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Fires of a House—Burning Events in a Middle Bronze Age Vatya House as Evidenced by Soil Micromorphological Analysis of Anthropogenic Sediments

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Abstract: The investigation of fires and burning within the archaeological record has a long history, and the applied methods are diverse. There have been several investigations of prehistoric archaeological sites, but Middle Bronze Age contexts (2000–1450 BC) of the Carpathian Basin have not been widely studied beyond studies of ritual burning or warfare. In this paper, we aimed to add further details to this topic in the household context via thin-section soil micromorphology and related phytolith and charred plant matter analysis. The combination of these techniques has been proven to be advantageous due to their high-resolution quality, but phytolith analysis of soil/sediment via thin sections (i.e., in fixed environment) has not been largely explored yet. In this study, these methods were used to investigate various burning events that affected a Middle Bronze Age Vatya house within the tell site of Százhalombatta-Földvár, Hungary. Three types of fire/burning events were investigated. One was related to hearth activity, another one to a presumed 'cleaning' of the house, and the last one to the termination of the building. In the first two cases, everyday life was under the microscope; the latter was more enigmatic, and probable intentional destruction was demonstrated.

Keywords: Middle Bronze Age; Carpathian Basin; fire; burning; thin-section soil micromorphology; phytolith analysis; Százhalombatta-Földvár; household archaeology

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Citation: Kovács, G.; Vicze, M.; Pető, Á. Fires of a House—Burning Events in a Middle Bronze Age Vatya House as Evidenced by Soil Micromorphological Analysis of Anthropogenic Sediments. *Land* **2023**, *12*, 159. https://doi.org/10.3390/land12010159

Academic Editors: Deodato Tapete and Avto Goguitchaichvili

Received: 17 November 2022
Revised: 19 December 2022
Accepted: 23 December 2022
Published: 3 January 2023

1. Introduction

Fire and pyrotechnological activities (e.g., cooking, heating, and smelting) in prehistoric contexts have been explored by applying various techniques [1–7], but less was done in this field within Bronze Age tell sites, particularly in Hungary [8]. Such activities and events were investigated in various environments and time periods via numerous techniques such as soil micromorphology [3,6,9–15]. However, the combination of thin-section soil micromorphology complemented by phytolith analysis in a fixed environment (i.e., in thin sections) has only been applied in a few cases to date [16–20], and their use is even more limited in studies of fire issues [21]. As burning causes a long-lasting transformation of the affected material, fire-related activities can be effectively studied in thin sections under a microscope [22–29]. The reddening of the soil particles, the melting of the minerals, and the charring of the organic material are all indicators of heat/fire that can be clearly recognized in thin section ([22,30]; see also [21] for characterization and extended literature on the topic). Most of the data regarding house fires is in the macro range, such as that from excavation observations [31], experimental archaeology [32,33], or ethnoarchaeological [30,34] studies.

The aim of this study was to describe the possible effects and manner of fire events by using the method of thin-section soil micromorphological analysis and to highlight the observations of plant microremains within the relevant thin sections. In order to achieve this aim, a Middle Bronze Age house structure within the tell site of Százhalombatta-Földvár (Hungary) was selected. The analyzed samples of house ID 3497 opened new avenues and possibilities for the understanding of the nature of fire events in domestic contexts. The occurrence and thus the study of the remnants of different fires and/or fire events found in this house may offer additional information about the (household) activities of the family that lived there.

1.1. Research Area

Százhalombatta-Földvár is a fortified tell settlement (Figure 1) that was continuously occupied for hundreds of years from the Early Bronze Age until the end of the Middle Bronze Age [35–38] (2000/1900–1500/1450 BC in recent studies dated according to [39]).

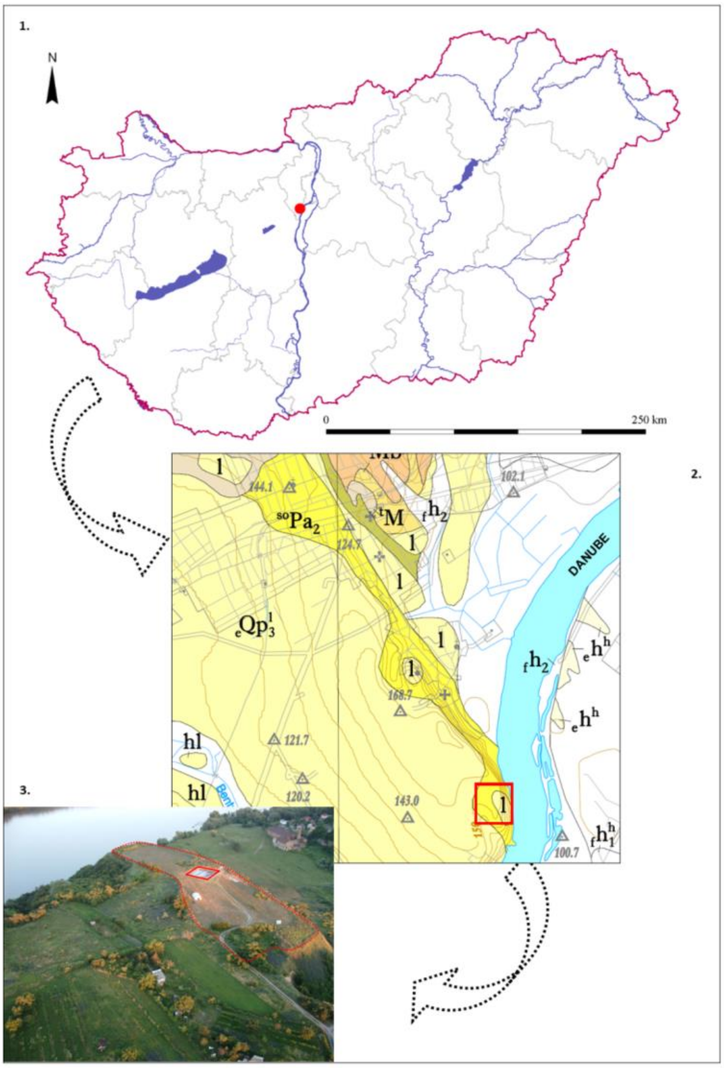

Figure 1. (**1**) Location of the Százhalombatta-Földvár Bronze Age fortified settlement within Hungary; (**2**) the geographic setting of the settlement marked with a red square. Notes: $_{e}Qp_3{}^{l}$—loess; $^{so}Pa_2$—Somlói Formation (gray aleurit with clayey marl with molluscs such as *Congeria*, *Melanopsis*, and *Dreissena*); ^{t}M—Tinnyei Formation (yellow biogenic limestone with molluscs); (**3**) aerial view of the site with the boundary of the tell (dashed red line) and that of the excavation trench (red continuous line) (modified after [40]).

The excellent position of the site on top of a loess plateau overlooking the river Danube and surrounded by protective valleys made the settlement's long-term development possible. During the Middle Bronze Age, all of the resources (building materials, livestock, crops, and water [41–43]) needed for a stable and sustainable life were available. Houses, streets, and alleys with additional communal areas were constructed [42] (Figure 2). At the time under inspection (c. 1650 BC), the remains of five houses from the so-called Vatya–Koszider period were found in the 20 × 20 m excavation trench [42], out of which the middle house (identified as ID 3497) is discussed here in relation to fire events.

The geographical setting and soil conditions of the site and its close proximity were described in detail in Kovács et al. 2020, therefore only the main and most important details were emphasized here. Százhalombatta-Földvár is part of the Mezőföld mesoregion and lies within the Érd–Ercsi-hátság microregion, which is bordered by the Danube in the east, the Transdanubian foothills in the west, and the Buda foothills in the north [44]. During the Pleistocene, fluvial erosion produced complex valley systems in this landscape, and areas that were left intact by these geological processes emerged from the landscape and formed ideal places for later human occupation. A ridge built up of the Upper Pannonian (Miocene–Pliocene) Somlói Formáció ($^{so}Pa_2$) stretches in a northwestern direction from the Danube bend [45]. Loess ($_{e}Qp_3{}^{l}$) mosaics on the surface form plateaus, and the site is located in close proximity to the Danube overlooking the river bend.

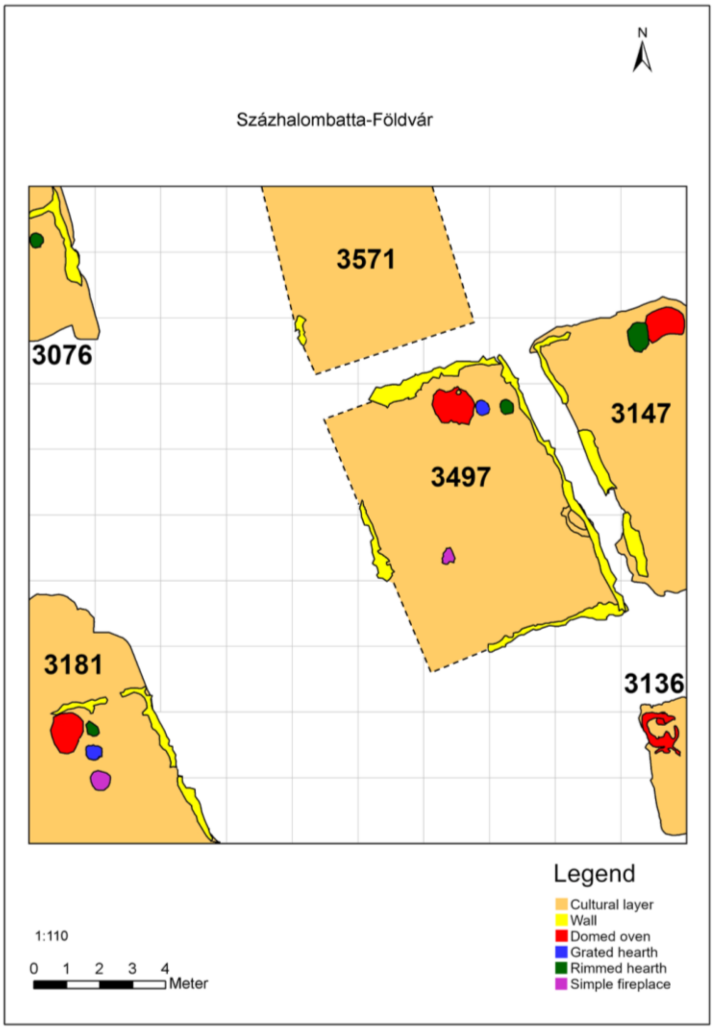

Figure 2. Location of house ID 3497 within the excavation trench (edited after [45]).

1.2. The Vatya House ID 3497

Preliminary study shows that this household probably belonged to one of the most densely populated phases of the site along with neighboring houses that were clearly established archaeologically. The 20 m by 20 m excavation trench comprises remains of at least four more houses at the level of the tell under inspection; a system of different pathways and a communal area revealed a very busy and dynamic daily life [35,41] (Figure 2). The house (ID 3497) went through several construction phases that included smaller, rather localized inner changes (such as the relocation of a fireplace, for instance) or major alterations such as remaking the entire floor surface with clean, yellow silty clay. In the case of this house, the entire structure lay within the excavated area, and preserved walls on all four sides could be identified. The house, at least during one of its phases, was c. 8 m long and 5 m wide. The use of different types of fireplaces (hearths and ovens) and a daub-constructed inner 'furniture-like' structure could be documented here. The pattern of grouping a domed oven, a walled-grated hearth, and a rimmed hearth (ID 3322) close to each other within a confined, so-called domestic area was observed (Figure 2). It is interesting to note that at Százhalombatta, this special area seemed to be regularly located in the northern part of the relevant room close to its northern wall. However, an open fireplace halfway between this area and the south end of the house was also in use during a certain period of the utilization of the house. Small finds and other find analyses indicated that these diverse cooking/backing structures were indeed used in the preparation of food types that required different treatments [41,42]. A unique and novel feature of the house was the so-called 'basin' (ID 3517; Figure 3). It was an 80 cm long, shallow, rimmed structure that was half-circle in shape, constructed from dauby material (silty clay with vegetal tempering) and attached to the inner side of the eastern long wall (Figures 2 and 3). The function and use of this feature are not entirely clear, but it was definitely an integrated part of the household installations. This was indicated by the fact that similarly to the house, at least two major construction phases of this feature could be detected. During the early phase of the house, there was a structure indicated by a half-circle ring of stakes next to the wall. It was interesting to note that the area of the feature was not lined with the silty clayey floor material but seemed as if the floor was constructed around it. In other words, the stake-lined feature was constructed on an earthen floor while the rest of the house had silty clay floor. We believe this structure was rebuilt from daub (so the basin (ID 3517) came to life) and that it was constructed when the floor was remade during the next phase with yellow silty clay. The presence of this auxiliary/complementary 'furniture', as well as the various hearths and ovens, indicated a complex household and reflected careful planning and a dynamic life within this house.

Figure 3. Basin-like clay feature (ID 3517) attached to the eastern wall of house ID 3497.

2. Materials and Methods

2.1. Samples

Three thin sections were available for analysis from house ID 3497 (Figure 4 and Table 1). Samples were selected to investigate various fire-related activities that could then be compared with other contexts and fire events (i.e., contemporary houses, combustion features, and contexts of earlier and later phases of the tell).

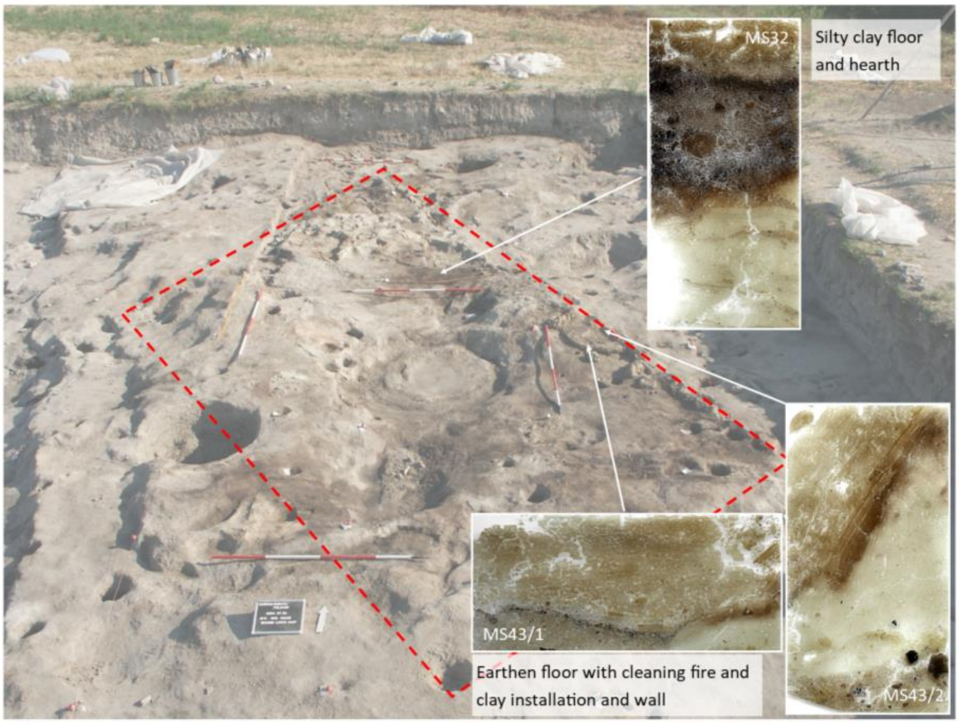

Figure 4. Locations of the origins of the thin-section soil micromorphological samples within house ID 3497.

Table 1. Inventory of the investigated micro-horizons.

	Sample Code	Description	Stratigraphy/ Micro-Horizons	Archaeological Context of the Stratigraphical Unit
Burning Type #1	MS32 2004	Silty clay floor and hearth with burning episodes	Hp2 Be3 Be2 Hp1 Be1 Cfb/be C	Hearth platform 2 Burning event 3 Burning event 2 Hearth platform 1 Burning event 1 Floor build-up/burning event Silty clay floor
Burning Type #2	MS43/1 2004	Probable cleaning fire	B1	Burning event
Burning Type #3	MS43/1 2004	Earthen floor (with cleaning fire and ash dump), clay installation (basin), and burnt wall	I Cfb E W	Installation/furniture (basin) Floor build up—ashy layer Earthen floor Wall
	MS43/2 2004	Wall of house ID 3497 with the clay installation	I Wp W SM	Installation/furniture Wall replastering Wall plaster Sediment matrix

The samples discussed provided insight into domestic behavior and added further details to traditional archaeological techniques in relation to the fire/burning activities of Bronze Age people at Százhalombatta-Földvár. Sample MS32 2004 provided microdetails of hearth use and related fires. MS43/1 2004 demonstrated the use of fire for cleaning, while the MS43/1 and MS43/2 2004 samples demonstrated the destruction of the house by fire.

2.2. Thin-Section Soil Micromorphology

Intact sediment blocks were taken from vertical profiles opened at various locales in the house ID 3497 (Figure 4) that enabled the study of some unusual burning activities. Kubiena boxes were employed to collect the samples, which were air-dried and impregnated with epoxy resin and then cut and polished to approximately 30 microns to reach a thickness that was permeable to light so the slides could be studied under a microscope [46]. The so-called mammoth thin sections (c. 7 × 14 cm in size) were processed by G. Kovács at the University of Cambridge, Department of Archaeology, using the standard protocol of the McBurney Laboratory. A Nikon E200 polarizing microscope was used, and the slides were examined under cross- and plane-polarized light at various magnifications ranging from 20–200×. The thin sections were analyzed and described using standard micromorphological nomenclature [21,47] (for details, see ESM in the Supplementary Materials).

2.3. Phytolith Analysis

Phytoliths as well as silicified tissue elements were analyzed in the thin sections prepared for the soil micromorphological analysis at magnifications ranging from 100× to 400×. Description of the phytoliths was based on the International Code for Phytolith Nomenclature 2.0. [48]. A modern reference collection of inflorescence bract elements of cereals and relevant scientific literature [49–56] was used to identify the anatomical origin of the observed morphologies. Numerous criteria influenced the visibility of phytoliths within a thin section [57–61]. The phytolith analysis of the thin sections implied five direct indices:

1. The Observed/Not Observed Index (O/NO) referred to the absence or presence of phytoliths within the thin section.
2. The Distribution Index (D) defined whether the observed phytoliths occurred in the groundmass or in voids.
3. The Morphotype Identification Index (MI) implied the identification of the plant opal particles observed in the thin sections. It relies on standard phytolith nomenclature sources such as the ICPN 2.0 [48] and on plant anatomical knowledge.
4. The Aspect Index (A) considered the plant opal particles individually in terms of their visibility and appearance. Visibility referred to the fact that phytoliths might have been wholly, partly, or not at all released from the organic tissues (for details, check ESM2 in the Supplementary Materials.)
5. The Associated Material Index (AM) provided additional contextual data relevant to the presence or absence of plant opal particles and defined the presence of charred plant organic matter (POM).

3. Results

The Middle Bronze Age Vatya house ID 3497 that was under inspection here was affected by three types of burning episodes. Table 1 lists the investigated micro-horizons and their archaeological contexts. The detailed microscopic observations of the micro-horizons can be seen in ESM1 and ESM2 in the Supplementary Materials. Table 2 provides an overview of the most important characteristics of the examined micro-horizons.

Table 2. Characteristics of the examined micro-horizons.

Sample Code	Stratigraphy/ Micro-Horizon	Main Characteristics
MS32 2004	Hp2	Fine (c/f 100:10/90), porous (porosity: 30–40%), and undisturbed to slightly bioturbated horizon. Mineral components dominated with some phytoliths (2–5%) and charcoal (<2%). Phytoliths were partly well exposed, which was an indication of vegetative plant organs.
	Be3	Fine (c/f 100:20/80), porous (porosity: 30–40%), and slightly to moderately bioturbated horizon. Charcoal (10–20%) dominated with some phytoliths (2–5%) and occasional burnt bone and daub fragments (<2%). Laminated plant deposition and chaff indication.
	Be2	Very fine (c/f 100:5/95), moderately porous (porosity: 20–30%), and slightly to moderately bioturbated horizon. Charcoal (30–50%) dominated with occasional phytoliths (<2%).
	Hp1	Coarser (c/f 100:40/60), slightly porous (porosity: 20–25%), and slightly bioturbated horizon. Charcoal and burnt daub fragments (5–10%) dominated with some burnt bone (2–(5)%) and with occasional burnt phytoliths (<2%) indicating the presence of chaff.
	Be1	Very fine (c/f 100:5/95), porous (30–40%), and highly bioturbated horizon. Charcoal and burnt plaster fragments (30–50%) dominated with some phytoliths (2–5%) and an extremely high content of charred amorphous plant organic matter (POM).
	Cfb/be	Fine (c/f 100:10/90), moderately porous (20–30%), and moderately bioturbated horizon. Wall plaster dominated (30–50%) with some charcoal (2–5%) and phytoliths (<2%) as well as charred plant organic matter (POM). Burnt bone fragments were also present (<2%).
	C	Very fine (c/f 100:<5/>95), compact (5–10%), and slightly to moderately bioturbated; mainly mineral horizon with some daub (2–5%), a wall plaster fragment (5–10%), and occasional phytoliths (<2%).
MS43/1 2004	B1	Very fine (c/f 100: 5/95), moderately porous (porosity: 20–30%), highly bioturbated horizon. Charcoal (30–50%) dominates with some phytoliths (2–5%) and occasional burnt bone and non-metallurgic slag fragments (<2%).
	I	Very fine (c/f 100: 5/95), porous horizon (porosity: 30–40%) with no/slight bioturbation. Mineral components dominate with some phytoliths (2–5%) and bioclast fragments (<2%).
	Cfb	Very fine (c/f 100: 5/95), porous (porosity: 30–40%), highly bioturbated horizon. Phytoliths (30–50%) dominate with some wall and non-metallurgic slag fragments (2–5%) and with occasional charcoal, burnt bone, ash and pottery fragments (<2%).
	E	Fine (c/f 100: 10/90), moderately porous (porosity: 20–30%), slightly to moderately bioturbated horizon. Charcoal (5–10%) dominates with some phytoliths, bone and ash (2–5%) and with occasional dung, burnt bone and daub fragments (<2%). Disturbed and mixed-up plant depositions are present.
	W	The daub fragment is mainly mineral in composition with some dung (2–5%) and occasional phytoliths, charcoal and pottery fragments (<2%).
MS43/2 2004	I	Very fine (c/f 100: 5/95), porous (porosity: 40–50%), undisturbed to slightly bioturbated horizon. Mainly mineral horizon with some phytoliths (2-5%) and with occasional dung and bioclast fragments (<2)
	Wp	Six layers of re-plasterings, which are composed of mainly mineral particles with some charcoal (2–5%) in one of them. The plaster layers are very fine and compact with no, or slight bioturbation.
	W	Very fine (c/f 100: 5/95), compact (porosity: 5–10%), undisturbed to slightly bioturbated horizon. Mainly mineral horizon with some dung (2-5%) and with occasional phytoliths, bioclast and charcoal fragments (<2%).
	SM	Fine (c/f 100: 15/85), moderately porous (porosity: 25–30%), moderately to highly bioturbated horizon with some phytoliths, charcoal, ash, pottery and daub fragments (2–5%) and with occasional bone and non-metallurgic slag (<2%)

4. Discussion

4.1. Burning Type #1—Hearth and Hearth-Related Activities

Fireplaces, hearths, and ovens are the most obvious places for the use of domestic fires in the archaeological record. At Százhalombatta-Földvár, several types of hearths/ovens have so far been identified that range from simple fireplaces to domed ovens to grated hearths [42,62]. The one under inspection here was a rimmed hearth (ID 3322) that was renewed during its lifetime. One thin section (encoded MS32 2004) was prepared to investigate the nature of fires at this locale (Figure 5).

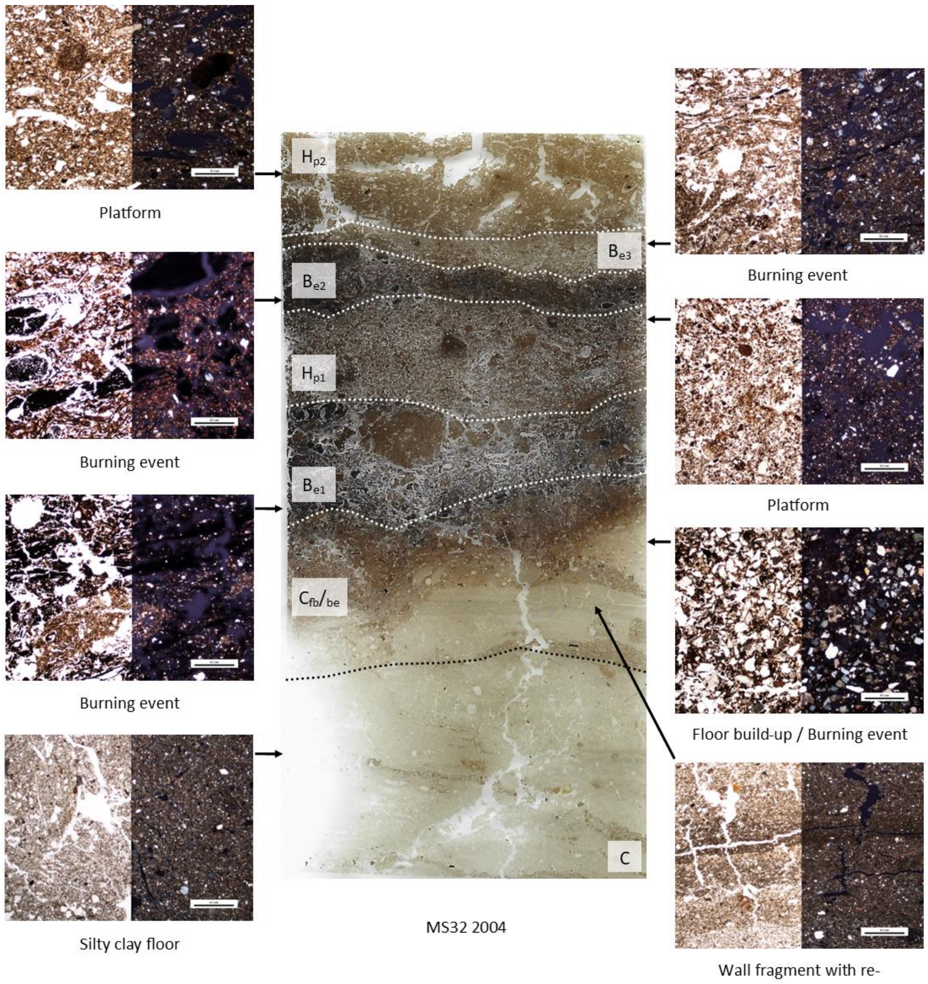

Figure 5. Thin section (MS32 2004) showing the two platforms of the hearth (Hp1 and Hp2) and the four burning events (Cfb/Be, Be1, Be2, and Be3). The scale bar in the microphotographs is 0.1 cm.

Before turning to the analysis of the fires, an interesting observation that was made needs to be pointed out here. In most of the cases, the hearths were associated with floors. One would think that they were prepared right on the surface of the floor (passive horizon), but that was not the case here. The silty clay floor (Figure 5, C microlayer) contained a small amount of plant inclusions (e.g., grass silica long-cell phytoliths of grass stems and leaves) that were in an ex situ position (see ESM2 in the Supplementary Materials). Interestingly, the platform of the hearth was not visible here, but some unburnt wall plaster with some floor build-up and burnt material on top was present (Figure 5, Cfb/be microlayer). This suggested that fires were lit directly on top of the floor build-up/activity remains as shown by the reddening of the sediment and the charred plant matter. On top of the fallen wall fragment, tiny dung fragments (in the form of phytoliths and faecal spherulites) were identified (Figure 6A,B), on top of which plant matter was placed (Figure 6C).

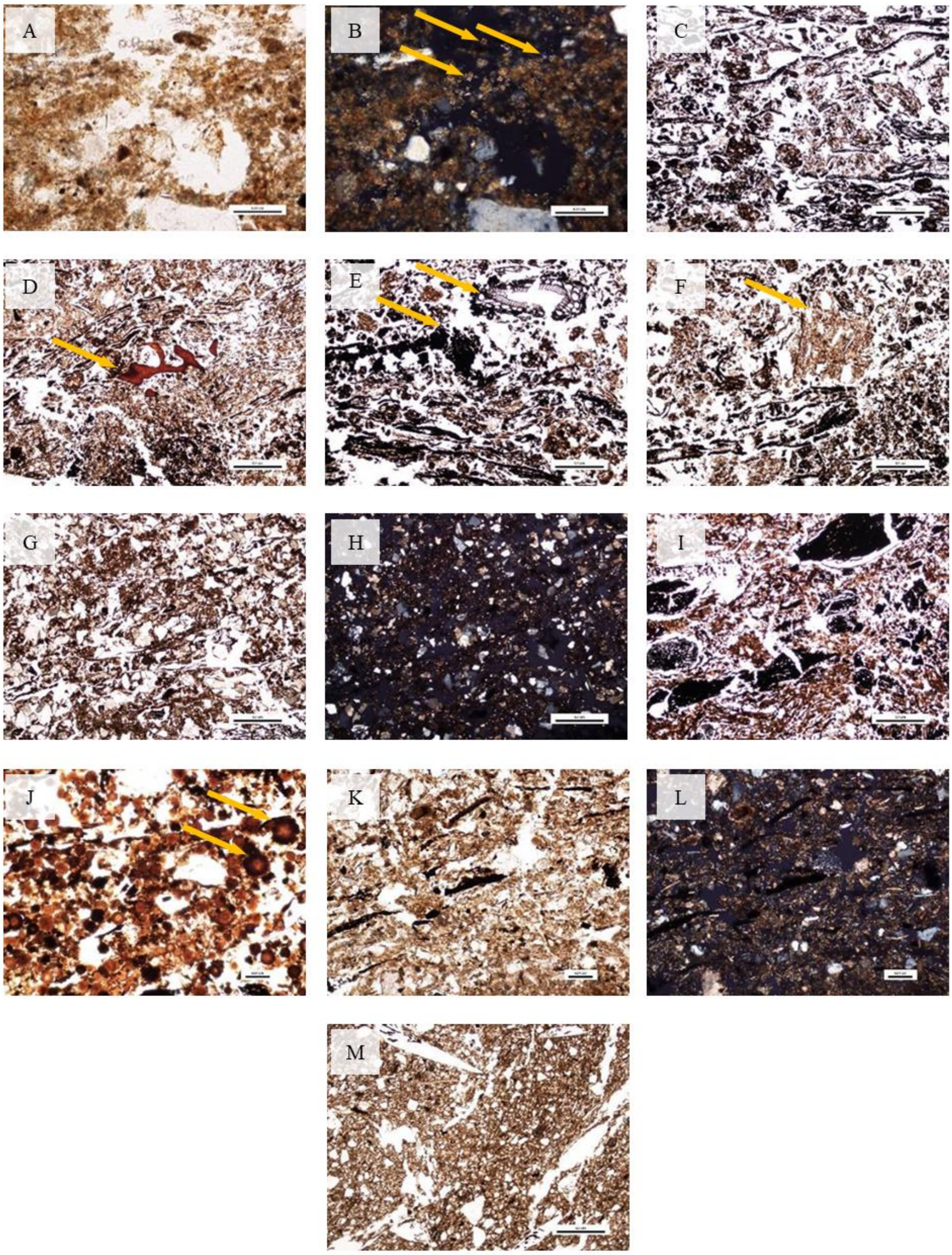

Figure 6. (**A**,**B**) Faecal spherulites and phytoliths associated with dung (indicated by arrows) (scale: 0.01 cm; PPL, XPL). (**C**) Laminated, charred plant matter (scale: 0.1 cm; PPL). (**D**) Burnt bone fragment (indicated by arrow) (scale: 0.1 cm; PPL). (**E**) Laminated, charred plant matter (indicated by arrows) (scale: 0.1 cm; PPL). (**F**) Burnt daub fragment in the charred matrix (indicated by arrow) (scale: 0.1 cm; PPL). (**G**,**H**) Material of the 1st platform of the hearth (scale: 0.1 cm; PPL, XPL). (**I**) Charred wood and fine plant matter (scale: 0.1 cm; PPL). (**J**) Detail of I with leucophosphate (indicated by arrows) (scale: 0.01 cm; PPL). (**K**,**L**) Fine, calcareous ash layer (scale: 0.01 cm; PPL, XPL). (**M**) Material of the 2nd platform of the hearth with vegetal tempering (void) (scale: 0.1 cm; PPL).

The fine plant matter showed lamination (i.e., purposeful placement) and was charred (Figure 6C). The charred plant organic matter (POM) blurred the plant opal (inorganic) particles, which made it difficult to clearly identify the anatomic origin of the plant material that was used here as fuel. The majority of the observed plant material was POM; however, the structure referred to both vegetative (leaves and stem) and generative (chaff) organs. In a few areas, some phytoliths were well exposed to the plant organic material. Both elongated epidermal long cells (e.g., ELO_ENT)—indicative of grass vegetative organs—and so-called dendritics (ELO_DEN) were partly visible.

Charred organic matter of chaff remains that showed a resemblance to chaff material identified earlier in ceramic thin sections [61] were visible at a few localities. The latter indicated the presence of cereal chaff. Unfortunately, the cell wall patterns were not visible enough to—at the least—estimate the possible genus that was used here. Despite the low visibility of the plant opal particles, the charred organic material nicely drew a pattern of a laminated plant structure that was mixed up and stirred by local activity. Within the charred material of the grasses, tiny particles of wood charcoal appeared, which indicated that the burnt substance might have been derived from both woody and herbaceous sources. This plant matter seemed to be ignited, and the underlying dung was also affected by the heat (Figure 5, Cfb/be horizon). Based on the excavation findings, wood was likely to be the most frequently used fuel. However, the microscopic observations might indicate that a limited amount of dung could have also been utilized. The miniscule burnt bone fragments (Figure 6D) observed in this layer hints at cooking activity in the vicinity. The area was affected by fire again as shown in the next layer (Figure 5, Be1 horizon; Figure 6E,F).

The very sharp boundary between the two layers indicated two separate burning events. The charred plant remains were still rather fine and laminated (Figure 6E), as was the previous plant matter, which indicated a deliberate placement and in situ burning. It was highly interesting to note that even fewer phytolith particles could be observed because charred plant material covered the entire microlayer. Based on the charred plant material's morphological features, the presence of chaff-related material could be inferred. However, due to the extremely high charred plant material content, it is likely that this fire event occurred under reductive conditions. In the case of an open-air fire for which an adequate amount of oxygen is provided, organic material burns. In this particular case, the charring was the main factor, which might point to the conscious smothering of the fire before the oxidative burning. Unfortunately, the purpose of this action could not be further determined based on the microscopic observations. One possibility is that the fire had to be doused suddenly for some reason, so it was put out. Roasting or smoking could also be an explanation but these could not be proved by the available data.

In addition to the charred plant matter, several burnt daub fragments were observed in the Be1 layer (Figure 6F) that ranged in size from a couple of millimeters up to 1 cm. What was even more interesting was that the remains of the 'initial' fires were not cleared away, but the platform of a hearth was built on top of their combined accumulated layer as shown in Figure 5 (Hp1 horizon). The first platform of the hearth had a coarser sandy matrix incorporated into the silty clay that was tempered with organic matter (Figure 6G,H). The charred remains of chaff organic material could be identified in some areas of the microlayer, but their appearance was sporadic and their preservation was very poor. Phytoliths only 'peak out' at very few localities. This platform was used for some time, which was indicated by the rich brown and black burnt discoloration. On top of the platform, the remains of a wood fire mixed with some fine, undisturbed plant matter was found horizontally embedded, which indicated in situ burning (Figure 5, Be2 horizon; Figure 6I,J). Overlying this was another ashy layer of fine plant matter with grey ash crystals, which again indicated a different type of fuel (Figure 5, Be3 horizon; Figure 6K,L). Similar to the previous burnt horizons, in situ burning was proposed based on the orientation, the even distribution, and the lack of mixing in the material. All of these indicated a probable multipurpose use of the fireplace. The hearth was renewed as the second platform showed (Figure 5, Hp2 horizon). The material (Figure 5M) was very similar to daub because it was made of silty clay (loam) with a low amount of vegetal tempering (in contrast to the floor plasters identified at the site that lacked vegetal tempering) [63].

Given the findings of the micromorphological investigation, some observations could be made not only regarding the nature of the hearth use and burning, but also with regard to the construction sequence within the area. The hearth (ID 3322) was built sometime after the floor. It also became evident that the location under investigation was burned/charred prior to the construction of the hearth, which indicated that the location of fire was important. It also must be added that the rimmed hearth (ID 3322) was one of three fireplaces in this area of the house (the other two were one large domed bread oven and one smaller grated heath). The location; i.e., the northeastern part of the house, was the center of the fire-related (primarily cooking) activities, which was indicated by the continuous use.

4.2. Burning Type #2—Cleaning Activities

The usage of ash for cleaning purposes at this site has already been discussed to some extent [40,63], but this study added further details to this aspect via the microscopic observations. Hearths are one of the most frequent installation types that are found in Vatya houses because they were made of a durable material (i.e., silty clay). However, the building under investigation had an interesting and unique feature—the so-called 'basin' (ID 3517)—made of dauby material (silty clay (loam) with plant tempering) (Figure 3). Because such a basin-like feature had not been previously reported, we decided to extensively sample it for micromorphological analysis. Samples MS43/1 2004 and MS43/2 2004 represent the feature. This installation (ID 3517) (Figure 7, 'I'), which was attached to the eastern wall of the house (Figure 7, 'W'), helped to preserve the remnants of a probable 'cleaning' fire (Figure 7, 'B1'). It was previously noted that the investigated hearth of the house was not placed straight on top of the floor surface but on burnt material, and the 'basin' was placed on charred matter as well (Figure 7, 'B1'). The thin section MS43/1 2004 (Figure 7) was examined in relation to the 'cleaning' fire.

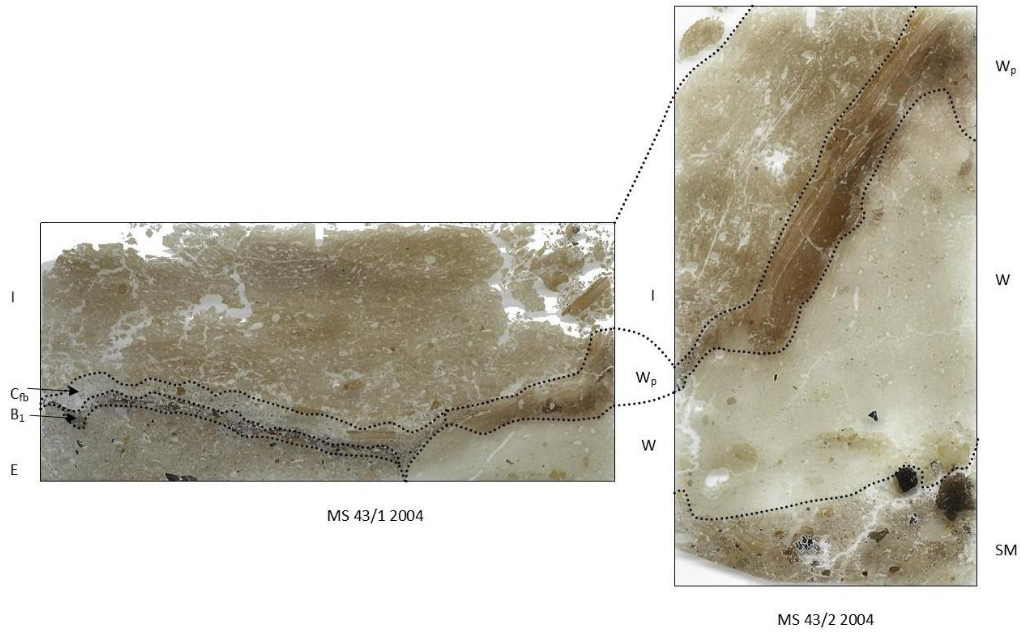

Figure 7. Thin section MS 43/1 2004 showing the 'cleaning' fire and thin section MS43/2 2004 showing the burnt wall of house ID 3497.

Before turning to the nature of the 'cleaning fire', it is necessary to discuss the underlying layer. An earthen floor was visible under the burnt horizon (Figure 7, 'E') in the thin section (Figure 7, 'E'; Figure 8A,B). It must be noted that in the case of this house, several phases and construction episodes could be distinguished. During its early phase, the half-circle feature was prepared with an earthen floor (Figure 7 'E'), while the rest of the floor was plastered with yellow silty clay (this was not captured in the thin section but was documented on site). During the later phase, a new yellow silty clay floor (Figure 5, horizon 'C') was laid, and the hearth discussed above (ID 3322) and the 'basin' (ID 3517)

(Figure 7 'I′) were constructed. The use/integration of earthen floors is typical of some of the Vatya houses, as has been illustrated previously [63], so that will not be discussed here. However, it must be mentioned that plant inclusions in the earthen floor part of house ID 3479 showed similarities to the earthen floors of the neighboring building (ID 3147), which was analyzed in detail [40].

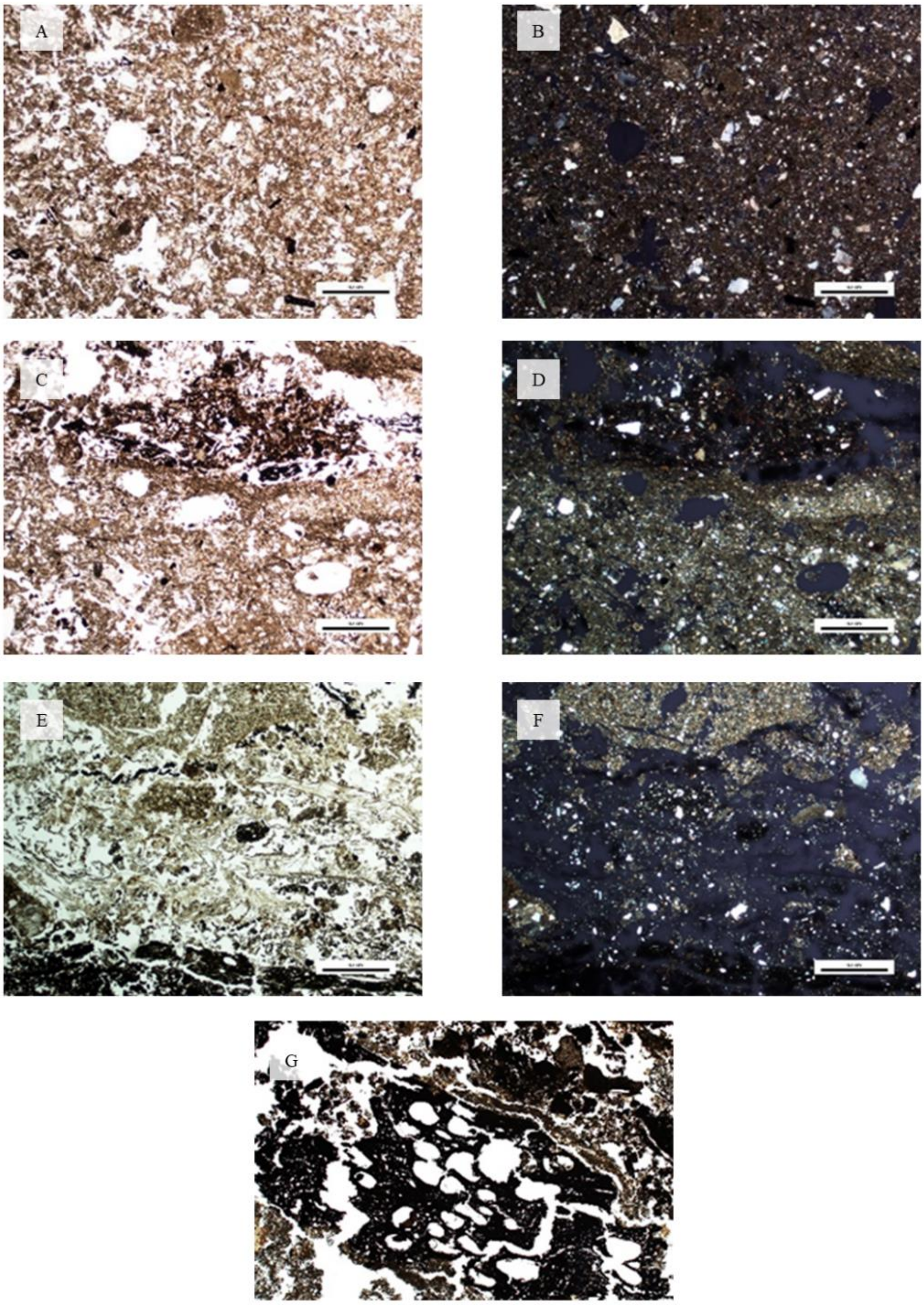

Figure 8. Microphotographs of MS43/1 2004: (**A**,**B**) material of the earthen floor (scale: 0.1 cm; PPL, XPL). (**C**,**D**) Fine, charred, laminated plant matter on the earthen floor (scale: 0.1 cm; PPL, XPL). (**E**,**F**) Material of the ashy layer on top of the charred horizon (scale: 0.1 cm; PPL, XPL). (**G**) cf. *Quercus* sp. charcoal (PPL, 50×).

The earthen floor part was not strongly affected by burning, as Figure 7 shows. This can also be seen in the intact state and well-exposed condition of the phytolith material that could be observed in sample MS43/1 2004. Similarlyto the earthen floor microlayers of the neighboring house ID 3147 [40] (Kovács et al. 2020), plant material was abundant in the matrix. Plant depositions were not observed here. The dominant morphotypes included GSSCP and GSLCP (e.g., ELO_ENT and ELO_ECH), which represented grass stem and leaf tissues. Signs of cereal chaff were also detected, although a robust signal could not be observed (see ESM2 in the Supplementary Materials). The sediment source used for preparing this floor segment in house ID 3497 was similar to that of the earthen floor of house ID 3147, for which a substance without vegetal tempering was used to create the foundation of the living space.

The burning immediately overlaid the top of the earthen floor (Figure 7, 'E′'), and no other floor build-up was visible underneath (Figure 7). It seemed that everything was removed from the floor prior to the burning. The charred plant matter was laminated and undisturbed (Figure 8C,D), which indicated deliberate placement and in situ burning as opposed to secondary deposition. The floor surface was hardly affected by the fire, which indicated a lower temperature and most likely a rapid fire. Although a couple of tiny charcoal fragments could be observed in the horizon (Figure 8G), the majority of the plant material used for this fire was fine plant matter such as the leaf and stem of cereals, while a minor amount of the burning substance could have been chaff material, which was a compositional difference with the previously observed phytolith spectral patterns of the tell [40] (Kovács et al. 2020). This evidence suggested that the firelighter could have been straw that contained mostly (but not exclusively) vegetative parts of cereals. In addition, a methodological comment must be made here. The plant material—most probably due to the very rapid fire event—was not entirely freed from the organic matter. Most of the grass material was in a charred condition (POM), and only a few phytoliths (e.g., ELO_ENT and ELO_SIN) were exposed, which provided hints regarding the anatomical identification. However, some of the charred and very well-preserved plant remains supported the abovementioned evidence.

The 'cleaning' nature of the fire under examination was further supported by the location of the micromorphological sample. Sample MS 43/1 2004 was taken from the southeastern part of the house (Figure 2). As previously noted, the hearths were located in the northern and central parts of the house. Hearth-related fire effects were more localized during proper use, so traces of such effects were unlikely to appear at such a distance. The different origin of the cleaning fire was further supported by the fact that in sample MS 43/1 2004 on top of the charred horizon, another ashy (burnt plant) layer (Figure 7, 'Cfb'; Figure 8E,F; and Figure 9A–D) was found, indicating some other activity (i.e., ash disposal) at that locale. The latter one consisted of a large amount of phytoliths that were affected by an oxidative fire; therefore, less organic material was left behind, which blurred the plant opal particles. The plant matter was not laminated here, but rather was disrupted (Figure 9E,F), which showed that it was spread here from somewhere else. The composition of the plant material exhibited sporadic evidence of the use of cereal-haff-related material (Figure 9G). The majority of the observed phytoliths reflected vegetative grass organs (Figure 9H) and were only partly exposed to the tissue. In many areas, they were aggregated to various extents (Figure 9E–H).

Charred material was basically absent in the matrix. The phytolith material referred to grass stem and leaf material that could be linked to straw or even hay because the size and morphology of the phytoliths observed here seemed to differ slightly from that of the cereals. The basin-like feature was constructed on top of this ashy layer (Figure 7, 'I′').

Based on the microscopic evidence, it seemed that the cleaning fire was short and well controlled. It was lit using some quickly and easily ignitable material (e.g., straw or hay) that could not produce a high temperature. The fire was probably put out or died out quickly because it did not affect the soil particles to a great extent but was probably enough to clean or clear the floor surface. However, other symbolically significant events or even a mere accidental flare-up cannot be disregarded.

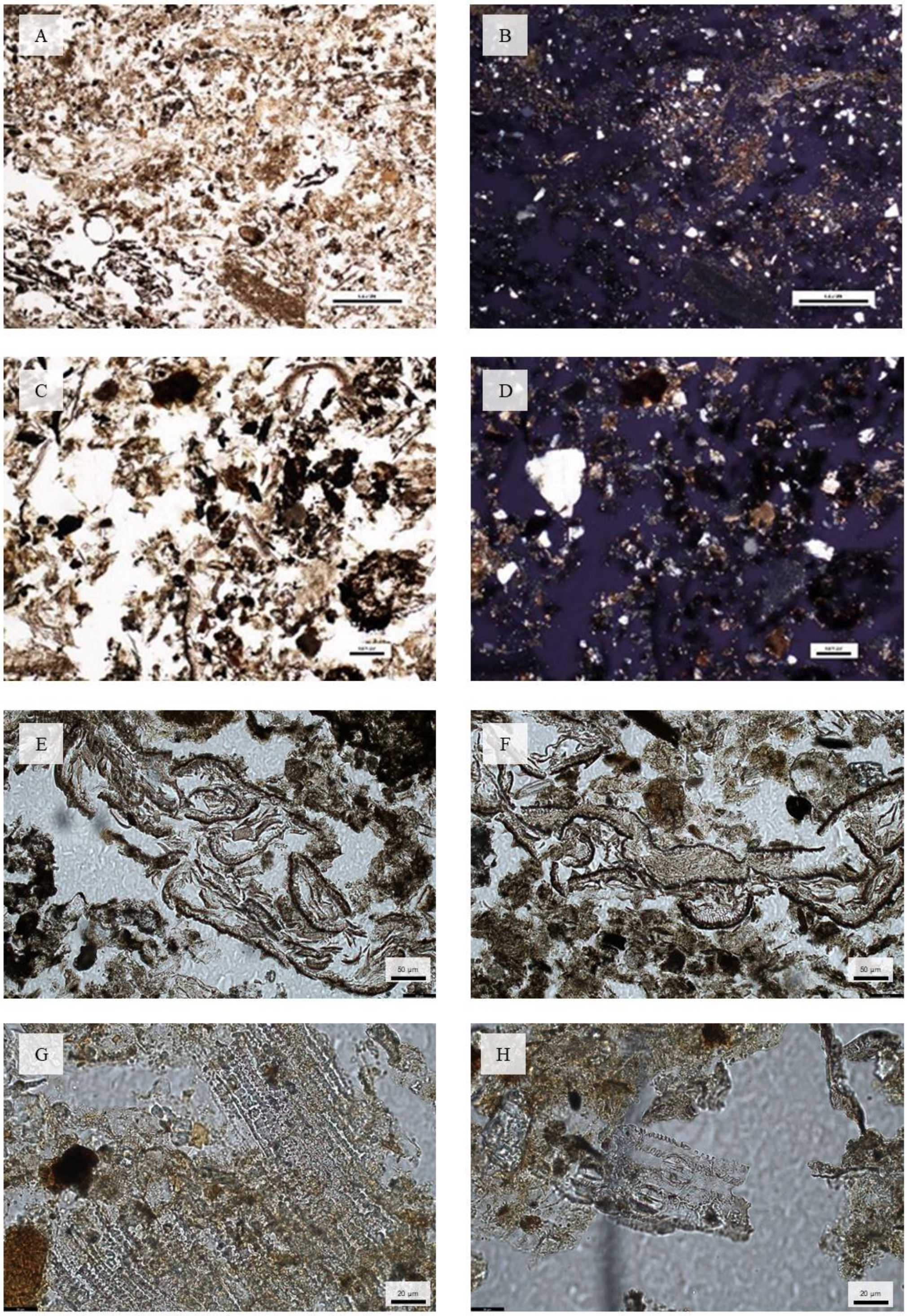

Figure 9. Microphotographs of MS43/1 2004: (**A**,**B**) matrix of the ashy layer (scale: 0.05 cm; PPL, XPL). (**C**,**D**) The same layer at higher magnification (scale: 0.01 cm; PPL, XPL). (**E**,**F**) Indication of vegetative organs of Gramineae with partly exposed silica content and charred organic matter (PPL, 50×), (**G**) Partly exposed elongated dendritic tissue element indicating the presence of cereal chaff material (PPL, 400×). (**H**) Stomata and epidermal cells of Gramineae as indication of grass vegetative organs (PPL, 400×).

4.3. Burning Type #3—The End of the House's Lifecycle

As the excavation findings showed, the last phase of the house ended due to a high-intensity fire that left a fully charred surface behind (Figure 10).

Figure 10. Burnt surface of house ID 3497 (and position of the neighboring houses).

As previously mentioned, this house was situated in the middle of the excavation trench and at least four houses surrounded it (Figure 2). It was interesting to note that the house (ID 3147) closest to this one on the east did not seem to have been affected by the burning of this house (see Kovács et al., 2020 for details), although only a narrow alley separated the two buildings. However, the structure to the north (ID 3571) seemed to have been destroyed by fire at the same time. Further, the fact that almost all usable and whole utensils were removed from the house prior to its burning down might indicate that the burning of this house was controlled or could have been controlled to some extent. It is certain that it did not affect the entire neighborhood.

Two thin sections (MS43/1 2004 and MS43/2 2004) were examined to investigate the final burning of the house (Figure 7). Based on the excavation findings, it was evident that the entire house was burned down, which ended the life of the house, so it was not specifically sampled for micromorphology. This obviously means that no information will be presented on the nature of the burning material from the thin sections. However, the thin sections clearly showed that a high-intensity, high-temperature fire ended the life of the house. As Figure 7 shows, the fire must have been so intense that not only the basin-like clay feature was burned to a great extent, but even the wall plaster (Figure 7 'Wp') of the house wall (Figure 7 'W') partially underlying the feature (Figure 7 'I') was affected. The darker brownish discoloration suggested a lack of oxygen in the process; meanwhile, just above the sampling location, orangey-red burnt daub was observed. This indicated that the basin-like feature transferred some of the heat, and therefore an in situ fire was not responsible for the observed effect that was captured in the thin section. It should also be noted that the cleaning fire had no effect on the wall material because no evidence of burning was present in the thin sections (Figure 7). Phytolith occurrence in the matrix of the wall plasters was sporadic; charred plant material was almost totally absent, which pointed to the low quantity of plant tempering in these features (see ESM2 in the Supplementary Materials). Another interesting observation also was made here that regarded some technical details of house maintenance. The wall of the house was replastered several times prior to the building of the basin-like feature. This indicated that it was not part of the furnishings in its 'daub form' at the time of the construction of the house but was built later. In other words, the earthen floor phase of the half-circle feature (preceding the 'basin') must have been a 'longer' period in which the house wall was replastered several times. After some use the floor was renewed, and the basin-like feature was constructed from daub.

4.4. Fire and the House's Lifecycle

As demonstrated by the thin-section analysis, fire was an important factor during the life of the house. Figure 11 reconstructs the processes evident in the thin sections, although the exact timing could not be determined. The ongoing analysis of the archaeological material will hopefully add more time depth to the microscopic observations.

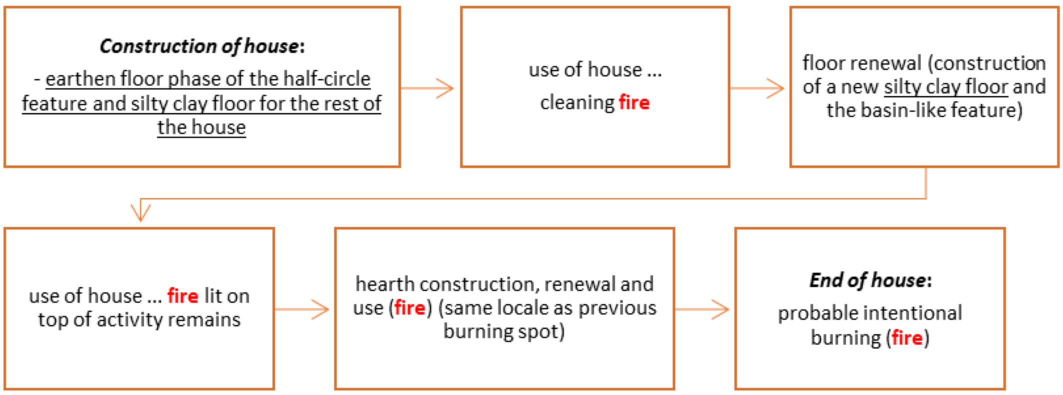

Figure 11. Lifecycle of house ID 3497 and related burnings.

5. Conclusions

Ever since the first fire was lit by humans, fire became an inevitable part of our lives. The microscopic analysis of Bronze Age fire remains at Százhalombatta-Földvár shed light on several aspects of fire used in that period. Not only was the fire itself of great value and part of everyday life for the inhabitants, but the location of the fireplaces was also very important [42]. This was indicated not only by the planned placement of the fireplaces in general, but also as shown in the microscopic analysis. Controlled fire was used even at a locale where no fire installation was found. A variety of fuel types (wood, plant matter (i.e., straw, leaves, and chaff), and possibly dung) were used during the everyday activities. Fine plant matter derived partly from cereals and from other grass sources, as well as branches/twigs and even possibly dung, were used for fires. This variation not only showed the number of available resources, but also the deliberate application of the fuel types for specific uses. It also became evident that the people of the Vatya cultural complex were skilled at controlled burning because in our present examples, fires (i.e., for cleaning) did not damage the house or the broader neighborhood. The end of the house's life due to burning was well managed because the closest building was affected to a very slight degree even if the burning was at a high intensity as determined by microscopic analysis and field observations. Some aspects of the Vatya building maintenance techniques (e.g., plastering) could also be observed, which contributed to a sense of timing and details of the construction and expanded our knowledge beyond the already-observed techniques in the case of the neighboring house (cf. the analysis of house/building ID 3147 in [40]).

Overall, it became evident that the thin-section soil micromorphology and related phytolith analysis (from thin sections) used together with traditional archaeological methods could add highly valuable details when investigating the past. While the standard micromorphological analysis established the basis for understanding the microscale evidence of household-related activities (in this particular case, burning practices), the phytolith analysis shed light on the role of plants within these processes. On one hand, the observation of burnt and/or charred plant material helped to reconstruct the possible impact of the fire, while an oxidative fire left only phytoliths—the inorganic particles—behind. It seemed that swift fires that were probably extinguished before they burned out on their own left a high amount of charred plant matter. On the other hand, the fuel used for fires, should it be wood, a handful of straw or hay, or even dung, all had a botanical 'fingerprint' that could be 'scanned' by using certain tools of the phytolith analysis. For these aforementioned reasons, the application of phytolith studies in a fixed environment together with the application of thin-section micromorphology and phytolith analysis was proven to be advantageous and indicated that further studies of this type should be encouraged.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/land12010159/s1. ESM1: Detailed results of the micromorphological analysis; ESM2: detailed results of the phytolith analysis.

Author Contributions: Conceptualization: G.K. and M.V.; Formal analysis: G.K. and Á.P.; Funding acquisition: Á.P. and G.K.; Methodology: G.K. and Á.P.; Writing: G.K., Á.P. and M.V. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Research, Development, and Innovation Office (grant number: FK_142894). This research was done within the frames of the DAAMBA project.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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