University of Tehran Press

Journal of Archaeological Studies

P. ISSN: 2251-9297 - E. ISSN: 2676-4288

Vol. 17, No. 2, Serial No. 37 / Summer-Autumn, 2025

https://jarcs.ut.ac.ir/

AMS Radicarbon (C14) Dating of Human Skeletal Remains from the Mersinchal Cemetery, Semnan, Iran

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Article Info

Pp: 167-187

Article Type:
Research Article

Article History:

Received:
2025/05/23

Revised:
2025/07/06

Accepted:
2025/07/06

Published Online:
2025/07/23

Keywords:
Central Plateau of Iran,
Mersinchal Cemetery,
Radiocarbon Date,
AMS.

Abstract

Radiocarbon dating is a fundamental method employed in archaeological, historical, and paleographic research to determine the chronological framework of findings. This article discusses the results of radiocarbon dating analyses conducted on human remains recovered from six graves excavated during the fourth season of the Mersinchal Archaeological Project. The Mersinchal Cemetery is located in Telajim Village, Mehdi Shahar County, Semnan Province, Iran. Four seasons of archaeological excavations have been conducted at this site, leading to the proposal of a relative dating for the cemetery, attributed to the late first millennium BC, based on the analysis of the findings. This article adopts a research methodology that integrates both fieldwork and laboratory analysis. During the fieldwork phase, burial practices and graves Finds were carefully examined and systematically documented. Human samples were selected for further scientific analysis. In the laboratory phase, six human skeletal samples discovered during the fourth season of excavations at the Mersinchal cemetery were analyzed for absolute dating using radiocarbon (14C) techniques and employing the Accelerator Mass Spectrometry (AMS) method. The main purpose of this article is to establish an absolute chronology for the Mersinchal cemetery and answer some fundamental questions, including: To which cultural periods does this cemetery belong? What do burial practices and the associated findings within the graves? And what insights can be gained about their diet? The radiocarbon dating results indicate that this cemetery was used between 409 BC to 51 BCE, corresponding to Achaemenid, Seleucid, and Parthian periods. Interestingly, the burial practices and objects inside the graves remained consistent throughout these periods, showing no significant change over time. The isotopic values of the individuals indicated that their diet, influenced by local agriculture, consisted of both C3 and C4 plants. Animal proteins, including meat and dairy products, were also included in the diet.

Cite this The Author(s): Nemati, M. & Bakhtiari, S., (2025). "AMS Radicarbon (C14) Dating of Human Skeletal Remains from the Mersinchal Cemetery, Semnan, Iran". *Journal of Archaeological Studies,* 17(2): 167-187.
DOI: https://doi.org/10.22059/jarcs.2025.395930.143351

Publisher: University of Tehran.

Homepage of this Article: https://jarcs.ut.ac.ir/article_102937.html?lang=en

1. Introduction

The northern part of the central plateau of Iran exhibits distinct geographical and climatic characteristics. Over time, factors such as topography, precipitation patterns, and vegetation cover have significantly influenced the lifestyle and settlement patterns of its inhabitants. The favorable geographical conditions and relatively suitable climate of the central plateau of Iran have been among the main factors in the growth of human settlement and population concentration in this region. The presence of mountains, foothills of intermountains plains, and fertile lands of the rivers made this region one of the gathering places for human groups in the past. The Central Plateau of Iran served as a crossroads of ancient trade routes. The communication routes in this area facilitated interregional interactions in three principal directions: eastward, westward, and southward. Consequently, the area has historically served as a hub for nomadic populations, military campaingns, and commercial as well as cultural exchanges. One of the notable archaeological sites in this context is the Mersinchal cemetery, located in the northern part of the central Iranian plateau, within the north of Semnan province, along the southeastern margin of the Caspian Sea. This cemetery was in use during three distinct historical periods: the Achaemenid, Seleucid, and Parthian eras. Semnan Province, historically known as Qumis or Hecatompylos, served as the capital of the Parthian Empire and was situated along the Great Khorasan Road, a branch of the Silk Road. This strategic geographical position has contributed to the region's historical significace (Sharifi, 2019: 145). The Mersinchal cemetery is of interest for three reasons. First, it represents the first site from the Achaemenid period to be excavated in this part of of Iran, located on the southeastern coast of the Caspian Sea (Malekzadeh *et al.,* 2023: 14). Second, it lies in proximity to the Qumis cultural region, the former Parthian capital. Third, the site provides valuable data for understanding the socio-political and cultural transitations from the Achaemenid to Parthian empires at the regional level.

Establishing a precise chronological framework and a clear understanding of the cultural sequence of each region is a fundamental prerequisite for conducting rigorous archaeological research. The application of absolute dating methods, such as radiocarbon dating, has significantly enhanced archaeological research. Unlike traditional dating techniques, radiocarbon dating provides more accurate and reliable age estimates for ancient finds, thereby improving the precision, credibility, and scientific rigor of Archaeology research.

Given the absence of absolute chronological data for cemeteries located along the southeastern shore of the Caspian Sea, obtaining a precise radiocarbon date for the mersinchal site is essential for reconstructing the long-term patterns of human habitation in the region. Moreover, absolute dating for this cemetery spanning the Achaemenid, Seleucid, and Parthian periods will provide a valuable reference point for establishing relative chronologies at other contemporaneous sites. During the fourth season of the Mersinchal cemetery archaeological excavations, 34 graves were excavated in Trench E13, and samples from six of these graves were selected for radiocarbon analysis. Therefore, the primary aim of this research is to employ scientific analysis to determine the absolute chronology and dietary habits of the individuals interred at the mersinchal cemetery.

To achieve this, six human bone samples were collected from selected graves and analyzed for radiocarbon datingand stable isotopic ratios ($\delta^{13}C$ and $\delta^{15}N$). The questions that can be raised in this research are as follows: What cultural periods are represented in the Mersinchal Cemetery? What were the burial practices and the types of objects found in each period? What dietary patterns can be inferred for individuals buried at the site?

2. Research methods

This research is primarily carried out using a descriptive-analytical approach. The methodology of this research combines both fieldwork and laboratory analysis. During the fieldwork phase, the findings from the excavation were systematically documented and studied, after which appropriate samples were selected for further laboratory analysis. In the second phase, samples were taken from the skeletal remains of six individuals buried in six distinct graves discovered during the fourth season of the Mersinchal cemetery excavations. These samples were subjected to absolute dating using radiocarbon techniques. The analysis was conducted at a radiocarbon laboratory in China, employing accelerator mass spectrometry (AMS) methods for high-precision results.

3. Research background

The Mersinchal cemetery is located in the eastern part of Telajim village, within the Poshtkoh district in the northern part of Semnan province, situated on the Iranian central plateau (Fig. 1). It was identified in 2010 during a survey of the Finesk Dam conducted by Ali Maleki (Maleki, 2010). To date, four seasons of archaeological excavations have been conducted at this site. The first and second seasons of the excavations were conducted in 2014 and 2020, respectively, under the direction of Mehrdad Malekzadeh (Malekzadeh *et al.,* 2015), The third season (Fig. 3) took place in 2021 and two archaeological teams under direction of Mohammad Reza Nemati (Nemati, 2021) and Ata Hassanpour (Hassanpour, 2021). The fourth season (Fig. 4) was completed by Mohammad Reza Nemati (Nemati, 2022).

4. Description of the Site

The Mersinchal cemetery (36°02'36''N, 53°25'56''E) is situated approximately 250 meters southwest of Telajim village, 300 meters southeast of Tom village, two kilometers southeast of Moladeh village and three kilometers southwest of Finesk village in northwestern Semnan province, and 70 kilometers north of the city of Semnan (Figs. 1-2). Topographically, the site can be divided into three distinct sections. The first section lies on a relatively flat terrace on the northern slope of Mount Sartala and at the southern edge of the Sefidrud river, at an elevation of 1626 meters above sea level. This section is bounded by a shallow valley to the east and west and by a river to the north. It has an approximately rectangular shape, with a maximum length of 120 meters and a maximum width of 55 meters along the east-west axis. The terrain slopes from north to south and from west to east, and the majority of the graves are concentrated in this area (Nemati, 2021: 469). The second section lies to the south of the first section and is situated on the steep northern slope of Mount Sar tala. It covers an area of approximately one hectare and is located at an elevation of 1,663 meters above sea level (Nemati, 2020: 12). Based on the 2014 excavations, the steep gradient and ongoing soil erosion have led to the disappearing or significant shallow of many grave surfaces (Malekzadeh *et al.,* 2014: 464). The third section is positioned west of the first and second sections, separated from them by a shallow valley, it extends northward toward the Sefidrud river and southward toward the steep mountain slope. Locally known as "Gharash mal khil", this area covers approximately 15,000 square meters and features a slope from south to north. Due to agricultural activity, a considerable number of stones have been gathered from the surface and deposited in various parts of the area. A limited number of pottery fragments are scattered across the surface, some of which are of the clinky ware type. This section appears to have functioned as a seasonal, nomadic settlement (Nemati, 2020: 13).

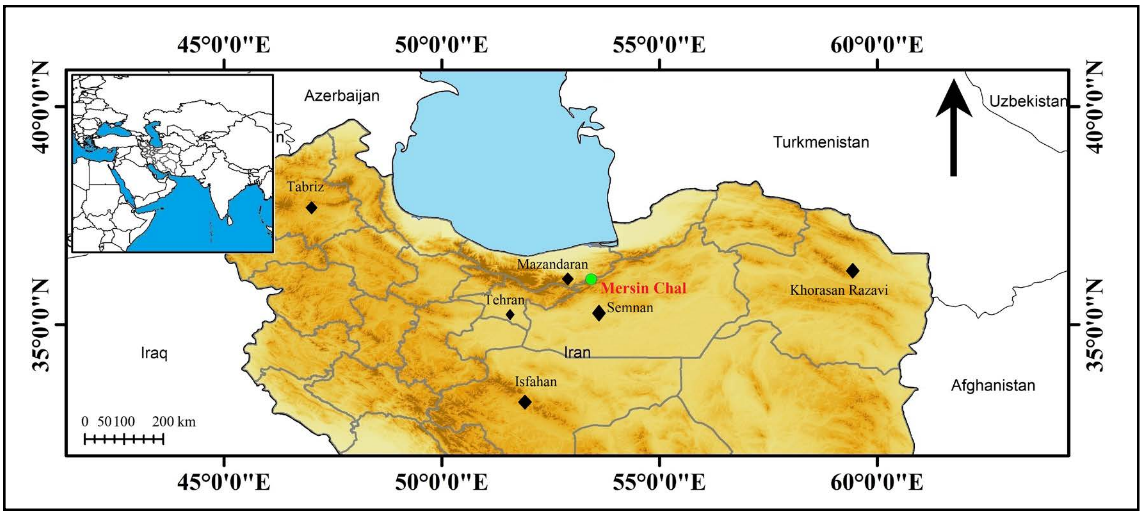


Fig. 1: Map showing the location of Mersinchal (based on Google Maps, drawn by: S. Bakhtiari).

Fig. 2: The location of the Mersinchal cemetery in the aerial image (Google Earth, 2024).

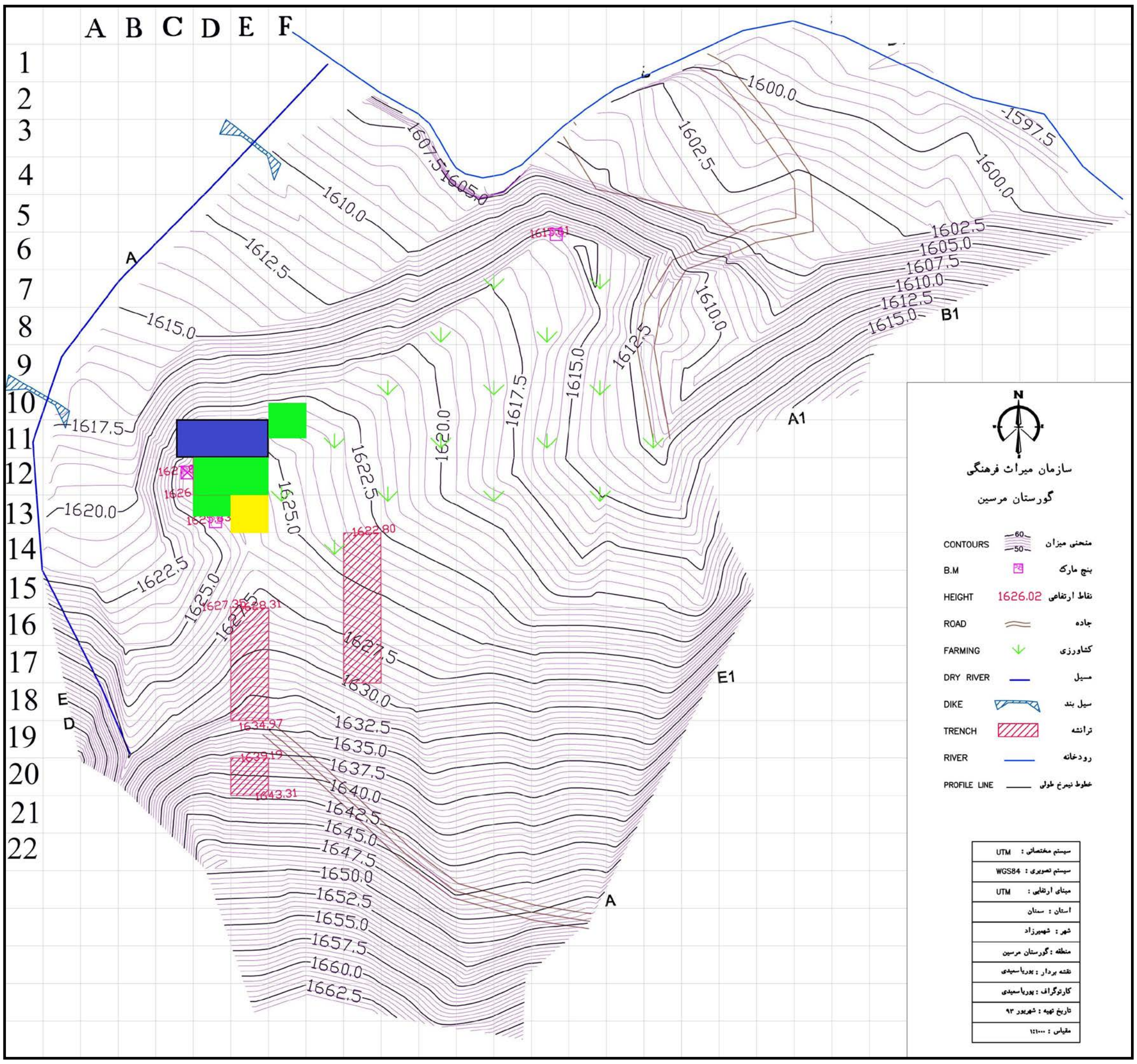


Fig. 3: Topographic map of the Mersin Chal cemetery and the location of the excavated trenches in the third and fourth seasons (Authors, 2013).

5. Materials

Bone collagen serves as the primary material of radiocarbon dating and paleodietary reconstruction (Talamo *et al.,* 2021). The quality of collagen preservation is affected by various factors, including the method of extraction, burial practices, soil composition, extreme pH levels, organic acids, temperature, and groundwater infiltration (Afshar, 2014: 123; Fetner, 2015: 88). Standard criteria for evaluation collagen quality in human skeletal remains include the Carbon-to-nitrogen (C:N) atomic ratio, which should range between 2.9 and 3.6 (Ambrose, 1990: 443; DeNiro, 1985: 808), along with minimum thresholds for carbon (> than 13%) and nitrogen (> than 4.8%) content (Ambrose, 1990: 447). Based on these criteria all collagen samples from the Mersinchal skeletal remains exhibit good preservation. Sex estimation of the individuals was conducted using morphological features of the pelvis (e.g., subpubic angle, greater sciatic notch) and skull (e.g., glabella, mastoid process, frontal and parietal eminences, occipital protuberance, supra-orbital margin, and mental eminence), (Buikstra & Ubelaker, 1994; Hager, 1996; Mays, 1998; Tague, 1995; White & Folkens, 2005). Age-at-death estimation was based on skeletal maturation, morphological changes in the pubic symphysis and sternal ends of the ribs, transformation of the auricular surface of the ilium, and dental wear patterns (Buikstra & Ubelaker, 1994; Işcan *et al.,* 1984; Lovejoy *et al.,* 1985; Meindl & Lovejoy, 1985; Oliveira *et al.*, 2006; White & Folkens, 2005), (Table 1).

6. Methods

All samples selected for radiocarbon dating were analyzed using the Accelerator Mass Spectrometry (AMS) method at the China Radiocarbon Laboratory. Samples preparation followed the standardized protocols of the Oxford Radiocarbon Accelerator Unit, as outlined by Brock *et al.,* (2010). Collagen extraction was performed using a modified Longin method (Longin, 1977). The analytical process involved several steps: initially, macro-contaminants were removed from the bone samples and the surfaces were cleaned under a light microscope. Further cleaning was performed to eliminate any potential chemical contamination. The prepared samples were then combusted in sealed quartz tubes to convert organic material into CO^2. The resulting CO^2 was reduced to elemental carbon (graphite) using hydrogen gas and an iron catalyst. The graphite-iron mixture was pressed into target holders and stored under an argon atmosphere until AMS measurement, following the method described by Czernik & Goslar (2001: 284). Radiocarbon (C14) concentrations were measured by comparing the ion beam intensities of C12, C13 and C14 in the samples relative to known standards (Goslar *et al.,* 2004). The calibration of radiocarbon dates was performed using OxCal software, version 4.4 (Bronk Ramsey, 2001, 2021), based on the intcal 20 atmospheric calibration curve (Reimar *et al.,* 2020). The calibrated results are reported with a 95.4% probability (2σ range) and are illustrated in Figures 2-3. Stable isotope analysis (δC13 and δN15) was conducted on extracted bone collagen using an isotope Ratio Mass Spectrometer (IRMS). For this purpose, "collagen preparation followed a modified Longin protocol as described by Fetner (2015). Initially, bone samples were cleaned using an air blaster with aluminum oxide particles and then manually ground into powder. The powdered samples were demineralized by immersion in a 0.5 M hydrochloric acid (HCl) solution for several days. Fallowing demineralization, samples were rinsed three times Milli-Q water. The remaining material was then heated with Milli-Q water adjusted to PH3 at 65- 70ºC for 48 hours to gelatinize the organic fraction of the bone. the gelatinized solution was filtered using an Ezee Filter separator, frozen in liquid nitrogen, and subsequently freeze-dried" (Fetner, 2015: 67-68). Stable isotope ratios for nitrogen and carbon are reported relative to international standards (δN15 AIR‰ and δC13 VPDB‰) using delta (δ)notation, expressed in parts per mil(%). The isotopic values are summarized in Table 1.

7. Stable Isotope Analysis of Humans

The analysis of stable carbon and nitrogen isotopic signatures is a well-established method for understanding and reconstructing past human diets and subsistence strategies. The stable carbon

Table 1: AMS 14C dates, calibrated ranges, and δ13C and δ15N isotope values of human bone from Mersinchal cemetery (Authors, 2021).

Mersinchal Cemetery													
Submitter No	**Trench**	**Context**	**Grave**	**Material**	**Sex**	**Age at Death**	**^{14}C Date BP**	**Cal BCE Calibrated Date 2σ Range**	**IRMS δ13C**	**IRMS δ15N**	**CN**	**Wt %C**	**Wt %N**
T2304-5	E13	410	G5	Human Bone	Female	Adult (?)	2240 +/- 30	320-202 calBCE (69.4%) 390-343 calBCE (26.1%)	-17	11/3	3/2	40/27	14/6
T2304-6	E13	411	G6	Human Bone	Female	Middle Adult	2270 +/- 30	304-208 calBCE (51.9%) 398-350 calBCE (43.5%)	-17	10/84	3/2	41/83	15/13
T2304-7	E13	412	G7	Human Bone	Female	Young Adult	2200 +/- 30	368-173 calBCE (95.4%)	-18	10/71	3/2	41/08	14/84
T2304-8	E13	417	G12	Human Bone	Female	Middle Adult	2130 +/- 30	205-51 calBCE (84.6%) 346-316 calBCE (10.9%)	-17	9/76	3/2	37/94	13/82
T2304-9	E13	425	G20	Human Bone	Female	Middle Adult	2200 +/- 30	368-173 calBCE (95.4%)	-22	10/33	3/2	41/27	15/14
T2304-10	E13	438	G33	Human Bone	Female	Young Adult	2300 +/- 30	409-353 calBCE (70.2%) 286-228 calBCE (24.6%) 217-211 calBCE (0.7%)	-16	9/33	3/2	40/83	14/82

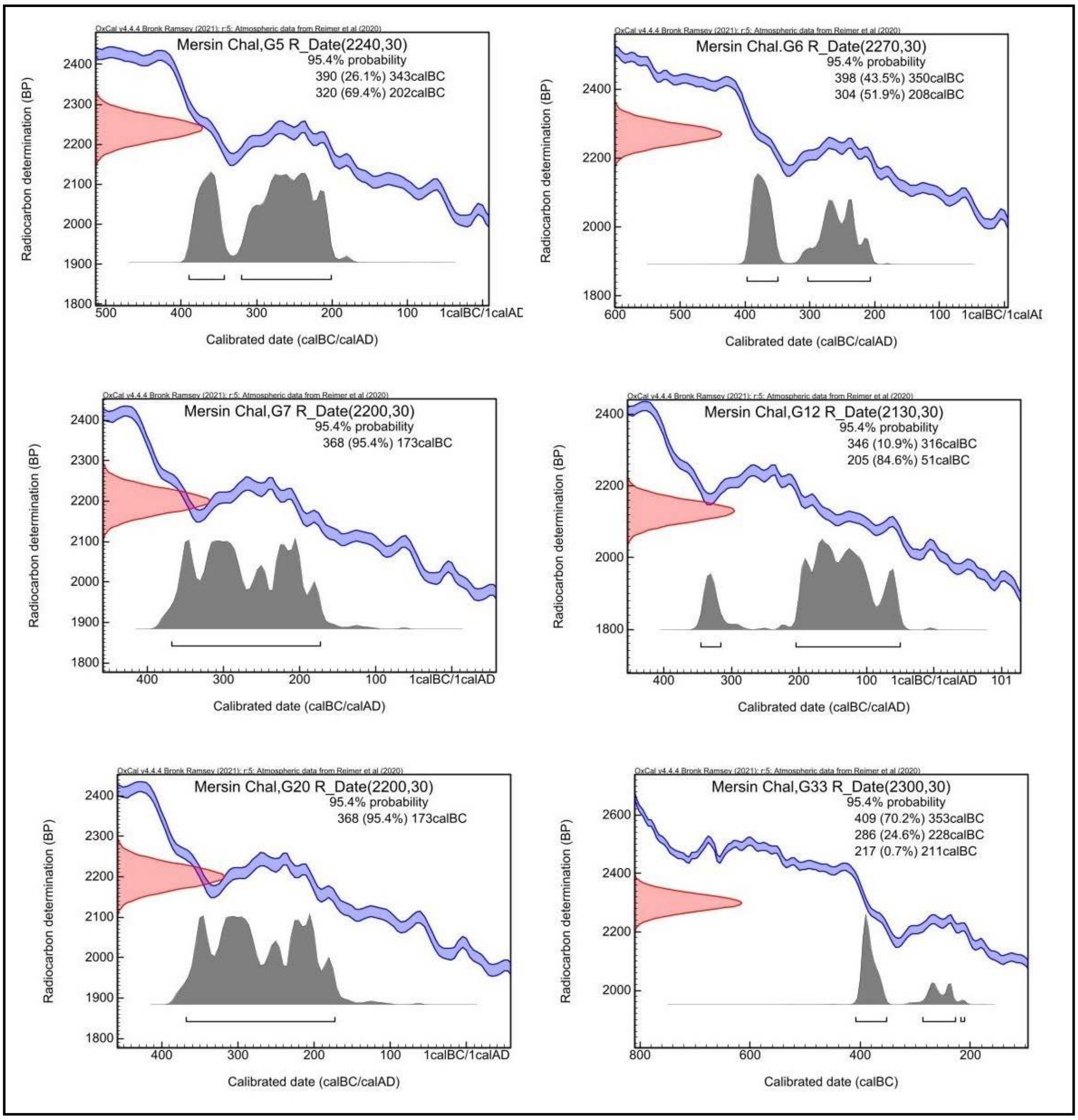


Fig 4. Calibrated age graphs of radiocarbon dates of Mersinchal Cemetery (Authors, 2021).

isotope ratio (δC13) is particularly useful in distinguishing the relative dietary contributions of C3, C4, and CAM (Crustacean Acid Metabolism) plants consumed by humans and animals. C3 plants-such as wheat, barley, rice, most fruits, vegetables, legumes, trees, and shrubs-are characterized by more negative δC13 values in human collagen, typically ranging from -20 to -35‰ (per mille). In contrast, diets incorporating significant amounts of marine resources or C4 plants- such as millet, maize(corn), and teff- result in more enriched (less negative) δC13 values, generally falling within the range of -14 to -9‰ (Agarwal & Glencross, 2011: 414, Price, 2015: 73, Katzenberg, 2008: 423-424, Ambrose, 1986: 711, Ambrose & Lynette, 1993: 2-3). CAM plants utilize both C3 and C4 plants remain clearly distinguishable due to their distinct physiological processes. The separation allows for δC13 values. (Schoeninger & Moore, 1992: 255-256; Ambrose, 1986: 711; Ambrose & Lynette, 1993: 2-3; Kelly, 2000: 4-5; Agarwal & Glencross, 2011: 414). Nitrogen

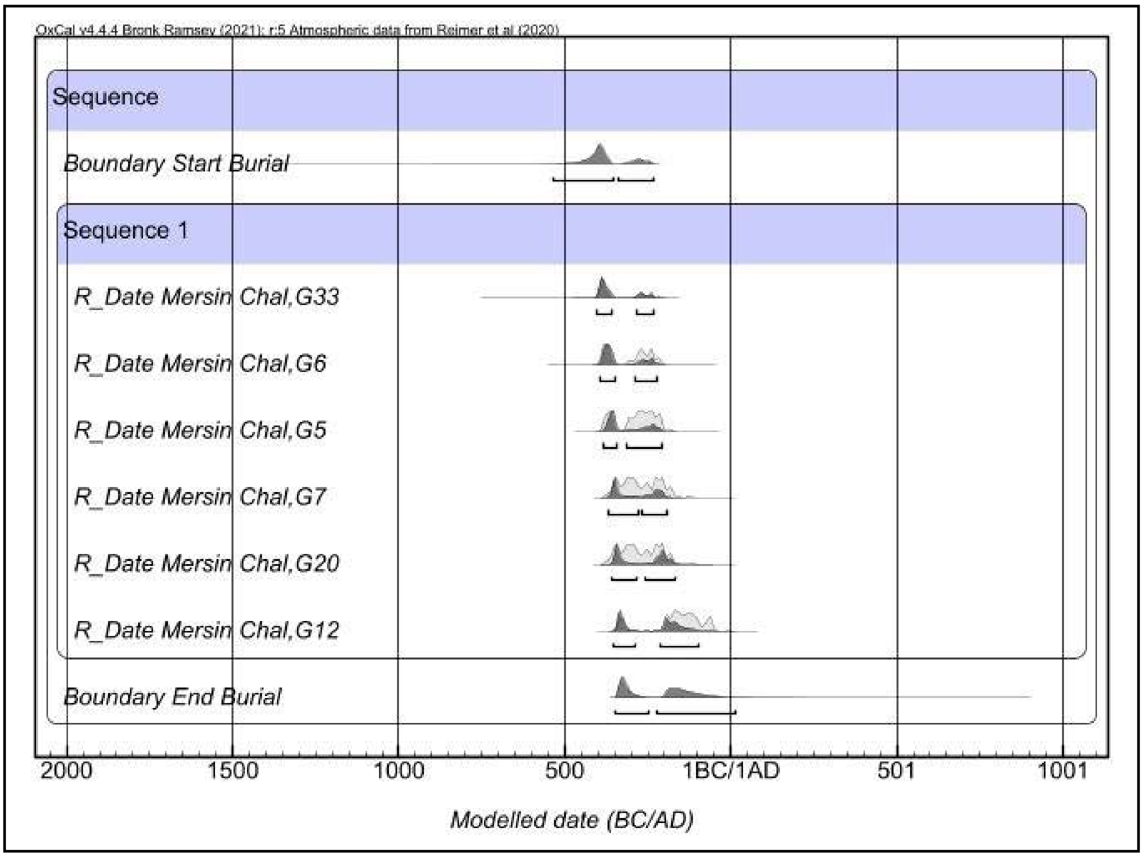


Fig 5. Calibrated age of the radiocarbon dates from Mersinchal Cemetery (Authors, 2021).

isotope analysis (δC13) of bone collagen provides complementary information by reflecting an individual's trophic level and the protein content of their diet. δC13 values typically increase by 3-5 with each step up the food chain, enabling differentiation between marine and terrestrial diets and the detection of nitrogen-fixing plant consumption (Kelly, 2000: 14, Budd *et al.,* 2017: 5). The ratio of stable carbon isotope abundance differs depending on diet, whereas the ratio of stable nitrogen isotope abundance is influenced by both diet and habitat (Katzenberg, 2008: 430-431). Consequently, "nitrogen isotope values (δ15N), alongside trophic levels, provide insight into environmental factors such as aridity resulting from water stress or human activities (indicated by higher δ15N), as well as animal management practices involving manuring (resulting in higher δ15N)". (Sołtysiak & Schutkowski, 2018: 1). As shown in table 1, the isotopic values for the Mersinchal cemetery range from -16% to -22% for δC13 and from 11.3% to 9.3% for δ15N. These results suggest a predominantly mixed diet centered on C3 plants- such as cultivated cereals, legumes, vegetables, and fruits- with a minor contribution from C4 plants, likely millet. The primary sources of dietary Protein appear to have come from herbivores feeding mainly on C3 plants, including goats, sheep, and camels. In addition, consumption of animals with mixed C3 and C4 plants, based on diets-such as cattle, gazelles, and equines-was also likely. There is also evidence of a small contribution from carnivorous species to the overall protein intake.

8. Discussions

To establish a chronological framework for the Mersinchal cemetery, a bone sample from Grave No.13 discovered during the second season of excavations was selected for radiocarbon dating. The results of the C14 analysis of bone collagen indicated a date to be corresponding to the Achaemenid period (Malekzadeh *et al.,* 2023: 1). Hassanpour provides an interpretive overview of the cemetery's period of use, stating: "There are several indicators regarding the chronological span of the cemetery's use. These include iconographic elements on the rings-such as the depiction of Hercules-along with diagnostic pottery types including Clinky ware, Rhytons, and other characteristic vessels. Additionally, burial customs and typological comparisons with neighboring archaeological sites such as Gandab, Kharand, Velem, Qumis, and Vestemin suggest that the mersinchal cemetery was likely in use from the Seleucid period and continued into the Parthian period" (Hassanpour, 2022: 291). Nemati based on the archaeological evidence recovered from both surface survey and excavated graves including pottery discovered during the excavation season argues that the cemetery was in use from the Iron Age III to the early Parthian period, with relatively consistent burial pratices observed throughout (Nemati, 2022: 472). Following the fourth excavation season, six human bone samples were collected from six separate graves for radiocarbon dating (Fig. 6). The results of this analysis are presented below.

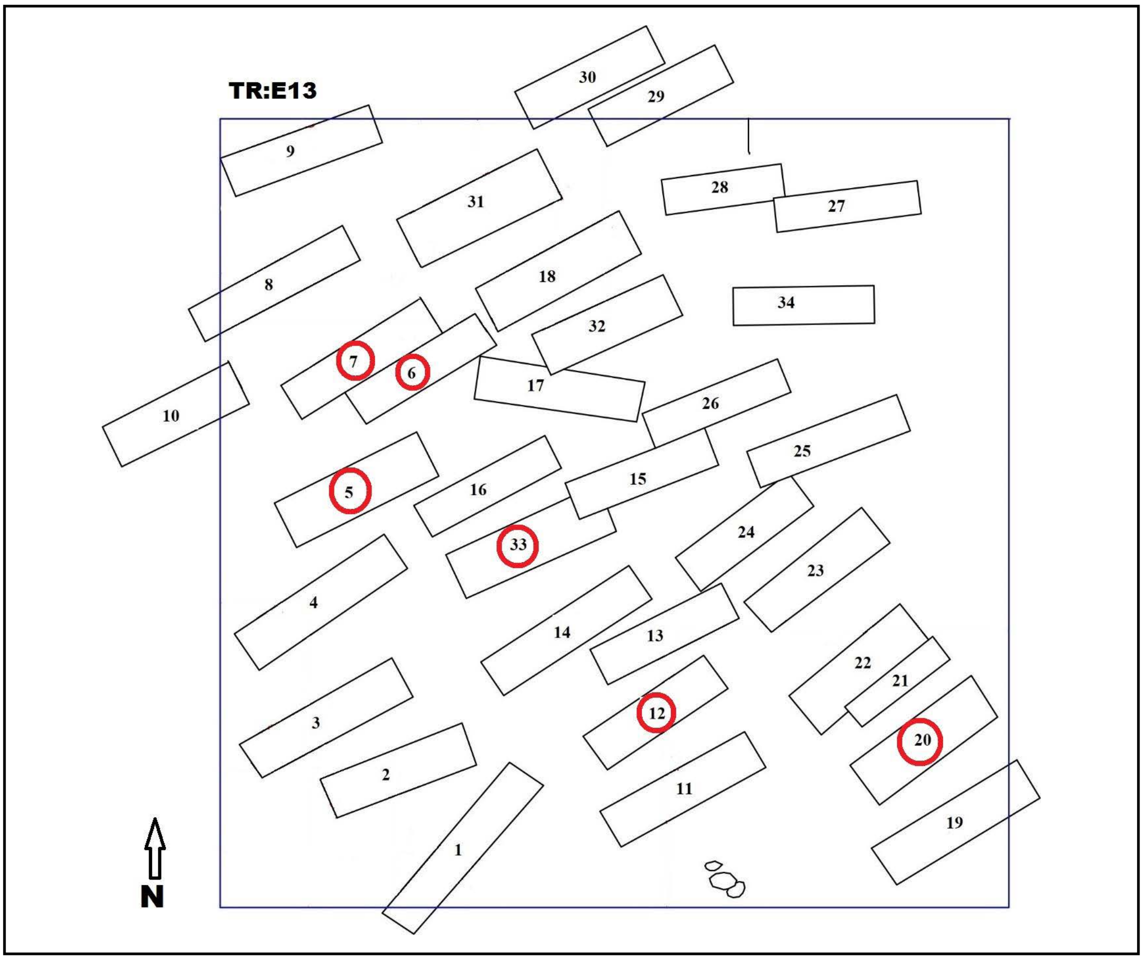


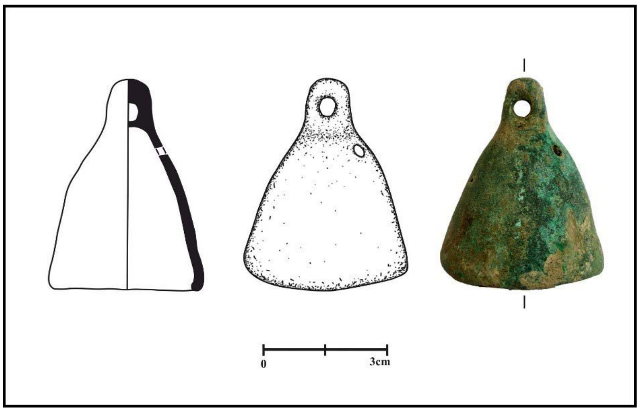
Fig. 6: Plan of the excavated graves from Trench E13 and the graves from which samples were taken (Authors, 2021).

Grave 5: The results of the radiocarbon analysis indicate a conventional C14 age of 2240±30 BP. The calibrated calendar date suggests that the sample from Grave G5 most likely (69.4%) dates to the Seleucid or Parthian periods (320–202 calBCE), while there is a lower probability (26.1%) that it belongs to the late Achaemenid period (390–343 calBCE), (Figs. 2–3). A comparative analysis of the pottery assemblage from Grave 5 (Fig. 4) reveals notable similarities with pottery materials from Parthian sites in the Damghan Plain, including Tepe Dibaj (Sharifi, 2011: 48, 50), Kesht Dasht Tepe (Sharifi, 2019: 21), and Shahr-i Qumis (Stronach *et al.,* 2019: 26, Fig. 12:3). Both the absolute and relative chronologies support the attribution of this grave to the Parthian period.

Historically, this phase represents a transitional era in Iranian history. During the early stages of the Parthian period, Iran was under Seleucid control. However, the Seleucid Empire faced persistent political and military challenges, which gradually undermined its central authority. As a result, various regions within Iran sought autonomy, contributing to the decline of Seleucid dominance and the concurrent rise of the Parthian Empire. The Parthians eventually established control over large parts of eastern Iran and effectively countered Seleucid influence. Consequently, this period may be characterized as a transformative epoch marked by the waning of Seleucid power and the emergence and territorial expansion of the Parthian state (Figs. 7–9).

Fig. 7: Burial of Grave No. 5 and the objects inside it (Authors, 2021).

Grave 6: Radiocarbon (C14) analysis of the sample from Grave G6 yielded a conventional radiocarbon age of 2270±30 BP, as reported by the Chinese Radiocarbon Laboratory (Table 1, column “Date BP”). The calibrated calendar age indicates that the burial most likely dates to the



Figs. 8-9: A pottery vessel and a bronze bell obtained from Grave 5 (Authors, 2021).

Seleucid or early Parthian periods (304–208 calBCE; 51.9% probability), with a lesser probability of belonging to the late Achaemenid period (398–350 calBCE; 43.5%), (Figs. 2–3).

The pottery assemblage recovered from Grave 6 (Fig. 4) exhibits typological similarities with Parthian pottery from Shahr-i Qumis, as documented in various contexts (Stronach *et al.,* 2019: 22, Fig. 8:4; 38, Fig. 24: 12; 42, Fig. 28: 12). In addition to the pottery, a seal ring was discovered in the grave (Fig. 5), further supporting the chronological attribution to the Seleucid or early Parthian period.

This timeframe corresponds to a significant transitional phase in Iranian history, during which the weakening of Seleucid rule coincided with the emergence of Parthian political and military power in eastern Iran. The gradual decline of the Seleucid Empire and the rise of the Parthians laid the foundation for a new imperial structure, marking a pivotal moment of transformation in the sociopolitical landscape of ancient Iran (Figs. 10-12).

Fig. 10: Burial of Grave No. 6 and the funerary objects (Authors, 2021).

Graves 7: Radiocarbon (^{14}C) analysis of the sample from Grave G7 yielded a conventional ^{14}C age of 2200±30 BP. The calibrated calendar dates for the samples from Graves G7 and G20

Fig 11 - 12: A pottery bowl and a bronze bracelet discovered from Grave 6 (Authors, 2021).

fall within the range of 368–173 calBCE, with a 95.4% probability (Figs. 2–3). The pottery assemblages recovered from these graves (Fig. 4) exhibit close typological affinities with Seleucid and Parthian pottery found at Shahr-i Qumis (Stronach *et al.,* 2019: 22, Fig. 8:12; 24, Fig. 10: 19; 25, Fig. 11: 2), as well as material from Qizlar Qalʾeh on the Gorgan Plain (Puschnigg *et al.,* 2019: 33, Fig. 9:2). The morphological and stylistic characteristics of the pottery clearly align with ceramic traditions associated with the Seleucid and early Parthian cultural spheres.

Both the absolute radiocarbon data and relative ceramic typology support the attribution of these burials to the Seleucid–Parthian transitional period. Historically, this era in Iran was marked by the decline of Seleucid control and the concurrent rise of the Parthian Empire. Specifically, it coincides with the reign of Phraates I (Farhad I), under whom the Parthian state expanded its territory and solidified its political and military strength (Figs. 13–15).

Fig. 13: Burial of Grave No.7 and the funerary objects (Authors, 2021).

Figs. 14-15: A pottery vessel and a bronze figurine Discoverd from Grave No 7. (Authors, 2021).

Grave 12: Radiocarbon (C14) analysis of the sample from Grave G12 yielded a conventional age of 2130±30 BP. The calibrated calendar age provides two possible date ranges: the most probable (84.6%) falls between 205–51 calBCE, while a less probable range (10.9%) spans 346–

316 calBCE (Figs. 2–3). Based on the absolute chronology, the burial is most likely associated with the early to middle Parthian period. This interpretation is further supported by the ceramic assemblage from Grave G12 (Fig. 4), which closely resembles pottery types documented at Shahr-i Qumis (Stronach *et al.*, 2019: 24, Fig. 10: 16, 19). These typological parallels strengthen the attribution of the grave to the period between 205–51 calBCE.

This timeframe corresponds to a critical phase in Iranian history when the Parthians, having emerged as a dominant regional power, consolidated their authority across the Iranian plateau. During this period, the Seleucid presence was effectively eradicated, marking the full establishment of Parthian political and territorial control (Figs. 16–18).

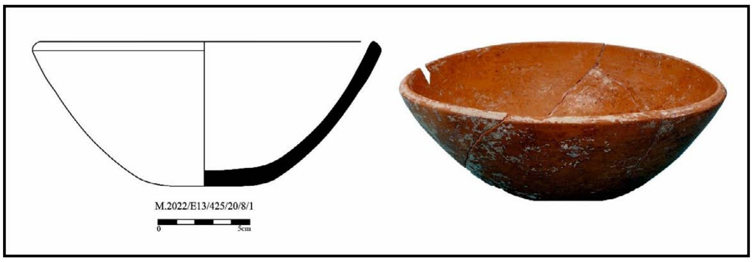
Fig. 16: Burial of Grave No 12 and funerary objects (Authors, 2021).

Fig. 17-18: A footed bowl and a handled vessel Discoverd from Grave No 12 (Authors, 2021).

Grave 20: Radiocarbon (^{14}C) analysis of the sample from Grave G20 yielded a conventional age of 2200±30 BP. The calibrated calendar age places the samples from Graves G7 and G20 within the range of 368–173 calBCE, with a 95.4% probability (Figs. 2–3). The pottery assemblages recovered from Graves 7 and 20 (Fig. 4) display clear typological similarities to ceramic materials attributed to the Seleucid and Parthian periods, particularly those found at Shahr-i Qumis (Stronach *et al.,* 2019: 22, Fig. 8:12; 24, Fig. 10:19; 25, Fig. 11: 2) and at Qizlar Qalʿeh in Bandar Torkaman (Puschnigg *et al.,* 2019: 33, Fig. 9: 2). These stylistic correspondences suggest strong cultural connections with sites located within the Seleucid–Parthian cultural sphere.

Both the absolute chronology, provided by radiocarbon dating, and the relative dating based on pottery typology, confirm that these graves belong to the Seleucid–Parthian period. Historically, this era in Iran represents the decline of the Seleucid Empire and the concurrent rise of Parthian political dominance. The dating of these graves corresponds specifically to the reign of Phraates I (Farhad I), under whom the Parthian Empire significantly expanded its territorial boundaries and consolidated its power and influence in the region (Figs. 19–21).

Fig. 19: Burial of Grave No 20 and the funerary aobjects (Authors, 2021).



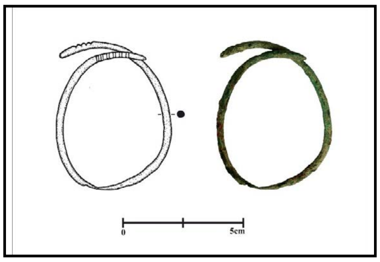
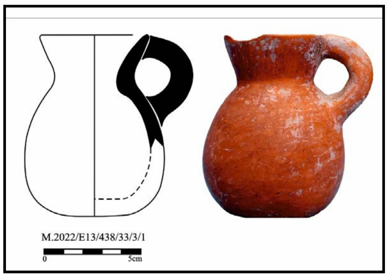


Fig. 20: The bronze bracelet discovered from Grave No. 20 & Fig. 21: A pottery bowl discovere d from Grave No. 20. (Authors, 2021).

Grave 33: Radiocarbon analysis of the sample from Grave G33 yielded a conventional age of 2300±30 BP. The calibrated calendar age provides three possible ranges: the most probable range (70.2%) corresponds to the Achaemenid period (409–353 calBCE); a secondary possibility (24.6%) falls within the transitional phase between the Seleucid and Parthian periods (286–228 calBCE); and a minor probability (0.7%) is associated with the period 217–211 cal BC (Figs. 2–3).

The absolute chronology strongly supports the attribution of this burial to the Achaemenid period (409–353 calBCE), with a high degree of confidence. This timeframe coincides with the final stages of the Achaemenid Empire, a period marked by increasing political instability, internal rebellions, and expanding involvement in Greek affairs. Despite these challenges, the Achaemenid central authority remained largely functional. Nevertheless, this era reflects the beginning of the empire's gradual decline and the erosion of its administrative and military cohesion.

Fig. 22: Burial of Grave No 33 and the funerary objects (Authors, 2021).



Figs. 23-24: A tripod bowl and a small pottery jar discovered from Grave No 33 (Authors, 2021).

9. Conclusion

During the second season of excavations at the Mersinchal Cemetery, based on the analysis of a human skeletal sample, the site was initially attributed to the Achaemenid period. In the third season, comparative analysis of pottery and burial features with those from sites in the Shahr-i Qumis region and northern Iran extended the chronological framework to include the Achaemenid through Parthian periods. To achieve more precise dating during the fourth excavation season, six human samples were selected from among 34 excavated graves for radiocarbon analysis.

Accelerator Mass Spectrometry (AMS) radiocarbon (^{14}C) dating revealed that the cemetery was in use from the late fifth century (409 BCE) to the mid-first century BCE (51 BCE), indicating continuous activity over a span encompassing the Achaemenid, Seleucid, and Parthian periods. This temporal range reflects the site's cultural vitality and strategic importance, likely attributable to its favorable environmental conditions and geographic position. Significantly, Mersinchal is the first archaeological site in the shire of Qumis and the southeastern Caspian Sea littoral definitively attributed to the Achaemenid period. The ^{14}C results affirm the relative dating inferred from ceramic comparisons with contemporaneous sites in northern and northeastern Iran, including Qiz Qalʿeh in Bandar-e Torkaman, Tepe Dibaj, Tepe Kesht, and Shahr-i Qumis in Damghan, as well as Vestemin Cemetery in Kiasar, Shahneh Poshteh in Babol, and the Velem Cemetery in Behshahr. The burial traditions observed in Mersinchal including grave architecture, burial type, and associated grave goods remained largely consistent throughout the Achaemenid, Seleucid, and Parthian periods. This continuity suggests that despite shifts in political power, cultural and funerary practices persisted with minimal disruption. Furthermore, stable isotope analysis (characterized by a decrease in $\delta^{15}N$ and an increase in $\delta^{13}C$ values) indicates a mixed diet. The individuals likely consumed both animal-derived proteins (meat and dairy) and a significant quantity of C_4 plants, such as millet. The isotopic signatures also suggest the consumption of animal products from livestock raised on C_4 plant-based fodder.

Acknowledgments

The authors consider it necessary to thank the respected reviewers of the journal who significantly enhanced the clarity and scholarly rigor of this manuscript.

Observation Contribution

The percentage of authors' participation Was equal.

Conflict of Interest

In adherence to ethical publication standards, the authors affirm that there are no conflicts of interest.

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مـطالعات باسـتان‌شـناسی
شاپای چاپی: ۹۲۹۷-۲۲۵۱ - شاپای الکترونیکی: ۴۲۸۸-۲۶۷۶
شمارۀ ۳۷ | سال هفـدهم | تابستان و پاییز
https://jarcs.ut.ac.ir/
University of Tehran Press

تاریخ‌گذاری رادیوکربن بقایای انسانی گورستان مرسین‌چال

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چکیده

استفاده از گاهنگاری مطلق با روش سالیابی رادیوکربن یا کربن ۱۴در مطالعات باستان‌شناسی امروزی در جهان به‌طور چشمگیری متداول شده است. گورستان مرسین‌چال در روستای تلاجیم، شهرستان مهدی‌شهر، استان سمنان واقع شده است. تاکنون چهار فصل کاوش در این محوطه انجام گرفته و کاوشگران بر پایۀ یافته‌های حاصل از گورهای کاوش شده، تاریخ‌گذاری نسبی آن به اواخر هزارۀ اول پیش‌ازمیلاد پیشنهاد داده‌اند. این پژوهش دارای ماهیت بنیادی با رویکردی توصیفی-تحلیلی و روش گردآوری آن دارای دو بخش میدانی و آزمایشگاهی است. در مطالعات میدانی یافته‌های حاصل از کاوش مورد مستندنگاری و مطالعه قرارگرفتند و سپس نمونه‌های آزمایشگاهی انتخاب شدند. در مرحلۀ دوم برای تاریخ‌گذاری مطلق نمونه‌هایی از بقایای شش اسکلت انسانی از شش گور که در طول فصل چهارم کاوش گورستان مرسین‌چال کشف شده بودند، انتخاب شدند. این نمونه‌ها با استفاده از تکنیک‌های رادیوکربن (C۱۴) و با استفاده از روش طیف‌سنجی جرمی شتاب‌دهندۀ (AMS)، مورد تجزیه و تحلیل قرار گرفتند؛ بنابراین هدف اصلی این پژوهش گاهنگاری مطلق گورستان مرسین‌چال و یافته‌های داخل گورهاست. پرسش‌های قابل طرح در این پژوهش عبارتند‌از: گورستان مرسین‌چال مربوط به چه دوره‌های فرهنگی است؟ و شیوه‌های تدفین و نوع اشیای داخل گورها در دوره‌های به چه شکلی بوده است؟ و افراد دفن شده در این گورستان دارای چه نوع رژیم غذایی بودند؟ نتایج تاریخ‌گذاری نشان‌داد که این گورستان در بازۀ زمانی ۴۰۹ تا ۵۱ پ.م. هم‌زمان با ادوار هخامنشی، سلوکی و اشکانی مورداستفاده قرار گرفته و شیوه‌های تدفین و اشیای درون گورها در تمام این دوره‌ها ثابت مانده و تغییر چشمگیری در گذر زمان نداشته‌اند. بررسی ترکیب ایزوتوپی کربن (δ13C) و نیتروژن (δ15N) کلاژن این افراد با روش IRMS، بیانگر مصرف ترکیبی مواد غذایی گیاهی و حیوانی در رژیم غذایی افراد مورد مطالعه است.

تاریخچه مقاله

صص: ۱۸۷-۱۶۷

نوع مقاله: پژوهشی

تاریخ دریافت:
۱۴۰۴/۰۳/۰۳

تاریخ بازنگری:
۱۴۰۴/۰۴/۱۵

تاریخ پذیرش:
۱۴۰۴/۰۴/۱۹

تاریخ انتشار:
۱۴۰۴/۰۵/۰۱

کلیدواژگان:
فلات‌مرکزی ایران،
گورستان مرسین‌چال،
تاریخ‌گذاری رادیوکربن.

ارجاع به مقاله: نعمتی، محمدرضا؛ و بختیاری، سحر، (۱۴۰۴). «تاریخ‌گذاری رادیوکربن بقایای انسانی گورستان مرسین‌چال». مطالعات باستان‌شناسی، ۱۷(۲): ۱۸۷-۱۶۷.

DOI: https://doi.org/10.22059/jarcs.2025.395930.143351

صفحۀ اصلی مقاله در سامانۀ نشریه: https://jarcs.ut.ac.ir/article_102937.html