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ZOOARCHAEOLOGICAL STUDIES OF THE TOL-E SABZ SITE BELONGING TO THE 5TH MILLENNIUM BC BASED ON ANATOMICAL AND MOLECULAR ANALYSES AND THE LSC METHOD

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Abstract: Due to its nature, the field of archaeology has caused archaeologists to establish a close relationship with other scientific fields in the interpretation of data. With the entry of interdisciplinary sciences in archaeology, including genetics and osteology (animal-human bones), archaeologists can interpret and explain ecological conditions, different species and distribution of animals, behavioral development, and subsistence system of human societies. In other words, archaeologists need to understand how animal remains have been altered by human and non-human processes, where such activities took place, and how they might affect the interpretation of the specimens. This research investigates and identifies the abundance of animal species in the Tol-e Sabz site in Marvdasht City, Fars province, based on molecular analyses, anatomical studies, and half-life tests on animal bone samples from this site. Eventually, the inhabitants' diet type has been discussed. The results of these studies indicate that the inhabitants of this site in the 5th millennium BC were livestock keepers, and their diet consisted of animal protein.

Keywords: Tol-e Sabz, animal remains, molecular-anatomical analyses, LSC method, 5th millennium BC.

چکیده: رشته باستان‌شناسی به دلیل ماهیت خود باعث شده است که باستان‌شناسان ارتباط تنگاتنگی با سایر حوزه‌های علمی در تفسیر داده‌ها برقرار کنند. با ورود علوم میان‌رشته‌ای به باستان‌شناسی از جمله ژنتیک و استخوان‌شناسی (استخوان حیوان و انسان)، باستان‌شناسان می‌توانند شرایط بوم‌شناختی، گونه‌های مختلف و پراکندگی جانوران، رشد رفتاری و نظام معیشتی جوامع انسانی را تفسیر و توضیح دهند. به عبارت دیگر، باستان‌شناسان باید بدانند که چگونه بقایای حیوانات توسط فرآیندهای انسانی و غیرانسانی تغییر یافته است، چنین فعالیت‌هایی در کجا صورت گرفته و چگونه ممکن است بر تفسیر نمونه‌ها تأثیر بگذارند. این تحقیق به بررسی و شناسایی فراوانی گونه‌های جانوری در محوطهٔ تل سبز در شهرستان مرودشت استان فارس بر اساس آنالیزهای مولکولی، مطالعات تشریحی و آزمایش نیمهٔ عمر بر روی نمونه‌های استخوان‌های حیوانی از این محوطه می‌پردازد. در نهایت، نوع رژیم غذایی ساکنان مورد بحث قرار گرفته است. نتایج این مطالعات نشان می‌دهد که ساکنان این محوطه در هزارهٔ پنجم قبل از میلاد دامدار بودند و رژیم غذایی آن‌ها عمدتاً شامل پروتئین حیوانی بوده است.

کلیدواژه: تل سبز، بقایای جانوری، تحلیل‌های مولکولی ـ آناتومی، روش LSC، هزارهٔ پنجم ق.م.

I. Introduction

Today, animal remains obtained from archaeological excavations are carefully recorded and collected. Biologists, paleoanthropologists, and zoologists have conducted comprehensive investigations and studies on these findings and have obtained comprehensive and valuable information about the ancient societies' social, cultural, and economic status. To carry out such research, studying the more resistant parts of the skeleton, especially the teeth, is more beneficial than other parts of the bone. Researchers believe tooth enamel is less porous than bone and, therefore, less susceptible to erosion and damage from postmortem changes. Using basic science methods in archeology has a history of over a century.

The discovery of the radioactivity has opened new horizons in scientific research. The field of archaeometry includes all the scientific methods utilized in archeology. Dating is a branch of science that also seeks to answer the most important questions about archaeological findings. Thanks to archaeometry, the methods of data extraction and analysis have fundamentally changed archaeological research in the last few decades. In addition to archaeometry, which is used to determine the half-life of ancient data, significant information can be obtained using genetics. On the other hand, palaeozoology is a science that aids experienced archaeologists by providing specialized training in studying and analyzing animal remains.

In the past, palaeozoology primarily focused on compiling statistics from bone remains, identifying existing species, and providing brief descriptions. Today it has evolved into a science that tries to collect various information by studying all types of animal remains to interpret, explain, and describe human societies' behavior, ecology, and human evolution in the past (Abdi, 2001: 14). Palaeozoologists examine animal remains from ancient layers, the most important of which include bones, teeth, snail shells, the shells of a group of crustaceans and echinoderms. Sometimes, hair, the outer shell of insects, and various tissues may also be preserved under special conditions.

Examining animal remains from ancient deposits provides much information about the relationship

between humans and animals - such as seasonal activities and practices in animal husbandry, sex, age, and number of animals kept by human groups. Additionally, it sheds light on how ancient people made decisions regarding transporting, distributing, and butchering cattle and distributing meat and other products. All of this information provides us with clues about the ancient economy.

By examining animal remains, it is also possible to obtain information on the tools and techniques of hunting, butchery, or animal husbandry, as well as the role of various animals in the bio-based economy, the amount of meat consumed in ancient people's diet, signs of domestication of specific species and changes in regional fauna, local exchange systems, such as the exchange of live cattle or meat between ranchers and farmers (Mashkour, 1995: 41-45).

The importance of this research is essential because the faunal data of the region can provide significant information about the lives of the inhabitants of the Marvdasht region, especially the ancient site of Tol-e Sabz, during the prehistoric settlement period.

In addition, the prominent goals of this research include: determining the age of animal remains in Tol-e Sabz, determining the type, gender, and age of domestic and non-domestic animals, and determining the type of livelihood of the in Tol-e Sabz

The main research question:

What was the livelihood of the inhabitants of the ancient Tel Sabze site?

The questions raised in this research are: The animal bone data obtained from the exploration and determination of Tol-e Sabz territory belong to which period?, The animal data studied from the Tol-e Sabz exploration belong to which group of animals?, What do the residents of Tol-e Sabz rely on for their livelihood? What is the average age of the animal data studied in Tol-e Sabz?

The research hypotheses include: The ancient animal remains studied in Tol-e Sabz date back to the fourth and fifth millennia BC. Most of the animal data from this site include domestic animals. Based on archaeological data, the livelihood of the inhabitants of Tol-e Sabz in the Marvdasht region is more based on domestic animals. The average age of the livestock data studied in Tol-e Sabz indicates the maturity of the animals.

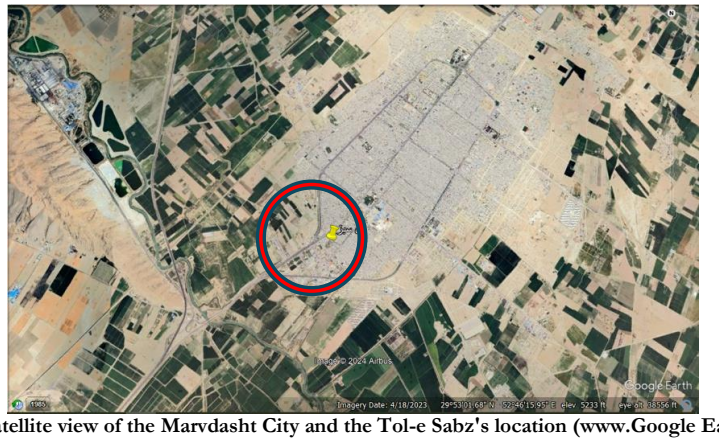

Figure 1. Satellite view of the Marvdasht City and the Tol-e Sabz's location (www.Google Earth.com).

Figure 2. A view of the Tol-e Sabz site (Authors, 2013).

Figure 3. The Marvdasht plain and the Tol-e Sabz site location (Authors, 2013).

II. Archaeological studies and background of Tol-e Sabz

Tol-e Sabz in Marvdasht has been investigated by archaeologists such as Herzfeld (1935), Vanden Berghe (1952), Schmidt (1939), and Stein (1936). According to Vanden Berghe, Tol-e Sabz (Tol-e Qaleh) in the Marvdasht region was scientifically-archaeologically explored by this Belgian board in 1951-1955 (Vanden Berghe, 1954: 20-59). In 1972, Sumner investigated this hill archeologically, estimating its area to be more than 12 hectares. In Sumner's survey, the importance of this hill is expressed chiefly due to the presence of cultural layers and materials from the third millennium to the 1st millennium BC. "He believed this place was a large Elamite City and the largest eastern city of the Cyrus River in Marvdasht plain, which was very important (Sumner: 1972). Ali Sami, who has done several archaeological excavations in the Marvdasht plain, has also mentioned this hill in his reports (Sami, 1959: 19-20). Alizadeh also investigated and studied Tol-e Sabz archaeologically in 2004 (Alizadeh, 2004: 69-91). This research was carried out to determine the nomads' migration routes in the Kor River basin (Alizadeh, 2004: 69-91). According to Alizadeh's archaeological report, three residential and settlement periods were identified on this hill: 1- the Lapui period, 2- the Kaftari period, 3- the Banesh period, and 4- the Late Islamic period (Alizadeh, 1997).

In 2012, Tol-e Sabz was subjected to archeological sounding and exploration under the supervision of Farideh Shirani and in cooperation with the General Directorate of Cultural Heritage, Handicrafts, and Tourism of the Marvdasht and Fars Province, which was accompanied by an official authorization from the Archaeological Research Institute of the country. The boundary of Tol-e Sabz was determined by creating 9 trenches in the southern part of this site (Shirani, 2012). According to the report presented by the head of the archeological exploration team, which aligns with Sumner's theory, it was pointed out that the importance of Tol-e Sabz is due to the layers of different historical periods, including Elamite, Kaftari, Qaleh, Shoqa, and Timuran cultures, in the first to third millennium BC. Unfortunately, the site has been severely damaged over time and the need for soil for producing brick kilns resulted in the removal of many parts to meet this demand. With the expansion of Marvdasht City and urban and residential constructions, more parts of the hill were destroyed and lost forever, so that now only nearly one hectare of this hill is left (Rajabi, 2014).

III. Materials and methods

The information needed in this research was obtained by studying and researching scientific sources and texts, surveying, and archaeological scientific explorations at the Tol-e Sabz site. Moreover, this research utilized Persian and English sources concerning the archaeological reports of both Iranian and foreign explorers in the ancient sites of Fars province (especially the Kor River area) and environmental information of Fars province and Marvdasht region. Furthermore, data obtained from the available bones were recorded and analyzed. In summary, the research was conducted in four primary phases as follows:

1-Field studies: Field studies at this site include 9 trenches with 2 × 2 m dimensions, which were created in different parts of the hill and at certain intervals on the southern side.

2-Library studies: Library studies include preparing sources needed for this research on the prehistoric era in Fars province. In this regard, various archaeological reports compiled in the field of archaeological scientific activities of Fars province, especially prehistoric periods, are of great importance. In addition, other sources were used to study the science of cognition of living beings. Unfortunately, due to the unavailability of fundamental sources, sites with related content, which had at least scientific value, were inevitably used.

3-Anatomical studies and molecular tests: to recognize and identify the animal type and species of the findings obtained from the scientific archaeological excavations of Tol-e Sabz, these data were sent to the genetics research laboratory and also the anatomy laboratory of the Faculty of Veterinary Medicine of Tehran University for assessment.

4-Determining the half-life using the LSC method: the existing bone samples were sent to the Atomic Energy Organization laboratory to perform tests related to determining the half-life of the data so that their age can be determined using the carbon-14 isotope test method.

5-Molecular studies and tests: to recognize and identify the type and species of animals and fauna of the findings obtained from the scientific archaeological excavations of Tel Sabz, these data were sent to the genetics research laboratory and also the anatomy laboratory of the Faculty of Veterinary Medicine of Tehran University for assessment.

IV. Analysis of bone data obtained from Tol-e Sabz based on molecular studies

To carry out this research, animal bones obtained from the ancient layers of different trenches during the site exploration were carefully collected and sent to the workshop. Then, primary information was counted and recorded. There were 1,250 animal bones, of which only a limited number (about 70 pieces) had a species identification index in terms of anatomical study. It should be mentioned that DNA sequencing tests (polymerase chain reaction (PCR)) were required to determine the animal species of these remains. Due to their age, most of the bones have minus DNA extracts, and only a few pieces of these bones have significant (albeit very limited) DNA.

Figure 4. Samples of animal bone collection of the Tol-e Sabz site.

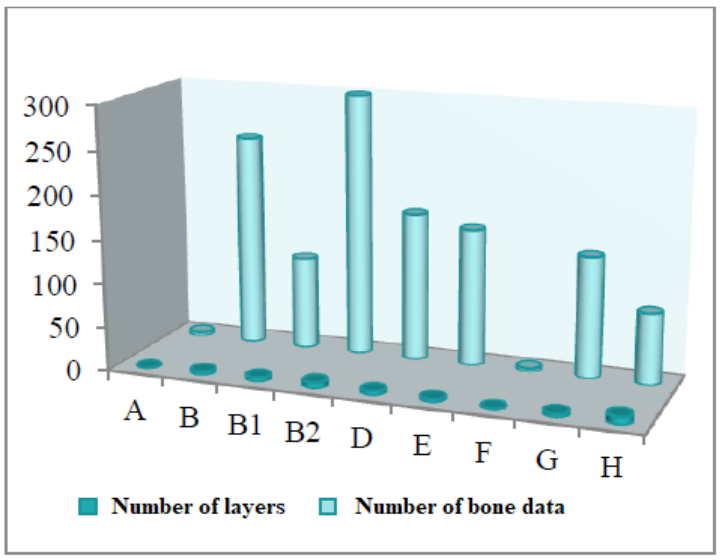

Figure 5. The number of layers and data in the created trenches.

V. Determining DNA sequencing using PCR method

We have two different types of mapping for determining DNA sequencing. Genetic mapping uses classical genetic methods to define sequence features in a genome. Maps derived from modern molecular biology methods, with a similar purpose to the genetic map, are called physical maps or mappings.

Gene mapping or genome mapping is constructing a genetic map that assigns DNA fragments to chromosomes. When we are initially working on a genome, this mapping does not exist. The mapping is improved as scientific progress and will be completed when the DNA sequencing for the species' genome is complete. During this process, the fragments are identified by small tags. These tags may be genetic markers or patterns dependent on the unique sequence of DNA-cutting enzymes. Sequences are obtained from genetic observations such as marker recombination rates or, in the latter case, from a computational community of fingerprint data. The term "mapping" applies to two different but related topics. In physical mapping, DNA is cut by a restriction enzyme. With a cut, the DNA fragments are separated by electrophoresis. The resulting pattern of DNA transfer is used to identify which part of the DNA is involved in molecular pairing. By analyzing fingerprints, overlapping pieces are assembled using automated and manual methods. Now, we can have a good choice of molecular pairing to determine the DNA sequence under study. In general, restriction is a physical mapping in which high molecular weight DNA is degraded using a restriction enzyme.

VI. DNA extraction from animal bone remains

Using a DNA extraction kit from MBST-Iran, dental tissue samples from sheep, a suspected boar tooth sample, and two samples from a horse/donkey and cow were extracted.

First, 100 mg of the tested sample was crushed entirely and pulverized until a soft and uniform powder texture was obtained. Then, briefly, 50 µg was placed in a 1.5 ml microtube. Next, 180 µl of lubricating buffer (Merck-Germany) was added followed by 20 µl of proteinase K enzyme. The solution was incubated for 10 minutes at 55°C. After ensuring complete lubrication of the sample and obtaining a uniform solution, 360 µl of connecting buffer was added to the solution and incubated for 10 minutes at 70°C. Then, 270 µl absolute ethanol alcohol (*Merck-Germany*) was added and vortexed, and ultimately, the solution was transferred to special filter columns and centrifuged for 1 minute under 8000g. The solution removed from the column was discarded and was washed twice with the washing solution. After centrifugation at 12000 g for 10 minutes, to completely remove the alcohol from the column and transfer the column to a new sterile microtube, 70 µl of the DNA dissolving solution was poured on the column and incubated for three minutes at room temperature. Finally, after centrifugation under 8000 g for 1 minute, the extracted DNA solution was immediately transferred to a freezer at a temperature of minus 20 °C for use in the following experiments.

VII. Quality evaluation of DNA prepared on 1.5% agarose gel

To prepare 1.5% agarose gel, 75g of agarose was dissolved in 50 ml TBE (Tris/Boric acid/EDTA,) buffer x 0.5 bar, 108g Tris base, 55g Boric acid, and 40 ml of EDTA molar 0.5 pH=8, were dissolved in one liter of distilled water to obtain 1X buffer. Then, 50 ml of this buffer was added to a volume of one liter with distilled water to obtain a buffer of 0.5 bars and completely melted at 100 °C until a clear solution was obtained. After transferring the liquid gel prepared in the special tank for horizontal electrophoresis and clotting the gel, 5 microliters of the DNA solution prepared with 2 microliters of DNA Loading Buffer (Fermentas) containing 10 mM of Tris-HCl (pH 7.6), 0.03% Bromophenol blue, 0.03% xylene cyanole FF, 60% glycerol and 60 mM of EDTA were mixed and transferred in one of the pits formed on the gel. Five microliters of DNA Ladder 100bp marker (Fermentas) were poured into the adjacent pit, and DNA separation was done with 100V electrophoresis. Due to the age of the samples and the minimal amount of DNA that could be extracted, the band related to the DNA of the samples was not visible. Consequently, the presence of DNA was verified using the PCR test, both for positive and negative controls.

VIII. Quality evaluation of DNA using the Polymerase Chain Reaction (PCR) method

To check the quality control and the type of animal species of the extracted DNA sample, a pair of primers (P1/P2) was designed to perform a PCR reaction on the α-actin bovine gene to identify the species of cattle, a pair of primers (P3/P4) was designed to carry out PCR reaction on TUFT1 gene of sheep and two pairs of primers, respectively (P5/P6) and (P7/P8), was designed to detect Perissodactyla (single-toed) species and swine (Table 1).

Table 1. Primary comparison between different animal species.

Animal Species	Accession number	Primer Name	Primer Sequence	PCR Product Length
Ovine	XM_004002499.1	P1/P2	FO: 5' ttttccttccatctcacaa 3' RO: 5' aatcgatgagtccattagaa 3'	108
Bovine	AY293622.1	P3/P4	FB: 5' tttgcagaag ggaaaggtt 3' RB: 5' tgaagttgagtgactaa 3	241
Equine	AAWR02016332.1	P5/P6	FEq: 5' tttttgttattatatttga 3' REq: 5' ttttttgaggaagattagc 3'	374
Swine	DQ452569.1	P7/P8	FSw: 5' ttttcttctctgacctgagt 3' RSw: 5' ttgaaggtctcgaacatgatc 3'	341 bp

It should be considered that the segment reproduced by the primer pair (P3/P4) was common in the ovine and bovine samples. Therefore, firstly, this pair of primers confirmed the ability to reproduce the extracted DNA and the ungulate pair of the tested sample. Then, the bovine or ovine species subtraction was checked using the pair of primers (P1/P2). The primers were made available after being designed by CinnaGen Company. 10ng of DNA extracted in a 100µl reaction solution containing 10µl of 10X PCR Buffer, 2.5 U Taq Polymerase (CinnaGen, Iran), 2µl of 20µM of each synthesized sense and antisense primer, 2µl of 200µM of each of deoxyribonucleotides dATP, dTTP, dCTP and dGTP, (Fermentas) and 1.5mM of MgCl2 solution (CinnaGen, Iran) were prepared in a thermocycler (MWG Biotech Primus, Germany) using the program designed for the reaction, as follows:

Five minutes at 95°C for denaturation and complete separation of the two DNA strands from each other (Denaturation step), then 35 cycles consisting of 45 seconds at 95°C (Denaturation step), 45 seconds at the connection temperature for each pair of tested primers for connecting oligonucleotide primer to single-stranded DNA (Annealing step), 45 seconds at 72°C to carry out the replication reaction and at the end of 35 cycles, 5 minutes at 72°C for full replication of the PCR product (Elongation step). After the completion of the reaction, 10 microliters of the PCR product were mixed with 2 microliters of DNA loading buffer and poured on a 1.5% agarose gel along with 7 microliters of DNA Ladder 100bp in separate pits and electrophoresed for 30 minutes with a voltage of 100 volts. The intended gel was examined under UV rays after staining with ethidium bromide solution.

IX. PCR test results

After conducting the polymerase chain reaction on the Artiodactyls samples (B1 and B3 samples) using P3/P4 primers, a band with a length of 108 bp was obtained. This result indicates that the host was likely a sheep or cattle (Fig. 6).

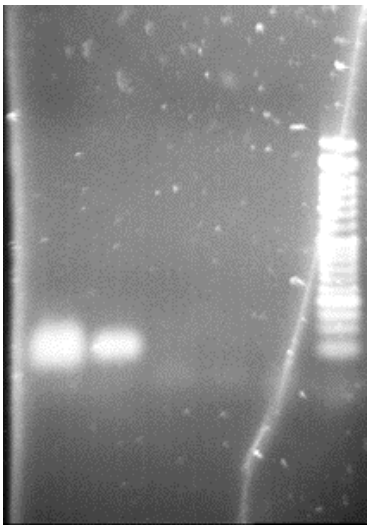

Figure 6. Sign of whether the host is sheep or cattle in the PCR test.

The test was performed using (P1/P2) primers to confirm that the host type of the sample in question is cattle. After performing electrophoresis on 1.5% agarose gel, it was found that the length of the PCR product band is 241bp, which indicates that the tested sample (Sample B1) belongs to the bovine species (Fig. 7).

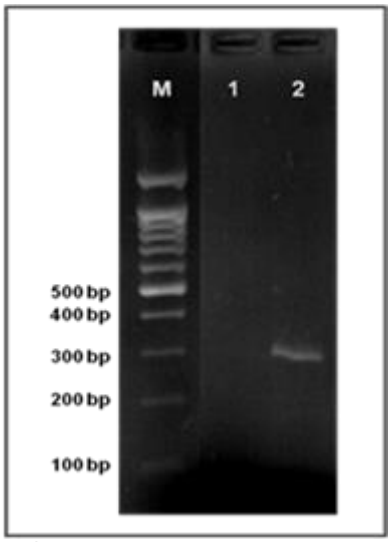

Figure 7. Confirmation sign that the host type is cattle.

After the B3 sample was negative using the primer pair (P1/P2), it was confirmed that the B3 sample belonged to the ovine host. The PCR test performed on equine and swine bone samples (6B) was negative, which could be due to the loss of DNA of the samples due to the passage of time and the age of the bones and teeth.

X. Comparing the animal range of the ancient sites of Fars province with that of Tol-e Sabz

Tappeh Mehr Ali: The study of the collection of bone remains at this site indicates that this site had a livestock breeding system. In this sense, the meat consumption pattern was based on raising and consuming sheep, goats, and cattle, like the general trend we see in Iran (Mashkour, 2002: 17-33).

Tol-e Spid: This site is located 15 kilometers far from Noorabad, a city in the Central District of Mamasani County, Fars province. The importance of this site is due to the high percentage of remains, such as domestic cattle, pigs/boars (Mashkour, 2006: 135-143).

Tappeh Qasr-al-Dasht: The ancient Tappeh Qasr-al-Dasht is one kilometer east of Vakil Abad village. Based on the statistical data, it is concluded that Tappeh Qasr-al-Dasht was a village where livestock breeding activities focused on keeping and profiting sheep and mainly domesticated goats, occasional hunting, especially wild boar, wild ovine, deer, and zebra. Probably, cattle have been exploited to the necessary extent to meet the needs of the residents (Beizaee et al., 2020: 1).

Tel Bashi: related to the 6th to 4th millennium BC indicates that in this settlement, a large number of different species of deer were hunted, which is about 1.5 times the number of domestic goats' remains (Mashkour and Bailon 2010: 262 & 3219).

Tal-e Malyan: The animal remains studied in this area belong to the Banesh and the Qala period. 300 inscriptions written in Elamite cuneiform have been found, with articles about animal products such as sheep and goat skins. Goats and perhaps sheep were given to certain individuals as wages and food rations. Some buildings have also been discovered in this area with the possible use of a center for distributing food rations (meat) to the area's residents (Zeder, 1991: 207-220).

According to the information obtained from the mentioned areas, it can be concluded that:

1- In all the sites, the animal husbandry system is active, and the need to feed the residents of these sites with animal protein and dairy has been done by raising domestic animals.

2- In the nutritional pattern of these areas, the domestic animals include species such as sheep and cattle, which are the most abundant, and the consumption of sheep is of primary importance.

3- The hunting system of these areas is of low importance and contribution.

According to the information obtained from the sites Tol-e Sabz, Tappeh Mehr Ali, Tol-e Spid, and Tappeh Qasr-al-Dasht, it can be concluded that:

1- In all four mentioned sites, the active animal husbandry system and the need to feed the residents with animal protein and dairy through breeding domestic animals have been established.

2- In the nutritional pattern of these sites, the domestic animals included species such as sheep and cattle, which are the most abundant, and the consumption of sheep products is of primary importance.

3- The hunting system of these sites is of little importance and has a low contribution.

XI. Determining the half-life (age) of Tol-e Sabz animal remains by LSC method

Almost all materials containing carbon, whose initial concentration of carbon 14 is known during the formation of the material, are suitable for carbon 14 dating. Suitable materials for carbon 14 dating include wood, coal, sediments containing carbon, bone, iron-containing carbon (steel, cast iron), paper, leather, and (Bahrololumi, 2009: 56). To perform half-life tests, the samples must first be cleaned from contamination, and they must also be mechanically and manually cleaned. If necessary, all young materials containing carbon, such as the remains of plant roots, seeds, and plaster particles, should be separated from the sample under a microscope.

Contamination of the sample with young organic materials will introduce additional carbon 14 into the sample, and the dating results indicate a younger age than the original age of the sample. Old samples, especially, are susceptible to impurities. Due to the rapid increase of errors in old samples, the sample, its location, and how to discover it should be carefully checked regarding contamination. However, contamination with old carbon of 1% can also cause an error of up to eighty years for old samples. Wood samples, plant residues, and charcoal should be washed with appropriate chemicals.

The absorption of carbon dioxide in the air must be controlled in all stages of sample cleaning and preparation to avoid contamination of the sample as much as possible (Ibid.: 62). To determine the half-life (age) of the animal remains of the Tol-e Sabz site, we have tried to find out the exact dating of those samples using the LSC method. In this regard, 19 samples of animal remains from different trenches during consecutive days from different layers were selected for carbon 14 testing and referred to the dating laboratory of the Atomic Energy Organization's Nuclear Science and Technology Research Institute (Table 2).

In the next step, the samples were washed with a hydrochloric acid solution, 0.1M, to remove the carbonates altogether. Then, the samples were washed with distilled water, pounded, and passed through a 53-micrometer sieve. To count the beta emitted from the decay of carbon 14 of bone organic carbon samples, benzene must be converted from a solid state to a liquid one. Benzene is suitable for measuring carbon-14 due to its high carbon content, ability to mix with scintillators without losing its properties, ability to transmit light, and resistance to extinction error. The chronology of the Tol-e Sabz site indicates a dating record of around 6800 ± 540 (5th millennium BC at the same time as the Bakun A period) for the site.

Table 2. Samples used for half-life determination experiments.

T:B2 SU:1 DATE:91.7.5	T:B SU:2 DATE:91.7.10	T:G SU:2 DATE:91.7.9	T:H SU:5 DATE:91.7.10
T:B1 SU:5 DATE:91.7.9	T:B SU:5 DATE:91.6.28	T:E SU:1 DATE:91.6.29	T:H SU:7 DATE:91.7.12
T:B SU:5 DATE:91.7.2	T:B1 SU:7 DATE:91.7.3	T:E SU:1 DATE:91.7.1	T:H SU:6 DATE:91.7.12
T:B SU:2 DATE:91.6.21	T:D SU:6 DATE:91.7.1	T:H SU:3 DATE:91.7.9	T:F SU:1 DATE:91.7.2
T:B SU:5 DATE:91.6.22	T:D SU:1 DATE:91.6.27	T:H SU:4 DATE:91.7.9	

XII. Conclusion

Over the past 11,000 years, humans have brought various animals under domestication. Domestic animals belong to all Linnaean animal classes - mammals, birds, reptiles, amphibians, fish, insects, and even, arguably, bacteria. Domestic animals raised for food, secondary products, labor, and companionship have become intricately integrated into the human economy, society, and religion. Animal domestication is an ongoing process as humans, with increasingly sophisticated technology for breeding and rearing animals in captivity, continue to bring more and more species under their control (Zeder, 2012).

Based on the anatomical and laboratory studies, the results of which are described below, a significant difference between sheep and cattle is evident in this

site. In addition, regarding animal meat consumption among the site's residents, the use of sheep ranks first, and cattle ranks second. Therefore, it can be concluded that in the 5th millennium BC, the inhabitants of the Tol-e Sabz area of Marvdasht preferred raising and consuming livestock over hunting wild animals. Thus, livestock production in the livelihood economy system of the inhabitants of this site is the dominant economic system. The development and feeding of the Tol-e Sabz people have been based on animal husbandry. In other words, the study of the collection of animal bone remains of this ancient site shows that in the 5th millennium BC, it had a livestock breeding system. This means that the meat consumption pattern of the inhabitants of this site was based on the breeding and consumption of domestic animals such as sheep and cattle.

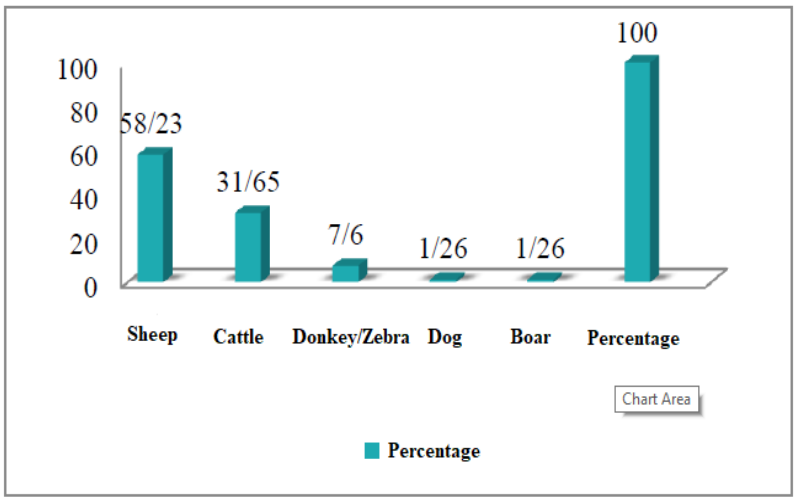

Figure 8. Percentage abundance of animal remains at the Tol-e Sabz site.

Table 3. Percentage of the abundance of animal remains of the Tol-e Sabz site.

Row	Type of animal	Number	Percent
1	Sheep	46	58.23
2	Cattle	25	1.65
3	Donkey/Zebra	6	7.6
4	Boar	1	1.26
5	Dog	1	1.26

References

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