64	11.39	12.37	11.55	10.35	10.58	16.40	9.94	15.47	13.75	13.53
	GCZ DORSET	ad	-	27.42	13.12	13.94	12.82	11.99	11.66	17.95	11.15	17.23	15.16	15.31
	MHNP 1930-159	ad	m	21.27	10.01	10.18	10.16	9.15	10.36	15.31	9.43	14.28	12.20	12.55
	AMNH 17980	ad	f	26.50	12.70	12.69	12.65	11.35	10.97	16.81	9.70	15.82	13.94	13.90
	AMNH 21528	ad	m	29.43	13.44	13.46	14.46	12.98	13.26	20.42	12.32	18.93	17.24	16.42
	AMNH 35494	ad	f	22.92	10.69	11.90	11.08	10.02	11.03	16.46	10.32	15.63	13.62	13.98

Ovis aries (Rambouillet)	MHJ O rb 4, 8	ad	m	31.94	14.76	15.78	14.86	13.84	14.10	21.10	12.96	20.45	17.05	17.16
	MHJ O rb 6, 14/75	ad	f	32.94	10.77	11.44	10.81	9.67	9.88	15.63	9.01	14.62	12.65	12.65
	MHJ MHJ O rb 9, 15/82	ad	m	33.94	13.84	14.92	12.72	12.00	12.06	18.33	10.53	17.38	14.67	15.40
	MHJ MHJ O rb 2, 1	ad	f	34.94	13.69	13.70	14.16	12.61	15.05	21.67	14.06	20.50	17.66	17.53
	MHJ MHJ O rb 18, 432	ad	f	35.94	11.47	11.48	10.78	9.87	9.45	15.26	8.70	14.29	12.35	12.15
	MHJ O rb 13, 20/75	ad	f	36.94	11.00	11.38	11.50	10.05	10.43	16.41	9.92	15.57	13.75	13.58
	MHJ O rb 3, 2	ad	f	37.94	12.86	14.63	13.14	12.14	12.63	19.98	12.01	18.97	16.54	16.54
	MHJ O rb 17,209/76	ad	m	38.94	13.09	13.65	14.00	12.02	13.47	19.85	12.16	18.56	16.08	15.99
	MHJ O rb 19, 433	ad	m	39.94	13.62	15.34	14.16	12.62	13.58	20.03	12.05	19.05	16.89	16.84
	MHJ O rb 10, 17/75	ad	f	40.94	10.78	11.53	11.02	9.99	9.76	15.34	9.00	14.12	12.31	12.28
	MHJ O sfrz m 1	ad	f	41.94	10.99	11.44	10.86	9.91	10.54	16.31	10.05	15.25	13.76	13.48
	MHJ O rb 7, 14/82	ad	f	42.94	13.11	12.15	10.62	9.37	9.98	15.80	8.95	14.66	13.00	12.77
	MHJ O rb 5, 13/75	ad	f	43.94	12.63	12.20	10.86	9.39	10.76	15.89	9.78	15.14	12.73	13.02
Ovis aries (crossbreed, Argali ×sheep)	MHJ O rb/ag 87, 811/92	ad	f	23.09	11.37	11.43	10.37	9.48	9.68	15.62	9.45	15.07	12.75	12.89
	MHJ O rb/ag 191, 1014/03	ad	m	24.09	12.49	12.43	12.17	10.70	11.31	17.29	10.15	16.23	14.02	13.87
	MHJ O rb/ag 59,708/90	ad	m	25.09	11.03	12.00	10.87	9.90	10.42	16.42	9.83	15.85	13.45	13.83
	MHJ O rb/ag 251,1093/02	ad	m	26.09	12.51	12.29	11.71	10.87	10.84	-	9.85	15.35	13.34	9.97
	MHJ O rb/ag 246, 109/97	ad	m	27.09	14.31	14.48	13.11	11.37	11.34	18.45	10.70	17.38	15.13	15.11
	MHJ O rb/ag 311,1148/06	ad	m	28.09	11.06	12.54	11.66	10.61	11.69	17.65	10.75	16.68	14.90	14.71
	MHJ O rb/ag 286,1115/97	ad	m	29.09	11.25	11.41	-	-	-	-	-	-	-	-
	MHJ O rb/ag 17,	ad	m	30.09	14.52	14.35	11.71	11.00	10.80	16.81	10.04	16.08	14.13	14.05

	986/06													
	MHJ O rb/ag 281, 1100/97	ad	m	31.09	12.10	11.63	11.32	10.34	10.78	16.67	9.51	16.09	13.38	13.57
	MHJ O rb/ag 193, 1015/95	ad	m	32.09	11.78	12.36	10.97	10.33	10.89	17.47	10.41	16.90	14.40	14.42

* Measurement 6 of Specimen LMU Bastam 72 (1) is slightly eroded but was still taken for analysis

sub: sub-adult; **juv**: juvenile; **ad:** adult; **m**: male; **f**: female

Appendix G Comparative Osteomorphology and Osteometry of the Caprinae and Gazella on Cheek Teeth

The teeth of different species of Caprinae are observed. However, it is found that only the Maxilla teeth of *Nemorhaedus* and *Capricornis* could likely be distinguished from the other species. There are slight differences existing between the teeth of the other Caprinae, but it is very difficult to distinguish them, especially in fragmentary archaeological samples. Therefore, only the diagnostic characters of *Nemorhaedus* and *Capricornis* from the others are presented here. The characteristics of these two species are similar to each other.

All the teeth observed are at a mature wearing stage, which could be coded as "□□" following Payne (1987).

Maxilla M1, M2 & M3

Viewing From Above

a. In *Nemorhaedus* and *Capricornis*, it bulges out strongly at the middle point of the pillars on its buccal surface, especially when the teeth are in a light wearing stage. In addition, it usually bulges out more on the mesial pillar than the distal pillar. In all the other species, the middle point of the pillar of the buccal surface often does not bulge out so much. (Figure G.1)
b. In *Ovis*, *Capra*, and *Pseudois*, the ridge on the buccal side of the twin cusps usually protrudes far beyond the general edge on the buccal face and pointing toward buccal direction straightly. In *Nemorhaedus* and *Capricornis*, the ridge mostly points towards a mesial-buccal direction, and if it points toward buccal direction straightly, it is not strongly developed as O/P/C does. However, a few exceptional cases were also observed. (Figure G.1)

Altogether 23 samples of maxilla were observed. Measurements were taken on the teeth. Table K.1 shows the size range of the upper M1, M2 and M3 on the samples that observed.

	M1	M2	M3
Length*	9.8-16.9	12.4-18.5	14.5-20.9
Breadth*	11.5-16.5	11.9-14.9	8.19-15.9

Table G.1 Osteometrics of Nemorhaedus and Capricornis. The length and breadth are taken just below the occlusal surface. Length is the greatest mesial-distal distance, and breadth is the greatest buccal-lingual distance.

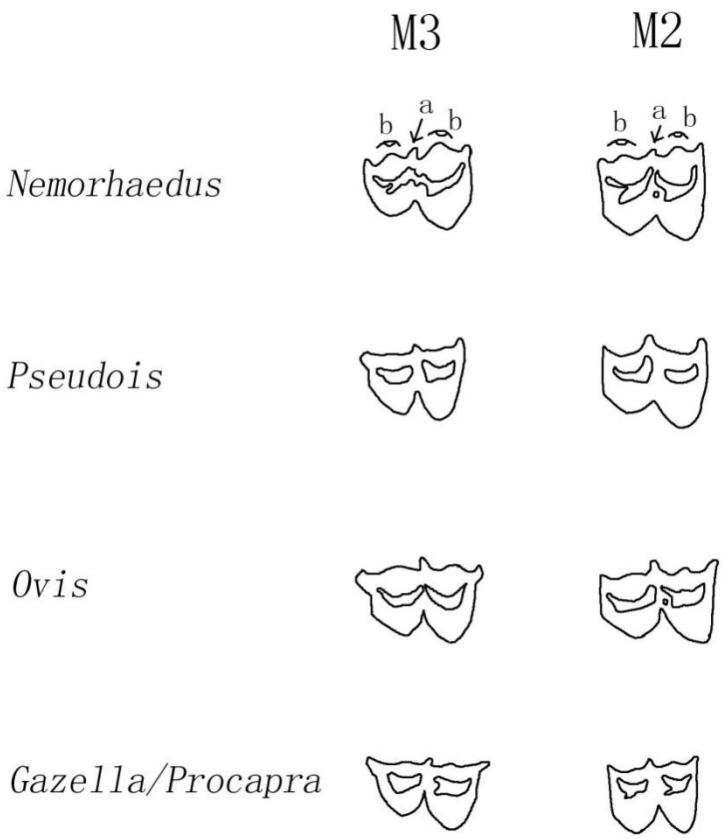


Figure G.1 Nemorhaedus, Capricornis, Pseudois, Ovis, Gazella/Procapra, osteomorphology, maxillia teeth, proximal view.

Appendix HComparative Osteomorphology and Osteometry of the Caprinae and Gazella on Distal Scapula

1. Introduction

Anatomical terms

As can be seen in Figure H.1, in the description of the morphology of the distal humerus, there are three anatomical terms been used:

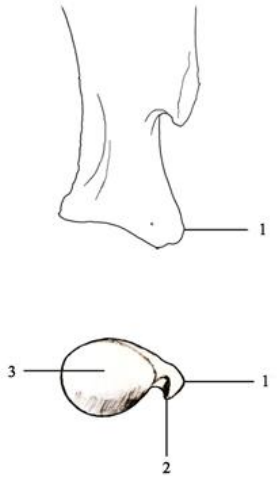


Figure H.1 Anatomical terms addressed on the scapula. 1. Tuberculum supraglenoidale; 2. The ridge of the Coracoid process; 3.Glenoid cavity.

Measurements

Apart from the standard measurements ‘GLP’, ‘LG’, ‘BG’, ‘LGm’, ‘SLC’ following von den Driesch (1976), one additional measurement was taken when applicable (Figure H.2):

LGm: the greatest length of the medial side of the glenoid cavity. Measured from the medial-cranial indent of the glenoid cavity to its caudal boarder, parallel to LG and GLP.

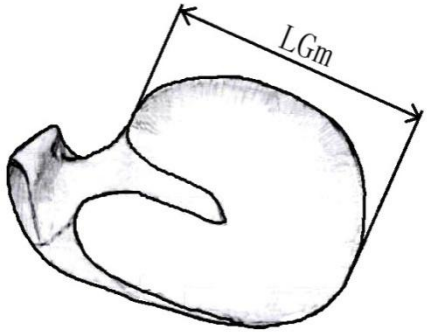


Figure H.2 Additional measurements taken on the scapula.

2. All Caprinae and *Gazella*

2.1 Absolute size

Table H.1 shows the size differences between the different Caprinae species. *Capricornis* is the largest among these species. *Pseudois nayaur* overlaps with all the *Ovis* species and *Capra hircus*. *Nemorhaedus* is the smallest and overlaps with European Mouflon and domestic sheep (see also Table H.3).

	GLP			
	N	Range	Mean	SD

Capricornis	3	42.3-50.3	45.0	4.59
Pseudois nayaur	19	33.4-41.6	37.9	2.25
Ovis	53	27.8-52.0	36.1	5.58
Nemorhaedus	5	29.2-33.9	30.7	1.91
Capra hircus	9	26.1-45.2	32.6	5.91

Table H.1 Osteometrics of Caprinae. The number of measurements taken (N), range, mean, and standard deviation (SD). Values are given for greatest length processes articularis (GLP) of the scapula in millimetre (mm).

2.2 Comparative Osteomorphology

Anterior view

1. The shape of the glenoid cavity in distal view

a. The shape of the glenoid cavity in is highly variable in *Pseudois nayaur* (see also von G. Götze 1998). It varies as different age stage of the animal. In adult *Pseudois nayaur*, the caudal lateral corner of the glenoid cavity is in a shape of a round square. In subadult and juvenile *Pseudois*, this part is of an oval shape. It becomes more like a square as the animal grows older. The medial edge of glenoid cavity is always in an oval shape in sub-adults and juveniles, but it would be a round-square at the medial-caudal or medial-cranial corner in some adults (Figure H.3).

b. The shape of the glenoid cavity is also variable in *Ovis* species. The general shape of the glenoid cavity in *Ovis* is oval (Boessneck 1969), although round shape is observed in juvenile individuals. The caudal lateral edge of the glenoid cavity is usually oval and no square, although in very few cases the rounded-square is observed, such as adult Argali. (Figure H.3)

c. In adult *Capra hircus*, the shape of the glenoid cavity is more rounded than *Ovis* (Boessneck 1969), but on juvenile or sub-adult individuals, longer/irregular shaped glenoid cavity is observed. There is no square corner on *Capra hircus* at any age stage. (Figure H.3). In general, it is the easiest to separate *Pseudois* from other *Ovis* and *Capra* when it is a full adult but not easy when it is a sub-adult or juvenile.

d. In *Nemorhaedus* and *Capricornis*, the shape of the glenoid cavity varies from round to oval. On some samples, there is no indent at the medial cranial corner of the glenoid cavity, unlike most of the other Caprinae studied. This is a good criterion to separate them from the other Capinaes. (Figure H.3)

e. On *Gazella* and *Procapra*, the shape of the glenoid cavity also varies from round to oval. Sometimes there is an indent at the lateral boarder of the glenoid cavity. (Figure H.3)

2. The form of the Tuberculum supraglenoidale and coracoids process

   a. On adult Pseudois, the Tuberculum supraglenoidale is strongly developed. coracoids process is long and developed like a large hook pointing medially. This is a good feature to separate them from other Caprinae. However, on juvenile and sub-adult Pseudois, the Tuberculum supraglenoidale is not so developed as in adults and cannot be separated easily from other Caprinae (Figure H.3).

b. The form of the Tuberculum supraglenoidale and Coracoids process also varies in Argali at their different age stages. The Tuberculum supraglenoidale extends more medially and becomes comparatively shorter as the animal grows older. But the Coracoids process is not as long as the adult *Pseudois* at any stage of Argali. The features on domestic sheep are closer to juvenile Argali. (Figure H.3)

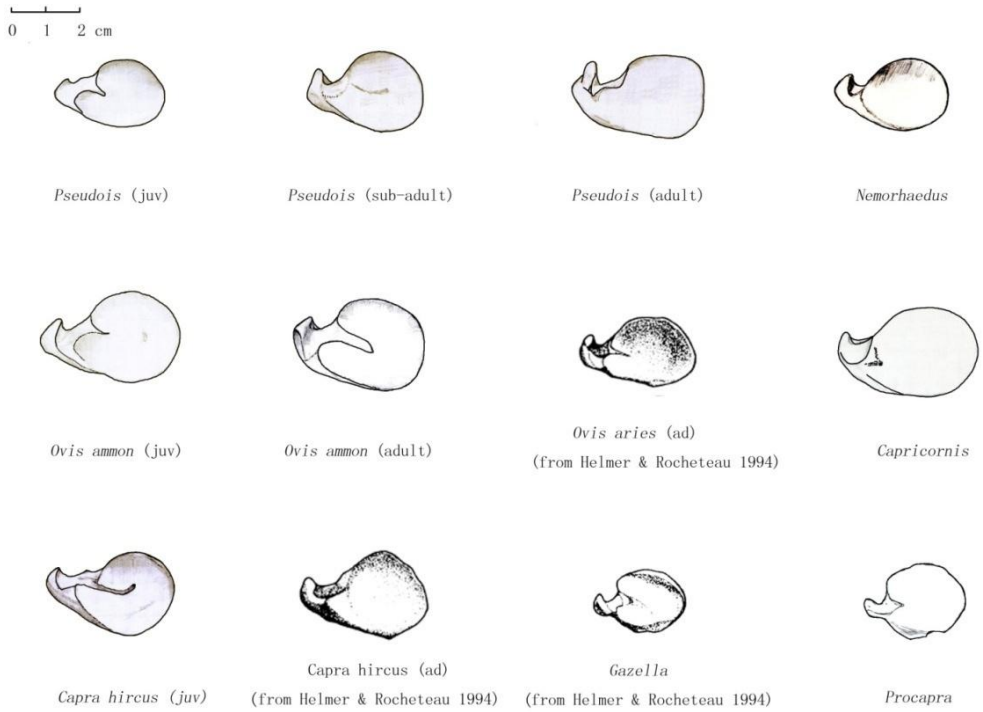


Figure H.3 Pseudois, Ovis, Nemorhaedus, Capra hircus, Capricornis, Gazella, Procapra, Scapula, anterior view, Comparative osteomorphology. The arrows show the most distinctive features that separate that species from the others.

a. In *C. hircus*, the Tuberculum supraglenoidale just develops toward the cranial direction and the Coracoids process point medially only slightly. In contrast, in *Psuedois* and Argali the process point toward medially very obviously (Figure H.3).

b. The features on *Nemorhaedus* and *Capricornis* are similar to each other, although *Nemorhaedus* is more delicate. The medial side of the Tuberculum supraglenoidale is deeply indented; the lateral side is sharp and high. The coracoids process is like a small hook pointing medially. (Figure H.3)

c. On *Gazella* and *Procapra*, the ridge of the Tuberculum supraglenoidale is not continuously connected with the lateral border of the glenoid cavity like Caprinae. Rather, it is broken from the lateral border of the glenoid cavity, looks like a small bud protruding out from the boarder of the cavity, similar to the feature of roe deer (Figure H.3).

Lateral view

a. The tuberculum supraglenoidale in lateral view

In *Ovis*, *Capra*, *Pseudois nayaur*, *Nemorhaedus*, *Capricornis*, this part is rounded, and the border line is smooth; in *Gazella* and *Procapra*, there is a small indentation at the cranial side --- this is a good feature to separate them from the Caprinae. (Figure H.4)

b. The caudal side of the collum of the scapula

a. In *Ovis*, there is a pecten rising on the caudal side of the collum (Boessneck 1964). It is more strongly developed in adult than sub-adult and juveniles, and more strongly developed in males than females. This feature is similar in all the species of *Ovis*. (Figure H.4)

b. In *Pseudois nayaur*, the caudal side of the collum does not bulge out like *Ovis*, rather, it looks generally straight from the lateral side. The ragged edge is developed for muscle attachment, and it is more obvious on the adult males than females and has not yet developed or just about to develop on juvenile and sub-adults. (Figure H.4)

c. On *Capra hircus*, as stated in Boessneck, the pecten is absent or only hinted (1969). It is not as rough as *Pseudois* on the adult ones. But on a very few samples of adult, the slightly higher ridge is observed. (Figure H.4)

d. In *Nemorhaedus*, the pecten is not strongly developed as on Ovis and seldom rises up. On very few samples it is a little bit high. (Figure H.4)

e. In *Gazella* and *Procapra*, the pectin is not as strongly developed as *Ovis*, although may be a little bit stronger than *Capra* (see also Helmer & Rocheteau, 1994) (Figure H.4).

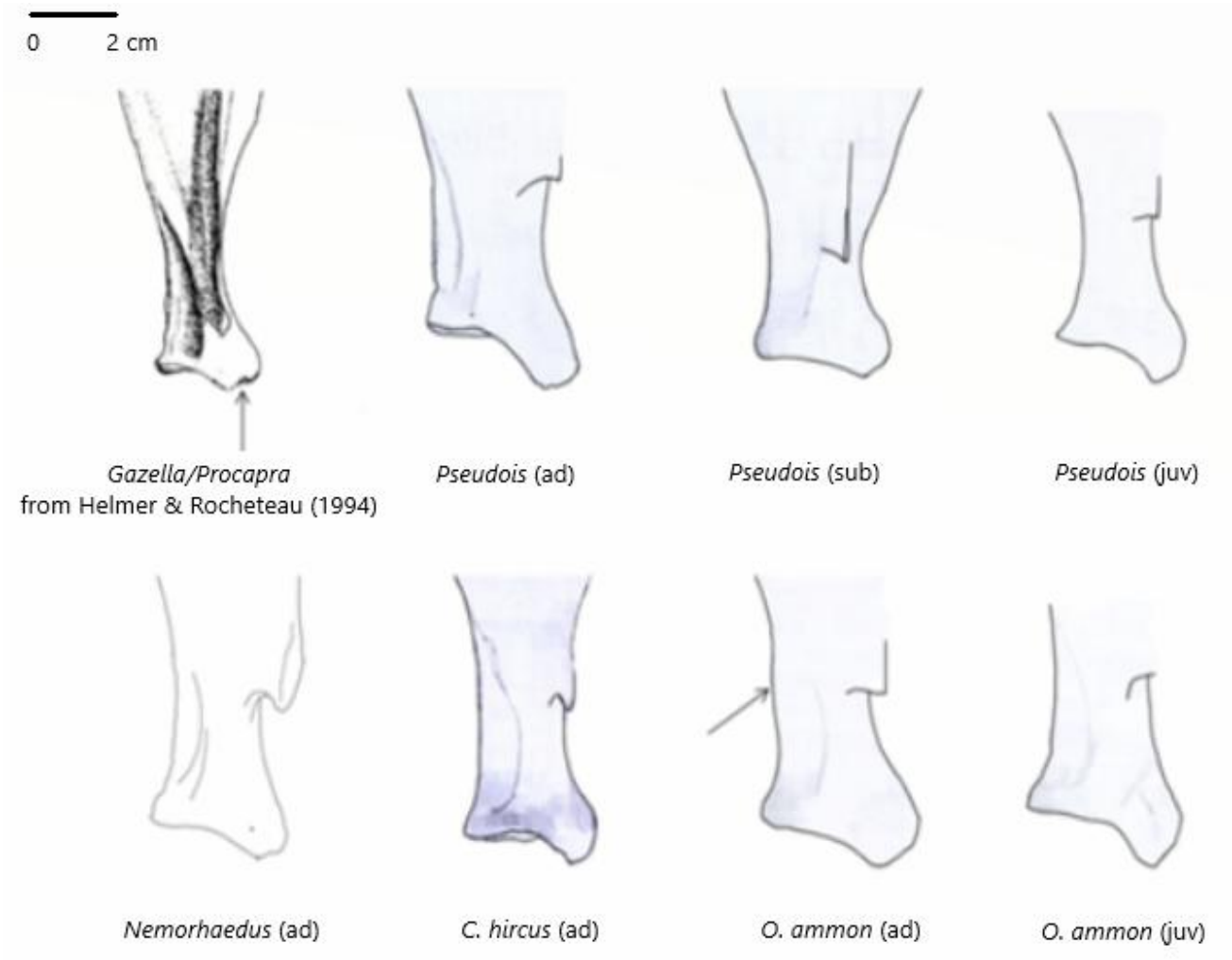


Figure H.4 Pseudois, Ovis, Nemorhaedus, Capra hircus, Gazella, Procapra, Scapula, lateral view, Comparative osteomorphology. The arrows show the most distinctive features that separate that species from the others.

2.3 Comparative Osteometry ------ Relative Proportions of the Different Parts

The general shape of the glenoid cavity could be expressed by LG/BG. Larger values indicate a longer shape of the glenoid cavity, while smaller values suggest a more rounded shape. As can be seen in Table H.2, *Pseudois nayaur* has the longest shape of the glenoid cavity, followed by *Capricornis* and Argali sheep. *Nemorhaedus*, Urial, WA Mouflon, *Capra*, EU Mouflon are comparatively more rounded.

	LG/BG			
	No	Range	mean	SD
Pseudois nayaur	18	1.21-1.52	1.34	0.09
Capricornis	4	1.18-1.43	1.3	0.13
Argali	7	1.13-1.37	1.24	0.09
EU domestic	5	1.12-1.4	1.23	0.11
EU Mouflon	13	1.1-1.26	1.18	0.05
Capra hircus	8	1.11-1.29	1.18	0.08
Urial and WA Mouflon	7	1.09-1.21	1.15	0.04
Nemorhaedus	5	1.08-1.21	1.14	0.04

Table H.2 Osteometrics of Caprinae. Number of measurements taken (N), range, mean, and standard deviation (SD). Values are given for LG/BG for scapula.

3 *Ovis*

3.1 Absolute size

	GLP			
	N	Range	Mean	SD
Argali	7	36-41.9	38.8	1.93
zoo Urial	5	33.8-36.2	34.2	1.18
wild WA Mouflon	2	35.9-38.9	37.1	2.53
EU Mouflon	13	27.8-36.8	31.4	2.65
EU domestic	5	31.5-47.9	37.1	6.30

Table H.3 Osteometrics of Ovis. Number of measurements taken (N), range, mean, and standard deviation (SD).Values are given for greatest length processus articularis (GLP) of the scapula in millimetre (mm).

For the wild *Ovis*, generally, it follows a gradual descending gradient from the *Ovis* in the east to the west. It should be noted that the European domestic sheep (*Ovis aries*) measured here have quite large variations, and one individual has even larger values than the largest Argali. This one comes from Graeme Clark Laboratory with unknown origin. But it is unsurprising because modern domestic sheep breeding sometimes would produce quite large individuals for meat consumption, as noted in Chapter 4.

3.2 Comparative Osteomorphology

The shape of the glenoid cavity is different in different species of *Ovis*, and it could be expressed by metric LG/BG. It is found that in Argali, the shape of the glenoid cavity is the longest, and it becomes more rounded in the sheep from the west. On the domestic sheep, however, the observed samples didn't show that they are similar to EU Mouflon. Rather, it is found that there are lots of variations and the mean values are closer to Argali.

Because domestic sheep shows lots of variation on this feature and this is not useful to securely separate *Ovis* from *Pseudois* and *Capra*, especially from archaeological materials, detailed data and figures of this feature will not be presented here.

3.3. Comparative Osteometry ------ Relative proportions of the different parts

The *Tuberculum supraglenoidale* is comparatively longer in EU Mouflon and shorter in Argali.The sheep from central and western Asia is generally in between the two extremes. This feature could be expressed by GLP/LG, which is small in Argali, and become larger in *Ovis* in the west (Table H.4). However, it was found that different breeds of domestic sheep have quite large variations on this feature although not all presented due to small sample size.

	GLP/LG			
	N	Range	Mean	SD
Argali	7	1.18-1.31	1.22	0.05
Urial and WA Mouflon	7	1.24-1.3	1.29	0.05
EU Mouflon	13	1.23-1.36	1.31	0.04
EU domestic	5	1.25-1.37	1.31	0.05

Table H.4 Osteometrics of Ovis. Number of measurements taken (N), range, mean.Values are given for GLP/LG for the scapula.

Appendix I Ratios of Pairs of Measurements on Distal Humerus Between the Difference Modern Caprinae and Gazella

1. All Caprinae and *Gazella*

BT/HT

	BT/HT			
	N	Range	Mean	SD
Capra sibirica	5	1.51-1.83	1.62	0.12
Capra hircus	16	1.54-1.79	1.62	0.06
Pseudois	24	1.48-1.73	1.59	0.06
Capricornis	16	1.47-1.70	1.58	0.08
Nemorhaedus	23	1.44-1.69	1.57	0.06
Ovis	141	1.36-1.67	1.53	0.06
Gazella & Procapra	15	1.25-1.43	1.35	0.05

Table I.1 Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for BT/HT. All Ovis samples are grouped together because their values are homogeneous. The shaded area means they are most distinctive and easy to be separated from the others.

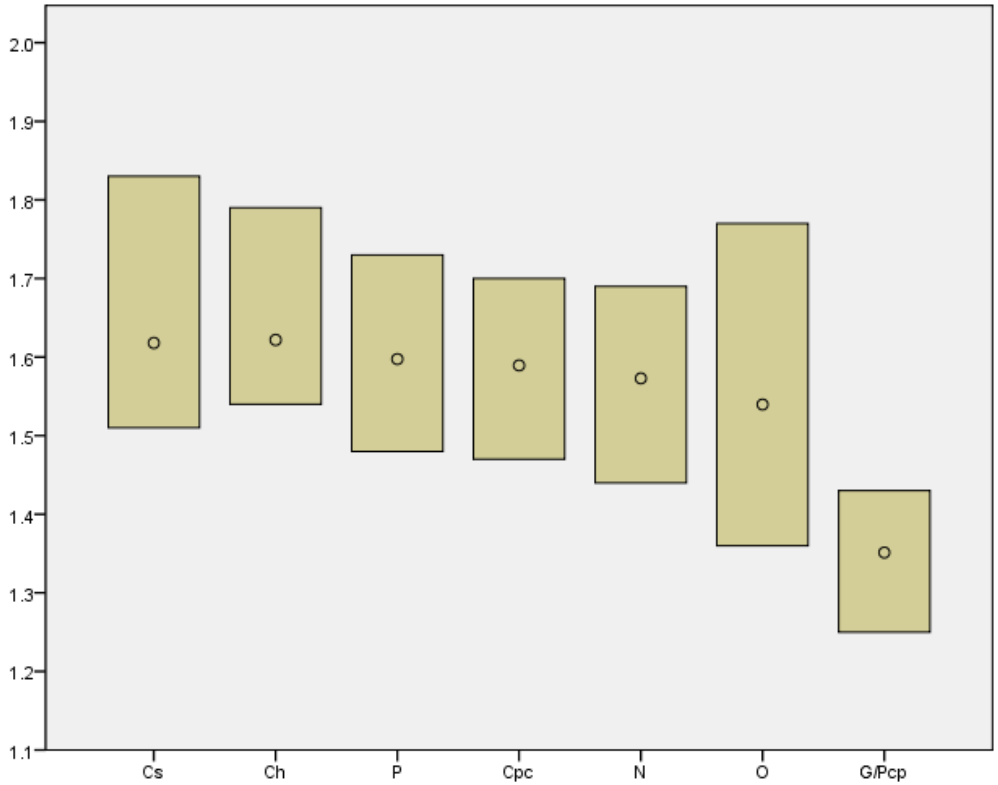


Figure I.1 High-low chart of Caprinae and *Gazella* studied. Values are given for BT/HT. The bars represent the range; the circles represent the mean values. Cs=*Capra sibirica*; Ch=*Capra hircus*; P=*Pseudois nayaur*; Cpc=*Capricornis*; N=*Nemorhaedus*; O=*Ovis*; G/Pcp=*Gazella/Procapra*.

HT/SHT

		HT/STH		
	N	Range	Mean	SD
Pseudois	25	1.21-1.59	1.37	0.07
Ovis ammon	24	1.31-1.45	1.37	0.03
Capra sibirica	5	1.27-1.43	1.36	0.07

Gazella & Procapra	15	1.26-1.49	1.33	0.58
Ovis orientalis	16	1.20-1.44	1.33	0.06
Ovis vignei	14	1.25-1.42	1.31	0.04
Capra hircus	15	1.21-1.37	1.31	0.05
Ovis musimon	32	1.18-1.39	1.29	0.05
Nemorhaedus	23	1.16-1.35	1.25	0.05
Capricornis	15	1.14-1.31	1.25	0.04

Table I.2 Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for HT/SHT.

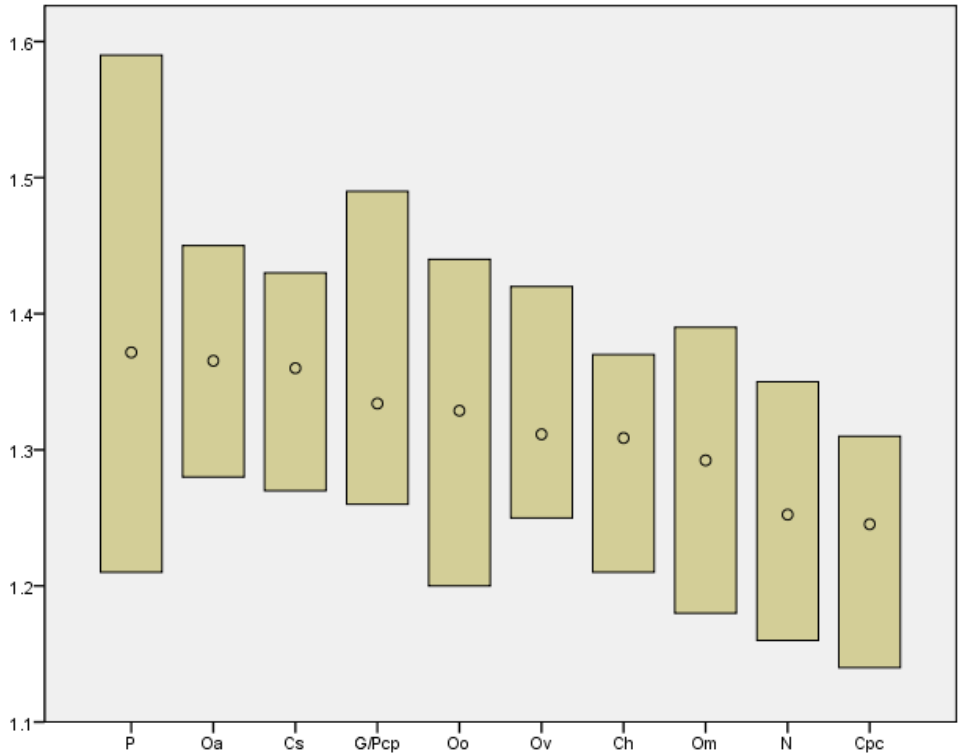


Figure I.2 High-low chart of Caprinae and *Gazella* studied. Values are given for HT/SHT. The bars represent the range; the circles represent the mean values.

LHT/BTl

		LHT/BTl		
	N	Range	Mean	SD
EU Mouflon	32	1.42-2.20	1.82	0.17
Gazella & Procapra	15	1.49-2.02	1.75	0.15
WA Mouflon	16	1.34-1.91	1.61	0.13
Urial	13	1.50-1.80	1.60	0.08
Argali	24	1.42-1.93	1.60	0.15
Capra sibirica	4	1.30-1.70	1.47	0.20
Pseudois (sub/juv)	14	1.26-1.63	1.45	0.12
Capra hircus	17	1.15-1.68	1.43	0.14
Pseudois (ad)	11	1.12-1.54	1.35	0.14
Capricornis	15	1.02-1.58	1.30	0.13
Nemorhaedus	23	1.09-1.40	1.24	0.09

Table I.3 Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for LHT/BTl. All WA Mouflon, wild and zoo European Mouflon are grouped together in 'Mouflon' group because their values are homogeneous.

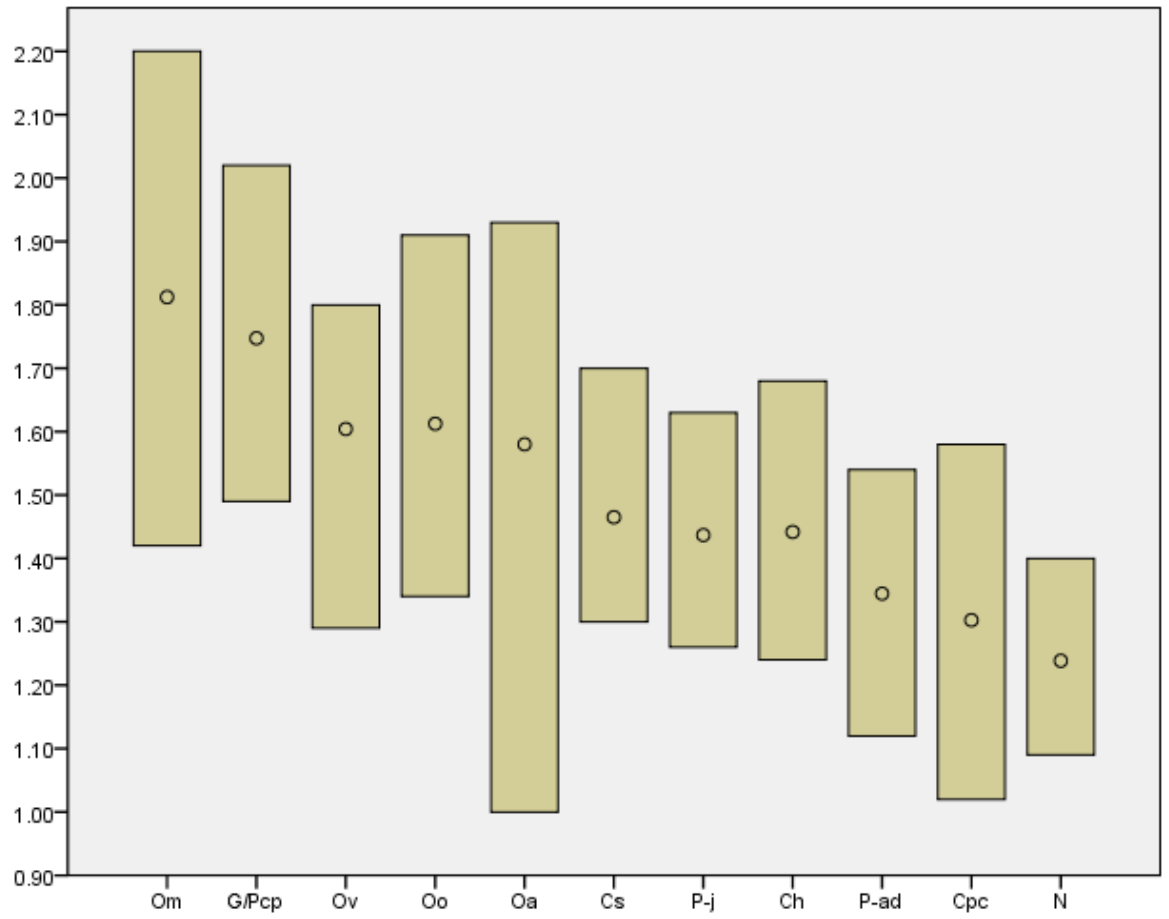


Figure I.3 High-low chart of Caprinae and *Gazella* studied. Values are given for LHT/BTl. The bars represent the range; the circles represent the mean values.

SHT/BTl

This ratio expresses the hight of the trochlea in the sagittal groove to the breadth of the lateral part of the *trochlea humeri*. As can be seen in Table I.4 and Figure I.4:

	No	SHT/BTl	Mean	SD

Gazella/Procapra	15	1.63-2.14	1.89	0.16
European Mouflon	32	1.57-2.23	1.86	0.17
Urial	14	1.39-1.85	1.68	0.12
WA Mouflon	16	1.50-1.85	1.66	0.09
Capricornis	15	1.49-1.83	1.65	0.12
Argali	24	1.43-1.99	1.63	0.14
Nemorhaedus	23	1.43-1.74	1.59	0.09
Capra sibirica	4	1.38-1.79	1.53	0.19
Capra hircus	15	1.31-1.72	1.52	0.15
Pseudois (sub/juv)	11	1.31-1.73	1.51	0.13
Pseudois (ad)	9	1.17-1.63	1.38	0.14

Table I.4 Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for SHT/BTl. All wild and zoo European Mouflon are grouped together in 'European Mouflon' group because their values are homogeneous.

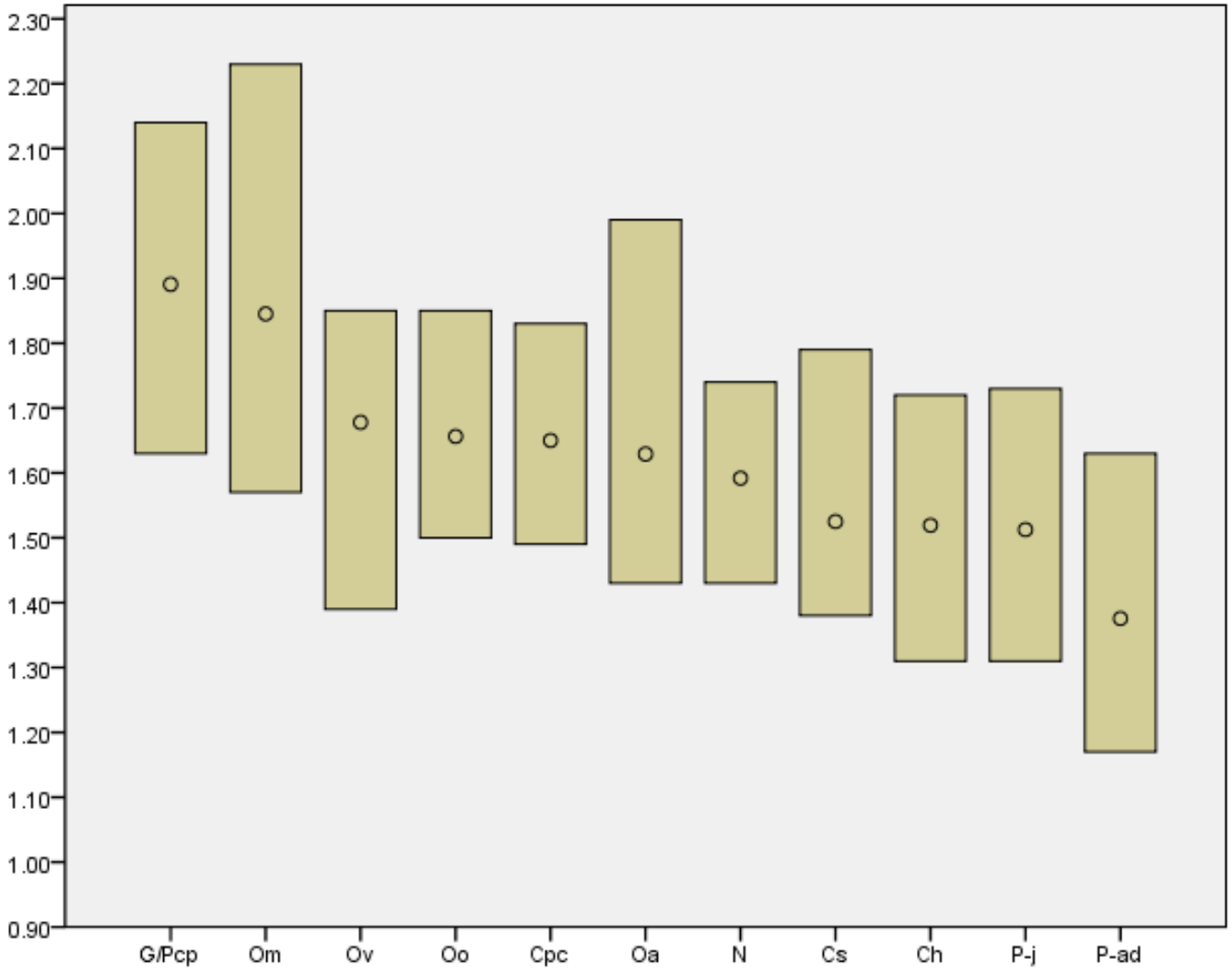


Figure I.4 High-low chart of Caprinae and *Gazella* studied. Values are given for SHT/BTl. The bars represent the range; the circles represent the mean values.

HT/LHT.

		HT/LHT		
	N	Range	Mean	SD
Nemorhaedus	23	1.50-1.82	1.61	0.08
Capricornis	15	1.42-1.78	1.58	0.12
Pseudois ad	11	1.26-1.55	1.45	0.09
Gazella & Procapra	15	1.33-1.59	1.44	0.07
Pseudois (sub/juv)	14	1.26-1.55	1.42	0.09
Argali	23	1.29-2.04	1.42	0.14
Capra hircus	17	1.28-1.55	1.40	0.08
Capra sibirica	5	1.34-1.46	1.40	0.05
Urial	14	1.28-1.49	1.37	0.06
WA Mouflon	17	1.26-1.61	1.37	0.08
European Mouflon	32	1.18-1.39	1.29	0.05

Table I.5Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for HT/LHT. The grids in grey mean they are most distinctive and easy to be separated from the others in this metric.

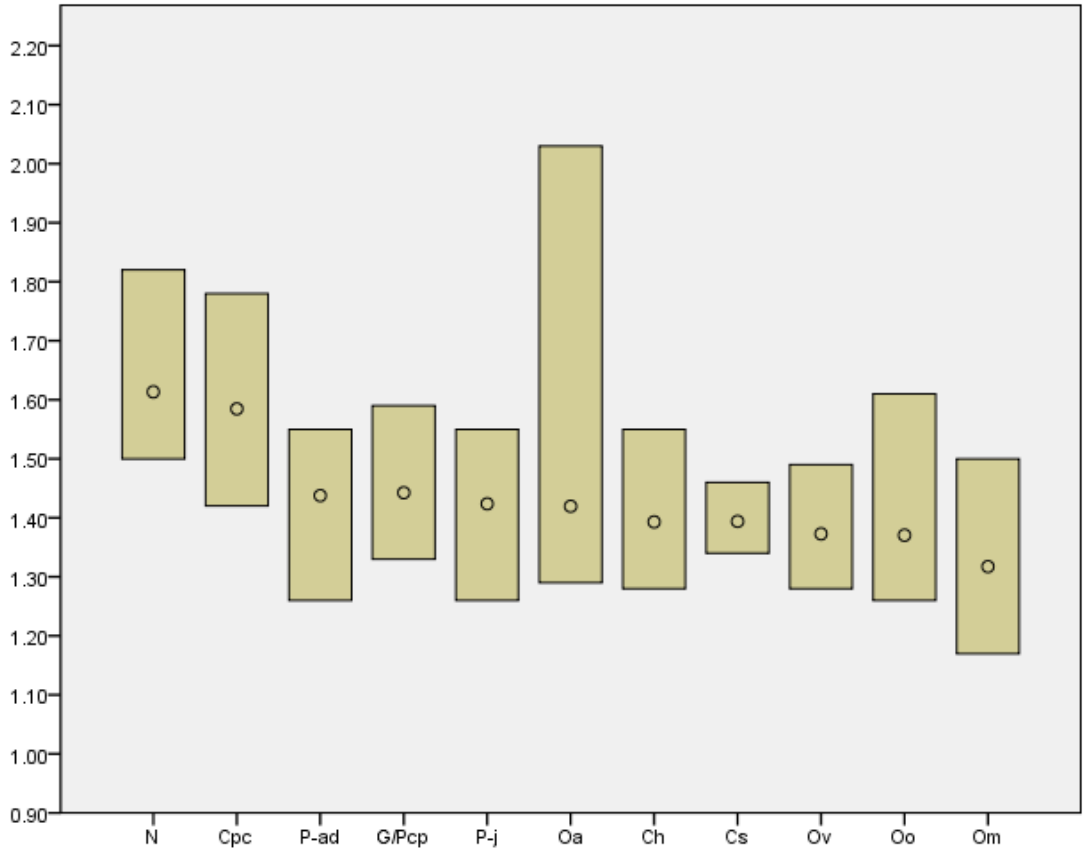


Figure I.5 High-low chart of Caprinae and *Gazella* studied. Values are given for HT/LHT. The bars represent the range; the circles represent the mean values.

2. All *Ovis*

SHT/BTl

		SHT/BTl		
	N	Range	Mean	SD
Ovis ammon	24	1.43-1.99	1.63	0.14
Ovis orientalis	16	1.50-1.85	1.66	0.09
Ovis vignei	14	1.39-1.85	1.68	0.12
Ovis musimon-wild	15	1.57-2.23	1.84	0.19
Ovis musimon-zoo	17	1.65-2.13	1.87	0.14
Ovis aries	16	1.54-2.31	1.76	0.19
Rambouillet	13	1.44-1.88	1.71	0.14
Rambouillet x Argali	21	1.59-1.96	1.69	0.10

Table I.6Osteometrics of Ovis. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for SHT/BTI.

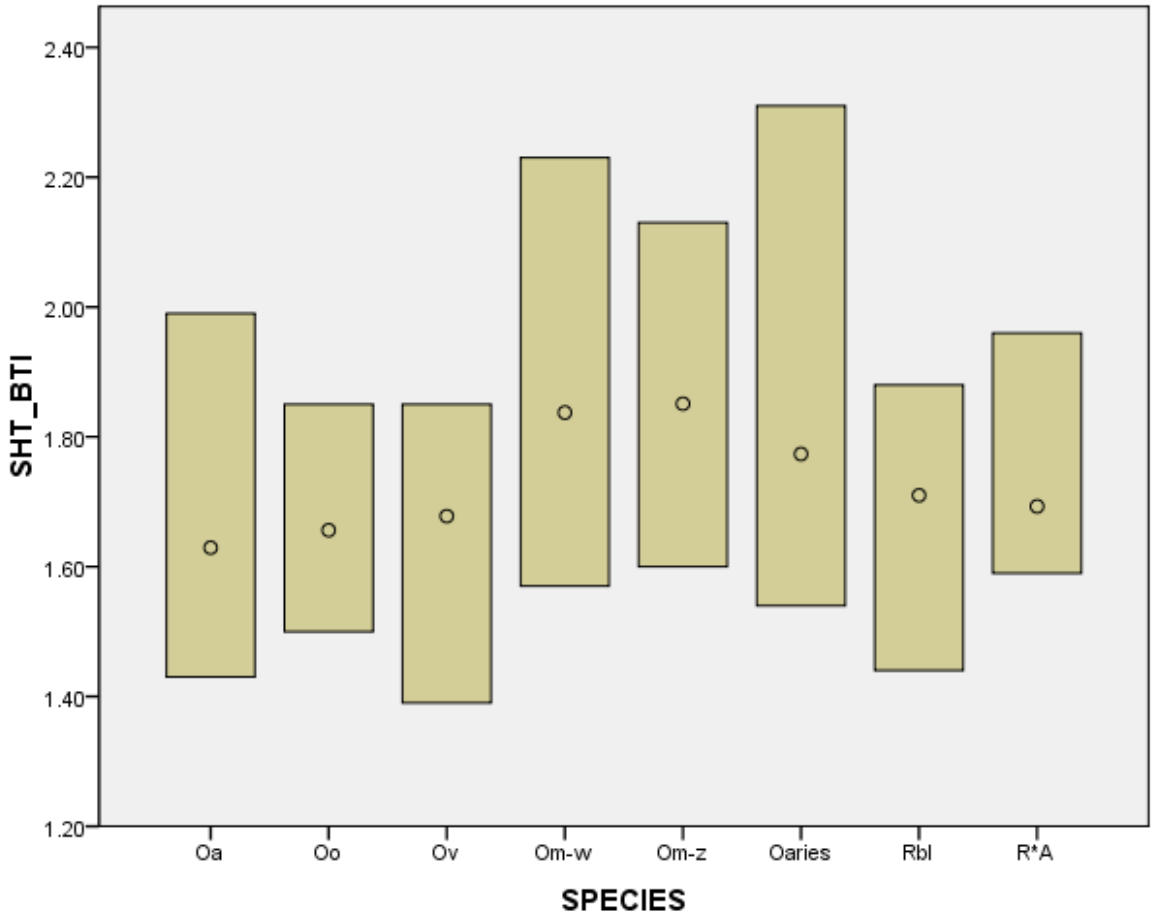


Figure I.6 High-low chart of *Ovis* studied. Values are given for SHT/BTl. The bars represent the range; the circles represent the mean values.Oa=Ovis ammon; Oo=Ovis orientalis; Ov=Ovis vignei; Om-w=Ovis musimon (wild); Om-z=Ovis musimon (zoo); Oaries= Ovis aries; Rbl=Rambouillet; R*A=Rambouillet*Argali.

LHT/BTl

		LHT/BTl		
	N	Range	Mean	SD
Ovis ammon	24	1.42-1.93	1.60	0.15
Ovis orientalis	13	1.50-1.80	1.65	0.08
Ovis vignei	16	1.34-1.91	1.61	0.13
Ovis musimon-wild	15	1.42-2.20	1.82	0.21
Ovis musimon-zoo	17	1.62-2.01	1.81	0.13
Ovis aries	16	1.54-2.42	1.77	0.21
Rambouillet	13	1.44-1.88	1.71	0.14
Rambouillet x Argali	21	1.59-1.96	1.69	0.10

Table I.7Osteometrics of Ovis.Number of specimens taken (N), range, mean, and standard deviation (SD). Values are given for LHT/BTI.

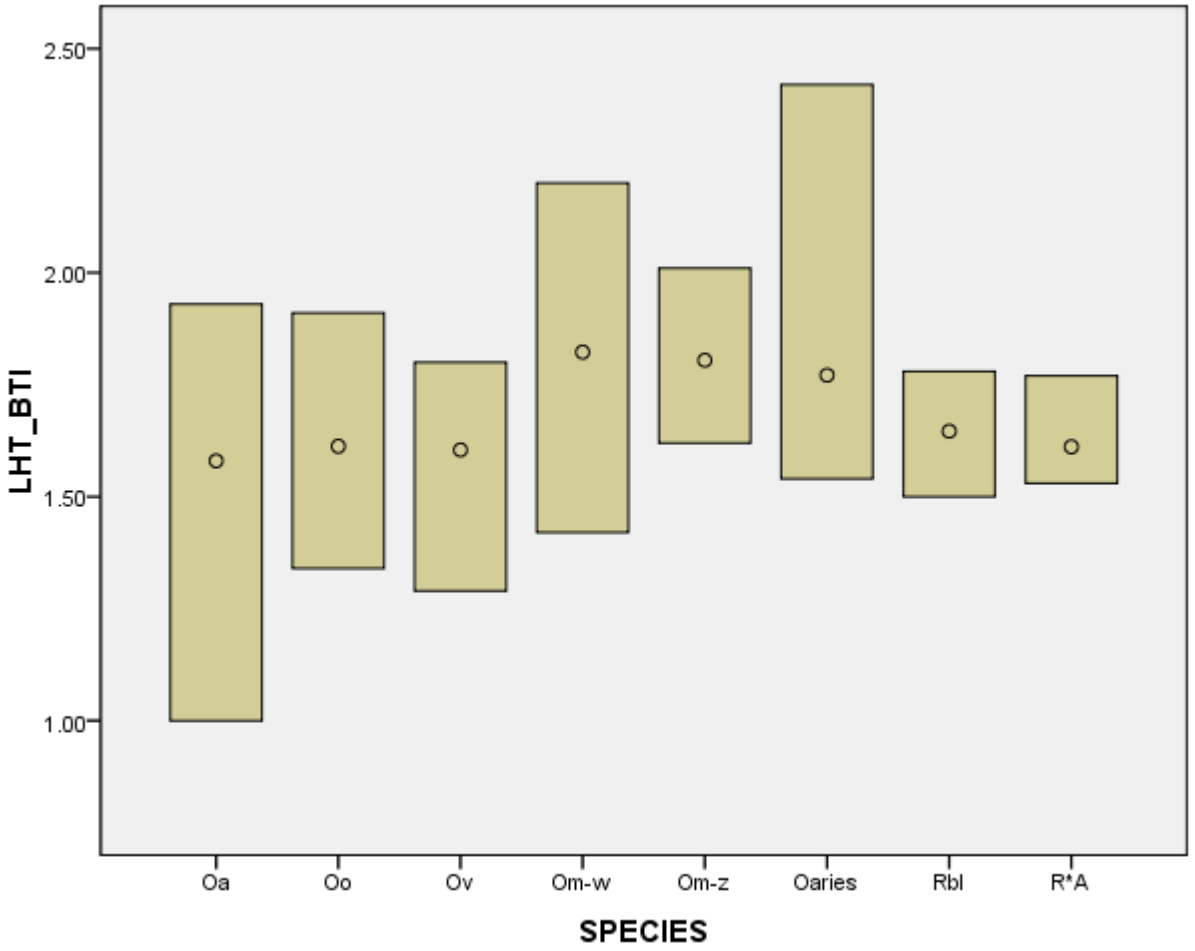


Figure I.7 High-low chart of *Ovis* studied. Values are given for LHT/BTl. The bars represent the range; the circles represent the mean values.

HT/SHT

		HT/STH		
	N	Range	Mean	SD
Ovis ammon	24	1.31-1.45	1.37	0.03
Ovis orientalis	16	1.20-1.44	1.33	0.06
Ovis vignei	14	1.25-1.42	1.31	0.04
Ovis musimon-wild	15	1.22-1.39	1.30	0.05
Ovis musimon-zoo	17	1.18-1.34	1.27	0.04
Ovis aries	20	1.21-1.40	1.31	0.04
Rambouillet	13	1.22-1.38	1.29	0.05
Rambouillet x Argali	21	1.22-1.40	1.30	0.06

Table I.80.1Osteometrics of Ovis.Number of specimens taken (N), range, mean, and standard deviation (SD). Values are given for LHT/BTI.

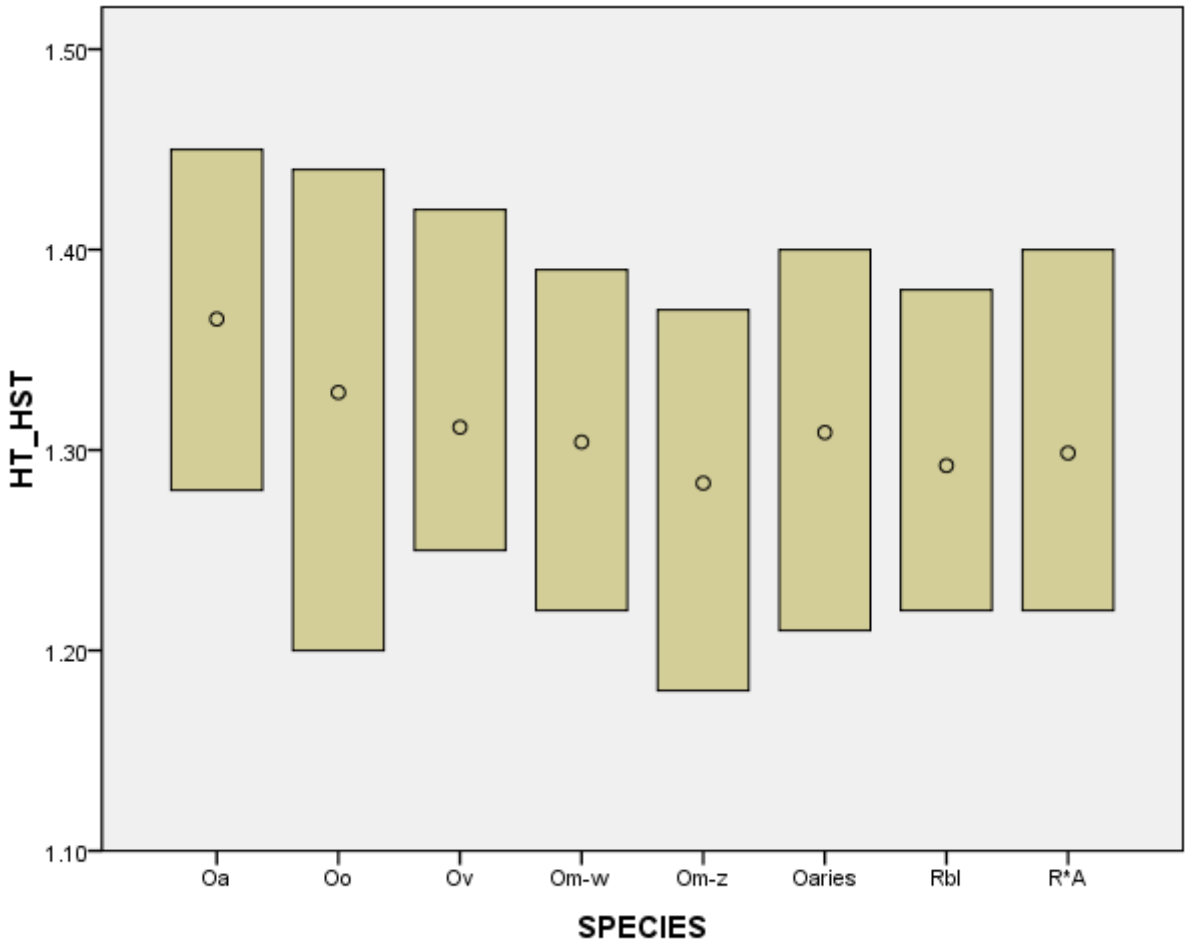


Figure I.8 High-low chart of *Ovis* studied. Values are given for HT/HST. The bars represent the range; the circles represent the mean values.

HT/LHT

		HT/LHT		
	N	Range	Mean	SD
Ovis ammon	23	1.29-1.49	1.39	0.05
Ovis orientalis	14	1.28-1.49	1.37	0.06
Ovis vignei	17	1.26-1.61	1.37	0.08
Ovis musimon-wild	15	1.17-1.50	1.32	0.08
Ovis musimon-zoo	17	1.25-1.46	1.31	0.05
Ovis aries	20	1.26-1.43	1.32	0.05
Rambouillet	13	1.27-1.45	1.34	0.05
Rambouillet x Argali	21	1.28-1.52	1.36	0.06

Table I.90.2Osteometrics of Ovis.Number of specimens taken (N), range, mean, and standard deviation (SD). Values are given for LHT/BTI.

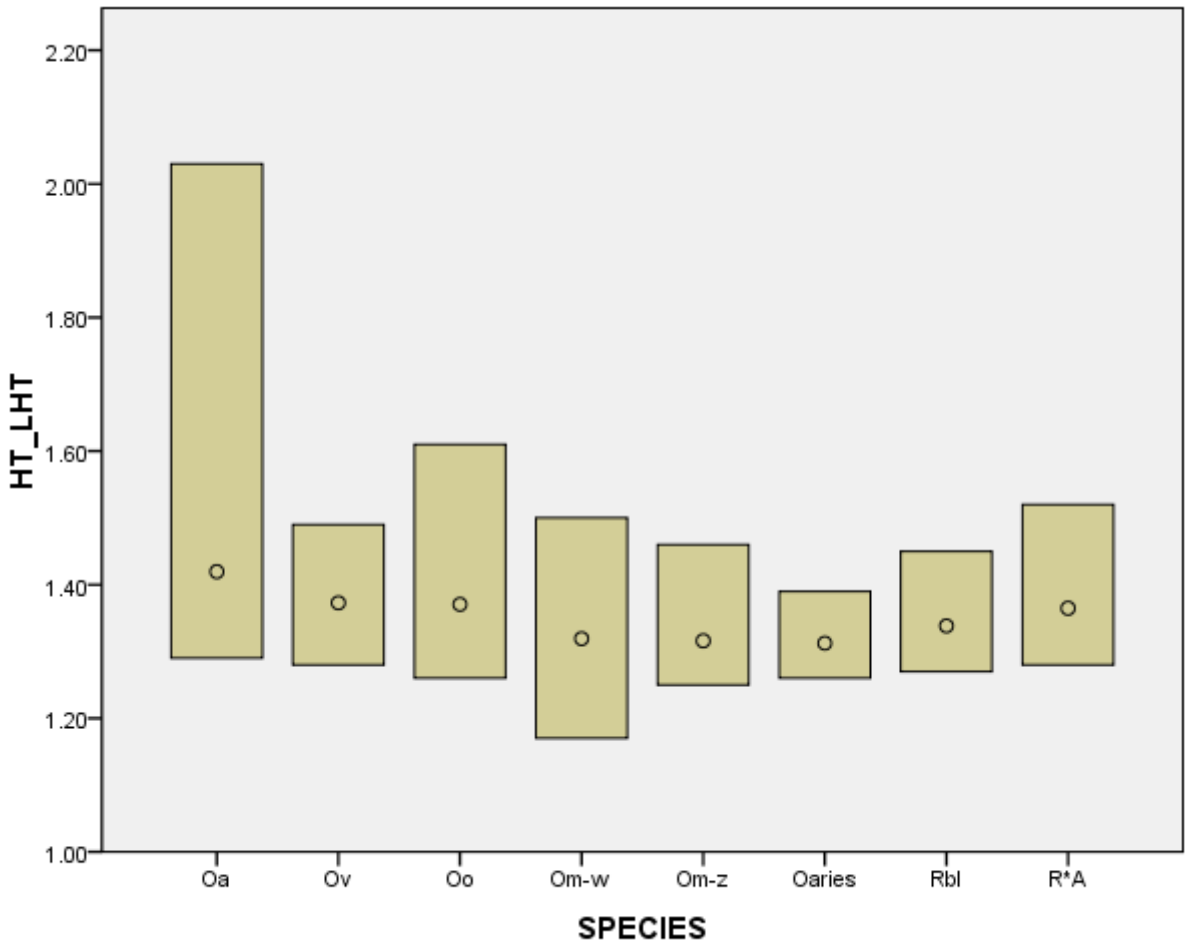


Figure I.9 High-low chart of *Ovis* studied. Values are given for HT/LHT. The bars represent the range; the circles represent the mean values.

Appendix J Comparative Osteomorphology and Osteometry of the Caprinae and Gazella on Proximal Radius

1. Introduction

Radius proximal is one of the early fused elements in the life of Caprinae. Different *Ovis* species and Caprinae exhibited quite different features that make them be separated from each other.

1.1 Anatomical Terms

In the description of the morphology of the radius, the following terms are used: lateral protuberance, *fovea capitis radii*, ulna notch (Figure J.1).

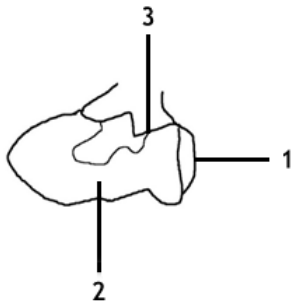


Figure J.1 Anatomical terms addressed on radius proximal. 1. lateral protuberance; 2. fovea capitis radii; 3. ulna notch

1.2 Measurements

Apart from the standard measurement ‘Bp’, ‘BFp’, and ‘GL’ (von den Driesch 1976), the following new measurements are added (Figure J.2):

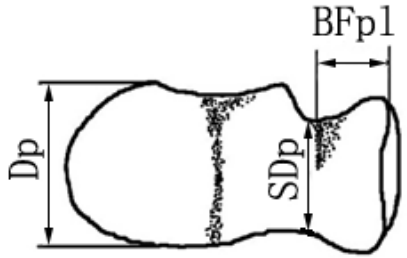


Figure J.2 Additional measurements taken on the radius proximal.

Dp: (Greatest) depth of the proximal end

SDp: Smallest depth proximal. Measured on the deepest point of the ulna notch

BFpl: Breadth of the lateral articular facet of the proximal end. Measured from the raised edge of the lateral facet to the medial margin

2. All Caprinae and *Gazella*

2.1 Absolute Size

As can be seen in Table J.1, the pattern of size differentiation among the different species of Caprinae as revealed in Bp of the proximal radius is similar to that shown on distal humerus.

		Bp (mm)		
	N	Range	Mean	*SD*
Capricornis	6	32.4-52.0	40.7	6.41
Pseudois	26	27.5-41.7	36.6	3.60
Ovis	35	20.1-41.4	33.3	4.56
Capra	17	26.3-38.3	31.8	3.02
Nemorhaedus	9	32.4-52.0	29.6	1.98
Gazella & Procapra	12	20.9-29.5	24.6	2.69

Table J.1 Osteometrics of different Caprinae and Gazella. Number of measurements taken (N), range, mean, and standard deviation (SD). Values are given for proximal breadth (Bp) of the radius in millimetre (mm).

2.2 Comparative Osteomorphology

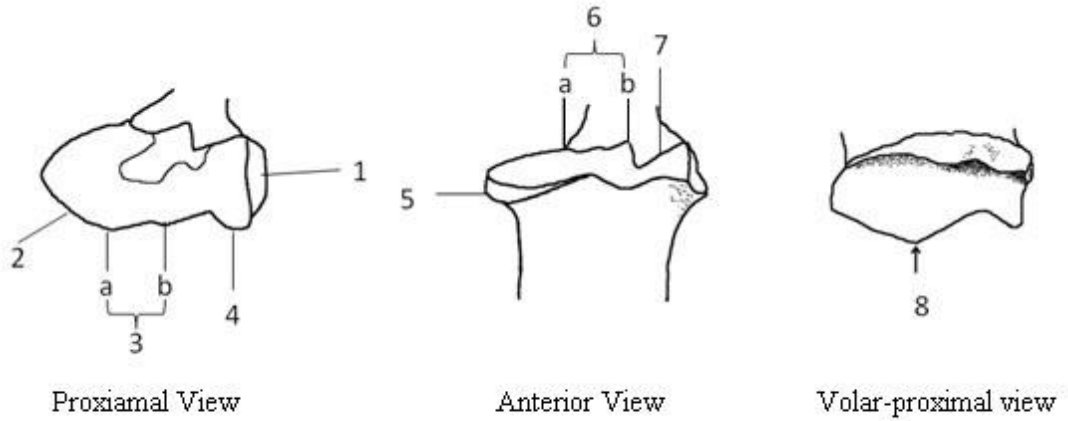


Figure J.3 Proximal radius, the diagnostic characters considered in separating different Caprinae and Gazella. 1. Lateral protuberance; 2. The dorsomedial margin of the Fovea capitis radii; 3. Dorsal margin of the medial half of the Fovea capitis radii; 'a' and 'b' refers to the two different points on the dorsal edge; 4. Dorsal edge of the lateral articular facet; 5.Lip of the medial margin; 6. Central-volar edge of the caput radii; 'a' and 'b' refers to the two different points on the edge; 7. ulna notch; 8. the dorsal edge of the fovea capitis radii in volar-proximal view.

Proximal View

1. Lateral protuberance

a. Strongly developed and sits high up on the lateral side of the proximal end in EU Mouflon and domestic sheep (Figure F.6); not developed and sits lower in *Capra* and Argali (Figure J.6; Figure J.4); intermediate or not developed in adult and sub-adult *Pseudois.* In juvenile *Pseudois* it is rounded and not strongly developed (Figure J.4).

b. Almost straight or forms only a small protuberance at the lateral side in *Nemorhaedus* and *Capricornis*, similar to *Capra* (Figure J.5).

c. Highly developed in *Procapra* and *Gazella*, similar to EU Mouflon (Figure J.4; Figure J.5).

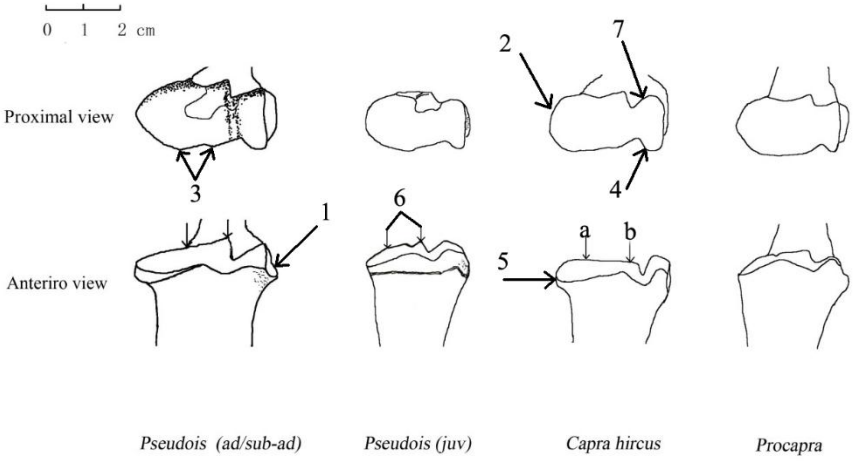


Figure J.4 Proximal radius, morphological characters of Pseudois, Capra hircus, and Procapra.

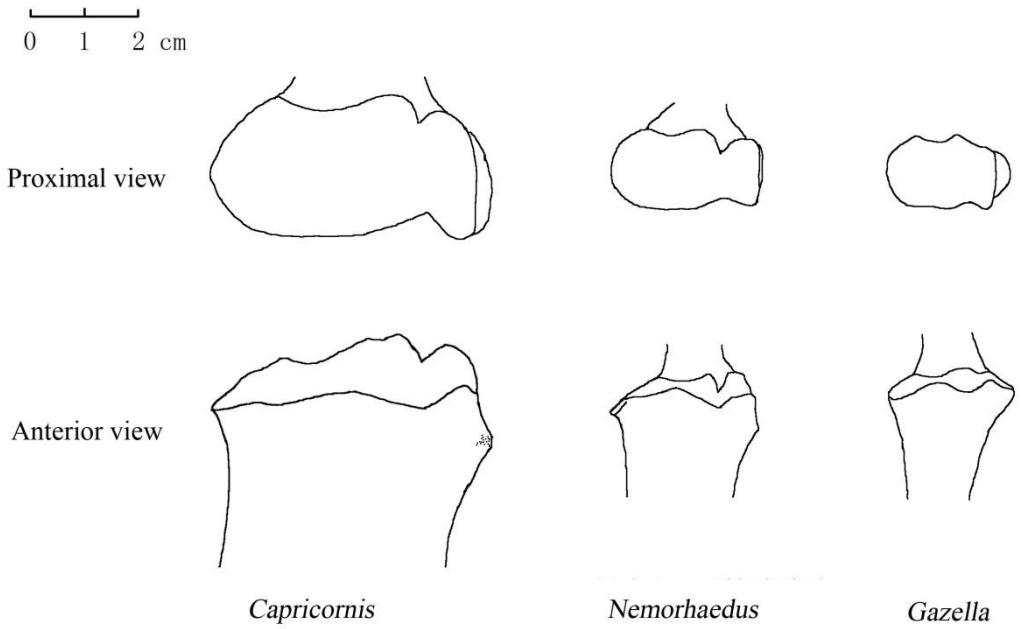


Figure J.5 Proximal radius, morphological characters of Capricornis, Nemorhaedus, and Gazella

2. Dorsomedial margin of the Fovea capitis radii

a. In a form of a round curve in most samples of all *Ovis* (Figure J.6); it takes the shape of a straight line and forms an angle against the dorsal margin in *Capra*; It forms a straight margin and a larger angle in adult *Pseudois* compared to *Capra*; In juvenile *Pseudois* however, it is still rounded becoming gradually straight in sub-adult *Pseudois* (Figure J.4).

b. Rounded in *Capricornis* and *Nemorhaedus* (Figure J.5).

c. In *Procapra* and *Gazella*, rounded in the majority of the cases observed*;* straight and forms an angle in a small part of the samples observed (Figure J.4; Figure J.5).

3. Dorsal margin of the medial half of the Fovea capitis radii.

a. In *Pseudois* the medial half of the dorsal margin is slightly concave with "a" extending more dorsally than "b" (Figure J.4); In *Ovis* (Figure J.6) and *Capra* (Figure J.4), the medial half of the dorsal margin runs more or less straight. This is a very good criterion to separate *Pseudois* from *Ovis* and *Capra*.

b. 'a' and 'b' are always at the same level in *Capricornis* and *Nemorhaedus, Procapra* and *Gazella* (Figure J.4; Figure J.5).

4. Dorsal edge of the lateral articular facet

a. Oblique in the lateral-dorsal direction and in a form of a straight line in the most cases of adult and sub-adult *Pseudois*; in a few cases it does not protrude much dorsally and in the form of a small curve, especially in juvenile; in *Capra hircus*, this edge mostly protrudes dorsally in the form of either a straight line or a curve, although the ones which only a slightly protruding dorsally are also observed. (Figure J.4). In *Ovis*, however, in most cases it does not protrude dorsally very much, rather it is in a slight oval curve dorsally or parallel with the medial-lateral axis (Figure J.6; Figure J.8).

b. Varies in *Capricornis* and *Nemorhaedus*: protrudes dorsally in the most cases, but an even edge is also observed (Figure J.5).

c. In the form of a small curve protruding dorsally in vast majority cases of *Procapra* and *Gazella* (Figure J.4; Figure J.5).

Anterior View

5. Lip on the medial margin

a. It is well-developed and turned over medially in *Ovis*, *Capra* and adult *Pseudois* (Figure J.6; Figure J.4).

b. the margin is only slightly flared in *Nemorhaedus* and *Capricornis* (Figure J.5).

c. The margin is nearly straight or only slightly flares outward in *Gazella* and *Procapra* (Figure J.4; Figure J.5).

6. Central-volar edge of the caput radii

a. In *Pseudois* and *Ovis*, the edge is tilted, and point ‘b’ always protrudes higher proximally than point ‘a’. In addition, it forms a sharp point at point ‘b’; in *C. hircus*, this edge is level, and point ‘b’ does not protrude higher proximally than point ‘a’ (Figure. J.6; Figure J.4; Figure J.5).

b. In *Nemorhaedus*, point ‘b’ is almost at the same level as or slightly higher than point ‘a’. In *Capricornis*, point ‘b’ is slightly higher than point ‘a’. In addition, there is no sharp angle at point ‘b’; rather it is rounded (Figure J.5).

c. The edge is horizontal, and the two points are almost at the same level in *Procapra* and *Gazella* (Figure J.4; Figure J.5).

7. Ulna notch

a. In most cases of adult and sub-adult *Pseudois*, it is a deep V-shaped notch, and the angle of the notch is around 60^{o}; the lateral edge of the notch reaches the lateral margin of the *caput radii*. In *Capra hircus*, the form of the notch varies: both V- and U-shaped are observed, but the angles are generally smaller than *Pseudois*(Figure J.4). It also varies in different species of *Ovis*: Argali is generally closer to the form of *Pseudois* and EU Mouflon are closer to *Capra* (Figure J.6).

b. In *Nemorhaedus* and *Capricornis*, it is a small shallow V-shaped angle; the lateral edge of the notch never reaches the lateral margin (Figure J.5).

c. In *Procapra*, it is a shallow U-shaped notch, and the lateral edge reaches the lateral margin; in *Gazella*, it does not present in many cases and is a very shallow small V-shaped if present (Figure J.4; Figure J.5).

Proximal-Volar View

8. Dorsal Edge of the fovea capitis

Comparing with other species, only in *Ovis ammon* it is in the form of a big, large open angle at the middle of the dorsal edge, in all the other species it is an even line or the medial side is slightly lower than the lateral side (Figure J.6; Figure J.4; Figure J.5).

Comparative Osteometry -------Relative Proportions of the Different parts

1. BFpl is the widest and SDp the narrowest in *Pseudois*, followed by *Capra*. In contrast, BFpl is the narrowest and SDp is the widest in *Gazella* and *Procapra*. *Nemorhaedus* and *Capricornis* are intermediate (Figure J.4; Figure J.5). The metric data of BFpl/SDp expresses this feature (Table J.2). However, there are a lot of overlaps between the species. The data recorded for Argali, Urial, and WA Mouflon are generally close to *Nemorhaedus* and *Capricornis*. Wild EU Mouflon and Zoo EU Mouflon are in between *Capricornis* and *Gazella/Procapra* (see also Table J.2).

		BFpl/SDp		
	N	Range	Mean	SD
Pseudois	20	0.70-1.17	0.95	0.13
Capra	17	0.69-1.26	0.86	0.15
Nemorhaedus	9	0.69-0.93	0.82	0.08
Zoo Argali	7	0.72-0.86	0.80	0.05
Capricornis	5	0.62-0.97	0.77	0.13
Zoo Urial	6	0.63-0.84	0.77	0.07
Wild WA Mouflon	3	0.71-0.79	0.74	0.04
ZooEU Mouflon	14	0.62-0.86	0.70	0.07
WildEU Mouflon	9	0.48-0.80	0.65	0.09
Gazella&*Procapra*	12	0.54-0.67	0.58	0.04

Table J.2 Osteometrics of the Caprinae and Gazella studied. Number of measurements taken (N), range, mean, and standard deviation (SD). Values are given for BFpl/SDp.

2. SDp is the narrowest and Dp is the widest in *Pseudois*, followed by *Capra*. In contrast, SDp is the widest and Dp is the narrowest in *Capricornis* and *Nemorhaedus*. *Gazella* and *Procapra* are intermediate (Figure F.4; Figure J.5). The metric data of SDp/Dp expresses this feature (Table J.3). However, there are a lot of overlaps between the species. The data recorded for Urial and WA Mouflon are generally close to Pseudois and Capra; Argali is smaller than Pseudois; wild EU Mouflon is larger than Capricornis, and zoo EU Mouflon are in between *Capricornis* and *Gazella/Procapra*(Table J.9).

		SDp/Dp		
	N	Range	Mean	SD
WildEU Mouflon	9	0.53-0.76	0.64	0.15
Capricornis	8	0.53-0.68	0.60	0.06
Nemorhaedus	13	0.52-0.73	0.60	0.05
ZooEU Mouflon	14	0.57-0.62	0.59	0.05
Gazella & Procapra	12	0.56-0.61	0.58	0.04
Wild WA Mouflon	3	0.46-0.66	0.56	0.04
Capra	13	0.49-0.64	0.54	0.05
Zoo Urial	6	0.49-0.59	0.54	0.05
Pseudois	20	0.41-0.62	0.52	0.07
Zoo Argali	7	0.44-0.55	0.50	0.06

Table J.3 Osteometrics of the Caprinae and Gazella studied. Number of measurements taken (N), range, mean and standard deviation (SD).Values are given for SDp/Dp.

3. All *Ovis*

Absolute Size

As can be seen in table J.4, the general trend of the size distinction between different groups of *Ovis* is the same as it is on the previous elements.

		Bp (mm)		
	N	Range	Mean	SD
Zoo Argali	7	35.7-41.4	38.1	1.87
Zoo Urial	6	30.5-36.4	33.7	2.5
Wild WAMouflon	3	32.7-37.7	36.0	2.89
WildEUMouflon	10	27.7-35.7	31.6	2.81
Zoo EUMouflon	14	26.6-36.5	29.8	2.72

Table J.4 Osteometrics of Ovis. Number of measurements taken (N), range, mean, and standard deviation (SD).Values are given for proximal breadth (Bp) of the radius in millimetre (mm).

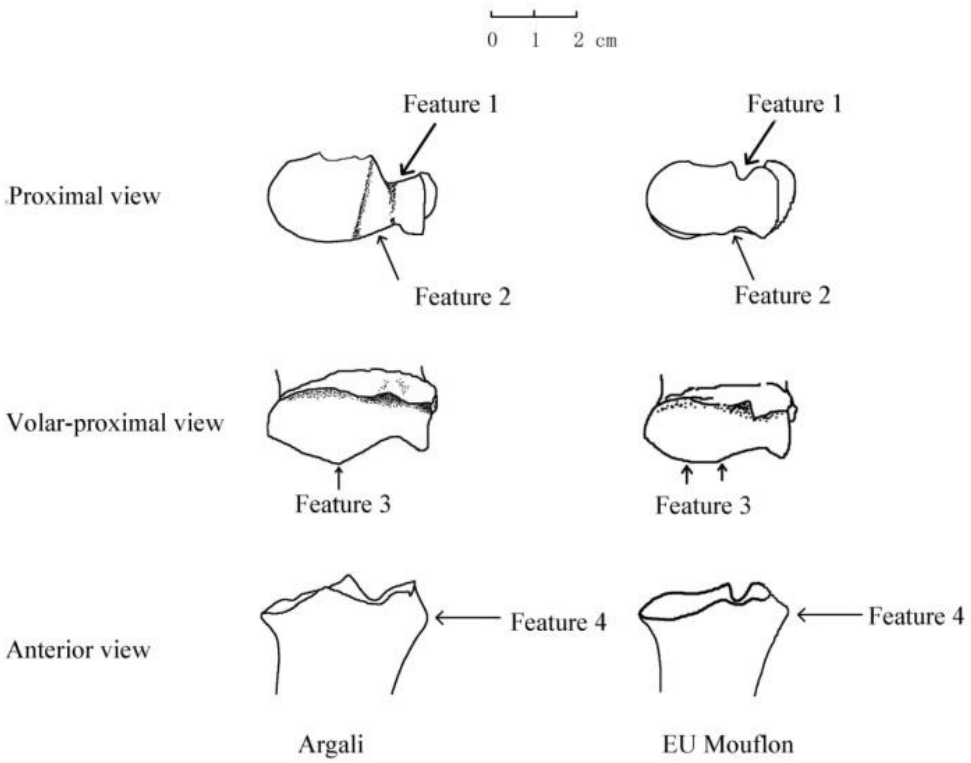


Figure J.6 The morphological distinctions between different Ovis species

Proximal View

1. The ulna notch forms a large open angle (>90^{o}) in most Argali, scored '1'; in contrast, it is the smallest in European Mouflon, scored '3'; intermediate in Urial and WA Mouflon, scored '2' (Figure J.6, Figure J.7, Table J.5). There is a cline of the morphological differences in this feature from the *Ovis* in the East to the West.

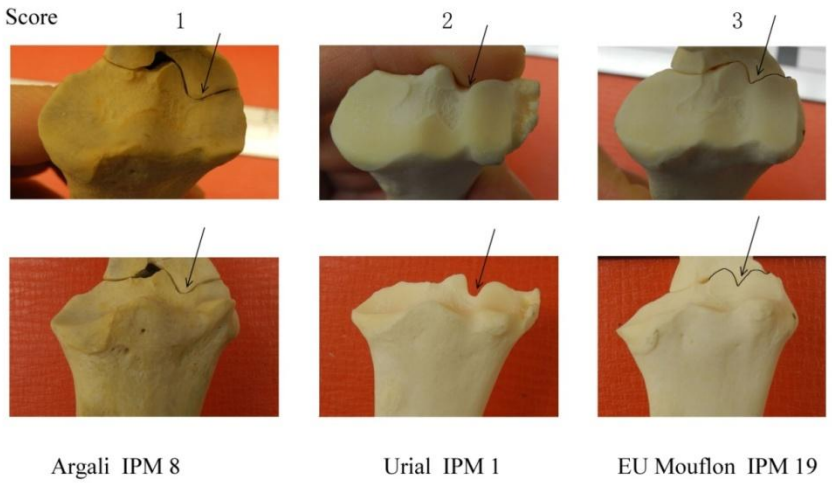


Fig J.7 The morphological distinctions between different Ovis species, Feature 1

Feature 1	Angle of the ulna notch		
score-value	*1*	*2*	*3*
Zoo Argali	5	2	0
Zoo Urial	3	3	0
Wild WA Mouflon	0	2	1
Wild EU Mouflon	0	0	5
Zoo EU Mouflon	0	1	8

Table J.5 Ovis, proximal radius, scored counts of Feature 1

2. The dorsal edge of the lateral part of the medial *fovea capitis radii* is formed in a straight line in most Argali, scored '1'; it is in a small curve in most European Mouflon, and is nearly a small curve in WA Mouflon and Urial, scored '2' (Figure F.6; Figure F.8; Table F.6). The cline of the morphological differences in this feature between the different wild *Ovis* species is similar to the above.

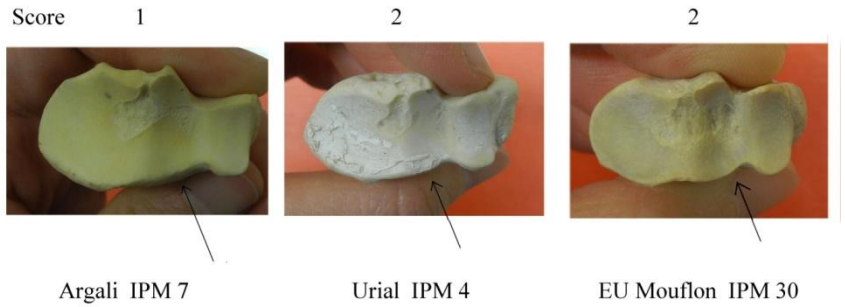


Fig J.8 The morphological distinctions between different Ovis species, Feature 2

Feature 2	the dorsal edge of the lateral part of the medial *fovea capitis radii*	
score-value	*1*	*2*
Zoo Argali	6	1
Zoo Urial	3	3
Wild WA Mouflon	2	1
Wild EU Mouflon	1	4
Zoo EU Mouflon	3	7

Table J.6 Ovis, proximal radius, scored counts of Feature 2

Volar-proximal View

3. The dorsal edge of the *fovea capitis radii* forms a large open angle in Argali, scored '1', while in European Mouflon it is always a horizontal line, scored '3', intermediate in WA Mouflon and Urial, scored '2'. The cline of the morphological differences in this feature between the different wild *Ovis* species is similar to the above (Figure J.6; Figure J.9; Table J.7).

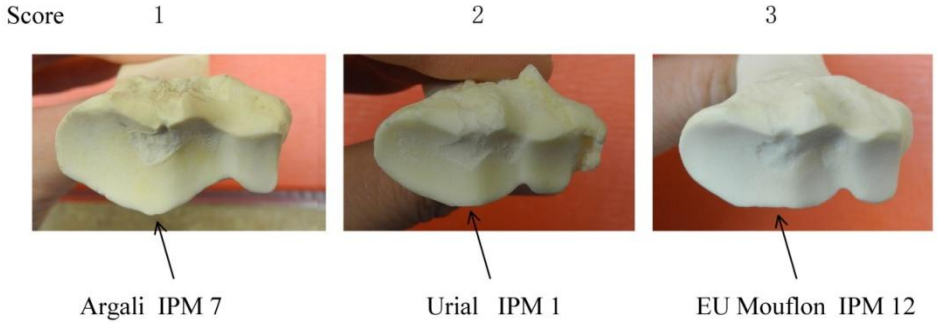


Fig J.9 The morphological distinctions between different Ovis species, Feature 3

Feature 3	The dorsal edge of the *fovea capitis radii* in proximal-volar view		
score-value	*1*	*2*	*3*
Zoo Argali	5	0	1
Zoo Urial	3	2	2
Wild WA Mouflon	0	0	1
Zoo EU Mouflon	0	0	7

Table J.7 Ovis, proximal radius, scored counts of Feature 3

Anterior View

4. The lateral protuberance is less strongly developed in *Ovis ammon*, scored '1', while it is usually strongly developed in EU Mouflon, scored '3', and intermediate in Urial, scored '2'. The cline of the morphological differences in this feature between the different wild *Ovis* species is similar to the above (Figure J.6; Figure J.10; Table J.8).

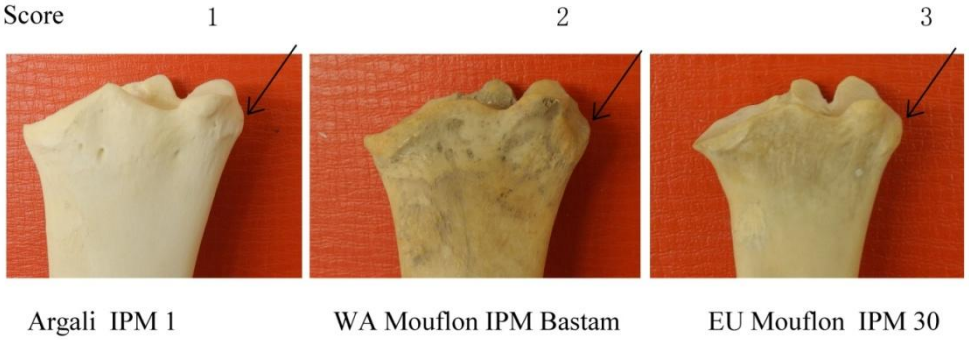


Figure J.10The morphological distinctions between different Ovis species, Feature 4

Feature 4	The lateral protuberance		
score-value	*1*	*2*	*3*
Zoo Argali	4	2	1
Zoo Urial	0	0	6
Wild WA Mouflon	1	2	0
Wild EU Mouflon	1	2	3
Zoo EU Mouflon	0	3	7

Table J.7 Ovis, proximal radius, scored counts of Feature 4

Comparative Osteometry ------ Relative Proportions of the Different Parts

1. In proximal view (Fig F.6), and compared to the other taxa, BFpl is the widest and SDp the narrowest in Argali; in contrast, BFpl is the narrowest and SDp is the widest in European Mouflon. Urial and WA Mouflon are intermediate the above two. The metric of BFpl/SDp expresses this feature. There is a gradual descending gradient in this value from the *Ovis* in the east to the west. Zoo European Mouflons are slightly larger than Wild EU Mouflon, but they are generally close to each other compared with the other groups (Table J.9).

		BFpl/SDp		
	N	Range	Mean	SD
Zoo Argali	7	0.72-0.86	0.80	0.05
Zoo Urial	6	0.63-0.84	0.77	0.07
Wild WA Mouflon	3	0.71-0.79	0.74	0.04
WildEU Mouflon	9	0.48-0.80	0.65	0.09
ZooEU Mouflon	14	0.62-0.86	0.70	0.07

Table F.9 Osteometrics of Ovis. Number of measurements taken (N), range, mean, and standard deviation (SD). Values are given for BFpl/SDp.

2. SDp is the narrowest and Dp is the widest in Argali; in contrast, SDp is the widest and Dp is the narrowest in wild EU Mouflon; Urial and WA Mouflon are intermediate. Zoo European Mouflons are closer to Western Asian Mouflons (Figure J.6). The metric data of SDp/Dp expresses this feature (Table J.10). However, there are overlaps between these groups.

		SDp/Dp		
	N	Range	Mean	SD

Zoo Argali	7	0.44-0.55	0.50	0.06
Zoo Urial	6	0.49-0.59	0.54	0.05
Wild WA Mouflon	3	0.46-0.66	0.56	0.04
WildEU Mouflon	9	0.53-0.76	0.64	0.15
ZooEU Mouflon	14	0.57-0.62	0.59	0.05

Table J.10 Osteometrics of Ovis. Number of measurements taken (N), range, mean, and standard deviation (SD). Values are given for SDp/Dp.

Appendix K Ratios of Pairs of Measurements on Distal Metacarpals between the different Modern Caprinae and Gazella

1. DBV/DpBV

	DBV/DpBV			
	N	Range	Mean	SD
Gazella and Procapra	17	1.01-1.27	1.11	0.08
Capricornis	20	1.00-1.25	1.08	0.06
Nemorhaedus	21	0.96-1.20	1.07	0.06
Argali	33	0.99-1.15	1.07	0.04
Urial	12	1.01-1.14	1.06	0.05
WA Mouflon	21	0.95-1.13	1.03	0.05
EU Mouflon	33	0.91-1.15	1.01	0.06
Pseudois	20	0.93-1.01	0.96	0.03
Capra sibirica	20	0.78-1.07	0.93	0.07
Capra hircus	18	0.69-0.90	0.82	0.06

Table K.1 Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for DBV/DpBV on metacarpal.

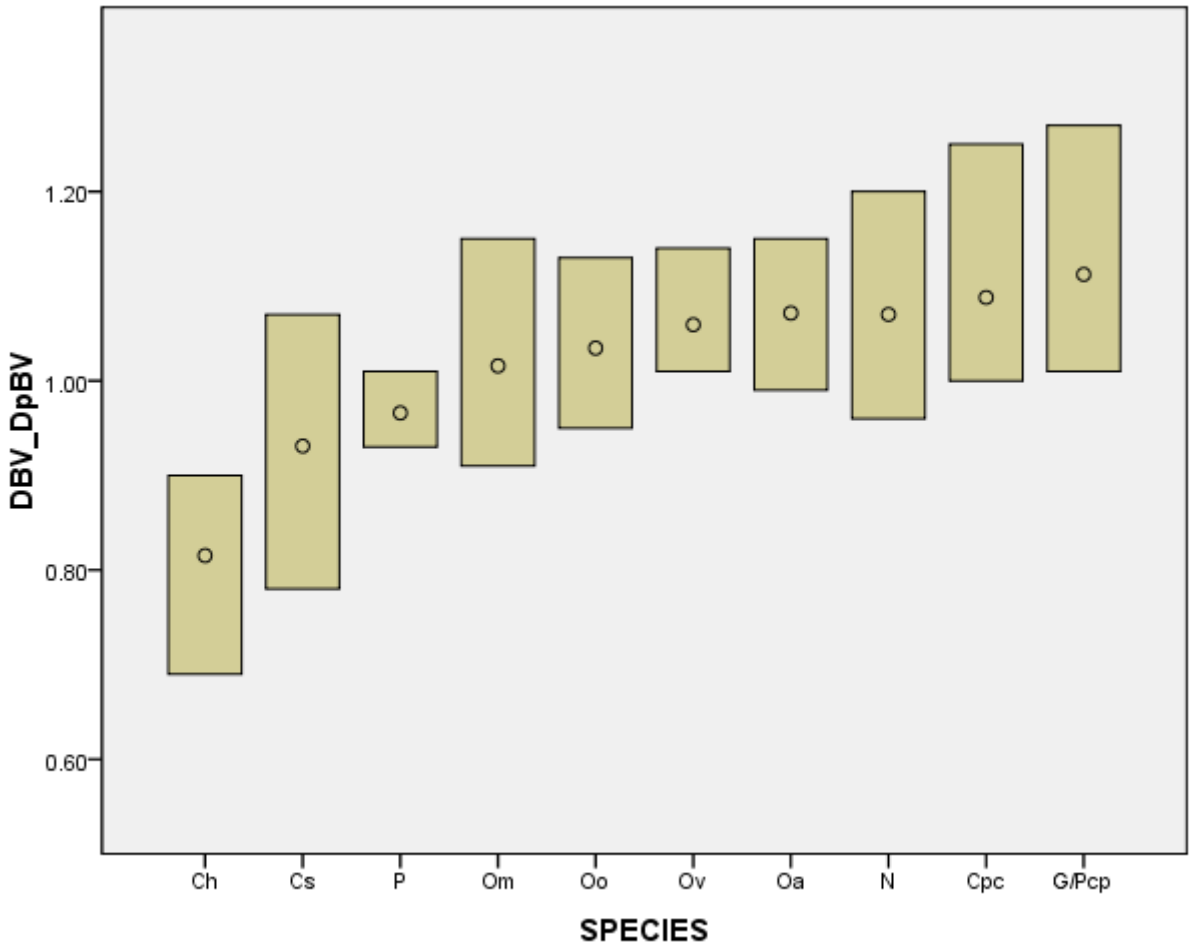


Figure K.1 High-low chart of Caprinae and Gazella studied. Values are given for Ratio DBV/DpBV on metacarpals. The bars represent the range; the circles represent the mean values.

2. Ratio 3/4

	Ratio 3/4			
	N	Range	Mean	SD
Gazella& Procapra	17	0.72-0.82	0.77	0.03
Ovis vignei	12	0.68-0.73	0.71	0.02
Ovis ammon	33	0.64-0.76	0.71	0.02
Ovis orientalis	20	0.68-0.73	0.70	0.02
Ovis musimon	33	0.63-0.72	0.68	0.02
Capricornis	20	0.61-0.71	0.66	0.02
Pseudois	27	0.62-0.70	0.65	0.02
Nemorhaedus	21	0.63-0.75	0.65	0.03
Capra sibirica	20	0.60-0.66	0.64	0.02
Capra hircus	16	0.57-0.67	0.62	0.03

Table K.2Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for the Ratio 3/4 in the metacarpal.

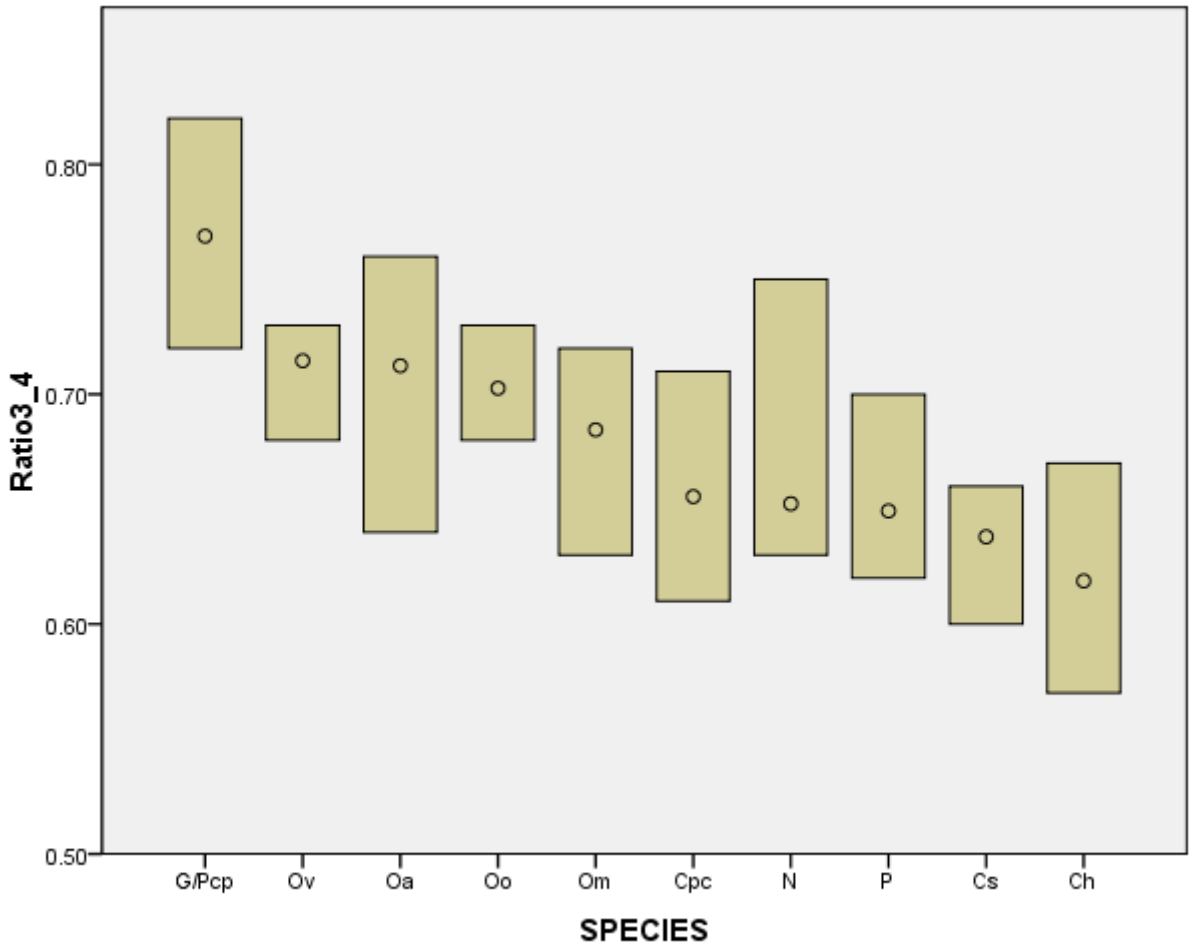


Figure K. 2 High-low chart of Caprinae and Gazella studied. Values are given for Ratio 3/4 on metacarpals. The bars represent the range; the circles represent the mean values.

3. Ratio 5/6

	Ratio 5/6			
	N	Range	Mean	SD
Gazella &Procapra	17	0.71-0.77	0.74	0.02
Argali	33	0.65-0.73	0.69	0.02
Urial	12	0.65-0.71	0.68	0.02
WA Mouflon	18	0.65-0.71	0.67	0.02
EU Mouflon	33	0.62-0.71	0.66	0.02
Capricornis	20	0.60-0.68	0.64	0.02
Nemorhaedus	21	0.60-0.70	0.63	0.02
Pseudois	27	0.59-0.67	0.63	0.02
Capra sibirica	20	0.59-0.65	0.62	0.02
Capra hircus	17	0.54-0.63	0.59	0.02

Table K.3Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for the Ratio 5/6 in metacarpal.

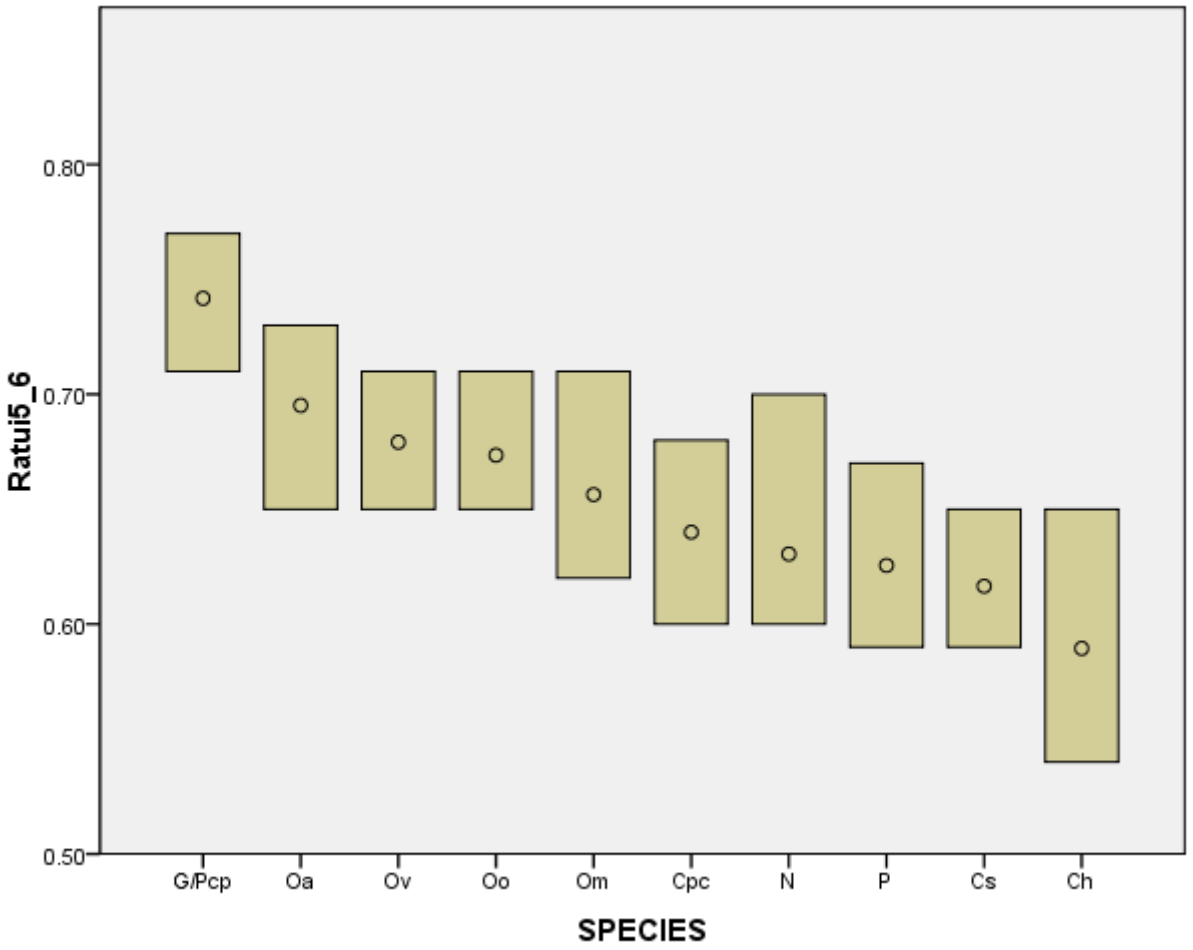


Figure K.3 High-low chart of Caprinae and *Gazella* studied. Values are given for 5/6 on metacarpals. The bars represent the range; the circles represent the mean values.

4. *Ratio 1/3*

	Ratio 1/3			
	N	Range	Mean	SD
Capra hircus	18	1.14-1.27	1.21	0.04
Capra sibirica	20	1.08-1.38	1.20	0.08
Capricornis	20	1.09-1.30	1.19	0.06
Nemorhaedus	21	1.00-1.31	1.18	0.07
Pseudois nayaur	20	1.03-1.18	1.10	0.04
Ovis musimon	33	0.90-1.19	1.03	0.06
Ovis orientalis	21	0.93-1.07	0.99	0.04
Ovis ammon	33	0.89-1.12	0.96	0.05
Ovis vignei	12	0.87-0.99	0.95	0.03
Gazella & Procapra	17	0.70-0.85	0.76	0.04

Table K.4 Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for the Ratio 1/3 on metacarpal.

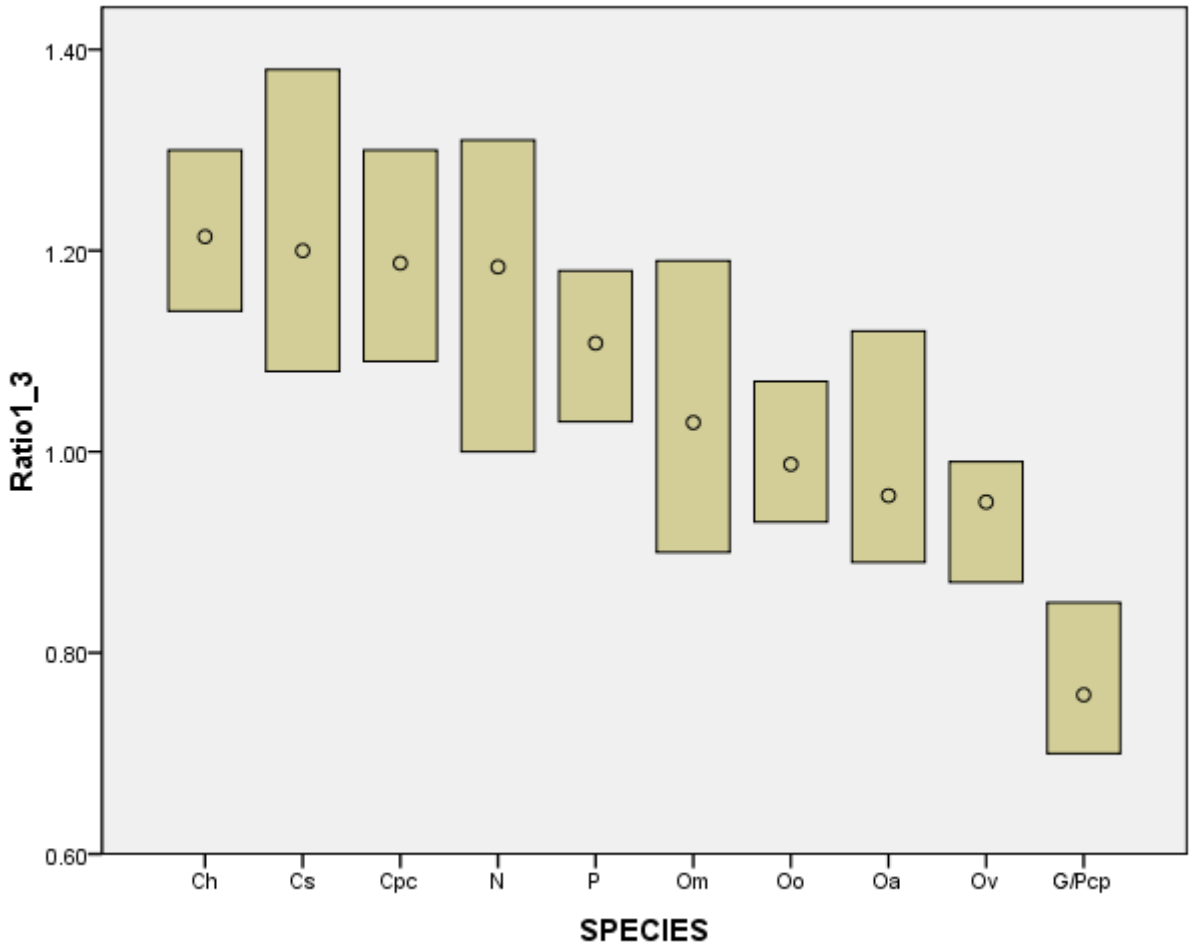


Figure 6.31 High-low chart of Caprinae and *Gazella* studied. Values are given for Ratio 1/3 on metacarpals. The bars represent the range; the circles represent the mean values.

5. Ratio 2/5

	Ratio 2/5			
	N	Range	Mean	SD
Capra hircus	18	1.17-1.33	1.26	0.04
Capra sibirica	20	1.10-1.36	1.23	0.07
Nemorhaedus	21	1.09-1.35	1.23	0.07
Capricornis	20	1.11-1.37	1.21	0.06
Pseudois nayaur	20	1.12-1.24	1.17	0.04
Ovis musimon	33	0.95-1.20	1.08	0.06
Ovis orientalis	21	0.94-1.11	1.03	0.06
Ovis vignei	12	0.92-1.08	1.00	0.05
Ovis ammon	33	0.90-1.14	0.98	0.05
Gazella & Procapra	17	0.73-0.89	0.79	0.04

Table K.5Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for the Ratio 2/5 in the metacarpal.

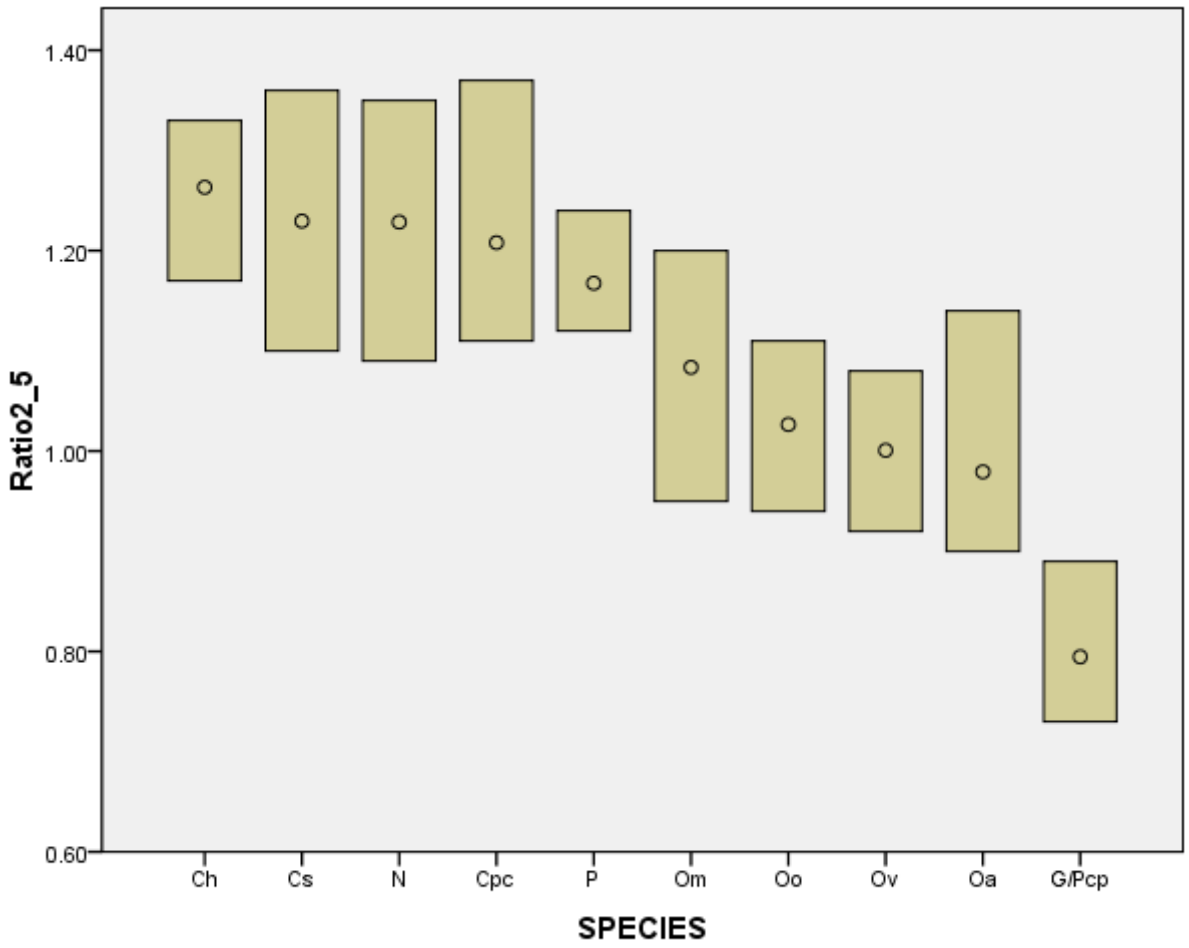


Figure 6.32 High-low chart of Caprinae and *Gazella* studied. Values are given for Ratio 2/5 on metacarpals. The bars represent the range; the circles represent the mean values.

6. *Ratio 7/4*

	Ratio 7/4			
	N	Range	Mean	SD
Nemorhaedus	21	0.83-0.94	0.89	0.02
Gazella & Procapra	15	0.86-0.92	0.88	0.02
Capricornis	20	0.84-0.93	0.88	0.02
WA Mouflon	17	0.83-0.99	0.88	0.04
Argali	33	0.84-0.90	0.87	0.02
Urial	12	0.82-0.89	0.86	0.02
EU Mouflon	31	0.80-0.89	0.84	0.02
Capra sibirica	20	0.80-0.89	0.84	0.02
Pseudois	20	0.80-0.87	0.83	0.02
Capra hircus	16	0.78-0.85	0.81	0.02

Table K.6 Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for the Ratio 7/4 in the metacarpal.

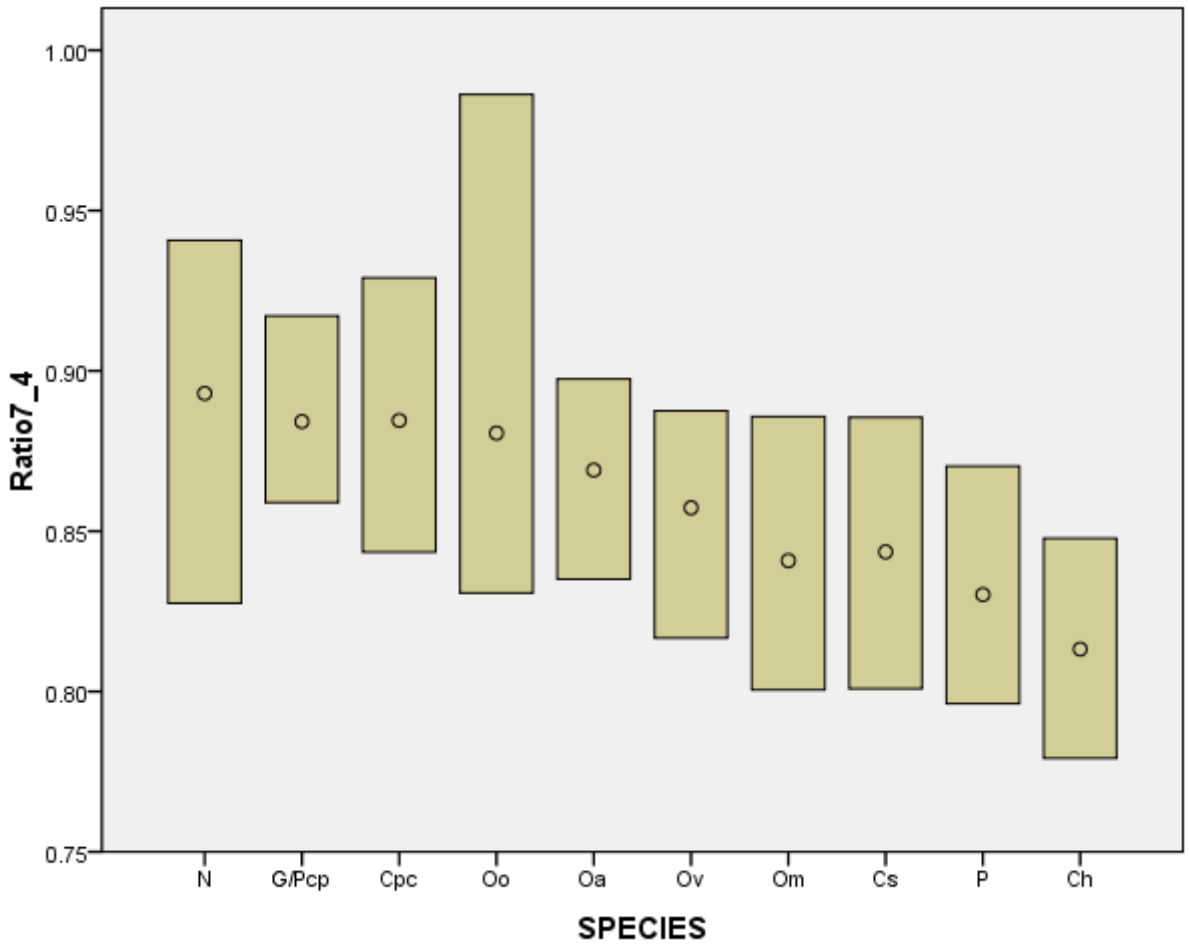


Figure 6.33 High-low chart of Caprinae and *Gazella* studied. Values are given for Ratio 7/4 on metacarpals. The bars represent the range; the circles represent the mean values.

7. Ratio 8/6

	Ratio 8/6			
	N	Range	Mean	SD
Nemorhaedus	21	0.88-0.93	0.90	0.01
Gazella & Procapra	15	0.86-0.95	0.90	0.03
Ovis orientalis	19	0.86-0.99	0.90	0.03
Ovis ammon	33	0.87-0.92	0.89	0.01
Capricornis	20	0.85-0.94	0.89	0.02
Ovis vignei	11	0.84-0.90	0.88	0.02
Ovis musimon	31	0.83-0.91	0.87	0.02
Capra sibirica	20	0.83-0.90	0.86	0.02
Pseudois nayaur	20	0.81-0.91	0.86	0.02
Capra hircus	16	0.80-0.88	0.84	0.02

Table K.7Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for the Ratio 8/6 in the metacarpal.

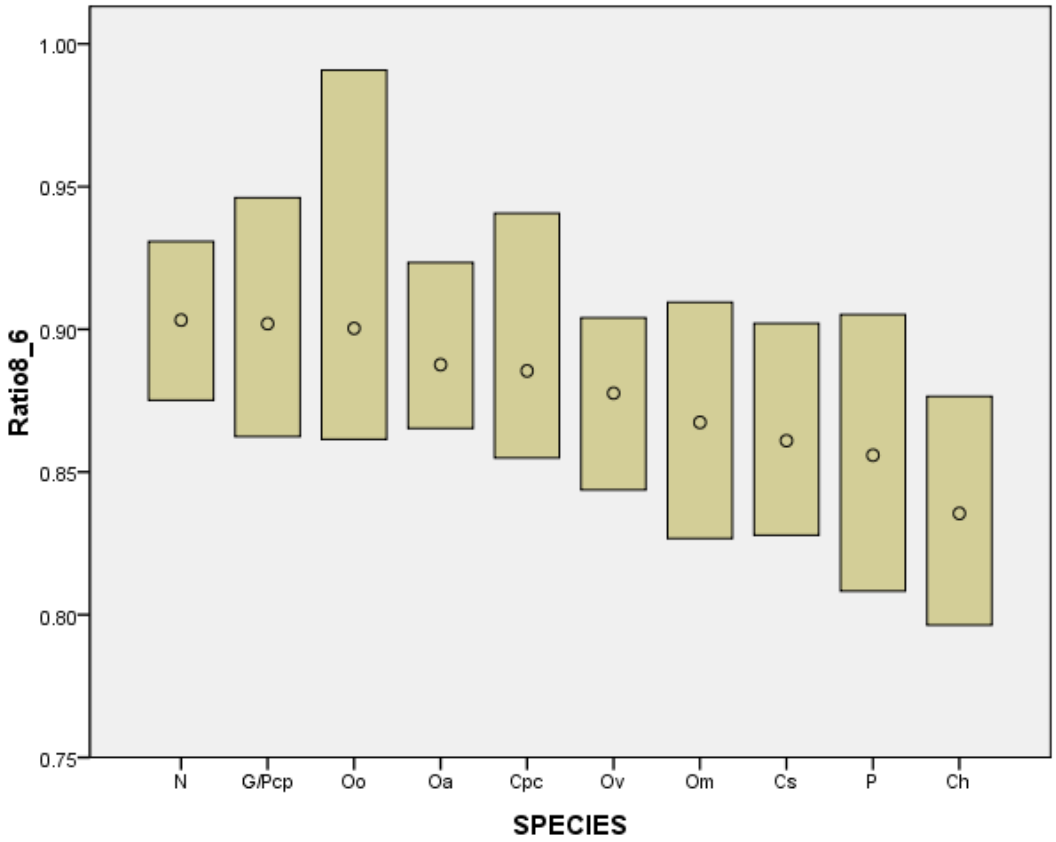


Figure 6.34 High-low chart of Caprinae and *Gazella* studied. Values are given for Ratio 8/6 on metacarpals. The bars represent the range; the circles represent the mean values.

Appendix LComparative Osteomorphology and Osteometry of the Caprinae and Gazella on Proximal Femur

1 Introduction

1.1 Anatomical terms

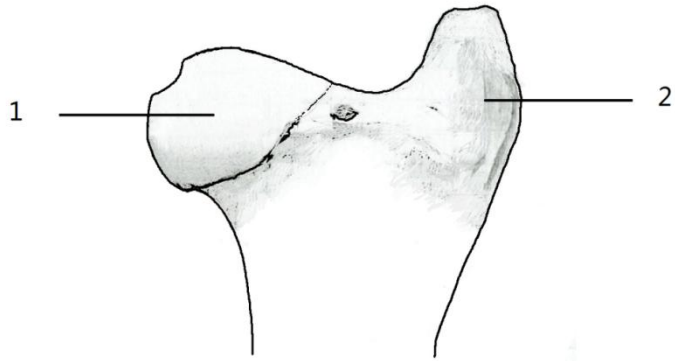


Figure L.1 Anatomical terms addressed on proximal femur. 1. Caput ossis femoris; 2. trochanter major

1.2 Measurements

Apart from the standard measurement were taken following von den Driesch (1976), one additional measurement was taken (Figure J.2):

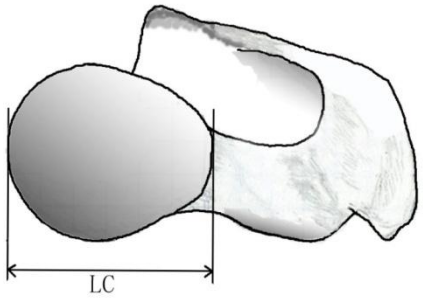


Figure L.2 Additional measurements taken on the proximal femur.

LC: the length of the caput ossis femoris. Measurements were taken from the fusion line of the caput in the lateral side to its medial edge. (+)

2. All Caprinae and *Gazella*

2.1 Absolute Size

Table J.1 shows the size differentiation between the different species of Caprinae. As always, *Capricornis* is the largest among all the species, followed by *Ovis* species from the east to the west of Eurasia, *Pseudois* has the mean value just between Argali and Urial, and the size range overlaps with all wild *Ovis* species. *Procapra gutturosa* is close to wild *Ovis. Capra hircus* has the mean value close to domestic sheep, but the variation is large: there are very large and very small individuals. *Nemorhaedus, Gazella dorcas* and *Gazella gazelle* are among the smallest of all these studied species.

	Bp (mm)		
	N	Range	*Mean*

Capricornis	2	51.8-69.9	60.8
Pseudois nayaur	22	49.5-64.5	54.8
Ovis	20	41.7-62.0	48.9
Procapra gutturosa	2	47.2-50.5	48.8
Capra hircus	9	33.7-59.0	44.6
Nemorhaedus	3	39.5-41.2	40.2
Gazella dorcas/gazelle	9	35.5-40.6	38.5

Table L.1 Osteometrics of the Caprinaes and Gazella studied. Number of measurements taken (N), range, and mean. Values are given for proximal breadth (Bp) of the femur in millimetre (mm).

2.2 Comparative Osteomorphology

1. The form of the caput ossis femoris and trochanter major from anterior view

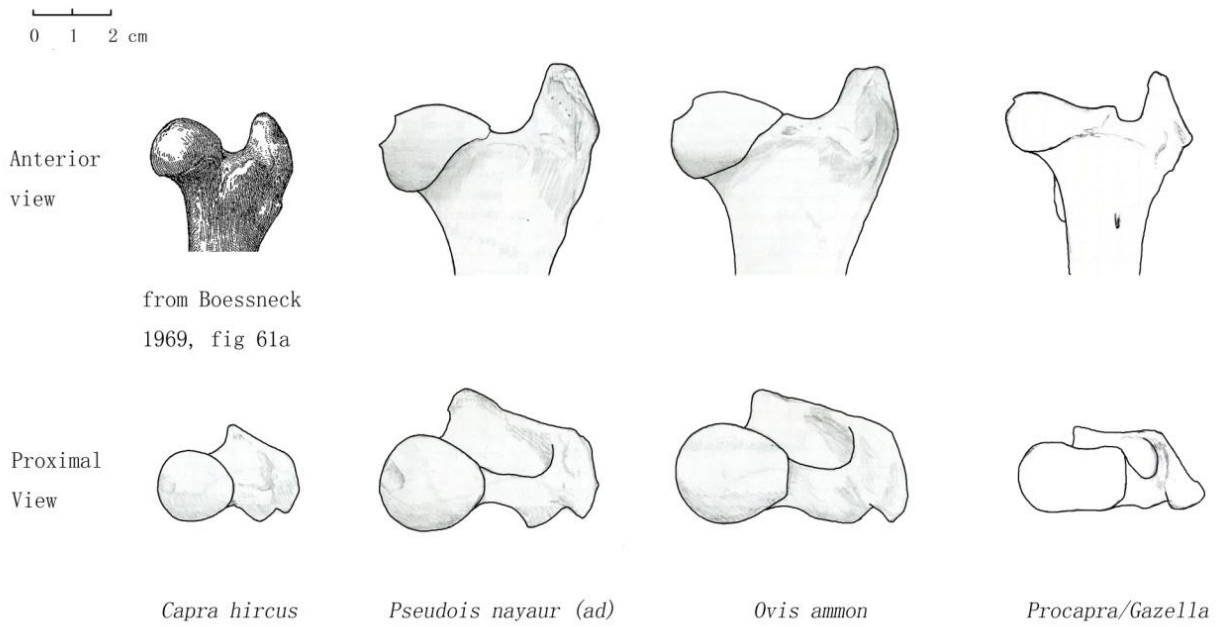


Figure L.3 Capra hircus, Pseudois, Ovis, Procapr, osteomorphology, proximal femur, anterior view.

a. The form of the caput in the different wild *Ovis* and domestic *Ovis* are similar. They are all roller-like, elongated in the lateral-medial direction, and the transition to the saddle take place gradually without or with an only insignificant change of the contour. In contrast, that on *Capra hircus* is ball-shaped, projects less medially but more proximally than *Ovis*, and the caput often forms a shelf toward the saddle (see Boessneck 1964, 1969). On all these features, *Pseudois nayaur* is just in between *Ovis* and *Capra hircus*, and adult *Pseudois* are closer to *Capra* and sub-adult/juveniles are more like *Ovis*. (Figure L.3)

b. The shape of the caput on *Capricornis* is closer to *Ovis*. It projects medially in a roller-like shape. There is a slight step/shelf at the transition from the caput to the saddle. The form of *Nemorhaedus* is close to *Pseudois nayaur*, just in the middle between *Ovis* and *Capra*. (Figure L.4)

c. The shape of the caput on *Gazella* and *Procapra* is long and cylindrical and projects medially. There is a very obvious step in the transition from the Caput to the saddle. (Figure L.3)

2. The form of trochanter major

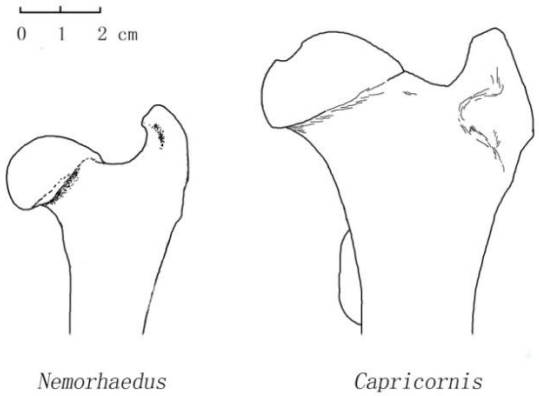


Figure L.4 Nemorhaedus, Capricornis, osteomorphology, proximal femur, anterior view.

a. The trochanter major stands closer to the Caput in *Capra hircus* than in *Ovis*, and it projects more laterally in *Ovis* than in *Capra hircus*. *Pseudois nayaur* is also between the above two on this feature. (Figure L.3)

b. The trochanter major stands closer to the caput on *Capricornis* and *Nemorhaedus,* and there is a bump in the anterior aspect of the trochanter major. (Figure L.4)

c. The trochanter major is thin and sharp in *Gazella* and *Procapra* than Caprinae species. (Figure L.3)

2.3 Comparative Osteometry ------ Proportions of the Different Parts

The metric LC/DC expresses the breadth against the depth of the Caput. As can be seen in Table J.2, *Gazella* and *Procapra* have the largest value and could be separated from the other species quite clearly. *Gazella* is followed by *Ovis,* and *Ovis* is followed by *Capricornis* and *Nemorhaedus*, although they overlap in 1.09-1.13. *Pseudois* and *Capra* are close to each other, although *Pseudos* is only a little bit smaller than *Capra hircus*. (Figure L.3, proximal view)

There are not too much overlaps between *Ovis* and *Pseudois*, and therefore it is a good feature to separate *Ovis* and *Pseudois* apart, which overlaps in size and always constitute big problems in archaeological identification.

	LC/DC		
	N	Range	Mean
Gazella&Procapra	11	1.23-1.43	1.33
Ovis	20	1.09-1.20	1.14
Capricornis	3	1.09-1.13	1.11
Nemorhaedus	3	1.09-1.10	1.10
Capra hircus	10	1.06-1.12	1.09
Pseudois nayaur	14	0.95-1.10	1.07

Table L.2 Osteometrics of Caprinaes and Gazelles studied. Number of measurements taken (N), range, and mean. Values are given for LC/DC. All Ovis samples are grouped together because their values are homogeneous. The unfused articulation in Argali sheep is also included.

3. All *Ovis*

Absolute size

	Bp(mm)		
	N	Range	Mean
zoo *O. ammon*	3	55.7-62.0	59.18
zoo *O. vignei*	3	43.6-51.9	48.35
wild *O. orientalis*	1	52.2	52.21
Zoo *O. musimon*	8	41.69-50.07	44.43
O. aries	2	44.16-45.95	45.06

Table L.3 Osteometrics of the Ovis. Number of measurements taken (N), range, and mean. Values are given for proximal breadth (Bp) of the femur in millimetre (mm).

Appendix MComparative Osteomorphology and Osteometry of the Caprinae and Gazella on Distal Tibia

1.Introduction

1.1 Anatomical Terms

As can be seen in Figure M.1, in the description of the morphology of the distal tibia, some anatomical terms are used.



Figure M.1 Anatomical terms addressed on the distal tibia. 1. malleolus medialis; 2. sulcus malleolaris

1.2 Measurements

Apart from the standard measurement ‘Bd’ is taken (von den Driesch 1976), the following new measurements are added (Figure M.2):

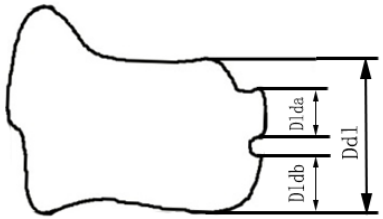


Figure M.2 Additional measurements taken on the distal tibia.

Dd: (greatest) depth of the distal end.

Ddl: Depth of the distal end on the lateral side.

Dlda: the depth of the dorsal articular facet of the *Facies articularis malleolaris* in lateral side.

Dldb: the depth of the plantar articular facet of the *Facies articularis malleolaris* in lateral side.

2. Caprinaes and *Gazella*

2.1 Absolute Size

As can be seen in Table M.1, the size range of the different species differs in distal tibia, and the sequence is the same as that on the other elements.

		Bd (mm)		
	N	Range	*Mean*	SD
Capricornis	2	36.20-45.80	41.00	6.79
Pseudois	26	27.00-35.29	30.95	1.98
Ovis	23	21.86-38.81	28.13	4.38

Capra hircus	16	21.82-35.36	27.31	3.18
Nemorhaedus	5	23.83-31.49	26.01	3.16
Gazella	12	18.86-27.16	21.77	2.40

Table M.1 Osteometrics of Caprinae and Gazellas studied. Number of measurements taken (N), range, mean, and standard deviation .Values are given for proximal breadth (Bd) of the tibia in millimetre (mm).

2.2 Comparative Osteomorphology

There are altogether six features considered in separating different Caprinae and *Gazella* species, as shown in Figure M.3.

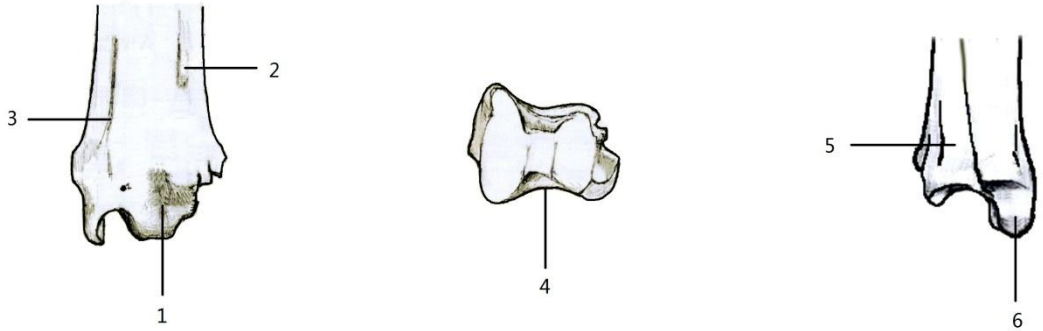


Fig M.3 Distal tibia, the diagnostic characters considered in separating different Caprinaes and Gazelles. 1. The anterior face of the distal articulation; 2. The protuberantinia above the distal end of the anterior face 3.The process on the medial part of the anterior face; 4.The posterior edge of the distal articular surface; 5.Sulcus malleolaris; 6.The medial malleolus.

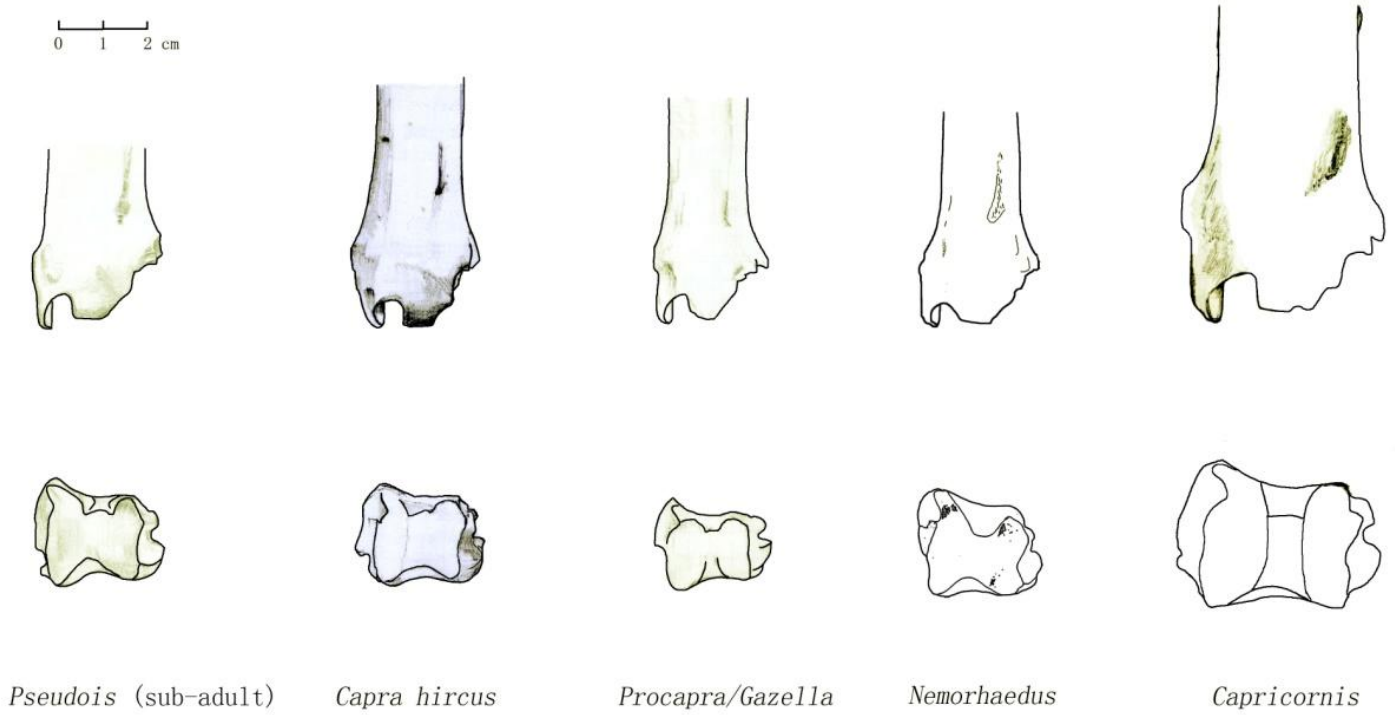


Figure M.4 Pseudois nayaur, Capra hircus, Procapra/Gazella, Nemorhaedus, and Capricornis, distal tibia, anterior and distal view, Comparative osteomorphology.

Anterior View

1. The anterior face of the distal articulation

a. The anterior face of *Pseudois, Capra hircus, Procapra, Capricornis, Nemorhaedus* are all quite flat. However, on juvenile *Pseudois nayaur,* at the place of the fusion line at the lateral side, it is also slightly raised up (Figure M.4).

b. On *Procapra* and *Gazella*, it only slightly raises up on the lateral part, less than the level of the *Ovis*, similar or slightly higher than goats. This feature could be viewed/felt from the anterior side of the bone, and could also be discerned from the distal view (Figure M.4).

2. The protuberantinia above the distal end of the anterior face

a. This ridge runs from the lateral edge to the middle of the anterior face in *Capra hircus*, in opposed to that of sheep which remains on the lateral side and mostly vertical (see also Prummel and Frisch 1986). In adult *Pseudois nayaur*, it is also oblique and runs from the lateral to the middle of the anterior face on adult individuals, just like *Capra*. However, in juvenile *Pseudois* it does not present or only slightly hinted (Figure M.4).

b. In *Capricornis*, this protuberantinia is quite oblique. In *Nemorhaedus*, the protuberantinia is not obvious in most cases observed, but in one case it is highly developed in an oblique line (Figure M.4).

c. In *Gazella* and *Procapra*, it is in the form of a sharp ridge on the lateral side in the vertical direction, protruding highly from the anterior surface of the bone (Figure M.4).

3. The process on the medial part of the anterior face

This process is highly developed in the form of a sharp ridge in *Procapra* and *Gazella*, and not so much developed in all the other species (Figure M.4).

Distal View

4. The posterior edge of the distal articular surface

a. As noted in Prummel and Frisch (1986), this edge shows a deep curve in domestic sheep (*Ovis aries*), and curve less in *Capra hircus*. In all the wild sheep studied, this feature resembles domestic sheep. On *Pseudois nayaur*, this curve is similar to *Ovis* on sub-adults, but on adults, it curves less, although still deeper than that of *Capra hircus* (Figure M.4).

b. This feature on *Capricornis* and *Nemorhaedus* is similar to *Capra*, also curve inward shallowly (Figure M.4).

c. This curve on Gazella/Procapra is almost similar to that of *Ovis* (Figure M.4).

Medial Side View



Figure M.5 Pseudois nayaur, Capra hircus, Procapra/Gazella, Nemorhaedus, and Capricornis, distal tibia, medial side view, Comparative osteomorphology.

5. Sulcus malleolaris

a. This groove is pronounced in *Capra hircus* and fainted in all *Ovis* species examined (see also Prummel and Frisch 1986). On *Pseudois nayaur*, the groove is more clearly pronounced than *Ovis* but less striking and often wider than *Capra* (see also G. G ÖTZE 1998). It is also found that it faints in juvenile *Pseudois* (Figure M.5).

b. On *Gazella* and *Procapra*, this groove is not as deeply notched in as *Capra*, but the ridge of the groove (especially the anterior ridge) is quite clearly defined (Figure M.5).

c. In *Capricornis*, this groove is also quite notched in, but not as clearly defined as *Capra hircus*. In *Nemorhaedus*, the sulcus could be observed, but shallow and not very obvious (Figure M.5).

6. The medial malleolus

a. As noted in Zeder (2010), the medial malleolus appears flat or concave in *Capra hircus*, and it appears bulbous and bulging out convexly in a medial direction in most zoo Urial, EU Mouflon and domestic sheep; it appears flat in some samples of in wild Argali and wild WA Mouflon. In *Pseudois nayaur*, it is usually more bulbous and bulging out convexly than *Capra hircus*, but the level of convex is less than that of domestic sheep (Figure M.5).

b. In *Capricornis* and *Nemorhaedus*, the medial malleolus is bulbous and bulging out convexly in a medial direction. Some samples also have sharp point at the distal end. The juvenile *Capricornis* has a sharp pointed distal point toward the anterior side (Figure M.5).

c. On *Procapra* and *Gazella*, the medial malleolus also bugles out a little bit in a medial direction. But the shape of the medial malleolus is slightly different --- distally it forms a small point or ends with a flat surface. In juvenile *Pseudois nayaur*, the form of the medial malleolus is more or less similar (Figure M.5).

2.3 Comparative Osteometry ------Relative Proportions of the Different Parts

In distal view, the protrusions on the lateral side

a. In *Pseudois*, the depth of the anterior protrusion in comparison to that of the posterior is smaller than Argali, larger than EU Mouflon, but overlaps with all the other *Ovis* groups. In *Capra hircus*, this value overlaps with all the *Ovis* and *Pseudois*, although smaller than most of the *Ovis ammon*. This is not a good feature to distinguish separate *Pseudois*, *Capra*, and *Ovis*, apart from some exceptional Argali sheep (Table M.2; Table M.4).

b. In *Capricornis*, this value is very large; in *Nemorhaedus*, it is quite small, but our samples are limited (Table M.2).

c. In *Gazella* and *Procapra*, it overlaps with most other species (Table M.2).

	Dlda/Dldb		
	N	Range	Mean
Capricornis	2	0.84-0.88	0.86
Argali	7	0.65-0.88	0.77
Capra hircus	16	0.45-0.83	0.62
Pseudois nayaur	13	0.52-0.72	0.60
Soay domestic	5	0.57-0.63	0.60
Zoo Urial	4	0.53-0.61	0.57
Gazella/Procapra	5	0.42-0.70	0.56
Nemorhaedus	3	0.45-0.59	0.53
WA Mouflon	1	0.53	0.53
Zoo EU Mouflon	4	0.37-0.52	0.45

Table M.2 Osteometrics of Caprinae and Gazella. Number of measurements taken (N), range, mean.Values are given for Dlda/Dldb.

3. *Ovis*

3.1 Absolute Size

As can be seen in Table M.3, the size differentiation between the different species of *Ovis* shows the same pattern as observed in other elements: there is a gradual descending gradient from the *Ovis* in the east to the *Ovis* in the west and to the domestic sheep. The wild sheep are larger than the zoo sheep --- the wild western Asian Mouflons are larger than the zoo Urials although Urials distribute further east.

		Bd (mm)		
	N	Range	Mean	SD

Argali	7	30.27-38.81	32.95	2.82
Zoo Urial	4	24.48-30.17	27.51	2.33
Wild WA Mouflon	1	29.23	29.23	-
EU Mouflon	9	22.79-27.53	25.04	1.66
EU Domestic	9	21.86-27.12	24.33	1.91

Table M.3 Osteometrics of Ovis. Number of measurements taken (N), range, mean, and standard deviation. Values are given for proximal breadth (Bd) of the tibia in millimetre (mm)

Among the seven specimens of Argali, one wild specimen (BMN 5391) has an exceptionally large dimension of Bd=38.81, and all the others are zoo specimens ranging 30.27-33.45. BMN 5391 was caught wild in Western Siberia (Southern Altai) and then sold to Berlin Zoo. It's unsurprising that it's much larger than the other zoo Argalis.

3.2 Comparative Osteomorphology

Anterior View

1. **The anterior face of the distal articulation**

This face is quite flat in Argali and Urial, but there is a slight depression in the middle of the anterior face on European Mouflon. Maybe it is related to the size of the sample. (Figure I.6)

2. **The lateral part of the anterior face of the distal articulation**

This part rises up on most of the European Mouflon and domestic sheep samples, and the highest position is at the lateral border. However, on the only wild Argali and most of the zoo Urial samples observed, this part is quite flat, just like Capra hircus. This feature could also be discerned from the distal view. (Figure I.6)

3. The protuberantinia laterodorsal muscle attachment on the distal articular end proximal of the distal surface

This protuberantinia is in the form of a verticle ridge on most of the *Ovis* samples. On some adult samples of Argali and Urial, there is a tendency of being a little bit oblique; on EU Mouflon this ridge all positioned quite vertically. On juvenile samples, this ridge doesn't exist or only slightly hinted.(Figure I.6)

Medial View

4. Malleolus medialis

On zoo Urial, EU Mouflon and domestic sheep, it all appears bulbous, bulging out convexly in a medial direction (see also Zeder 2010, Fig. 4). On Argali, on the only wild Argali sample MNB 5391 this facet is quite flat with a small step in the middle, and all the others are bulbous like other *Ovis* species.(Figure M.6)

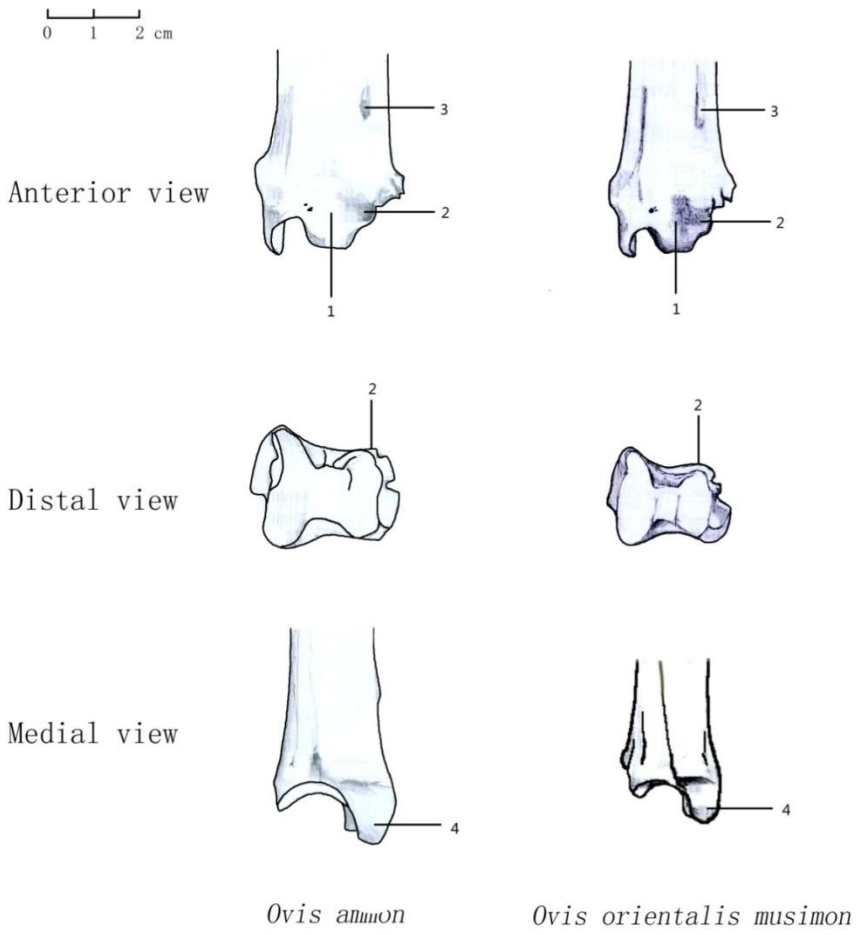


Figure M.6 Argali (Ovis ammon) and European Mouflon (Ovis orientalis musimon), distal tibia, Comparative osteomorphology.

3.3 Comparative Osteometry ------ Relative Proportions of the Different Parts

The protrusions on the lateral side

On Argali, the depth of the anterior protrusion on the lateral side is larger in comparison to that of the posterior protrusion. It becomes smaller as the sheep distributing to the west. This feature could be expressed by Dlda/Dldb. Argali has the largest value whilst EU Mouflon the smallest.(Figure M.6)

		Dlda/Dldb		
	N	Range	Mean	SD
Argali	7	0.65-0.88	0.77	0.08
Zoo Urial	4	0.53-0.61	0.57	0.04
WA Mouflon	1	0.53	0.53	-
Zoo EU Mouflon	4	0.37-0.52	0.45	0.05
Soay domestic	5	0.57-0.63	0.60	0.03

Table M.4 Osteometrics of Ovis. Number of measurements taken (N), range, mean, and standard deviation (SD). Values are given for Dlda/Dldb.

One noticeable thing is that Soay domestic sheep is larger than the zoo EU Mouflon and close to Urial sheep on this metric feature.

Appendix N Ratios of Pairs of Measurements on Distal Metatarsals Between the Caprinae and Gazella on Metatarsals

A. Caprinae and Gazella

1. DBV/DpBV

	DBV/DpBV			
	N	Range	Mean	SD
Gazella and Procapra	17	1.00-1.25	1.12	0.07
Capricornis	23	0.92-1.19	1.06	0.06
Nemorhaedus	18	0.97-1.12	1.05	0.05
Urial	11	0.94-1.13	1.03	0.06
Argali	33	0.94-1.11	1.01	0.04
WA Mouflon	21	0.96-1.09	1.01	0.04
EU Mouflon	27	0.89-1.09	0.99	0.05
Pseudois	21	0.85-1.04	0.95	0.05
Capra sibirica	16	0.84-1.04	0.91	0.06
Capra hircus	20	0.73-0.88	0.81	0.05

Table N.1 Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for DBV/DpBV on metatarsal.

2. Ratio 3/4

	Ratio 3/4			
	N	Range	Mean	SD
Gazella &Procapra	17	0.68-0.77	0.72	0.02
Argali	29	0.63-0.72	0.68	0.02
Urial	14	0.63-0.69	0.66	0.02
WA Mouflon	22	0.63-0.71	0.66	0.02
Capricornis	21	0.59-0.67	0.64	0.02
Nemorhaedus	18	0.60-0.68	0.64	0.02
EU Mouflon	27	0.60-0.70	0.64	0.03
Capra sibirica	16	0.61-0.67	0.63	0.02
Pseudois	28	0.57-0.65	0.62	0.02
Capra hircus	17	0.57-0.65	0.62	0.02

Table N.2Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for the Ratio 3/4 in the metatarsal.

3. Ratio 5/6

	Ratio 5/6			
	N	Range	Mean	SD
Gazella & Procapra	17	0.64-0.74	0.70	0.02
Argali	29	0.62-0.69	0.67	0.02
Urial	12	0.60-0.67	0.65	0.02

WA Mouflon	18	0.62-0.69	0.65	0.01
Nemorhaedus	18	0.60-0.68	0.63	0.02
Capricornis	21	0.60-0.66	0.63	0.02
EU Mouflon	27	0.58-0.69	0.63	0.03
Capra sibirica	16	0.60-0.67	0.63	0.02
Pseudois	27	0.58-0.65	0.62	0.02
Capra hircus	18	0.55-0.62	0.59	0.02

Table N.3 Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for the Ratio 5/6 in the metatarsal.

4. Ratio 1/3

	Ratio 1/3			
	N	Range	Mean	SD
Capra hircus	18	1.04-1.22	1.14	0.05
Capricornis	21	1.03-1.25	1.13	0.06
Nemorhaedus	18	1.03-1.24	1.12	0.07
Capra sibirica	16	0.95-1.19	1.07	0.06
Pseudois nayaur	22	0.99-1.25	1.07	0.06
Ovis musimon	27	0.92-1.14	1.03	0.06
Ovis orientalis	22	0.92-1.13	1.00	0.06
Ovis vignei	12	0.88-1.07	0.97	0.05
Ovis ammon	30	0.90-1.08	0.96	0.04
Gazella & Procapra	17	0.73-0.89	0.81	0.04

Table N.4Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for the Ratio 1/3 in the metatarsal.

5. Ratio 2/5

	Ratio 2/5			
	N	Range	Mean	SD
Capra hircus	18	1.04-1.25	1.15	0.06
Nemorhaedus	18	1.06-1.22	1.13	0.05
Capricornis	21	1.06-1.22	1.12	0.04
Capra sibirica	16	0.98-1.23	1.08	0.06
Pseudois nayaur	21	0.96-1.10	1.04	0.04
EU Mouflon	27	0.91-1.13	1.03	0.06
WA Mouflon	22	0.88-1.07	0.98	0.05
Urial	12	0.85-1.10	0.97	0.06
Argali	30	0.88-1.11	0.94	0.05
Gazella & Procapra	17	0.76-0.95	0.85	0.05

Table N.5 Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD) Values are given for the 2/5 in the metatarsal.

6. Ratio 7/4

	Ratio 7/4			
	N	Range	Mean	SD
Nemorhaedus	18	0.82-0.89	0.87	0.02
Capricornis	21	0.83-0.90	0.86	0.02
Gazella & Procapra	17	0.80-0.89	0.85	0.02
Argali	28	0.82-0.87	0.85	0.01
WA Mouflon	19	0.82-0.86	0.84	0.01
Urial	10	0.81-0.86	0.83	0.02

Pseudois	22	0.80-0.86	0.83	0.02
Capra sibirica	16	0.80-0.87	0.83	0.02
Capra hircus	11	0.79-0.88	0.82	0.03
EU Mouflon	27	0.79-0.86	0.82	0.02

Table N.6 Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for the Ratio 7/4 in the metatarsal.

7. Ratio 8/6

	Ratio 8/6			
	N	Range	Mean	SD
Nemorhaedus	18	0.86-0.91	0.89	0.01
Capricornis	21	0.85-0.92	0.89	0.02
Gazella & Procapra	17	0.84-0.92	0.88	0.02
Argali	31	0.84-0.90	0.87	0.01
WA Mouflon	17	0.83-0.91	0.87	0.02
Capra sibirica	16	0.82-0.91	0.87	0.02
Urial	8	0.84-0.89	0.86	0.02
EU Mouflon	27	0.83-0.90	0.86	0.02
Pseudois	22	0.79-0.91	0.85	0.02
Capra hircus	12	0.81-0.92	0.85	0.03

Table N.7Osteometrics of Caprinae and Gazella studied. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for the Ratio 8/6 in the metatarsal.

B.Ovis

1. DBV/DpBV

	DBV/DpBV			
	N	Range	Mean	SD
Ovis ammon	33	0.94-1.11	1.01	0.04
Ovis orientalis	11	0.94-1.13	1.03	0.06
Ovis vignei	21	0.96-1.09	1.01	0.04
Ovis musimon-wild	8	0.89-1.09	1.00	0.06
Ovis musimon-zoo	19	0.92-1.08	0.98	0.04
Ovis aries	15	0.86-1.00	0.94	0.04
Rambouillet	13	0.88-1.08	0.96	0.06
Rambouillet x Argali	10	0.88-1.04	0.98	0.05

Table N.8Osteometrics of Ovis. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for DBV/DpBV in the metatarsal.

2. Ratio 3/4 and 5/6

	Ratio 3⁄4				Ratio 5⁄6			
	N	Range	Mean	SD	N	Range	Mean	SD
Ovis ammon	29	0.63-072	0.68	0.02	29	0.62-0.69	0.67	0.02
Ovis orientalis	14	0.63-0.69	0.66	0.02	12	0.60-0.67	0.65	0.02
Ovis vignei	22	0.63-0.71	0.66	0.02	18	0.62-0.69	0.65	0.01
Ovis musimon-wild	8	0.62-0.70	0.66	0.03	8	0.62-0.69	0.66	0.02
Ovis musimon-zoo	19	0.60-0.68	0.63	0.02	19	0.58-0.67	0.62	0.03
Ovis aries	15	0.61-0.68	0.65	0.02	15	0.60-0.67	0.64	0.02
Rambouillet	7	0.62-0.69	0.65	0.02	13	0.61-0.69	0.64	0.02
Ramoubillet x Argali	8	0.61-0.66	0.64	0.02	9	0.59-0.64	0.62	0.02

Table N.9Osteometrics of Ovis. Number of specimens measured (N), range, mean, and standard deviation (SD). Values are given for ratio 3/4 and ratio 5/6 in the metatarsal.

3. Ratio 1/3 and 2/5

		Ratio 1/3			Ratio 2/5		
	N	Range	Mean	SD	Range	Mean	SD
Ovis ammon	30	0.90-1.08	0.96	0.04	0.88-1.11	0.94	0.05
Ovis orientalis	12	0.88-1.07	0.97	0.05	0.85-1.10	0.97	0.06
Ovis vignei	22	0.92-1.13	1.00	0.06	0.88-1.07	0.98	0.05
Ovis musimon-wild	8	0.93-1.08	1.01	0.05	0.92-1.05	0.99	0.05
Ovis musimon-zoo	19	0.92-1.14	1.05	0.06	0.91-1.13	1.04	0.05
Ovis aries	15	0.98-1.25	1.09	0.07	0.97-1.17	1.05	0.06
Rambouillet	13	0.94-1.14	1.06	0.05	0.90-1.14	1.04	0.07
Ramoubillet x Argali	9	1.00-1.16	1.06	0.05	0.99-1.10	1.04	0.05

Table N.10 Osteometrics of Ovis. Number of specimens measured (N), range, mean, and standard deviation (SD).Values are given for Ratio 1/3 and Ratio 2/5 in the metatarsal.

Appendix OComparative Osteomorphology and Osteometry of the Caprinae and Gazella on Phalanx 1

1. Introduction

1.1 Anatomical terms

There is one anatomical term used in describing the morphology of phalanx 1 (Figure O.1).

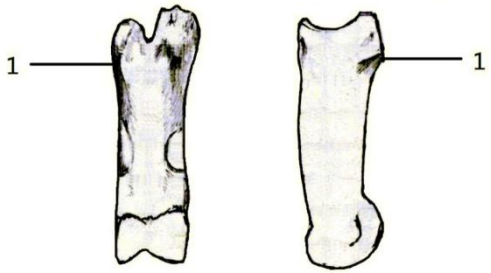


Figure O.1 Anatomical terms addressed on phalanx I: 1.the axial ligament tubercle on the posterior side of the proximal end

1.2 Measurements

Apart from the standard measurement “Bp”, “SD”, “GLpe” and “Bd” following von den Driesch (1976), two additional measurements are taken (Figure O.2):



Figure O.2 Additional measurements taken on the distal tibia.

DP: Depth of the proximal end

Dd: (greatest) depth of the distal end

2. Caprinae and *Gazella*

2.1 Absolute size

Table O.1 shows the size distinctions on BP and GLpe between the different Caprinae and *Gazella* species. There are a balanced number of measurements from fore-limb and hind-limbs for each species.

	Bp				GLpe			
	N	Range	Mean	SD	N	Range	Mean	SD
Capricornis	13	15.65-21.23	18.74	1.81	13	44.20-63.23	53.59	6.14
Pseudois	40	10.37-17.4	14.19	1.44	37	34.76-49.48	42.17	3.08
Ovis	39	10.55-16.02	13.06	1.41	39	34.56-52.22	42.51	5.12
Nemorhaedus	15	11.10-14.12	12.89	0.95	15	39.08-39.86	39.47	0.55
Capra	2	9.66-9.92	9.79	0.18	2	39.08-39.86	39.47	0.55
Gazella	2	8.57	8.57	0.00	2	33.89-34.25	34.07	0.25

Table O.1 Osteometrics of Caprinae and Gazella. Number of measurements taken (N), range, mean, and standard deviation (SD). Values are given for proximal breadth (Bp) and greatest length of the peripheral half (GLpe) of the phalanx I in millimetre (mm)

2.2 Comparative osteomorphology

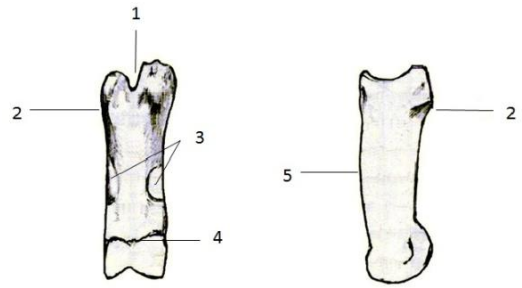


Figure O.3 Phalanx 1, the diagnostic characters considered in separating different Caprinae and Gazella. 1. The groove between the peripheral and axial articulations of the proximal end; 2. The axial ligament tubercle on the posterior side of the proximal end; 3.The originating points for ligaments on the posterior side toward the distal end of the Bone; 4.The posterior edge of the distal articular surface; 5.The anterior surface of the bone from a side view.

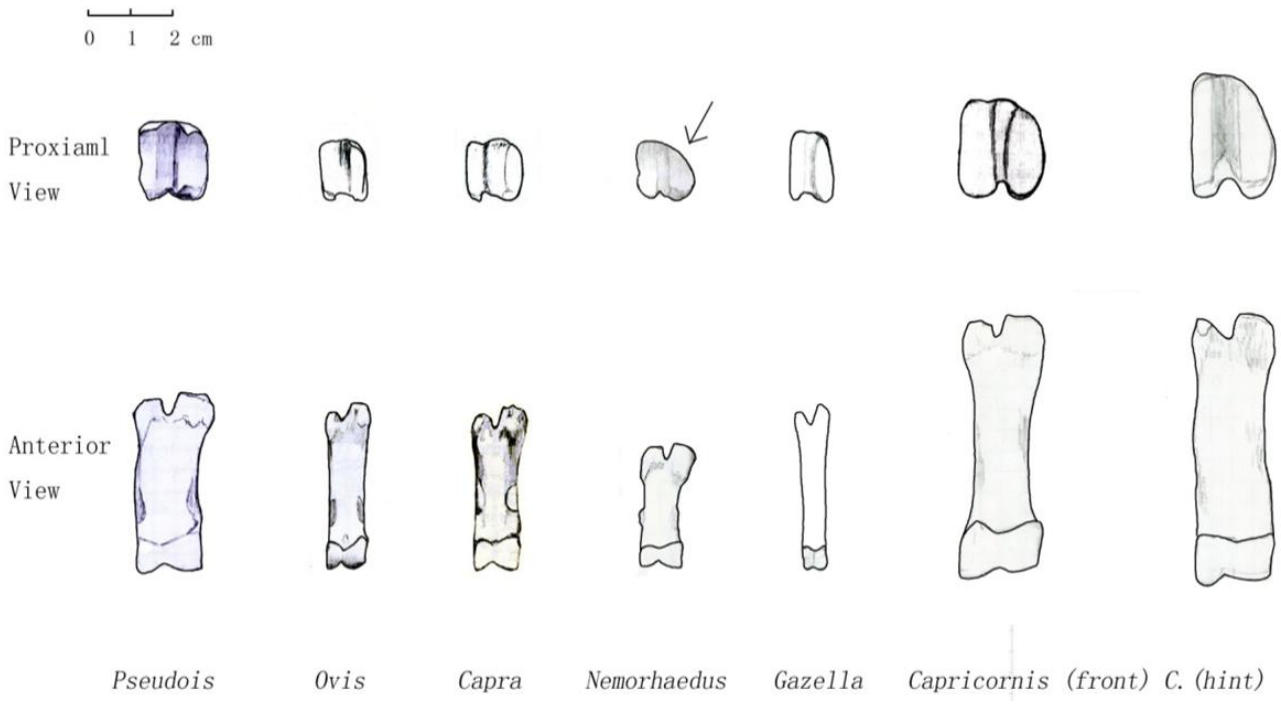


Figure O.4Pseudois, Ovis, Capra hircus, Nemorhaedus, Capricornis, Gazella, Comparative osteomorphology, phalanx 1, proximal and anterior view.

Posterior View

1. **The groove between the peripheral and axial articulations on the proximal end**

   a. On *Pseudois nayaur*, both U-shaped and V-shaped cases are observed. It is noted in G. Götze (1998) that this groove in *Pseudois* is deeper than in *Ovis aries* and shallower than that in *Capra hircus*. But there are considerable overlaps between *Pseudois* and Argali. Especially on the juvenile *Pseudois*, this groove is quite shallow. (Figure O.4)

   b. On *Nemorhaedus*, the grooves are V-shaped or U-shaped. Some look deep, and some are shallow. On all the *Capricornis* specimens that observed, the grooves are V-shaped or deep U-shaped. All looks quite deep. (Figure O.4)

   c. On *Gazella*, this groove is quite deep and narrow. (Figure O.4)

2. **The axial ligament tubercle on the posterior side of the proximal end**

   a. It was noted that this tubercle is more strongly developed in *Capra hircus* than *Ovisaries* (Boessneck 1969). In Argali, there is usually a more developed tubercle than that on *Ovis aries*, but it is not as strongly developed as that on adult *Pseudois*. In *Pseudois nayaur*, it shows a stronger tendency of being drawn out distally to a high ridge on the adults, similar to *Capra hircus*. On juvenile *Pseudois*, the ridge is not strongly developed. (Figure O.4)

   b. In *Nemorhaedus*, most of the samples are similar on this feature to *Capra hircus*, but some others look like *Ovis*. In *Capricornis*, there is no strongly developed axial ligament tubercle on the posterior side of the proximal end. (Figure O.4)

   c. On *Gazella*, it is not strongly developed. (Figure O.4)

3. **The originating points for ligaments on the posterior side toward the distal end of the bone**

   a. In *Pseudois*, there are lots of variations on this feature. In the cases of some adults, the points on both sides are strongly developed, even more than *Capra hircus*, but on some other adults and juveniles, they are not that much developed: the axial side point bulge out and peripheral side concave, similar to that on wild *Ovis*. (Figure O.4)

   b. Most *Nemorhaedus* are strongly developed and although in juveniles they are not. On Capricornis, it varies. (Figure O.4)

   c. Not distinctive in *Gazella*. (Figure O.4)

4. The posterior edge of the distal articular surface

It is open or straight in *Capricornis,* most cases of *Nemorhaedus*, and most cases of *Pseudois nayaur*.

Side View

5. The anterior surface from side view

a. On juvenile *P. nayaur,* it bulges out strongly, on adult *Pseudois* it bulges out slightly. On all *Ovis* species and *Capra hircus* it is straight, or in very few cases there is a very slight tendency of being bulging out (Figure O.5).

b. It bulges out strongly in most cases of adult *Nemorhaedus* (Figure O.5).

c. It is straight on *Gazella* (Figure O.5).

Proximal View

6. Shape of the proximal articular surface

The peripheral border of the proximal end tends to be more oblique in *Nemorhaedus*, and squarer in *Gazella, Ovis, Pseudois nayaur* and *Capra* (Figure O.4).

It should be noted that the proximal articular surface of the anterior Phalanx 1 is always wider than its homologue in the hind leg (Figure O.4, see *Capricornis*). This holds for all the Caprinae.

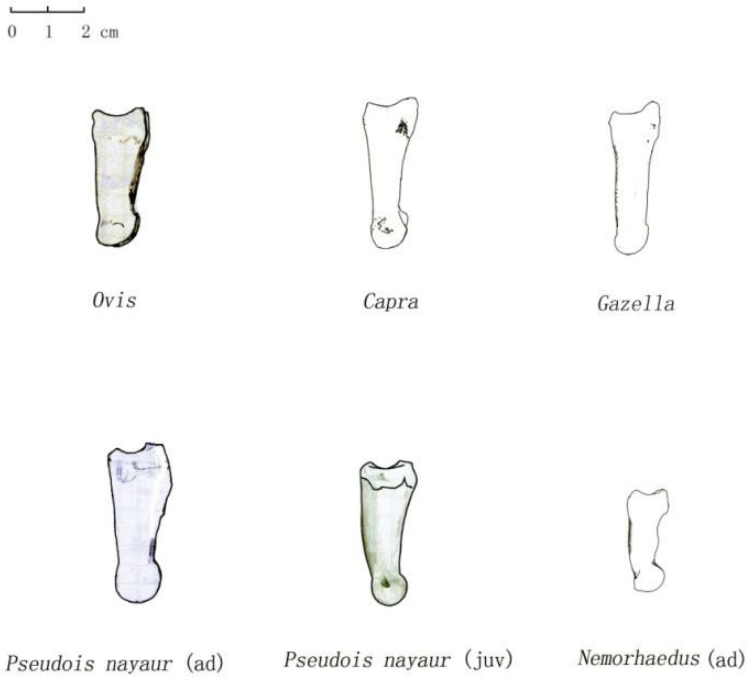


Figure O.5 Pseudois, Ovis, Capra hircus, Nemorhaedus, Capricornis, Gazella, Comparative osteomorphology, phalanx 1, proximal and anterior view.

2.3 Comparative osteometry ------ Relative Proportions on Different Parts

1. **The form of the proximal articular surface**

When viewed from the above, the proportion of the breadth against the depth of the proximal articular surface is expressed by Bp/Dp. As can be seen in Table O.2, it is the largest in *Nemorhaedus* and the smallest in *Capra*. *Nemorhaedus* is followed by *Pseudois*, and then *Capricornis*. Different *Ovis* species are all similar to each other: the slightly smaller value of wild WA Mouflon might be a result of a small sample size. But *Gazellas* are much smaller than the above.

	Bp/Dp			
	N	Range	Mean	SD
Nemorhaedus	15	0.83-1.04	0.91	0.06
Pseudois	20	0.78-0.95	0.86	0.05
Capricornis	15	0.70-0.94	0.86	0.06
Zoo Urial	12	0.80-0.88	0.84	0.03
EU Mouflon	11	0.79-0.90	0.84	0.04
Argali	13	0.75-0.91	0.83	0.05
Wild WA Mouflon	3	0.78-0.85	0.81	0.04
Gazella	2	0.71	0.71	0.00
Capra hircus	2	0.61-0.63	0.62	0.01

Table O.2 Osteometrics of Caprinae and Gazella. Number of measurements taken (N), range, mean, and standard deviation (SD). Values are given for Bp/Dp of the phalanx I.

2. Length against the breadth of the bone

This feature is expressed by GLpe/Bp. As can be seen in Table O.3, among all the studied species, it is the longest and narrowest in *Gazella* and *Capra*, followed by different *Ovis* species (see Table O.3), and then it is *Pseudois nayaur*. After *Pseudois* it is *Capricornis*, and *Nemorhaedus* is the shortest.

		Glpe/Bp		
	N	Range	Mean	SD
Capra	2	3.94-4.13	4.03	0.13
Gazella	2	3.95-4.00	3.97	0.04
Ovis	39	2.84-3.63	3.25	0.19
Pseudois	37	2.65-3.37	2.96	0.20

Capricornis	15	2.95-3.22	2.87	0.18
Nemorhaedus	15	2.38-3.23	2.78	0.22

Table O.3 Osteometrics of Caprinae and Gazella. Number of measurements taken (N), range, mean, and standard deviation (SD). Values are given for GLpe/Bp of the phalanx I.

3 Ovis

3.1 Absolute Size

Being similar to the other elements, it shows a gradual descending size gradient from the species in the east to the west of the Eurasia (Table O.4). It is the largest in Argali and smallest in European Mouflon. The zoo samples are smaller than the wild ones.

		Bp		GLpe	
	N	Range	Mean	Range	Mean
Argali	13	12.39-15.75	14.27	44.18-52.22	47.42
Zoo Urial	12	11.15-14.39	12.90	37.17-48.28	42.60
Wild WA Mouflon	3	12.18-14.32	13.00	39.17-47.32	41.99
Wild EU Mouflon	5	11.06-13.21	12.11	37.17-39.74	38.98
Zoo EU Mouflon	6	10.55-12.44	11.62	34.56-35.13	34.94

Table O.4 Osteometrics of Ovis. Number of measurements taken (N), range, and mean.Values are given for proximal breadth (Bp) and greatest length of the peripheral half (GLpe) of the phalanx I in millimetre (mm)

It should be noted that for most of the samples two measurements were taken --- one on the fore-limb and the other on the hind-limb. Only one measurement was taken on some samples when one is lost. Generally, there is a balanced number of fore-limb and hind-limb bone phalanx.

3.2 Comparative Osteomorphology

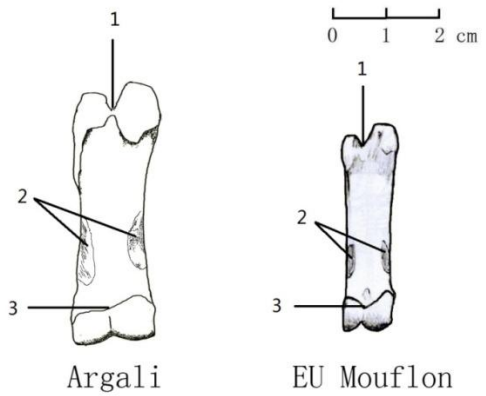


Figure O.7 Argali (Ovis ammon) and European Mouflon (Ovis orientalis musimon), phalanx I, comparative osteomorphology.

1. **The groove between the peripheral and axial articulations on the proximal end**

Both U-shape and V-shaped groove are observed on the wild *Ovis* species. This groove is the deepest in Argali, followed by Urial, and becomes wide and shallow in WA Mouflon and European Mouflon. Again, there are lots of overlaps between these species, although the general trend is still obvious (Figure O.6).

2. **The attachment for the ligaments on the palmar/plantar side of the diaphysis**

As noted by Boessneck (1964), these points at the commencement of the distal half of the phalange I do not stand out clearly in *Ovis aries* as *Capra hircus*. In Argali, Urial, and Mouflon, it is noted that the axial attachment protrudes in a posterior direction, whereas the peripheral side is flattened or even concave (Figure O.6).

3. The posterior edge of the distal articular surface

As noted by Boessneck (1964), in Ovis aries the posterior edge of the distal articular surface forms an angle that is obtuse and wide open, and sometimes there is hardly an indication of it. In Argai, Urial, and Mouflon, most of the samples confirm this rule. But in very few cases, the right-angled form is also observed (Figure O.6).

3.3 Comparative osteometry ------ Relative proportions of the different parts

The length against the breadth of the bone

This feature is expressed by metric GLpd/Bp. As shown in Table O.5, the value is the largest in Argali, and gradually becomes smaller as it comes to the western sheep groups, it is the smallest in zoo EU Mouflon sheep. However, there are considerable overlaps between them, and in Zoo EU Mouflon there are also the large values similar to Argali.

		GLpe/Bp		
	N	Range	Mean	SD
Argali	13	3.06-3.63	3.34	0.17
Zoo Urial	12	3.13-3.55	3.30	0.14
Wild WA Mouflon	3	3.14-3.30	3.23	0.08
Wild EU Mouflon	4	3.01-3.33	3.17	0.16
Zoo EU Mouflon	7	2.82-3.63	3.08	0.22

Table O.5 Osteometrics of Ovis. Number of measurements taken (N), range, mean, and standard deviation (SD). Values are given for proximal breadth (Bp) and greatest length of the peripheral half (GLpe) of the phalanx I in millimetre (mm)

Appendix PStatistical Tests on Humerus, Metacarpals, and metatarsals

Ratios of Pairs of Measurements on Humerus between Different *Ovis*

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	RambouilxArgali
O. ammon	0.105	0.240	0.001	0.000	0.006	0.072	0.035
O.vignei	-	0.394	0.023	0.002	0.233	0.369	0.813
O.orientalis	-	-	0.003	0.000	0.033	0.124	0.389
O. musimon-wild	-	-	-	0.594	0.374	0.181	0.010
O. musimon-zoo	-	-	-	-	0.016	0.024	0.000
O. aries	-	-	-	-	-	0.438	0.116
Rambouillet	-	-	-	-	-	-	0.414

Table P.1 Mann-Whitney tests applied to the humerus of different Ovis for the value SHT/BTl. After Bonferroni correction, four pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned (p<0.0018).

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	Rambouilx Argali
O. ammon	0.486	0.481	0.001	0.000	0.002	0.123	0.236

O.vignei		0.917	0.002	0.000	0.011	0.560	0.510
O.orientalis			0.002	0.000	0.006	0.469	0.854
O. musimon-wild				0.677	0.384	0.014	0.000
O. musimon-zoo					0.265	0.003	0.000
O. aries						0.044	0.002
Rambouillet							0.329

Table P.2 Mann-Whitney tests applied to the humerus of different Ovis for the value LHT/BTl. After Bonferroni correction, six pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned (p<0.0018).

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	Rambouilx Argali
O. ammon	0.002	0.029	0.001	0.000	0.001	0.000	0.000
O.vignei		0.243	0.759	0.114	0.984	0.295	0.327
O.orientalis			0.198	0.015	0.311	0.071	0.072
O. musimon-wild				0.270	0.879	0660	0.723
O. musimon-zoo					0.102	0.657	0.432
O. aries						0.388	0.377
Rambouillet							0.887

Table P.3 Mann-Whitney tests applied to the humerus of different Ovis for the value HT/HST. After Bonferroni correction, four pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned (p<0.0018).

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	Rambouilx Argali

O. ammon	0.133	0.047	0.001	0.000	0.000	0.002	0.020
O.vignei		0.425	0.024	0.004	0.005	0.051	0.352
O.orientalis			0.156	0.010	0.013	0.322	0.941
O. musimon-wild				0.664	0.733	0.627	0.091
O. musimon-zoo					0.891	0.096	0.003
O. aries						0.141	0.004
Rambouillet							0.189

Table P.4 Mann-Whitney tests applied to the humerus of different Ovis for the value HT/LHT. After Bonferroni correction, three pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned (p<0.0018).

Ratios of Pairs of Measurements on Metacarpals between Different *Ovis*

After Bonferroni correction, Mann-Whitney tests revealed that for the five ratios in the humerus, there are normally no significant differences between the adjacent groups, but there are significant differences between the two groups which are distant from another, especially the pairs *O. ammon*/zoo *O. musimon*,which exhibits significant difference on each ratio.

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	RambouilxArgali
O. ammon	0.339	0.005	0.019	0.000	0.000	0.000	0.002
O.vignei		0.209	0.343	0.015	0.001	0.000	0.144
O.orientalis			0.877	0.097	0.002	0.002	0.903
O. musimon-wild				0.163	0.009	0.008	0.757
O. musimon-zoo					0.040	0.036	0.075

O. aries						0.947	0.002
Rambouillet							0.002

Table P.5 Mann-Whitney tests applied to the metacarpals of different Ovis for the ratio DBV/DpBV. After Bonferroni correction, four pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned (p<0.0018).

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	RambouilxArgali
O. ammon	0.624	0.023	0.004	0.000	0.016	0.019	0.001
O.vignei		0.041	0.005	0.000	0.040	0.027	0.004
O.orientalis			0.160	0.001	0.526	0.571	0.211
O. musimon-wild				0.207	0.516	0.548	0.700
O. musimon-zoo					0.037	0.035	0.038
O. aries						1.000	0.730
Rambouillet							0.638

Table P.6 Mann-Whitney tests applied to the metacarpals of different Ovis for the ratio 3/4. After Bonferroni correction, four pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned (p<0.0018).

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	RambouilxArgali
O. ammon	0.025	0.000	0.010	0.000	0.001	0.000	0.000
O.vignei		0.416	0.722	0.000	0.444	0.029	0.016
O.orientalis			0.838	0.000	0.878	0.053	0.034
O. musimon-wild				0.001	0.693	0.071	0.063
O. musimon-zoo					0.001	0.034	0.084
O. aries						0.148	0.085
Rambouillet							0.712

Table P.7 Mann-Whitney tests applied to the metacarpals of different Ovis for the ratio 5/6. After Bonferroni correction, seven pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned ($p<0.0018$).

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	RambouilxArgali
O. ammon	0.624	0.009	0.014	0.000	0.000	0.000	0.000
O.vignei		0.010	0.030	0.000	0.000	0.000	0.001
O.orientalis			0.320	0.001	0.010	0.044	0.071
O. musimon-wild				0.270	0.278	0.852	0.877
O. musimon-zoo					0.943	0.268	0.117

O. aries						0.441	0.159
Rambouillet							0.824

Table P.8 Mann-Whitney tests applied to the metacarpals of different Ovis for the ratio 1/3. After Bonferroni correction, nine pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned (p<0.0018).

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	RambouilxArgali
O. ammon	0.126	0.004	0.004	0.000	0.000	0.000	0.000
O.vignei		0.223	0.115	0.000	0.000	0.005	0.016
O.orientalis			0.612	0.000	0.018	0.076	0.272
O. musimon-wild				0.023	0.222	0.435	0.894
O. musimon-zoo					0.053	0.055	0.004
O. aries						0.509	0.093
Rambouillet							0.471

Table P.9 Mann-Whitney tests applied to the metacarpals of different Ovis for the ratio2/5. After Bonferroni correction, seven pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned (p<0.0018).

Ratios of Pairs of Measurements on Metatarsals between Different *Ovis*

After Bonferroni correction, Mann-Whitney tests revealed that for the five ratios in the humerus, there are normally no significant differences between the adjacent group, but there are significant differences between the two groups which are distant from another, especially the pairs *O. ammon*/*O. aries*, which exhibits significant difference in each ratio.

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	RambouilxArgali
O. ammon	0.798	0.714	0.490	0.003	0.000	0.002	0.079
O.vignei		0.461	0.562	0.025	0.000	0.007	0.154
O.orientalis			0.760	0.021	0.000	0.014	0.214
O. musimon-wild				0.243	0.012	0.096	0.534
O. musimon-zoo					0.013	0.309	0.521
O. aries						0.279	0.027
Rambouillet							0.321

Table P.10 Mann-Whitney tests applied to the metacarpals of different Ovis for the ratio DBV/DpBV. After Bonferroni correction, three pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018. The shaded area indicates the significant difference was discerned (p<0.0018).

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	RambouilxArgali
O. ammon	0.038	0.000	0.146	0.000	0.000	0.003	0.000
O.vignei		0.115	0.946	0.001	0.036	0.120	0.004
O.orientalis			0.542	0.006	0.739	0.685	0.025
O. musimon-wild				0.026	0.478	0.469	0.059

O. musimon-zoo					0.028	0.088	0.633
O. aries						0.982	0.121
Rambouillet							0.192

Table P.11 Mann-Whitney tests applied to the metacarpals of different Ovis for the ratio 3/4. After Bonferroni correction, four pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned (p<0.0018).

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	RambouilxArgali
O. ammon	0.012	0.000	0.224	0.000	0.000	0.000	0.000
O.vignei		0.472	0.589	0.008	0.205	0.064	0.013
O.orientalis			0.739	0.002	0.613	0.020	0.001
O. musimon-wild				0.004	0.245	0.051	0.009
O. musimon-zoo					0.013	0.053	0.290
O. aries						0.279	0.060
Rambouillet							0.217

Table P.12 Mann-Whitney tests applied to the metacarpals of different Ovis for the ratio 5/6. After Bonferroni correction, seven pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned (p<0.0018).

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	RambouilxArgali
O. ammon	0.226	0.007	0.008	0.000	0.000	0.000	0.000
O.vignei		0.234	0.133	0.001	0.000	0.001	0.001
O.orientalis			0.446	0.008	0.001	0.002	0.005
O. musimon-wild				0.212	0.014	0.111	0.102
O. musimon-zoo					0.086	0.604	0.417
O. aries						0.279	0.387
Rambouillet							0.764

Table P.13 Mann-Whitney tests applied to the metacarpals of different Ovis for the ratio 1/3. After Bonferroni correction, nine pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned ($p<0.0018$).

	O. vignei	*O. orientalis*	*O. musimon-wild*	*O. musimon-zoo*	*O. aries*	Rambouillet	RambouilxArgali
O. ammon	0.051	0.004	0.010	0.000	0.000	0.000	0.000
O.vignei		0.726	0.413	0.001	0.002	0.015	0.010
O.orientalis			0.446	0.000	0.000	0.010	0.003
O. musimon-wild				0.056	0.024	0.111	0.068
O. musimon-zoo					0.690	0.924	0.941
O. aries						0.475	0.743
Rambouillet							0.867

Table P.14 Mann-Whitney tests applied to the metacarpals of different Ovis for the ratio2/5. After Bonferroni correction, seven pairs were found with a significant difference between each other. The threshold is 0.05/(8×7/2)=0.0018.The shaded area indicates the significant difference was discerned (p<0.0018).

Differences between the absolute size (Bd) Between the different species on metacarpals and metatarsals.

	O. ammon	*C. sibirica*	*Pseudois*	*O. ammon-z*	*C. hircus*	*O. orientalis*	*Nemorhaedus*	*O. aries*	*O. vignei*	*O. musimon*	*Gazella & Procapra*
Capricornis	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
O. ammon-w		0.772	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C. sibirica			0.000	0.024	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pseudois				1.000	0.572	0.005	0.003	0.000	0.000	0.000	0.000
O. ammon-z					0.981	0.413	0.355	0.007	0.053	0.002	0.000
C. hircus						0.916	0.865	0.016	0.189	0.001	0.000
O. orientalis							1.000	0.536	0.958	0.257	0.000
Nemorhaedus								0.595	0.974	0.304	0.000
O. aries									1.000	1.000	0.000
O. vignei										1.000	0.000
O. musimon											0.000

Table P.15 Significant values of Tukey HSD test in One Way ANOVA of the Bd between the different studied species on metacarpal. The shaded area indicates the significant difference was discerned ($p<0.05$).

	O. ammon-w	*O. orientalis*	*C. sibirica*	*O. aries*	*O. ammon-z*	*Pseudois-ad*	*Pseudois-sub*	*O. vignei*	*C. hirucs*	*Nemorhaedus*	*O. musimon*	*Gazella /Procapra*
Capricornis	0.165	0.799	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
O. ammon-w		1.000	0.418	0.000	0.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000
O. orientalis			0.109	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C. sibirica				0.000	0.959	0.112	0.012	0.000	0.000	0.000	0.000	0.000
O. aries					0.066	0.055	0.941	1.000	1.000	1.000	1.000	0.005
O. ammon-z						1.000	0.879	0.279	0.137	0.057	0.004	0.000
Pseudois-ad							0.987	0.361	0.134	0.036	0.000	0.000
Pseudois-sub								1.000	0.993	0.941	0.483	0.000
O. vignei									1.000	1.000	0.939	0.000
C. hirucs										1.000	0.985	0.000
Nemorhaedus											1.000	0.001
O. musimon												0.010

Table P.16 Significant values of Tukey HSD test in One Way ANOVA of the Bd between the different studied species on metatarsal. The shaded area indicates the significant difference was discerned ($p<0.05$).

Complete Results of Canonical Discriminate Classifications[4]

A. Classification of all Caprinae and *Gazella* to 6 Groups on distal humeri (Figure 6.9, Chapter 6; Figure 7.1, Figure 7.2, Figure 7.3, Figure 7.4, Chapter 7, vol. 1)

	Wilks' Lambda	F	df1	df2	Sig.
SI_Bt	.496	43.866	5	216	.000
SI_HT	.668	21.494	5	216	.000
SI_SHT	.556	34.507	5	216	.000
SI_BTM	.557	34.425	5	216	.000
SI_BTI	.533	37.805	5	216	.000
SI_LHT	.594	29.536	5	216	.000

Table P. 17 Test of equality of group means for the canonical discriminate classification for all modern Ovis, Caprinae, and Gazella on distal humerus.

As can be seen in Table P.17, all the six shape indices do not pass the test of the equality of the group means, and there are significant differences between the means of at least two groups. Therefore, there is discriminate power in all of these factors.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	3.083[a]	58.6	58.6	.869
2	1.455[a]	27.7	86.2	.770

[4] Abbreviation throughout this section: F= F value, a value got when run an ANOVA test to find out whether there are significant difference between the means between two groups; df: degree of freedom in statistics that is free to vary; sig: significance probability or p-value.

3	.542[a]	10.3	96.6	.593
4	.170[a]	3.2	99.8	.381
5	.011[a]	.2	100.0	.106

Table P. 18 Eigenvalues of the canonical discriminate classification for all modern Ovis, Caprinae, and Gazella on distal humerus.

As can be seen in Table P. 18, five functions are built, and the eigenvalues of the functions 1-5 are 3.083, 1.455, 0.542, 0.170, 0.011 respectively. The first two functions extracted accounted for 86.2% of the variance, which is quite high.

As can be seen in Table P. 19, the significant values of the wilks' Lambda tests for all first four functions are smaller than 0.01, which means that these functions built are quite effective.

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 5	.055	624.909	30	.000
2 through 5	.223	322.464	20	.000
3 through 5	.548	129.330	12	.000
4 through 5	.845	36.214	6	.000
5	.989	2.428	2	.297

Table P. 19 Wilk's Lambda of the canonical discriminate classification for all modern Ovis, Caprinae, and Gazella on distal humerus.

	Function				
	1	2	3	4	5
SI_Bt	.302	.640*	.382	.589	-.070

SI_BTM	.172	.616*	.471	.434	-.328
SI_SHT	.330	.320	.703*	.519	.134
SI_LHT	-.142	.499	.614*	.564	.186
SI_HT	.192	.326	.479	.783*	-.051
SI_BTl	.380	.497	.046	.629*	.397

Table P. 20 Structure Matrix of the canonical discriminate classification for all modern Ovis, Caprinae, and Gazella on distal humerus.

Table P. 20 shows the contribution of the different factors to the five functions built in the table of structure matrix.

	Function				
	1	2	3	4	5
SI_Bt	1.237	1.613	-.642	-.097	-.661
SI_HT	-.480	-1.759	-.525	2.362	-1.090
SI_SHT	1.520	-.613	1.634	-1.101	.729
SI_BTM	-.457	.394	.316	-.657	-.667
SI_BTl	.108	.243	-.647	.125	1.064
SI_LHT	-1.790	.748	.374	-.028	.858

Table P. 21Standardized canonical discriminate function coefficient of the classification for all modern Ovis, Caprinae, and Gazella on distal humerus.

Table P. 21 shows the coefficients of the standardised discriminate functions of this classification.

	GROUP	Predicted Group Membership	Total

			1	2	3	4	5	6	
Original	Count	1	20	0	0	4	0	0	24
		2	0	14	1	0	0	0	15
		3	0	0	21	0	0	0	21
		4	2	0	0	11	0	1	14
		5	0	0	0	0	15	0	15
		6	11	0	0	10	0	112	133
	%	1	83.3	.0	.0	16.7	.0	.0	100.0
		2	.0	93.3	6.7	.0	.0	.0	100.0
		3	.0	.0	100.0	.0	.0	.0	100.0
		4	14.3	.0	.0	78.6	.0	7.1	100.0
		5	.0	.0	.0	.0	100.0	.0	100.0
		6	8.3	.0	.0	7.5	.0	84.2	100.0

Table P. 22 Classification Results for all modern Ovis, Caprinae, and Gazella on distal humerus.

Table P. 22 reports the classification results. Overall, 86.9% of the original grouped cases were correctly classified. As can be seen in Table P. 21, all the cases in the original group 3 and 5 (Nemorhaedus and Gazelle) are correctly classified. Group 4 (C. hircus) are least correctly classified (78.6%), and all the other groups have the percentage of good classification ranging 83.3%-93.3%, which is quite good.

B. Classification of All Modern *Ovis* into6 Groups on Distal Humerus (Figure 6.10, Chapter 6; Figure 7.5, Chapter 7, vol. 1)

	Wilks' Lambda	F	df1	df2	Sig.
SI_BT	.388	40.128	5	127	.000
SI_HT	.447	31.466	5	127	.000

SI_SHT	.540	21.674	5	127	.000
SI_BTM	.449	31.122	5	127	.000
SI_BTI	.433	33.286	5	127	.000
SI_LHT	.509	24.454	5	127	.000

Table P.23 Test of equality of group means for the canonical discriminate classification for all modern Ovis on distal humerus.

As can be seen in Table P. 23, all the six shape indices do not pass the test of the equality of the group means, and there are significant differences between the means of at least two groups. Therefore, there is discriminate power in all of these factors.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1.947[a]	73.5	73.5	.813
2	.424[a]	16.0	89.5	.546
3	.250[a]	9.4	98.9	.447
4	.027[a]	1.0	99.9	.163
5	.001[a]	.1	100.0	.039

Table P. 24 Eigenvalues of the canonical discriminate classification for all modern Ovis on distal humerus.

As can be seen in Table P. 24, five functions are built, and the eigenvalues of the functions 1-5 are 1.947, 0.424, 0.250, 0.027, and 0.001 respectively. The first two functions extracted accounted for 89.5% of the variance, which is quite high.

As can be seen in Table P. 25, the significant values of the Wilks' Lambda tests for all first three functions are smaller than 0.01, which means that these functions built are quite effective.

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 5	.185	212.430	30	.000
2 through 5	.546	76.261	20	.000
3 through 5	.778	31.698	12	.002
4 through 5	.972	3.594	6	.731
5	.999	.188	2	.910

Table P. 25 Wilk's Lambda of the canonical discriminate classification for all modern Ovis on distal humerus.

	Function				
	1	2	3	4	5
SI_BT	.392	-2.432	-.566	-.070	-1.032
SI_HT	.277	1.106	-.188	-1.086	-1.817
SI_SHT	-.671	.479	-.088	2.307	.019
SI_BTM	.442	.208	.172	.148	1.363
SI_BTI	.552	1.011	-.535	-.188	.871
SI_LHT	.121	.059	1.525	-.805	.893

Table P. 26 Standardized canonical discriminate function coefficient of the classification for all modern Ovis, Caprinae, and Gazella on distal humerus.

Table P. 26 shows the coefficients of the standardised discriminate functions of this classification.

	Function				
	1	2	3	4	5
SI_BT	.895*	-.152	.175	.298	-.215
SI_BTI	.794*	.408	-.216	.130	.083
SI_HT	.784*	.164	.337	.212	-.438
SI_BTM	.778*	-.255	.272	.298	.017
SI_SHT	.640*	.173	.365	.598	-.249
SI_LHT	.656	.145	.677*	.183	-.121

Table P. 27 Structure Matrix of the canonical discriminate classification for all modern Ovis, Caprinae, and Gazella on distal humerus.

Table P. 27 shows the contribution of the different factors to the five functions built in the table of structure matrix.

			Predicted Group Membership						
		Species	1	2	3	4	5	6	Total
Original	Count	1	19	0	2	0	1	0	22
		2	0	10	1	0	1	2	14
		3	1	5	3	0	4	3	16
		4	0	2	2	23	6	2	35
		5	2	1	2	3	15	5	28
		6	0	3	4	0	4	7	18
	%	1	86.4	.0	9.1	.0	4.5	.0	100.0
		2	.0	71.4	7.1	.0	7.1	14.3	100.0
		3	6.2	31.2	18.8	.0	25.0	18.8	100.0

4	.0	5.7	5.7	65.7	17.1	5.7	100.0
5	7.1	3.6	7.1	10.7	53.6	17.9	100.0
6	.0	16.7	22.2	.0	22.2	38.9	100.0

Table P. 28 Classification Results for all modern Ovis on distal humerus.

Table P. 28 reports the classification results. Overall, 57.9% of the original grouped cases were correctly classified. As can be seen in Table P. 28, group 1 (O. ammon) is most well classified, with 86.4% of good classification. Group 3 (O. orientalis) is least correctly classified, with only 18% of the original grouped cases correctly classified. All the other groups have the percentage of good classification ranging 38.9%~65.7%.Overall, the efficiency of this classification is not very good.

C. Classification of all Caprinae and *Gazella*into 11 Groups on distal humerus (Figure 6.11, Chapter 6, vol. 1)

	Wilks' Lambda	F	df1	df2	Sig.
SI_Bt	.245	64.938	10	211	.000
SI_HT	.374	35.275	10	211	.000
SI_SHT	.362	37.209	10	211	.000
SI_BTM	.301	49.090	10	211	.000
SI_BTl	.297	49.884	10	211	.000
SI_LHT	.390	33.020	10	211	.000

Table P. 29 Test of equality of group means for the canonical discriminate classification for all modern Ovis and Caprinae into 11 groups on distal humerus.

As can be seen in Table P. 29, all the six shape indices do not pass the test of the equality of the group means, and there are significant differences between the means of at least two groups. Therefore, there is discriminate power in all of these factors.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	4.376[a]	52.5	52.5	.902
2	2.540[a]	30.5	83.0	.847
3	.751[a]	9.0	92.0	.655
4	.519[a]	6.2	98.2	.585
5	.126[a]	1.5	99.8	.335
6	.020[a]	.2	100.0	.140

Table P.30 Eigenvalues of the canonical discriminate classification for all modern Ovis on distal humerus.

As can be seen in Table P. 30, six functions are built, and the eigenvalues of the functions 1-6 are 4.376, 2.540, 0.751, 0.519, 0.126, and 0.020 respectively. The first two functions extracted accounted for 83.0% of the variance, which is quite high.

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 6	.017	863.346	60	.000
2 through 6	.092	505.933	45	.000
3 through 6	.327	237.313	32	.000
4 through 6	.573	118.302	21	.000
5 through 6	.871	29.459	12	.003
6	.980	4.221	5	.518

Table P. 32 Wilk's Lambda of the canonical discriminate classification for all modern Ovis on distal humerus.

	Function					
	1	2	3	4	5	6
SI_Bt	1.112	.237	-1.386	-1.135	-1.517	-2.179
SI_HT	-.459	-.377	.888	1.734	-1.364	.122
SI_SHT	.471	-1.214	.871	-1.255	.898	.074
SI_BTM	.133	.571	.251	.090	.616	2.078
SI_BTl	.368	.113	-.051	.930	1.190	.597
SI_LHT	-.951	1.315	.186	-.086	.632	-.427

Table P. 33 Standardized canonical discriminate function coefficient of the classification for all modern Ovis, Caprinae, and Gazella on distal humerus.

Table P. 30 shows the coefficients of the standardised discriminate functions of this classification.

	Function					
	1	2	3	4	5	6
SI_Bt	.734*	.481	.417	-.018	-.148	-.185
SI_BTl	.689*	.222	.207	.454	.394	-.267
SI_BTM	.563*	.551	.442	-.166	-.237	.318
SI_SHT	.526	.160	.794*	-.160	.076	-.189
SI_HT	.471	.315	.746*	.212	-.236	-.146
SI_LHT	.185	.653	.662*	-.050	.098	-.298

Table P. 34 Structure Matrix of the canonical discriminate classification for all modern Ovis, Caprinae, and Gazella on distal humerus.

Table P. 34 shows the contribution of the different factors to the six functions built in the table of structure matrix.

			Predicted Group Membership											
		GROUP	1	2	3	4	5	6	7	8	9	10	11	Total
Original	Count	1	18	0	0	3	0	2	1	0	0	0	0	24
		2	0	14	1	0	0	0	0	0	0	0	0	15
		3	0	0	21	0	0	0	0	0	0	0	0	21
		4	0	0	0	8	0	1	2	0	1	0	2	14
		5	0	0	0	0	13	0	0	0	0	0	2	15
		6	3	0	0	0	0	16	0	2	0	1	0	22
		7	0	0	0	3	0	0	6	1	1	1	2	14
		8	1	0	0	1	0	1	3	4	0	3	3	16
		9	0	0	0	1	0	0	0	2	24	5	3	35
		10	0	0	0	1	0	2	2	0	4	15	4	28
		11	0	0	0	0	0	0	3	3	1	3	8	18
	%	1	75.0	.0	.0	12.5	.0	8.3	4.2	.0	.0	.0	.0	100.0
		2	.0	93.3	6.7	.0	.0	.0	.0	.0	.0	.0	.0	100.0
		3	.0	.0	100.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0
		4	.0	.0	.0	57.1	.0	7.1	14.3	.0	7.1	.0	14.3	100.0
		5	.0	.0	.0	.0	86.7	.0	.0	.0	.0	.0	13.3	100.0

6	13.6	.0	.0	.0	.0	72.7	.0	9.1	.0	4.5	.0	100.0
7	.0	.0	.0	21.4	.0	.0	42.9	7.1	7.1	7.1	14.3	100.0
8	6.2	.0	.0	6.2	.0	6.2	18.8	25.0	.0	18.8	18.8	100.0
9	.0	.0	.0	2.9	.0	.0	.0	5.7	68.6	14.3	8.6	100.0
10	.0	.0	.0	3.6	.0	7.1	7.1	.0	14.3	53.6	14.3	100.0
11	.0	.0	.0	.0	.0	.0	16.7	16.7	5.6	16.7	44.4	100.0

Table P. 35 Classification Results for all modern Ovis on distal humerus.

Table P. 35 reports the classification results. Overall, 66.2% of the original grouped cases were correctly classified. As can be seen in Table P. 35, group 3 (Nemorhaedus, goral) is most well classified, with 100% of good classification. This is followed by Group 2 (Capricornis, serow) Group 8 (O. orientalis, western Asian Mouflon) is least correctly classified, with only 25% of the original grouped cases correctly classified. All the other groups have the percentage of good classification ranging 42.9%~75%. Overall, the efficiency of this classification is not very good.

D. Classification of all Caprinae and *Gazella*into 6 groups on distal metacarpals (Figure 6.21, Chapter 6; Figure 7. 14, Figure 7.15, Chapter 7, vol. 1).

	Wilks' Lambda	F	df1	df2	Sig.
SI_Bd	.425	59.534	5	220	.000

SI_DBV	.468	49.954	5	220	.000
SI_DpBV	.345	83.579	5	220	.000
SI_1	.413	62.506	5	220	.000
SI_2	.433	57.547	5	220	.000
SI_3	.715	17.539	5	220	.000
SI_4	.715	17.539	5	220	.000
SI_5	.733	15.997	5	220	.000
SI_6	.703	18.604	5	220	.000
SI_7	.724	16.790	5	220	.000
SI_8	.745	15.047	5	220	.000

Table P. 36 Test of equality of group means for the canonical discriminate classification for all modern Caprinae and Gazella on distal metacarpals.

As can be seen in Table P. 36, all the eleven shape indices do not pass the test of the equality of the group means, and there are significant differences between the means of at least two groups. Therefore, there is discriminate power in all of these factors.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	8.520[a]	76.5	76.5	.946

2	1.671[a]	15.0	91.5	.791
3	.638[a]	5.7	97.2	.624
4	.264[a]	2.4	99.6	.457
5	.046[a]	.4	100.0	.209

Table P. 37 Eigenvalues of the canonical discriminate classification for all modern Caprinae and Gazella on distal metacarpals.

As can be seen in Table P. 37, five functions are built, and the eigenvalues of the functions 1-5 are 8.520, 1.671, 0.638, 0.264, and 0.046 respectively. The first two functions extracted accounted for 91.5% of the variance, which is quite high.

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 5	.018	869.923	50	.000
2 through 5	.173	380.925	36	.000
3 through 5	.462	167.695	24	.000
4 through 5	.756	60.570	14	.000
5	.956	9.685	6	.139

Table P. 38 Wilk's Lambda of the canonical discriminate classification for all modern Caprinae and Gazellaon distal metacarpals.

As can be seen in Table P. 38, the significant values of the Wilks' Lambda tests for all first four functions are smaller than 0.01, which means that these functions built are quite effective.

	Function				
	1	2	3	4	5
SI_Bd	1.351	-.677	.447	-.497	.857
SI_DBV	-.781	1.149	.326	.107	-.494
SI_DpBV	.543	-1.205	-.172	-.327	.440
SI_1	-.268	.511	2.300	-1.515	1.820
SI_2	.799	1.028	-2.180	1.589	-2.311
SI_3	-1.586	-.874	1.309	-.975	-3.038
SI_5	-1.670	.340	.418	.374	4.117
SI_6	1.287	-2.917	-.265	3.035	-1.563
SI_7	.745	2.286	.072	-.088	-2.640
SI_8	-.242	.450	-1.577	-1.199	3.043

Table P. 39 Standardized canonical discriminate function coefficient of the classification for all modern Caprinae and Gazella on distal metacarpals.

Table P. 39 shows the coefficients of the standardised discriminate functions of this classification.

	Function				
	1	2	3	4	5
SI_1	.340	.190	.712*	.448	.138
SI_Bd	.330	.204	.686*	.456	.174
SI_3	-.061	.061	.661*	.554	.082
SI_4[a]	-.061	.061	.661*	.554	.082
SI_DBV	.279	.328	.632*	.363	.111
SI_2	.329	.223	.589*	.556	.116
SI_DpBV	.444	-.102	.550*	.201	.212
SI_6	.104	.073	.547	.700*	.138
SI_5	-.055	.115	.562	.650*	.257
SI_8	.065	.183	.486	.608*	.211
SI_7	.073	.200	.523	.597*	.153

Table P. 40 Structure Matrix of the canonical discriminate classification for all modern Caprinae and Gazella on distal metacarpals.

Table P. 40 shows the contribution of the different factors to the five functions built in the table of structure matrix.

			Predicted Group Membership						
		GROUP	1	2	3	4	5	6	Total
Original	Count	1	19	0	0	0	0	1	20
		2	1	18	1	0	0	0	20
		3	1	0	19	0	0	1	21
		4	1	0	0	15	0	0	16
		5	0	0	0	0	15	0	15
		6	4	1	5	0	0	124	134
	%	1	95.0	.0	.0	.0	.0	5.0	100.0
		2	5.0	90.0	5.0	.0	.0	.0	100.0
		3	4.8	.0	90.5	.0	.0	4.8	100.0
		4	6.2	.0	.0	93.8	.0	.0	100.0
		5	.0	.0	.0	.0	100.0	.0	100.0
		6	3.0	.7	3.7	.0	.0	92.5	100.0

P. 41 Classification results for all modern Caprinae and Gazella on distal metacarpal.

Table P. 41 reports the classification results. Overall, 92.9% of the original grouped cases were correctly classified. As can be seen in Table P. 41, group 5 (*Gazella*) is most well classified, with 100% of good classification. All the other groups have the percentage of good classification ranging 90.0%~95.0%. Therefore, the efficiency of this classification is quite good.

E. Classification of All *Ovis* to 6 Groups on Distal Metacarpals (Figure 6.22, Chapter 6, vol. 1).

	Wilks' Lambda	F	df1	df2	Sig.
SI_Bd	.375	42.587	5	128	.000
SI_DBV	.399	38.543	5	128	.000
SI_DpBV	.553	20.657	5	128	.000
SI_1	.394	39.385	5	128	.000
SI_2	.363	44.886	5	128	.000
SI_3	.323	53.665	5	128	.000
SI_4	.323	53.665	5	128	.000
SI_5	.268	69.814	5	128	.000
SI_6	.260	72.849	5	128	.000
SI_7	.260	72.861	5	128	.000
SI_8	.263	71.866	5	128	.000

Table P.42Test of equality of group means for the canonical discriminate classification for all modern Ovis on distal metacarpal.

As can be seen in Table P. 42, all the six shape indices do not pass the test of the equality of the group means, and there are significant differences between the means of at least two groups. Therefore, there is discriminate power in these indices.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation

1	4.173[a]	71.0	71.0	.898
2	.779[a]	13.3	84.2	.662
3	.454[a]	7.7	91.9	.559
4	.292[a]	5.0	96.9	.476
5	.181[a]	3.1	100.0	.392

P. 43 Eigenvalues of the canonical discriminate classification for all modern Ovis on distal metacarpal.

As can be seen in Table P. 43, Five functions are built, and the eigenvalues of the functions 1-5 are 4.173, 0.779, 0.454, 0.292, 0.181 respectively. The first two functions extracted accounted for 84.2% of the variance, which is quite high.

As can be seen in Table P. 44, the significant values of the Wilks' Lambda tests for all five functions are smaller than 0.01, which means that these functions built are quite effective.

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 5	.049	377.081	50	.000
2 through 5	.253	171.659	36	.000
3 through 5	.451	99.639	24	.000
4 through 5	.655	52.876	14	.000

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 5	.049	377.081	50	.000
2 through 5	.253	171.659	36	.000
3 through 5	.451	99.639	24	.000
4 through 5	.655	52.876	14	.000
5	.847	20.811	6	.002

P. 44 Wilk's Lambda of the canonical discriminate classification for all modern Ovis on distal metacarpal.

Table P. 45 shows the coefficients of the standardized discriminate functions of this classification.

	Function				
	1	2	3	4	5
SI_Bd	-.713	1.966	-2.018	-.664	.132
SI_DBV	.976	-1.331	-.390	-.197	-.677
SI_DpBV	-.423	.540	.233	.987	.251
SI_1	-1.002	1.379	.171	1.138	-1.523

SI_2	.770	-1.708	2.594	-.733	1.353
SI_3	-.722	-.046	-.362	-1.469	1.410
SI_5	.310	.968	.164	.128	.449
SI_6	.992	.020	-.046	-1.018	-2.815
SI_7	1.076	-1.431	.051	1.469	-.145
SI_8	-.426	.187	-.282	.604	1.650

P. 45 Standardized canonical discriminate function coefficient of the classification for all modern Ovis, Caprinae, and Gazella on distal metacarpal.

	Function				
	1	2	3	4	5
SI_7	.802*	.438	.011	.165	.191
SI_8	.795*	.447	.009	.156	.208
SI_6	.793*	.528	.106	-.018	.012
SI_5	.772*	.539	.074	-.034	.273
SI_3	.665*	.552	.028	-.093	.250
SI_4[a]	.665*	.552	.028	-.093	.250
SI_2	.593*	.533	.370	.038	-.068
SI_DBV	.580*	.310	-.087	.209	-.234
SI_Bd	.571	.621*	.028	.073	-.110

SI_1	.538	.616*	.248	.119	-.138
SI_DpBV	.347	.536*	.110	.502	-.073

P. 46 Structure Matrix of the canonical discriminate classification for all modern Ovis, Caprinae, and Gazella on distal metacarpal.

			Predicted Group Membership						
		Group	1	2	3	4	5	6	Total
Original	Count	1	30	1	2	0	0	0	33
		2	0	8	0	2	1	1	12
		3	1	0	12	3	0	0	16
		4	0	4	3	21	3	0	31
		5	0	2	0	3	18	3	26
		6	0	2	0	0	1	13	16
	%	1	90.9	3.0	6.1	.0	.0	.0	100.0
		2	.0	66.7	.0	16.7	8.3	8.3	100.0
		3	6.2	.0	75.0	18.8	.0	.0	100.0
		4	.0	12.9	9.7	67.7	9.7	.0	100.0
		5	.0	7.7	.0	11.5	69.2	11.5	100.0
		6	.0	12.5	.0	.0	6.2	81.2	100.0

Cross-validated[a]	Count	1	29	1	2	1	0	0	33
		2	0	5	1	3	1	2	12
		3	1	1	11	2	0	1	16
		4	0	4	3	19	4	1	31
		5	0	2	0	4	17	3	26
		6	0	3	0	0	2	11	16
	%	1	87.9	3.0	6.1	3.0	.0	.0	100.0
		2	.0	41.7	8.3	25.0	8.3	16.7	100.0
		3	6.2	6.2	68.8	12.5	.0	6.2	100.0
		4	.0	12.9	9.7	61.3	12.9	3.2	100.0
		5	.0	7.7	.0	15.4	65.4	11.5	100.0
		6	.0	18.8	.0	.0	12.5	68.8	100.0

P. 47 Classification Results for all modern Ovis on distal metacarpal. Cross-validation is done only for those cases in the analysis. In cross-validation, each case is classified by the functions derived from all cases other than that case.

Table P. 47 reports the classification results. Overall, 76.1% of the original grouped cases were correctly classified, and 68.7% of cross-validated grouped cases were correctly classified. As can be seen in Table P. 48, group 1 (*O. ammon*) is most well classified, with 90.9% of good classification. Group 2 (*O. vignei*) is least correctly classified, with only 66.7% of the original grouped cases correctly classified. All the other groups have the percentage of good classification ranging 67.7%~81.2%. Overall, the efficiency of this classification is not very good.

F. Classification of all Capraineand *Gazella* to 10 Groups on Distal Metacarpal (Figure 6.23, Chapter 6, vol. 1).

	Wilks' Lambda	F	df1	df2	Sig.
SI_Bd	.299	51.904	9	199	.000
SI_DBV	.333	44.381	9	199	.000
SI_DpBV	.387	35.066	9	199	.000
SI_1	.309	49.493	9	199	.000
SI_2	.283	56.056	9	199	.000
SI_3	.305	50.294	9	199	.000
SI_4	.305	50.294	9	199	.000
SI_5	.272	59.218	9	199	.000
SI_6	.267	60.768	9	199	.000
SI_7	.267	60.559	9	199	.000
SI_8	.272	59.159	9	199	.000

Table P. 48 Test of equality of group means for the canonical discriminant classification for all Caprinae and Gazella to 10 groups on distal metacarpal.

As can be seen in Table P. 48, all the six shape indices do not pass the test of the equality of the group means, and there are significant differences between the means of at least two groups. Therefore, they all have discriminant power.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	5.863[a]	46.2	46.2	.924
2	4.267[a]	33.6	79.8	.900
3	1.654[a]	13.0	92.9	.789
4	.366[a]	2.9	95.8	.518
5	.275[a]	2.2	97.9	.465
6	.200[a]	1.6	99.5	.408
7	.039[a]	.3	99.8	.194
8	.020[a]	.2	100.0	.140
9	.002[a]	.0	100.0	.041

Table P. 49 Eigenvalues of the canonical discriminant classification for all Caprinae and Gazella to 10 groups on distal metacarpal.

As can be seen in Table P. 49, five functions are built, and the eigenvalues of the functions 1-5 are 1.947, 0.424, 0.250, 0.027, and 0.001 respectively. The first two functions extracted accounted for 89.5% of the variance, which is quite high.

As can be seen in Table P. 50, the significant values of the Wilks' Lambda tests for all first three functions are smaller than 0.01, which means that these functions built are quite effective.

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 9	.005	1061.490	90	.000
2 through 9	.032	680.119	72	.000
3 through 9	.170	351.155	56	.000
4 through 9	.450	157.916	42	.000
5 through 9	.615	96.098	30	.000
6 through 9	.785	47.919	20	.000
7 through 9	.942	11.796	12	.462
8 through 9	.979	4.234	6	.645
9	.998	.335	2	.846

Table P. 50 Wilk's Lambda of the canonical discriminant classification for all Caprinae and Gazella to 10 groups on distal metacarpal.

	Function								
	1	2	3	4	5	6	7	8	9
SI_Bd	-.952	-.694	.998	2.397	-.884	-2.089	-2.541	-.268	.624
SI_DBV	.854	1.036	-.782	-.585	-.139	-.326	1.263	.001	.257
SI_DpBV	-.593	-.743	.658	-.071	-.529	.887	.061	.240	.460
SI_1	.204	-.428	-.093	1.934	.786	1.065	2.876	-.603	-1.809
SI_2	-.636	.849	-1.051	-2.751	1.515	.840	-1.420	.708	.945

SI_3	1.413	-.937	.330	-.369	.676	-.296	-.556	2.158	-.416
SI_5	.988	.272	.297	.870	.300	1.171	.619	-2.385	1.412
SI_6	-1.145	.359	1.782	-1.715	-.233	-2.124	.939	-.458	-.334
SI_7	-.376	1.165	-1.098	-.352	-.196	-.019	-.260	2.282	2.015
SI_8	.247	-.117	-.478	.827	-1.250	1.302	-.810	-1.391	-2.990

Table P. 51 Standardized canonical discriminant function coefficient of the classification for all Caprinae and Gazella to 10 groups on distal metacarpal.

Table P. 51 shows the coefficients of the standardized discriminant functions of this classification.

	Function								
	1	2	3	4	5	6	7	8	9
SI_7	.038	.737*	.480	.181	-.026	.277	-.107	.299	-.092
SI_8	.034	.722*	.499	.173	-.051	.298	-.170	.170	-.210
SI_2	-.272	.647*	.381	.238	.401	.214	-.099	.171	.041
SI_DBV	-.157	.642*	.180	.365	-.015	-.019	.219	.222	.281
SI_5	.209	.638*	.626	.176	.151	.288	-.129	.029	.042
SI_Bd	-.232	.623*	.416	.452	.217	.052	-.082	.201	.109
SI_1	-.239	.596*	.417	.392	.358	.194	.087	.239	-.059

SI_6	-.025	.679	.681*	.069	.091	.129	-.039	.153	-.134
SI_3	.243	.534	.640*	.190	.193	.195	-.118	.323	-.070
SI_4[a]	.243	.534	.640*	.190	.193	.195	-.118	.323	-.070
SI_DpBV	-.363	.293	.483*	.249	-.147	.369	.160	.299	.298

Table P. 52 Structure Matrix of the canonical discriminant classification for all Caprinae and Gazella to 10 groups on distal metacarpal.

Table P. 52 shows the contribution of the different factors to the five functions built in the table of structure matrix.

			Predicted Group Membership										
		GROUP	1	2	3	4	5	6	7	8	9	10	Total
Original	Count	1	20	0	0	0	0	0	0	0	0	0	20
		2	0	19	1	0	0	0	0	0	0	0	20
		3	0	0	19	0	0	0	0	1	0	0	20
		4	0	0	0	16	0	0	0	0	0	0	16
		5	1	0	0	0	29	1	2	0	0	0	33
		6	0	0	0	0	0	7	1	3	0	1	12
		7	0	0	0	0	1	0	12	2	0	1	16
		8	1	0	2	0	0	2	3	18	3	1	30

		9	0	0	0	0	0	1	0	3	18	4	26
		10	0	0	0	0	0	3	0	0	1	12	16
	%	1	100.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0
		2	.0	95.0	5.0	.0	.0	.0	.0	.0	.0	.0	100.0
		3	.0	.0	95.0	.0	.0	.0	.0	5.0	.0	.0	100.0
		4	.0	.0	.0	100.0	.0	.0	.0	.0	.0	.0	100.0
		5	3.0	.0	.0	.0	87.9	3.0	6.1	.0	.0	.0	100.0
		6	.0	.0	.0	.0	.0	58.3	8.3	25.0	.0	8.3	100.0
		7	.0	.0	.0	.0	6.2	.0	75.0	12.5	.0	6.2	100.0
		8	3.3	.0	6.7	.0	.0	6.7	10.0	60.0	10.0	3.3	100.0
		9	.0	.0	.0	.0	.0	3.8	.0	11.5	69.2	15.4	100.0
		10	.0	.0	.0	.0	.0	18.8	.0	.0	6.2	75.0	100.0
Cross-validated[a]	Count	1	19	0	0	0	0	0	0	1	0	0	20
		2	1	18	1	0	0	0	0	0	0	0	20
		3	0	2	17	0	0	0	0	0	1	0	20
		4	1	0	0	15	0	0	0	0	0	0	16
		5	1	0	0	0	29	1	2	0	0	0	33
		6	0	0	0	0	0	4	1	4	1	2	12
		7	0	0	0	0	1	0	11	2	0	2	16
		8	1	0	2	0	0	3	4	16	3	1	30

		9	0	0	0	0	1	2	0	4	17	2	26
		10	0	0	0	0	0	4	0	0	2	10	16
	%	1	95.0	.0	.0	.0	.0	.0	.0	5.0	.0	.0	100.0
		2	5.0	90.0	5.0	.0	.0	.0	.0	.0	.0	.0	100.0
		3	.0	10.0	85.0	.0	.0	.0	.0	.0	5.0	.0	100.0
		4	6.2	.0	.0	93.8	.0	.0	.0	.0	.0	.0	100.0
		5	3.0	.0	.0	.0	87.9	3.0	6.1	.0	.0	.0	100.0
		6	.0	.0	.0	.0	.0	33.3	8.3	33.3	8.3	16.7	100.0
		7	.0	.0	.0	.0	6.2	.0	68.8	12.5	.0	12.5	100.0
		8	3.3	.0	6.7	.0	.0	10.0	13.3	53.3	10.0	3.3	100.0
		9	.0	.0	.0	.0	3.8	7.7	.0	15.4	65.4	7.7	100.0
		10	.0	.0	.0	.0	.0	25.0	.0	.0	12.5	62.5	100.0

Table P. 53 Classification Results for all Caprinae and Gazella to 10 groups on distal metacarpal.

Overall, 81.3% of the original grouped cases were correctly classified, and 74.6% of the cross-validated grouped cases were correctly classified. As can be seen in Table P. 53, group 1 (*P. nayaur*) and group 4 (*C. hircus*) is most well classified, with 100% of good classification. Group 6 (*O. vignei*) is least correctly classified, with only 58.3% of the original grouped cases correctly classified. All the other groups have the percentage of good classification ranging 60.0~95.0%. Overall, the efficiency of this classification is quite good.

G. Classification of all Caprinae and *Gazella* to 6 Groups on Distal Metatarsal (Figure 6.24, Chapter 6; Figure 7.19, Figure 7. 20, Chapter 7, vol. 1).

	Wilks' Lambda	F	df1	df2	Sig.
SI_Bd	.661	20.795	5	203	.000
SI_DBV	.459	47.799	5	203	.000
SI_DpBV	.370	69.088	5	203	.000
SI_1	.401	60.686	5	203	.000
SI_2	.448	50.114	5	203	.000
SI_3	.732	14.858	5	203	.000
SI_4	.630	23.810	5	203	.000
SI_5	.748	13.695	5	203	.000
SI_6	.650	21.890	5	203	.000
SI_7	.663	20.615	5	203	.000
SI_8	.651	21.732	5	203	.000

P. 54 Test of euqality of group means for the canonical discriminate classification for Caprinae and Gazella on distal metatarsal.

As can be seen in Table P.54, all the six shape indices do not pass the test of the equality of the group means, and there are significant differences between the means of at least two groups. Therefore, there is discriminate power in these indices.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	4.629[a]	48.0	48.0	.907
2	3.146[a]	32.6	80.6	.871
3	1.447[a]	15.0	95.6	.769
4	.312[a]	3.2	98.9	.488
5	.108[a]	1.1	100.0	.313

P. 55Eigenvalues of the canonical discriminate classification for Caprinae and Gazella on distal metatarsal.

As can be seen in Table P.55, five functions are built, and the eigenvalues of the functions 1-5 are 4.629, 3.146, 1.447, 0.312, and 0.108 respectively. The first two functions extracted accounted for 80.6% of the variance, which is quite high.

As can be seen in Table P. 56, the significant values of the Wilks' Lambda tests for all five functions are smaller than 0.01, which means that these functions built are quite effective.

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 5	.012	881.667	55	.000

2 through 5	.068	536.952	40	.000
3 through 5	.281	253.220	27	.000
4 through 5	.688	74.702	16	.000
5	.902	20.522	7	.005

Table P. 56 Wilk's Lambda of the canonical discriminate classification for Caprinae and Gazella on metatarsal.

	Function				
	1	2	3	4	5
SI_Bd	.086	.146	.149	-.118	-.174
SI_DBV	-.330	-.614	.934	.331	-.418
SI_DpBV	.584	1.038	-1.123	-.522	.531
SI_1	.719	1.015	2.296	-1.296	-.064
SI_2	.663	-2.120	-1.835	.823	-.146
SI_3	-1.296	-.751	.316	-2.328	2.718
SI_4	-1.420	4.623	.906	3.326	-2.632
SI_5	-1.007	.878	-.269	1.490	-1.944
SI_6	1.955	-1.132	-2.214	.183	2.400
SI_7	.495	-.809	-.585	-.871	-1.394
SI_8	-.048	-2.067	1.911	-.699	1.655

Table P. 57 Standardized canonical discriminate function coefficient of the classification for all modern Caprinae and Gazella on distal

metatarsal.

P. 57 shows the coefficients of the standardized discriminate functions of this classification.

	Function				
	1	2	3	4	5
SI_DpBV	.563*	.220	.179	.139	.507
SI_1	.466	.076	.529*	.370	.457
SI_DBV	.405	-.053	.498*	.347	.336
SI_Bd	.216	.132	.408*	.037	-.072
SI_6	.209	.055	.343	.616*	.591
SI_4	.186	.131	.397	.594*	.566
SI_5	.058	.018	.363	.562*	.538
SI_3	.009	.066	.407	.452	.674*
SI_8	.201	-.008	.395	.521	.597*
SI_7	.182	.028	.401	.531	.535*
SI_2	.446	-.067	.376	.477	.481*

Table P. 58 Structure Matrix of the canonical discriminate classification for all modern Ovis, Caprinae, and Gazella on distal humerus.

Table P. 58 shows the contribution of the different factors to the five functions built in the table of structure matrix.

			Predicted Group Membership						
		GROUP	1	2	3	4	5	6	Total
Original	Count	1	19	0	0	1	0	2	22
		2	1	21	0	0	0	0	22
		3	0	1	18	0	0	0	19
		4	0	0	0	11	0	0	11
		5	0	0	0	0	17	0	17
		6	4	1	0	0	0	113	118
	%	1	86.4	.0	.0	4.5	.0	9.1	100.0
		2	4.5	95.5	.0	.0	.0	.0	100.0
		3	.0	5.3	94.7	.0	.0	.0	100.0
		4	.0	.0	.0	100.0	.0	.0	100.0
		5	.0	.0	.0	.0	100.0	.0	100.0
		6	3.4	.8	.0	.0	.0	95.8	100.0
Cross-validated[a]	Count	1	17	1	0	2	0	2	22
		2	1	20	0	0	0	1	22
		3	0	1	18	0	0	0	19
		4	1	0	0	10	0	0	11

		5	0	0	0	0	17	0	17
		6	5	1	0	0	0	112	118
	%	1	77.3	4.5	.0	9.1	.0	9.1	100.0
		2	4.5	90.9	.0	.0	.0	4.5	100.0
		3	.0	5.3	94.7	.0	.0	.0	100.0
		4	9.1	.0	.0	90.9	.0	.0	100.0
		5	.0	.0	.0	.0	100.0	.0	100.0
		6	4.2	.8	.0	.0	.0	94.9	100.0

Table P. 59 Classification Results for all modern Ovis on distal humerus. In cross-validation, each case is classified by the functions derived from all cases other than that case.

Table P. 59 reports the classification results. Overall, 95.2% of the original grouped cases were correctly classified, and 92.8% of cross-validated grouped cases were correctly classified. As can be seen in Table P. 54, group 4 (*C. hircus*) and 5 (*Gazella/Procapra*) are most well classified, with 100% of good classification. Group 1 (*P. nayaur*) is least correctly classified, with 86.4% of the original grouped cases correctly classified. All the other groups have the percentage of good classification at about 95%. Overall, the efficiency of this classification is very good.

Classificati	Wilks' Lambda	F	df1	df2	Sig.
SI_Bd	.579	16.272	5	112	.000
SI_DBV	.456	26.732	5	112	.000
SI_DpBV	.474	24.849	5	112	.000
SI_1	.409	32.409	5	112	.000
SI_2	.380	36.587	5	112	.000
SI_3	.307	50.465	5	112	.000
SI_4	.294	53.814	5	112	.000
SI_5	.299	52.472	5	112	.000
SI_6	.286	55.796	5	112	.000
SI_7	.265	62.271	5	112	.000
SI_8	.276	58.726	5	112	.000

Table P. 60 Test of equality of group means for the canonical discriminant classification for all Ovis to 6 groups on metatarsal.

As can be seen in Table P. 60, all the six shape indices do not pass the test of the equality of the group means, and there are significant differences between the means of at least two groups. Therefore, they all have discriminant power.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	3.757[a]	63.5	63.5	.889
2	1.180[a]	19.9	83.4	.736

3	.693[a]	11.7	95.1	.640
4	.192[a]	3.2	98.3	.401
5	.100[a]	1.7	100.0	.301

Table P. 61 Eigenvalues of the canonical discriminant classification for all Ovis to 6 groups on metatarsal.

As can be seen in Table P. 61, five functions are built, and the eigenvalues of the functions 1-5 are 3.757, 1.180, 0.693, 0.192, 0.100 respectively. The first two functions extracted accounted for 83.4% of the variance, which is quite high.

As can be seen in Table P. 62, the significant values of the Wilks' Lambda tests for all first four functions are smaller than 0.01, which means that these functions built are quite effective.

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 5	.043	340.250	55	.000
2 through 5	.207	171.022	40	.000
3 through 5	.451	86.471	27	.000
4 through 5	.763	29.333	16	.022
5	.909	10.298	7	.172

Table 6. 62 Wilk's Lambda of the canonical discriminant classification for all Ovis to 6 groups on metatarsal.

Table P. 63 shows the coefficients of the standardized discriminant functions of this classification.

	Function				
	1	2	3	4	5
SI_Bd	-.168	.762	-.703	.082	-.064
SI_DBV	.720	-.755	.021	.632	.257
SI_DpBV	-.881	.869	.807	.596	-.062
SI_1	-1.235	1.096	.938	.245	.958
SI_2	.678	-.312	-.743	-1.555	-1.227
SI_3	-.059	.438	.646	-.316	1.947
SI_4	.396	-1.575	.418	-2.921	-2.678
SI_5	-.460	.265	-.191	-.160	.581
SI_6	.099	-.371	.053	4.267	1.188
SI_7	1.317	.111	-.705	.296	1.246
SI_8	.178	.649	-.486	-.950	-2.083

Table P. 63Standardized canonical discriminant function coefficient of the classification for all Ovis to 6 groups on metatarsal.

	Function				
	1	2	3	4	5
SI_7	.812*	.457	.288	-.068	-.042
SI_8	.781*	.471	.306	-.012	-.095
SI_6	.772*	.392	.313	.026	-.106
SI_4	.751*	.406	.349	-.078	-.113
SI_5	.743*	.437	.231	-.076	.190
SI_3	.720*	.426	.346	-.132	.230
SI_2	.570*	.493	.409	-.179	-.211
SI_DBV	.480*	.421	.372	.337	-.020
SI_Bd	.078	.648*	-.538	.192	-.036
SI_1	.500	.547*	.462	-.167	-.156
SI_DpBV	.339	.581	.615*	.247	-.211

Table P. 64Structure Matrix of the canonical discriminant classification for all Ovis to 6 groups on metatarsal.

Table P. 64 shows the contribution of the different factors to the five functions built in the table of structure matrix.

			Predicted Group Membership						
		GROUP	1	2	3	4	5	6	Total
Original	Count	1	28	0	2	1	0	0	31
		2	0	6	0	0	1	0	7
		3	1	1	13	2	0	0	17
		4	0	5	0	17	1	4	27
		5	1	0	1	3	21	2	28
		6	0	0	0	0	1	7	8
	%	1	90.3	.0	6.5	3.2	.0	.0	100.0
		2	.0	85.7	.0	.0	14.3	.0	100.0
		3	5.9	5.9	76.5	11.8	.0	.0	100.0
		4	.0	18.5	.0	63.0	3.7	14.8	100.0
		5	3.6	.0	3.6	10.7	75.0	7.1	100.0
		6	.0	.0	.0	.0	12.5	87.5	100.0
Cross-validated[a]	Count	1	26	2	2	1	0	0	31
		2	0	4	0	2	1	0	7
		3	1	1	13	2	0	0	17
		4	0	7	0	15	1	4	27
		5	2	0	1	2	19	4	28

		6	0	0	1	1	1	5	8
	%	1	83.9	6.5	6.5	3.2	.0	.0	100.0
		2	.0	57.1	.0	28.6	14.3	.0	100.0
		3	5.9	5.9	76.5	11.8	.0	.0	100.0
		4	.0	25.9	.0	55.6	3.7	14.8	100.0
		5	7.1	.0	3.6	7.1	67.9	14.3	100.0
		6	.0	.0	12.5	12.5	12.5	62.5	100.0

Table P. 65Classification Results for all Ovis to 6 groups on metatarsal.

Table P. 65 reports the classification results. Overall, 78.0% of the original grouped cases were correctly classified, and 69.5% of cross-validated cases correctly classified. As can be seen in Table P. 66, group 1 (*O. ammon*) is most well classified, with 90.3% of good classification. Group 4 (*O. musimon*) is least correctly classified, with only 63.0% of the original grouped cases correctly classified. All the other groups have the percentage of good classification ranging 75.0%~87.5%. Overall, the efficiency of this classification is not very good.

H. Classification of all Caprinae and *Gazella* to 10 Groups on Distal Metatarsals (Figure 6.26, Chapter 6, vol. 1).

	Wilks' Lambda	F	df1	df2	Sig.
SI_Bd	.495	20.591	9	182	.000
SI_DBV	.319	43.088	9	182	.000
SI_DpBV	.394	31.086	9	182	.000
SI_1	.276	52.948	9	182	.000
SI_2	.268	55.302	9	182	.000
SI_3	.296	48.150	9	182	.000
SI_4	.259	57.949	9	182	.000
SI_5	.286	50.542	9	182	.000
SI_6	.257	58.400	9	182	.000
SI_7	.243	62.993	9	182	.000
SI_8	.252	60.148	9	182	.000

Table P. 66Test of equality of group means for all Caprinae and Gazella to 10 groups on metatarsals.

As can be seen in Table P. 66, all the six shape indices do not pass the test of the equality of the group means, and there are significant differences between the means of at least two groups. Therefore, they all have discriminant power.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	4.520[a]	38.7	38.7	.905
2	3.257[a]	27.9	66.6	.875
3	1.578[a]	13.5	80.1	.782
4	1.350[a]	11.6	91.7	.758
5	.588[a]	5.0	96.7	.609
6	.226[a]	1.9	98.6	.429
7	.113[a]	1.0	99.6	.318
8	.042[a]	.4	99.9	.200
9	.006[a]	.1	100.0	.078

Table P. 67 Eigenvalues of the canonical discriminant classification for all Caprinae and Gazella to 10 groups on metatarsals.

As can be seen in Table P. 67, nine functions are built. The first two functions extracted accounted for 66.6% of the variance, which is not quite high.

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 9	.003	1042.956	99	.000
2 through 9	.017	734.596	80	.000

3 through 9	.073	473.134	63	.000
4 through 9	.187	302.168	48	.000
5 through 9	.441	147.973	35	.000
6 through 9	.700	64.479	24	.000
7 through 9	.858	27.748	15	.023
8 through 9	.954	8.459	8	.390
9	.994	1.101	3	.777

Table P. 68 Wilk's Lambda of the canonical discriminant classification for all Caprinae and Gazella to 10 groups on metatarsals.

As can be seen in Table P. 68, the significant values of the Wilks' Lambda tests for all first seven functions are smaller than 0.01, which means that these functions built are quite effective.

	Function								
	1	2	3	4	5	6	7	8	9
SI_Bd	-.058	.019	-.177	.603	.874	-.011	.100	-.118	-.040
SI_DBV	.675	.337	-.570	-.406	-.625	-.524	.919	.641	.172
SI_DpBV	-.959	-.297	1.160	.433	.179	.735	.173	.202	.174
SI_1	-.341	.474	.055	1.993	-1.192	-.561	-.072	-.178	-1.285
SI_2	.919	-1.520	-.012	-1.008	.828	.351	-1.489	.105	.604
SI_3	.022	.134	-.573	.587	-.910	1.938	.466	-.952	-.811
SI_4	-1.753	2.229	.746	-.960	-.135	-3.015	-1.603	1.013	3.317

SI_5	-.717	.527	-.111	-.042	.702	-.318	-1.122	2.595	.516
SI_6	1.023	-1.024	1.137	-.970	.607	.715	2.417	-.997	-3.701
SI_7	1.231	.298	-.305	-.886	.785	1.485	-.313	-1.753	-2.574
SI_8	.558	-.711	-.873	1.374	-.673	-.478	.636	-.250	3.688

Table P. 69 Standardized canonical discriminant function coefficient of the classification for all Caprinae and Gazella to 10 groups on metatarsals.

Table P.69 shows the coefficients of the standardized discriminant functions of this classification.

	Function								
	1	2	3	4	5	6	7	8	9
SI_2	.691*	.119	.524	.249	-.018	.055	-.299	.168	.038
SI_8	.667*	.431	.448	.146	.064	.226	-.068	.001	.240
SI_7	.653*	.506	.449	.116	.086	.238	-.126	-.013	.122
SI_DBV	.615*	.171	.327	.308	-.135	-.024	.275	.422	.073
SI_1	.611*	.279	.511	.428	-.137	-.046	-.244	.112	-.067
SI_6	.609*	.468	.554	.049	.111	.130	-.054	.059	.018
SI_5	.544*	.535	.337	.067	.129	.321	-.188	.310	.050

SI_3	.463	.605*	.312	.138	-.034	.402	-.162	.083	.055
SI_4	.538	.576*	.539	.100	.057	.085	-.152	.007	.108
SI_DpBV	.320	.083	.752*	.325	-.040	.249	.139	.219	.194
SI_Bd	.185	.214	-.025	.581	.652*	-.140	.176	.061	-.019

Table P. 70 Structure Matrix of the canonical discriminant classification for all Caprinae and Gazella to 10 groups on metatarsals.

Table P. 70 shows the contribution of the different factors to the five functions built in the table of structure matrix.

			Predicted Group Membership										
		GROUP	1	2	3	4	5	6	7	8	9	10	Total
Original	Count	1	19	0	0	1	0	0	0	2	0	0	22
		2	1	21	0	0	0	0	0	0	0	0	22
		3	0	1	18	0	0	0	0	0	0	0	19
		4	0	0	0	11	0	0	0	0	0	0	11
		5	2	0	0	0	29	0	0	0	0	0	31
		6	0	0	0	0	0	6	0	0	1	0	7
		7	1	0	0	0	0	3	13	0	0	0	17
		8	1	0	0	0	0	6	0	17	1	2	27

		9	0	0	0	0	2	0	1	2	21	2	28
		10	0	0	0	0	0	0	1	0	1	6	8
	%	1	86.4	.0	.0	4.5	.0	.0	.0	9.1	.0	.0	100.0
		2	4.5	95.5	.0	.0	.0	.0	.0	.0	.0	.0	100.0
		3	.0	5.3	94.7	.0	.0	.0	.0	.0	.0	.0	100.0
		4	.0	.0	.0	100.0	.0	.0	.0	.0	.0	.0	100.0
		5	6.5	.0	.0	.0	93.5	.0	.0	.0	.0	.0	100.0
		6	.0	.0	.0	.0	.0	85.7	.0	.0	14.3	.0	100.0
		7	5.9	.0	.0	.0	.0	17.6	76.5	.0	.0	.0	100.0
		8	3.7	.0	.0	.0	.0	22.2	.0	63.0	3.7	7.4	100.0
		9	.0	.0	.0	.0	7.1	.0	3.6	7.1	75.0	7.1	100.0
		10	.0	.0	.0	.0	.0	.0	12.5	.0	12.5	75.0	100.0
Cross-validated[a]	Count	1	17	1	0	2	0	0	0	2	0	0	22
		2	1	20	0	0	0	0	0	0	0	1	22
		3	0	1	18	0	0	0	0	0	0	0	19
		4	0	0	0	11	0	0	0	0	0	0	11
		5	2	0	0	0	29	0	0	0	0	0	31
		6	0	0	0	0	0	4	0	2	1	0	7
		7	1	0	0	0	0	3	13	0	0	0	17
		8	1	0	0	0	0	8	0	15	1	2	27

		9	0	0	0	0	2	0	4	2	17	3	28
		10	0	0	0	0	0	0	1	1	1	5	8
	%	1	77.3	4.5	.0	9.1	.0	.0	.0	9.1	.0	.0	100.0
		2	4.5	90.9	.0	.0	.0	.0	.0	.0	.0	4.5	100.0
		3	.0	5.3	94.7	.0	.0	.0	.0	.0	.0	.0	100.0
		4	.0	.0	.0	100.0	.0	.0	.0	.0	.0	.0	100.0
		5	6.5	.0	.0	.0	93.5	.0	.0	.0	.0	.0	100.0
		6	.0	.0	.0	.0	.0	57.1	.0	28.6	14.3	.0	100.0
		7	5.9	.0	.0	.0	.0	17.6	76.5	.0	.0	.0	100.0
		8	3.7	.0	.0	.0	.0	29.6	.0	55.6	3.7	7.4	100.0
		9	.0	.0	.0	.0	7.1	.0	14.3	7.1	60.7	10.7	100.0
		10	.0	.0	.0	.0	.0	.0	12.5	12.5	12.5	62.5	100.0

Table P. 71 Classification Results for all Caprinae and *Gazella* to 10 groups on metatarsals.

Table P. 71 reports the classification results. Overall, 83.9% of the original grouped cases were correctly classified, and 77.6% of the cross-validated grouped cases correctly classified. As can be seen in Table P. 71, group 4 (*C. hircus*) is most well classified, with 100% of good classification. Group 8 (*O. musimon*) is least correctly classified, with only 63.0% of the original grouped cases correctly classified. All the other groups have the percentage of good classification ranging 75.0~95.5%. Overall, the efficiency of this classification is quite good.

Appendix QScore Values on Modern Specimens

A. Non-*Ovis* Caprinae and *Gazella*, Distal Humerus

Species	Specimen Number	C1*	C2*	C3*	C4*
Pseudois nayaur	LMU 1	1	2	3	1
Pseudois nayaur	LMU 2	2	2	1	1
Pseudois nayaur	BMN 43038	2	2	2	1
Pseudois nayaur	BMN 68735	1	2	2	1
Pseudois nayaur	BMN 68735(2)	1	2	2	1
Pseudois nayaur	BMN 68736	1	2	2	1
Pseudois nayaur	BMN 68737	1	-	1	-
Pseudois nayaur	BMN 83323 (1)	1	1	1	1
Pseudois nayaur	BMN 83323	-	-	-	-
Pseudois nayaur	MNHN 1966-136	1	2	1	1
Pseudois nayaur	MNHN 1971-245	1	2	1	1
Pseudois nayaur	MNHN 2005-569	1	2	2	1
Pseudois nayaur	LMU 4	-	2	-	-
Pseudois nayaur	LMU 3	1	2	1	-
Pseudois nayaur	LMU 5	1	2	3	-
Capricornis	BMN 47492	1	1	3	1
Capricornis	MNHN 1874.283	2	1	3	1
Capricornis	CMZ H25602	1	1	3	1
Capricornis	FMNH 114384	-	1	-	1
Capricornis	USNM 258653	-	1	-	1

Capricornis	USNM 258670	-	1	-	2
Capricornis	USNM 152165	-	1	-	1
Capricornis	USNM 259025	-	1	-	1
Capricornis	USNM 259404	-	1	-	2
Capricornis	AMNH 43037	-	1	3	2
Capricornis	AMNH 54614	-	2	-	1
Capricornis	MNHN 1937-314	-	1	-	-
Capricornis	AMNH 115578	-	1	3	1
Capricornis	AMNH 54613	-	1	3	1
Capricornis	MNHN 1919.28	-	1	-	-
Capricornis	BMN 7476	1	1	3	2
Capricornis	AMNH 165685	-	-	3	1
Capricornis	AMNH 184976	-	-	1	1
Capricornis	AMNH X	-	-	3	1
Nemorhaedus goral	BMN 70589	1	1	3	2
Nemorhaedus goral	BMN 70035	3	1	3	1
Nemorhaedus goral	BMN 70721	1	1	1	1
Nemorhaedus goral	BMN 83318	2	1	3	1
Nemorhaedus goral	BMN 14451	1	1	-	-
Nemorhaedus goral	FMNH 36922	-	1	-	-
Nemorhaedus goral	FMNH 26921	-	1	3	1
Nemorhaedus goral	FMNH 36786	-	1	3	2
Nemorhaedus goral	USNM 259398	-	2	3	1
Nemorhaedus goral	USNM 258677	-	1	1	1

Nemorhaedus goral	USNM 259390	-	1	-	1
Nemorhaedus goral	USNM 259396	-	1	1	1
Nemorhaedus goral	USNM 259397	-	1	1	2
Nemorhaedus goral	USNM 259023	-	1	3	1
Nemorhaedus goral	USNM 258678	-	1		2
Nemorhaedus goral	AMNH 43004	-	2	1	1
Nemorhaedus goral	AMNH 43001	-	1	1	1
Nemorhaedus goral	AMNH 110481	-	1	1	1
Nemorhaedus goral	FMNH 36787	-	-	3	1
Capra hircus	LMU 2	-	-	1	1
Capra hircus	LMU 3	2	2	1	1
Capra hircus	LMU 5	2	2	1	1
Capra hircus	LMU 10	2	2	1	1
Capra hircus	LMU 14	3	2	1	1
Capra hircus	LMU 18	2	2	-	-
Capra hircus	LMU 27	3	2	-	-
Capra hircus	LMU 28	2	2	-	-
Capra hircus	LMU 30	1	2	-	-
Capra hircus	LMU 31	2	2	-	-
Capra hircus	LMU 34	2	2	1	1
Capra hircus	LMU 39	-	2	1	1
Capra hircus	LMU 47	2	2	1	1
Capra hircus	LMU 48	2	2	1	1
Capra hircus	LMU 50	3	2	1	1

Capra hircus	LMU 51	3	2	1	1
Gazella gazella	LMU 3	1	2	1	1
Gazella gazella	MNHN 1960-3646	-	-	-	1
Procapra guttorosa	LMU 1	-	2	1	-
Procapra guttorosa	USNM 240984	1	-	-	1
Procapra guttorosa	USNM 282355	1	-	1	2
Procapra guttorosa	USNM 240986	-	2	1	1
Procapra guttorosa	USNM 282355	-	2	-	1
Procapra guttorosa	USNM 328577	-	2	1	1
Procapra guttorosa	USNM 328578	-	1	1	1
Procapra guttorosa	USNM X1	-	-	-	2
Procapra guttorosa	USNM X2	-	-	-	1
Procapra guttorosa	USNM X3	-	-	-	1
Procapra guttorosa	USNM X4	-	-	-	1
Procapra guttorosa	USNM X5	-	-	-	1

***C1, C2, C3, C4 are the scored characters of the humerus specimens. See explanation of these characters on pp. 143-148, Chapter 6, volume 1 of this dissertation.**

B. *Ovis*, Distal Humerus

Species	Specimen Number	C1*	C2*	C3*	C4*
Ovis ammon	MNB 1	1	2	1	1
Ovis ammon	LMU 9 (SAPM 02233)	2	2	1	1
Ovis ammon	LMU 6 (SAPM 02235)	3	2	1	1
Ovis ammon	LMU 8 (SAPM 02237)	1	2	1	1
Ovis ammon	LMU 7 (SAPM 02236)	2	2	1	1
Ovis ammon	LMU 1 (SAPM 02230)	-	-	-	-
Ovis ammon	LMU 3 (SPAM 02232)	-	-	-	-
Ovis ammon	MHNP 1876-524	1	1	1	1
Ovis ammon	MHJ 216, O pol hein 1	1	2	1	1
Ovis ammon	MHJ II, O am ltld 3	1	2	1	1
Ovis ammon	MHJ 163,O am alt 2	1	2	1	1
Ovis ammon	MHJ ohne, O am ltld 1	1	2	1	1
Ovis ammon	MHJ 218, O am ltld 9	2	2	1	1
Ovis ammon	MHJ 217,O am alt 3	1	2	1	1
Ovis ammon	MHJ ohne, O am ltld 2	2	2	2	1
Ovis ammon	MHJ 204, O am ltld 7	2	2	-	-
Ovis ammon	MHJ USNM 62100	2	2	1	1
Ovis ammon	USNM 62096	1	2	1	1
Ovis ammon	USNM 62101	1	2	1	1
Ovis ammon	MCZ 19941	1	2	1	1
Ovis ammon	AMNH 45490	1	2	1	1
Ovis ammon	AMNH 45493	1	2	1	1

Ovis ammon	AMNH 54931	1	2	1	1
Ovis ammon	AMNH 54865	1	2	1	1
Ovis ammon	AMNH 8730	1	2	1	1
Ovis vignei	MNB 83438	1	2	1	1
Ovis vignei	MNB 83437	1	2	1	1
Ovis vignei	LMU 4 (SAPM 02233)	-	-	-	-
Ovis vignei	MHJ 153/07	1	2	-	-
Ovis vignei	MHJ 430, O ur 26	1	2	1	1
Ovis vignei	MHJ O ur 21	1	2	-	-
Ovis vignei	MHJ 165, O ur 23	1	2	-	-
Ovis vignei	MHJ 392, O ur 25	1	2	-	-
Ovis vignei	MHJ 161, O ur 22	1	2	-	-
Ovis vignei	AMNH 119526	1	2	1	1
Ovis vignei	AMNH 54616	1	2	1	1
Ovis vignei	MNB vignei	3	2	1	1
Ovis orientalis	MHJ 289, O gml 1	3	2	-	-
Ovis orientalis	MHJ 290, O gml 2	1	2	-	-
Ovis orientalis	MHJ Ovis anatolicum 145/02	1	2	1	1
Ovis musimon	MNB 22773	1	-	-	-
Ovis musimon	MNB 22776	1	-	-	-
Ovis musimon	MNB 41394	1	-	-	-
Ovis musimon	MNB 22772	2	-	-	-
Ovis musimon	MNB 11527	1	-	-	-
Ovis musimon	MNB 22771	3	-	-	-

Ovis musimon	MHNP 1907-579	2	-	-	-
Ovis musimon	MHNP 1930-G68	1	-	-	-
Ovis musimon	MHNP 1872-19	2	-	-	-
Ovis musimon	MHNP 1987.058	1	-	-	-
Ovis musimon	MHNP 1967-924	1	-	-	-
Ovis musimon	MHNP 1909-317	1	-	-	-
Ovis musimon	MHNP UN4	1	-	-	-
Ovis musimon	MHNP UN1	1	-	-	-
Ovis musimon	MHNP UN3	1	-	-	-
Ovis musimon	MHNP 1909-307	1	-	-	-
Ovis musimon	LMU 19	1	2	-	-
Ovis musimon	LMU 32	1	2	-	-
Ovis musimon	LMU 8	1	2	-	-
Ovis musimon	LMU 22	1	2	-	-
Ovis musimon	LMU 14	-	2	-	-
Ovis musimon	LMU 30	-	2	-	-
Ovis musimon	LMU 28	-	2	-	-
Ovis musimon	LMU 20	-	2	-	-
Ovis musimon	LMU 10	-	2	-	-
Ovis musimon	LMU 12	-	2	-	-
Ovis musimon	LMU 31	-	2	-	-
Ovis musimon	LMU 27	-	2	-	-
Ovis musimon	LMU 257	-	2	-	-
Ovis musimon	LMU 259	-	2	-	-

Ovis musimon	MNB IIA 1501	-	2	-	-
Ovis musimon	MNB 2II 1924	-	2	-	-
Ovis musimon	MNB 13.VI.1923	-	2	1	1
Ovis musimon	AMNH 6238	-	2	-	-
Ovis musimon	AMNH 10261	-	2	-	-
Ovis musimon	AMNH 35478	-	2	-	-
Ovis musimon	AMNH 35316	-	2	-	-
Ovis musimon	AMNH 35683	-	2	-	-
Ovis aries	LMU 6	-	-	-	-
Ovis aries	AMNH 10072	1	2	-	-
Ovis aries	AMNH 53596	1	2	-	-
Ovis aries	AMNH 53598	1	2	-	-
Rambouillet	MHJ O rb 4, 8	1	2	1	1
Rambouillet	MHJ O rb 6, 14/75	1	2	1	1
Rambouillet	MHJ O rb 9, 15/82	1	2	1	1
Rambouillet	MHJ O rb 2, 1	2	2	1	1
Rambouillet	MHJ O rb 18, 432	1	2	1	1
Rambouillet	MHJ O rb 13, 20/75	1	2	1	1
Rambouillet	MHJ O rb 3, 2	2	2	1	1
Rambouillet	MHJ O rb 17,209/76	1	2	1	1
Rambouillet	MHJ O rb 19, 433	1	2	1	1
Rambouillet	MHJ O rb 10, 17/75	1	2	1	1
Rambouillet	MHJ O sfrz m 1	1	2	1	1
Rambouillet	MHJ O rb 7, 14/82	1	2	1	1

Rambouillet	MHJ O rb 5, 13/75	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 87, 811/92	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 191, 1014/03	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 59,708/90	2	2	1	1
Rambouillet*Argali	MHJ O rb/ag 251,1093/02	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 246, 1092/97	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 311,1148/06	2	2	1	1
Rambouillet*Argali	MHJ O rb/ag 286,1115/97	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 17, 986/06	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 281, 1100/97	2	2	1	1
Rambouillet*Argali	MHJ O rb/ag 193, 1015/95	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 258，977/01	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 173，986/05	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 95，826/92	2	2	1	1
Rambouillet*Argali	MHJ O rb/ag 116，290/85	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 59，708/90	2	-	1	1
Rambouillet*Argali	MHJ O rb/ag 246，1092/97	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 126, 902/01	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 200,1030/95	2	2	1	1
Rambouillet*Argali	MHJ O rb/ag 155, 978/94	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 259, 1093/08	1	2	1	1
Rambouillet*Argali	MHJ O rb/ag 116; 885/93	1	2	1	1

C1, C2, C3, C4 are the scored characters to separate between the different *Ovis* on the humerus specimens. See explanation of these characters on pp. 143-148, Chapter 6, volume 1 of this dissertation.

C. Non-*Ovis* Caprinae and *Gazella*, Distal Metacarpal

Species	Specimen Number	C1*	C2*	C3*
Pseudois	LMU1	2	2	2
Pseudois	LMU2	2	2	2
Pseudois	LMU3	2	2	2
Pseudois	MHNP 1966-136	2	2	2
Pseudois	MHNP 1971-245	2	2	2
Pseudois	MCZ 29959	1	2	1
Capricornis	BMN 47492	2	3	3
Capricornis	CZM H25602	1	3	3
Capricornis	FMNH 31137	1	3	3
Capricornis	FMNH 36783	1	3	3
Capricornis	MHNP 1902-411	1	3	3
Capricornis	MHNP 1919-28	1	3	3
Capricornis	MHNP 1974-283	1	3	3
Nemoehaedus	BMN 14451	2	3	3
Nemoehaedus	BMN 70035	3	3	3
Nemoehaedus	BMN 70589	1	3	3
Nemoehaedus	BMN 83318	1	3	3
Capra hircus	LMU X1	1	3	2
Capra hircus	LMU X2	2	3	2

Capra hircus	LMU X3	2	3	2
Capra hircus	LMU X4	3	3	3
Capra hircus	LMU X5	3	3	2
Capra hircus	LMU X6	3	3	3
Capra hircus	LMU X7	3	3	2
Capra hircus	LMU X8	3	3	2
Capra hircus	LMU X9	3	3	2
Capra hircus	LMU 17	3	3	3
Gazella/Procapra	LMU X1	3	1	1
Gazella/Procapra	LMU X2	3	1	1
Gazella/Procapra	LMU X3	3	1	1
Gazella/Procapra	LMU X4	3	1	1

***C1, C2, C3 are the scored characters of the metacarpal specimens. See explanation of these characters on pp. 162-167, Chapter 6, volume 1 of this dissertation.**

C. *Ovis*, Distal Metacarpal

Species	Specimen Number	C1*	C2*	C3*
Ovis ammon	BMN 5391	1	2	2
Ovis ammon	CMZ 19940	1	3	1
Ovis ammon	CMZ 19941	1	3	1
Ovis ammon	CMZ 19942	1	3	1
Ovis ammon	Halle 163	1	3	1
Ovis ammon	Halle 216	1	-	-
Ovis ammon	Halle 217	1	-	-
Ovis ammon	Halle 218	1	3	1
Ovis ammon	Halle II	1	3	1
Ovis ammon	LMU 2	2	-	1
Ovis ammon	LMU 5	2	2	
Ovis ammon	LMU 6	2	3	2
Ovis ammon	LMU 8	2	3	2
Ovis ammon	LMU 9	2	3	1
Ovis ammon	ohne ltld2	2	3	1
Ovis vignei	AMNH 54616	1	2	1
Ovis gmelini	AMNH 119526	2	3	2
Ovis gmelini	LMU 1	2	3	2
Ovis gmelini	LMU 2	2	3	2
Ovis gmelini	LMU 4	2	3	2
Ovis gmelini	LMU 5	2	3	3
Ovis gmelini	LMU Bastam x1	1	3	2
Ovis gmelini	LMU Bastam x2	1	3	1
Ovis gmelini	LMU Bastam x3	1	3	1
Ovis gmelini	LMU Bastam x4	1	3	1
Ovis gmelini	LMU Bastam x5	1	3	1
Ovis gmelini	LMU Bastam 72	1	3	2
Ovis orientalis	AMNH 6283	1	3	3
Ovis orientalis	LMU 19	2	3	2
Ovis orientalis	LMU 8	2	3	2
Ovis orientalis	LMU 28	2	3	2
Ovis orientalis	LMU 6	2	3	2
Ovis aries	Ram x Argali 811/92	1	3	2
Ovis aries	Ram x Argali 1014/03	2	3	3
Ovis aries	Ram x Argali 708/90	1	3	2
Ovis aries	Ram x Argali 1093/02	1	3	2
Ovis aries	Ram x Argali 1092/97	1	3	2
Ovis aries	Ram x Argali 1148/06	1	3	2
Ovis aries	Ram x Argali 1115/97	1	3	2
Ovis aries	Ram x Argali 986/06	1	3	2

Ovis aries	Ram x Argali 1100/97	2	3	2
Ovis aries	Ram x Argali 827/92	1	3	1

***C1, C2, C3 are the scored characters of the metacarpal specimens. See explanation of these characters on pp. 162-167, Chapter 6, volume 1 of this dissertation.**

D. Non-*Ovis* Caprinae, Distal Metatarsal

Species	Specimen Number	C1*	C2*	C3*
Pseudois	LMU1	2	3	2
Pseudois	LMU2	3	2	3
Pseudois	LMU3	2	3	3
Pseudois	MHNP 1966-136	3	3	3
Pseudois	MHNP 1971-245	2	2	3
Capricornis	AMNH 43001	1	3	2
Capricornis	AMNH 43037	1	3	2
Capricornis	AMNH 54613	2	3	2
Capricornis	AMNH 54614	1	3	1
Capricornis	AMNH 115578	1	3	3
Capricornis	AMNH 165683	1	3	2
Capricornis	AMNH X	1	3	2
Capricornis	MHNP 1902-411	1	3	2
Capricornis	MHNP 1919-28	1	3	3
Capricornis	MHNP 1974-283	1	3	1
Capricornis	USNM 152165	1	3	1
Capricornis	USNM 258670	1	3	2
Capricornis	USNM 258671	1	3	3
Capricornis	USNM 258831	1	3	1
Capricornis	USNM 258832	1	3	2
Capricornis	USNM 258833	1	3	1
Capricornis	USNM 259025	1	3	2
Capricornis	USNM 259404	1	3	2
Nemoehaedus	AMNH 43004	2	3	2
Nemoehaedus	BMN 14451	1	3	3
Nemoehaedus	BMN 70035	1	3	2
Nemoehaedus	BMN 70589	1	3	2
Nemoehaedus	BMN 83318	3	3	1
Capra hircus	LMU 5	2	3	3
Capra hircus	LMU 8	3	3	3
Capra hircus	LMU X1	2	3	2
Capra hircus	LMU X2	1	3	3
Capra hircus	LMU X3	3	3	3
Capra hircus	LMU X4	1	3	3
Capra hircus	LMU X5	1	3	2
Capra hircus	LMU X6	2	3	3
Gazella/Procapra	LMU X1	2	1	2
Gazella/Procapra	LMU X2	3	2	2
Gazella/Procapra	LMU X	2	1	1

E. *Ovis,* Distal Metatarasal

Species	Specimen Number	C1*	C2*	C3*
Ovis ammon	AMNH X	3	3	1
Ovis ammon	AMNH 45490	1	3	2
Ovis ammon	AMNH 45492	1	3	1
Ovis ammon	AMNH 45494	1	3	2
Ovis ammon	AMNH 45867	2	3	2
Ovis ammon	AMNH 45873	1	3	2
Ovis ammon	AMNH 45875	1	2	2
Ovis ammon	AMNH 45931	1	2	2
Ovis ammon	AMNH 54874	1	3	1
Ovis ammon	AMNH 54881	1	3	2
Ovis ammon	CMZ 19940	1	3	3
Ovis ammon	CMZ 19941	1	3	3
Ovis ammon	CMZ 19942	1	3	2
Ovis ammon	Halle 216	1	3	2
Ovis ammon	Halle 217	1	2	3
Ovis ammon	Halle 218	2	3	3
Ovis ammon	Halle II	2	2	3
Ovis ammon	LMU 2	1	2	3
Ovis ammon	LMU 6	2	2	3
Ovis ammon	LMU 9	2	2	2
Ovis ammon	LMU 8	1	3	2
Ovis ammon	LMU 1	2	3	
Ovis ammon	LMU 7	2	3	2
Ovis ammon	LMU 3	1	3	3
Ovis ammon	Halle ltld 2	1	2	2
Ovis vignei	AMNH 54616	1	3	2
Ovis gmelini	LMU 1	1	3	2
Ovis gmelini	LMU 2	1	3	2
Ovis gmelini	LMU 4	1	3	3
Ovis gmelini	LMU 5	2	3	2
Ovis gmelini	LMU 4.2	2	3	2
Ovis gmelini	LMU Bastam x1	1	2	2
Ovis gmelini	LMU Bastam x2	1	2	2
Ovis gmelini	LMU Bastam x3	1	2	2
Ovis gmelini	LMU Bastam x4	1	3	2
Ovis gmelini	LMU Bastam x5	1	3	2
Ovis gmelini	LMU Bastam 72	1	2	2
Ovis gmelini	AMNH 145.02	1	3	2
Ovis orientalis	AMNH 875CA	1	2	2
Ovis orientalis	AMNH 10262	1	3	2

Ovis orientalis	AMNH 35316	1	2	3
Ovis orientalis	AMNH 35478	1	3	2
Ovis orientalis	AMNH 35683	1	2	3
Ovis aries	LMU 1	2	3	2
Ovis aries	LMU 2	1	3	2
Ovis aries	LMU 3	1	3	3
Ovis aries	LMU 4	1	3	2
Ovis aries	Ram Halle8	1	2	2
Ovis aries	Ram 14/75	1	3	2
Ovis aries	Ram 15/82	1	3	2
Ovis aries	Ram Halle1	1	2	2
Ovis aries	Ram Halle7594	1	3	3
Ovis aries	Ram 20/75	1	3	3
Ovis aries	Ram Halle2	1	3	2
Ovis aries	Ram 209/76	2	3	2
Ovis aries	Ram Halle433	1	3	2
Ovis aries	Ram 17/75	2	3	2
Ovis aries	Ram 17/82	1	3	2
Ovis aries	Ram 14/82	2	3	2
Ovis aries	Ram 13/75	1	2	3
Ovis aries	Ram Halle2	1	3	2
Ovis aries	Ram Halle2	1	3	2
Ovis aries	Ram 209/76	1	3	3
Ovis aries	Ram Halle433	1	3	3
Ovis aries	Ram 17/75	1	3	3
Ovis aries	Ram 17/82	2	3	2
Ovis aries	Ram 14/82	1	3	3
Ovis aries	Ram 13/75	1	3	2
Ovis aries	Ram×Argali 811/92	1	3	2
Ovis aries	Ram×Argali 1014/03	2	3	3
Ovis aries	Ram×Argali 708/90	2	3	2
Ovis aries	Ram×Argali 1093/02	2	3	2
Ovis aries	Ram×Argali 1092/97	1	3	2
Ovis aries	Ram×Argali 1148/06	1	3	3
Ovis aries	Ram×Argali 1115/97	1	3	3
Ovis aries	Ram×Argali 986/06	1	3	2
Ovis aries	Ram×Argali 1100/97	1	3	3
Ovis aries	Ram×Argali 1015/95	1	3	2

***C1, C2, C3 are the scored characters of the metatarsal specimens. See explanation of these characters on pp. 162-167, Chapter 6, volume 1 of this dissertation.**

Appendix R Scales of Estimating the Surface Preservation Condition



1 2 3

Three scales of surface preservation condition:

1. good: the surface of the bone smooth to lightly eroded with cut marks can be observed;

2. average: most of the surface lost and normal cut marks cannot be seen apart from very large ones;

3. poor: the bone appears porous and amorphous.

Appdendix SFaunal Remains Identified at Jiangxigou 2

Specimen Number	Date	Taxonomy	SC*	C*	Element	SC*
jxg2(70-80)-2	7,000BP	small rodent	3	1	single tooth in upper draw	3
jxg2(70-80)-1	7,000BP	Subfamily Caprinae	3	1	loose lower tooth	3
jxg2(70-80)-3	7,000BP	small mammal	3	1	ulna	3
jxg2(70-80)-4	7,000BP	small rodent	2	1	loose lower tooth	2
jxg2(70-80)-5	7,000BP	small rodent	2	1	loose lower tooth	2
jxg2(70-80)-6	7,000BP	small rodent	2	1	single upper teeth	2
jxg2(70-80)-6	7,000BP	small rodent	2	1	single upper teeth	2
jxg2(70-80)-6	7,000BP	small rodent	2	1	single upper teeth	2
jxg2(70-80)-6	7,000BP	small rodent	2	1	single upper teeth	2
jxg2-B7(74cm)	7000-8000BP	*Gazelle* or *Procapra*	3	2	astragalus	3
jxg2-B8(70-80 cm)	7000-8000BP	small mammal	3	1	scapula	3
jxg2-B10(70-80)	7000-8000BP	Subfamily Caprine	3	2	phalanx 1	3
jxg2-B11(78CM)-1	7000-8000BP	*Nemorhedus/ Capricornis*	3	2	single upper teeth	3
jxg2-B14(78CM)	7000-8000BP	small mammal	2	2	scapula	2

jxg2-B11(78CM)-2	7000-8000BP	Small mammal	-	2	single upper teeth	-
jxg2-B11(78CM)-1	7000-8000BP	Subfamily Caprinae	-	1	single upper teeth	-
jxgB15(85CM)	8000BP	Subfamily Caprinae	3	2	calcaneus	3
jxg2-B155(83CM)	8000BP	*Gazelle* or *Procapra*	-	2	phalanx 3	-
jxg2-(80-90cm)	8000BP	Subfamily Caprinae	-	1	single upper teeth	-
jxg2-(100-110cm)	9400BP	Subfamily Caprinae	-	1	single upper teeth	-
jxg2(110-120)-1	9400-10000BP	small rodent	1	1	single tooth	1
jxg2(110-120)-2	9400-10000BP	Subfamily Caprinae	1	2	loose lower tooth	1
jxg2B-21 (120cm)	9400-10000BP	Subfamily Caprinae	-	1	single tooth in lower draw	-

*** C (Certainty): 1=certain; 2=uncertain**

SC (Surface Condition)

1: the surface of the bone smooth to lightly eroded with cut marks can be observed;

2: most of the surface lost and normal cut marks cannot be seen apart from very large ones (average);

3: the bone appears porous and amorphous (poor).

Appendix T Faunal Remains Identified at Andaqiha

A. Horizons

Taxa	5a	5b	5c	5d	5e	5f	6	Area II(3)	Area II(3)	Total
	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP
Cervidae	151	119	5	6	5	4	17	9	1	317
Caprinae	105	58	1	5	3	3	7	3	1	186
Gazella/Procapra	18	15	1	0	0	0	0	0	0	34
Bovidae/Cervidae	30	21	1	0	0	8	3	0	0	63
Sus	9	9	2	1	0	0	0	2	0	23
Carnivora	13	13	0	0	0	0	0	0	0	26
Lepus	2	3	0	1	0	0	0	0	0	6
Aves	2	8	1	0	0	0	1	0	0	12
Rodentia	3	8	0	0	0	0	1	0	0	12
Homo sapiens	0	0	0	0	1	0	0	0	0	1
Total	333	254	11	13	9	15	29	14	2	680

B. Ash Pits

Taxon	H2	H3	H10	H12	H14	H19	H22	H36	Area II(3) H27	Area II(3):H24	Area II(3):H29	Total
	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP
Cervidae	91	4	5	1	2	0	2	1	3	1	1	111
Caprinae	26	0	1	0	1	0	0	0	0	0	0	28
Gazella/Procapra	7	0	1	0	0	0	0	0	0	0	0	8
Bovidae/Cervidae	12	0	0	0	0	0	0	1	0	0	0	13
Sus	6	1	0	0	0	1	0	0	0	0	0	8
Carnivora	5	0	1	0	0	0	0	0	0	0	0	6
Lepus	3	0	0	0	0	0	0	0	0	0	0	3
Aves	4	0	0	0	0	0	0	3	0	0	0	7
Rodent	3	0	0	0	0	0	0	0	0	0	0	3
Total	157	5	8	1	3	1	2	5	3	1	1	187

C. House

Taxon	F1	F2	F3	F5	F6	F9	F10	F11	F12	F13	F14	F15	F16	F17
	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP
Cervidae	13	84	1	1	10	11	3	9	2	1	5	3	3	24
Caprinae	8	23	0	0	4	2	1	1	0	0	4	3	1	10
Gazella/Procapra	1	3	0	0	0	0	0	0	0	0	0	0	0	1
Bovidae/Cervidae	3	8	0	0	3	1	0	0	0	0	0	1	0	3
Sus	0	2	0	0	0	0	0	0	0	0	0	0	0	2
Carnivora	5	7	0	0	4	3	0	1	1	0	1	1	0	2
Lepus	0	1	0	1	1	1	0	0	0	0	0	0	0	2
Aves	3	5	0	0	0	0	0	0	0	0	1	1	0	3
Rodentia	1	4	0	0	0	0	0	0	0	0	0	0	0	1
Total	34	137	1	2	22	18	4	11	3	1	11	9	4	48

D. Other Contexts

Taxon	Area I:G1	Area II:(3)G1	Z3	Z7	T2	Unknown	Total
	NISP	NISP	NISP	NISP	NISP	NISP	NISP
Cervidae	0	4	0	0	0	5	9
Caprinae	1	1	1	0	1	2	6
Gazella/Procapra	1	1	0	0	0	1	3
Bovidae/Cervidae	0	1	0	1	0	1	3
Carnivora	0	1	0	1	0	0	2
Rodentia	0	0	0	0	0	1	1
Total	2	8	1	2	1	10	24

E. Summary

Taxa	**NISP**	**%**
Cervidae	607	50.8
Caprinae	277	23.2
Gazella/Procapra	50	4.2
Bovidae/Cervidae	98	8.2
Sus	35	2.9
Carnivora	59	4.9
Lepus	15	1.3
Aves	32	2.7
Rodentia	22	1.8
Homo sapiens	1	0.1
Total	**1196**	**100.0**

Appendix UAnimals Identified at Shannashuzha

Provided by Lele Ren

Wolf (*Canis lupus*)

Red fox (*Vulpes vulpes*)

Racoon dog (*Nyctereutes procyonoides*)

Brown bear (Ursus arctos)

Asian black bear (*Ursus thibetanus*)

Domestic pig (*Sus scrofa domestica*)

Dog (*Canis familiaris*)

Pig (*Sus domesticus*)

Cattle (*Bos sp.*)

Roe deer (*Capreolus pygargus*)

Sika deer (*Cervus nippon*)

Red deer (*Cervus elaphus*)

Chinese goral (*Naemorhedus goral*)

Serow (*Capricornis sumatraensis*)

Blue sheep (*Pseudois nayaur*)

Barking deer (*Muntiacus muntjak*)

Chinese forest musk deer (*Moschus berezovskii*)

Alpine musk deer (*Moschus chrysogaster*)

Chinese muntjac (*Muntiacus reevesi*)

Water deer (*Hydropotes inermis*)

European badgers (*Meles meles*)

Hog badger *(Arctonyx collaris)*

bamboo rats (*Rhizomys pruinosus*)

Chinese zokor (Myospalax fontanieri)

Hare (*Lepus capensis*)

Gazelle (*Gazella sp./ Procapra sp.*)

Golden snub-nosed Monkey (*Rhinopithecus roxellanae*)

Sumatran rhinoceros (*Dicerorhinus sumatrensis*)

Appendix VBasic Data of Humerus Specimens from Archaeological Sites

A. Taphonomic Information and Metric Data of Archaeological Specimens from Andaqiha, Jinchankou, Shannashuzha, and Sanbadongzi.

Specimen Number	SC *	Burning	Context Number	Bd	BT	HT	SHT	BTm	BTI	LHT
ADQH21	2	0	T0101(5)a-64	32.59	31.67	19.11	14.01	20.50	9.98	13.13
ADQH22	1	2	T0102H2(3)-38	34.23	32.21	20.34	14.29	21.83	9.62	13.64
ADQH264	2	0	T0101(5)b-7	34.24	33.90	20.15	14.26	22.53	10.90	13.70
ADQH266	1	2	T0101H2-2	30.60	29.59	17.49	13.30	18.52	9.13	12.24
ADQH516	2	0	T0110(3)-1	33.73	30.40	20.00	14.90	23.39	9.99	13.06
ADQH824	2	0	T0102(5)b-1	38.33	35.67	22.11	16.22	23.85	10.90	13.84
ADQH828	3	0	T0101(5)a-5	-	30.32	19.21	14.50	19.14	9.62	12.49
ADQH829	2	0	T0102(5)a-4	-	29.63	19.14	14.14	19.86	9.30	13.10
ADQH827	2	0	T0102(5)a-7	-	31.90	20.19	14.26	19.60	11.15	13.35
ADQH825	3	0	T0102(5)a-3	-	30.66	-	-	-	-	-
ADQH826	3	0	T0102(5)XKF-1	-	31.57	19.30	13.06	19.93	9.75	11.41
ADQH1177	2	0	T0103(5)-102	-	36.46	23.21	15.73	23.67	12.11	14.76
ADQH1203	2	0	T0103(5)a-101	36.74	34.21	22.51	17.36	21.99	10.93	13.68
ADQH1371	2	0	T0402F9-101	-	35.86	21.03	14.83	23.38	11.66	14.24
ADQH1553	2	0	T0110(3)XIA-200	-	35.42	22.08	-	22.52	11.58	14.51
ADQHRM30	2	0	T0104(5)b-21	-	30.65	19.29	13.26	20.67	8.52	12.12
ADQH822	2	0	T0102(5)a-17	31.97	29.91	20.50	14.54	19.35	8.40	13.66
ADQH892	1	3	T0102H2(3)-2	34.99	32.75	19.93	15.49	22.46	9.22	14.62
ADQH1224	1	0	T0303F2(2)-113	31.28	30.03	18.08	13.98	20.51	8.2	13.19
A1061	1	0	T0405(3)	31.28	30.85	21.59	16.10	21.91	7.67	14.16
A1026	2	0	T0405(3)	32.10	31.64	19.87	15.43	22.74	8.09	14.53
A1918	1	0	T0405F5-XBJD	-	33.43	21.66	16.17	23.01	9.76	15.09
A1709	1	0	2012HJF3	-	30.14	18.83	14.65	20.66	9.05	13.21
A1028	1	0	T1104(2)	32.74	31.73	19.95	15.85	21.55	9.63	11.79
A1789	1	0	T0907F3(1)	35.31	33.50	20.54	15.72	21.48	10.71	13.63
A1920	1	0	T0405F4-XBJD	35.07	31.17	20.17	16.25	20.58	8.99	15.00
A1466	3	0	T1102(2)	-	-	19.00	14.53	-	-	-
A1338	3	0	T0103Y2	-	-	18.36	-	-	-	-
A1205	2	0	T1102(3)	-	-	21.96	16.60	-	-	-
A1356	1	0	T0907(5)	-	30.55	19.79	14.83	21.17	8.22	12.95

A1316	1	0	T0906(2)	32.42	-	21.89	17.55	-	-	-
A2179	2	0	T0305F1-MQCD	-	30.63	20.04	16.14	-	9.23	15.27
A918	1	0	T0405F4-CCS	-	30.91	20.33	15.85	21.62	8.45	14.65
A919	1	0	T0405F4-CCS	-	33.02	21.36	17.06	21.26	10.47	12.31
SNSZ1561	1	0	T01104C	-	35.00	22.27	16.11	23.39	11.09	15.44
SNSZ1562	2	0	T02103B	35.37	-	20.72	16.90	18.48	11.17	13.00
SNSZ1563	1	0	IT0309(2)	-	35.18	22.70	17.59	22.85	11.43	13.37
T0210H159	2	0	T0210H159	37.56	27.06	19.68	16.00	16.00	9.29	12.43
SNSZ1564	1	0	IT0107H13	28.98	22.90	22.99	17.37	22.60	9.95	13.54
SNSZ1565	2	0	IT0107G2	36.03	26.72	19.65	16.15	16.18	9.17	11.05
SNSZ1566	2	0	T0210H99	-	33.41	23.30	17.63	22.87	10.01	13.45
SNSZ1567	2	0	T0210(4)	38.59	-	-	18.47	-	11.91	13.81
SNSZ1568	1	0	T0210(4)	-	27.66	23.18	17.93	16.82	10.04	14.30
SBDZ-49-2	2	0	-	31.89	37.38	24.18	17.94	29.66	13.56	20.22
SBDZ-49-3	1	0	-	-	35.78	32.42	19.13	26.00	11.28	18.78
SBDZ-49-4	1	0	-	-	32.62	21.28	16.00	22.35	9.17	15.70
SBDZ-49-1	1	0	-	-	31.54	19.68	15.90	20.50	9.65	14.88

***Surface Condition:**

1: the surface of the bone smooth to lightly eroded with cut marks can be observed;

2: most of the surface lost and normal cut marks cannot be seen apart from very large ones (average);

3: the bone appears porous and amorphous (poor).

***Burning:**

0: no traces of burning were observed

1: lightly burnt appearing light traces of burning

2: medium burnt appearing charred or carbonized

3: heavily burnt appearing grey and calcinations

Bd, BT, HT, SHT, BTm, BTI, LHT are the measurements taken on distal humerus specimens. See Figure 6.2, Chapter 6, vol. 1 for an explanation of these measurements.

B. Score Values of the Osteoscopic Characters (C1-C4) of Specimens from Andaqiha, Jinchankou, Shannashuzha, and Sanbadongzi.

Specimen No.	C1	C2	C3	C4
ADQH21	1	2	2	1
ADQH22	1	2	3	1
ADQH266	2	2	3	1
ADQH822	2	2	2	1
ADQH828	1	2	3	2
ADQH829	2	2	2	-
ADQH827	1	2	3	-
ADQH825	1	-	-	2
ADQH892	1	1	2	1
ADQH1203	3	1	2	2
ADQH1224	1	2	1	-
A1061	1	2	1	1
A1026	1	2	2	1
A1918	2	2	3	1
A1709	2	2	2	1
A1028	3	1	3	2
A1789	1	1	2	1
A1920	1	2	1	1
A1356	2	2	3	1
A919	3	1	3	2
SNSZ1561	1	2	2	1
SNSZ1562	2	1	3	1
SNSZ1564	2	1	3	1
SNSZ1566	3	1	3	1
SBDZ-49-3	1	2	1	1

C1, C2, C3, C4 are the scored characters of the humerus specimens. See explanation of these characters in Figure 6.4-Figure 6.7, Chapter 6, volum 1 of this dissertation.

C. Metric Data of the Specimens from Andaqiha, Jinchankou, Shannashuzha and Sanbadongzi.

Specimen Number	SHT/BTl	BT/HT	HT/SHT	HT/LHT	LHT/BTI
ADQH21	1.40	1.66	1.36	1.46	1.32
ADQH22	1.49	1.58	1.42	1.49	1.42
ADQH264	1.31	1.68	1.41	1.47	1.26
ADQH266	1.46	1.69	1.32	1.43	1.34
ADQH516	1.49	1.52	1.34	1.53	1.31
ADQH824	1.49	1.61	1.36	1.60	1.27
ADQH828	1.51	1.58	1.32	1.54	1.30
ADQH829	1.52	1.55	1.35	1.46	1.41
ADQH827	1.28	1.58	1.42	1.51	1.20
ADQH826	1.34	1.64	1.48	1.69	1.17
ADQH1177	1.30	1.57	1.48	1.57	1.22
ADQH1203	1.59	1.52	1.30	1.65	1.25
ADQH1371	1.27	1.71	1.42	1.48	1.22
ADQH1553	-	1.60	-	1.52	1.25
ADQHRM30	1.56	1.59	1.45	1.59	1.42
ADQH822	1.73	1.46	1.41	1.50	1.63
ADQH892	1.68	1.64	1.29	1.36	1.59
ADQH1224	1.70	1.66	1.29	1.37	1.61
A1061	2.10	1.43	1.34	1.52	1.85
A1026	1.91	1.59	1.29	1.37	1.80
A1918	1.66	1.54	1.34	1.44	1.55
A1709	1.62	1.60	1.29	1.43	1.46
A1028	1.65	1.59	1.26	1.69	1.22
A1789	1.47	1.63	1.31	1.51	1.27
A1920	1.81	1.55	1.24	1.34	1.67
A1466	-	-	1.31	-	-
A1205	-	-	1.32	-	-
A1356	1.80	1.54	1.33	1.53	1.58
A1316	-	-	1.25	-	-
A2179	1.75	1.53	1.24	1.31	1.65
A918	1.88	1.52	1.28	1.39	1.73
A919	1.63	1.55	1.25	1.74	1.18
SNSZ1561	1.45	1.57	1.38	1.44	1.39
SNSZ1562	1.51	-	1.23	1.59	1.16
SNSZ1563	1.54	1.55	1.29	1.70	1.17
T0210H159	1.72	1.38	1.23	1.58	1.34
SNSZ1564	1.75	1.00	1.32	1.70	1.36
SNSZ1565	1.76	1.36	1.22	1.78	1.21
SNSZ1566	1.76	1.43	1.32	1.73	1.34

SNSZ1567	1.55	-	-	-	1.16
SNSZ1568	1.79	1.19	1.29	1.62	1.42
SBDZ-49-2	1.32	1.55	1.35	1.20	1.49
SBDZ-49-3	1.70	1.10	1.69	1.73	1.66
SBDZ-49-4	1.74	1.53	1.33	1.36	1.71
SBDZ-49-1	1.65	1.60	1.24	1.32	1.54

SHT/BTI, BT/HT, HT/SHT, HT/LHT, LHT/BTI are ratios of pairs of measurements taken from humerus specimens. See Figure 6.2, Chapter 6 of this dissertation for the explanation of these measurements.

D. Values of the Osteometrics and Identification (ID) Based on Them for Andaqiha Specimens

Specimen No.	SHT/BTl		BT/HT		HT/SHT		HT/LHT		LHT/BTI		ID
	Value	ID	Value	ID	Value	ID	Value	ID	Value	ID	
ADQH266	1.46	O/N/Ch/P	1.69	Ch/P/Cpc/N/O	1.32	Ch/P/G/N/O	1.43	O/P/Ch/Cpc/N/G	1.34	P/Cpc/O/Ch/N	O/N/Ch/P
ADQH516	1.49	O/N/Ch/P/Cpc	1.52	P/Cpc/N/O	1.34	Ch/P/G/N/O	1.53	N/Cpc/P/G/O/Ch	1.31	P/O/Ch/Cpc/N	O/N/P
ADQH828	1.51	O/N/Ch/P/Cpc	1.58	Ch/P/Cpc/N/O	1.32	Ch/P/G/N/O	1.54	N/Cpc/P/G/O/Ch	1.30	P/O/Ch/Cpc/N	N/O/P/Ch
ADQH829	1.52	O/N/Ch/P/Cpc	1.55	Ch/P/Cpc/N/O	1.35	Ch/P/G/N/O	1.46	Cpc/P/G/O/Ch	1.41	P/O/Ch/Cpc/N	O/P/Ch
ADQH822	1.73	P/O/G/Cpc/N	1.46	N/O	1.41	P/O/G	1.50	P/O/G/Cpc/N/Ch	1.63	O/Ch/P/G	O
ADQH892	1.68	P/O/G/Cpc/N/Ch	1.64	Ch/P/Cpc/N/O	1.29	P/O/G/Ch/N/Cpc	1.36	P/O/G/Ch	1.59	O/Ch/P/G	O/P/Ch
ADQH1224	1.70	P/O/G/Cpc/N/Ch	1.66	Ch/P/Cpc/N/O	1.29	P/O/G/Ch/N/Cpc	1.37	P/O/G/Ch	1.61	O/Ch/P/G	O/P/Ch

The identification (ID) in the last column is the parsimonious one made considering the overlapping taxa of all five identifications before. SHT/BTI, BT/HT, HT/SHT, HT/LHT, LHT/BTI are ratios of pairs of measurements taken from humerus specimens. See Figure 6.2, Chapter 6 of this dissertation for the explanation of these measurements, and Appendix I for the values of these ratios on modern specimens. O: *Ovis,* P: *Pseudois,* Ch: *Capra hircus,* G: *Gazella/Procapra;* N: *Nemorhaedus;* Cpc: *Capricornis.*

E. Values of the Ratio Criteria in Götze (1998, p. 88, Tab 12) and Identification Results (ID) Based on Them for the Archaeological Specimens from Jinchankou, Shannashuzha, and Sanbadongzi.

Specimen	BTl/HTF		HTF/BTR		Götze
No.	Value	ID	Value	ID	ID
A1061	0.48	-	0.52	Ch/O	-
A1026	0.52	O	0.49	Ch/O/P	O
A1918	0.60	O	0.48	Ch/O/P	O
A1709	0.62	O	0.49	Ch/O/P	O
A1028	0.61	O	0.50	Ch/O/P	O
A1789	0.68	Ch/P	0.47	Ch/O/P	Ch/P
A1920	0.55	O	0.52	Ch/O	O
A1356	0.55	O	0.49	Ch/P/O	O
A2179	0.57	O	0.53	O	O
A918	0.53	O	0.51	O/Ch	O
A919	0.61	O	0.52	O/Ch	O
SNSZ1561	0.69	Ch/P	0.46	Ch/O/P	Ch/P
SNSZ1562	0.66	O/Ch/P	-	-	-
SNSZ1563	0.65	O/Ch/P	0.50	Ch/O/P	Ch/O/P
T0210H159	0.58	O	0.59	-	-
SNSZ1564	0.57	O	0.76	-	-
SNSZ1565	0.57	O	0.60	-	-
SNSZ1566	0.57	O	0.53	O	O
SNSZ1567	0.64	O/Ch/P	-	-	-
SNSZ1568	0.56	O	0.65	-	-
SBDZ-49-2	0.76	Ch/P	0.48	Ch/O/P	Ch/P
SBDZ-49-3	0.59	O	0.53	O	O
SBDZ-49-4	0.57	O	0.49	Ch/O/P	O
SBDZ-49-1	0.61	O	0.50	Ch/O/P	O

O: ***Ovis;*** **P:** ***Pseudois;*** **Ch:** ***Capra hircus.***

Specimen numbers starting with 'ADQH' are from the site of Andaqiha; those starting with 'SNSZ' are from the site of Shannashuzha;those starting with 'A' are from the site of Jinchankou, and those starting with 'SBDZ' are from the site Sanbadongzi.

Appendix W Basic Data of Metacarpal Specimens from Archaeological Sites

A. Taphonomic Information and Metric Data of Archaeological Specimens from Andaqiha, Jinchankou and Sanbadongzi.

Specimen number	Context number	SC*	Burning	Bd	DBV	DpBV	1	2	3	4	5	6	7	8
ADQH43	T0102H2(1)-18	2	1	28.13	13.10	12.98	12.66	12.69	11.19	16.94	11.37	16.43	14.75	14.51
ADQH44	T0102H2(1)-12	2	1	29.06	13.81	13.18	13.15	12.70	12.00	17.36	11.15	-	14.64	14.54
ADQH46	T0101(5)a-89	3	0	25.85	12.24	12.27	11.67	11.69	10.91	16.15	9.81	15.82	13.85	13.74
ADQH47	T0101(5)a-10	2	1	29.92	-	-	13.26	13.12	12.69	18.12	11.19	16.96	15.27	15.52
ADQH186	T0101(5)a-26	3	1	-	-	-	10.19	-	12.61	15.41	-	-	13.62	-
ADQH1719	T0101(5)a-98	3	0	-	-	-	8.95	-	11.63	14.77	-	-	13.03	-
ADQH513	T0403F6-3	2	0	-	-	-	-	11.17	-	-	10.05	16.14	-	-
ADQH514	T0303(5)a-13	2	0	-	-	-	-	10.33	-	-	11.10	17.25	-	-
ADQH941	T0102H2(1)BGL-28	1	0	26.74	12.32	12.67	12.27	11.59	11.29	17.58	10.73	-	14.35	13.93
ADQH942	T0102H2(1)-26	3	0	28.88	12.66	14.43	13.38	12.92	11.96	-	10.53	15.27	-	-
ADQH1181	T0302(5)b-103	2	0	28.66	13.82	14.27	12.89	12.80	12.35	18.00	11.59	17.67	15.10	15.21
SNSZ1597	T0310(4)-1	2.00	0.00	22.69	11.04	-	-	10.25	-	-	11.66	15.43	-	13.70
SNSZ1598	T0209H37-1	2.00	0.00	-	13.13	11.91	10.68	-	10.83	14.70	-	14.65	13.53	10.30
SNSZ1599	IT0309H113(1)-2	1.00	0.00	23.30	11.67	10.49	10.83	10.80	11.63	15.47	11.24	15.41	13.43	13.56
A1065	T0405(3)	1.00	0.00	27.16	12.15	13.20	12.57	12.52	13.36	18.20	13.14	18.04	16.14	16.35
A1924	T0405F4XBJD	2.00	0.00	25.37	10.96	13.86	12.32	11.77	11.82	17.33	10.52	16.56	14.18	14.09
A1301	T0806(4)	1.00	0.00	-	-	-	11.69	-	13.14	17.75	-	-	15.02	-
A858	T0405F4CCS	1.00	0.00	31.17	14.34	16.20	14.58	14.25	13.05	19.60	12.35	19.27	16.89	17.02
A927	T0405F4CCS	2.00	0.00	28.26	12.77	13.18	13.01	12.73	12.60	17.70	11.89	17.16	15.02	15.03

A926	T0405F4CCS	1.00	0.00	-	12.13	13.86	-	13.05	-	18.35	12.04	17.81	15.73	15.56
A928	T0405F4CCS	1.00	0.00	24.92	10.97	12.78	11.96	11.56	12.04	16.69	11.57	16.38	14.26	14.23
A850	T0405F4CCS	1.00	0.00	22.64	10.90	10.25	10.53	10.32	11.28	15.46	10.96	15.38	13.36	13.59
A868	T0405F4CCS	2.00	0.00	27.03	13.01	12.21	13.04	11.78	13.35	19.08	11.71	17.91	16.09	16.11
SBDZ-45/46-2	SBDZ-45/46-2	1.00	0.00	25.95	12.05	12.44	12.29	11.30	13.89	-	12.85	19.20	17.70	17.26

***SC (Surface Condition):**

1: the surface of the bone smooth to lightly eroded with cut marks can be observed;

2: most of the surface lost and normal cut marks cannot be seen apart from very large ones (average);

3: the bone appears porous and amorphous (poor).

***Burning:**

0: no traces of burning were observed

1: lightly burnt appearing light traces of burning

2: medium burnt appearing charred or carbonized

3: heavily burnt appearing grey and calcinations

Bd, DBV, DpBV, 1, 2, 3, 4, 5, 6, 7, 8 are measurements taken on metacarpal specimens. See the explanations of these specimens in Figure 6.13, Chapter 6, volume 1 of the dissertation.

B. Score Values of the Osteoscopic Characters (C1-C3) of Specimens from Andaqiha, Jinchankou, and Sanbadongzi and Identification (ID) Based on Them

Specimen No.	C1		C2		C3		ID
	Score	ID	score	ID	score	ID	
ADQH43	1	P/Cpc/N/Ch/O	3	Ch/O	1	P/G/O	O
ADQH44	1	P/Cpc/N/Ch/O	3	Ch/O	2	P/Ch/O	O/Ch
ADQH46	-	-	2	P/Cpc/N/O	3	Cpc/N/Ch/O	Cpc/N/O
ADQH186	2	P/Cpc/N/Ch/O	3	Ch/O	1	P/G/O	O
ADQH1181	1	P/Cpc/N/Ch/O	3	Ch/O	1	P/G/O	O
A1065	1	P/Cpc/N/Ch/O	3	Ch/O	2	P/Ch/O	Ch/O
A1924	3	N/Ch/G	2	P/Cpc/N/O	2	P/Ch/O	-
A858	2	P/Cpc/N/Ch/O	2	P/Cpc/N/O	2	P/Ch/O	P/O
A927	1	P/Cpc/N/Ch/O	3	Ch/O	2	P/Ch/O	Ch/O
A926	1	P/Cpc/N/Ch/O	3	Ch/O	3	Cpc/N/Ch/O	Ch/O
A928	2	P/Cpc/N/Ch/O	3	Ch/O	2	P/Ch/O	Ch/O
A868	1	P/Cpc/N/Ch/O	3	Ch/O	2	P/Ch/O	Ch/O
SBDZ-45/46-2	2	P/Cpc/N/Ch/O	3	Ch/O	3	Cpc/N/Ch/O	Ch/O

C1, C2, C3, C4 are the scored characters of the metacarpal specimens. See explanation of these characters in Figure 6.16-Figure 6.18, Chapter 6, volume 1 of this dissertation.

The identification (ID) in the last column is the parsimonious one made considering the overlapping taxa of all three identifications before. O: *Ovis,* P: *Pseudois,* Ch: *Capra hircus,* G: *Gazella/Procapra;* N: *Nemorhaedus;* Cpc: *Capricornis*

C. Metric Data of the Specimens from Andaqiha, Shannashuzha, Jinchankou, and Sanbadongzi.

	DBV/DpBV*	3/4*	5/6*	1/3*	2/5*
ADQH43	1.01	0.66	0.69	1.13	1.12
ADQH44	1.05	0.69	-	1.10	1.14
ADQH46	1.00	0.68	0.62	1.07	1.19
ADQH47	-	0.70	0.66	1.04	1.17
ADQH186	-	0.82	-	0.81	
ADQH1719	-	0.79	-	0.77	
ADQH513	-	-	0.62	-	1.11
ADQH514	-	-	0.64	-	0.93
ADQH941	0.97	0.64	-	1.09	1.08
ADQH942	0.88	-	0.69	1.12	1.23
ADQH1181	0.97	0.69	0.66	1.04	1.10
SNSZ1597	-	-	0.76	-	0.88
SNSZ1598	1.10	0.74	-	0.99	-
SNSZ1599	1.11	0.75	0.73	0.93	0.96
A1065	0.92	0.73	0.73	0.94	0.95
A1924	0.79	0.68	0.64	1.04	1.12
A1301	-	0.74	-	0.89	
A858	0.89	0.67	0.64	1.12	1.15
A927	0.97	0.71	0.69	1.03	1.07
A926	0.88	-	0.68	-	1.08
A928	0.86	0.72	0.71	0.99	1.00
A850	1.06	0.73	0.71	0.93	0.94
A868	1.07	0.70	0.65	0.98	1.01
SBDZ-45/46-2	0.97	-	0.67	0.88	0.88

***DBV/DpBV, 3/4, 5/6, 1/3, 2/5 are ratios of pairs of measurements taken on metacarpal specimens. See explanation of the measurements in Figure 6.13, Chapter 6, volume 1 of this dissertation.**

D. Values of the Osteometrics and Identification (ID) Based on Them for Andaqiha and Jinchankou specimens

Specimen	DBV/DpBV		3/4		5/6		1/3		2/5		7/4		8/6		ID
	Value	ID	Value	ID	Value	ID	Value	ID	Value	ID	Value	ID	Value	ID	
ADQH43	1.01	P/O/N/Cpc/G	0.66	O/Cpc/N/P/	0.69	O/N	1.13	N/P/O	1.12	O	0.87	N/Cpc/G/O/P/Ch	0.88	G/O/Cpc/P/Ch	O
ADQH44	1.05	O/N/Cpc/G	-	-	-	-	1.10	Cpc/N/P/O	-	-	-	-	-	-	O/N/Cpc
ADQH46	1.00	P/O/N/Cpc/G	0.68	O/N/P	0.62	O/N/P/Ch	1.07	N/P/O	1.19	Ch/N/Cpc/P	0.86	N/G/Cpc/O/P	0.87	N/G/O/Cpc/P/Ch	N/P
ADQH47	-	-	0.70	O/N/P	0.66	O/Cpc/N/P	1.04	N/P/O	1.17	Ch/Cpc/N/P	0.84	N/Cpc/G/O/P/Ch	0.92	N/G/O/Cpc	N
ADQH186	-	-	0.82	Cpc	-	-	0.81	G	-	-	0.88	N/G/Cpc/O	-	-	-
ADQG1719	-	-	0.79	Cpc	-	-	0.77	G	-	-	0.88	N/G/Cpc/O	-	-	-
ADQH513	-	-	-	-	0.62	O/Cpc/N/P/Ch	-	-	1.11	Ch/Cpc/N/P/O	-	-	-	-	O/Cpc/N/P
ADQH514	-	-	-	-	0.64	O/Cpc/N/P/Ch	-	-	0.93	O	-	-	-	-	O/Cpc/N/P/Ch
ADQH941	0.97	P/O/N	0.64	O/Cpc/N/P/Ch	-	-	1.09	Cpc/N/P/O	1.08	Ch/Cpc/N/P/O	0.82	N/G/O/P/Ch	-	-	O/N/P
ADQH942	0.88	Ch/O	-	-	0.69	O/N	1.12	Cpc/N/P/O	1.23	Cpc/N/P	-	-	-	-	-
ADQH1181	0.97	P/O/N	0.69	O/N/P	0.66	O/Cpc/N/P	1.04	N/P/O	1.10	Ch/Cpc/N/P/O	0.84	N/Cpc/G/O/P/Ch	0.86	G/O/Cpc/P/Ch	O/P
A1924	0.79	Ch	0.68	O/N/P	0.64	O/Cpc/N/P/Ch	1.04	N/P/O	1.12	Ch/Cpc/N/P/O	0.82	N/G/O/P/Ch	0.85	G/O/Cpc/P/Ch	-

DBV/DpBV, 3/4, 5/6, 1/3, 2/5, 7/4, 8/6 are ratios of pairs of measurements taken on metacarpal specimens. See explanation of the measurements in Figure 6.13, Chapter 6, volume 1 of this dissertation.The identification (ID) in the last column is the parsimonious one made considering the overlapping taxa of the identifications of the 7 different ratios.

Specimen numbers starting with 'ADQH' are from the site of Andaqiha; those starting with 'SNSZ' are from the site of Shannashuzha;those starting with 'A' are from the site of Jinchankou, and those starting with 'SBDZ' are from the site Sanbadongzi.

Appendix X Basic Data of Metatarsal Specimens from Archaeological Sites

A. Taphonomic Information and Metric Data of Archaeological Specimens from Andaqiha and Jinchankou.

Context Number	Specimen Number	SC*	*Burning	Bd	DBV	DpBV	1	2	3	4	5	6	7	8
T0101(5)b-54	ADQH289	2	1	23.89	10.59	10.89	11.16	10.61	10.97	-	10.35	14.75	13.07	12.80
T0303F2(2)-2	ADQH509	2	1	23.52	11.17	11.51	11.12	11.46	13.15	17.50	11.84	17.04	15.45	15.15
T0302(5)b(2)-18	ADQH505	1	0	23.30	11.48	12.00	11.05	11.92	12.88	18.20	12.11	17.98	15.89	15.97
T0403F2(2)-18	ADQHF2(2)-18	-	-	24.44	11.23	11.46	11.08	10.60	10.02	16.69	9.72	16.02	13.38	13.57
T0404F17-15	ADQH510	2	0	-	-	-	13.14	-	11.57	16.70	-	-	15.31	-
T0403(5)b-4	ADQH511	1	0	-	-	-	10.63	-	11.73	16.21	-	-	13.67	-
T0302(5)b(2)-21	ADQH1718	3	0	-	-	-	9.75	-	11.53	14.70	-	-	13.30	-
T0302(5)b-104	ADQH1182	2	0	26.63	12.06	13.03	12.19	11.88	12.32	-	11.46	-	15.25	14.90
T0303F2(1)-117	ADQH1240	1	0	26.27	12.22	12.60	11.95	11.53	11.78	18.16	11.21	17.20	14.78	14.39
HJ12 F3	A1716	1	0	25.58	12.09	13.25	11.99	11.04	11.05	18.33	10.31	17.61	14.67	14.40
T0405F4-XBJD	A1925	1	0	24.43	11.22	13.38	11.68	10.84	12.12	17.54	10.83	16.64	14.26	14.49
T0906F3(1)	A1571	1	0	25.01	11.86	12.55	12.07	10.78	12.46	17.97	11.25	17.07	15.01	15.28
T1103F2-MQCD	A2081	2	0	22.24	10.59	11.50	10.71	9.26	11.43	16.71	10.52	-	14.30	13.68
F3-XCFZ	A2068	2	0	26.08	11.67	11.97	12.31	11.92	12.14	18.54	11.65	-	14.78	14.73
T0405F4-CCS	A811	1	0	28.66	13.43	14.33	13.46	12.27	12.97	19.53	11.73	18.08	16.04	16.00
T0405F4-CCS	A925	1	0	25.98	12.24	12.31	12.39	11.44	12.30	17.73	-	-	14.32	-

***SC (Surface Condition):**

1: the surface of the bone smooth to lightly eroded with cut marks can be observed;

2: most of the surface lost and normal cut marks cannot be seen apart from very large ones (average);

3: the bone appears porous and amorphous (poor).

***Burning:**

0: no traces of burning were observed

1: lightly burnt appearing light traces of burning

2: medium burnt appearing charred or carbonized

3: heavily burnt appearing grey and calcinations

DBV/DpBV, 3/4, 5/6, 1/3, 2/5, 7/4, 8/6 are ratios of pairs of measurements taken on metatarsal specimens. See explanation of the measurements in Figure 6.13, Chapter 6, volume 1 of this dissertation.

B. Metric Data of the Specimens from Andaqiha and Jinchankou, and identification (ID) based on Them

Specimen No.	DBV/DpBV*		1/3*		2/5*		3/4*		5/6*		ID*
	Value	ID	Value	ID	Value	ID	Value	ID	Value	ID	
ADQH289	0.97	Cpc/N/O/P	1.02	P/O	1.03	P/O	-	-	0.70	G	-
ADQH510	-	-	1.14	Ch/Cpc/N/P/O	-	-	0.69	G/O	-	-	O
ADQH511	-	-	0.91	O	-	-	0.72	G/O	-	-	O
ADQH1718	-	-	0.85	G	-	-	0.78	-	-	-	G
ADQH1182	0.93	Cpc/O/P	0.99	P/O	1.04	Ch/P/O	-	-	-	-	P/O
A2081	0.92	Cpc/O/P	0.94	O	0.88	O/G	0.68	G/O/N	-	-	O
A2068	0.97	Cpc/O/P/N	1.01	P/O	1.02	P/O	0.65	O/Cpc/N/P/Ch	-	-	O/P
A925	0.99	N/O/P	1.01	P/O	-	-	0.69	G/O	-	-	O

***DBV/DpBV, 1/3, 2/5, 3/4, 5/6 are ratios of pairs of measurements taken on the metatarsal specimens. See the explanations of these measurements in Figure 6.13, Chapter 6, volume 1 of the dissertation.**

***The identification (ID) in the last column is the parsimonious one made considering the overlapping taxa of all five identifications before.**

C. Score values of the morphological characters (C1-C3) of specimens from Andaqiha and Jinchankou, and the taxonomic diagnosis (ID) based on Them

Specimen No.	C1*		C2*		C3*		ID*
	score	ID	score	ID	score	ID	
ADQH289	2	P/Cpc/N/Ch/G/O	3	P/Cpc/N/Ch/O	3	Cpc/N/Ch/O	Cpc/N/Ch/O
ADQH509	1	Cpc/N/Ch/O	3	P/Cpc/N/Ch/O	2	P/G/O	O
ADQH1182	1	Cpc/N/Ch/O	3	P/Cpc/N/Ch/O	2	P/G/O	O
A1716	3	P/N/Ch/G/O	3	P/Cpc/N/Ch/O	3	P/Cpc/N/Ch/O	P/Cpc/N/Ch/O
A1925	3	P/N/Ch/G/O	3	P/Cpc/N/Ch/O	2	P/Cpc/N/Ch/O/G	P/N/Ch/O
A1571	2	P/Cpc/N/Ch/O/G	3	P/Cpc/N/Ch/O	3	P/Cpc/N/Ch/O	P/Cpc/N/Ch/O
A2081	1	P/Cpc/N/Ch/O	2	P/G/O	2	P/Cpc/N/Ch/O/G	P/G/O
A2068	1	P/Cpc/N/Ch/O	3	P/Cpc/N/Ch/O	2	P/Cpc/N/Ch/O/G	P/Cpc/N/Ch/O
A811	1	P/Cpc/N/Ch/O	3	P/Cpc/N/Ch/O	2	P/Cpc/N/Ch/O/G	P/Cpc/N/Ch/O
A925	1	P/Cpc/N/Ch/O	3	P/Cpc/N/Ch/O	2	P/Cpc/N/Ch/O/G	P/Cpc/N/Ch/O

***C1, C2, C3 are the scored characters of the metatarsal specimens. See explanation of these characters in Figure 6.16-6.18, Chapter 6, volume 1 of this dissertation.**

The identification (ID) in the last column is the parsimonious one made considering the overlapping taxa of all five identifications before.
O: ***Ovis,*** **P:** ***Pseudois,*** **Ch:** ***Capra hircus,*** **G:** ***Gazella/Procapra;*** **N:** ***Nemorhaedus;*** **Cpc:** ***Capricornis.***

Specimen numbers starting with 'ADQH' are from the site of Andaqiha; those starting with 'SNSZ' are from the site of Shannashuzha;those starting with 'A' are from the site of Jinchankou, and those starting with 'SBDZ' are from the site Sanbadongzi.

Appendix Y Summary of Identifications on Humerus, Metacarpals, and Metatarsals from Archaeological Sites

A. Humerus

a. Andaqiha

	Surface Condition	Burning	LDA 1 ID	LDA 1 Probability	LDA 2	Götze 1998	Osteoscopic	Ratio	ID	Certainty
ADQH21	2	0	P	54.3	Ch	Ch/P	P	-	P	1
ADQH22	1	2	P	75.5	Ch	Ch/P	P	-	P	1
ADQH264	1	0	P	78.9	4	P	P	-	P	1
ADQH266	1	2	Ch	71.6	P	Ch/P	P	O/N/Ch/P	P	2
ADQH824	-	0	-	-	-	C/P	P	-	P	1
ADQH822	2	0	O	48.1	P	O	O/P	O	O	3
ADQH828	3	0	-	-	-	Ch/P/O	P	N/O/P/Ch	P	2
ADQH829	2	0	-	-	-	Ch/P/O	P	O/P/Ch	P	2
ADQH827	2	0	-	-	-	Ch/P	P	-	P	2
ADQH825	3	0	-	-	-	-	P	-	P	2
ADQH826	-	-	-	-	-	P	P	-	P	1
ADQH892	1	3	Ch	49.6	O	O	O/P	O/P/Ch	P	3
ADQH1203	2	-	N	95.5	Cpc	C.h	N	-	N	1
ADQH1224	1	-	Ch	58.9	O	O	O/P	O/P/Ch	O	2
ADQH1371	-	-	-	-	-	P	P	-	P	1

b. Jinchankou Sanbadongzi, Shannashuha

Specimen	Surface Condition	Burning	ID	LDA 1 Probability	LDA 2	Götze	Osteoscopic	ID	Certainty
A1061	1	0	O	0.68	G	O	O	O	1
A1026	2	0	O	0.88	C	O	O	O	2
A1918	1	0	O	0.50	C	O	O	O	1
A1709	1	0	Ch	0.68	O	O	O/P	O	1
A1028	1	0	N	0.99	Cpc	N	N	N	1
A1789	1	0	Ch	0.55	P	Ch/P	P/O	P	3
A1920	1	0	O	0.83	Ch	O	O/P	O	1
A1356	1	0	O	0.41	Ch	O	O	O	1
A918	1	0	O	0.93	Ch	O	O	O	1
A919	1	0	N	0.98	Cpc	N	N	N	1
SBDZ-49-2	2	0	O	0.86	P	Ch/P	O	O	2
SBDZ-49-3	1	0	G	1.00	O	O	O	O	1
SBDZ-49-4	1	0	O	0.87	Ch	O	O	O	1
SBDZ-49-1	1	0	Ch	0.53	O	O	O	O	1
SNSZ1561	1	0	P	0.68	Ch	Ch/P	P	P	1
SNSZ1562	2	0	-	-	-	O/Ch/P	N	N	2
SNSZ1563	1	0	N	0.96	Cpc	Ch/O/P	N	N	1
T0210H159	2	0	N	0.82	G	-	N	N	2
SNSZ1564	1	0	G	1.00	O	-	N	N	1
SNSZ1565	2	0	N	1.00	Cpc	-	N	N	2
SNSZ1566	2	0	N	0.97	Cpc	O	N	N	2
SNSZ1567	2	0	-	-	-	-	N	N	2
SNSZ1568	1	0	G	1.00	N	-	-	G	1

B. Metacarpals

Specimen	SC	Burning	LDA1		LDA2	Götze	Osteoscopic	Ratio	ID	Certainty
			ID	Prob						
ADQH43	2	1	N	0.87	O	P/O	O	O	O	2
ADQH44	2	1	-	-	-	-	O/Ch	O/N/Cpc	O	2
ADQH46	3	0	P	0.92	N	P/O	Cpc/N/O	N/P	P	2
ADQH47	2	1	-	-	-	P/O	N	N	N	2
ADQH186	3	1	-	-	-	O	O	-	O	3
ADQH1719	3	0	-	-	-	O	-	-	-	-
ADQH513	2	0	-	-	-	-	P/O	O/Cpc/N/P	O/P	2
ADQH514	2	0	-	-	-	-	P/O	O/Cpc/N/P/Ch	-	-
ADQH941	1	0	-	-	-	P/O	P/N	O/Cpc/N/P/Ch	P	2
ADQH942	3	0	-	-	-	-	P/O	-	O/P	2
ADQH1181	2	0	P	0.58	O	P/O	O	O/P	O/P	2
SNSZ1597	2	0	-	-	-	-	deer/N		deer/N	2
SNSZ1598	2	0	-	-	-	O	deer/N		deer/N	2
SNSZ1599	1	0	O	0.86	G	O	deer		deer	1
A1065	1	0	O	0.99	P	O	Ch/O		O	2
A1924	2	0	P	0.89	O	P/O	Ch/O/P		P/O/Ch	2
A1301	1	0	-	-	-	O	O		O	2
A858	1	0	P	0.96	Ch	P/O	P/O		P	2
A927	2	0	O	0.99	P	O	Ch/O		O	2
A926	1	0	-	-	-	-	Ch/O		O	1
A928	1	0	O	0.99	P	O	Ch/O		O	1
A850	1	0	O	0.99	G	O	O		O/G	1
A868	2	0	O	0.99	P	P/O	Ch/O		O	1

C. Metatarsals

Specimen	SC*	Burning	LDA1		LDA2	Götze	Osteoscopic	Ratio	ID	Certainty
			ID	Prob						
ADQH289	2	1	-	-	-	-	Cpc/N/Ch/O	-	N/P/O	2
ADQH509	2	1	G	0.81	N	O	O	G/O	G	2
ADQH505	1	0	N	0.99	G	O	deer	-	deer	1
ADQHF2(2)-18	-	-	P	0.97	O	O/P	deer	-	deer	2
ADQH510	2	0	-	-	-	O	O	O	O	3
ADQH511	1	0	-	-	-	O	O	O	O	3
ADQH1718	3	0	-	-	-	O	O/P	G	O/P/G	3
ADQH1182	2	0	-	-	-	-	O	O/P	O/P	2
ADQH1240	1	0	P	0.80	O	P/O	O/P	O/P	P	2
A1716	1	0	P	0.90	Ch	P/O	P	P	P	1
A1925	1	0	O	0.70	Ch	O	O	Ch/O	O	2
A1571	1	0	O	0.99	P	O	O	O	O	1
A2081	2	0	-	-	-	O	O	O	O	2
A2068	2	0	-	-	-	P/O	O	O/P	O	2
A811	1	0	O	0.99	P	O	O	O	O	1
A925	1	0	-	-	-	O	O	O	O	1

***SC(Surface Condition):**

1: the surface of the bone smooth to lightly eroded with cut marks can be observed;

2: most of the surface lost and normal cut marks cannot be seen apart from very large ones (average);

3: the bone appears porous and amorphous (poor).

Burning:

0: no traces of burning were observed

1: lightly burnt appearing light traces of burning,

2: medium burnt appearing charred or carbonized,

3: heavily burnt appearing grey and calcinations.

LDA 1: highest predicted assignation by linear discriminate analysis based on shape indices

LDA 2: second highest assignation by linear discriminate analysis based on shape indices

Götze 1998: the identification results made based on the metric criteria in Götze 1998

Osteoscopic: the identification results made based on the osteoscopic characters

Ratio: Identification based on different ratios in this study

ID: the current identification results considering the available evidence

O: *Ovis*,**P**: *Pseudois*, **Ch:** *Capra hircus*, **N:***Nemorhaedus.*

Certainty: the certainty of the current identification results: 1. Highly probable; 2. Probable/likely; 3. Possible/Uncertain

Specimen numbers starting with ‘ADQH’ are from the site of Andaqiha; those starting with ‘SNSZ’ are from the site of Shannashuzha;those starting with ‘A’ are from the site of Jinchankou, and those starting with ‘SBDZ’ are from the site Sanbadongzi.

Appendix Z Preliminary Identification Results of the Other Elements in Archaeological Sites

Check Teeth

Specimen	Taxa	
	Pseudois/Nemorhaedus/Ovis	***Ovis/C. hircus***
Andaqiha	24	-
Sanbadongzi	-	1

Distal scapula

Specimen	Taxa			
	Pseudois	***Ovis***	***Nemorhaedus***	***Capricornis***
Andaqiha	6	3	1	-
Shannashuzha	2	-	7	-
Jinchankou	1	1	-	1
Sanbadongzi	-	-	-	-

Proximal Radius

Specimen	Taxa			
	Pseudois	*Ovis*	*Nemorhaedus*	*Pseudois/Ovis/Nemorhaedus*
Andaqiha	24	6	-	8
Shannashuzha	-	-	1	1
Jinchankou	2	-	-	4

Proximal femur

Specimen	Taxa			
	Pseudois	*Ovis*	*Ovis/P*	*Gazella/Procapra*
Andaqiha	1	2	3	6
Shannashuzha	1	-	-	-
Jinchankou	-	1	-	-

Distal tibia

Specimen	Taxa			
	Pseudois	*Ovis*	*Nemorhaedus*	*Procapra/Gazella*
Andaqiha	8	8	2	-
Shannashuzha	1	-	2	-
Jinchankou	1	4	-	-

First phalanges

Specimen	Taxa			
	Pseudois	*Ovis*	*Nemorhaedus*	*Procapra/Gazella*
Andaqiha	13	5	-	1
Shannashuzha	0	0	0	0
Jinchankou	1	3	-	-