



www.maajournal.com

Mediterranean Archaeology and Archaeometry
Vol. 22, No 3, (2022), pp. 133-148
Open Access. Online & Print.



DOI: 10.5281/zenodo.7306042

RADIOCARBON DATING EVIDENCE AND CULTURAL SEQUENCING IN CHRONOLOGY OF NEOLITHIC SETTLEMENT AT BILECIK-BAHÇELIEVLER FROM NORTHWEST ANATOLIA

Erkan Fidan*¹, Savaş Sarıaltun*², Turhan Doğan³, Sezer Seçer-Fidan⁴, Erhan İlkmen³

¹Bilecik Şeyh Edebali University, Department of Archaeology, Turkey

²Çanakkale Onsekiz Mart University, Dept. of Museology and Cultural Heritage Management, Turkey

³TÜBİTAK MAM, National 1Mv Accelerated Mass Spectroscopy (AMS) Laboratory, Turkey

⁴Istanbul University, Department of Ancient History, Turkey

Received: 05/07/2022

Accepted: 16/11/2022

*Corresponding authors: Erkan Fidan (erkanfidan@gmail.com)

Savaş Sarıaltun (savassarialtun@gmail.com)

ABSTRACT

In this article, the chronological development of the settlement at Bilecik-Bahçelievler is defined by evaluating the radiocarbon dates; and the place of material culture found in the settlement is discussed within the chronology. Radiocarbon measurements should be used in statistical methods to obtain a more consistent and usable graphic chronologically for settlement. The most widely used calibration method is Bayesian statistics, which uses the information from the ¹⁴C analysis results graph curve. This article provides an overview of the culture in addition to the statistical components used in the chronological analysis. Calibrated ageing data used in both the creation of C-14 graphs and the bayesian model were performed by TÜBİTAK Members using the latest version of OxCal software and some classifications were made. Bahçelievler settlement, inhabited between approximately 7100 BC and 6000 BC, can be claimed to be a settlement where the earliest results of the Neolithic Period in Western Anatolia have been obtained. In addition, the archaeological and chronological findings offer a solution to the historical problem of where the first pottery in Northwest Anatolia was made, as well as provide information about the beginning and development of Fikirtepe Culture, which is the dominant cultural period of the area in question. Twenty C14 dating data were published for the first time in this study. In addition, Bayesian statistical modelling was also carried out using the AMS dating of the three layers from the Bahçelievler. According to AMS dating and pottery data, the Bahçelievler settlement is the earliest site in Northwest Anatolia and also it was inhabited for about a thousand years. In this context, the Bahçelievler settlement provides significant contributions to the chronology of the Northwest Anatolian Neolithic Period. All the dating results presented in this study are essential evaluations and interpretations of the change in the cultural stages of the settlement and the Northwest Anatolian Neolithic process.

KEYWORDS: Neolithic, Chronology, Radiocarbon, Bahçelievler settlement, Fikirtepe Culture, Northwest Anatolia

1. INTRODUCTION

From the latest research on the Neolithic Period in Western Anatolia, we have substantially added to our knowledge in recent years. Since new excavations have started to provide information regarding the period before 6500 BC, this has led to ground-breaking views on the beginning and development of Neolithic elements in the study area. The research in question shows that Neolithic items date back to earlier than previously known (Horejs *et al.*, 2015; Çilingiroğlu, 2017; Guilbeau *et al.*, 2019; Gerritsen & Özbal, 2019; Fidan, 2020). According to the data before 6500 BC from the Bahçelievler settlement, it is understood that domesticated animals were raised, wheat and barley were cultivated, and pottery production had commenced. Due to the clarification of these dates with radiocarbon data, the opportunity has arisen to create a new and more reliable chronology for the period

and also it has become clear that we need to re-examine our existing stereotypes.

Bahçelievler settlement is located in the province of Bilecik from Northwest Anatolia / Turkey (Fig.1). At this settlement, which was discovered for the first time in 2013 during the surface surveys carried out by Turan Efe in Bilecik (Efe *et al.*, 2015), three seasons of archaeological rescue excavations were carried out between 2019-2021. These were performed under the authority of the Bilecik Museum Directorate and supervised by Erkan Fidan (Fidan, 2020; Kolankaya-Bostancı & Fidan, 2021). The dating analysis at the Bahçelievler settlement traces the beginning of Neolithic elements in the region back to 7100/7000 BC, to our current knowledge. Levels 8 to 6 of the eight-layered settlement are dated to between 7100/7000 and 6500 BC, while levels 5-2 date to between 6500-6000 BC. The uppermost level of the settlement (Level 1) represents the remains of the Western Anatolian Archaic Period.

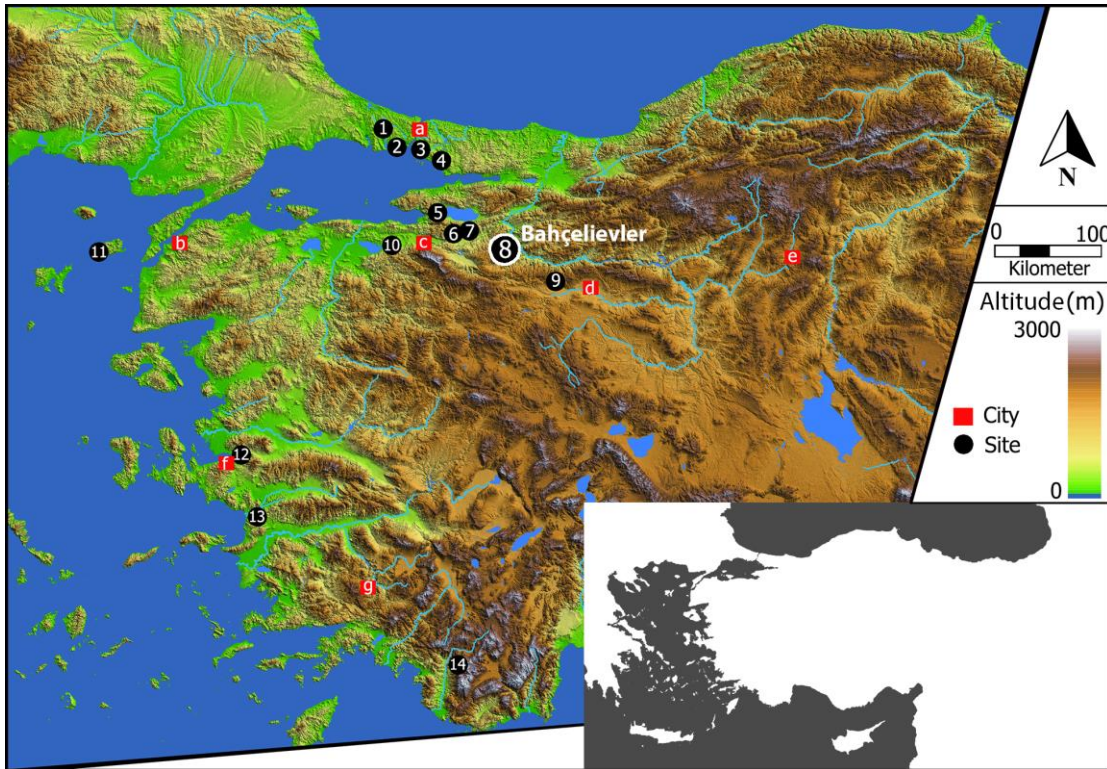


Figure 1. Map of study area showing location of selected settlements in northwest Anatolia and the Bahçelievler (8) settlement (Sites in black: 1: Yarımburgaz, 2: Yenikapı, 3: Fikirtepe, 4: Pendik, 5: Ilıpınar, 6: Menteşe, 7: Barcın, 8: Bahçelievler, 9: Demircihüyük, 10: Aktopraklık, 11: Uğurlu, 12: Ulucak, 13: Çukuriçi, 14: Girmeler. Cities in red a: İstanbul, b: Çanakkale, c: Bursa, d: Eskişehir, e: Ankara, f: İzmir, g: Muğla) (Drawing by Savaş Sarıaltun).

The Neolithic settlement at Bahçelievler was inhabited for the first time between 7192-7052 Cal BC and continued in use until 6063-5971 BC. Therefore, Bahçelievler is a key settlement marking the beginning and development of the Neolithic Period in Western Anatolia. The settlement, which contains all phases and temporal sequences of the Pottery Neolithic Period, is one of the oldest known settlements in

Western Anatolia. In addition to this, the fact that it includes finds related to Fikirtepe Culture, which is a dominant period in the study area, and that it contains Late Neolithic/Late Chalcolithic levels in its uppermost phases, are other factors that bring this settlement to the fore (Fig. 2).



Figure 2. General view of Bahçelievler Neolithic Settlement from northwest (Excavation archive).

Assuming that the Neolithic period in Northwest Anatolia is the last stage of the process where the first agricultural activities allegedly spread from east to west, this region is generally referred to as the "Late Neolithic" (Alpaslan-Roodenberg & Roodenberg, 2021) in Anatolian chronology. Moreover, it has been argued that Anatolia was almost completely unrelated to Thrace and developed under the influence of Mesopotamia-Central Anatolia (Özdoğan, 2011: 420-421). Therefore, attempts have been made to place the Anatolian Plateau, which is vast in area with distinct geographical features, on a single and expansionist chronological plane in the 20th century. In the generalist perception of social science, this is a reasonable way of making sense and producing a solution because ever since Aristotle and the emergence of classical science when considering observed phenomena, cultural processes involve forming generalizations such as natural laws, through induction.

However, Karl Popper criticized the inductive method of logical positivism in the 1930s, and states that generalization from a particular proposition, that is, the induction method, is not logically certain (Güvenç, 2020: 113; Kurtyılmaz, 2018: 27-28) because speculation has brought about many problems, especially in the cultural formation chart of Central and

Western Anatolia and Northwest Anatolia prehistory, such as the idea that the Neolithization process of Western Anatolia was due to migration or colonization from the Near East. Generalizations formed into a law that cannot be valid for every situation cause errors that may arise from the observed or the observer, or the inconsistency or inadequacy of the examples. Dating cannot be expected to be correct. On the other hand, as can be seen in many Eurocentric studies, archaeology in the Southeast European region is concentrated on a local scale. For this reason, even the simplest concepts of culture or periods have created significant differences between Anatolian-Mesopotamian and European archaeology (Özdoğan, 2011: 418-421). On the other hand, a study was carried out on red slipped wares around Uşak, but its relationship with Fikirtepe culture could not be established (Oy, 2021:89). Apart from all this, according to the characterization and origin study of the pottery finds dating from the Neolithic period to the Bronze Age in the Sarakinos cave, the existence of a trade model in the Aegean and Anatolia is also claimed (Liritzis et al, 2021: 107)

It should be noted here that prehistoric settlements such as Tell Seker al-Aheimar (Nishiaki & Le Miere, 2017) and Sumaki Höyük (Gündüzalp, 2021; Erim-

Özdoğan & Sarıaltun, 2018) or Akarçay Tepe (Arimura *et al.*, 2000) are where the first pottery dated to 7100 BC appeared in Upper Mesopotamia. Bahçelievler is almost contemporary with the first Pottery Neolithic phase in Upper Mesopotamia. In this case, the first question that comes to mind is: From which direction did immigration or colonization occur? Or did each region simultaneously reach a similar stage because of their development dynamics? We hope that all these questions will be further clarified by the latest excavation projects.

The existence of Western Anatolian Epi-Palaeolithic and Mesolithic groups has been revealed in detail in studies carried out in recent years (Çilingiroğlu *et al.*, 2016; Çilingiroğlu *et al.*, 2020; Kartal, 2003; Özdoğan, 2019). The Öküzini and Karain caves are the most prominent places known in terms of the Epi-Palaeolithic period on the Anatolian plateau. Apart from these two caves, Epi-Palaeolithic finds were also discovered in Northwest Anatolia, as in many parts of the Anatolian Plateau. Amongst them, the Yarım-burgaz Cave as well as Ağaçlı, Tepecik, Değirmenlik, Kefken, Haramidere and Pasha Area (Kartal, 2003: 35) can be listed.

Finds from the Mesolithic period came to light in two important sites south of the Marmara Sea at Çalca in Çanakkale and Musluçeşme in Balıkesir; dated to the Mesolithic by evaluating the data obtained from surveys (Özdoğan & Gatsov, 1988). During the detailed survey conducted at Musluçeşme and the slopes of this area in 2017, multi-planar flake cores and flakes as well as scrapers and piercing stone tools were found. In addition, micro-blade cores, micro-scrapers and drills made of flint were also found. Among the chipped stone finds, grinding stones and flat axes were also found in Musluçeşme. Prehistoric pottery was also documented, concentrated on the slope of Musluçeşme and in the south-eastern part of the area (Özdoğan, 2019: 48). The Musluçeşme finds in the area were dated to the Pre-Pottery Neolithic period due to the many flint and ground stone samples, compared to the pottery fragments and the quality of the stone tools. Due to the existence of different types of tools, the Musluçeşme area has been interpreted as being inhabited at intervals from the Pre-Pottery Neolithic period to the beginning of the Chalcolithic period.

Based on the stone tools found in the Karaburun surveys, it is claimed that the Epi-Palaeolithic and Mesolithic periods developed one after the other and are dated to between 10000-8000 BC (Çilingiroğlu *et al.*, 2020: 1). In addition, it is claimed that the new culture was different from the local culture; in other words, it was formed from interaction between the first communities who came and settled in Northwest Anatolia, for various reasons, and the local Mesolithic

- Epi-Palaeolithic hunter and gatherer groups (Karul, 2009:1). However, it should be clearly stated here that the Anatolian Epi-Palaeolithic assemblage is older than the Mesolithic assemblage of Europe. The term Epi-Palaeolithic has started to be used more frequently for the Anatolian Plateau groups, instead of the term European Mesolithic, due to both the found assemblages and the close similarity of the cultural process before the Neolithic Period and after the Upper Palaeolithic Period in Mesopotamia and the Levant (Kartal, 2003: 35). In the Early Period of the post-Mesolithic Period in Northwest Anatolia, evaluated in this study, Initial Neolithic and Pre-Pottery Neolithic denominations were used, and this period is dated to around 7000-6600 BC (Çevik *et al.*, 2020a: 78; Erdoğan & Çevik, 2020: 49; Özdoğan, 2019: 42; Özdoğan, 2015). On the other hand, although the term Initial Neolithic has been labelled with the Pre-Pottery Neolithic period due to a preliminary report written by Jacobsen in 1969; this definition is not endorsed by the Franchthi Cave researchers (Perles *et al.*, 2013:1005). Because the Initial Neolithic term is based on a small number of pottery sherds found from the Franchthi Cave excavations in this report. Despite the similarities between the Late-Mesolithic and Neolithic periods in terms of lithic material in the cave excavation, it was concluded that this phase belongs to the Neolithic Period by Franchthi Cave researchers based on domestic wheat data (Perles *et al.*, 2013:1007). Taken all this together between the years 8000 to 7000 BC is still a mystery in the Northwest Anatolian chronology. This 1000-year period, which is likely to represent the post-Mesolithic Period, has not been fully elucidated yet.

The fact that no pottery was found in the Ulucak Höyük Level VI and Uğurlu Level VI, which are dated to 6800-6700 BC, while very little pottery was detected in the levels XIII-XII, which represent the earliest phase of Çukuriçi so that this data is the scientific background of the "Pottery Neolithic Period" or "Initial Neolithic" definition (Erdoğan & Çevik, 2020:49; Çevik & Erdoğan, 2020:77; Çevik *et al.*, 2020a: 78; Çevik *et al.*, 2020b: 13). Based on excavation data from Ulucak, Çukuriçi, Barcın and Uğurlu, it is claimed that the first pottery appeared in Western Anatolia around 6600 BC. Moreover, it is claimed that the pottery found in the Çukuriçi settlement, which is dated between 6680-6600 BC, is the earliest example after Girmeler Cave (Takaoğlu, 2014: 115-117; Horejs, 2015: 305, 311). However, in a later study by Horejs, it was stated that the sherds found in Level XIII of Çukuriçi settlement may have been mixed with later levels (Horejs, 2019: 77). The Çukuriçi settlement is followed by Uğurlu-Zeytinlik Höyük, which is dated between 6640-6500 BC (Erdoğan, 2017: 75). Ulucak (Çevik *et al.*, 2020b: 18) and Barcın Höyük (Gerritsen

et al., 2013: 73), both dated to approximately 6600 BC, follow the two settlements where the first pottery was found (Fig.1).

The excavations at Bahçelievler have divulged radiocarbon data that will change all this. A substantial amount of pottery was found in Level 8, which represents the first occupation period of the settlement and is dated to 7100-6800 Cal BC. Likewise, the same is true for Level 7, dated between 6800-6600 Cal BC, which represent the next cultural stage at Bahçelievler.

In this section, we find it useful to add a sidenote. We consider that the presence or absence of pottery is not sufficient for periodical designations. By far the best example to illustrate of this is the Sumaki Höyük Neolithic settlement. Although very high-quality burnished pottery samples were found in Phase N7, which represents the first occupation of the settlement in question and is dated to the LPPNB period (7134±57 Cal BC), the use of pottery was completely abandoned in the subsequent Phase N6 (6758- 6644 Cal BC). In Sumaki Höyük Phase N5, dated to 6576-

6541 Cal BC, the burnished early mineral-added pottery group, very similar to the tradition of Phase N7 pottery, was reintroduced into daily use (Erim-Özdoğan & Sarıaltun, 2018; Gündüzalp, 2021). Therefore, the absence of pottery alone is not sufficient for the definition of the “Pottery Neolithic Period”, and this is also valid in reverse. Perhaps it is necessary to abandon the generalist distinction and replace it with an inductive perspective concerning pottery. Because, instead of making sense of the parts from the whole, trying to understand the whole by starting from the parts allows us to obtain more consistent and accurate results. To give an example from the westernmost point of the Anatolian plateau; at the entrance “A” of Girmeler Cave in Fethiye, there are lime-based structures with branch-mesh walls, which were built adjacent to each other and renovated many times. In this very early structure, samples like the pottery of the Turkish Lakeland which is an area with a series of shallow tectonic lakes, dated to 7000 BC, were also found (Çevik & Erdoğu, 2020: 50-51).

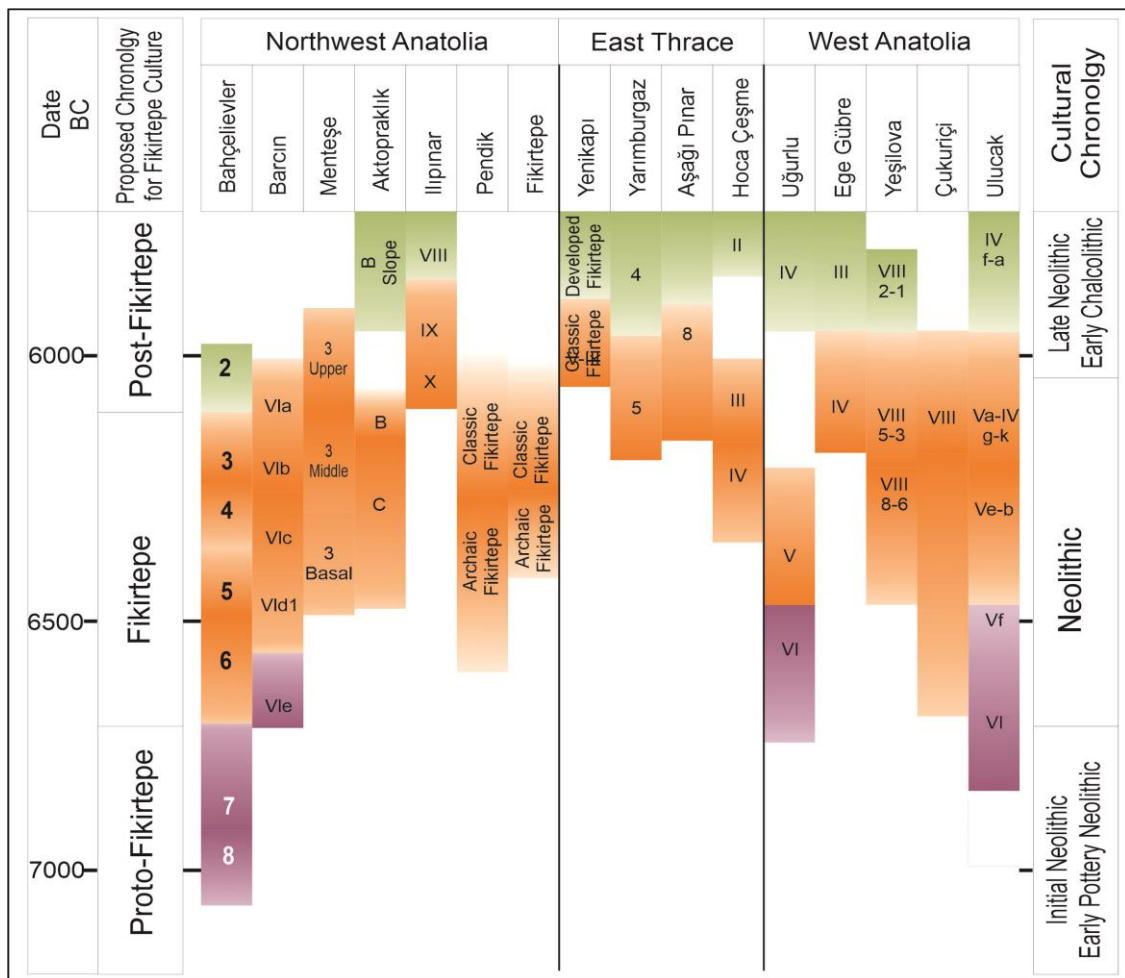


Figure 3. Neolithic to Early Chalcolithic chronology of Western Anatolia and East Thrace (Adapted from Gerritsen & Özbal, 2019 63 Fig.3 and Özdoğan, 2015:49 Fig.6)

Many Neolithic settlements on the coast of the Marmara Sea and east of it fall within the Fikirtepe Culture, which became evident after the "Initial Neolithic" period. After Özdoğan's (1979) doctoral study on the Fikirtepe settlement, communities that were named in the Fikirtepe group are now described as belonging to Fikirtepe Culture (Fig.3). This culture was widely spread on the shores of the Marmara Sea, but especially in the eastern and southern Marmara region. With the Yenikapı excavations carried out in recent years, apart from Yarımburgaz Cave (Özdoğan- Koyunlu, 1986), it has been proven that this culture spread to the western side of the Bosphorus. However, due to inadequate excavations, its proliferation in the eastern parts of the Marmara Sea and mountainous areas is not clear. Nevertheless, it is known that Fikirtepe Culture spread towards the inner parts of Anatolia, as can be understood from Demircihüyük (Seeher, 1987) and the surveys carried out at Eskişehir (Efe, 1995).

Multiple proposals have been made at different times regarding the dating of Fikirtepe Culture, whose cultural identity and settlement dynamics are widely discussed. The most prominent among these are the pre-Trojan Chalcolithic Age culture (Bittel, 1960: 32), the Marmara coast prehistoric culture (Kansu, 1963), and the Late Neolithic Age culture (Mellaart, 1967, fig. 7; French, 1967). J. Mellaart (1967) argues that Fikirtepe Culture is contemporary with the Hacilar levels IX-VI, while M. Özdoğan (1979) in his doctoral thesis dates this culture to between the end of Doğu Çatalhöyük and the beginning of Hacilar. As a result of increasing excavation data from different regions in the following years, the chronology of Fikirtepe was questioned again and Fikirtepe Culture was divided into three stages (Fig.3). The earliest period is defined as "Archaic Fikirtepe", the middle stage as "Classical Fikirtepe", and the last stage as "Developed Fikirtepe" (Özdoğan, 1997). *Archaic Fikirtepe* is dated between 6600-6300 BC, *Classic Fikirtepe* is dated between 6300-6000 BC and finally *Developed Fikirtepe* is dated between 6000-5800 BC (see fig.3). Chronologically, Archaic Fikirtepe consists of Pendik 1982, Ilıpınar X-IX, Menteşe, Demircihüyük, and Aktopraklık C, contemporary with Barçın Höyük. It has been claimed that Classical Fikirtepe is contemporary with Pendik 1992 and Advanced Fikirtepe: Yarımburgaz, Ilıpınar VIII is contemporary with the settlements (Özdoğan, 2007).

With the Ilıpınar excavations, Fikirtepe Culture was dated clearly and distinctly for the first time. The

levels reflecting the Fikirtepe Culture uncovered in the Ilıpınar excavations were examined by the radiocarbon dating method and this culture was dated to 6000 BC (Roodenberg - Schier, 2001). As a result of the excavations carried out in Menteşe Höyük, which is dated to the Archaic Fikirtepe period, this cultural phase is dated to 6400 BC (Roodenberg et al., 2003).

The Bilecik-Bahçelievler excavation fills a very important gap in this sense. As a result of the Bahçelievler excavations, the Fikirtepe Culture not only broke the perception of a culture spread solely around the Marmara Sea, but also its location in the mountain-passage region of Northwest Anatolia suggests that this culture may have had different dynamics than what is currently known.

The Bahçelievler settlement provides the most up-to-date data on the Neolithic Period in northwest Anatolia. This article presents the current results in question. In addition, age determination analyses indicate the Bahçelievler settlement as the oldest settlement of the Neolithic Period in Northwest Anatolia. The Bahçelievler settlement, where the use of pottery, animal domestication and agriculture has been done since the earliest phase, is a key settlement in this context. In addition, the new results in the Bahçelievler settlement, which revealed an uninterrupted settlement for approximately 1000 years, also reveal a new approach regarding the beginning and development of Fikirtepe Culture in the region in question.

2. MATERIALS AND METHODS

The excavation method used in Bahçelievler is based on the modernized form of the excavation system which was developed in Demircihüyük in the 1970s and has been used for more than 40 years by the excavation team. During the excavation, the finds or units are collected and numbered in three groups: pottery, bone, and stone. Archaeological objects and finds, as well as botanical and C14 samples, are also numbered separately. In addition, all the finds, including the C14 samples, are documented *in situ* by photogrammetric methods. During the excavations, multi-image photogrammetry and terrestrial stereo photogrammetry methods are used where necessary. Again, DEM (Digital Elevation Model) maps are produced, and the height, length or width of any wall or find above sea level are defined. In this way, the coordinates of each C14 specimen in the x, y and z planes are included in the database in the excavation archive (Fig.4).

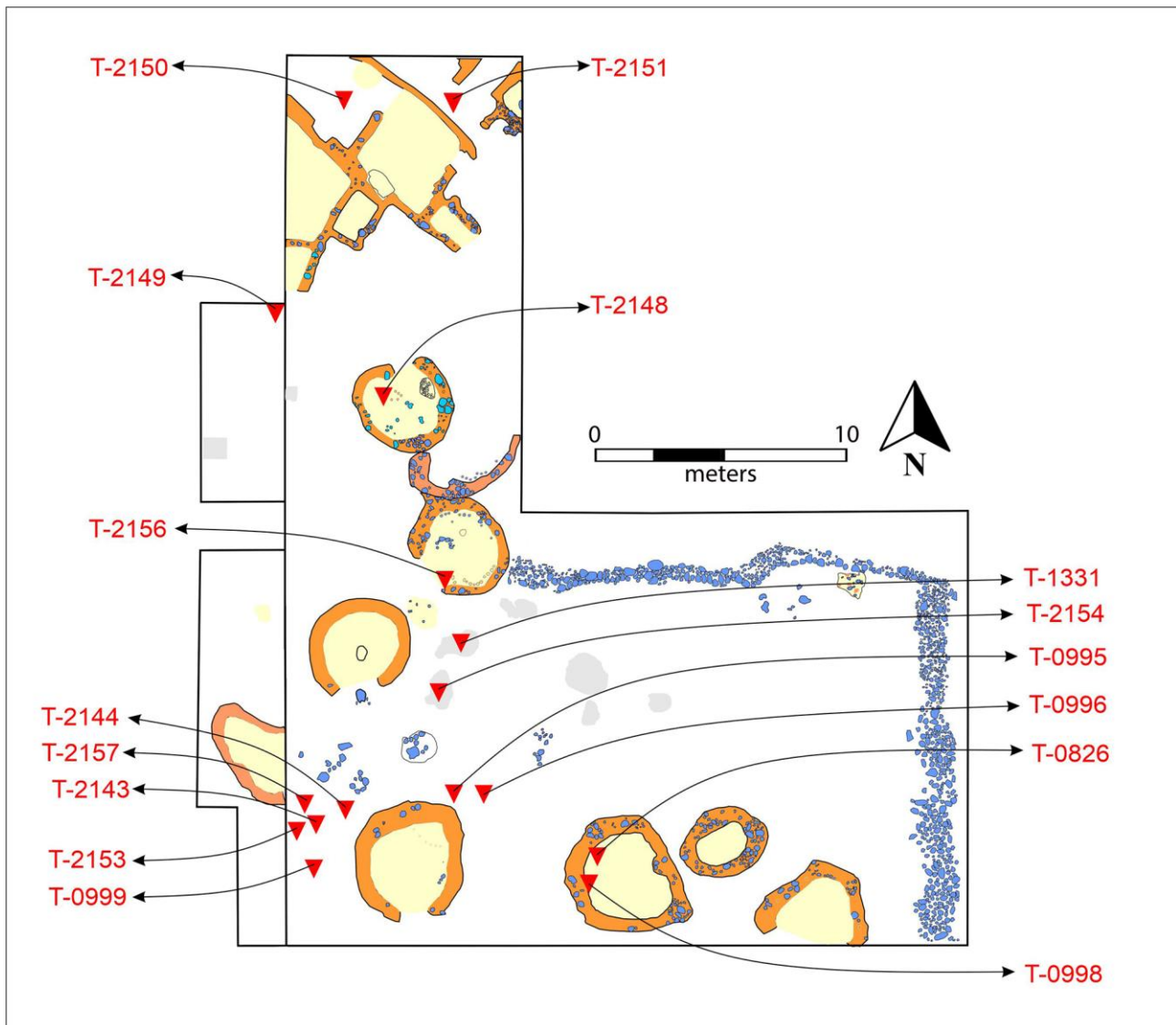


Figure 4. Architecture of Bahçelievler Neolithic Settlement and location of radiocarbon samples (Excavation archive)

Although mostly charcoal samples were used for radiocarbon analyses from Bahçelievler, and also special attention was paid to samples taken from both sediment and human skeletons to minimize the “old wood” effect. In addition, both the stratification features and the archaeological findings were examined mutually. So particular attention has been paid to contextual information in this study. Apart from all these, this study tried to minimize the possible “old wood” effect by using a substantial number of dating results for a Neolithic settlement rather than determinations based on a few dating results.

In this study, 20 samples were collected from the Bahçelievler settlement for radiocarbon analysis. Radiocarbon dating of 15 charcoals, 3 bone and 2 organic sediment samples was carried out at the TÜBİTAK Marmara Research Center National 1 MV AMS Laboratory (Doğan et al., 2021). Charcoal samples were subjected to physical and chemical cleaning proce-

dures: Based on the amount and condition of the samples, Acid-Base-Acid or only-Acid washes were applied (Mook, 1983). For the bone samples, following physical cleaning, an ultra-filter protocol was applied for collagen extraction (Hajdas et al., 2009). The quality of the collagen was evaluated based on colour, %C and %N content together with C:N ratios. Samples with C:N ratios between 2.9 and 3.5 were considered as uncontaminated macromolecules (DeNiro, 1985).

Pre-treated samples were graphitized via AGE 3 from Ion plus AG, measured by the 1MV TÜBİTAK AMS system (National Electrostatics Corp. UAMS 3SDH-1). Background corrections and measurement normalizations were done with Phthalic anhydride, Sigma Aldrich, Purity 99% and NIST SRM 4990C – Ox-II, respectively, and they went through the same graphitization procedure. Furthermore, each AMS measurement included the reference materials IAEA C-7 and C-8 for quality control purposes. Although <1% uncertainty is generally deemed acceptable,

<0.6% uncertainty was achieved during these measurements. It had been verified that the measurements with real samples at TÜBİTAK laboratory agreed with those of various AMS Labs across the globe (Yaka et al., 2021). Radiocarbon dates were calibrated

using OxCal 4.4 (Bronk Ramsey, 2009), and the IntCal20 calibration curve (Reimer et al., 2020), then the dates were subsequently modelled based on the archaeological periods.

Table 1. AMS measurements of Charcoal, Bones and Sediment samples from Bahçelievler settlement, given in ¹⁴C yr BP and calibrated BC dates (Excavation archive). [The rate of 95.4% could not be reached in each sample (see Figs.5,6). Therefore, the date with the highest and most consistent probability was chosen]*

Lab. Code	AMS Date	Calibrated Date* (%95 - 68)	Sample type	Pre-treatment	Bahçelievler Layers	Sample Context
TÜBİTAK - 2146	7111±32	6063-5971	Charcoal	Acid-Base-Acid	Level 2	Open space
TÜBİTAK - 2151	7125±36	6068-5974	Charcoal	Acid-Base-Acid	Level 2	Courtyard
TÜBİTAK - 2150	7216±35	6100-5996	Charcoal	Acid-Base-Acid	Level 2	Indoor
TÜBİTAK - 2145	7225±31	6103-6014	Charcoal	Acid wash	Level 3	Open space
TÜBİTAK - 2147	7248±31	6221-6029	Charcoal	Acid-Base-Acid	Level 3	Indoor
TÜBİTAK - 2148	7357±59	6276-6076	Charcoal	Acid wash	Level 3	Indoor
TÜBİTAK - 2156	7433±33	6392-6233	Charcoal	Acid-Base-Acid	Level 4	Indoor
TÜBİTAK - 2149	7448±34	6399-6236	Bone	Collagen Extraction - Ultrafiltration	Level 5	Human skeleton
TÜBİTAK - 2144	7449±33	6399-6236	Charcoal	Acid wash	Level 5	Courtyard
TÜBİTAK - 2152	7473±34	6420-6243	Charcoal	Acid-Base-Acid	Level 5	Indoor
TÜBİTAK - 0996	7660±37	6590-6445	Sediment	Acid wash	Level 6	Open space
TÜBİTAK - 2154	7669±35	6591-6446	Bone	Collagen Extraction - Ultrafiltration	Level 6	Human skeleton
TÜBİTAK - 1331	7715±34	6612-6471	Bone	Collagen Extraction - Ultrafiltration	Level 6	Human skeleton
TÜBİTAK - 0995	7772±43	6681-6496	Sediment	Acid wash	Level 6	Courtyard
TÜBİTAK - 2153	7840±34	6776-6592	Charcoal	Acid-Base-Acid	Level 7	Courtyard
TÜBİTAK - 0826	7843±32	6769-6600	Charcoal	Acid wash	Level 7	Indoor
TÜBİTAK - 2143	7886±33	6831-6642	Charcoal	Acid wash	Level 7	Courtyard
TÜBİTAK - 0998	7904±37	6846-6648	Charcoal	Acid-Base-Acid	Level 7	Indoor
TÜBİTAK - 0999	7944±38	7032-6694	Charcoal	Acid-Base-Acid	Level 8:	Courtyard
TÜBİTAK - 2157	8147±35	7192-7052	Charcoal	Acid-Base-Acid	Level 8	Courtyard

Table 2. The %C, %N, C:N, δ¹³C results of collagen for the dated bones.

Lab. Code	%C	%N	C:N (atomic ratio)	δ ¹³ C (AMS Measurement)
TÜBİTAK - 2149	44.52	16.05	2.97	-19.52±0.58
TÜBİTAK - 2154	44.83	16.01	3.00	-18.56±0.56
TÜBİTAK - 1331	45.48	16.23	3.00	-19.43±0.51

A table is added for the %C, %N, C: N, δ¹³C results of collagen for the dated bones from Bahçelievler Settlement. We don't have δ¹⁵N data for these samples (Table 2).

In this study, Bayesian statistical modelling was carried out where contexts were taken as phases. The

modelling of phases as being continuous has also been applied according to archaeological periods as well (Fig.5) Accordingly, the 3 phases were selected as continuous.

This model assumption can be considered hypothetical because chronological gaps may occur (Fig. 5).

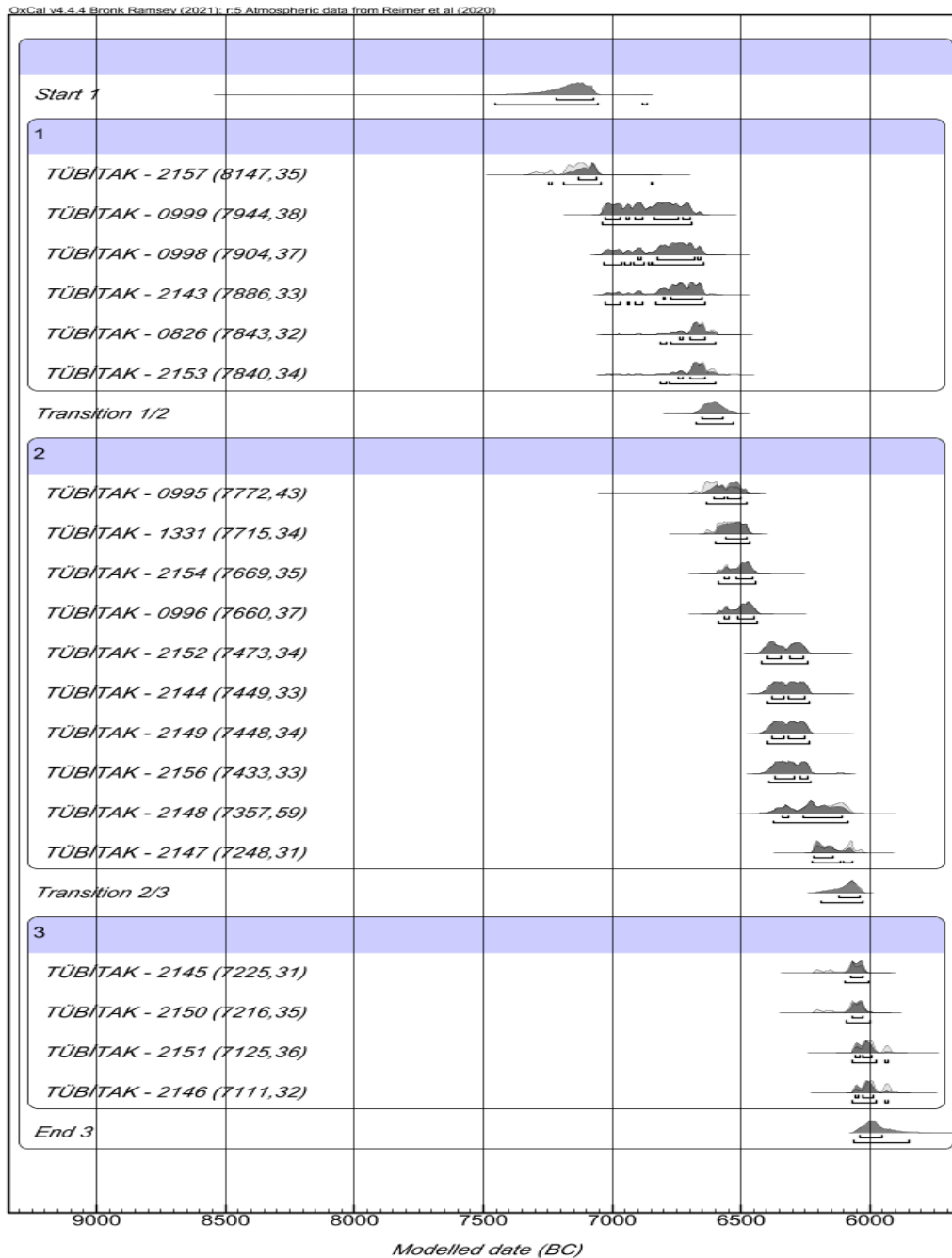


Figure 5. Bayesian statistical modelling is given where contexts are taken as phases (edited by TÜBİTAK-MAM).

3. RESULTS

Before revealing the chronology of Neolithic Bahçelievler, it would be useful to review the unique aspects of the settlement and the material cultural remains. Bahçelievler settlement has been dated from between 8147 ± 35 to 7111 ± 32 BP (7192 - 7052 to 6063 - 5971 cal BC) (Fig.6, Table 1). It is understood that the round/oval planned structures in the settlement were built with the branch knitting technique from the first phases. In the oldest phase (Level 8), there is an oval

house with a pit bottom dug into the main soil, while the oval/round structures in other phases are flat-bottomed (Levels 7-3). The empty spaces between houses were used as workshops. All of the human remains recovered belonged to individuals who were buried in the hocker position in the pits dug in courtyards. In the last prehistoric phase (Level 2), the architectural tradition changes sharply; and the architecture is represented by rectangular planned structures. The uppermost layer of the settlement represents the Iron Age (Level 1).

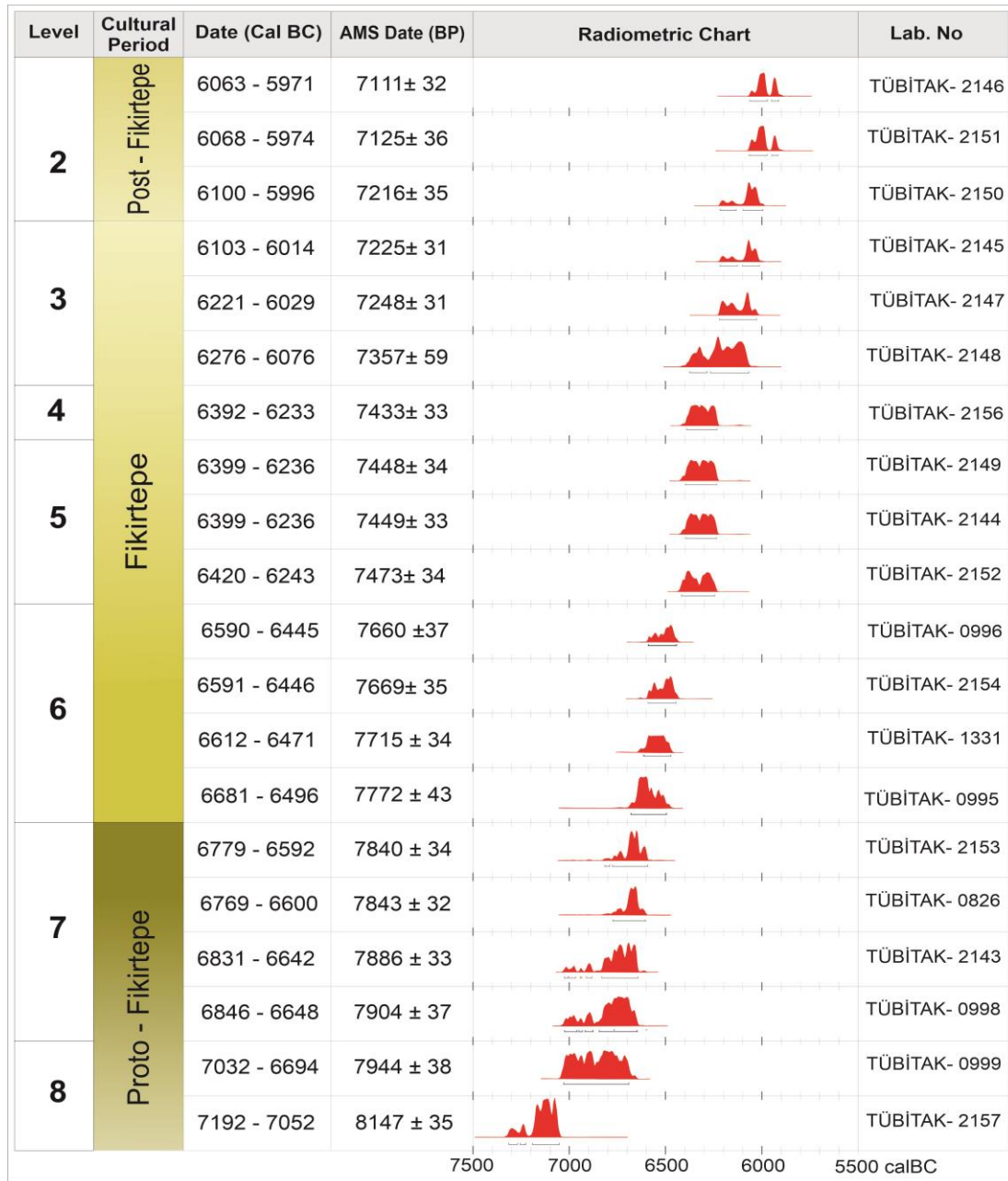


Figure 6. Neolithic to Early Chalcolithic Chronology of Bilecik Bahçelievler Settlement (Excavation archive)

The Neolithic pottery from the Bahçelievler settlement is divided into six main ware groups. Sherds belonging to the buff, cream and brown wares are more abundant in the early phases. The walls of simple vessels with narrow rims and straight rims are generally thick. Significant and intense grit tempering was observed in the paste of the vessels found in levels 8-7 which are dated to 7192-7092 – 6779-6592 Cal BC (Fig.6, Table 1). Grit inclusions in Level 8-7 pottery clays can be divided into three subgroups. The first group consists of pebble, coarse sand, and suchlike. (it can be found everywhere) in the stone added wares. The second group is basalt or granite tempered wares (selected), and the third group is quartz or lime tempered wares (selected or naturally found in the

clay paste). As a result of micromorphological examination and analysis to be made in the future, the boundaries and/or characteristics of the above groups will be further clarified. The level 7 pottery group is generally like the previous level. However, it was observed that the light tones in the surface colour of the vessels decreased in number and the red, mottled brown ware group became more pronounced. The variety of forms of the vessels is not as diverse as in the previous phase. The form of Level 8 vessels was added to Level 7 with narrow-rimmed vessels having retracted rims and very few open vessels, such as bowls.

In Level 6 which is dated to 6681-6496 – 6590-6445 Cal BC (Fig.6, Table 1), significant differences were

found in the Bahçelievler pottery-making tradition. Dark wares, which are perhaps the predecessors of Fikirtepe Culture Pottery, together with occasional and a few scratch-scraped decorations, begin to be seen in this phase. In addition, a significant variation in the form of Bahçelievler Neolithic vessels was detected with this level. Conical bowls, slightly “S-profile” bowls and shallow-necked spherical bowls were also used together with narrow rimmed pots. One of the obvious differences in Level 6 is the colour change on the vessels’ surface. Dark tones begin to gain weight on the surface of the sherds belonging to this level, and the buff-brown tones have decreased compared to the previous phases. Orange and red tones also became more evident in the pottery paste colours. Mica begins to appear in Level 6 pottery pastes, especially in the red/orange-coloured pastes. Based on these mica samples, it can be argued that different clay deposits from the previous levels began to be used. Advanced analysis methods will clarify this situation. Significant changes were also detected in the pottery paste additives. Quartz or lime tempered pastes, which are detected in levels 8-7, are decreasing, and basalt-tempered pastes are rarely seen. Grit addition is usually evident in pastes of this stage. A small contribution of sherds was also detected.

With Level 5 of the Bahçelievler settlement (approximately after 6400 BC), the number of dark wares and incised decorations of Fikirtepe Culture increased. This level is dated to 6420-6243 – 6399-6236 Cal BC (Fig.6, Table 1). Level 5 pottery container attachments such as handles have also increased. The number of narrow rimmed pots decreased; instead, the number of steep-sided pots, bowls or conical body bowls increased. The forms of the “S-profile” bowls have also diversified. Vertebrate “S-profile” vessels have come into use, albeit a little. The number of shallow-necked spherical-bodied jars and everted-necked jars has also increased. Level 4 is dated to 6392-6233 Cal BC according to a single C_{14} date (Fig.6, Table 1). Red and orange wares increased significantly in this level. Sherds with incised decorations have also become evident and the variety of decoration has increased. Box-shaped vessels, albeit very few, were also found.

In level 3, which is dated to 6276-6076– 6103-6014 Cal BC (Fig.6, Table 1), the pottery generally consists of dark ware. Red and orange items decrease in number at this stage. The numerical predominance of Black, Dark Brown, Mottled Dark Brown, and Red-brown wares is seen. It was determined that the boxes, which are the phenomenon vessel form of the Northwest Anatolian Neolithic, were used more intensively in Level 3. In addition, the diversity of decoration, which is the defining feature of Fikirtepe Culture, has increased and the surface of the vessel has

begun to be processed more intensively. The variety in container forms has increased to a great extent. In particular, the number of “S-profiled” vessels has increased enough to be divided into subgroups. It was also determined that the number of long-necked spherical-bodied pots increased with this phase. In Level 2, which represents the highest phase of the Bahçelievler settlement, Fikirtepe Culture is dominant. This level is dated to 6100-5996 – 6063-5971 Cal BC (Fig.6, Table 1). Fikirtepe pottery containers are usually in dark tones. The number of orange/red wares has decreased, while the number of black and dark brown wares increased. In this level, where the number of box-shaped vessels increased, the foot typology of the boxes also diversified.

The first evaluations made on the chipped stone finds show that the local flint was used to a large extent in the settlement, and that obsidian was imported from Central Anatolia at a rate of 9% according to the data, in which only the first year was examined (Kolakaya-Bostancı & Fidan, 2021). The chipped stone assemblage in Bahçelievler, where the chipping process took place mostly in the courtyards, is based on the production of blades and bladelets. Among the tool types recovered from the buildings, a few sickle blades and bladelets were mostly found, which indicates that agriculture had an important place in the settlement. This shows that the general character of the settlement is very similar to other Northwest Anatolian finds, where grinding stones and pestles for agriculture were recovered (Kolakaya-Bostancı & Fidan, 2021; Gatsov 2003; Gatsov, 2009; Balcı 2011; Balcı 2016; Budd et. al 2020).

There is a wide range of economic plant data. Archaeobotanical studies were reported by Hüreyila Balcı who is PhD candidate from Koç University. The cereal group has more abundance compared to the pulse group. The cereal group includes *Triticum ssp. aestivum/durum* (bread/hard wheat), *Hordeum vulgare ssp. Vulgare* (six-row barley-naked/hulled), *Triticum turgidum ssp. Dicocon* (emmer wheat), *Triticum monococcum ssp. Monococcum* (einkorn wheat - only one grain), and *Triticum/Hordeum* (cereal/barley fragments). Only lentil and bitter vetch seeds are identifiable in the pulse group. From the gathered fruits/seeds, we obtained a good assemblage of *Pistacia ssp.* (pistacia), about 80 fruits, especially from Phase 5 (courtyard area), and two fruits of *Vitis ssp.* (grape) were identified. When we look at the data, it is not possible to talk about a full farming package in the site, especially for the pulse group; on the other hand, the site shows similarities and some dissimilarities with other sites in the Marmara region concerning economic plant selection. Bahçelievler is important in providing earlier dates as current evidence

so that the data can help us to interpret the early farming activities in the region.

When we look at the animal bone remains at Bahçelievler, the domestic fauna includes sheep, goats, and cattle; while in the wild fauna, bone remains of Cervidae (red deer, fallow deer) and wild boar were identified. Non-mammalian fauna includes gastropods and tortoises. It was observed that long or flat bones of medium and/or large mammals were mostly preferred for bone tools. Deer antlers were also used. Older animal bones were used more. Among the finds are awls, bowls, spatulas, pendants, and a flute. Bone tools were reported by Hazal Azeri who is PhD candidate from Frei University.

4. DISCUSSION

The nature of prehistoric chronology does not allow us to determine and examine any period sequentially because the cultural material or evidence of age from any stage of prehistory is probably a combination of the remains of several decades or even centuries. In terms of defining the chronology of the studied period, it is very unlikely that it refers to phases shorter than 50 years. Although we are talking about ± 25 years owing to the AMS method used in radiocarbon analysis and detailed studies in recent years, the calibrated date range and variation may reach a century. Thus, not only is there a problem dealing with a period that may be in a state of continuous, gradual change but the time and space itself that we describe represents a mixture of remnants of society during that period of change.

In some ways, the most obvious way, and certainly the most widely accepted, is to allocate the date based on the relative comparison of material distribution and temporal variability based on cultural material comparisons made previously. Material-based relative comparison is the composite form of the process that is the subject of this study, rather than reflecting any particular time of the settlements. It should not be forgotten that if the material remains due to sudden abandonment at one stage of a single settlement was either accumulated in a short time or abandoned gradually, it could last for more than tens of years. To provide the absolute dating of each site, the ideal dating can be done by comparing it with abundant radiocarbon dates and contemporary sites. While the existence of an irregular radiocarbon chronology and a small amount of dating analysis for the Western Anatolian Neolithic period is evident, the absolute chronology data of the Bahçelievler, Ulucak and Çatalhöyük settlements confronts us with an important problem to solve. However, it is more realistic to assume that the apparent contemporaneity of a combination of radiocarbon and pottery chronological data can only be separated by 100 years, rather

than being dated to the same year. In addition to the difficulties of this approach, the existence of an unknown process in the production of any material remains puts us in a quandary. When all these aspects are evaluated together, the main axis of this study is not only to aim for an absolute dating method, but also to incorporate the mutual examination of archaeological elements such as pottery, stone tools and botanical data and compare the results within a multi-window perspective. Therefore, in this study, we have tried to present a more realistic range of dating by mentioning material remains as well as radiocarbon data.

The basic reason for groupings formed by relative chronologies divided into regions or sub-regions is to divide them into larger, more significant cultural periods. However, this chronological method based on relative and cultural names may cause some unresolved problems. Periodic and/or regional chronologies created with relative chronologies traditionally use culture designations. The chronology of Fikirtepe Culture is a good example of this. For example, while talking about Fikirtepe Culture, distinctions such as Archaic Fikirtepe and Classical Fikirtepe are made. In the case of Fikirtepe Culture, these distinctions were generally accepted without first making a critical examination of their validity, and all settlements were slotted into their relative chronology accordingly. The Bahçelievler excavations and the dating of the levels by the AMS method also provide a good opportunity to observe the development of the culture itself.

The problem of Neolithization and the emergence of the first pottery in Western Anatolia has been clarified a little more with the Barcın, Uğurlu, Ulucak and Bahçelievler excavations carried out in recent years (Fig. 1). Especially the Barcın and Bahçelievler excavations in Northwest Anatolia are significant in this context. Likewise, it can be argued that the earliest pottery found in both settlements has pivotal importance in terms of both the formation process and the inter-regional interaction and understanding of the Neolithic network. Due to the geographical location of the settlements in question, and interaction with peoples in the Balkans, the coastal Aegean region, and other important settlements in Central Anatolia, the Neolithization of the entire western Anatolia has the potential to illuminate the problem through a different window.

As mentioned above, although the Neolithization process of Western Anatolia has been studied to varying degrees over the last four decades, starting with the Fikirtepe excavations, the basic assumptions and models have remained essentially unchanged. Most of the generalizations about the Northwest Anatolian chronology are based on Fikirtepe chronology, and the Initial Neolithic has been the traditional cultural

group, defined as Classical to Developed Fikirtepe Culture. In the context of cultural history, this is perhaps a useful chronological sequence. However, excavations in recent years have also revealed the inadequacy of this nomenclature. When talking about the chronology of the Neolithic Period in Western Anatolia, there is need for a more defined temporal se-

quence in which the years are specified. For this reason, we would like to offer the following chronological nomenclature as a suggestion here for the first time (Table 3). Since Fikirtepe Culture spread in the Marmara region for many years, a chronology has been created using Fikirtepe names, since they have become familiar as such.

Table 3. New chronological nomenclature and latest dating of the Northwest Anatolia (edited by authors).

Cultural Stages	Definitional Chronology	Date
Post-Fikirtepe	Late Neolithic-Early Chalcolithic Yarımburgaz IV Developed Fikirtepe	5800/5600 to 6100/6000
Fikirtepe I-II-III	Classical Fikirtepe Archaic Fikirtepe Pendik	6100/6000 to 6600/6500
Proto-Fikirtepe	Pre-Pottery Neolithic Initial Neolithic Early Pottery Neolithic	6600/6500 to 7100/7000

5. CONCLUSION

Interpreting the results obtained from archaeological excavations scientifically is indispensable nowadays. The most accurate result is achieved when the archaeological and archaeometric results are mutually matched with each other. The archaeological data and age determination analyses of the Bahçelievler excavations have enabled us to reach important conclusions. Results from 20 measurements are given in table 1. They agree with the stratigraphy and context based on their radiocarbon dates of 7th to 8th millennium BC. Calibrated date intervals together with the geographical distribution are presented in this table.

According to the results of C14, the Bilecik-Bahçelievler settlement becomes an open-air settlement from which the earliest results from the Neolithic Period in Western Anatolia are taken. However, the fact

that agriculture, domestication, and pottery were also present in the earliest level of the settlement, starting from 7100/7000 BC, is very important for Western Anatolia in terms of it hosting many firsts. In addition, the archaeological and chronological results obtained from Bahçelievler provide new information about the beginning and development of Fikirtepe Culture, which gave its name to the Neolithic Period Culture in Northwest Anatolia. This shows that Fikirtepe Culture should be re-evaluated. In fact, new data covering the thousand years that Bahçelievler, which was inhabited uninterruptedly between roughly 7000 BC and 6000 BC, opens the chronology of the Western Anatolian Neolithic Period to discussion. Indubitably, new research and excavations yet to be made will reduce the unknowns about the Neolithic Period, which we have begun to understand much better in Western Anatolia in recent years.

AUTHOR CONTRIBUTION

Conceptualization, S.S. and E.F.; methodology, E.F., T.D., S.S.F and E.İ.; validation, E.F., S.S.F.; investigation, E.F. and S.S.; resources, S.S.F; data curation, T.D. and E.İ.; writing – original draft preparation, E.F., S.S., S.S.F., T.D.; writing, review and editing, S.S. and E.F.; visualization, S.S.; supervision, E.F.; project administration, E.F., S.S.F. All authors have read and agreed to the published version of the manuscript.

ACKNOWLEDGEMENTS

This research was able to be carried out thanks to the generous funding of the radiocarbon analysis provided by Bilecik Municipality, to whom we are most grateful. The excavations were conducted with the permission of the Turkish Ministry of Culture and Tourism. Sezer Seçer Fidan is a PhD candidate. We would like to thank the TÜBİTAK MAM, National 1Mv Accelerated Mass Spectroscopy (AMS) Laboratory staff for their devoted efforts and sensitivity. We would also like to thank the Bahçelievler excavation team members for their devoted efforts and Mr Graham Lee for proofreading the English text of the article.

REFERENCES

- Alpaslan-Roodenberg M. S. and Roodenberg J. (2021) Doğu Marmara'nın İlk Çiftçi Köylerinde Neler Oldu: Şiddet, İnsan Yaşamının Bir Parçası mıydı? *Arkeoloji ve Sanat Dergisi*, Vol. 167, pp. 21-36. <https://reich.hms.harvard.edu/sites/reich.hms.harvard.edu/files/inline-files/Makale.pdf>
- Arimura M., Balkan-Atlı N., Borell F., Cruells W., Duru G., Erim-Özdoğan A., Ibanez J., Maeda O., Miyake Y., Molist M. and Özbaşaran M. (2000) A New Neolithic settlement in the Urfa region: Akarçay Tepe, 1999. *Anatolia Antiqua*, Vol.8, pp. 227-255. <https://doi.org/10.3406/anata.2000.949>
- Balcı, H. (2018) *Kuzeybatı Anadolu'da Tarımın Başlangıcı: Barcın Höyük Bitki Kalıntıları Üzerine Bir Değerlendirme*. Social Sciences Institute, MA Thesis, İstanbul University.
- Balcı, S. (2011) The Chipped Stone Industry of Aktopraklık C (Bursa): Preliminary Results. *Anatolia Antiqua*, Vol.XIX, pp. 1-11.
- Bittel K. (1960) Fikirtepe Kazısı. V. *Türk Tarih Kongresi – Kongreye Sunulan Tebliğler*. Türk Tarih Kurumu Basımevi, Ankara, Turkey.
- Bronk-Ramsey C. (2009) Bayesian analysis of radiocarbon dates. *Radiocarbon*, Vol. 51, No.1, pp. 337-360. <https://doi.org/10.1017/S0033822200033865>
- Brock F., Higham T., Ditchfield P. and Ramsey C. (2010) Current Pretreatment Methods for AMS Radiocarbon Dating at the Oxford Radiocarbon Accelerator Unit (ORAU). *Radiocarbon*, Vol. 52, No.1, pp. 103-112. <https://doi.org/10.1017/S0033822200045069>
- Budd, C., A. Galik, S. Alpaslan-Roodenberg, R. Schulting, M. Lillie. (2020) Early farmers in northwest Turkey: First dietary isotopes study of human diet at Neolithic Barcın Höyük. *Journal of Archaeological Science: Reports* Vol. 31, p. 1-8. DOI: <https://doi.org/10.1016/j.jasrep.2020.102288>
- Çevik Ö., and Erdoğan, B. (2020) Absolute chronology of cultural continuity, change and break in western anatolia between 6850-5460 cal. BC: the ulucak höyük case. *Mediterranean Archaeology and Archaeometry*, Vol. 20, No 1, pp. 77-92. DOI: 10.5281/zenodo.3605670
- Çevik Ö., Vuruşkan O. and Sivil C. (2020) Ulucak Höyük (6850-5460). *İzmir Araştırmaları Dergisi*, Vol.12, pp. 11-40. https://www.academia.edu/43986348/%C4%B0ZM%C4%B0R_ARA%C5%9ETIRMA-LARI_DERG%C4%B0S%C4%B0_12_SAYI
- Çilingiroğlu Ç., Dinçer B., Uhri A., Gürbıyık C., Baykara İ. and Çakırlar C. (2016) New Palaeolithic and Mesolithic sites in the eastern Aegean: The Karaburun Archaeological Survey Project. *Antiquity*, Vol. 90, No. 353, E1. <https://doi.org/10.15184/aqy.2016.168>
- Çilingiroğlu Ç. (2017) The Aegean Before and After 7000 BC: Defining Patterning and Variability. *Neo-Lithics*, Vol. 16, pp. 32-41. https://www.exorient.org/repository/NEO-LITHICS/NEO-LITHICS_2016_1.pdf
- Çilingiroğlu Ç., Kaczanowska M., Kozłowski J. K., Dinçer B., Çakırlar C. and Turan D. (2020) Between Anatolia and the Aegean: Epipalaeolithic and Mesolithic Foragers of the Karaburun Peninsula. *Journal of Field Archaeology*, Vol. 45, No. 7, pp. 479-497. <https://doi.org/10.1080/00934690.2020.1786929>
- DeNiro M. J. (1985) Postmortem preservation and alteration of in vivo bone collagen isotope ratios in relation to palaeodietary reconstruction. *Nature*, Vol. 317 (6040), pp. 806-809. <https://doi.org/10.1038/317806a0>
- Doğan T., İlkmen T. and Kulak F. (2021) A new national 1 MV AMS laboratory at TÜBİTAK MRC in Turkey. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*. Vol. 509, pp. 48-54. <https://doi.org/10.1016/j.nimb.2021.08.013>
- Efe T. (1995) İç Batı Anadolu'da İki Neolitik Yerleşme: Fındık Kayabaşı ve Akmakça. In İ. *Metin Akyurt-Bahattin Devam Anı Kitabı*, H. Erkanal et al. (eds.), pp. 105-114, Arkeoloji ve Sanat Yayınları, İstanbul, Turkey.
- Efe T., Türkteki M., Sarı D. ve Fidan E. (2015) Bilecik İli 2013 Yılı Yüzey Araştırması. 32. *Araştırma Sonuçları Toplantısı*, Vol. 1, pp. 495-504. Türkiye Kültür ve Turizm Bakanlığı Yayınları, Ankara, Turkey. <https://kvmgm.ktb.gov.tr/TR-44760/kazi-sonuclari-toplantilari.html>
- Erdoğan B. (2017) A Preliminary Report on the Earliest Neolithic Levels at Uğurlu on the Island of Gökçeada. *Anatolica*, Vol. XLIII, pp. 71-82. https://www.nino-leiden.nl/publication/anatolica-xliii#An43_03-Erdogu
- Erdoğan B. and Çevik Ö. (2020) Kıyı Batı Anadolu Kronolojisi ve Terminolojisinin Yeniden Değerlendirilmesi. *Arkeoloji Dergisi*, Vol. 25, pp. 45-66. <https://dergipark.org.tr/tr/download/article-file/1324741>
- Erim-Özdoğan A. and Sanialtun S. (2018) Sumaki Höyük Batman/Beşiri. In: *Batman Müzesi İlisu Barajı HES Projesi Arkeolojik Kazıları*, F. Baş (ed.), pp. 55-88. Batman Museum Publications, Batman/Turkey.

- Fidan E. (2020). Fikirtepe Kültürü ve Öncesi: Bilecik Bahçelievler Kurtarma Kazısı'nın İlk Sonuçları. *Arkeoloji ve Sanat Dergisi*, Vol. 163, pp. 29-38.
- French D. (1967) Prehistoric Sites in Northwest Anatolia I. The İznik Area. *Anatolian Studies*, Vol. XVII, pp. 49-100.
- Gatsov, I. (2003). The Latest Results from the Technological and Typological Analysis of Chipped Stone Assemblages from Ilıpınar, Pendik, Fikirtepe and Mentеше, NW Turkey. *Documenta Praehistorica*, Vo.XXX, pp. 153-158.
- Gatsov, I. (2009) Prehistoric Chipped Stone Assemblages from Eastern Thrace and the South Marmara Region 7th-5th mill. B.C. *BAR International Series*, (1904), pp. 1-135.
- Gerritsen F. and Özbal R. (2019) Barcın Höyük, a seventh millennium settlement in the Eastern Marmara region of Turkey. *Documenta Praehistorica*, Vol. 46, pp. 58-67. <https://doi.org/10.4312/dp.46.4>
- Gerritsen F. A., Özbal R. and Thissen L. C. (2013) The Earliest Neolithic Levels at Barcın Höyük, Northwestern Turkey. *Anatolica*, Vol. XXXIX, pp. 53-92. <https://doi.org/10.2143/ANA.39.0.2990784>
- Guilbeau D., Kayacan N. Altınbilek-Algül Ç. Erdoğan B. and Çevik Ö. (2019) A comparative study of the Initial Neolithic chipped-stone assemblages of Ulucak and Uğurlu. *Anatolian Studies*, Vol. 69, pp. 1-20. <https://doi.org/10.1017/S0066154619000024>
- Güvenç C. (2020) Sosyal Bilimlerde Yöntem Olarak Pozitivizm Bakış Açısı ve Değerlendirmesi. *İşletme Ekonomi ve Yönetim Araştırmaları Dergisi*, Vol. 3, No. 2, pp. 109-120. <https://doi.org/10.33416/baybem.672257>
- Gündüzalp S. (2021) Beginning and development of pottery use in Upper Mesopotamia in the light of Sumaki Höyük data. *Neo-Lithics*, Vol. 21, pp. A29-A31. <https://doi.org/10.48632/nl.2021.1.84912>
- Hajdas I., Michczyński A., Bonani G., Wacker L., and Furrer H. (2009) Dating Bones near the Limit of the Radiocarbon Dating Method: Study Case Mammoth from Niederweningen, ZH Switzerland. *Radiocarbon*, Vol. 51, No. 2, 675-680. <https://doi.org/10.1017/S0033822200056010>
- Horejs B., Milić B., Ostmann F., Thanheiser U., Weninger B. and Galik A., (2015) The Aegean in the Early 7th Millennium BC: Maritime Networks and Colonization. *Journal of World Prehistory*, Vol. 28, pp. 289-330. <https://doi.org/10.1007/s10963-015-9090-8>
- Horejs B. (2019) Long and short revolutions towards the Neolithic in Western Anatolia and Aegean. *Documenta Praehistorica*, Vol. XLVI, pp. 68-83. <https://doi.org/10.4312/dp.46.5>
- Kansu Ş. A. (1963) Marmara Bölgesi ve Trakya'da Prehistorik İskân Tarihi Bakımından Araştırmalar (1959-1962), *Belleten*, Vol. 27, pp. 657-705. <https://belleten.gov.tr/tam-metin-pdf/3173/tur>
- Kartal M. (2003) Anadolu'nun Epi-Paleolitik Dönem Buluntu Toplulukları: Sorunlar, Öneriler, Değerlendirmeler ve Çeşitli Yaklaşımlar. *Anadolu*, Vol. 24, pp. 35-43. https://doi.org/10.1501/andl_0000000288
- Karul N. (2009) Kuzeybatı Anadolu'da Anahatlarıyla Neolitik-Kalkolitik Dönemler. *Türk Eskiçağ Bilimleri Enstitüsü Haberler*, Vol. 28, pp. 1-6. http://turkinst.org/my_documents/my_files/PDF/Haberler/haberler_28.pdf
- Kolankaya Bostancı N. and Fidan E. (2021) Bilecik Bahçelievler Neolitik Çağ Yontmataş Topluluğuna Ait İlk Değerlendirmeler. *Anadolu Araştırmaları*, Vol. 0, No. 24, pp. 93-116. <https://doi.org/10.26650/anar.2021.24.935202>
- Kurtyılmaz D. (2018) Pozitivizmin Doğrulama ve Yanıtlama İlkeleri Ekseninde Modern Bilimin Bilgiyi Metafizikten Arındırma İdeali. *BEÜ İlahiyat Fakültesi Dergisi*, Vol. 5, No. 1, pp. 15-33
- Liritzis, I., Drivaliari, A., and Vafiadou, A. (2021) A review of archaeometric results on sarakenos cave, Greece: first stable isotope data (18O and 13C) on mollusk shell (unio sp) including OSL dating and characterization-provenance of ceramics by pXRF. *Scientific Culture*, Vol. 7, No. 1, pp. 93-110. DOI: 10.5281/zenodo.3742358
- Mellaart J. (1967) Anatolia Before 4000 BC. In. *Cambridge Ancient History*, Vol. 1, Chapter VII, pp. 304-326.
- Mook W.G. and Streurman H.J. (1983) Physical and chemical aspects of radiocarbon dating. *PACT 8*, Vol. II, pp. 45-53.
- Nishiaki Y. and Le Mière M. (2017) The oldest Neolithic pottery at Tell Seker al-Aheimar, the Upper Khabur, Northeast Syria. In: *The Emergence of Pottery in West Asia: The Search for the Origin of Pyrotechnology*, A. Tsuneki, O. Nieuwenhuyse, and S. Campbell (eds), pp. 43-54. Oxford: Oxbow Books.
- Oy H. (2021) New survey and typological study of prehistoric wares of dutluca region, Uşak, Turkey. *Mediterranean Archaeology and Archaeometry* Vol. 21, No. 2, pp.69-92. DOI: 10.5281/zenodo.4681727
- Özdoğan E. (2015). Current Research and New Evidence for the Neolithization Process in Western Turkey. *European Journal of Archaeology*, Vol. 18, No. 1, pp. 33-59. <https://doi.org/10.1179/1461957114Y.0000000079>

- Özdoğan E. (2019) Manyas Gölü Doğu Kesim Neolitik Dönem Araştırmaları. 36. *Araştırma Sonuçları Toplantısı*, Vol. 2, pp. 41-52. Türkiye Kültür ve Turizm Bakanlığı Yayınları, Ankara, Turkey. <https://kvmgm.ktb.gov.tr/TR-44760/kazi-sonuclari-toplantilari.html>
- Özdoğan M. (1979) Fikirtepe. *Unpublished PhD Thesis*, İstanbul Üniversitesi, İstanbul.
- Özdoğan M. (1997) The Beginning of Neolithic Economies in Southeastern Europe: An Anatolian Perspective. *Journal of European Archaeology*, Vol. 5, No. 2, pp. 1-33. <https://doi.org/10.1179/096576697800660267>
- Özdoğan M. (2007). Marmara Bölgesi Neolitik Çağ Kültürleri. In *Anadolu'da Uygarlığın Doğuşu ve Avrupa'ya Yayılımı. Türkiye'de Neolitik Dönem: Yeni Kazılar, Yeni Bulgular*, M. Özdoğan ve N. Başgelen (eds.), pp. 401-426 (Text), pp. 405-430 (Plate). Arkeoloji ve Sanat Yayınları, İstanbul, Turkey
- Özdoğan M. (2011) Archaeological Evidence on the Westward Expansion of Farming Communities from Eastern Anatolia to the Aegean and the Balkans. *Current Anthropology*, No. 52, No. 4, pp. 415-30. <https://www.journals.uchicago.edu/doi/10.1086/658895>
- Özdoğan M. and Gatsov I. (1998) The Aceramic Neolithic Period in Western Turkey and in the Aegean. *Anatolica*, Vol. XXIV, pp. 209-232. DOI: 10.2143/ANA.24.0.2015481
- Özdoğan M. and Koyunlu A. (1986) Yarımburgaz Mağarası, 1986 yılı çalışmalarının ilk sonuçları ve bazı gözlemler. *Arkeoloji ve Sanat Dergisi*, Vol. 32/33, pp. 4-17.
- Perlès, C., Quiles, A. and Valladas H. (2013). Early seventh-millennium AMS dates from domestic seeds in the Initial Neolithic at Franchthi Cave (Argolid, Greece). *Antiquity*, Vol. 87, pp. 1001-1015 [doi:10.1017/S0003598X00049826](https://doi.org/10.1017/S0003598X00049826)
- Reimer P., Austin W., Bard E., Bayliss A., Blackwell P., Bronk-Ramsey C., Butzin M., Cheng H., Edwards R., Friedrich M., Grootes P., Guilderson T., Hajdas I., Heaton T., Hogg A., Hughen K., Kromer B., Manning S., Muscheler R., Palmer J., Pearson C., van der Plicht J., Reimer R., Richards D., Scott E., Southon J., Turney C., Wacker L., Adolphi F., Büntgen U., Capano M., Fahrni S., Fogtmann-Schulz A., Friedrich R., Köhler P., Kudsk S., Miyake F., Olsen J., Reinig F., Sakamoto M., Sookdeo A. and Talamo S. (2020) The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0-55 cal kBP). *Radiocarbon*, Vol. 62, pp. 725-757. <https://doi.org/10.1017/RDC.2020.41>
- Roodenberg J, van As A., Jacobs L. and Wijnen M. H. (2003) Early Settlement in the Plain of Yenişehir (NW Anatolia). The Basal Occupation Layers at Menteşe. *Anatolica*, Vol. XXIX, pp. 17-60. DOI: 10.2143/ANA.29.0.2015511
- Roodenberg J. and Schier W. (2001) Radiocarbon determinations, In: *The Ilıpınar excavations II*, J.J. Roodenberg and L.C. Thissen (eds.). PIHANS 93, pp. 257-278. Leiden: Nederlands Instituut voor het Nabije Oosten.
- Seeher J. (1987). *Demircihöyük. Die Ergebnisse der Ausgrabungen 1975-78, III, Die Keramik 1*, Mainz, Verlag Philipp von Zabern.
- Takaoğlu T., Korkut T., Erdoğan B. and Işın G. (2014) Archaeological evidence for 9th and 8th millennia BC at Girmeler Cave near Tlos in SW Turkey. *Documenta Praehistorica*, Vol. 41, pp. 111-118. <https://doi.org/10.4312/dp.41.6>