

WOOD CONSTRUCTION AT THE COPPER AGE TELL SITE OF HOTNITSA, NORTH CENTRAL BULGARIA: FOUR LATE CHALCOLITHIC CASE STUDIES

Paul Bacoup¹

¹ University Paris 1 Panthéon-Sorbonne; UMR 7041 ArScAn – Aegean Prehistory, France, paul.bacoup@gmail.com

Abstract

Between 2000 and 2017, the research project at the Copper Age tell site of Hotnitsa, located just a stone's throw from the banks of the river Bohot, uncovered several levels of occupation dated to the Late Chalcolithic. During the last two excavation seasons of 2016 and 2017, architectural remains were systematically examined, in particular the wooden floors of four buildings (horizons 4–5). A xylological study was also undertaken. The specific preservation of the material hinders identification, but new approaches could enable the timber palaeobotanical study and a better understanding of the conservation process undergone by the remains. Our main objectives were to reconstruct the chaîne opératoire involved, from the selection of the wood (species, dimensions, etc.) to the assemblies used to construct the buildings. Focusing on wooden floors, our analysis revealed three principles of floor construction based on the timber's organization and dimensions. The chaîne opératoire approach also allows for an understanding of the planning process which starts from the raw materials acquisition step while highlighting the woodworkers' technical finesse. Through construction techniques, the study also sheds light on larger scale concerns as the site's organization.

Keywords: Balkan Copper Age – timber – construction techniques – wooden floor – woodworking.

<https://doi.org/10.53250/stprae17.103-131>

1. Introduction

The present-day village of Hotnitsa is located approximately 15 km northwest of Veliko Tarnovo in north central Bulgaria (fig. 1). The Chalcolithic tell site of Hotnitsa is situated at the northwest exit of the village, on the left bank of the river Bohot. It covers an area of approximately 0.95 ha and is 5 m high. The site, identified in 1956 during earth removal, was first excavated as part of a rescue archaeology operation (Angelov 1958).



Figure 1. Location of the Copper Age tell site of Hotnitsa (in red). Image Credit: background (zoom) map: Esri, NASA, NGA, USGS; Main map: the author.

Subsequently, the Veliko Tarnovo Museum decided to launch an archaeological operation consisting of three excavation seasons, carried out in 1957, 1958, and 1959 under Nikola Angelov (Angelov 1959 & 1961).

Over the course of four years, Angelov's excavations achieved two main objectives. First, an initial stratigraphic sequence of the site was determined, thanks to a 10 x 4 m trench dug in the southern part of the tell (Chohadzhiev & Chohadzhiev, forthcoming). Fourteen occupation levels were identified, numbered from top to bottom and dated to the first three quarters of the fifth millennium BCE (Todorova 1986, 78; Chohadzhiev 2009, 67; Chohadzhiev & Chohadzhiev, forthcoming). The second objective was to excavate entirely the highest stratigraphic level. Thus, the general layout of the site during its last period of occupation could be established. Twenty-one burnt quadrangular buildings were uncovered ranging from a dozen square meters to 57 m². Unfortunately, part of the field records of the earlier excavations was missing and some of the information cannot be verified or used (Chohadzhiev 2009, 67–68; Chohadzhiev & Chohadzhiev, forthcoming). All the buildings of the upper level appear to have been built of daub on wooden frames. Angelov described a few wattle and daub imprints. Whenever information on the wall thickness is

provided, it is around 0.40 m (Chohadzhiev & Chohadzhiev, forthcoming).

Before the end of the twentieth century, the site was slowly reclaimed by nature and remained forested until 2000, when Stefan Chohadzhiev resumed the excavations within an archaeological operation of the St. Cyril and St. Methodius University of Veliko Tarnovo and the Veliko Tarnovo Regional Museum of History. The 2nd and 3rd occupation levels were excavated from 2000 to 2005, and the 4th level was excavated until 2009. Finally, level 5 was excavated until 2017, which marked the end of the investigation project (Chohadzhiev & Chohadzhiev 2005, 9; and 2017, 94–95; Chohadzhiev 2009, 68; Chohadzhiev et al. 2018, 1). It was during that phase, more specifically in 2016 and 2017, that I was offered the chance to study the architectural material.

Two areas were studied: North and South (fig. 2). Our evidence comes from four structures: features 112, 124 and 99 in the North area, and feature 132 in the South area. These four houses belong to horizons 4 and 5, dated between 4600 and 4400 BCE, which were not destroyed by fire, and the elements made of daub¹ were poorly preserved; the material has disintegrated, and the structures were badly damaged and difficult to study. As for the wood, it was preserved in an unusual form, which will be discussed below.

The analyzed structural remains were mainly floor parts, but some roof and wall framing was also uncovered, providing evidence on the assembly techniques of the superstructures. A total of 393 pieces of wood were studied and 51 samples were taken, including 49 wood samples for identification and two charcoal samples for radiocarbon dating.

2. Xylological examination

2.1. Macroscopic study

Timbers preserved at Hotnitsa were close to a layer of agglomerated wood particles 1 to 5 mm thick (fig. 3). These wood residues formed a thin, relatively continuous layer over the impressions left by the pieces of wood in the sediment.

Two types of wood remains were recorded. The first type is a light-colored material, with a few fibers still visible. Fragments measuring several centimeters long and several millimeters wide and thick were preserved. The second type is brown, of a powdery texture, and has no distinct fragments (fig. 4). These forms of wood preservation have also been recorded at other sites in north Bulgaria, e.g., Tell Petko Karavelovo and Tell Sushina (Bacoup 2020, 25f; and 2022a, 43; Chohadzhiev 2021; Chohadzhiev et al. 2021, 289f).

The macroscopic examination of the wood remains did not identify the main anatomical structure of wood. Based on previous archaeobotanical analyses (Popova 2009), hardwood (oak, ash, etc.) could have been used in construction. Looking at the distribution of the two types of remains on each wood piece, it seems that the lighter form is what is left from heartwood, while the brown material reveals the presence of bark/sapwood.²

¹ In this paper, 'daub' is used as a synonym for the French term *terre à bâtir*.

² Without knowing if the trees were stripped from their bark, macrodifferentiating between the two anatomical parts seems difficult.



Figure 2. Layout of the excavated areas. Image Credit: A. Chohadzhiev & the author.



Figure 3. Thickness of the wood layer after a sampling with a die-cutter. Image Credit: the author.



Figure 4. Halflog showing both types of wood remains. Image Credit: the author.

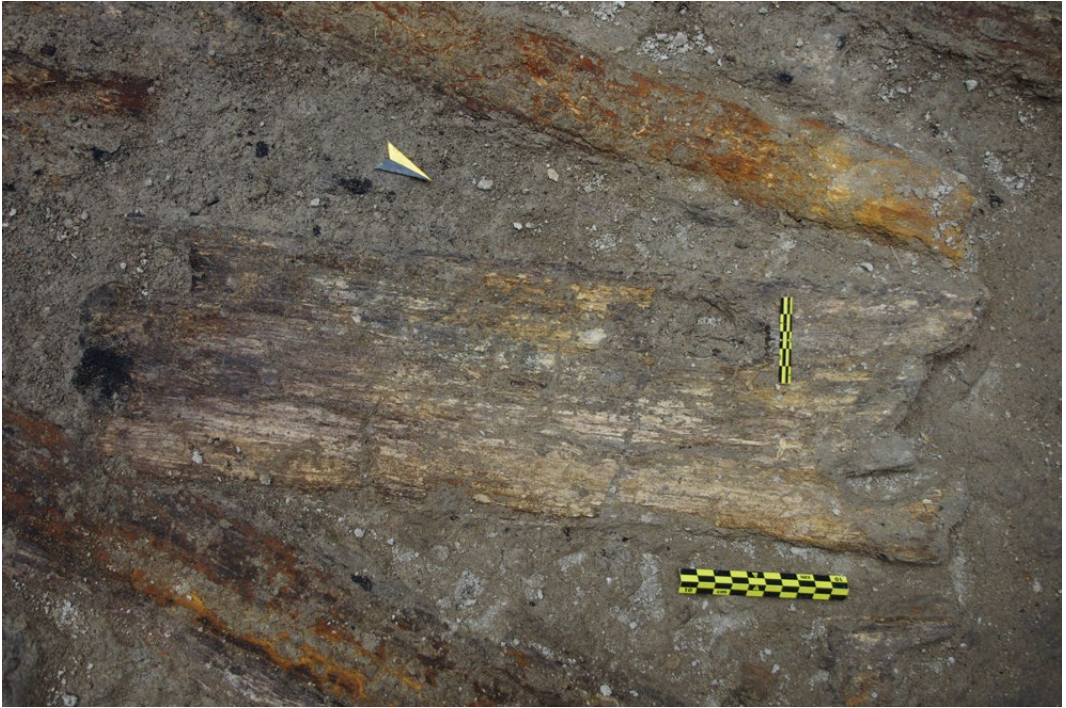


Figure 5. *Light remains of the squared-off wood piece 092-027. Image Credit: A. Chohadzhiev.*

Taking the example of a squared piece of timber, 092-027,¹ it would have been cut entirely from heartwood as it consisted only of lighter material (fig. 5). On the half-logs used for wooden floors, both types of preservation could be observed. The brown material was located above the lighter one, which might suggest that these pieces of wood had a flat surface (mainly composed of heartwood) facing downwards, while their bark/sapwood was facing upwards (fig. 4).

2.2. Laboratory analysis

During field sampling, wood fibers were visible in what appeared to be heartwood, which might suggest that a xylological identification of the wood species, even rough, would be possible by analyzing at least the tangential planes of the wood horizontal pieces. The wood compression by sediment and past occupation, which is significant at a tell site, had reduced them to layers a few millimeters thick. This situation, noticed after sampling, makes for a much more complicated analysis of the radial and transverse planes.

Our doubts were confirmed as soon as we observed the first samples under a reflection microscope.² The transverse and radial planes showed a confused cellular structure,

¹ During the investigation, each wood piece received a label. As No. 092-027 will be discussed extensively below, it would be easier to use its label, even though no other labels of wood pieces are given in the text.

² Analysis attempted with the help of Dr. Claire Alix, Assistant Professor at the Paris 1 Panthéon-Sorbonne University, UMR 9086 ArchAm.

both fragmented and compressed, which made it impossible to identify the wood rings or pores. We were slightly more successful when we switched to reflective microscopy of the tangential planes, since a few cells could be observed, although they were not well preserved. However, we were unable to identify them. When we tried to observe some samples with a transmission microscope lens, we also hit a (mud)brick wall. The fragments were too crumbly for suitable slides to be extracted. What is more, no characteristic anatomical features were visible. A few samples were nevertheless sent to the radiocarbon dating center in Lyon.

It is more than likely that the Hotnitsa wood might have gone through a more or less complete mineralization process. This hypothesis was then confirmed by the 'dating' results: after the acid-base treatments, which removed all the mineral elements, the samples were entirely dissolved.¹

Therefore, the prospects for analyzing the Hotnitsa samples seemed limited. Tests of microscopic observation and discussions with several specialists, including Dr Anais Boura,² a specialist in the study of wood and leaf fossils, enabled us to discover a new avenue of analysis. The observation of the samples using a scanning electron microscope was envisaged, and we have contacted the microscopy laboratory at the *Maison des Sciences de l'Homme Mondes René Ginouvès* to carry this out in the near future. Finally, micro-morphological sampling could have been another solution, for example by taking a core sample of the sediment including the pieces of wood. Such a study could have provided us with evidence on the types of wood used, as well as with information on the material degradation process. Similar samples have been taken from Tell Petko Karavelovo but have not yet been processed.

3. Architecture studies

3.1. Feature 112 / building 20

Feature 112, also known as building 20, is located in the northern part of the North area, squares 75-85 and 77-87 (fig. 6). It was excavated between 2015 and 2017. It is oriented north-south and measures 7 m wide, with a length of at least 12 m; its north wall was not excavated (fig. 7). Excavations revealed a building consisting of three adjoining rooms. The southern room was 6 m long, the central room 2 m long and the northern room at least 2.7 m long. These rooms were separated by partition walls whose posts were founded in holes, apparently without foundation trenches. These partitions, 0.30 m thick, may have been built of daub on a wattle frame.³ The perimeter walls, also built of daub on a wooden

¹ Personal discussion with Z. Tsirtsoni (CNRS, UMR 7041 ArScAn) who received the results from the laboratory.

² Assistant Professor at the Paris 6 University Pierre et Marie Curie, UMR 7207 Paleodiversity and environments research center.

³ To date, there is no evidence of the use of wattle framing at Hotnitsa, horizons 4-5, even though this appears to have been the most common type in the region.

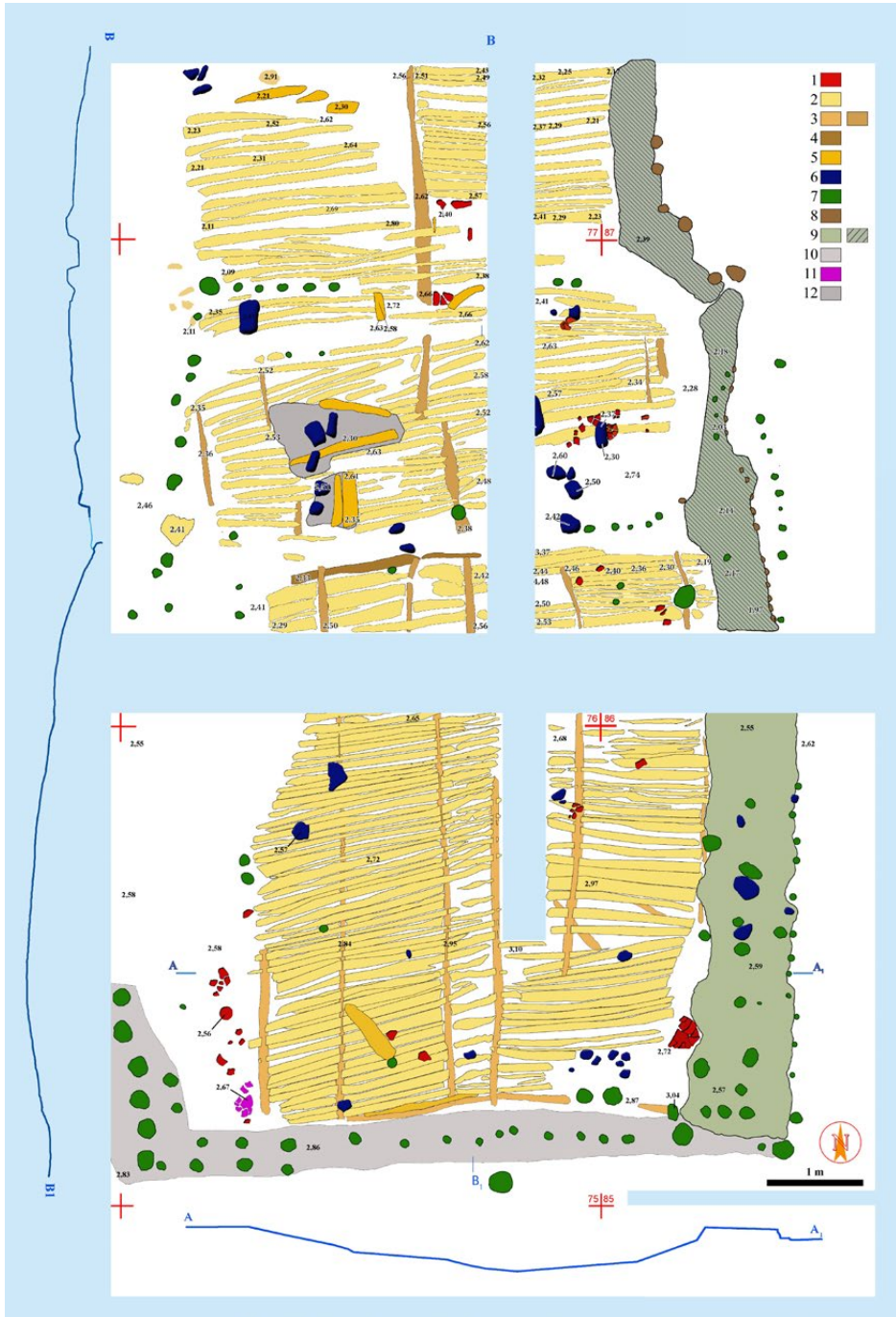


Figure 6. Layout of building 20. Key: (1) ceramics; (2) floorboard; (3) joist; (4) main beam; (5) wood piece from wall or roof frame; (6) rock; (7) posthole; (8) posthole with wood remains; (9) wall; (10) foundation trench; (11) thermal installation's base; (12) unexcavated debris layer. Image Credit: A. Chohadzhiev.



Figure 7. *Different views of building 20: (a) view to the northeast of the north half of the building; (b) view to the north of the north half of the building; (c) view to the northeast of the building at the end of the 2016 season. Black lines = 1 m. Image Credit: A. Chohadzhiev.*

frame, have a maximum thickness of almost 1 m at their base. Their posts are founded in holes dug in wide trenches, 0.50 to 0.60 m deep (Chohadzhiev et al. 2018, 48).

3.1.1. Timber: morphology and function

The study of timber in building 20 focused mainly on the floor elements. We had very little evidence about the walls and roof. There were eight unidentified pieces from the roof framing or walls, as well as several postholes. The postholes only allowed for an estimation of posts' maximum diameter. Their alignment and spacing about 15 cm apart suggests the use of loose wattle as framing (well-known from Tell Petko Karavelovo; Ba-coup 2022a & 2022b, 177).

Similar construction processes were identified for the floors in the three rooms. The floor surfaces were made of boards that were almost all laid side by side. The average width of a floorboard is 9.7 cm (maximum 18 cm, minimum 4 cm). In most cases, the small gaps between some of the boards could reveal bad preservation.

These boards rested on joists running north-south. In the central and southern rooms, the five or six rows of joists allowed the builders to use boards that were shorter than the width of the building. A single, wide and squared central joist was uncovered in the north room. There may have been two more joists along the long walls but no evidence of their existence was uncovered. When uncovered, the central joist supported only the boards of the eastern part of the floor, and the floorboards in the western part had fallen from this joist (fig. 8). We can therefore deduce that the floorboards were shorter than the width of the room. In addition, the north room was slightly narrower than the other two rooms.

The floor joists had two different shapes: two of them were squared and the others were round. The two squared pieces were 13 and 17 cm wide. The others were between 5 and 15 cm in diameter (10.7 cm on average). Finally, the joists rested on main beams (binders) with diameters between 10 and 12 cm. Only two main beams could be identified. The floors were not dismantled at the end of the excavation project in 2017, and the lower elements of the timber frame could not be fully observed.

These floors appear to have been heightened. On the one hand, if they were built directly on the ground, the three-level wooden framework (main beam, joist, and board) would not have been necessary, as was the case at the tell site of Omurtag, for example (Angelova 1999, 66f). Furthermore, the sagging shape of the floors seems to indicate that they were raised and have collapsed (figs. 6 and 8).¹ Moreover, the discovery of a two-story house model at Hotnitsa seems to prove the existence of such raised floors (Chohadzhiev & Yordanova 2014, fig. 1). Nevertheless, the height of floors is not easy to determine, but the fact that they were preserved in connection to most of the timbers indicates that their collapse was neither sudden nor high. As the floors were not dismantled during the excavation, it was not possible to uncover the substructure but one can assume that some posts were strategically placed to support the raised floor.

It is complicated to assess the original diameter of the trunks used to make the boards, as we cannot determine whether they were done by radial or tangential splitting (for more information on the two types of splitting, cf. Darrah 2006, 118; Bacoup 2022b, 352ff). The same applies to the squared joists. However, if we consider only the size of the wood pieces used, it should be noted that they are of similar dimensions, regardless of their architectural function (see fig. 22 below). Thus, the timber pieces appear to have been mostly interchangeable and could have been used for several architectural functions.

¹ Alternatively, the sagging could have been the result of a pit underneath that served as a basement for the house. For the moment, however, we decided to stick to the term 'raised floor', meaning that it was not in contact with the ground surface and had a supporting framework.



Figure 8. *Different views of building 20: (a) view to the south of the south part of the building; (b) view to the northeast of the northwest part of the building; note that the planks have fallen under the joist; (c) floor-level view to the east of the northwest side of the building. Black line = 1 m. Image Credit: A. Chohadzhiev.*

3.1.2. Assembling the wood pieces

There is very little evidence of how each piece of timber was joined together in building 20. The boards couldn't have been fixed to the joists, a technique still common in parquet flooring until the twentieth century.¹ As for the superstructure of the building, a single fixture was identified: a mortise and tenon T-joint with an almost quadrangular

¹ Personal comment by F. Bacoup, woodworker.

cross-section and rounded corners, 11.5 cm long and 2.5 cm thick (fig. 9). The piece of wood showed traces of squaring. It might have been part of the roof structure, fitted into a post where the corresponding mortise was made.

3.1.3. Entry between rooms

The floor of the north room appeared to be slightly higher than those of the south and central rooms. No evidence of the entry between the latter two rooms is available, not least because it was partially located in the north-south balk. However, the entry between the central and the north room was investigated (fig. 10a). The study of the timbers and their layout revealed a small three-step staircase with three risers (fig. 10b). The pieces of wood appear to have been planks 6 or 7 cm wide.

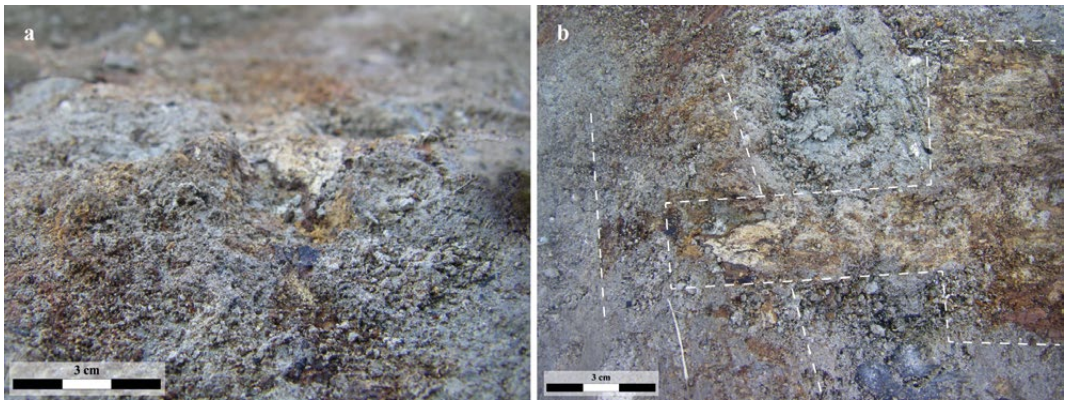


Figure 9. *Assembling through mortised tenon identified in the ruins of building 20: (a) tenon's profile, view to the west; (b) view from above at the two assembled pieces. Image Credit: the author.*

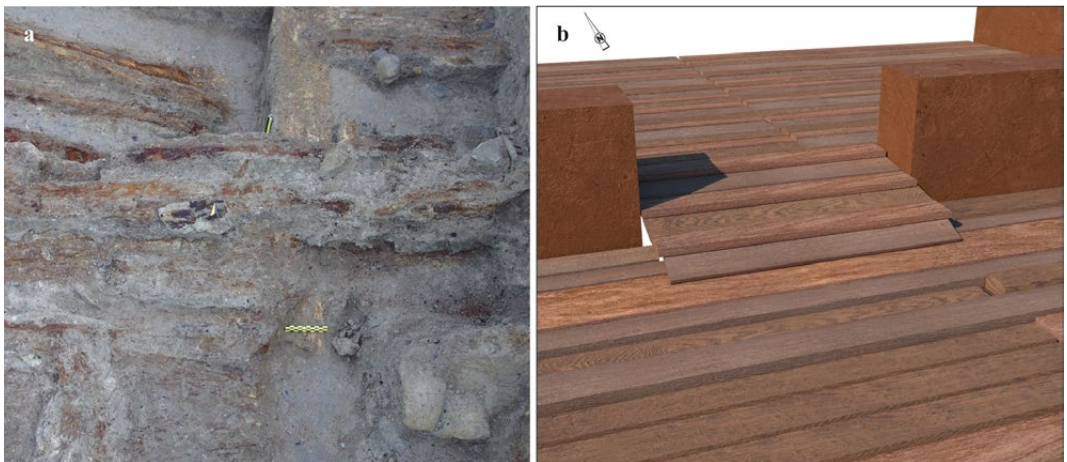


Figure 10. *Entry between the central and north rooms. Image Credit: A. Chohadzhiev (photo) & the author (3D rendering).*

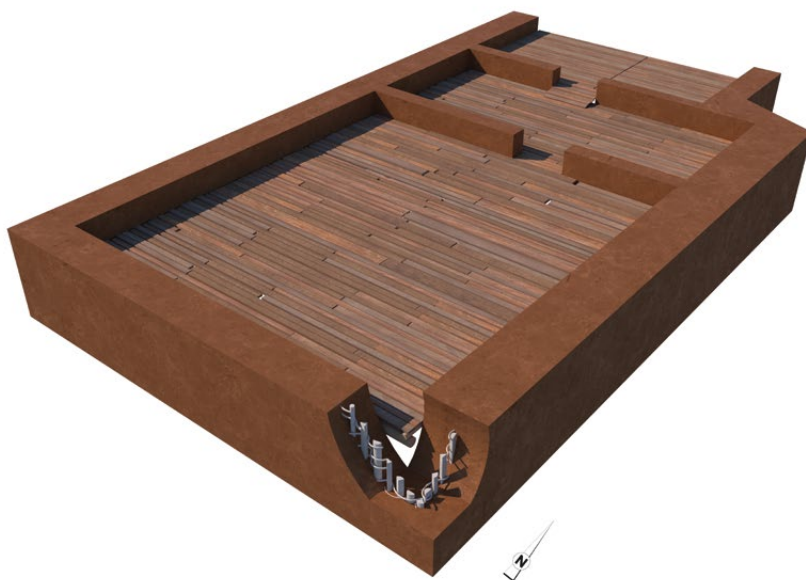


Figure 11. 3D model of the lower part of building 20. The white elements indicate interpretative hypotheses. Image Credit: the author.

3.1.4. Architectural synthesis and reconstruction

Building 20 is therefore a structure with walls of daub on a wooden frame, comprising three communicating rooms separated from each other by partition walls. While there's no doubt that all three rooms were parts of the same house (doorways between rooms), the contemporaneity of their construction remains uncertain. The wooden frameworks of the floors in the south and central rooms are similar. They both feature several rows of joists, and the height of these floors seems to have been the same (fig. 11). This suggests that the construction of the south and central rooms was a single event. The 8.6-meter-long building might initially have consisted of two 5.5-meter-wide rooms (interior space).

However, the north room may have been added at a later date. The state of wood preservation excluded dendrochronological dating, which would have been the only way to precisely assess the chronology of each room. However, technical and architectural data offer some arguments that could confirm the existence of two periods. The first point would be the building's east wall, which was best investigated and shows an offset in its alignment to the north room suggesting that the perimeter walls of the north room were not built simultaneously with those of the other rooms. Second, the construction strategy for the floor in the north room is different. Unlike the floors of the other two rooms, it rested on a large central joist. What is more, the planks appeared to be butt-jointed on the joist, which differed from the construction strategy for the other floors.

What about the entrance to the house? Its location is not easy to determine.

1. If we consider the layouts of the twenty-one buildings of occupation level 1 excavated by Angelov, their entrances face either south (19) or west (2) and are always situated along the structures' length (Chohadzhiev & Chohadzhiev, forthcoming). No gaps in the foundation trench of the south wall of building 20 were found, unlike the investigated buildings at Petko Karavelovo, e.g., building 127 (Chohadzhiev 2021; Bacoup 2022a). However, building 20 at Hotnitsa was not a single-story building and the wall might have been built to a small height below the entrance opening. Thus, it could have been in the south wall, where two post holes were uncovered at the border between squares 75 and 85. These posts would have supported a structural element at the entrance.

2. Of the buildings of Hotnitsa's occupation level 1, three had two rooms each. In two of them, the rooms were of a similar size (houses 9 and 10¹). In the third, house 12, the first room was very narrow compared to the second: 2.00 x 5.80 m, and 6.50 x 5.80 m, respectively. This structure could have been similar to an earlier phase of building 20, when the latter had only two rooms. In this case, the building's entrance would have been positioned to the north, and when the third room was built, it would not have been necessary to break through the north wall of the central room to make an entry to the new room as the old entrance could have simply been used.

Finally, the floors consisted of wooden boards running east-west across the width of the building, resting on perpendicular joists that rested on main beams. The widths and diameters of these pieces were quite similar. The main beams were slightly elevated, perhaps to provide a crawlspace, as well as security against flooding from the river Bohot.

3.2. Feature 124

Feature 124 is located in the southern part of the North area (squares 73 and 74) and corresponds to the wooden floor of a building that was approximately 3 m wide on the inside. Its total length is not known as the building continues further south, out of the excavation area, but it was at least 6 m long (fig. 12). The building is oriented north-south, with a slight northwest-southeast deviation. There are two main orientations of the floor's wood pieces: east-west in the south half of the building and north-south in the north half (figs. 12 and 13). A west-east line of postholes separates the two floors starting from the west wall and running in the western two-thirds of the room. The foundation trench of the east wall was uncovered measuring 60 to 70 cm thick. It was not excavated. The north wall of the building was marked by three postholes aligned east-west. The west wall of the building was made of daub on a wooden frame; it was 20 to 30 cm thick and was preserved between 15 and 18 cm high, with numerous post imprints (fig. 13; Chohadzhiev et al. 2014, 85; Chohadzhiev & Chohadzhiev 2017, 95f).

3.2.1. Timber: morphology and function

Remains of the superstructure of the building's west wall were only uncovered. The imprints left by the posts in the daub likely reflect the size of the wood pieces. Eighteen

¹ To avoid confusion, the structures excavated by Angelov are referred to as 'houses', and those excavated by Chohadzhiev are referred to as 'buildings'.



Figure 12. *Layout of feature 124. Key: (1) ceramics; (2) floorboard; (3) joist; (4) rock; (5) post-hole; (6) foundation trench; (7) cut; (8) clay installation. Image Credit: A. Chohadzhiev.*

post imprints were preserved, their average diameter being 7.6 cm (maximum 12.6 cm, minimum 5.1 cm). The state of daub preservation does not allow to determine whether the timbers were split or worked. Nevertheless, the posts' arrangement suggests the use of wattle as an internal framework for the wall, even if no wattle sticks were identified during the excavation.

The floor in the south room was made of boards running east-west almost side by side, with widths ranging from 2.3 to 16.5 cm (average: 6.2 cm; see fig. 22 below). Same as in building 20, it is difficult to determine the original diameter of the logs used to make



Figure 13. *View from above of the south floor of feature 124 excavated in 2016. Image Credit: A. Chohadzhiev.*

the boards. Without any known assembly, they rested on three joists spaced 1.50–1.60 m apart. The joists were made of small logs measuring 7.5, 7.9, and 8.9 cm in diameter.

The wood pieces of the floor in the north room were worse preserved. The floorboards ran north-south and had an average width of 6.9 cm (maximum 10.4 cm, minimum 4 cm; see fig. 22 below). Only three joists were preserved over a short length in this structure, but they were not distributed in the same way as in the south room. Spaced about forty centimeters apart, they form a mesh that seems tighter than in the south room. These round joists were made of logs measuring 4, 6.3, and 10.4 cm in diameter.

If we consider the size of the wood pieces used, it seems obvious that, as in building 20, they have a very similar average width/diameter in both rooms. However, the joists

vary less in diameter than the floorboards. This can be explained by their limited number and by the builders' objective of obtaining a relatively flat floor surface, which would not have been possible with joists of too varied sizes. Moreover, the floors in both rooms were made of wood pieces of very similar sizes.

3.2.2. *Structural interpretations*

The relatively small number and diameter of the joists in the south room indicate that the floorboards covered the entire width of the room. In the case of the north room, it is possible that a larger number of joists were used to form a 'grid-base' for the planks across the whole area. This means that each floorboard did not necessarily cover the entire length of the room.

Unlike building 20, the floors of feature 124 showed no sagging. It is therefore not certain if the floor of this building was raised, and only an excavation of the underlying levels would help to confirm or refute this hypothesis.

The evidence is too fragmentary to enable the reconstruction of the building's entrance. The partition wall between the rooms could have not been daubed; a simple wooden (wattle?) partition wall could have been used to separate the spaces. Finally, the entry between the rooms was located at the east wall (fig. 14).

It is highly likely that the floors in both rooms were built as a single event, as suggested by the similar size of the timbers which had the same functions. However, the strategy for placing the timbers is different, as we discussed above; the boards in the south room covered the entire width of the area, while those in the north room did not. This would indicate that the floor builders made a practical choice. They reserved all the boards long enough for the south room, which required the use of only three joists of similar size, and then made do with the shorter boards for the north room.



Figure 14. 3D model of the lower part of the building whose floor is labeled as feature 124.

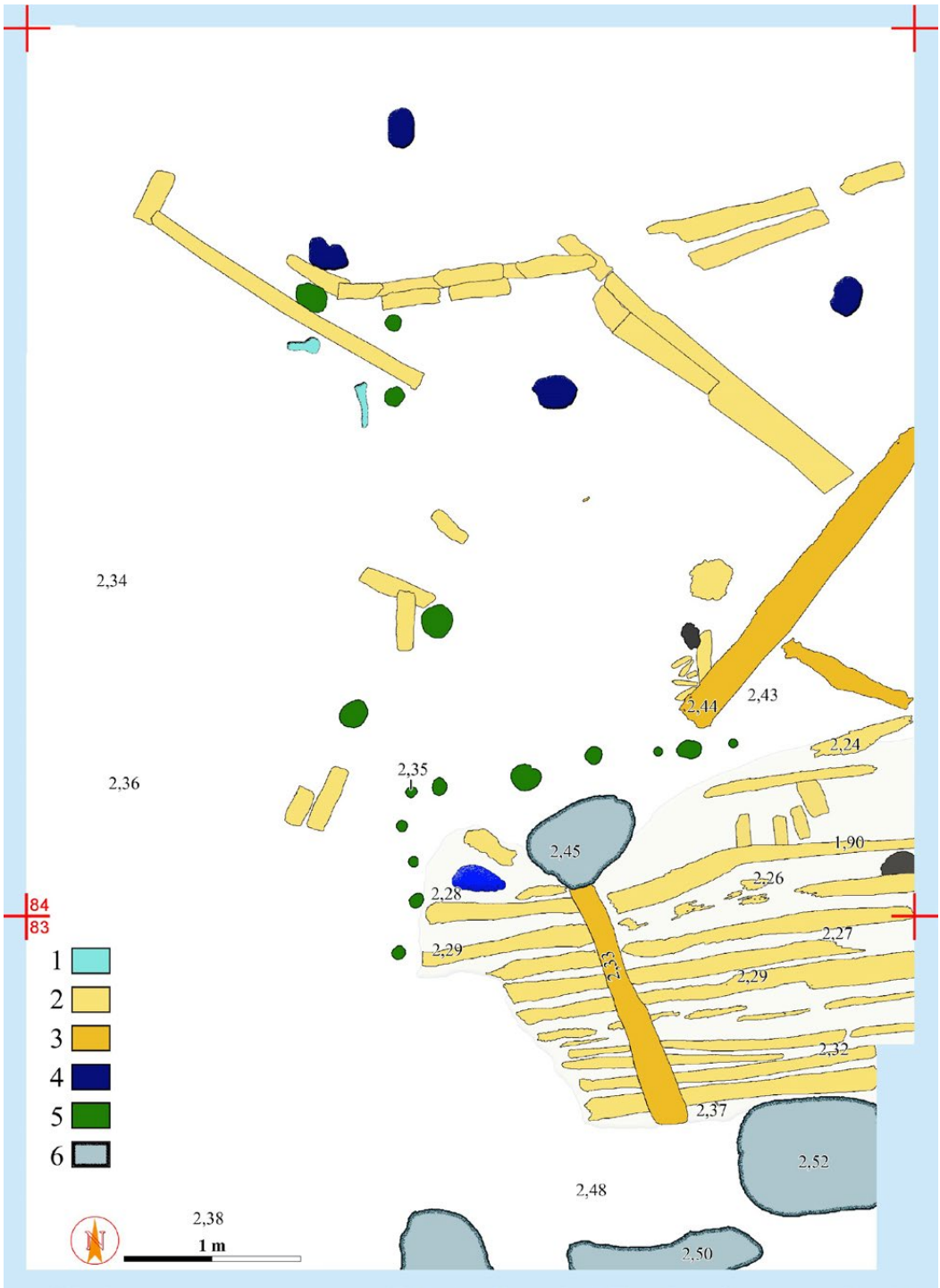


Figure 15. *Layout of feature 99. Key: (1) animal bones; (2) floorboard; (3) a wood piece from a wall or roof frame; (4) rock; (5) posthole; (6) cut. Image Credit: A. Chohadzhev.*

3.3. Feature 99

The badly preserved remains of feature 99 were uncovered in squares 83 and 84 of the North area (figs. 15 and 16). An east-west row of postholes (with a slight north-east-southwest deviation) divided the structure in two rooms, similarly to the layout of feature 124. Another row of postholes aligned roughly north-south forms an angle with the first row pointing to the northwest. These postholes yielded no evidence on the posts' diameter, and even though it seems that they outline the northwest corner or the south room, it is impossible to assess the size of the building.

Only wood remains were preserved from the north room, and not very informative at that. The remains in the south room, however, suggest that the floor was built of boards ranging in width from 2.2 to 16 cm (8.6 cm in average). As with feature 124, it is not possible to say whether the floor of feature 99 was raised, but the total absence of joists does not seem to suggest such a construction.

3.4. Feature 132

Feature 132 is located in squares 91 and 92 of the South area (figs. 17 and 18). Most of the wood pieces there were the remains of a floor which extended further west and



Figure 16. *View to the north of the floor of the south room of feature 99. Image Credit: A. Chohadzhiev.*

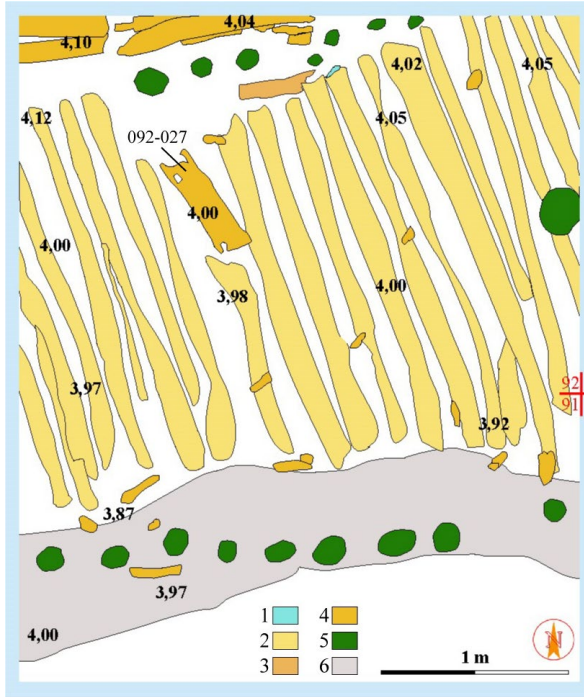


Figure 17. *Layout of feature 132. Key: (1) animal bones; (2) half-round logs; (3) a wood piece from a wall or roof frame; (4) rock; (5) posthole; (6) cut. Image Credit: A. Chohadzhev & the author.*



Figure 18. *View from above of feature 132. Image Credit: A. Chohadzhiev.*

east, out of the excavation area. A later, east-west running trench cut the south end of the floor. Most of the central part of the feature was occupied by wood pieces aligned south-east-northwest. A northeast-southwest row of postholes was uncovered at the north end of the area that seem to have been contemporary to the floor. The wood pieces that were found north of them ran parallel to the postholes' row (Chohadzhiev et al. 2018b, 46).

3.4.1. Timber: morphology and function

The central part of the feature was occupied by a floor whose boards were oriented southeast-northwest. These were half-round logs lying on their flat sides (fig. 19). Their diameter varies between 4.5 cm and 15 cm (9.1 cm on average). The upper sides of some of them showed traces of work with a stone adze or axe (fig. 20). These marks indicate that the height of the boards making up the floor was adjusted to produce a flat surface, and/or that the logs were delimbed.

A single piece of wood was preserved that was long enough (ca. 50 cm) to be clearly defined as a joist, a small round log measuring 7 cm in diameter. No evidence is available as to how the boards were joined to the joist, but it seems highly likely that they were simply laid on top.

The northeast-southwest oriented wood pieces at the northern end of the area did not belong to a floor. They overlapped and appeared to have fallen from above. The same applies to piece 092-027 (figs. 5, 17, and 18). They could have fallen either from the roof frame or from the walls.

Four of these wood pieces were squared off, making it impossible to reconstruct the original trunk from which they were cut. Their width varies between 2 and 16 cm. The others were round logs with diameters ranging from 2.7 to 8 cm (4.6 cm on average).

3.4.2. Assemblies

As soon as the feature was excavated, several holes were identified in the timbers. Some of them, particularly those found in the floorboards, could be linked to the disappearance (decayed or simply come off) of dead knots. At the same time, six other holes appear to have been mortises: two circular and four quadrangular. The first circular mortise has a regular shape and measures 4 cm in diameter (MT-003; fig. 21a). The second has a more irregular outline and a diameter of 3 cm (MT-005; fig. 21b). The quadrangular mortises are quite distinct. Two have similar dimensions: 5 by 3 cm and 6 by 3.5 cm (MT-002a and b; fig. 21c1 and c2). The other two are smaller: 3.5 by 2.3 cm (MT-004; fig. 21d) and 4 by 3 cm (MT-001; fig. 21e).

One example of a tenon, very poorly preserved, was found very close to the MT-001 mortise. It is 8.5 cm long and 2.5 cm wide (TN-001). Although we cannot be certain that these are two elements of the same assembly, their size and proximity support this hypothesis.

3.4.3. Conclusions about feature 132

The small surface area of this feature makes it impossible to reconstruct the morphology and dimensions of the building it comprises.



Figure 19. Floor-level view (to the north) of feature 132. Note the half-round shape of the logs. Width of the trench 3 m. Image Credit: A. Chobadzhiev.



Figure 20. Wood pieces bearing work traces, probably from ground stone tools (marked with white arrows). Image Credit: A. Chobadzhiev & the author.



Figure 21. *Mortises identified in feature 132: (a) circular mortise MT-003; (b) circular mortise MT-005; (c) quadrangular mortises MT-002a (c1) and MT-002b (c2) on the wood piece 092-027; (d) quadrangular mortise MT-004; (e) quadrangular mortise MT-001. Image Credit: A. Chohadzhiev & the author.*

This floor is the only one studied made up of half-round timbers, all the others being made up of planks. The single joist makes it impossible to compare the dimensions of the timbers in terms of their structural function. However, its diameter is of the same order of magnitude as the average diameter of the half-round logs (7 and 9.1 cm).

Last, this study enabled us to identify a variety of traces of woodworking within the same feature. Indeed, several pieces clearly bear traces of squaring. Stone adzes or axes have probably been used for delimbing or levelling half-round logs as also for squaring. There is also evidence of the shaping of a tenon and several mortises, indicating mostly the use of chisels (bone or stone). Finally, there is evidence of splitting to shape floor pieces.

4. Interpretations and conclusion

The study of these four features has enabled us to reconstruct the techniques used for the construction of wooden floors. The buildings, which were not destroyed by fire, did not leave much trace of their superstructure.

From the point of view of the layout of the site, the structural study provides few answers, as the plans of the buildings have not been uncovered in their entirety (fig. 2). Features 99, 124 and 128 (unexcavated) are three small parallel buildings whose walls may have been very close to each other, as is known for horizon I of the site (Chohadzhiev & Chohadzhiev forthcoming). Concerning building 20, its north room was very probably not built during the first phase of the building's life. The east wall was slightly offset to the west, a potential indication of a nearby building in the unexcavated area.

The raising of floors also remains an unresolved issue for several buildings. Only building 20 showed clear evidence of raised floors. In other excavation contexts, even when the wood material is better preserved, it is often difficult to be sure that floors were raised, since the connections between the beams, joists and posts are not known (see for example Lundström-Baudais et al. 1989, 128f).

In all, 326 of the 393 pieces of wood investigated could be linked to an architectural function and give a measure of their width or diameter. The most significant pieces are those used in the frames of the floors (fig. 22). It is quite clear that the sections of the floor pieces in feature 112 (building 20) are larger than those of the other ones. The other three structures have wood pieces which, regardless of their structural function, have similar widths or diameters. The examination of the dimensions of the wood pieces for each function separately suggested a desire to obtain flat levels for each stage of construction: leveled beams, equivalent joists and a regular floor. It could also reflect a fairly standardized timber sourcing strategy from trees whose diameters rarely exceed 13 or 14 cm. Experimental work carried out on the felling of trees with stone axes reveals that a hardwood tree such as oak, ash or maple (species attested on the site) with a diameter of less than 14 cm can be felled in about three times less than a tree larger than 14 cm (Bacoup 2022b, 322ff). However, the use of boards (as well as squared timbers) does not allow us to get the dimensions of the tree used to make them.

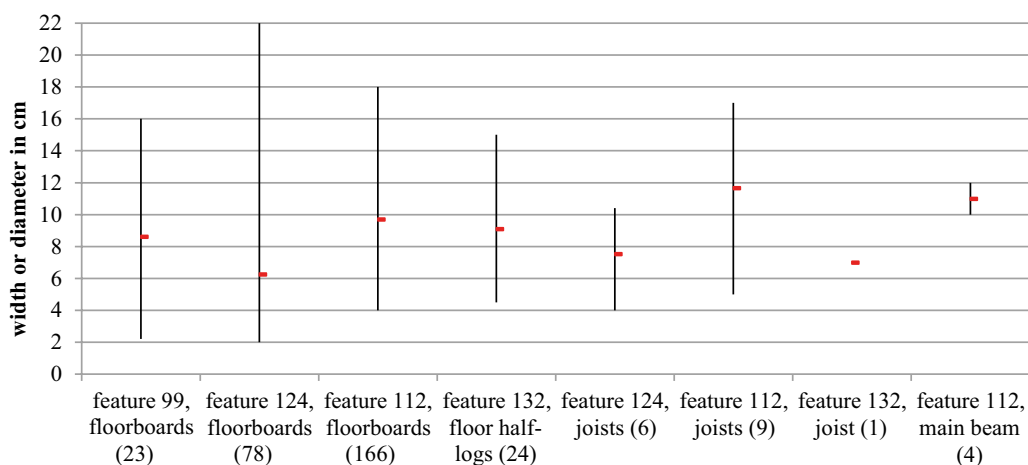


Figure 22. HLC chart showing average diameters or widths (in red) and their ranges (from minimum to maximum diameters/widths) for timber used for different structural functions in each feature. Image Credit: the author.

The regularity of the wooden floors also provides an answer to one of the questions asked during the excavation: were these floors used to support a layer of daub, as was the case at other Neolithic sites such as Dikili Tash, Stara Zagora and Promachonas-Topolnitsa (Bacoup 2022b, 80ff and 103ff; Kalchev 2013, 23 and 90f; Aslanis 2010, 38 and 41)? Our impression at the time of excavation was that there was no daub on these floors, like those at Omurtag (Angelova 1999, 66f). The sediments found on these structures seems to have come from the walls. Furthermore, the presence of animal bones, lithic material, and a few pottery sherds directly on these floors also makes us believe that the occupation deposits cover directly the wooden surfaces. Another argument is the regularization of the half-round logs in feature 132 with a stone adze or axe. If these wood pieces had been covered with daub, there would have been no point in standardizing their thickness.

It is highly probable that adzes or axes were used for squaring, as attested by the remains of all excavated buildings, but also for shaping tenons and mortises, as attested by the experimental work, which combined stone adzes and bone chisels and the use of fire (Guillonnet 2021, 41f, figs. 6 and 7). The splitting of the logs for feature 132 most probably involved the use of wooden tools that have not been preserved (Darrah 2006; Bacoup 2022b, 352ff; Muigg et al. 2023).

Several floor construction schemes have been identified. (1) The first is related to the construction of the floor of the south room of feature 124 and potentially of feature 132. This involves the use of floorboards as long as the width of the room. In this case, the floorboards rest on just three joists, two of which are placed along the walls and a third halfway between the first two. (2) The second scheme is related to the construction of the floor of the north room of feature 124, the floor of the south room of feature 99

and the floors of the south and central rooms of feature 112 (building 20). In this case, the floorboards vary in length. This means that they lay on more joists, which were less widely spaced, so that all the boards rested on at least two supports. (3) The final scheme is related to the floor of the north room of feature 112 (building 20). Here we see the use of two categories of distinct lengths of floorboards. The shorter pieces were laid parallel to each other, with one end resting on a joist along one of the walls and the other end resting on a wide joist inside the room. The longer pieces perfectly covered the remaining width between the wide joist on which they also rested and a third joist along the opposite wall.

The first and third schemes show that the lengths needed to build the floor were anticipated before the wooden trunks were cut. This does not mean, however, that the lengths were standardized, unlike the widths. The second pattern shows that the attempt to anticipate the lengths of the pieces was not always successful, perhaps because of mistakes during the splitting process. It turns out that the builders did not throw away boards that did not correspond to the lengths required for schemes 1 and 3 and used them to make the floor of other rooms. This demonstrates the adaptability of the builders when faced with certain situations. Anticipation and adaptability therefore seem to be two important concepts (Berthoz 2003; Pigeot 2011; Procopiou 2011) in the use of wood to make floors.

Finally, it is worth discussing how the pieces of wood were joined together. During the excavation of these structures, when two pieces of wood were placed one on top of the other, it was rare for the wooden material to have been preserved, which explains why, on the plans, the floorboards stop at the joists (fig. 13). This lack of preservation has not yet been fully explained and results in a loss of information about the techniques used to join the boards to the joists, even though it seems very likely that no joint was used.¹ In addition to the floors, the joints found at the site relate to the walls or roofs of the buildings. The use of mortise and tenon assembly is attested for building 20 (feature 112). In the other cases, these are either tenons or unassembled mortises. The latter indicates the use of cylindrical and parallelepipedal tenons, as known from other sites in the Balkan, Aegean, and European Neolithic/Chalcolithic (for examples, cf. Bocquet 2010, 27; Tegel et al. 2012, figure 4; Bacoup 2022b, 70ff).

Acknowledgements

This article is based on the doctoral studies carried out by the author at the University of Paris 1 Panthéon-Sorbonne and the UMR 7041 ArScAn (Aegean Prehistory team), under the supervision of Prof. Hara Procopiou and Dr. Zoë Tsirtsoni. The author would particularly like to thank the directors of the archaeological operations at the Chalcolithic tell site of Hotnitsa, Stefan Chohadzhiev and Alexander Chohadzhiev, for

¹ Personal communication with A. Chohadzhiev; where two wooden pieces were in contact, it seems that the disintegration process usually occurred quicker than the mineralization process and this can explain the missing links too.

their trust, their help, and the free access to all the unpublished site records without any restrictions.

Finally, this article is the first to appear since the death of the person at the origin of my family's love for wood, Mr. Roger Bacoup, carpenter, joiner. May he receive a tribute with these words.

REFERENCES

- Angelov 1958:** N. Angelov. Selishtna mogila pri s. Hotnitsa. – In: V. Beshevliev & V. Georgiev (eds.) *Izsledvaniya v chest na akad. Dimitar Dechev po sluchay 80-godishninata mu / Studia in honorem acad. D. Dechev*. Sofia: BAN, 1958, 390–403.
- Angelov 1959:** N. Angelov. Zlatnoto sakrovishte ot Hotnitsa. – *Arheologia* 1/1–2, 1959, 38–46.
- Angelov 1961:** N. Angelov. Rabotilnitsa za ploski kosteni idoli v selishtnata mogila pri s. Hotnitsa, Tarnovsko. – *Arheologia* 3/2, 1961 34–38.
- Angelova 1999:** I. Angelova. Selishtna mogila “Omurtag” – predvaritelni rezultati ot arheologicheskite prouchvaniya. – In: M. Kumanov & M. Toshev (eds.) *Grad Omurtag i omurtagskiyat kray: istoriya i kultura*, 1. Varna: Zograf, 1999, 65–73.
- Aslanis 2010:** I. Aslanis. I katoikisi stin Elláda katá tin 5ⁱ kai 4ⁱ chiliétia p. Ch. – In: N. Papadimitriou & Z. Tsirtsoni (eds.) *I Elláda sto evrytero politismikó pláisio ton Valkaníon katá tin 5ⁱ kai 4ⁱ chiliétia p. Ch.* Athens: Mouseío Kykladikís Téchnis Ídryma N.P. Goulandrí, 2010, 39–53.
- Bacoup 2020:** P. Bacoup. Construire en terre et bois au Chalcolithique à Petko Karavelovo (Bulgarie). – In: F. Bouché, L. Bouzagliou, A. Pinto & P. Sauvageot (eds.) *Artisanat et savoir-faire: archéologie des techniques*. (Archéo.doct) Paris : Éditions de la Sorbonne, 2020. <http://books.openedition.org/psorbonne/78497>
- Bacoup 2022a:** P. Bacoup. L'architecture en terre crue du tell chalcolithique de Petko Karavelovo (Bulgarie du Nord) : des choix de construction à la société. – In: C.-A. de Chazelle, É Léal & P. Devillers (eds.) *Architecture et construction en terre crue. Approches historiques, sociologiques et économiques. Proceedings of the ‘5^{es} Échanges transdisciplinaires sur les constructions en terre crue’ (Montpellier, 23-25 october 2019)*. Montpellier: Édition de l'Es-pérou, 2022, 37–59.
- Bacoup 2022b:** P. Bacoup. Le bois de construction dans le sud des Balkans au 5^e millénaire av. n. è. PhD These, Paris 1 Panthéon Sorbonne University, 2022.
- Berthoz 2003:** A. Berthoz. *La décision*. Paris : Odile Jacob, 2003.
- Bocquet 2010:** A. Bocquet. *Les villages néolithiques de Charavines, Isère. Volume 5 : Le Bois et son Travail*. Montmélian: Fontaine de Siloé, 2010.
- Chohadzhiev 2009:** A. Chohadzhiev. The Hotnitsa tell – 50 years later. Eight years of new excavations – some results and perspectives. – In: F. Draşovean, D.L. Ciobotaru & M. Maddison (eds.) *Ten years after: the Neolithic of the Balkans as uncovered by the last decade of research*. Timişoara: Editura Marineasa, 2009, 67–84.
- Chohadzhiev 2021:** A. Chohadzhiev. To raise a tell and raise it well: some odd regularities of the early Chalcolithic construction techniques and the building strategies at Tell Petko Karavelovo. – *Studia Praehistorica* 15, 2021, 149–179.
- Chohadzhiev & Chohadzhiev 2005:** S. Chohadzhiev & A. Chohadzhiev. Some results of the

- investigations of Hotnitsa tell in 2001. – In: L. Nikolova, J. Fritz & J. Higgins (eds.) Prehistoric archaeology & anthropological theory and education. (Reports of Prehistoric Research Projects 6–7) Salt Lake City & Karlovo: International Institute of Anthropology, 2005, 9–12.
- Chohadzhiev & Chohadzhiev 2017:** S. Chohadzhiev & A. Chohadzhiev. Halkolitna selishtna mogila pri s. Hotnitsa. – *Arheologicheski otkritiya i razkopki* prez 2016 g., 2017, 94–96.
- Chohadzhiev & Chohadzhiev, forthcoming:** S. Chohadzhiev & A. Chohadzhiev. The Chalcolithic Hotnitsa tell-site. Excavations 1956–1959.
- Chohadzhiev & Yordanova 2014:** A. Chohadzhiev & R. Yordanova. Model na dvuetazhna postroyka ot Hotnitsa. Rekonstruktsiya, analiz i interpretatsiya. – In: V. Petrova, S. Taneva & K. Boyadzhiev (eds.) In memoriam Lilyana Pernicheva-Perets. (Godishnik na Natsionalniya arheologicheski muzey 12) Sofia: NAIM–BAN, 2014, 183–197.
- Chohadzhiev et al. 2014:** S. Chohadzhiev, A. Chohadzhiev, A. Atanasov & M. Gurova. Arheologicheski prouchvaniya na selishtnata mogila pri s. Hotnitsa, obshtina Veliko Tŭrnovo. – *Arheologicheski otkritiya i razkopki* prez 2013 g., 2014, 84–86.
- Chohadzhiev et al. 2018:** S. Chohadzhiev, A. Chohadzhiev & P. Bacoup. Halkolitna selishtna mogila pri s. Hotnitsa. – *Arheologicheski otkritiya i razkopki* prez 2017 g., 2018, 44–48.
- Chohadzhiev et al. 2021:** S. Chohadzhiev, A. Atanasov, M. Veleŭ & A. Guadelli. Redovno arheologicheskoto prouchvane na halkolitna selishtna mogila Nuriyuk v m. Chanadzhik, s. Sushina, obl. Shumen. – *Arheologicheski otkritiya i razkopki* prez 2020 g., 2021, 288–290.
- Darrah 2006:** R. Darrah. Wood technology. – In: C. Evans & I. Hodder (eds.) *A woodland archaeology: Neolithic sites at Haddenham*. Cambridge: Donald Institute for Archaeological Research, 2006, 118–127.
- Georgiev 1961:** G. Georgiev G. Kulturgruppen der Jungstein- und der Kupferzeit in der Ebene von Thrazien (Sŭdbulgarien). – In: J. Böhm & S.J. de Laet (eds.) *L'Europe à la fin de l'âge de la pierre. Actes du symposium consacré aux problèmes du Néolithique européen* (Prague, Liblice, Brno, 5-12 octobre 1959). Prague: Éditions de l'Académie tchécoslovaque des sciences, 1961, 45–100.
- Guillonnet 2021:** P. Guillonnet. Comprendre les chantiers mégalithiques à partir d'un outil emblématique du Néolithique : la hache polie. – *Bulletin de l'APERA* 1, 2021, 37–46. <https://apera.hypotheses.org/555>
- Kalchev 2013:** P. Kalchev. Dvuetazhna rannoneolitna postroyka v selishtna mogila Okrazhna bolnitsa v Stara Zagora. Stara Zagora: Obshtina Stara Zagora / Regionalen istoricheski muzey, 2013.
- Lundström-Baudais et al. 1989:** K. Lundström-Baudais, F. Passard & P. Pétrequin. Plan des villages, matériaux de construction et architecture. – In: P. Pétrequin (ed.) *Les sites littoraux néolithiques de Clairvaux-les-Lacs (Jura). Tome II : Le Néolithique moyen*. Paris: Éditions de la Maison des sciences de l'Homme, 1997, 107–136.
- Muigg et al. 2023:** B. Muigg, R. Elburg, W. Hein, A. Probst-Böhm, S. Böhm, P. Walter & W. Tegel. Woodworking and carpentry skills of the first agricultural societies in central Europe. – In: P. Bacoup & J. Taïeb (eds.) *Proceedings of international meetings 'Journées bois. Échanges interdisciplinaires sur le bois et les sociétés'* (Paris, 18-19 octobre 2021). Paris: Archaeology, Society and Environment 3/1, 213–226. <https://doi.org/10.21494/ISTE.OP.2023.1035>
- Pigeot 2011:** N. Pigeot. Chaînes opératoires : contexte théorique et potentiel cognitif. – In: R. Treuil (ed.) *L'archéologie cognitive*. Paris: Éditions de la Maison des sciences de l'Homme,

2011, 149–171. <https://doi.org/10.4000/books.editionsmsmh.14554>

Procopiou 2011: H. Procopiou. Choix et décision, sens et émotions : le début des études de perception. – In: R. Treuil (ed.) *L'archéologie cognitive*. Paris: Éditions de la Maison des sciences de l'Homme, 2011, 233-255. <https://doi.org/10.4000/books.editionsmsmh.14476>

Popova 2009: T. Popova. Paleobotanic catalog of sites and studied plant remains in the territory of Bulgaria (1980-2008). – *Interdistsiplinari izsledvaniya* 21, 2009, 71–166.

Tegel et al. 2012: W. Tegel, R. Elburg, D. Hakelberg, H. Stäuble & U. Büntgen. Early Neolithic water wells reveal the world's oldest wood architecture. – *PLoS ONE* 7/12, e51374. <https://doi.org/10.1371/journal.pone.0051374>

Todorova 1986: H. Todorova. *Kamenno-mednata epoha v Bulgaria (peto hilyadoletie predi novata era)*. Sofia: Nauka i izkustvo, 1986.