# Zooarchaeology of the Pre-Pottery and Pottery Neolithic site of Qasr-e Ahmad (Iran)

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# ARCHAEOZOOLOGY OF THE NEAR EAST XII

Proceedings of the 12th International Symposium of the ICAZ Archaeozoology of Southwest Asia and Adjacent Areas Working Group, Groningen Institute of Archaeology, June 14-15 2015, University of Groningen, the Netherlands


Edited by

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Photo cover: Ceramic vessel from Late Neolithic Köşk Höyük depicting a scene of equid (hydruntine) hunting (photo by A.Öztan). See Chapter 4.



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# Preface

by the editors

We grew up in the ASWA Working Group. We were in our early 20s, still doing our MAs or fresh graduates when we attended our first ASWA meeting. ASWA was first a school; a place where, for the first time, we had the opportunity to have a drink or two with the great scientists we knew from publications, but wondered what they looked like, how they acted, and whether they would mind answering couple of questions. ASWA quickly became a platform where we could present our own research, participate in debates with peers, and expand our scholarly network. At some point ASWA became a place to meet good friends, discuss research plans with close colleagues, and initiate new collaborations. When we got our first positions, it was only 'natural' that we all came up with the idea to host a meeting at our respective home institutions at about the same time in early 2013. One of us (CC) had the most urgent 'excuse': Dr. Hijlke Buitenhuis, one of the founders of ASWA Working Group, was to officially retire in 2015 –a perfect moment to celebrate this most dedicated scholar of archaeology of Southwest Asia and bring the bi-annual meeting back to its birthplace exactly 25 years after it was started by Hijlke and his mentor Prof. Dr. Anneke Clason.

This is the short story of how the 12th Meeting of the International Council of Archaeozoology (ICAZ) Archaeozoology of Southwest Asia and Adjacent Areas Working Group came to be. The months leading up to the meeting were thrilling. We received so many abstract submissions, mostly for oral presentations, that we had to introduce a session with 3-minute 'lightning' session alongside the poster session in order to maintain ASWA's (implicit) policy of inclusivity. ASWA meetings are for everyone; this includes early-stage students, independent scholars, and retired experts. In the days and weeks before the meeting, colleagues from as far as the US made last-minute calls to register just so that they could attend the meeting without presentations. Student volunteers and GIA staff came to the rescue. We now appreciate the meaning of the presumed cliché "would not have been possible without" more than ever: Yes, none of it would have been possible without the help of student volunteers, Francesca Slim and Rianne Breider; volunteer Joris Oddens; and GIA-zooarchaeology assistants Youri van den Hurk and the magnificent Esther Scheele.

We received generous funds from the Groningen Institute of Archaeology (and actually still do) and from the Archéorient, as well as BETA Analytics. With these funds and the help of participation fees, we were able to offer financial aid to a number of student and early-career scientist presenters especially from Southwest Asia.

In a large number of sessions, including a lightning and a poster session, in three days, we discussed a huge variety of topics pertaining to humans and other animals in ancient Southwest Asia and beyond. We were enlightened by a talk by Dr. Wietske Prummel, Emeritus, Groningen Institute of Archaeology, about the archaeozoology of terps and the northern Netherlands. The most outstanding and perhaps the most important in terms of ASWA's sustainability was the final round table on the future of work in the troubled, war-torn region, which was the brainchild of Jwana Chahoud. Here, the challenges ahead were openly discussed and recorded (also see Zeder, this volume).

We visited the GIA zooarchaeology collections, escaped to the town's market during lunch for some fried cod and mussels, 'borreled' in the Dutch style, and celebrated Hijlke's lifetime achievements. Some of us stayed longer and joined the excursion to megalithic tombs and a prehistoric village in Drenthe (Thanks also to our drivers on the excursion; Dr. Nimrod Marom and Christian Küchelmann).

We were honored to organize the 12th ASWA meeting, and we are honored to present the Proceedings herein, also sponsored by the Groningen Institute of Archaeology and supported by its staff. Esther Scheele, Youri van den Hurk, and Francis Koolstra helped with the copy-editing, Siebe Boersma handled the design and the layout. We thank them all for their fantastic and flawless work. All contributions have been peer-reviewed by at least two anonymous reviewers.

Canan Çakırlar, Remi Berthon, Jwana Chahoud, and Suzanne Pilaar Birch

# Hijlke Buitenhuis and ASWA

## Archaeozoologist and archaeologist

The palaeontologist Bert Boekschoten introduced Hijlke Buitenhuis to Anneke Clason in 1974. At that time Hijlke was a student in biology, with an interest in archaeozoology. He was immediately sent to the excavation of Tell Hadidi, a Bronze Age tell in Syria to study the archaeozoological material. While there, he collected skeletons for the archaeozoological reference collection of the then Biologisch-Archaeologisch Instituut (BAI), now the Groningen Institute of Archaeology (GIA). Hijlke published the results of his Tell Hadidi research in his master's thesis in biology. After finishing his degree in biology, he started his PhD research on the archaeozoological material from a large number of excavations along the Middle-Euphrates in Southeast Turkey and North Syria, dating to the period 10.000 BP till AD 1400. Hijlke was awarded his Dr. title in 1988.

After he became a doctor he got a job as an archaeozoologist at the Archaeological Research Centre (ARC), which was at first connected to the University of Groningen and later became an independent archaeological company. At the ARC, Hijlke studied archaeozoological material from many Dutch sites including rescue excavations conducted before the construction of the *Betuwelijn*, the rail freight connection between Rotterdam harbour and the German rail freight system. Because archaeozoological work was not always available, Hijlke developed a new skill: a specialization in coring. He developed himself to a qualified KNA-senior prospector (KNA is the quality system for people working in Dutch archaeology).

Although his job was in Dutch archaeology and archaeozoology, Hijlke continued his archaeozoological work in the Near East with a never-dying enthusiasm. He saved up all his holidays and travelled to Turkey each summer to participate in archaeological excavations as an archaeozoologist. His work in Turkey is focused on the Neolithisation of two areas; the Sea of Marmara, based on his work at several sites excavated by the Dutch Institute in Turkey (NIT) and Central Anatolia, at well-known sites such as Aşıklı and Güvercinkayası excavated by the Istanbul University. Hijlke's involvement with the archaeozoology of Anatolian Neolithic is ever growing, with new collaborations with University of Arizona and Munich among several others, with special emphasis on sheep and goat domestication and the westward dispersal of domestic animals through Central and western Anatolia. His work on Neolithisation and domestication in Turkey is recognized and celebrated worldwide.

Hijlke was among the founders of the Archaeozoology of Southwest Asia and Adjacent Areas working group of the International Council of Archaeozoology in 1990. He hosted, together with Anneke Clason, the first ASWA meeting in Groningen in 1992. He co-edited seven ASWA proceedings since then.

Although he never held an official teaching position, Hijlke has supervised several BA, MA and PhD theses in Groningen and Leiden, and trained Turkish students in archaeozoology. Hijlke became an official affiliate of the Groningen Institute of Archaeology in 2013. His contribution to the formation of the GIA zooarchaeology collections is immense, with more than 100 skeletons from Turkey and Syria. He is currently busy with digitizing part of the collection, for use at fieldwork specifically in the Near East.

Hijlke's activities in archaeology and archaeozoology are represented in this very large and diverse bibliography. Hijlke's research activities will not seize now that he reached his 65$^{th}$ birthday. He will continue and his list of publication will increase!

June 2015

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# 3 Zooarchaeology of the Pre-Pottery and Pottery Neolithic site of Qasr-e Ahmad (Iran)

Kamjan Safoora[1], Mashkour Marjan[2], Mohaseb F. Azadeh[2], Fathi Homa[3], Azizi Kharanaghi Hossein[4]

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## Abstract

The zooarchaeological study of the Neolithic site of Qasr-e Ahmad in Fars Province (southern Zagros, Iran) provides valuable evidence for a better understanding of the process of caprine domestication and dispersal in Southwest Asia.

Goat was the most commonly exploited animal in Qasr-e Ahmad during both phases of prehistoric settlement (Pre-Pottery Neolithic and Pottery Neolithic). Sheep were also present but represent a limited contribution to the subsistence economy at the site. Limited osteometric data from sheep suggest that they were already domesticated at the site, which is earlier than hitherto suggested for the region. Kill-off and osteometric data indicate that the majority of goats and sheep were managed using strategies known at other later sites in the region. Cattle and pig were not domesticated and were not regularly exploited. The location of the site next to the Qara Aqhaj permanent river, the presence of architectural remains in the PPN phases of the site, as well as the abundance of lithic tools indicate pastoral and agricultural components in the Qasr-e Ahmad subsistence economy.

## Keywords

Pre-Pottery Neolithic, Pottery Neolithic, Zagros, domestication, goat, sheep, secondary products, milk

## Introduction

Several studies since the mid-60s have suggested that the Zagros highlands were the natural habitat and domestication center for goats (Hole *et al.* 1969; Flannery 1969; Bökönyi 1977; Hesse 1978). Recent re-examinations of previously excavated faunal assemblages and recent investigations in the Zagros mountains highlighted the importance of this region for the initial domestication of cereals and caprines (Zeder and Hesse 2000; Zeder 2008; Matthews *et al.* 2010; Riehl *et al.* 2013; Moradi *et al.* 2016). From 8000 BC onwards, Neolithic communities dispersed from this region towards the eastern periphery of the Fertile Crescent (Broushaki *et al.* 2016). Work at various sites in southern Zagros, such as the recently excavated site of Kelek Asad Morad (Luristan) (Moradi *et al.* 2016) or Ali Kosh (Hole 1962; Zeder 2008), and further south in the Fars region, such as Mushki (Mashkour *et al.* 2006) and Rahmat Abad (Davoudi *et al.* in prep), together with the first Neolithic communities, shed light on the introduction of managed goats to southern Zagros. It seems, however, that the first domesticated sheep arrived in Zagros some time later, around 7000 BC, as shown by the Pottery Neolithic assemblages of Tepe Guran, Sarab, and Jarmo (Zeder 2008).

In this paper we present the archaeozoological results from Qasr-e Ahmad in Fars province, recently excavated by H. Azizi Kharanaghi, (Fig. 1), where the transition between the Pre-Pottery and Pottery Neolithic – (from now on PPN and PN) can be traced through the material culture and bioarchaeological data (Azizi Kharanaghi *et al.* 2012; Tenberg and Azizi Kharanaghi 2016), and address two questions:

1) Which species were exploited in southwest Zagros during both phases of the Neolithic (PPN and PN);
2) what was the domestication status of these animals, in particular the small and large ungulates?


**Fig. 1.** Location of the archaeological sites mentioned in the text.

**Fig. 2.** A view of Qasr-e Ahmad along the Qara Aghaj River.

## The site

Qasr-e Ahmad is located along the Qara Aqhaj River near the village of Kavar in Fars province (Fig. 2). In 2003 a survey was conducted at the site by Kamyar Abdi and Reinhard Bernbeck to further archaeological investigations. For more precision on the absolute chronology of the site, a program of radiocarbon dating was initiated by M. Mashkour, H. Azizi Kharanaghi and A. Zazzo[1]. The radiocarbon dating of a sheep bone from this survey operation provided a date around 7900 BP (end of the 8th mill. BC-1st quarter of the 7th mill. cal. BC) (Mashkour unpublished data), drawing attention to the importance of this Early Neolithic settlement (Bernbeck *et al.* 2006). Unfortunately, as a result of recent bulldozing for irrigation and agricultural activities, the preserved evidence at the site only dates from the Neolithic period (Ibid.).

In winter 2011, the site was excavated during one campaign by H. Azizi Kharanaghi. The site covers an area of ca. 6.5 ha and stands at 1,515 m above sea level. Three trenches were excavated. Trench A (4x2 m) is located in the center of the mound. Trench B (2x2 m) is located in the eastern part of the site. Trench C is a one-meter-wide step trench on the northern slope of the mound (Azizi Kharanaghi *et al.* 2012).

1 Qasr-e Ahmad radiocarbon dates were performed by Antoine Zazzo at the Natural History Museum of Paris $C^{14}$ laboratory and supported by the personal grant of Marjan Mashkour (UMR 7209 CNRS/MNHN) and will be soon published in the complete excavation report.

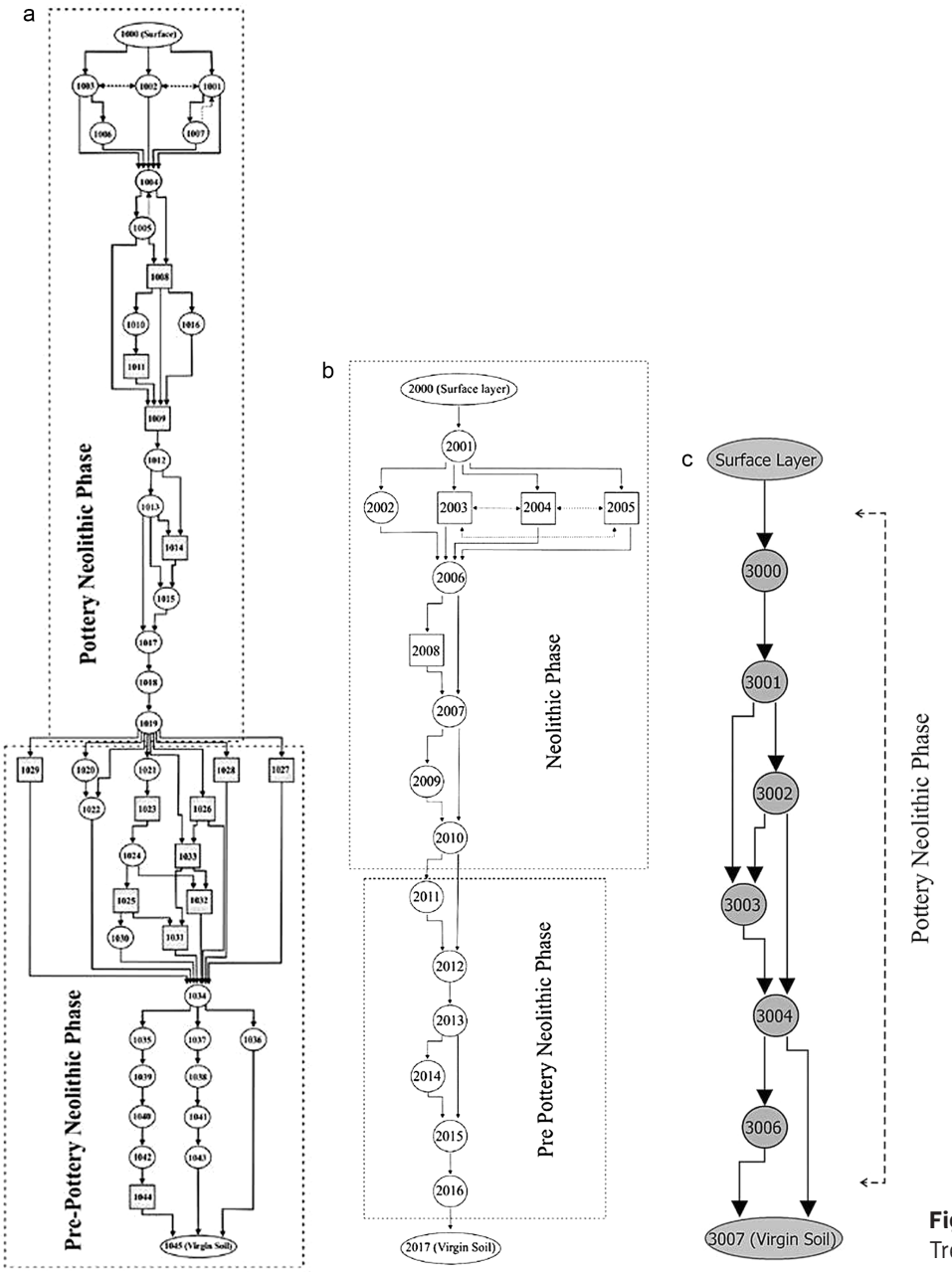


**Fig. 3.** Harris Matrix diagram of Trenches A (a), B (b), and C (c).

Among the 45 contexts from Trench A, 20 contexts belong to the Pottery Neolithic period (PN) and the rest to the Pre-Pottery Neolithic Period (PPN). Twelve out of 18 contexts in Trench B are attributed to the PPN. All seven contexts of Trench C belong to the PN. The PPN phase is situated immediately below the Pottery Neolithic phase, seemingly without any interruption (Figs. 3a, b, and c). The PPN and PN phases in the Fars region can respectively be dated to around the mid-8$^{th}$ and mid-7$^{th}$ millennia BC (Ibid.). The potteries from Qasr-e Ahmad are different from the other Neolithic sites in the Marvdasht Plain in terms of form and decoration. They can be divided to two phases: The earlier phase, which is represented by simple red ware bowls (formative mushki) and the later phase with potteries decorated with geometric motifs.

## Neolithic subsistence economies in Southern Zagros

Evidence for Neolithic subsistence practices is limited in southern Zagros, particularly in the Fars province. A research gap is evident between the PPN sites from the mid-8$^{th}$ mill BC and the PN sites of the late 7$^{th}$ and 6$^{th}$ mill BC (Weeks 2013). Archaeozoological studies are very rare. Except for Tang-e Bolaghi, (Hongo and Mashkour 2008), Arsanjan A5 Cave (Mashkour and Khazaeli 2012 unpublished report) and the PPN and PN sites of Tal- i Mushki, Jari A and B (Payne 1991; Mashkour *et al.* 2006), Tol-e Nurabad (Mashkour 2009), Tol-e Bashi (Mashkour and Bailon 2010) and Rahmat Abad (Davoudi *et al.* in prep), there is no other available material for understanding the prehistoric subsistence economy in this area. However, the strategic position of the Zagros region, between the Fertile

**Table I.** Faunal spectra of Qasr-e Ahmad by means of Number of Remains.

| *Taxa* | *NR* | *Weight (g)* | *NR%* | *Weight%* |
|---|---|---|---|---|
| *Bos* cf. *Primigenius* (cattle/aurochs) | 17 | 656 | 0.9 | 7.8 |
| *Capra hircus* (goat) | 292 | 2025 | 16.3 | 24.1 |
| *Capra* cf. *aegagrus* (goat/wild goat) | 28 | 364 | 1.6 | 4.3 |
| *Ovis* cf. *aries* (sheep/wild sheep) | 31 | 328 | 1.7 | 3.9 |
| Caprinae (sheep/goat) | 1369 | 4901 | 76.4 | 58.3 |
| *Gazella subgutturosa* (goitered gazelle) | 4 | 13 | 0.2 | 0.2 |
| *Sus scrofa* (wild boar) | 7 | 49 | 0.4 | 0.6 |
| *Lepus capensis* (hare) | 2 | 2 | 0.1 | 0 |
| Rodentia | 11 | 1 | 0.6 | 0 |
| *Alectoris chukar* (chukar partridge) | 4 | 3 | 0.2 | 0 |
| *Testudo graeca* (spur-thighed tortoise) | 19 | 51 | 1.1 | 0.6 |
| Mollusk | 8 | 16 | 0.4 | 0.2 |
| **Total Identified taxa** | **1792** | **8409** | **27** | **45** |
| Large Mammal | 10 | 54 | 0.2 | 0.3 |
| Medium Mammal | 9 | 86 | 0.0 | 0.5 |
| Small Ruminants | 4741 | 10057 | 71.2 | 53.7 |
| Unidentified | 107 | 126 | 1.6 | 0.7 |
| **Total Unidentified** | **4867** | **10323** | **73** | **55** |
| **Grand Total** | **6659** | **18732** | **100** | **100** |

**Table 2.** Taphonomic summary of the vertebrate remains.

| *Taphonomic traces* | *PPN* | *PN* |
|---|---|---|
| Burnt fragments | 19% | 21% |
| Cut and chop marks | 2% | 1.6% |
| Tool manufacturing traces | 0.3% | 0.3% |
| Carnivore punctures | 0.4% | 1.7% |
| Rodent gnawing marks | 0.2% | 0.06% |

Crescent and the Indus valley, which are important zones for early domestication (Hongo and Mashkour 2008), makes Qasr-e Ahmad an interesting site for studying the domestication process of caprines.

The region of Qasr-e Ahmad is located in lowlands surrounded by piedmonts where we expect to find small and medium-sized wild ungulates such as wild sheep (*Ovis orientalis*), wild goat (*Capra aegagrus*), gazelles (*Gazella subgutturosa*), and wild boar (*Sus scrofa*) in a variety of ecotones (Ziaei 1996; Etemad 1985). Among the large herbivores, hemiones (*Equus hemionus*) and red or fallow deer (*Cervus elaphus/Dama mesopotamica*) can also live in this region. We could expect bird species to be exploited on account of the well-watered basin around Persepolis and Pasargadae (Djamali *et al.* 2009). Botanical studies (performed at the Archaeometry Laboratory of Tehran University) suggest warm and wet conditions in Qasr-e Ahmad with steppe vegetation, open tree and shrub growth. The assemblage provides evidence for both wild and domesticated wheat and barley, as well as wild/weedy-growing plants and fruits (mainly pistachio) (G, Ahadi, University of Tübingen personal communication).

## Methods

The faunal assemblage for this study was collected by hand. The remains were analysed at the Archaeometry Laboratory of Tehran University in 2014. The osteological reference collection of the laboratory was used, including wild and domestic herbivores present in the region of study, as well as anatomical and osteological atlases (Barone 1986; Pales and Garcia 1981; Boessneck *et al.* 1964; Clutton-Brock *et al.* 1990; Zeder and Lapham 2010; Halstead *et al.* 2002). In this study, all the faunal remains were counted and weighed to the nearest 0.1 g. Due to the high level of fragmentation, the NR (Number of Remains) is used as the basis of quantification. The specimens were measured following the protocol suggested by Von den Driesch (1976).

In order to address the question of the wild or domestic status of caprines, size indexing and the normalizing method following Meadow (1999), improved from Uerpmann (1979) were carried out. The standard measurements are based on the measurements of Field Museum wild goats (*Capra aegagrus*) and wild sheep (*Ovis orientalis*) published in Uerpmann and Uerpmann (1994).

Another proxy for approaching the question of domestication, as demonstrated by Helmer (1992), and Zeder and Hesse (2000), is the use of kill-off patterns. Here we used the tooth wear method based on Payne (1973) with further developments introduced by Helmer (1992; 1995; 2000a; 2000b), Helmer and Vigne (2004) and Vigne and Helmer (2007). The fusion data were obtained from Zeder 2006. The survivorship of sheep and goats based on their long-bone fusion stage is assessed following Zeder (2006).

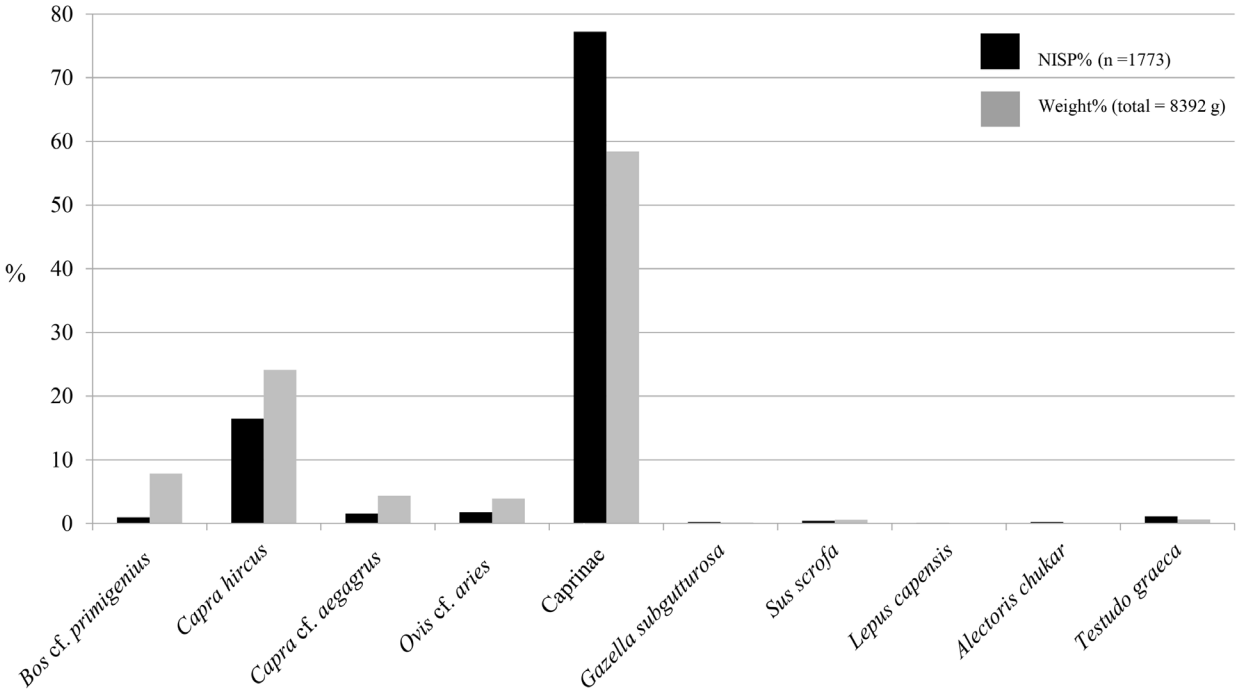


**Fig. 4.** Distribution of identified species by means of NISP percentage (Number of Identified Specimens).

## Results

Nearly 7,000 specimens (NR) were studied (Table 1), out of which only 27% could be identified to the species level. The rest of the assemblage was divided into three size categories: large (size of cattle and equids), medium mammals (size of red deer and wild boar), and small ruminants (size of sheep, goat and gazelle). A few bird bones (n =4) were present among the remains, as well as 11 remains of intrusive rodents, such as the Indian gerbil (*Tatera indica)*. Nineteen land tortoise shells (*Testudo graeca*) and eight mollusks were also found.

The considerable number of burnt bones from all three trenches is noteworthy (Table 2). These comprise about 19% of the PPN and 21% of the PN specimens. In total, 109 cases of human modification including cut marks are present, 81 of which belong to the PN. In addition, out of 49 cases of worked bones, 42 belong to the PN phases. Caprine long bones are the main raw material for manufacturing these worked bones.

Carnivore damage is common in both PPN and PN assemblages as well as rodent gnawing marks. All observations indicate that the bones were exposed before being buried. Pathological traces are observed on less than 1% of the specimens.

## Faunal composition

Goat, including wild and domestic specimens (*Capra aegagrus* and *Capra hircus*)**,** is the most commonly exploited taxon in Qasr-e Ahmad (Fig. 4). It represents 17% and 19% of the identified specimens in the PPN and PN phases respectively. No major change can be detected between the PPN and PN faunal exploitation patterns.

Sheep (*Ovis* cf. *aries*) are represented in low proportions; sheep remains do not exceed 2% of the identified specimens. Cattle Bovines (cf. *Bos primigenius*) are even less common than sheep, represented by c. 1% of the identified specimens.

Only a few gazelle bones were identified in the PN assemblage, including two first phalanges, one astragalus, and one radius, accounting for less than 1% of the identified specimens. Gazelle remains could not be identified down to the species level due to the lack of diagnostic parts such as horn cores. Today, the goitered gazelle (*Gazella subgutturosa*) is present in Fars and is the most widespread species on the Iranian Plateau. This animal is a common component of the late Pleistocene and early Holocene assemblages of Fars (Mashkour *et al*. 2006; Hongo and Mashkour 2008).

Wild boar *(Sus scrofa)* is generally rare in the prehistoric faunal assemblages of the Iranian Plateau (Mashkour 2006). Only one 3rd phalanx, two isolated upper jaw teeth and one upper jaw bone from the PPN phase, together with a fused tibia and a frontal part of a cranium from the PN phase, were identified in our assemblage. It was not possible to take any measurements from these suid bones.

The inhabitants of Qasr-e Ahmad also exploited other animals, such as the hare (*Lepus capensis*), which is only present in the PN phase, and the chukar partridge (*Alectoris chukar*) during both phases of the Neolithic. The land tortoise (*Testudo graeca*) is represented by plastron and carapace fragments during both phases of the Neolithic. This could have

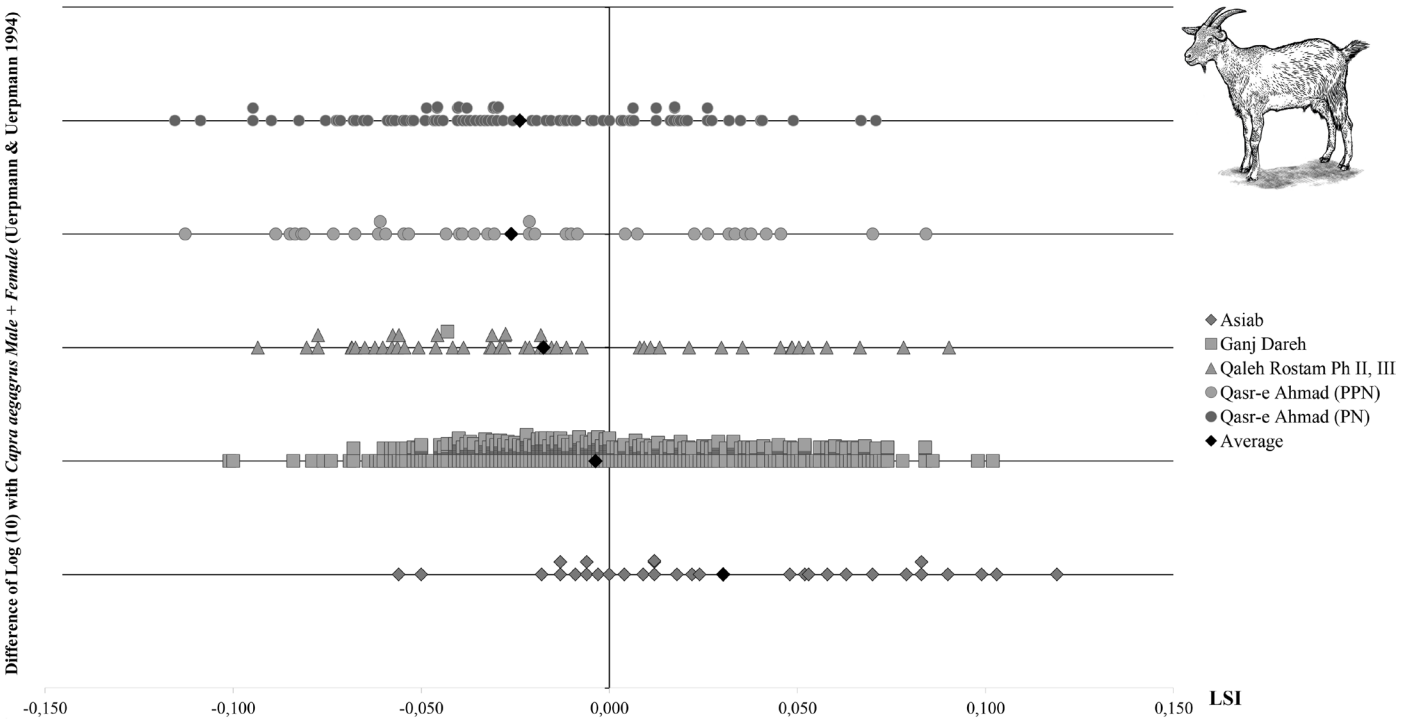


**Fig. 5.** Size distribution of goat population of Qasr-e Ahmad in comparison to some other Neolithic sites in Zagros.

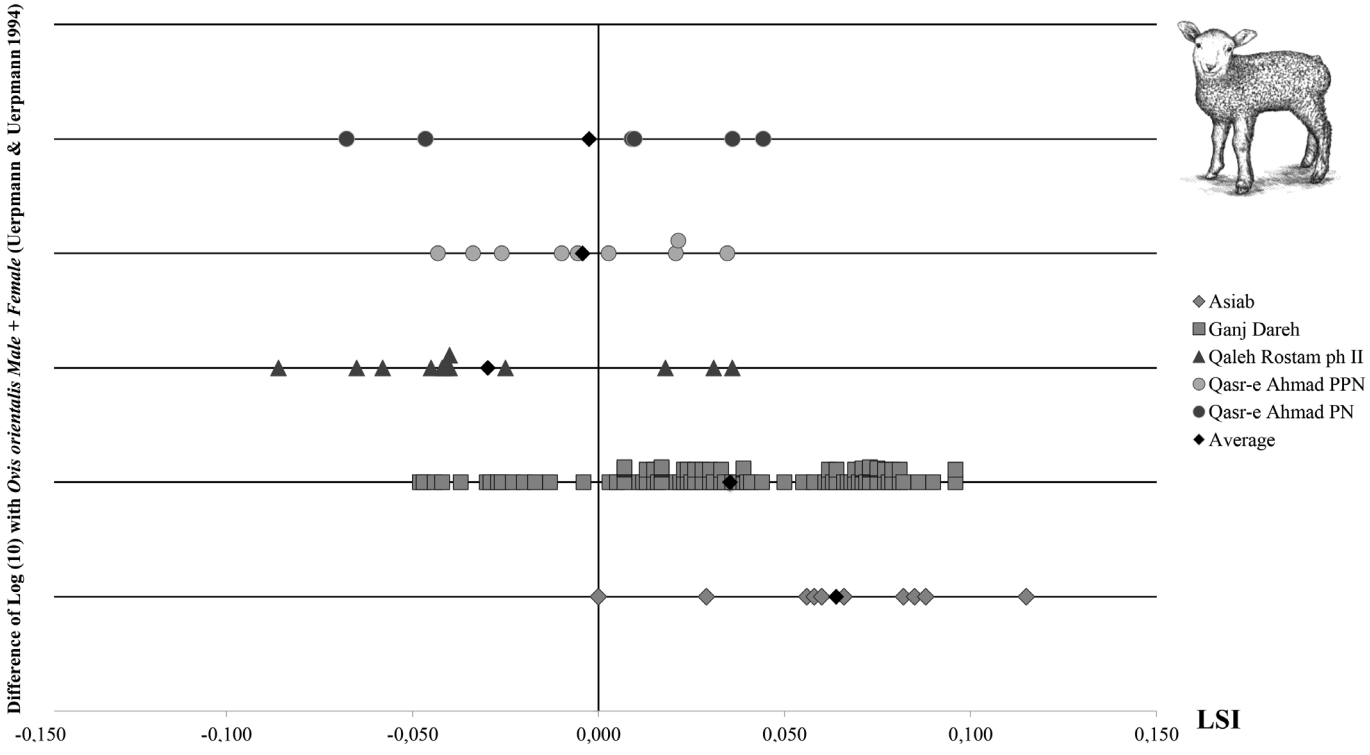


**Fig. 6.** Size distribution of sheep population of Qasr-e Ahmad in comparison to some other Neolithic sites in Zagros.

been consumed as a supplementary food source, used for its shell, or it could have been a commensal animal at the settlement.

Eight mollusk shells (four from the PPN and four from the PN) were recovered. In addition to the freshwater mollusks which probably originate from the vicinity of the site, *Conus* type shell fragments originating from the Persian Gulf are also present.

Finally, although no sieving was performed during the excavation campaign, some intrusive micro-vertebrate bones were present in the assemblage. These microvertebrate bones were identified as the Indian gerbil (*Tatera indica)*, which is a large rodent that burrows galleries. The bones are probably not contemporaneous with the Neolithic occupation of the site.

**Table 3.** The *t test* and *z test* results for the comparison of sheep size from Qasr-e Ahmad with three other Neolithic sites in the region.

| *Site* | *Asiab* | | *Ganj Dareh* | | *Qaleh Rostam* | | *Qasr-e Ahmad* | |
|---|---|---|---|---|---|---|---|---|
| | *t test* | *z test* | *t test* | *z test* | *t test* | *z test* | *t test* | *z test* |
| Asiab | * | * | 0.0105 | 0.0155 | 0.0000 | 0.0003 | 0.0000 | 0.0004 |
| Ganj Dareh | * | * | * | * | 0.0000 | 0.0002 | 0.0068 | 0.0052 |
| Qaleh Rostam | * | * | * | * | * | * | 0.0711 | 0.1021 |
| Qasr-e Ahmad (PPN. PN) | * | * | * | * | * | * | * | * |

**Table 4.** Survivorship data of sheep according to the long-bone fusion stages.

| | | *PPN* | | *PN* | |
|---|---|---|---|---|---|
| **Epiphyses (sheep)** | **Age (months)** | **Unfused** | **Fused** | **Unfused** | **Fused** |
| Proximal radius | 3-6 | | 3 | | 7 |
| Distal humerus, distal scapula | 6-12 | 1 | 2 | | 1 |
| Proximal first phalanx, proximal second phalanx | 12-18 | | | | 1 |
| Distal metapodia | 18-30 | | | | 3 |
| Proximal femur, proximal ulna, distal radius | 30-40 | | 1 | | 2 |
| **Total specimens no= 21** | | | | | |

## The morphology and age of the main ungulates

### *Horn core morphology*

The presence of several goat horn cores in the Qasr-e Ahmad assemblage was very useful for examining the morphological changes in this species during the transition to management and possibly domestication. In the faunal assemblage of Ali Kosh and Tepe Sabz, abundant horn cores with quadrilateral cross-sections were identified as wild goats in contrast to domestic herds with lozenge-shaped horn cores (Hole *et al.* 1969). Two goat horn cores in the assemblage clearly show the presence of both wild and domestic individuals in our PN assemblage. Unfortunately, there is no horn core from the PPN phase of the site. Furthermore, there are no well-preserved sheep horn cores or hornless frontal bones from the site to assess the domestication status of the sheep.

### *The size of goat and sheep*

The Logarithmic Size Index (LSI) graphs illustrate the change in size in sheep and goat between the PPN and PN at Qasr-e Ahmad (Figs. 5 and 6). For a better understanding of the chronological and regional evolution of goat size, the LSI profiles of Qasr-e Ahmad are compared to those from Neolithic sites in Central Zagros. These are the sites of Asiab (Bökönyi 1977), Ganj Dareh (Hesse 1978), and Qaleh Rostam (Daujat *et al.* 2016; Daujat and Mashkour 2017). The site of Qale Rostam, with three occupation phases during the Neolithic period (I-III), is the best comparison for Qasr-e Ahmad, as the settlements are almost contemporaneous, ranging in time from the start of the 7$^{th}$ millennium BC to the second half of the 7$^{th}$ millennium BC, i.e. the transition from the PPN to the PN (See Daujat and Mashkour 2017 for Qaleh Rostam,). This site is also suitable for comparison because it is situated between the central Zagros sites and Qasr-e Ahmad, in lower Zagros. Thus, any comparisons between the faunal remains from these two settlements can be informative regarding the dispersal and status of caprines, particularly sheep, towards the southern Zagros region.

### *The evolution of the size of goat*

Extensive studies of the caprine assemblage in Ganj Dareh (Kermanshah) by Zeder and Hesse (2000) have shown that size reduction cannot be used as the only criterion for documenting domestication as apparent size change can be mimicked by the sex-selective culling of these sexually dimorphic animals. Size modification accompanied by culling data can give a better picture of the domestication status of the species. However, the Qasr-e Ahmad assemblage contains a limited number of measurable bones, and does not allow for sex ratio evaluation. Therefore, both size and culling data were used for the assessment of goat domestication status.

The goats of Qasr-e Ahmad are relatively large but compared to the average size of the goats in Asiab, they are small. The population of Qasr-e Ahmad is smaller than Ganj Dareh and even Qaleh Rostam. However, the presence of wild specimens is evidenced by high LSIs, representing large individuals (Fig. 5). All these specimens have lower LSIs than the goat average at comparable Neolithic sites.

### *The evolution of the size of sheep*

The earliest evidence for sheep herding in Southwest Asia, with a clear shift in demographic profiles and body-size, comes from the Pottery Neolithic assemblages of Tepe Guran, Sarab, and Jarmo (Zeder 2008).

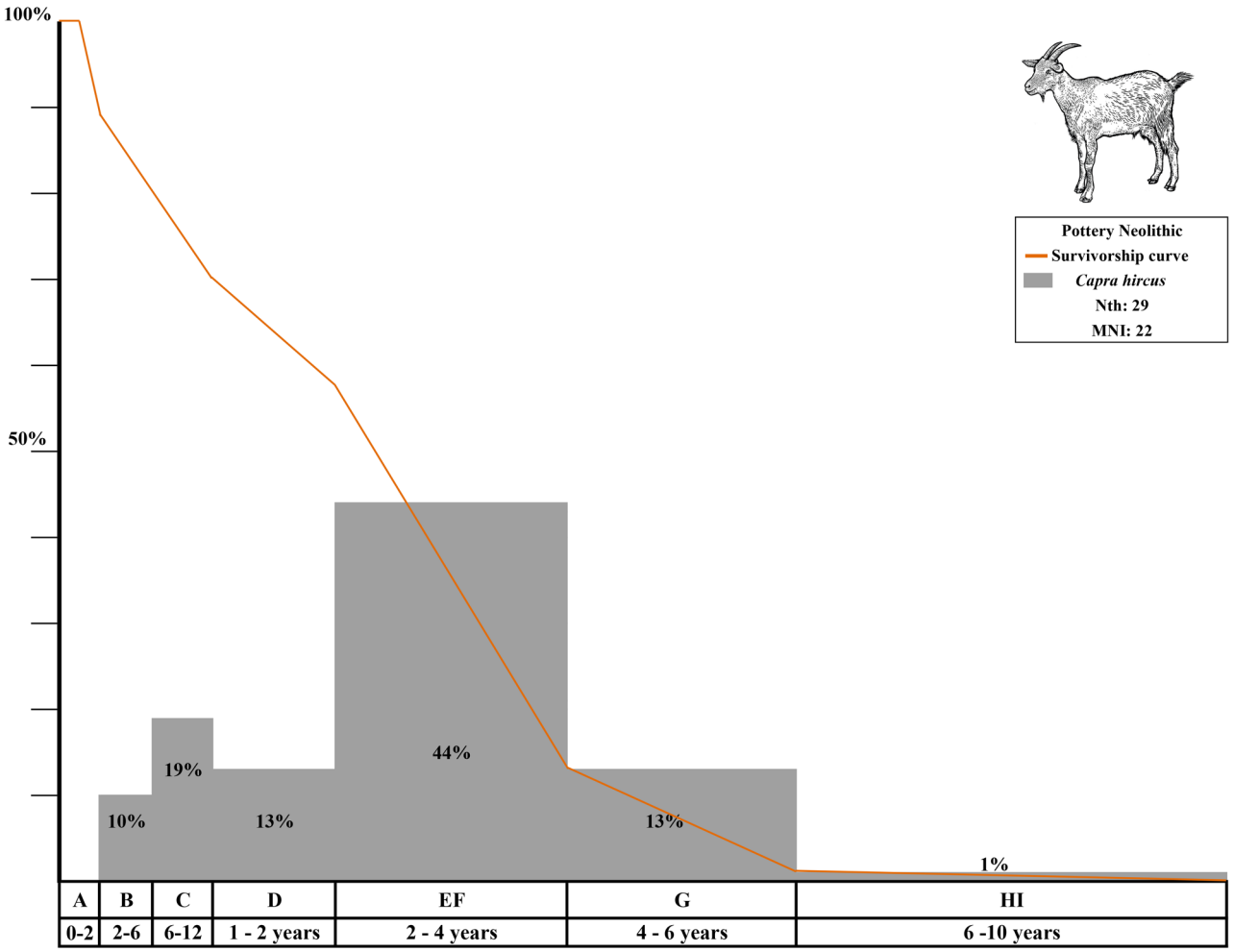


**Fig. 7.** Goat kill-off pattern during the pottery Neolithic.

Sheep measurements are less abundant than goat measurements in Qasr-e Ahmad and only fifteen could be measured. The LSI analyses (Fig. 6) and *t and z tests* (Table 3) for this assemblage indicate that sheep from Qasr-e Ahmad are significantly smaller than sheep in Asiab, but are similar in size to the sheep in Ganj Dareh. However, no significant difference between the average size of sheep in Qasr-e Ahmad and Qaleh Rostam has been observed.

In total, only 21 specimens provided information for epiphyseal fusion data (Table 4). However, to a great extent, this can be an artifact of hand collection methods during the excavation and presents limitations for identifying unfused long bones of caprines into separate species of sheep and goat. Except for one distal humerus, no specimen indicating the culling of the young has been identified in either occupation phase of the settlement. The present data suggest the culling of the majority of sheep in the settlement well after adulthood. However, due to the paucity of remains, any further interpretation is impossible.

### *Kill-off patterns for goat*

Due to the limited number of tooth remains for caprine, we could only assess the kill-off pattern for the goat remains for the PN phase (Fig. 7).

A total of 29 teeth were used in this analysis, corresponding to 22 individuals (MNI) after applying the combination of tooth wear and laterality. Interestingly, no remains could be allocated to Payne's (1973) stage A (0-2 months). However, this may be due to the absence of sieving in the field or to other reasons related to traditional herding practices which will be discussed below. A small percentage (10%) of the animals were killed before 6 months (stage B). Culling peaked (19%) between 6-12 months (stage C). This means that 29% of the population were killed before the age of one year. A small percentage (13%) of the animals were killed between one and two years (stage D). The bulk of the remains (44%) belong to Stage EF corresponding to animals between their 2$^{nd}$ and 4$^{th}$ years. Animals older than four years of age are rather well represented among the goat remains (14%).

The present picture can be interpreted as a *B milk type* exploitation pattern according to the Vigne and Helmer (2007) model. In this model, a proportion of the very young animals are culled in order to control the suckling of milk for human exploitation. A high number of ewes are kept for their milk as well as

**Table 5.** Survivorship data of goat according to the long-bone fusion stages.

| | | *PPN* | | *PN* | |
|---|---|---|---|---|---|
| **Epiphyses (goat)** | **Age (months)** | **Unfused** | **Fused** | **Unfused** | **Fused** |
| Proximal radius | 3-6 | | 2 | | 9 |
| Distal humerus, distal scapula | 6-12 | | 11 | | 43 |
| Proximal first phalanx, proximal second phalanx | 12-18 | | 31 | | 30 |
| Distal metapodia | 18-30 | | 9 | 9 | 10 |
| Proximal femur, proximal ulna, distal radius | 30-40 | 1 | 1 | 2 | 5 |
| **Total specimens no= 163** | | | | | |

their meat. They are then killed between the age of two and four when the peak time for lamb and milk productivity is over. The presence of animals between Stages B and D with a peak in Stage C can also be interpreted using the meat exploitation model. This age is the optimum weight time of the animals and a choice time for culling some of the young males in the herd for their meat (Ibid).

However, the high number of animals culled during Stage G is an interesting aspect of the kill-off pattern, and requires further discussion. Although there is no archaeological evidence related to textile production from goat hair in this site, such as loom weights, this practice cannot be ruled out. All of the abovementioned patterns could fit well with mixed production, including milk and hair, in addition to meat. In summary, milk production is expressed by the kill-off of young males and older ewes, and felt production by the presence of older animals.

The kill-off pattern seems to represent all seasons. As all age classes are present, the assemblage does not seem to reflect seasonal movements. A truncated harvest profile with noticeable proportions of one group and the absence of other slaughtering groups was demonstrated in seasonal settlements of south France and interpreted as an effect of seasonal herd movements (Helmer *et al.* 2005b). The presence of all ages in the culling profile of goats may point to the use of Qasr-e Ahmad as a year-round settlement.

The same exploitation pattern (meat and milk) has also been tracked in phase III-II of Qaleh Rostam for both sheep and goats (Daujat and Mashkour 2017), with however less emphasis on culling during the E-F Stage.

The fusion data of post-cranial goat bones show that about 10% of the caprines in the PPN and PN phases died prematurely. This mirrors the observations on teeth.

Unlike sheep remains, the goat yielded a higher number of long bones (no=163) for performing epiphyseal fusion data (Table 5). There is only one unfused specimen from the PPN and eleven from the PN. The fragile structure of the unfused bones decreases their chance of survival in archaeological contexts. However, the higher number of unfused specimens from the PN may be a result of the predominance of fauna from this phase in the assemblage or an indication of a different culling pattern during this phase, killing goats before the age of 18-30 months. During the PPN phase, the peak of slaughter is after 12-18 months, while a high proportion of goats were killed after the first year of their life in the PN phase. Unfortunately, the present data cannot provide further information on the killing pattern in Qasr-e Ahamd.

### *The size of cattle*

Qasr-e Ahmad presents one of the earliest datasets for early cattle in southwest Iran, after Tal-i Mushki where cattle remains were also attested (Mashkour *et al.* 2006; Mashkour *et al.* unpublished data), but also in limited numbers. In our assemblage, the only measurable bones were two distal humeri from the PN phase. They measured 102.6 mm and 95.8 mm for the distal trochlear breadth (BT). In Helmer and Gourichon (2017), a mean of 90.98 mm for this measurement was suggested for the aurochs in Neolithic Southwest Asia. Compared to this referential measurement, the two specimens form Qasr-e Ahmad clearly fall within the size range of aurochs.

## Pig in Qasr-e Ahmad

The earliest evidence for the beginning of pig management in Southwest Asia comes from Çayönü in the Upper Tigris catchment basin during the 9$^{th}$ millennium BC (Hongo and Meadow 1998), displayed by increasingly younger culling profiles and body size reduction throughout time. However, evidence from Zagros suggests a late adoption of pig husbandry in this region (Flannery 1983; Mashkour 2006; Price and Arbuckle 2015). The earliest evidence for domestication displayed by phenotypic changes along with changes in kill-off patterns of the pig population in Zagros comes from the Pottery Neolithic phases of Jarmo (early 7$^{th}$ millennium BC), or perhaps earlier during the Pre-Pottery occupation (mid to late 8$^{th}$ millennium BC) (Flannery 1983;

Stampfli 1983; Price and Arbuckle 2015). With a long delay of about one millennium, Matarrah during the late 7th millennium BC, Banahlik, Hajji Firuz, Siahbid during the 6th millennium BC, and Belt Cave (Pottery Neolithic phases) provide the next earliest evidence for pig domestication in the Zagros region (Coon 1951; Bökönyi 1977; Stampfli 1983; Laffer 1983; Meadow 1983). However, studies in the southern part of Zagros suggest an even later adoption of pig domestication for this area during the Chalcolithic period (Flannery 1983).

The paucity of pig remains from Qasr-e Ahmad, and their poor preservation do not allow for detailed analyses, yet their minor presence in the assemblage (six specimens) indicates their low contribution to the Neolithic subsistence economy, fitting the bigger picture of the late adoption of domesticated pigs in Iran (Mashkour 2006).

The arid climate and steppe vegetation have been suggested as the main factors making southern Zagros an unfavorable region for pig management, particularly for extensive husbandry techniques (Price and Arbuckle 2015). Although the botanical studies in Qasr-e Ahmad point to relatively warm and wet conditions with steppe vegetation for the region during the Neolithic, the unsuitable environment for wild boar populations, as well as possible cultural preferences, cannot be excluded for the late appearance of domestic pig in the subsistence economy of Zagros.

## Discussion and conclusion

The faunal study of the early Neolithic site of Qasr-e Ahmad bone assemblage is an important step towards enhancing our understanding of the three major Neolithic issues in the Zagros Mountains: the main orientation of animal husbandry, the domestication status of the ungulate mammals and their spread through Southwest Asia, as well as the settlement patterns of Neolithic sites in the Zagros region. The following conclusions are possible at this stage of research:

No major changes took place in terms of the general trends of animal exploitation between the PPN and PN. In both phases, the primary animals exploited were caprines and more specifically goats, while sheep, cattle and pigs played a limited role in subsistence. The same situation is observed in the faunal remains of Tal-i Mushki in Fars where sheep and cattle are very poorly represented (Mashkour *et al.* 2006). The semi-arid climate of the region, as well as the hilly topography of the Zagros Mountains, are not propitious to aurochs and sheep populations. The delayed arrival of both domestic sheep and cattle in the region (7th millennium for sheep and 6th millennium for cattle) concurs with this picture (Zeder 2008).

Other animals were also exploited, such as gazelles, hares and possibly the land tortoise. The limited number of bird remains suggests that the wetlands were not extensively used for hunting birds. The subsistence economy was specialized in pastoralism, focusing on caprines, especially goats.

The presence of marine shells is interesting to note. This exogenous material is commonly encountered during the Neolithic resulting from trade and exchange. Another traded material during this period is obsidian (Abdi 2004), which was also found in the site and is currently undergoing analysis.

The metric analysis of goat remains and their comparison with other Neolithic sites in the Zagros Mountains show that the majority of the goats present in the assemblage were domesticated. The presence of horn cores with quadrilateral cross-sections as well as specimens in the wild goat size range suggest a wild status for a number of goat populations in Qasr-e Ahmad.

The issue of sheep domestication and spread in this area remains complicated and the assemblage from Qasr-e Ahmad is not sufficient to address this issue with any rigor. So far, a late domestication, no earlier than the Pottery Neolithic, around the 7th millennium BC, has been suggested for sheep in this region. One of the main hypotheses advocates the introduction of already domesticated sheep from the upper Euphrates and Tigris areas to Zagros (Zeder 2008). The rugged landscape of the Zagros Mountains is more favorable for goats, and probably is not very suitable for the sheep and aurochs populations. The absence of sheep and aurochs in the early Neolithic assemblages of the region backs up this assumption. In the earlier phases of Qaleh Rostam (I), sheep is absent and is only represented by a few remains during the later phases (II-III). Based on the size and the culling pattern, a domestic status has been allocated to the sheep from Qaleh Rostam (Daujat and Mashkour 2017). No kill-off pattern can be assessed for the assemblage from Qasr-e Ahmad yet the absence of any statistical difference in the size of sheep from Qaleh Rostam and Qasr-e Ahmad may constitute evidence for a domesticated status for the Qasr-e Ahmad sheep population. The presence of small sheep in Qasr-e Ahmad during both phases (PPN and PN) may imply that sheep spread between central Zagros and southern Zagros earlier than previously thought.

The presence of a very limited number of bovine remains and their large size is indicative of the limited exploitation of aurochs rather than cattle management or husbandry in Qasr-e Ahmad. On the Iranian Plateau, the history of cattle domestication has not yet been clearly documented contrary to the extensive studies which have addressed the initial domestication of cattle in the Upper Euphrates

basin (Helmer and Gourichon 2017; Helmer *et al.* 2005a; Peters *et al.* 2005). The two sites with the earliest markers of cattle domestication in the Near East are Dja'de (Helmer *et al.* 2005a) and Çäyönu (Hongo *et al.* 2009; Bollongino *et al.* 2012). The paucity of cattle remains from the Early Neolithic sites in the Iranian plateau is the main obstacle for exploring the role of cattle in this area and testing present hypotheses. The low frequency of *Bos* remains prior to the 6th millennium BC in contrast to the sudden and dramatic increase of small-sized cattle during the Late Neolithic period (6th millennium BC) has been recorded in Central and Southern Zagros, Susiana plain, southeast and northern Iran. This distribution pattern has been suggested as an indicator for imported domesticated cattle from the adjacent Upper Euphrates basin to the Zagros region during the 6th millennium BC (Arbuckle *et al.* 2016).

Herding strategies are another important aspect in this assemblage. Studies of Near Eastern assemblages have revealed the prominence of mixed profiles during the early Neolithic (Helmer *et al.* 2007). Milk procurement can even be considered as one of the main motivations for the human domestication of animals as hunting does not provide this opportunity (Vigne and Helmer 2007). The goat kill-off pattern in Qasr-e Ahmad also points to milk exploitation, which is in line with the evidence from Qaleh Rostam, one of the earliest known cases for the Neolithic of southwest Iran (Daujat *et al.* 2016; Daujat and Mashkour 2017).

One of the long-lasting discussions for the prehistory of the Zagros Mountains and the Iranian plateau focuses on understanding Neolithic settlement patterns and land use. The mobility of human communities, as a response to environmental constraints, is a practice observable in variable forms in traditional communities, including nomadic and transhumant pastoralists, and has served as a reference model for several archaeologists for the interpretation of archeological material (Hole 1962; Hole *et al.* 1969; Hole and Neely 1979; Alizadeh 2004), although it is criticized by others (Potts 2014). Here we would like to examine this issue from our perspective and contribute to the debate. The location of Qasr-e Ahmad next to the permanent river of Qara Aghaj, as well as the abundance of pottery, lithics, and domesticated plants and animals are all features of the archaeological record in favor of interpreting this site as a permanently settled occupation. In Qasr-e Ahmad, two architectural structures were discovered in the 1023 and 1025 contexts of trench A (PPN phases), covered with ocher in some places. In addition, the location of the site, close to the river, could potentially facilitate farming. Wheat and barley cultivation, along with gathering wild fruit, was evidenced through botanical studies in Qasr-e Ahmad. Moreover, the kill-off pattern in Qasr-e Ahmad is not truncated, a criterion generally considered as an indication of the seasonal exploitation of animals (see Vigne and Helmer 2007). To answer this question more precisely, sequential isotopic analyses of carbon, oxygen and strontium isotopes from enamel are required for a better understanding of year-round herding practice in Neolithic Qasr-e Ahmad. The evidence for change in seasonal movements between summer and winter pasture lands can provide *in minima* evidence for seasonal herd mobility but not residency, which requires a more extensive and integral set of data, including landscape and site distribution analysis between lowlands and highlands with associated material culture and bioarchaeological material, in particular botanical and faunal remains. For the time being, based on the archaeological data and the analysis of the faunal remains, more elements point to a permanent settlement in Qasr-e Ahmad.

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The first international meeting of the Archaeozoology of Southwest Asia and Adjacent Areas (ASWA) working group of the International Council for Archaeozoology (ICAZ) took place at the University of Groningen in 1992. Ever since, ASWA meetings have served as an inspiring gathering for those conducting archaeozoological research in Southwest Asia, the Eastern Mediterranean, North Africa, Central Asia and the Caucasus. This book contains sixteen papers presented at the 12th ASWA meeting hosted at its inaugural institution, the University of Groningen, Groningen Institute of Archaeology, as a continuation of the usual series and to celebrate the career of Dr. Hijlke Buitenhuis, associated member and alumnus of the institute, co-organizer of the first ASWA meeting.

Like other ASWA proceedings before it, this volume is full of novel theoretical and methodological approaches and new research results, tackling a large variety of topics, from the geometric morphometrics of sheep in the Pre-Pottery Neolithic Period to Predynastic fishing in the Upper Nile, to the biogeography of hartebeest and hemione, and covering the vast region stretching between Hungary in the west and Azerbaijan in the east. The volume also features an opening article by ASWA founding member M.A. Zeder on the future of archaeozoology in the region. In honor of Dr. Hijlke Buitenhuis, his full bibliography is featured herein.

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