
	<p>Списание ЕПОХИ Издание на Историческия факултет на ВТУ „Св. св. Кирил и Методий“</p> <p>Journal EPOCHI [EPOCHS] Edition of the Department of History of “St. Cyril and St. Methodius” University of Veliko Tarnovo</p>		<p>Том / Volume XXXI (2023). Книжка / Issue 1</p>
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DOI: 10.54664/LSYH4086

## CHALCOLITHIC BONE SPINDLE WHORLS IN BULGARIA: FINDS FROM THE “TILKIYUK” SETTLEMENT MOUND (SADIEVO, SOUTHEASTERN BULGARIA)

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**Abstract:** *This study is focused on the collection of bone spindle whorls found at the Tilkiyuk settlement mound near the village of Sadievo, southeastern Bulgaria. The twelve animal bone spindle whorls are dated to the second half of the Chalcolithic period in Bulgaria (4600/4550 – 4100/3800 BC). The objects are made of the caput femoris of large ruminant species, and only one is made of scapula. The lack of whorls with trapezoidal and conical cross-section among the Tilkiyuk archaeological finds, usually made of the most common raw material (clay), posed the question about the specific development of local textile production in the settlement. These types of whorls are made of animal bones (and possibly wood), while ceramic sherds were used for flat spindle whorls. Standardization is observed in the production of bone spindle whorls – the same raw material, the same technological methods, and the same preference for two specific shapes only. The Tilkiyuk inhabitants had very good knowledge of these implements and their production. The earliest appearance of bone spindle whorls could be associated with the Middle Chalcolithic period (Maritsa IV–Karanovo V culture), but their greatest prevalence in the Late Chalcolithic cultural complex of Kodzhadermen-Gumelnitsa-Karanovo VI is a very distinctive pattern that was established in many Chalcolithic sites in Bulgaria.*

**Keywords:** *spindle whorls; processed animal bones; bone technology; chronological distribution; Chalcolithic; Bulgaria.*

### Introduction

Prehistoric weaving and spinning activities are well recorded archaeologically. Loom weights and spindle whorls are often found during archaeological excavations in prehistoric sites in Bulgaria, which proves the significant role of these items in the everyday life of prehistoric societies. Several papers focused on this type of archaeological finds examine the typology, functionality, geographical and chronological distribution of such items in association with textile production [Кочов, И. 2018, с. 13–24; Петрова, В. 2016, с. 115–218; Чохаджиев, А. 2003, с. 198–206; Чохаджиев, А. 2004, с. 227–238; Чохаджиев, А. 2007, с. 9–20; Kotsov, I. 2019, pp. 141–154]. These objects were usually made of clay and less often of other materials. In this study, the focus is on a group of bone spindle whorls found at the chalcolithic settlement mound of Tilkiyuk. Certain aspects regarding their chronological distribution are considered along with an attempt at tracing their appearance and development during the Chalcolithic period in Bulgaria (5<sup>th</sup> millennium BC).

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The settlement mound is located north of the Sadievo village (Sliven Province) in a locality called “Tilkiyuk” (“Fox Mound”) (**Fig. 1**). It is situated at the foot of the southern slope of the Sredna Gora Mountain, on a low terrace on the left bank of a stream whose waters are captured in the nearby fountain [**Койчев, Н.** 1959, с. 94; **Кънчев, М., Кънчева-Русева, Т.** 2005, с. 75]. The mound is oval in plan and slightly prolonged in an east–west direction. Its dimensions are 90–100 m and the preserved height reaches ca. 3 m. Gullies surround the mound terrace from the east and west. The soil is diluvial, shaped by the seasonal downpour in the space between them. Low non-erosion hills border the area from the north, and the terrain smoothly inclines downwards, 10–15° in the direction of the plain [**Todorova, N. et al.** 2003, p. 241]. The first archaeological excavations were carried out by the local historian Nikola Koychev in 1942 [**Койчев, Н.** 1959, с. 94]. Between 1975 and 1984, with some intervals, the excavations were led by Mityo Kanchev, curator at the Museum of History in the town of Nova Zagora [**Кънчев, М., Кънчева-Русева, Т.** 2005, с. 75]. Six horizons have been established on an area of 1700 m<sup>2</sup>, which belong to several chronological periods:

- first horizon: third phase of Kodzhadermen-Gumelnitsa-Karanovo VI;
- second horizon: second phase of Kodzhadermen-Gumelnitsa-Karanovo VI;
- third horizon: second phase of Kodzhadermen-Gumelnitsa-Karanovo VI;
- fourth horizon: Maritsa IV – Karanovo V;
- fifth horizon: Maritsa-Karanovo V;
- sixth horizon: Maritsa-Karanovo V [**Кънчев, М., Кънчева-Русева, Т.** 1993, с. 129,

Таблица 1].

### **Bone Spindles and Whorls**

Spinning is the art of pulling fibres from a mass and twisting them into a continuous thread. In the process of hand spinning, the spinner continuously rotates the spindle and the spun yarn attached to it. Three tools which may be used when spinning by hand are the distaff, the spindle, and the whorl, and of these the only one likely to be found by archaeologists is the whorl [**Becker, C. et al.** 2016, p. 114; **Carrington-Smith, J.** 1975, pp. 69, 79]. The spindle is a composite tool consisting of a rod and a weight (whorl). Spindle whorls are objects that function as a flywheel in the spindle. Their presence itself indicates an increase in the productivity of labour in comparison with the previous forms of production, because it allows for the manufacture of more thread within a shorter period of time. The whorl is a small, rounded object with various cross-sections. It has a hole perforated approximately in the geometric centre that attaches to the rod [**Basso Rial, R. E., López Padilla, J. E.** 2019, p. 28; **Grömer, K.** 2016, p. 73]. There are two main types of spindles according to the position on the rod: one having a whorl placed on the top of the spindle, and one having a whorl placed at the bottom of the spindle. The preferred type depends on the materials spun. High-whorl spindles are used for spinning plant fibres (e.g. flax, hemp), while low-whorl spindles are preferred for animal fibres (e.g. wool, goat hair) [**Kotsov, I.** 2019, p. 143; **Чохаджиев, А.** 2007, с. 11].

Large-scale complex studies on spindle whorls reveal certain patterns and trends as regards certain changes in their shape and size. However, their functionality as a flywheel cannot be subject to drastic shape variations, although there is some variation in other time periods. Their form and especially their ornamentation vary according to fashion trends and fads, which have always existed and still do [**Grömer, K.** 2016, pp. 82–83]. The different types of textiles used to produce garments, tents, carpets, sails, and sacks might have demanded whorls of very different weights and diameters depending on the thread’s coarseness and thickness and on the original raw material [**Becker, C. et al.** 2016, p. 114]. The spindle whorl has two main functions: it acts as a weight to the spindle, thereby maintaining the rotation inertia. In turn, this closely links the weight and size of the objects with their function. The spindle whorls’ weight usually varies between 10 and 150 g [**Чохаджиев, А.** 2007, с. 9, 12]. Spindles with heavy whorls have a lower rotation speed than those with light ones, and they rotate longer. Also, spindles with big whorls have a longer rotation time. Thus, when whorls are made of the same material, spindles with bigger whorls rotate slower and longer in comparison with the small ones. The former ones are suitable to spin long fibre materials (flax and hemp), while the latter

ones are suitable for spinning short fibre materials, such as animal ones which need more intensive twinning in order to make a strong thread [Kotsov, I. 2019, pp. 144–145]. As demonstrated by certain experiments, very heavy suspended spindle whorls (over 100 g) were not appropriate for making very fine yarns, and light whorls (> 25 g) were not efficient for thicker yarns, whereas the medium weights (40 g) would be suitable for almost every thickness of textile threads documented in prehistoric Europe [Grabundžija, A., Russo, E. 2016, p. 308; Grömer, K. 2016, pp. 86–87].

Furthermore, the shape and size of the perforation are also important. The perforation diameter should be suitable, so that the spindle rod can be inserted (0,3 – 1,0 cm), and the whorl diameter should be at least 2 cm, but not larger than 7–8 cm [Чохаджиев, А. 2007, с. 12]. Both the diameter and placement of the perforation define the type of the rotation, and they account for the stability of the whorl during the spinning process. To a certain extent, the perforation is also indicative of the spindle the whorl was used on. As this also defines the type of rotation, the dimensions and specific properties of the perforation should be considered as well [Grabundžija, A., Russo, E. 2016, p. 306]. As asymmetrically perforated whorls deviate from the proper rotation modes and harm the oscillations of the spinning process [Чохаджиев, А. 2007, с. 12], it can be suggested that the finds with perforations outside of the approximate centre of the whorl can be excluded from the group of the spindle whorls. An asymmetrically perforated whorl deviates from the expected trajectory during the rotation around its axis, thus harming the oscillations of the spinning process.

### The “Tilkiyuk” Bone Spindle Whorls

During the excavations at the Tilkiyuk mound, twelve spindle whorls made of animal bones were discovered (Fig. 2). Unfortunately, the preserved information regarding the context of the archaeological finds, as present in the field documentation, is insufficient. The depth measurements of the finds and the registered horizons are recorded in the textual field documentation and in the book of finds. Any data collected during the discovery of the finds are essential for analyzing the technology and functionality of this type of objects, as well as for exploring their role in the Chalcolithic domestic activities. For example, an important question refers to whether there were any traces of cloth or other materials related to textile production, present at the time of discovering the bone whorls. The animal bone spindle whorls were found in the following horizons: first (whorl No. 1217), second (whorls Nos. 405, 406, 728, 978, 900, 1164, 5886), third (whorl No. 5885), and fourth (whorls Nos. 2363, 2414, 2494). Only whorl No. 405 was found in dwelling No. 4 that refers to the second horizon. Only whorl No. 1164 is unfinished among the rest of the Tilkiyuk collection objects. This whorl has a smooth surface and lacks a perforation.

The spindle whorls studied here were made of the *caput femoris* of large ruminants (*Bos primigenius*, *Bos taurus*, and *Cervus elaphus*) (Fig. 3). Clearly, the different dimensions of the whorls' diameter depend on the age and sex of the animal. The smaller spindle whorls most likely originate from young animals that have not reached the age of sexual maturity (and maximal size and weight respectively), or they were made of bones belonging to female individuals (i.e. smaller in size than the male ones). The largest whorls from the Tilkiyuk collection include a find (item No. 2494, 65 mm diameter) made of the *caput femoris* of a male bovine (*Bos taurus*?). Only one whorl was made of a different bone from the animal skeleton – item No. 978, which was made of a large ungulate flat bone (*scapula*?) (Fig. 4). The bone fragment was probably extracted by using a stone tool and a percussion technique applied to the proximal part of the cranial side where the sunken surface is specific. The lateral edges of the semi-product were then smoothed by grinding the object on abrasive material until the round shape was obtained (Fig. 5). The information about the technology of the bone spindle whorls from the settlement mound near the village of Sadievo has been obtained by analyzing the striations on the surfaces of the objects. Traces of the final stages in processed bones have been recognized under low magnification (10 x), using a magnifying glass, and there is no evidence of *débitage* traces. We can assume that the separation of the *caput femoris* from the bone was performed by cutting (with a lithic tool) or by percussion on the area where the *caput* grips the thighbone. The *caput femoris* has very spongy tissue, thin and compact, and the separation had to be done carefully because fractures

usually occurred easily. According to observations on the Tilkiyuk bone spindle whorls, the next technological stage refers to smoothing the bone fragment on the abrasive stone surface to obtain two flat sides. There are erased spongy tissue and polishes on the surrounding edge as a result of removing the sharp edges (**Fig. 6**). The natural hemispherical shape of the *caput femoris* makes that part of the bone extremely suitable for producing spindle whorls, as it saves time and effort.

The perforation process is the penultimate stage of the bone spindle whorls' *chaîne opératoire* before the proximal surface has been smoothed. All traces of smoothing cover the perforations, as is visible from the whorls (**Fig. 6**). The perforation was made to avoid fracture during the drilling, while the volume of the semi-product was not yet reduced and had a more stable and massive structure. The perforation can be done by using different methods because of the relatively soft spongy tissue: with a rod and wet sand, with a flint drill, or by carving with a lithic tool. Traces of wear can be seen in the shape of the concentric striations on the surrounding perforation walls.

In this study, with regard to the typology of this category of finds, the classification of corresponding ceramic finds is used due to the lack of a bone spindle whorl classification. Ceramic spindle whorls are classified depending on the ratio between the diameter and the height, and regardless of the size. According to this indicator, three variations are distinguished: 1) high whorls (the height exceeds the diameter); 2) medium whorls (the height is greater than  $\frac{1}{2}$  of the diameter); and 3) short whorls (the height is less than  $\frac{1}{2}$  of the diameter) [Чохаджиев, А. 2007, с. 16–17]. The next classification level describes the objects according to their longitudinal cross-sections [see Чохаджиев, А. 2007, с. 17, Обр. 2]. The metric records of the bone whorls from the Tilkiyuk collection are represented on **Fig. 7**. The cross-section of the Tilkiyuk bone spindle whorls is trapezoidal (whorls Nos. 406, 405, 900, 1217, 2363, 2494, 5886), conical (whorls Nos. 728, 1164, 2414), or rectangular (whorls Nos. 978, 2885). The conical spindle whorls are associated with the lack of processing on the proximal part of the item. The perforation diameters indicate that a rod having a thickness from 6 to 10 mm was attached to the hole. This was probably a rod made of perishable materials such as wood that decays. The diameters vary between 35 and 65 mm, and the weight is between 6 and 41 g. The height of the whorls is similar except for three slightly higher specimens (whorls Nos. 406, 728, and 2414) (**Fig. 2**). The analysis of the dimensions of the bone spindle whorls shows the following trend – the diameter increases in direct proportion to the weight, as can be seen by the diagonal line in the presented graph (**Fig. 8**). According to the established ratios, two groups can be distinguished in the relation between weight and height. The group on the lower left distinguishes the shorter and respectively lighter whorls from the second group where the values are slightly more variable, and therefore the group is not as compact as the first one (**Fig. 9**). This ratio is most likely related to the function of the whorls, i.e. the type of spinning threads. The increase of the height corresponds to an increase of the diameter, and thus the three criteria (height, diameter, and weight) increase together. This relation confirms the standard form in the production of these textile implements in Tilkiyuk.

The data show that all Tilkiyuk items correspond to the major criteria and the usual parameters determined for spindle whorls. The bone spindle whorls may have been used to produce certain fibres intended for specific textiles. The presence of lighter bone whorls points to a relatively high speed in the spinning process, and, because of this, the bone spindle whorls were most likely used in processing short fibre materials like wool.

It should be noted that the 16 spindle whorls made of ceramic sherds have been listed in the Tilkiyuk field documentation. Their height varies according to the thickness – from 5 to 12 mm, the weight is from 9 to 35 g, and the diameter ranges between 25 and 55 mm. The ceramic whorls with trapezoidal and conical cross-sections that have bone analogues, discovered in other Chalcolithic sites in Bulgaria [see Kotsov, I. 2019, pp. 141–154; Коцов, И. 2018, с. 13–24], are missing among over 2,000 archaeological finds from Tilkiyuk, preserved at the museum. It can be suggested that this specific type could have been made of wood, which also has relatively low weight. Furthermore, it is possible that all Tilkiyuk spindle whorls with trapezoidal and conical cross-sections were made of animal bones (possibly wood as well) and used for wool spinning. They are specially made and perhaps are indicative of some kind of a 'luxury'; they have even been identified as ritual items. Ev-



idence of such practices could be found in other epochs in Europe, where bone spindle whorls were discovered as burial offerings [Grömer 2016, p. 83; Kovancaliev 2019, p. 121; Maldre 2001, pp. 20–21]. However, such hypothesis should be represented in another study based on a large amount of empirical material.

### Chalcolithic Animal Bone Spindle Whorls from Bulgaria

These items are among the rarest subjects in Bulgarian archaeological publications. This paper considers all Neolithic and Chalcolithic bone whorls included in the publications between 1926 and 2019 (Fig. 10). The information about the finds is poor, with the whorls often being simply mentioned along with other finds. Some of the earlier papers [Попов, Р. 1926; Миков, В. 1961] include comments on the whorls' shape and on the raw material used, as well as short discussions on their purpose. Illustrations are usually missing, and if present, the bone spindle whorls are represented on black-and-white photographs showing one side of the objects.

The spindle whorl that was found at the open-air settlement of Hotnitsa-Orlovka (Veliko Tarnovo Province, northern Bulgaria), was made of a red deer antler. Its relative dating points towards the end of the late Neolithic period (Kachitsa B phase) [Маркова, Х. 2019, с. 39, 45]. However, the chronology of this find is not quite certain due to the lack of detailed information regarding the stratigraphy of the Orlovka archaeological materials. Although the majority of finds are attributed to the Late Neolithic, materials dated to other periods (list the periods) have also been registered in the settlement area<sup>1</sup>. Thus, the dating of the find should be considered with caution.

Another region in southern Bulgaria reveals several Chalcolithic settlement mounds located in the Tilkiyuk area, and these are distributed within a zone of about 30 km in diameter (Fig. 1). A few bone spindle whorls originate from these sites. All of them are included in the Nova Zagora Museum collection, and I had the opportunity to examine the finds and their technological and use-wear traces.

The Himitliyata settlement mound, located southeast of Nova Zagora and near the village of Sokol, is a mid-sized mound reaching 120 m in diameter. Since 2004, with some intervals, systematic excavations have been carried out under the supervision of K. Leshtakov [Semmoto, M. et al. 2016, pp. 154–155]. During the archaeological excavations in 2008, a collective find of four clay loom weights and one bone spindle whorl were found among the remains of a burnt building, dated to the end of the Late Chalcolithic period [Лещаков, К. и др. 2009, с. 101, 102, Обр. 2: ОФ-III-120)]. The studied bone whorl has a conical shape and belongs to the short spindle whorl group. The surface is damaged due to the effect of a fire that took place in the building. It has acquired a chalky white colour and a crumbly structure. Because of the poor condition of the find, it was impossible to observe any traces on the surface of the whorl.

Another site in the same area, the settlement mound in Dyadovo, which is located about 7 km south of Nova Zagora, in the southwestern part of the village, is a large-sized mound with an irregular oval shape and with a base of 220 m (E-W) and 140 m (N-S). The thickness of the cultural levels in its northern part reaches 17 m; the layers containing materials date to several eras: Neolithic, Chalcolithic, Bronze Age, Early Iron Age, Antiquity, and Middle Ages. In absolute dates, this time-span covers a period of about seven millennia [Borisov, B. 1989, p. 1]. Two spindle whorls made of bovine *caput femoris* were discovered in the seventh horizon, attributed to the Late Chalcolithic period.

Other finds, two bone spindle whorls, originate from a Chalcolithic settlement located near the village of Rumanya (Stara Zagora Province)<sup>2</sup>. During the field surveys in this region conducted by the local historian Nikola Koychev in the first half of the 20<sup>th</sup> century, Late Chalcolithic items were found, including the two whorls. They are well preserved, with a perfectly round shape and a trapezoidal cross-section, and they belong to the group of short spindle whorls. The manufacture techniques in-

<sup>1</sup> I am grateful to Nedko Elenski (Regional Museum of History – Veliko Tarnovo) for the conversations regarding the chronology of the settlements on the territory of the village of Hotnitsa.

<sup>2</sup> I am grateful to Dragomir Markov (Museum of History – Nova Zagora) for the opportunity to observe the whorls from Rumanya.

clude smoothing of both the upper and bottom surface, transforming them into flat areas. There is also some wear on the perforation insides as a result of attaching the whorl to the wooden rod.

Another bone spindle whorl was found in the same region at the Chalcolithic settlement near the village of Kolena (Stara Zagora Province). The site had not been excavated systematically. The archaeological material was collected in the first half of the 20<sup>th</sup> century, and the objects from Kolena are vaguely represented in this paper, lacking descriptions or illustrations, which may cast some doubts on the interpretation of such finds. The whorls are only mentioned in a list find made of bone [Георгиев, Г. 1948, с. 68].

Bone spindle whorls dated to the Late Chalcolithic period were also found in other Bulgarian regions: the settlement mound at Ruse on the right bank of the Danube River (Ruse Province) [Костов, Д. 1926, с. 61–62, Обр. 106а; Георгиев, Г., Ангелов, Н. 1952, с. 135, 137, Обр. 110]; the settlement mounds at Kosharna (Ruse Province) [Чернаков, Д. 2012, с. 133, 156, Фиг. 3: 5]; the Nuriyuk mound near the village of Sushina (Shumen Province)<sup>3</sup>; the sites at Golyamo Delchevo (Varna Province)<sup>4</sup>; the Deve-bargan mound near the town of Simeonovgrad (Haskovo Province) [Попов, Р. 1926, с. 83]; the settlement mound of Kozareva Mogila [Георгиева, П. 2011, с. 100]; and the Аyyuk site near the village of Zavet (Burgas Province) [Миков, В. 1961, с. 27–28, Обр. 11: м. 1. κ]. All these finds have been published vaguely – in a way similar to the materials from Kolena.

The information presented above clearly demonstrates that, at this point, the chronology of the known whorls found at Bulgarian sites, along with potential statements regarding their typological development and chronological and geographical distribution, cannot be based on firm evidence. It remains unclear which of these finds represents the earliest whorl that can be associated with the emergence of the practice of making and using bone whorls in procedures related to textile processing. Unfortunately, the dating of the specimen from Hotnitsa-Orlovka to the Late Neolithic period remains uncertain because of the issues with the stratigraphy of the archaeological materials on the site. The chronological framework of the period of distribution of this type of textile implements can thus be set, only conditionally, in the Middle Chalcolithic. Importantly, the materials found at the Deve-bargan and Ruse settlement mounds, excavated in the second half of the 20<sup>th</sup> century, were also registered as Early Chalcolithic materials. These were neither identified, nor separated at the time of the field work campaigns. Another issue is the lack of excavations of the settlement mounds near the villages of Rumanya and Kolena, showing that the presence of other prehistoric layers below the surface cannot be established. Obviously, the accurate determination of the bone whorls' appearance and development can be proved only by conducting systematic field research and in-depth studies of old and new archaeological materials from museum collections, which are awaiting their rediscovery.

### Conclusions

Bone spindle whorls represent an intriguing type of archaeological finds that played an important role in prehistoric everyday life. Similarly to the animal bone as raw material, they remained in use for extensive periods of time, including Antiquity and the Middle Ages. Knowledge about their production and use is preserved in much later historical periods in Bulgaria [Borisov, B. 1989, с. 94, 98, Figs. 104–105; Борисов, Б. 2013, с. 457–458, Обр. 224 м-у; Чангова, Й. 1992, с. 55–56; Конаклиев, А. 2010, с. 528; Илиев, Н. и др. 1997, с. 199, Таблица 5; Владкова, П. 2018, с. 37–39].

The presented whorls from Tilkiyuk formed the largest known collection of bone spindle whorls in Bulgaria, from which, at present, it is possible to obtain the most extensive information about the distribution and technology of these items. This collection is dominated by the animal bone finds.

<sup>3</sup> In 2015, the author of this study successfully defends her bachelor's thesis at the University of Veliko Tarnovo on the bone assemblage of the Nuriyuk settlement mound and the belonging necropolis (Костеният ансамбъл от селищна могила „Нуриюк“ и принадлежащият ѝ некропол). Two spindle whorls are mentioned in the thesis.

<sup>4</sup> I am grateful to Vladimir Slavchev and Olga Pelevina (Regional Museum of History – Varna) for the opportunity to observe the unpublished two bone spindle whorls from Golyamo Delchevo.

The lack of whorls with trapezoidal and conical cross-section, usually made of the most common raw material (clay), raised the question about the specific development of local textile production. At this site, these types of whorls are made of animal bones (and possibly wood), while ceramic sherds were used for the flat whorls. Although further research is required, these observations can be used as a proof of certain patterns in the production of textile implements. Standardization is observed in the production of bone spindle whorls – the same raw material, the same technological methods, and the same preference for two specific shapes only. The Tilkiyuk inhabitants had very good knowledge of these implements and their production. Unfortunately, the origin of this know-how cannot be traced only on the basis of the available information about the finds discussed above.

Although bone spindle whorls are usually rarely found, at Bulgarian sites, according to the information available at present and as a result of the study of the Tilkiyuk whorls, their earliest appearance could be associated with the Middle Chalcolithic period (Maritsa IV–Karanovo V culture). Their greatest prevalence, however, falls within the period of the Late Chalcolithic cultural complex of Kodzhadermen-Gumelnitsa-Karanovo VI – a distinctive pattern valid for many Chalcolithic sites. Thus, although there is the probability that the bone spindle whorls appeared as early as the Early Chalcolithic period, more systematic research is required. Based on the few archaeological studies in Bulgaria represented in the text, it can be concluded that their chronological distribution is limited to the period 4600–4000 BC [see **Görsdorf, Y., Bojadžiev, Y.** p. 107, Abb. 1]. The lack of publications dedicated to the prehistoric sites in western Bulgaria is currently very controversial, mainly due to the lack of interest in bone items in Bulgaria and to insufficient or unsatisfactory published materials since the beginning of the first systematic archaeological excavations. Hopefully, this study will be a good basis for systematic research and thought on the development and chronological distribution of bone spindle whorls in Bulgaria.

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SUPPLEMENTS

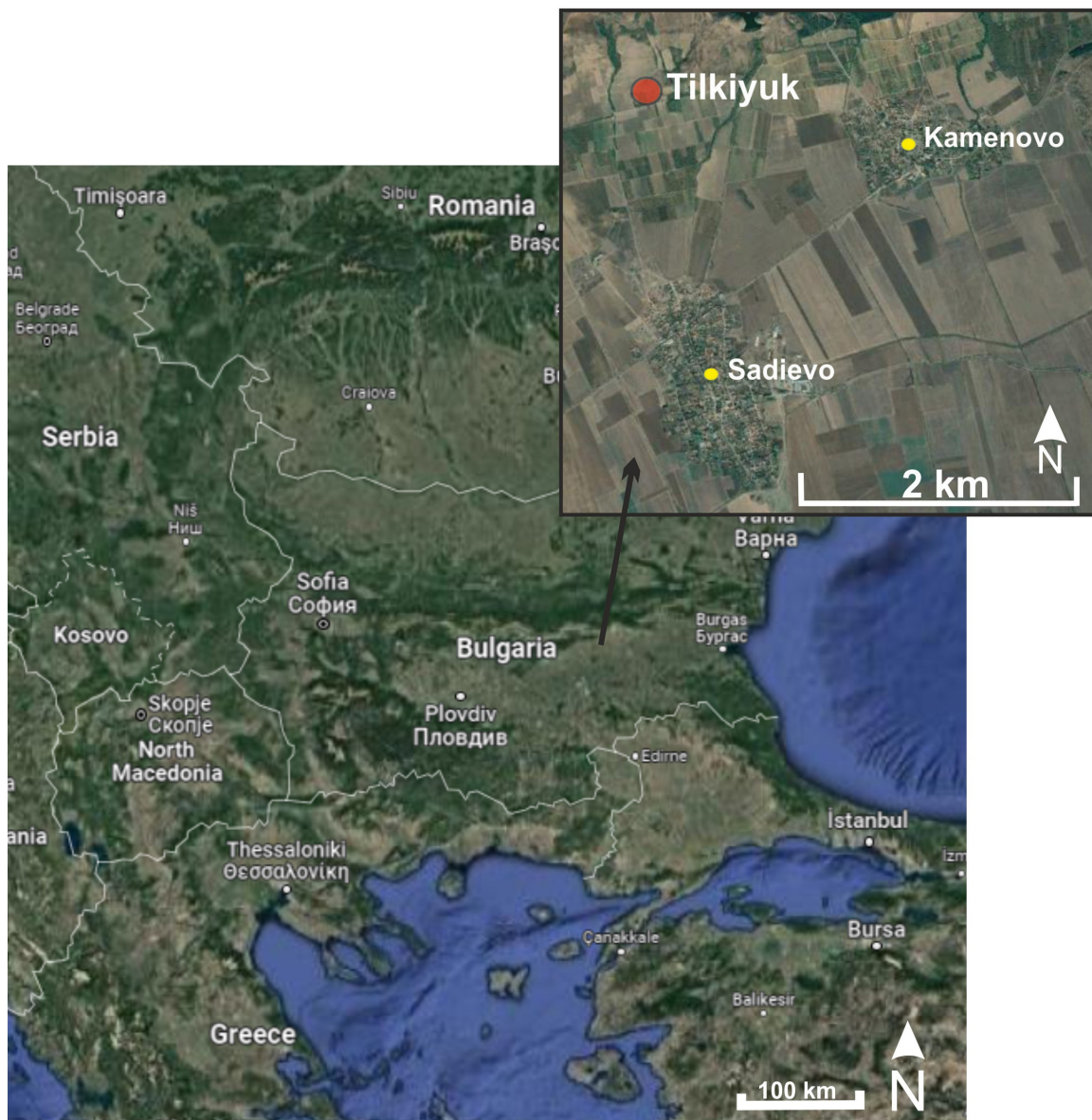


Fig.1. Settlement mound “Tilkiyuk” located near village of Sadievo

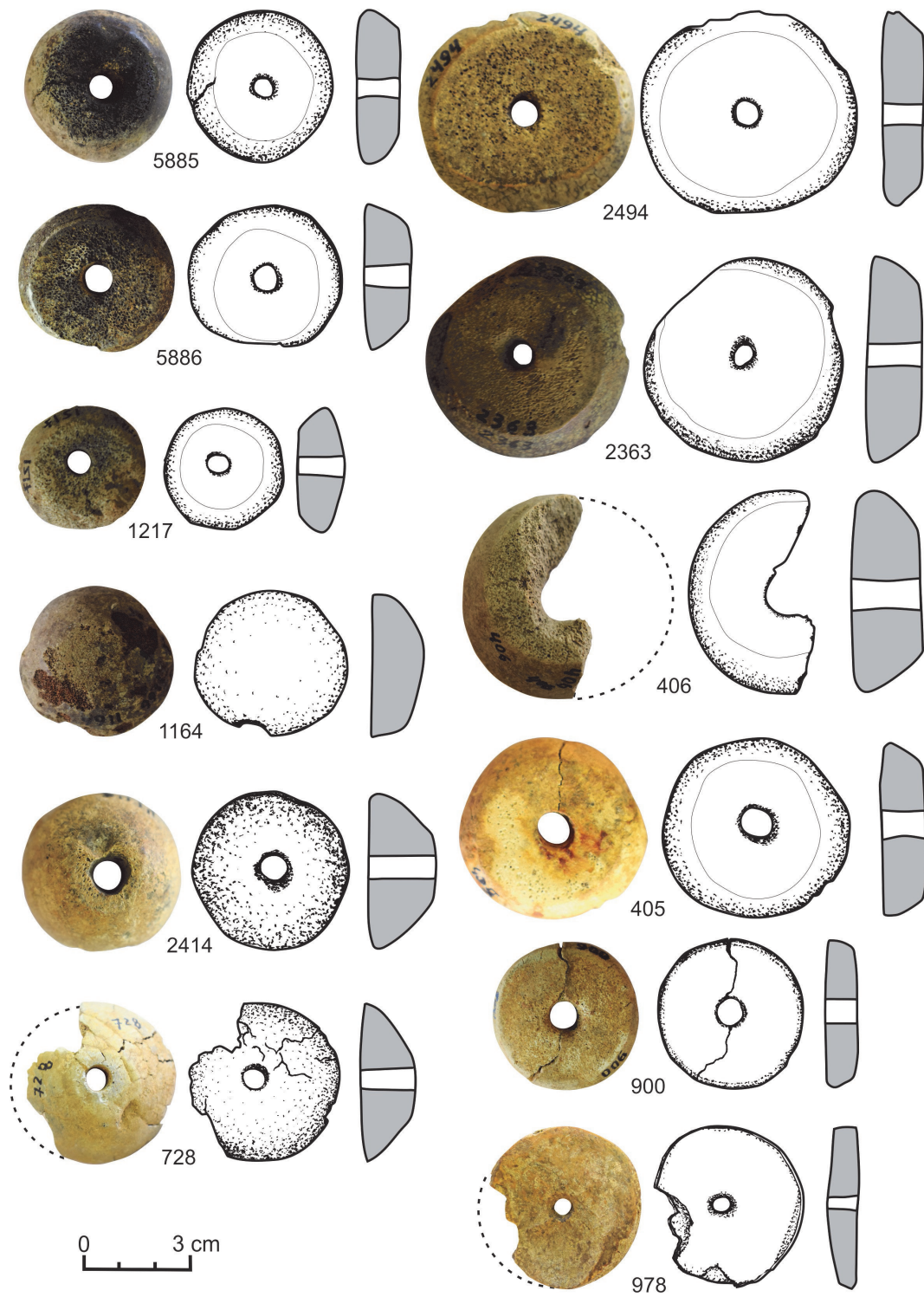
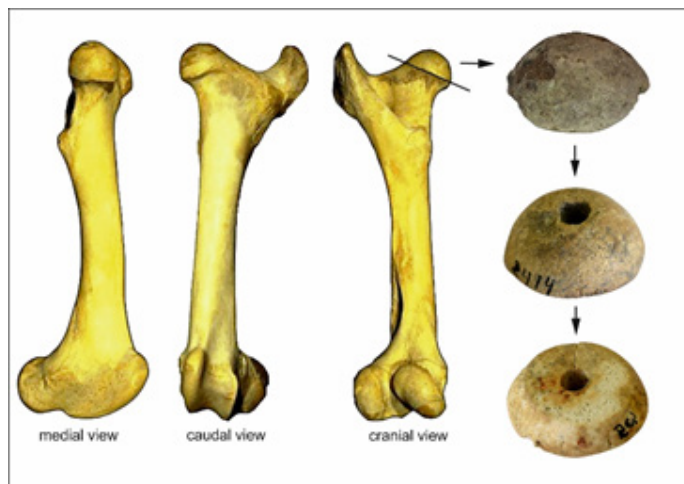
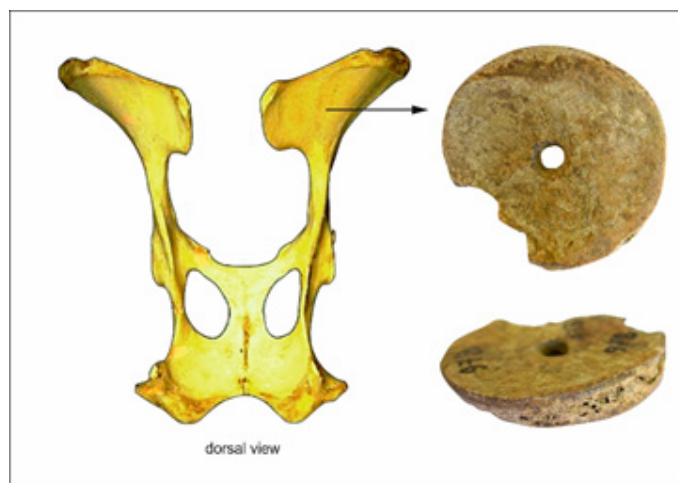


Fig.2. "Tilkiyuk" spindle whorls collection

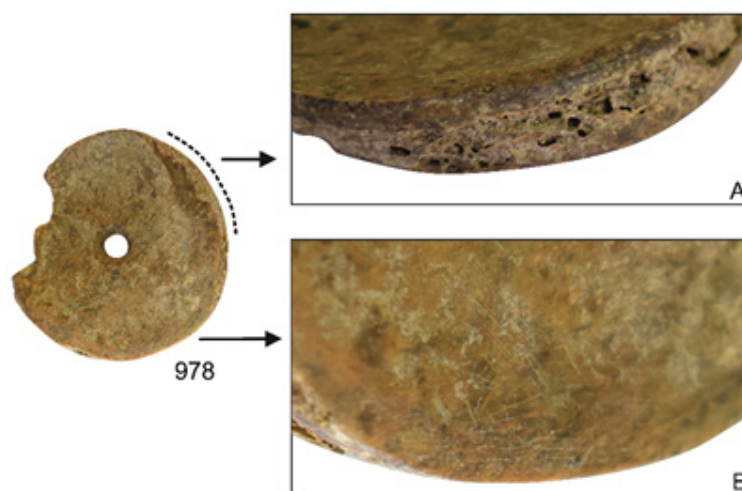




**Fig.3.** Bovine femur and part of the *chaîne opératoire* of the spindle whorls



**Fig.4.** Bovine *scapula* and spindle whorl



**Fig.5.** The spindle whorls made of *scapula* segment: A. Laterally smoothed edge; B. Traces of scraping



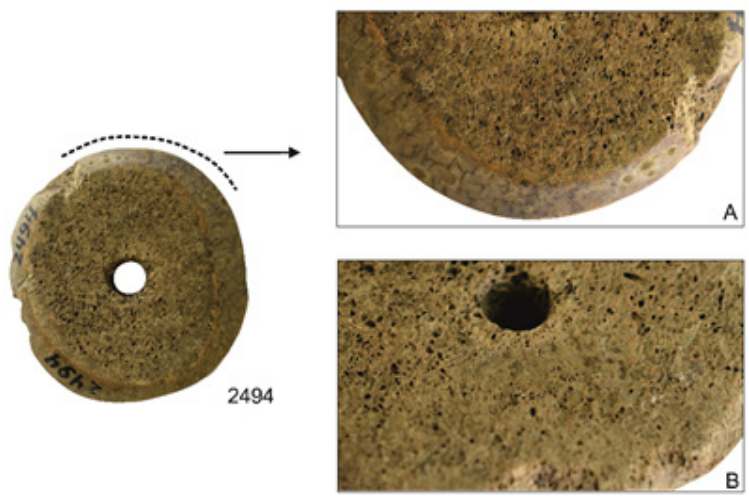


Fig.6. Spindle whorls with two smoothed surfaces, and some polished spongy tissue: A. Upper part; B. Bottom part

Inv. №.	High (mm)	Diameter (mm)	Perforation diameter (mm)	Weight (g)	Variation
405	12	38	9	10	short spindle whorl ( $h < \frac{1}{2} d$ )
406	20	59	11	16	short spindle whorl ( $h < \frac{1}{2} d$ )
728	19	49	7	16	short spindle whorl ( $h < \frac{1}{2} d$ )
900	11	45	8	13	short spindle whorl ( $h < \frac{1}{2} d$ )
978	10	42	6	12	short spindle whorl ( $h < \frac{1}{2} d$ )
1166	15	38	-	10	short spindle whorl ( $h < \frac{1}{2} d$ )
1217	14	35	7	6	short spindle whorl ( $h < \frac{1}{2} d$ )
2363	16	58	8	21	short spindle whorl ( $h < \frac{1}{2} d$ )
2414	21	44	10	20	short spindle whorl ( $h < \frac{1}{2} d$ )
2494	16	65	9	26	short spindle whorl ( $h < \frac{1}{2} d$ )
5885	15	37	7	7	short spindle whorl ( $h < \frac{1}{2} d$ )
5886	13	39	9	9	short spindle whorl ( $h < \frac{1}{2} d$ )

Fig.7. “Tilkiyuk” bone spindle whorls measurements

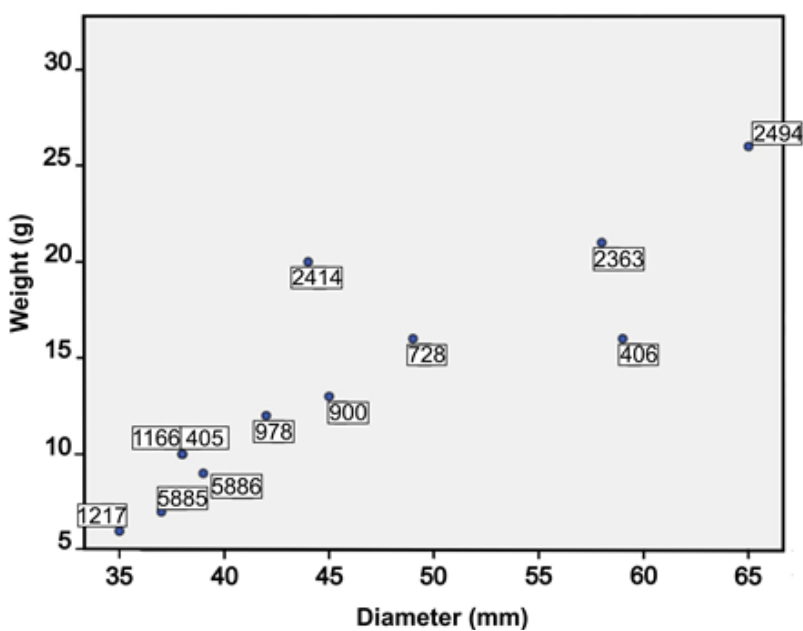
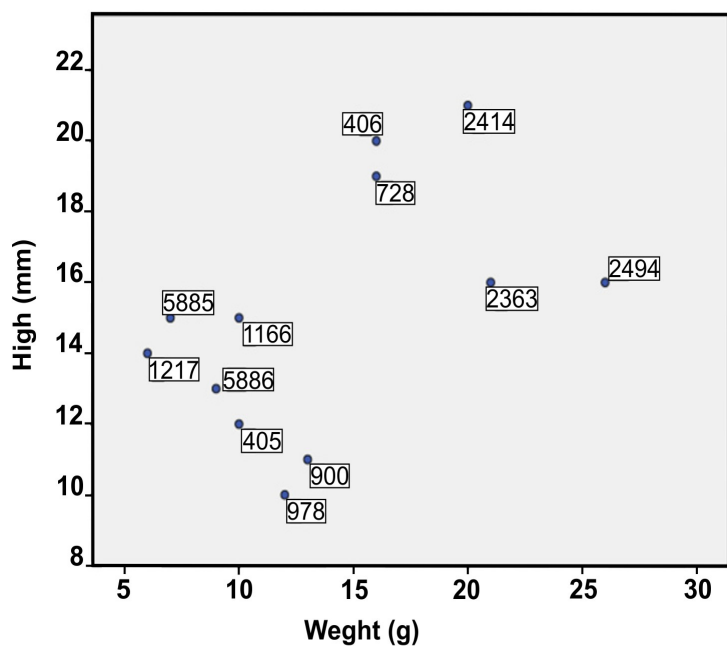


Fig.8. Correlation between the weight and the diameter of the bone spindle whorls from “Tilkiyuk”



**Fig.9.** Correlation between the weight and the height of the bone spindle whorls from “Tilkiyuk”



**Fig.10.** Location of the Neolithic and Chalcolithic sites in Bulgaria mentioned in the text: 1. Sadiovo-“Tilkiyuk”; 2. Sokol-“Himitliyata”; 3. Rumanya; 4. Kolena; 5. Simeonovgrad-“Deve-bargan”; 6. Kozareva mogila; 7. Ruse; 8. Kosharna; 9. Hotnitsa-Orlovka; 10. Nuriyuk; 11. Zavet-“Ayyuk”; 12. Dyadovo; 13. Golyamo Delchevo