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RESEARCH

Construction, Maintenance and Ritual Practices on the Neolithic Rondel at Nowe Objezierze (Northwestern Poland): The *chaîne opératoire* of Rondel's Architecture

Lech Czerniak[1]

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Abstract

In the history of the "Danubian Neolithic" society, monumental ceremonial centers appeared around 4800 BCE and lost their importance around 300 years later. Among them, one of the most distinctive forms are rondels. However, it is worth remembering the contemporary Rosheim-type circles and Passy-type tombs. The name "rondels" refers to the currently preserved architectural form, dominated by concentric ditches. The article presents an analysis of the biography of a rondel from Nowe Objezierze (north-western Poland). For this purpose, the *chaîne opératoire* method was used, which is a very effective tool for reconstructing the full sequence of events including the construction, use and abandonment of the examined monument, in its historical and social context. Thanks to this, it was possible to draw attention to previously little-explored details of planning construction works, the skills of ritual leaders and the seasonal availability of some construction materials. As a consequence, the construction and use of rondels can be presented as a complex ceremonial cycle, stretched over time and interrupted by festivals. When the rondel was ready, the cycle began with renovating the surrounding wall and digging the ditch, most likely reaching its culmination on the day of the winter solstice. The celebrations ended with a ceremony of backfilling of the ditch.

Keywords Chaîne opératoire · Central Europe · Neolithic · Monumental ceremonial centers · Rondels

✉ Lech Czerniak
lech.czerniak@ug.edu.pl

[1] University of Gdańsk, Gdańsk, Poland

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Introduction

In the history of the 'Danubian Neolithic' communities, monumental ceremonial centers appeared around 4800 BCE and lost their importance around 300 years later. Among them, one of the most distinctive forms are rondels (Barna, 2017; Pásztor et al., 2015; Řídký et al., 2019; Schier, 2023). However, it is worth remembering the contemporary Rosheim-type circles (Jeunesse, 2019; Lefranc & Jeunesse, 2012) and Passy-type tombs (Chambon & Thomas, 2023). The popular name 'rondels' refers to the currently preserved architectural form, which is dominated by concentric ditches (Fig. 1). Rondels occurred in the area from the middle Danube in the south, the Vistula in the east and the Rhine in the west. They served as places for cyclical commemoration ceremonies (Chapman et al., 2006; Whittle, 2013). Although

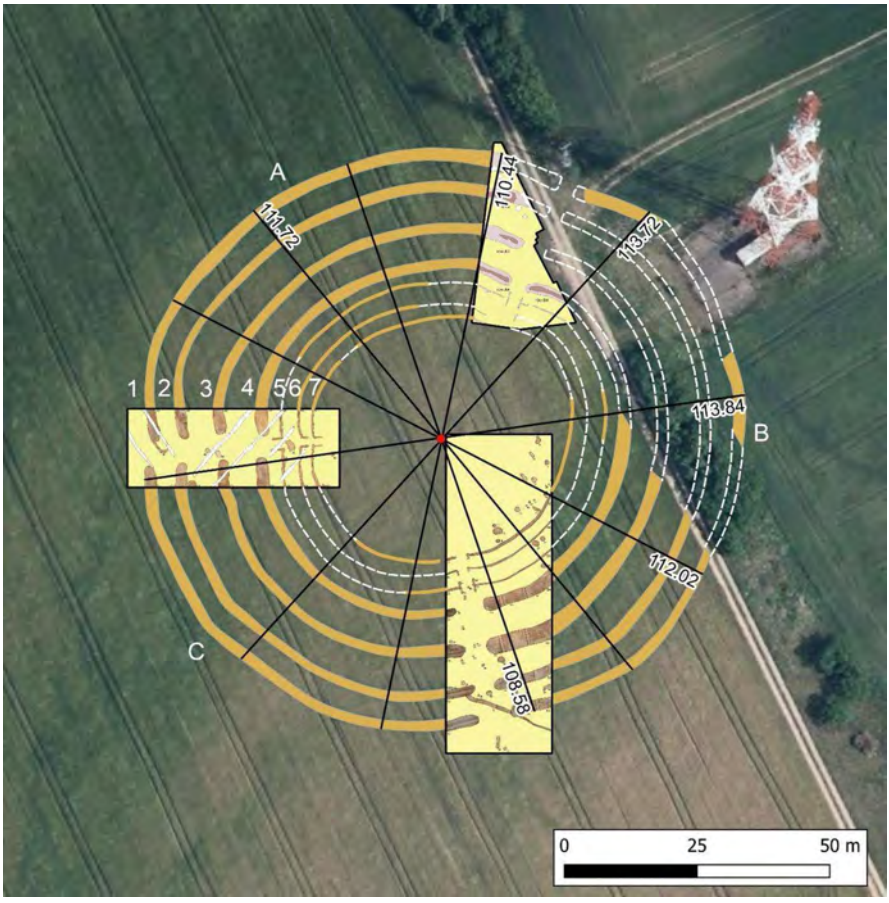

Fig. 1 Nowe Objezierze, Moryń comm., site 22. General plan of the rondel showing the extent of excavations, markings of ditches and measurements of the diameter of the largest dich. (graphic design and measurements: Michał Jakubczak). The plan was created by compiling aerial photogrammetric imaging with the results of geophysical and excavation research

intensive research on rondels has been carried out for over half a century, there is still a long list of controversial issues, including such basic ones as (1) use-life of individual structures, (2) potential astronomical functions, (3) appearance and (4) modus of operation.

One of available research tools is the biographical approach, which is not new in itself (*e.g.* Kopytoff, 1986), but in relation to rondels it brings a fresh perspective. It draws attention to and the need for solid data and the necessity of performing multi-aspect, interdisciplinary analyses. The use of the *chaîne opératoire* method, which interprets biography as a sequence of technological activities deeply rooted in the socialization process, seems particularly fruitful in this case (see below).

The subject of the analysis will be the rondel at Nowe Objezierze (NW Poland: Fig. 2), built around 4800 BCE, which functioned for about 250–300 years. Its maintenance consisted in cyclical renovation, which in itself had a ceremonial function and at the same time influenced the change of its architectural form.

Although the *chaîne opératoire* method suggests a specific narrative order referring to the biographical sequence of events, constructing the structure of the article in this way would be difficult due to the need to introduce threads of discussion regarding the appearance of the rondel and its functioning. For example, before attempting to recreate the sequence of construction activities, it must be decided whether the interior was enclosed by a simple palisade or a more complex

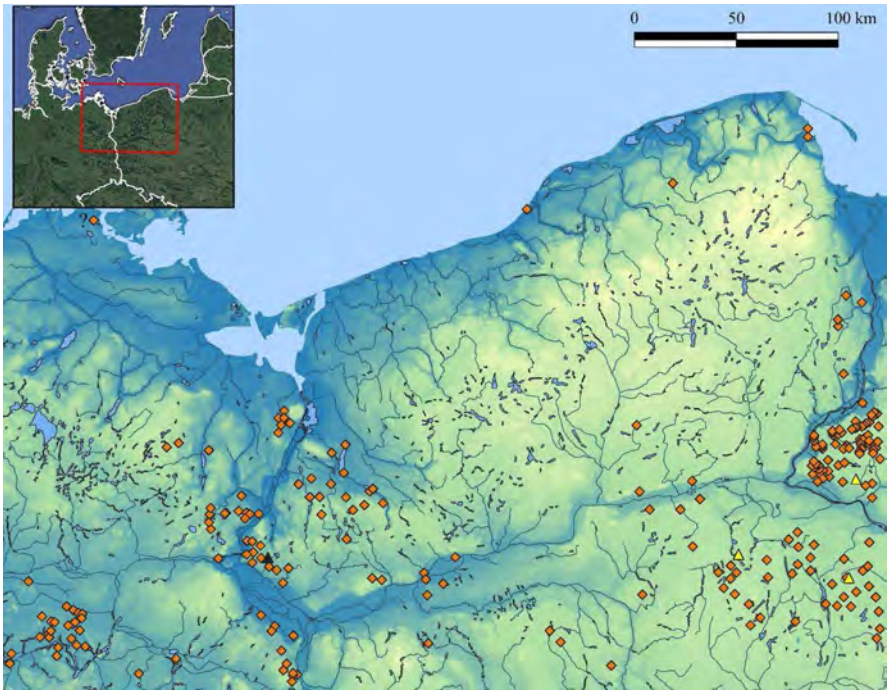

Fig. 2 Location of the rondel at Nowe Objezierze (black triangle) against the background of SBK sites in the Polish Lowlands. The locations of the remaining rondels are marked with yellow triangles (after Czerniak et al., 2022)

surrounding wall, and whether the ditch surrounding the rondel was permanently open and accompanied by an embankment or not. Additionally, marking out the circle and determining the position of the gates requires first addressing the controversial issue of the cosmology of the rondels and astronomical references, as this involves the specialized knowledge involved in the construction and its origin. Moreover, as links in the sequence chain of the construction process, I included festivals, the presence of which is a hypothesis based only on ethnographic analogies. However, it is necessary to break the stereotypes of thinking about construction technology as merely practical activities. A separate issue is the need to specify the scope of applicability of the *chaîne opératoire* method itself for analysing rondels.

Chaîne opératoire as a Method for Studying Rondels

The chaîne opératoire methodology was developed for the analysis of flint production (Leroi-Gourhan, 1943). However, due to its frequent and diverse applications, which have influenced the dynamic evolution of the method, it has found increasingly wider use in archaeology, including in the study of domestic architecture, megaliths and other structures (Naji & Douny, 2009; Roux, 2019; for a summary in the context of Neolithic monument studies: Kalogiropoulou et al., 2023). The diversity of configurations and applications allows us to consider it a form of hybrid methodology (in the sense of Lewis & Arntz, 2020), which comprises a collection of concepts and research postulates tailored to the specific characteristics of the subject under investigation. In the case of rondels, it seems particularly important to distinguish between structures created individually and those created collectively. A rondel was a collective endeavor, but in a different sense than a house, due to both its communal and ritual purposes and the significantly broader scope of social participation in its construction and the coordination of work by a leader. In other words, this process involved the refinement of skills and habits of many individual participants acquired through traditional construction practices, along with the specific knowledge possessed by the leader of these works. In this chapter, I aim to outline the main postulates of the *chaîne opératoire* methodology, adapting them to the specific characteristics of the structures known as rondels.

Chaîne opératoire as the Biography of Things

In its basic understanding, the term *chaîne opératoire* refers to any sequence of operations aimed at acquiring raw materials and transforming them into a finished product. The further development of the method has broadened the scope of this concept, which now extends beyond the creation of the object to include its functions, transformations and the circumstances under which it was abandoned. The influence of a biographical approach is evident here (Kopytoff, 1986). The application of this method as a tool for interpreting rondels justifies a departure from the established analytical practice of rondel studies, which focuses on comparative analysis of plans (*e.g.* Řídký et al. 2019). This can be seen as an embodiment of

the cultural-historical archaeology paradigm, which concentrates on finished products (cf. Lewis & Arntz 2020). When applying the chaîne opératoire methodology to the study of rondels, one cannot presuppose that their plans express the realization of a completed architectural project. For instance, the rondel in Nowe Objezierze would have had to consist from the outset of a triple palisade and a quadruple ditch (Fig. 3). However, it is necessary to establish what the actual situation was, without excluding the complex history of many phases of reconstruction. Moreover, there is no justification for focusing solely on architectural form while neglecting the ways in which rondels were utilized: the filling and renewing of ditches, the consumption of specific animals, the use of figurines, the deposition of offerings, the cleaning and burying of waste in the ditches, and so forth.

An additional inspiration for the approach that assumes rondels represent a completed architectural concept seems to be the model of contemporary public architecture (*e.g.* stadiums, theaters), where construction is a functionally separate act and simultaneously only an episode in relation to their later, prolonged use. Neolithic communities may have operated differently. The postulate of tracing the history of architectural changes and social engagement could contribute to uncovering additional connections between construction and usage. For example, the cyclical renewal of ditches, as well as the closing of old and the opening of new ditches, could be interpreted as a symbolic reenactment of the act of construction, which deepened the spiritual connection of the rondel's users with its original builders and reinforced the atmosphere of commemoration during the cyclical ceremonies held at the rondel.

Beyond everything else, reconstructing the chaîne opératoire is an effective method for constructing a narrative that presents the research findings of a specific structure. This is not merely about maintaining a particular sequence of events but rather about developing a "checklist" using the chaîne opératoire methodology, which ensures the tracking of various aspects of the technological process in question. This approach is proposed by Gosselain (2017), who uses the concept of

Fig. 3 Nowe Objezierze, Moryń comm., site 22. View from the outside of the rondel through the western gate onto the foundation trenches. There are also visible traces of deep plowing, which disturbs the examined structures (after Czerniak et al., 2022.)

"phases" as a set of sequences corresponding to the main "logical" stages of technical action. He identifies: location, actors, knowledge and expertise, raw materials, actions, tools, relation with other activities, organization, beliefs and religious practices.

The invocation of the "checklist" issue prompts reflection on the possibilities of reconstructing the full sequence of actions involved in the construction and functioning of a rondel. Given the gaps in archaeological data, it is necessary to consider the extent to which speculations based on very general premises derived from anthropological education are justified in such a context. I suggest that these should not be avoided, provided their main value lies in stimulating imagination and outlining possibilities that will become the field for further research. From this perspective, activities related to the construction and use of rondels can be divided into (1) obvious (digging and renewing ditches, setting wooden posts), (2) implicitly obvious due to their effects (*e.g.* procuring wood, marking out circles and gates, feasting) and (3) postulated; i.e. those that are probable due to practices described by ethnography. An example of the latter could be the feasts marking the opening/closing of successive stages of construction and use of the rondel.

Chaîne opératoire as a Phenomenon Rooted in Social, Cultural, Economic, Political and Ideological Contexts

The discussed method is not merely a linear description of the biography of an object but also justifies the need to consider the social context of the construction process, the constraints and opportunities of the involved individuals, and their mutual influences (Sillar and Tite, 2000). The concept of communities of practice (*e.g.* Wenger 2000) aptly characterizes this issue, providing concepts for analysing architecture, the construction process and the ways rondels function as a social practice in all its complexity, considering phenomena of mutual learning, commitment creation and performativity, even if these cannot always be confirmed in archaeological records (McFadyen, 2016).

Chaîne opératoire as a Method for Studying Knowledge Transmission

The method described highlights the importance of examining knowledge and its social transmission, which includes learning by offspring from parents, by apprentices from masters, within peer groups and through intergroup interactions. It also proposes identifying networks that form a *community of practice*. In this context, comparing *chaîne opératoire* is the most effective approach, as it broadens the traditional focus on the morphometry of finished products to include the processes of their creation and use (Roux, 2019). By identifying the *chaîne opératoire* of rondels, we could significantly transform our understanding of how this concept was transmitted, as it rapidly spread across much of Europe, and potentially explain why it did not encompass the entire area previously occupied by the Linearbandkeramik (LBK).

When analysing rondels, it is crucial to distinguish between the modes of knowledge transmission: (1) among individual creators of mass-produced utilitarian objects (such as ceramic vessels and flint tools) and (2) among leaders overseeing the collective construction of structures like rondels, which were not only built individually and infrequently but also had an innovative nature. In the first case, it is clear that knowledge is acquired through prolonged daily practice. In the second case, this type of learning is questionable, as it would require the unlikely assumption that rondel construction was directed by itinerant leaders from specific 'schools'. In other words, the source of the leaders' knowledge remains a mystery that needs to be solved.

I propose that, initially, in the construction of rondels, we should identify universally accessible technologies, which will help define the skills required of the construction leaders. This first group consisted of technologies widely used in the construction of longhouses, at least since the LBK period. These included skills in cutting, processing and transporting structural timber; techniques for setting posts in the ground and digging pits and ditches in clayey substrates; preparing clay for plastering; and using reeds for roofing. Therefore, a leader overseeing the construction needed to understand how a rondel should look, what cosmological meanings it should convey, how to delineate its plan, what magical and ritual practices to apply to integrate the elements of the rondel into a functional whole, and how and when the rondel should be used.

To a Neolithic researcher, it is evident that the unique configuration of rondel architecture integrates elements that appeared separately in much earlier contexts, such as the ditches and palisades surrounding some tells of the early Balkan Neolithic (including the tradition of deposit offerings and the filling and excavation of ditches; see Bacvarov et al., 2016) and exceptional LBK villages (such as Herxheim: Zeeb-Lanz, 2019). Whether knowledge of such structures was part of the cultural heritage passed down through generations is uncertain. Additionally, it is unclear whether this knowledge was widely accessible (through storytelling) or restricted to closed circles of initiation. In any case, it seems likely that this tradition was utilized by exceptional individuals who created the first rondels and associated ceremonies. From these individuals likely originated the knowledge of leader-followers, which could have been either deeply acquired through shared practice and initiation rituals or superficial, essentially improvised based on occasional observations of ceremonies at existing rondels. The concept of *chaîne opératoire* requires that these answers be grounded in findings rather than assumptions.

Findings on the transmission of leaders' knowledge can be based on analysing phenomena such as the speed of transmission of a given idea, the accuracy of replication of specific *chaîne opératoire* and the quality of execution (*e.g.* precision in delineating the circle). In the case of rondels, it is also necessary to assess the uniqueness and complexity of the knowledge employed. A crucial aspect is confirming or refuting hypotheses suggesting the involvement of astronomical knowledge by the rondel builders (*e.g.* Podborsky & Kovarnik, 2006; summary of research status Zotti & Neubauer, 2023). This will determine how high we set expectations regarding the knowledge possessed by leaders and the means by which it was obtained.

One method of identifying the mode of knowledge transmission is to examine the rapid diffusion of the rondel idea. For instance, the dating of the rondel's construction in Nowe Objezierze does not significantly differ from the dates of the oldest such structures, despite its location on the furthest periphery of the area where this architecture is found. This suggests that the leaders' knowledge was shaped during intergroup contacts, possibly including visits by the leaders themselves to the sites of the most renowned structures of this type.

Another indicator is the presence of numerous, rather carelessly, planned structures, which suggests that the leaders and builders were not 'rondel specialists'. This is further supported by the individualization of rondel features. A closer examination of the layout, orientation, size and components of rondels reveals two contrasting pictures. On one hand, there is diversity, expressed through the number of gates, foundation grooves ('palisades'), azimuths of gate axes and the number and form of ditches (*e.g.* Řídký et al., 2019). This suggests that construction leaders utilized knowledge acquired superficially, perhaps during brief visits to exemplary rondels, which they then adapted to their own needs (*e.g.* rondel size) and technological habits (*e.g.* methods of digging ditches). However, it is possible that some features, such as the number and orientation of gates, were interpreted according to an unknown key, possibly reflecting the organization of the local community (*e.g.* 'recording' the number of cooperating clans and their territorial divisions). Additionally, factors such as the duration of use, the number of repairs and modifications (*e.g.* one or more ditches) further complicate this picture.

On the other hand, the layout of rondels reveals a pattern with a high degree of repetition, suggesting a coherent architectural concept, or perhaps even a doctrine, that grants rondels their recognizability as ritual tools. Each rondel featured an open interior, bounded by two concentric circles: the inner circle, known as the palisade, and the outer circle, consisting of a V- or Y-shaped ditch and an earthen embankment. Entrances ('gates') led into the interior, possibly aligned according to azimuths imbued with specific symbolism. These characteristics allow us to recognize the compact distribution of rondels today and to distinguish them from Rosheim-type structures, which have much simpler architecture but originate from the same LBK tradition and likely served a similar function (Jeunesse, 2019; Lefranc & Jeunesse, 2012). This suggests that the relevant patterns were adopted with an understanding of their symbolic and functional content.

This conclusion brings to mind the concept of an architectural project (more broadly: Laporte, 2019). In my opinion, this concept can be particularly useful in studies of communal structures with collective builders. It facilitates the identification and more precise determination of the knowledge held by the construction leader, distinguishing it from the collective knowledge of builders who draw on experiences gained from other construction practices. The leader's knowledge, considering the skills and habits of the builders, social order and technical systems, simultaneously contained specific content related to the construction of the rondel, rituals and symbols. The results of applying the *chaîne opératoire* method, in the form of a description of technologies directly related to the construction and use of rondels, can be used to identify *communities of practice* with varying scales of connections (as per Roux, 2019). This includes (1) methods of forming ditch

cross-sections and the choice of embankment deposition sites, (2) the permanent opening of ditches or their cyclical filling and uncovering, (3) the cyclical renewal of the same ditch or the establishment of a new one, (4) the use of anthropomorphic figurines, (5) the consumption of specific animal species during ceremonies and (6) the deposition of ceramics in designated locations.

The language of globalization is particularly suited to describing the phenomenon of rondels as a process of idea transmission (*e.g.* as per Knappett, 2018). By naming this process *rondelization*, we gain a more appropriate term and a broader conceptual context for interpreting the *chaîne opératoire* of rondels. Using the concepts of *community of practice* in relation to the communities utilizing individual rondels, as well as *constellation of practices* in relation to the network of rondel users (Knappett, 2018: 976; also: Wenger, 2000; Mills 2016), allows for a more accurate description of the specificity of rondel diversity and the transmission of associated knowledge than by constructing maps of specific feature distributions.

Chaîne opératoire and the Temporal Rhythms of the Technological Process

The acquisition of various raw materials, the application of specific techniques, the construction process itself and the scale of possible social involvement have their optimal seasonal conditions and limitations resulting from social organization and the necessity to perform other types of work. This interweaving presents an opportunity for calendar refinements. I assume that the context of agricultural and livestock activities and the construction and maintenance of houses, as well as the traditions of celebrating at specific times, created stable time blocks into which the construction and use of the rondel were fitted. This assumption does not exclude the possibility that a given undertaking could be carried out concurrently or even disrupt the previous calendar. In this case, however, it is necessary to consider the social context: egalitarian social organization, the limited size of the local population, the communal nature of construction and cyclical celebrations. In my opinion, the application of the above method can yield more reliable results regarding the determination of the celebration date than in the case of the astronomical interpretation of azimuths marked by the gates.

Chaîne opératoire as a Technological Process and Social Event

Currently, numerous researchers posit that technological and social processes involved in the construction of more complex structures, such as houses and megaliths, are not linear but are intertwined with various cultural, social and symbolic events (*e.g.* Sillar and Tite, 2000; for a broader discussion, see Kalogiropoulou et al., 2023). This often manifests in the form of elaborate rituals and festivities encompassing the entire community, which occur at certain stages of construction, including the gathering and assembling of materials, the arrival of helpers, the founding of a new structure and its completion (Gibson, 1995; Waterson, 2013). While it is challenging to document their inclusion in the *chaîne opératoire* of a rondel, this does not suffice as a reason to overlook them. These events imbue the construction

and renewal process of rondels with new meanings. Festivities, by engaging the entire community, transformed the status of the construction, making it an integral part of ceremonies that were cyclically repeated during the renewal of the rondel. In conjunction with festivities, the construction became more than a purely pragmatic construction process involving a limited group of specialists. This has various implications, including the approach to analysing seasonality, prompting reflection on whether the construction/cyclical reconstruction could have occurred concurrently with agricultural work or if they were mutually exclusive.

Chaîne opératoire and Agency

Within the discussed methodology, it is posited that we are shaped by objects to the same extent that we shape them (Ingold, 2013). According to L. Coupaye, *chaînes opératoires* can be perceived as an aspect of living reality, wherein the social and material domains are interconnected and mutually influential (Coupaye, 2015: 69). This prompts us to move beyond traditional questions about the functions of rondels and consider how the presence of a rondel altered the social life of its users. It can be argued that the rondel, as a communal object, was inherently designed to influence social relations. In this context, it is not merely about the consequences of collective construction and feasting, which undoubtedly strengthened social bonds and a sense of shared identity. The collective construction, its complexity and duration, as well as the procurement of valuable materials, required cooperation and management. This process created new networks of obligations and a demand for leadership, which conferred prestige, established new hierarchies and stimulated competition.

In this article, I attempt to argue that the rondel was not merely a passive tool created out of the need for an appropriate setting for celebrations. Instead, it became an active agent responsible for the emergence of new networks of social relationships and tensions, which over time could have contributed to the decline of the rondels.

Site Description, Dating and Palynology

The rondel at Nowe Objezierze is situated in the Lower Oder region (52.848455 N; 14.338117 E). It was constructed by communities associated with the Stichbandkeramik culture (hereafter SBK) pottery (specifically during phase IVA according to Zápotocká 1970). These groups inhabited a microregion that forms an 'island' covering approximately 100 km^2, characterized by high-quality soils, gentle terrain and excellent irrigation provided by the Słubia River, as well as numerous lakes and ponds. In this river valley, we have identified three sites with longhouses that date back to the period when the rondel was in use.

The site was investigated through non-invasive methods, such as aerial photography and geophysical surveys, as well as through excavations. The latter, conducted over four seasons from 2017 to 2020, covered about 15% of the rondel's area (Czerniak *et al.*, 2020; 2022). The research focused on the gates, which were examined in three trenches with a total area of 2175 m^2. The rondel is circular, with a maximum

diameter of 112 m. It consists of four concentric ditches with characteristic Y-shaped cross-sections and a depth of about 2 m. Inside the circle, there were three concentric grooves, forming the foundation of a wooden palisade that enclosed an internal, empty courtyard with a diameter of 48 m. Three symmetrically located 'gates' provided access to the interior of the structure (Fig. 1).

In the following section, I present the most significant published results of Bayesian chronological modeling of radiocarbon dates and the outcomes of palynological analysis. These findings are crucial for understanding the proposed analysis of the *chaîne opératoire* of the rondel and are too important to be omitted, yet too complex and extensive to be published together in full.

Dating (According to Czerniak et al., 2024)

Forty-four samples were dated, all of which were single fragments of disarticulated animal bones. Bayesian chronological modeling was conducted using OxCal 4.4 (Bronk Ramsey 2009) and the internationally agreed calibration curve for the Northern Hemisphere (IntCal20; Reimer *et al.* 2020). Model 1 was based solely on the recorded stratigraphy in Nowe Objezierze. Alternative models were also developed to verify their consistency with the radiocarbon evidence. Initially, these were models (2A-C) that explored different scenarios of the construction and initial use of the complex, followed by models (3, 4A-B) that examined various types of termination of the rondel's use.

Model 2 indicates that radiocarbon evidence cannot determine the sequence in which the ditches were initially constructed. If the interpretation of model 2 is correct, the ditches were made between 4830 and 4740 BCE (95% probability) or between 4805 and 4760 BCE (68% probability). Model 3 examined the possibility that the ditches were not only built sequentially but that their initial use period was also consecutive. Model 3 estimates that the use of the rondel at Nowe Objezierze ended between 4545 and 4390 BCE (95% probability), likely between 4525 and 4445 BCE (68% probability).

Model 4A-B was an attempt to revisit model 1 and consider whether the activity at the rondel could have gradually declined, with activity in the main fills of ditches 2 and 1 lasting longer than in ditches 4 and 3. Model 4A suggests that the beginning of the end at Nowe Objezierze occurred between 4790 and 4575 BCE (95% probability), likely between 4760 and 4650 BCE (68% probability), and the activity ultimately ceased between 4605 and 4400 BCE (93% probability) or between 4540 and 4435 BCE (68% probability). In this scenario, the activity at the site declined over a period of 1–320 years (95% probability), likely over a period of 125–295 years (68% probability). The shape of this distribution makes a prolonged termination more likely. Variant 4B of this model restricts the ditches to filling from the center outward (*i.e.* ditch 4, then ditch 3, then ditch 2, then ditch 1).

The process of constructing and comparing alternative chronological models for Nowe Objezierze allows us to suggest which parts of our narrative for the site are securely based on radiocarbon dating, and which parts are more dependent on our archaeological interpretations. In all scenarios, the beginning of the

rondel dates to the first half of the forty-eighth century BCE. However, the subsequent construction history varies significantly between the two alternative readings. According to model 1, all four ditches were constructed roughly at the same time, although the results of models 2A–C clearly indicate that we do not know whether they were all excavated simultaneously or over a span of several decades. According to model 3, ditches 3 and 2 were not built until the later forty-seventh century BCE, and ditch 1 not before the end of the forty-sixth century BCE. It is evident that both models cannot be correct, although both are consistent with the radiocarbon dating evidence. The choice between them is, therefore, a matter of archaeological interpretation. Both models agree on an extended period well over a century for the initial fillings and re-digging of ditch 4, ending in the later part of the forty-seventh century BCE. Model 1 suggests a similarly prolonged period of re-digging for the remaining three ditches, although model 3 suggests much shorter periods of initial use for the other ditches. However, the estimated dates of their initial construction differ more than the estimated dates when their initial fillings were in place. Both models agree that very rapid deposition of the main fillings in ditches 4 and 3 is likely and that equivalent fillings and ditches 2 and 1 could have accumulated over a considerably longer period. The estimated dates when the rondel fell out of use differ by more than a century, as do the estimates of its period of use. Overall, it is difficult to determine the duration of the rondel's use and its final closure, but it is clear that in all scenarios, the site was used for over a century, most likely for two or three centuries. The poor agreement of individual samples with model 1 may suggest that its closure in the later forty-sixth or forty-fifth century BCE (as suggested by model 3 or the flexible trapezoid approach (models 4A–B)) is more consistent with the radiocarbon dates than a cessation at the end of the forty-seventh century BCE. This corresponds to changes in the local environment, namely a decline in settlement activity confirmed at a depth of 1440–1436 cm in the palynological sequence in a nearby lake.

The excavations at the rondel in Nowe Objezierze provide additional criteria for evaluating the presented models. They demonstrate that the ditches were only open during ceremonies and were subsequently filled in and re-excavated before the commencement of a new cycle. We have two groups of evidence supporting this hypothesis. The first pertains to the short period during which the ditches remained open and their repeated renewal, while the second group concerns the intentional closure of the ditches' life cycles through backfilling and sequential establishment of new ones.

Among the first group, the perfectly preserved shapes of the ditch cross-sections are of primary significance. This indicates that the ditches remained open for a short period after their excavation. Otherwise, the 'Y-shaped' cross-sections would have undergone significant erosion since the geological substrate consisted of loose gravel and sand. The second argument is the absence of phytoliths in the layers filling the ditches, which suggests that the ditch walls were not overgrown with vegetation and that leaves and other plant debris from the surroundings did not accumulate within them. Furthermore, the minimal amount of charred plant remains, despite flotation of numerous and large soil samples from the ditches,

supports the hypothesis that the ditches were open for a short period. Similar results were obtained from micromorphological studies, which recorded few traces of microcharcoal.

Additionally, all the ditches exhibited signs of multiple (from 2 to 5) renewals, visible in the characteristic 'Y-shaped' cross-sections as displacements of the narrow groove line formed at the bottom of the ditch. This indicates that the ditches were repeatedly re-excavated. Moreover, the re-excavation involved ditches that had already been filled in to such an extent that it was difficult to precisely recreate their original course, despite the possibility of using the trace of the ditch's course. Stratigraphic analysis reveals that after the ditches were filled in, a small depression was left, in which water and decaying organic matter accumulated. The current trace of the depression left after the final filling of the ditch is a characteristic darker coloration of the layer visible at the top of the ditch.

The second group of observations pertains to the functioning of the ditches and directly supports their intentional backfilling after use and the sequential opening of new ones. Four observations substantiate this. First, a cluster of adhering flint waste, formally and technologically corresponding to SBK, was found in the uppermost layer of ditch 4. This indicates that while the rondel was in use (and thus some ditches were open), flint was being worked next to the already filled-in ditch 4. Second, micromorphological studies revealed varying degrees of podzolization in the upper layers of the ditches, indicating that during the use of the more externally located ditches 1 and 2, ditches 3 and 4 were already filled in. In other words, the four ditches of the rondel did not function simultaneously.

Third, a cluster of several dozen ceramic vessel fragments dating to the early phase of the TRB was found in the uppermost layer of ditch 2 (section C in the area of the western gate). Their arrangement indicates that around 4000 BCE, this ditch was already completely filled, and a vessel was broken on its surface, the fragments of which formed a thin, 'trampled' layer.

The fourth argument is more complex, as it pertains to traces of deposition in the already definitively filled ditches of ceramic vessels (almost whole or large fragments, presumably intentionally broken). The style of decoration on the vessels is identical to other vessels left at the rondel, indicating that the deposits accompanied the functioning of the rondel. The deposits were found at a depth of 60–80 cm from the surface, approximately 20 cm below the natural depression level formed after the ditch was filled due to soil subsidence. Of the seven deposits, five come from ditch 4 (the oldest), and one each from ditches 3 and 2. None were found in ditch 1—the youngest. These observations confirm the particular significance of the oldest ditch (4), but also the filling of ditches 3 and 2 while the youngest ditch (1) was still in use, in which such deposits were absent, despite the fact that significantly more ceramics were found in it than in ditches 2 and 3 combined.

From the perspective of chronological model selection, the distinction between the system of ditch infilling at the time of the rondel's abandonment and the system of multiple infillings of each ditch immediately after ceremonies is particularly significant. For rondels with multiple ditches (and the possibility of sequential ditch functioning), it can be assumed that older bones could have entered each ditch than the period of its use. However, bones younger than the moment of ditch infilling

cannot be placed there. In other words, the results of dating the moment of ditch closure can be used as one of the criteria for evaluating the tested models. Since 14C dating suggests that ditches 2 and 1 were closed later than ditches 3 and 4, this decreases the archaeological credibility of model 1 (excavating all ditches, infilling ditches, abandoning the site) and significantly weakens model 2 (ditches may be excavated in any order or simultaneously). Model 4B is most consistent with this criterion, allowing for the construction of all trenches at the beginning of the forty-eighth century BCE, but sequential abandonment of the trenches in the order $4>3>2>1$. In further analysis, we considered the possibility that similar dating of the opening of all ditches might result from contamination with older bones. In other words, if the end of ditch use was sequential, why not the beginning? Consequently, model 3 should be adopted, which assumes the following: first, ditch 4 was excavated, maintained and infilled; then ditch 3 was excavated, maintained and infilled; followed by ditch 2; and finally trench 1. In summary, the choice between models 3 and 4B requires new arguments.

The issue of sequential ditch functioning in rondels is discussed in the literature (*e.g.* Bartels et al., 2003, 132). The most convincing hypothesis is that the ditch closest to the center of the rondel was the main ditch. Data can be cited showing that ditches located in this position tend to be deeper and wider, and more frequently re-excavated than others (Řídký et al. 2019, 80). This suggests that the initial intention was always to build and use a single ditch (Řídký et al. 2019, 83). According to data collected by Řidký *et al.* (2019, Fig. 6.17), up to 83% of rondels have one to two ditches, and only 3% have four. Considering the low population density in the in the Nowe Objezierze region, it can be assumed that there was a low level of intergroup competition, and thus a higher probability that the four ditches of the rondel were the result of prolonged use rather than the construction of a complete structure with four ditches. This is an argument for rejecting model 4B and adopting model 3, which assumes the sequential excavation and abandonment of trenches in the order $4>3>2>1$. It describes a system of cyclical ditch excavation and infilling. The result of chronological modeling is the determination that the rondel in Nowe Objezierze served local communities for many generations (approximately 250–300 years).

Palynology (According to: Czerniak et al., 2023)

A precisely dated palynological profile, developed using a series of AMS dates and located approximately 1.5 km from the rondel, was analysed at high resolution, providing detailed data on paleoenvironmental changes. The analysis of both archaeological and paleoenvironmental data offered an excellent opportunity to integrate independent observations and construct a biography of the rondel based on this foundation.

During the period 5327–5050 BCE, strong evidence of anthropogenic pressure is observed in the pollen profile, which can be linked to the LBK settlement boom. This is archaeologically confirmed by the presence of longhouses, two of which, located near the rondel, were investigated. Subsequently, there is a noticeable local decline in

settlement signals, marking the beginning of phase 2 in the pollen profile. This period began around 5050 BCE and lasted until approximately 4800 BCE, coinciding with the disappearance of traces of LBK presence across the entire Lowland (*e.g.* Marciniak et al., 2022). In the microregion we studied, these observations are interpreted as a signal of population decline, but not complete depopulation. This phase of the profile is characterized by fluctuations in the intensity of settlement traces, including the periodic disappearance of crops. It is likely that as a result of a significant population decline, many open habitats, arable fields and pastures emerged, allowing people to move freely and utilize these areas, especially for grazing. The increase in the importance of animal husbandry and greater mobility visible in the profile may indicate a radical change in the way of life.

The next strong anthropogenic signal appeared at the beginning of palynological phase 3 (4840 BCE) and coincides with the commencement of the rondel's construction (4800 BCE). At that time, significant deforestation, increased fire intensity and a rise in agricultural activity were observed. These data suggest that the construction of the rondel was associated with a substantial increase in the local population. Another factor concerning the course of events is the emergence of a new set of material culture traits. The community that built the rondel lived in longhouses with trapezoidal foundation trenches and produced pottery in the SBK style (subphase/style IVa), which represents a new culture in the Lowlands and its oldest phase (Czerniak, 2012). Its origin can be associated with the areas of Lower Silesia, northern Bohemia, or Saxony-Anhalt.

The migration events marked not only the beginning, but probably also the end of the rondel period. Here, we can combine data from subphase 3b of the profile (4574–4457 BCE) and the last phase of rondel operation (4550–4450 BCE). This suggests that a sudden drop in signals of human activity marked the beginning of phase 3b (ca. 4574 BCE), but the rondel may have continued to function for another two to three generations. Its youngest ditch (no. 1) has been renovated at least several times during this period and was backfilled by depositing the surviving remains of the bucranions in it, repeating the 'closure' practices used in earlier ceremonial cycles. Considering what happened, we have a choice between (1) local mobility, which could have been a common practice within a given way of farming, and (2) emigration, as a no less common method of defusing conflicts and limiting aggression within a given social organization system. With regard to a single profile, speculations around two such different hypotheses are risky. But they make sense due to the context, which is, on the one hand, the issue of the final abandonment of this specific rondel and, on the other hand, the issue of the collapse of the very idea of rondels at that time. These latter premises favor the hypothesis of the disintegration of the local community.

How Did Rondels Look and Function? The Case of the Rondel at Nowe Objezierze

Looking at the traces recorded during excavations, it is easy to fall under the illusion that the most crucial element of the rondel were four concentric ditches. In the case of Nowe Objezierze, these ditches had diameters ranging from 112 to 69 m, each

with a width of about 2.5 m and a depth of at least 2 m. Against this backdrop, the three concentric foundation trenches inside the rondel, with a width of 0.30–0.40 m and a depth of 0.10 to 0.30 m, seem quite modest (Fig. 3). However, it was these trenches that formed the foundation of the most important structure, both in terms of labor and visual significance. The following questions will be analysed in more detail: (1) were simple wooden palisades fixed in the foundation trenches, or a wooden frame of a surrounding wall—plastered with clay and covered with a roof? (2) Were the ditches permanently open and did an embankment accompany them, made of earth extracted from them? (3) Considering the presence of four ditches, were they all open simultaneously or sequentially?

Palisade or a More Complex Structure?

The analysis of this link in the *chaîne opératoire* first requires an understanding of what the structure looked like, as indicated by three concentric foundation trenches. The presence of rondels with single, double or triple foundation trench systems necessitates determining whether these trenches were contemporaneous or excavated sequentially in connection with rondel renewal cycles. This is particularly significant, as the number of external ditches of the rondel will be interpreted in this context (see below).

In the absence of stratigraphic data and radiocarbon dating, the primary argument hinges on the lack of correlation between the number of foundational ditches and the number of external ditches (see Řídký et al. 2019: 70–72). The most popular view is that these trenches were used to install wooden poles forming palisades (*e.g.* Stäuble, 2012). However, Řidký and colleagues do not rule out the possibility that it could have been a 'more complex structure, such as roofed atria, possibly even with plastered wicker walls' (Řídký et al. 2019: 98). This functional argument supports the simultaneity of the trenches.

It should be noted that we lack solid data for reconstructing this part of the rondel. The palisade hypothesis is merely the simplest interpolation of the post traces. The proposal by Řidký *et al.* (2019: 76) refers to analogies with house construction and examples of clay plaster with imprints found on rondels. These are compelling arguments, but in my opinion, the importance of clay plaster as a method of protecting the structure from decay should be emphasized. However, the strongest argument for reconstructing this part of the Nowe Objezierze rondel is its long period of use. If the rondel functioned for about 250–300 years, it is unlikely that a wooden palisade alone would have survived for such a long time. It is also worth considering whether the technology available at the time would have been sufficient to protect a wooden structure for such a prolonged period. In my opinion, a slight modification of the technology used in the construction of longhouses would have achieved the desired effect: sealing the wood with clay or clay-lime plaster, building a reed-covered roof and performing regular maintenance. The effectiveness of this technology is evidenced by early medieval defensive ramparts, where wooden skeletons have survived to the present day (1000 years: Brzostowicz, 2014).

To conclude, it is likely that the interior of the rondel at Nowe Objezierze was surrounded by a wooden structure covered with clay plaster and roofed with reeds (Fig. 4). However, given this reconstruction, it is difficult to continue using the term 'palisade'. I propose calling this part of the rondel the 'surrounding wall'.

It can be further suggested that the effectiveness of wood protection would be higher if the space between the walls formed by the posts set in the foundation trenches was filled with clay. This would also increase the stability, tightness and soundproofing of the structure. The cost would be a significant increase in the workload associated with obtaining and using several dozen tons of clay. It is worth noting that Vera Němejcová-Pavúková was the first to propose this idea (1995; dissent: Podborský & Kovárník 2006). However, her argumentation was different. She sought to find a use for the clay extracted during the ditch digging. According to her, the clay could have slumped into the ditch, which was supposed to remain open.

I previously adopted this hypothesis (Czerniak et al., 2024), but I now reject it in light of the discoveries of rondels whose surface traces have been preserved due to their location in forested areas, likely uncultivated since the Neolithic (Kovárník, 2012; Mario Wallner, personal communication: Berlin Conference 2023). If the space between the palisade posts had been filled with clay, a substantial mound would have remained after the destruction of the wooden frame, as is evident in the case of embankments from earth excavated from surrounding ditches.

Ditches

The ditches surrounding the rondel, due to their size, are currently the most visible remnants of these structures. Their operation raises many controversies, which will be discussed in the next three paragraphs.

Fig. 4 The interior of the rondel at Nowe Objezierze was surrounded probably by a wooden wall with a reed-covered roof (drawn by Marek Z. Barański)

Open or Closed Ditch? The Issue of the Embankment

The presence of constantly open ditches is the most deeply rooted stereotype related to the visualization of rondels. This seems logical, and besides, Neolithic ditches and an embankment in the famous circle at Avebury are still visible. Furthermore, more direct indications, like traces of rondels with open ditches and embankments, have recently been pointed out (Kovárník, 2012; Mario Wallner, personal communication: Berlin Conference 2023). However, hypotheses are also put forward suggesting that the ditches were filled as part of a ritual act of "closing" the life cycle of the rondel (Bartels et al., 2003: 132; Barna, 2017: 187; Řídký et al., 2019: 89). In this context, it can be assumed that either there were no universal solutions or that unfilled ditches are the result of abandoning the rondel without conducting a closing ceremony. In the latter case, they should be classified in a similar category as rondels that were abandoned before the external ditch was dug (examples: Podborský & Kovárník, 2006: 57).

In Chapter 2, I presented data from Nowe Objezierze, which suggests that the ditches were only opened during ceremonies and then filled in, only to be re-excavated before the commencement of a new cycle. This cyclical system of digging and backfilling simultaneously explains the problem of the embankment. It is evident that in such a situation, the soil extracted from the ditch was necessary for its backfilling. The embankment present by the open ditch should be considered, in this case, a periodically exposed architectural feature of the rondel. Alongside the open ditch, it might have served as a signal for entering the ceremonial phase of the rondel (Fig. 5).

One or More Ditches at the Same Time?

The most critical consequence of the static interpretation of rondels is the assumption that facilities with four ditches were more complex than those with fewer. Bayesian chronological modeling of radiocarbon dates and stratigraphic analysis showed (see Ch. 2) that the number of ditches at Nowe Objezierze was most likely dynamic, sequential and dependent on the length of the exploitation period (Fig. 6).

Who Built the Rondel? Raw Material Supply and Construction

The answer to this question involves, on one hand, the ethnicity of the inhabitants of the microregion at the time of the rondel's construction, and on the other hand, the social aspects of its organization.

Cultural Identity of the Rondel Builders

High-resolution palynological research, combined with radiocarbon dating of the rondel, shows a close correlation between its construction and a rapid population

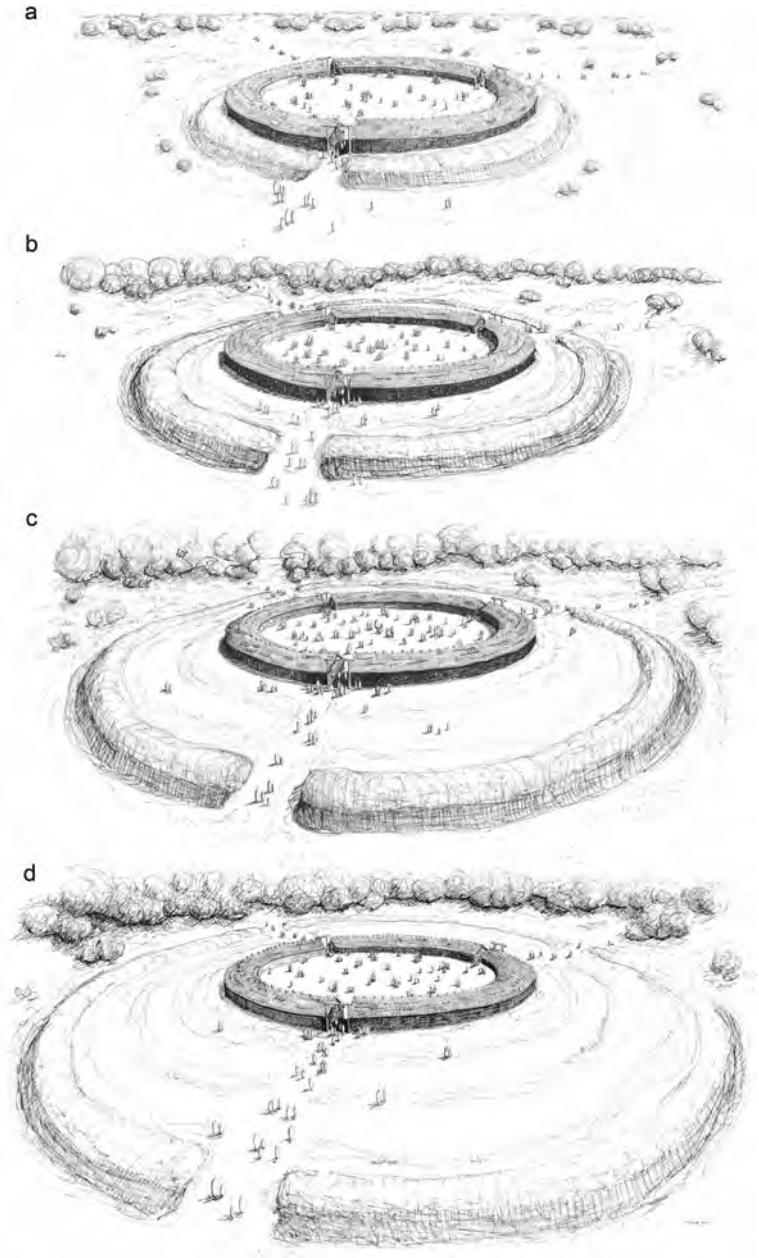

Fig. 5 Four subsequent phases of use of the rondel at Nowe Objezierze (**a**–**d**). The diches were only opened during ceremonies and then backfilled. Observations concerning the functioning of the ditches directly support their intentional backfilling after the end of use and the sequential opening of new ones (drawn by Marek Z. Barański)

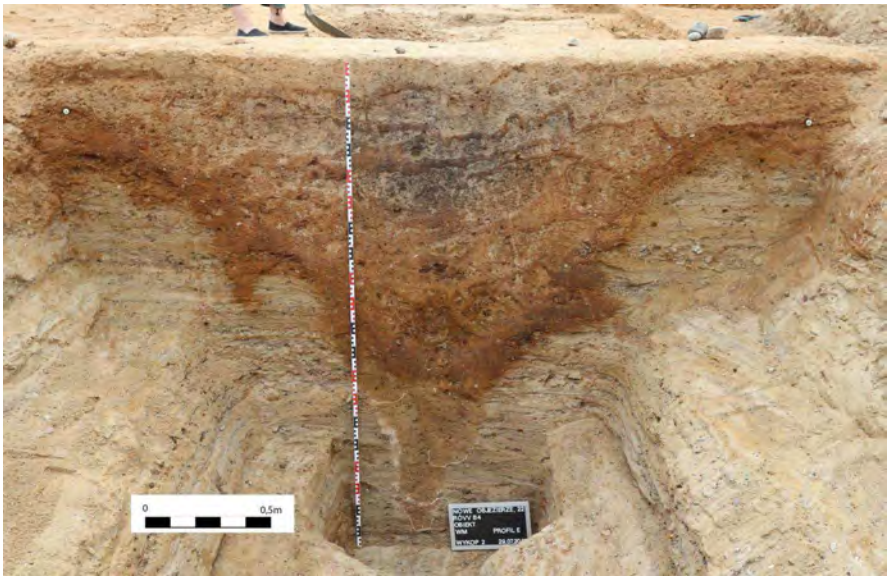

Fig. 6 Nowe Objezierze, Moryń comm., site 22. Example of a typical cross-section of a rondel ditch: ditch 4B, southern gate. The white lines mark the outlines of the bottoms of three separate grooves, which illustrate the different depths of the renewed trenches (photo Lech Czerniak)

increase (Czerniak et al., 2023, 2024). Based on the typo-chronological characteristics of the ceramics, it can be assumed that the rondel in Nowe Objezierze was built shortly after the arrival of the SBK migrants from what is today Lower Silesia, the Czech Republic or Saxony-Anhalt.

Palynological studies also provide evidence that the area was previously inhabited by small groups of farmers, who most likely survived from the times of intensive LBK settlement. The groups that persisted in the area of Nowe Objezierze until the construction of the rondel can be tentatively identified (given the lack of identification of their settlements) as 'epi/post-LBK'. The arrival of new SBK settlers was marked by strong indicators of clear demographic and economic dominance, but this does not determine the nature of their interactions with the former inhabitants.

The fact that only SBK ceramics were found in the ditches of the rondel, along with the rondel itself, indicates that the functioning of the rondel community was based on patterns brought from outside. The monumental architecture of the rondel and its rich ceremonial life could have attracted the local 'epi/post-LBK' groups and influenced their further choices regarding cultural identity. In other words, individuals or groups from the local population could have joined the community using the rondel. They could also have maintained a distance, selectively adopting only some innovations, such as the new ceramic style.

Therefore, there is no doubt that the rondel and the associated migrant community played an important role in the transmission of new ideas, most evident in the change in ceramic style. However, it cannot be automatically assumed that they absorbed the local groups. Two hundred years had passed since the latter had

functioned within the Danubian cultural world's supra-regional network of interactions. Although the memory of the migrations that almost depopulated the lowlands during the LBK decline could have survived for two centuries, it cannot be ruled out that a new network of contacts had been built during this time based on relations with local hunter-gatherers. These contacts could have changed their cultural identity (*e.g.* by discontinuing the construction of longhouses) to such an extent that they could have perceived the SBK newcomers as strangers.

An interesting signal regarding the way in which the microregion was occupied by new settlers is the location of the rondel close to the former LBK longhouses. This also applies to the SBK house built in the immediate vicinity of the LBK longhouse. These two settlement episodes were separated by a considerable time gap of up to 400 years. Nevertheless, it is certain that the LBK habitat was still visible, and such a location was a conscious demonstration of continuity reaching back to distant 'ancestors' (*e.g.* Pyzel, 2018). However, only further research will determine the scale of the phenomenon described here. Currently, we do not have a comprehensive picture of the changes in the settlement network that would allow us to compare the locations of LBK and SBK settlements.

Using aerial photography, we located three individual SBK houses scattered at a distance of about 500 m from each other along the valley of the Słubia River. Through excavation methods, we identified one almost complete SBK longhouse built on a trapezoidal plan and over 37 m long (Fig. 7). Assuming that it had a residential upper floor, it can be estimated that it could have been inhabited by an extended household group. There could have been more such farmsteads, not only by the river but also scattered throughout the microregion, which, based on soil analysis, is estimated to cover an area of about 100 km^2.

The landscape of the microregion, consisting of small lakes and ponds surrounded by gently rolling land with very fertile soils, was conducive to fairly even settlement

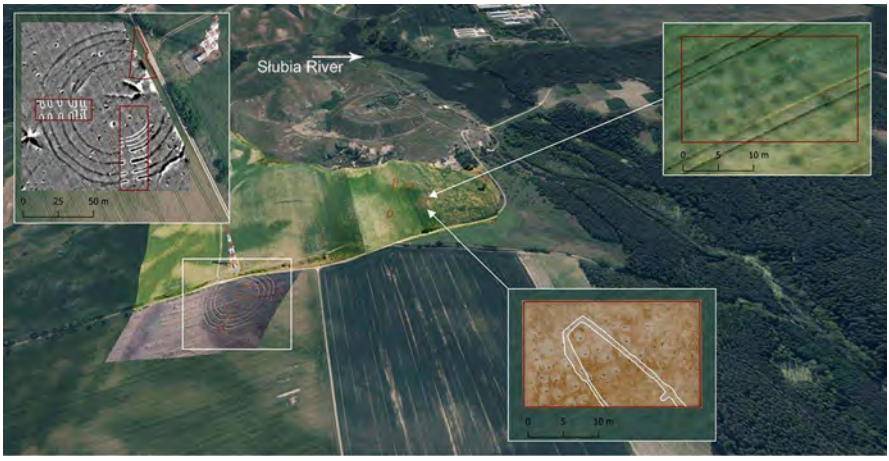

Fig. 7 The Słubia River Valley: synthetic imaging (geophysical research, remote photography and excavation trenches) on a 3D orthophotomap background, showing the rondel at Nowe Objezierze and its contemporary longhouse (after Czerniak et al., 2022)

throughout its area. It can be cautiously estimated that the population of the area did not exceed 300–500 people. When colonizing a new area, the SBK settlers had to face not only the challenge of establishing relations with the epi/post-LBK groups but also the task of 'settling in': building houses, establishing fields and creating pastures. It is doubtful that, in this situation, they would have been concerned from the outset with the problem of building a rondel, even if it would have been helpful in establishing good relations with the local communities. Unfortunately, we do not have precise data to determine the actual sequence and course of events.

Big Man or Secret Societies?

The complex architectural project leaves no doubt that rondels were a costly investment borne by the local community. It also seems evident that the construction was overseen by a ritual leader who held a high political status. However, it is questionable whether the construction of a rondel was solely the will of an individual, serving as evidence for the emergence of a Big Man type of leadership (as proposed, for example, by Řídký et al., 2019, contra: Petrasch, 2023: 407). Generally, and particularly in the Lowlands, it is challenging to find any indications (in terms of mortuary practices and village settlement organization) in the SBK that suggest a departure from the egalitarian ethos of the LBK era (cf. the insightful considerations of Rosenberg & Rocek, 2019). The most common settlement units in the SBK were hamlets and even single farmsteads surrounding a few villages, each with approximately a dozen houses (Frirdich et al., 2015; Řídký et al., 2019; Stäuble, 2012). This underscores, even more than in the LBK, the autonomous role of extended household groups. It is within this context that the construction possibilities and management system of the analysed rondel should be considered. In other words, it seems inappropriate to derive the leadership system solely from the emergence of unique architecture, while disregarding the historical context and other data on social organization.

At Nowe Objezierze, located on the distant outskirts, the rondel was utilized by a community whose population could range from 300 to 500 people. The capabilities of such a population should be considered when considering the form of leadership and the division of roles related to the supply of materials, the execution of construction works and the provision and distribution of food. The construction, operation and use of a rondel were a process that spanned several generations, generating a network of complex relationships, obligations, initiations and privileges, but also competition and a sense of inequality. In such small groups, rondels could focus and foster relationships that permeated all aspects of social life, creating an institution that controlled social dynamics at the microregional level.

The construction of a rondel required ritual and political leadership, yet it could have also embodied a collective character, resembling a *secret society* (*e.g.* Hayden & Villeneuve, 2011) or sodality (Mills, 2014), with roots tracing back to a much older past. The role of such organizations in managing the social life of Neolithic villages has been convincingly illustrated through the example of the tell in Çatalhöyük (Hodder, 2021;

Mills, 2014; Rosenberg & Rocek, 2019), whose influence on the Central European Neolithic is evident, though still underestimated.

The concept of building ceremonial centers, such as rondels and other monuments characteristic of the second quarter of the 5th millennium in Central Europe, introduced new, more effective opportunities for social integration and stabilization. These monuments became specialized tools that intensified cyclical ceremonies of commemoration, endowed them with new meanings and combined them with collective rebuilding and festivals. Simultaneously, they perhaps provided an opportunity to strengthen and highlight the role of *secret societies* without significantly altering existing organizational structures.

By analysing the function and social significance of rondels, one can explore why they began to be constructed around 4800 BCE. This draws attention to the similar historical context of the rondel in Nowe Objezierze and the monuments built by all post-LBK (SBK and others like Lengyel, Rössen and Cerny cultures) communities. This suggests that the history of rondels may have commenced about 200 years before their appearance, with the collapse of the LBK, which was marked by population decline and migrations (affecting the Lowlands the most: Bogucki, 2020; Czerniak et al., 2023; Marciniak et al., 2022), as well as new rituals, the most striking example being the double ditch structure in Herxheim (Zeeb-Lanz, 2019). These traumatic experiences opened communities of that time to creating and adopting new patterns, such as ceramic styles, changes in the structure of longhouses, new settlement organization and, of course, rondels. Their counterparts west of the Rhine were the Rosheim type enclosures (*e.g.* Jeunesse, 2019), whose genealogy seems most closely related to the Herxheim ditch system. The new ceremonial centers and monuments could have played a key role in the processes of social reintegration while providing the opportunity to assert claims to occupied territories. These were ideas strong enough to gain acceptance and unleash the social energy required to build and maintain the rondels.

Construction

The rondel was situated at the southern border of the microregion, on one of the highest hills at the edge of the Słubia River valley. This location suggests that proximity to the river, which served as the main communication route in the area, was a decisive factor. Although the specific site of the rondel was previously uninhabited, it was only 250 m from a long-abandoned Linear Pottery Culture (LBK) hamlets, where remnants of two longhouses might still have been visible. A solid trapezoidal house, contemporary with the rondel, was constructed near one of these longhouses (Fig. 7). The presence of earlier traces could have influenced the choice of location, as it allowed for the creation of a narrative of continuity and gave the rondel the character of a monument honoring ancestral memory (Pyzel 2018).

Preliminary Staking out of the Rondel Plan and Surface Preparation

The construction of the rondel likely began with a preliminary ('working') demarcation of the construction area to establish the boundaries of the clearing and remove

the topsoil. It is probable that a circle with a diameter of about 68 m was marked out, corresponding to the extent of the oldest ditch, surrounding wall and the interior of the rondel. I propose that the 'proper' staking out of the rondel was a public event with ceremonial elements, including a festival and communal feasting, to ensure collective social participation in the construction. Therefore, it was essential to prepare the open space beforehand, starting with the initial stakeout and ending with clearing and removing the topsoil. Cutting down larger trees, which could then be used to build the rondel, likely required the effort of a dozen or so skilled individuals. However, clearing the bushes (probably with limited use of fire, as suggested by palynological evidence of fires) and removing a thin layer of humus could have involved the entire community, including children.

Ceremonial Setting Out of the Circle and Marking the *Axis* of the Gates

The marking of the circles began with determining the central point. This is evidenced by the fact that at Nowe Objezierze, such a point can be identified at the intersection of straight lines drawn from all three gates simultaneously. Subsequently, the following steps were carried out: (1) marking the main outline of the three circles, along which foundation trenches were dug, and (2) marking the location of the gates and positioning the posts forming their frames.

The three gates of the rondel at Nowe Objezierze point approximately to the cardinal directions, except for the east. The most important circles marked out at this stage are (1) three foundation trenches of the surrounding wall (looking from the inside): R7, 46.61–49.01 m (average, 47.83 m = diameter of the interior of the rondel); R6, 48.23–52.13 m (average, 50.33 m); and R5, 58.98–61.53 m (average, 60.28 m = outer diameter of the rampart), and (2) the diameter of the first ditch dug around the rondel: R4, 67.80–71.17 m (average, 69.36 m). The next three ditches were opened successively during the long history of the rondel's renovation: R3, 82.55—85.41 m (average, 83.77 m); R2, 98.83–101.01 m (average, 99.72 m); and R1, 111.72–113.84 m (average, 112.52 m).

Supply of Basic Raw Materials

The construction of the rondel required materials such as wood, reed, bast ropes (likely oak or lime), clay, lime and dyes. Given that wood and reed are best harvested from December to the end of February, and the rondel was likely constructed between September and December (as discussed below), logistical challenges related to the supply of wood and reed must be considered. I propose three potential scenarios. First, following the foundation festival, there was a year-long pause during which the essential materials were collectively gathered. Second, the rondel was built immediately after the foundation festival using materials already available to individual households. It is plausible that each household annually collected a certain amount of wood, reed and bark for ropes during winter, which, after preliminary processing, was stored for future repairs or new construction. These materials were also valuable commodities that could be systematically stockpiled in surplus. Third, the rondel was constructed directly after the foundation festival, with materials being

sourced progressively during the construction process, despite their potentially lower quality. Each of these scenarios has both logistical and social implications. The first model assumes complete collective cooperation; the second is competitive, favoring the strongest households with pre-accumulated building materials; and the third can be described as cooperative and improvisational.

A significant decrease in the proportion of pine (from approximately 39 to 22%) and hazel (from 17 to 9%) observed in the palynological profile, which almost perfectly aligns with the dating of the rondel's construction phase, strongly suggests that these species were used as building materials for the rondel (for details, see Czerniak et al., 2023). Pine is suitable for load-bearing structures, while hazel is ideal for weaving the spaces between the posts in the wall structure, which were then filled and plastered with clay. Analysis of the potential vegetation indicates that pine and hazel stands were located on the slope between the rondel and the river. Deforestation in this zone simultaneously exposed the rondel from the river side.

The number of posts used as the primary elements of the surrounding wall frame can theoretically be estimated using data on the length of the foundation ditches and the density of post traces. However, in the case of the rondel analysed here, these traces are poorly visible due to significant podzolization (Fig. 3). Nonetheless, in a few instances where traces were observed, it appears that the posts were installed with considerable gaps, approximately every 0.5–1.0 m. This is rather unusual compared to other sites (*e.g.* Goseck in Saxony-Anhalt: Bertemes & Northe 2012). Considering the labor intensity, this might suggest a somewhat smaller local population than estimated based on the size of the microregion. Assuming that two posts could be obtained from one trunk (each about 4–5 m long), and the remaining parts could be used for lighter constructions (roofing, connections, *etc.*), it can be estimated that around 500 trees needed to be harvested. The felling, processing (branching, debarking, straightening, cutting to size) and transport required considerable effort, which supports considering the first schedule variant (1-year break) or a combination of the second and third variants (using previously accumulated resources supplemented with new ones) as the most likely scenarios.

Apart from a few fragments of stone axes, no typical tools associated with wood processing, such as axes and wedges made of stone, bone and antler, were found at the rondel construction site. Additionally, there are no flints with traces of wood cutting, which would have been necessary for minor repairs of handles, drilling holes, *etc.* This suggests that the main wood processing was probably carried out at the felling site or near the houses where the wood was stored.

Reed The relatively numerous lakes and wetlands in the area provided a rich reservoir of reed. Its acquisition was likely linked to the winter period when the reed has optimal properties. Among the fairly large collection of flints, no blades suitable for cutting reed were found, suggesting that it was delivered to the construction site in ready-made bundles.

Clay and Water Clay was needed for plastering the surrounding wall. A layer of loess-like clay was present at the site of the rondel construction, allowing it to be sourced locally and eliminating the need for transportation. No significant clay pits

were found in the immediate vicinity of the rondel, supporting the hypothesis that the clay was obtained during the leveling of the hill surface. This clay layer was 30–50 cm thick, and its removal revealed coarse gravels, which created a drier and more navigable surface during the rainy season. During dry periods, clay becomes very hard and compact, making extraction with Neolithic tools difficult without intensive wetting. This would require transporting thousands of liters of water from the river, located 800 m away. It would be more practical to perform these tasks during the naturally wet period (October–March). Extracting clay presented a logistical challenge, as it would be optimal to use the wet clay directly for plastering. This might provide insight into the timing of the construction and even the celebration (see below).

Lime and Other Pigments Lime was undoubtedly used by farmers of Anatolian-Balkan origin to protect wood, disinfect the interiors of houses and decorate walls, often serving as a base for patterns painted with other natural dyes, such as hematite. Evidence of such practices is well preserved on tells (*e.g.* Hodder, 2006). In the case of SBK, the use of lime was directly confirmed by incrustations of decorations on ceramic vessels. Traces of lime were also found on the remains of burnt clay daub with imprints of wooden construction and traces of white coloring (Schier & Gebhard, 2023: 262 and Fig. 9). When assessing these data, it should be noted that traces of lime are easily destroyed by soil acids.

On the studied rondel, distinct lime layers were observed at the bottom of the ditches surrounding the rondel (Fig. 8). While these could have resulted from the natural precipitation of lime from the loess soil, they might also have been due to the washing out of plasters during periods of heavy rain. Lumps of hematite were also found in the ditch fillings, which are a natural component of the local gravel substrate but could have been obtained during the digging of the ditches and used to paint plasters and the body.

Construction of the Surrounding Wall

The construction process involved the following sequence of tasks, assuming that the main posts were cut and debarked at the felling site: (1) marking out and digging foundation trenches; (2) leveling the interior surface of the rondel, combined with the removal of the clay layer; (3) constructing the framework of the structure, which included installing posts in foundation trenches, connecting posts with horizontal beams, constructing additional connections between walls to stabilize the entire structure, and building the framework for roof covering; (4) covering the roof with reed; (5) creating and installing wattle made from hazel twigs to fill the spaces between the posts; (6) plastering the surrounding wall; (7) coating the plaster and free-standing posts with lime; (8) creating geometric and figural paintings. In the last step, it is suggested that the use of plaster allowed for a large, smooth surface on the surrounding wall, which could be painted to add splendor and symbolic meaning to the architecture. This suggestion relates to the technologies and aesthetic standards

Fig. 8 Nowe Objezierze, Moryń comm., site 22. The lower layer of the final part of ditch 3B at the southern gate with a visible layer of lime (photo Lech Czerniak)

seen in the decoration of longhouses in the 'Danubian World'. The most notable evidence of plastering and painting rondel walls comes from Polgár-Csőszhalom (Raczky et al., 1996:17).

The above list highlights the complexity of organizing the entire construction process, which required dividing tasks among groups with different skills, as well as maintaining the proper sequence of actions. It also illustrates the potential for broad community participation in the construction, regardless of gender and age. The construction of the surrounding wall marked the conclusion of a prolonged and challenging building phase, resulting in the creation of the most visible and only permanent architectural element of the rondel. It is surmised that this phase culminated in a festival, which also initiated the period of preparations for the main

ceremonies. This final phase began with the excavation of the surrounding ditch, which remained open solely for the duration of the ceremonies and was filled in upon their conclusion.

Digging the Ditches

Digging and backfilling the ditches did not require special skills, which allowed for widespread community participation in preparing the rondel for the ceremonies. Three phases of ditch digging can be distinguished: (1) marking out, or outlining based on preserved traces in the case of ditch renovation; (2) digging the main V-shaped part of the ditch; (3) creating a narrow groove at the bottom, transforming the ditch cross-section into a 'Y-shape' (funnel-shaped, Fig. 6). This groove reached depths of up to 0.8 m, maintaining a constant width, which justifies its classification as a separate part of the ditch. This element requires special attention, as it was dug into a bed of loose gravel, causing it to quickly become buried. The purpose of such a narrow and fairly deep, but ephemeral, groove might have been to reach the groundwater level. The presence of water could have enhanced the symbolism of the ditch as a boundary separating the rondel's interior from the external world. This hypothesis could also explain the variable depth of the grooves in different renewal cycles, as the groundwater level varied with annual rainfall. Cattle scapulas might have been used for digging the grooves, as these tools fit perfectly with the size of the grooves and the loose consistency of the substrate (for scapulas as digging tools, see Sidéra 2001). Notably, scapulas found in the ditches of the discussed rondel appear as ritual deposits.

The Ceremonial Life of the Rondel: From the Building Ceremonies to the Culmination of the Celebration

Rondels were distinct from modern temples, theaters or sports stadiums, serving as more than mere architectural settings for ceremonies. Firstly, the construction of a rondel was not assigned to a specialized group; instead, it was a collective effort by the community that celebrated within its bounds. Thus, the construction process itself could have been ceremonial, a collective performance extended over time and divided into stages, blending work with rituals and festivals. Secondly, the cyclical reconstructions preceding the climactic ceremonies might be interpreted as symbolic reenactments of the original construction. For a structure that lasted nearly three centuries, this could have held profound emotional significance.

There are relatively few traces of the ceremonies that occurred within rondels. Therefore, it is important to remember that the primary functions of these structures are inferred from general assumptions about monumental structures. These assumptions are based on features such as their circular shape, large size, complex architectural design, the significant amount of labor required and the absence of habitation traces (*e.g.* Bradley, 1998; Chapman et al., 2006; Whittle, 2013; Brunke et al., 2016; Levenson, 2019). Additionally, it is worth mentioning phenomenological analyses

of cosmological symbolism, which I find somewhat controversial (*e.g.* Michel et al. 2015).

Nevertheless, certain aspects of a rondel's function, which left clear traces, can be identified and placed within the sequence of actions that comprise the rondel's *chaîne opératoire*. The scant evidence of the rondel's use can often be attributed to the erosion of the surface where its activities took place. The locations of rondels undoubtedly favored erosion, compounded by later activities and modern agriculture. However, there is evidence suggesting that rondels were maintained, and from the outset, surrounding ditches were the primary locations where traces of activity accumulated. This is supported by observations regarding (1) the species and anatomical composition of animal bones found in the ditches, (2) the presence of vessel deposits and (3) the distribution of waste in the ditches, which also suggests that different groups gathered at individual gates.

Ceremonial Marking of the Circle and Designation of the Gate Axes: Cosmology of the Rondel

The ceremonial marking of the rondel's layout could have been the initial opportunity to imbue the structure with magical power and confer significant social importance on its construction. Given the need to mobilize the community for such a significant endeavor, it is likely that this event was public and accompanied by a festival.

The criteria for determining the position of the gates within the circle remain a contentious topic. The prevailing theory suggests that the azimuths were aligned with the positions of the sun, moon or certain bright stars at specific times of the year (Becker, 1996; Iwaniszewski, 1996; Pavúk & Karlovský 2008; Pavúk & Karlovský, 2008; Zotti, 2010; Pásztor et al., 2015; Zotti & Neubauer, 2019; Henkel, 2021; Schier, 2021; for the latest discussion on the state of research, see Schier, 2023). However, archaeo-astronomical investigations often encounter difficulties due to methodological challenges and what appears to be an excessive range of variation among individual structures. As a result, alternative explanations are increasingly being explored, such as aligning the gates with territorial boundaries or natural landmarks within the surrounding landscape (*e.g.* Michel et al., 2015; Schier, 2021). Particularly noteworthy is the perspective of researchers who have dedicated significant effort to examining these hypotheses: Zotti and Neubauer (2023: 350–352). In their latest interpretation, they highlight that many 'solar' or 'calendric' orientations align with topographic explanations, which alone can adequately account for the location of most rondel entrances. In my view, this explanation does not fully address the doubts regarding the proposed hypotheses. Therefore, I suggest reframing the question: what kind of knowledge might the ritual leaders have possessed?

Given the large number of rondels constructed in a short period across a vast area, it seems unlikely that every local group had a ritual leader who was also a skilled astronomer. This skepticism extends to the group of migrants who built the rondel at Nowe Objezierze. This is the first argument against the involvement of advanced astronomical knowledge. The second argument is as follows: if we have

examples that the same community, while building subsequent rondels, changed the number of gates and their azimuths each time, it can be doubted that the reason was the selection of different astral objects or the change of the dates of the most important holidays. In both cases, they would have to violate such conservative values as cosmology. The examples supporting this hypothesis include three rondels at the Bylany site (Křivánek, 2019: Fig. 13) and two at the Praha-Krč site (Vondrovský et al., 2022). The latter group of authors suggests that abandoning certain rondels in favor of constructing new ones nearby resulted from political rivalry. I concur with this interpretation, and therefore, the hypothesis that the number of gates and their azimuths were linked to points with 'symbolic and political' significance—such as local territorial divisions, migration routes or commemorative sites—seems more plausible. In this way, rival groups and their leaders, aspiring to lead the ceremonies, could assert their importance and distinctiveness.

Moreover, it is essential to consider whether anything significant could be observed through the gates, given the forest cover and high likelihood of cloudiness. An analysis of the environment surrounding the rondel at Nowe Objezierze, based on palynological studies (Czerniak et al., 2023), indicates that the structure was built in a wooded area. The deforestation associated with the rondel's construction and the new settlement created a clearing that allowed for distant observation only through the southern gate facing the river. It is possible that similar forest cover limitations existed in many other regions. Coupled with the frequent cloud cover in Central Europe, particularly around the winter solstice, there was little chance that the rays of the rising or setting sun or other celestial bodies could be observed through the rondel gates. Of course, it cannot be entirely ruled out that ritual leaders still referenced relationships with specific celestial bodies, but this would likely involve a relatively free marking of the gate azimuths without precise astronomical measurements. This hypothesis is suggested by the analysis of the method used to mark out circles as the basic plan of the rondel.

More evidently than the directions indicated by the gates, it is apparent to the naked eye that most rondels were not constructed as precisely outlined circles (*e.g.* Trnka, 1991; Podborský, 1999). In the case of Nowe Objezierze, the differences in diameter measurements are approximately 3 m (Fig. 1). In such instances, the task at hand is simple, requiring only a stick and string. Therefore, the resulting inaccuracies are difficult to explain except by considering the circumstances under which the marking occurred. If we assume that the symbolism of the circle was an ideal in monument planning (Bradley, 1998: 82), then perhaps using a stick and string was not sufficiently magical, being too simple and mundane for a public ceremony. Undoubtedly, marking out 'freehand' could have made a greater impression, as the large diameter would have prevented the audience from noticing any inaccuracies. Thus, we might be encountering a special kind of fiction. Its essence was the 'theatricalization' of a fairly simple action, which allowed the ritual leader to create social power (see similar observations in Chapman et al., 2006: 38–39).

Another conclusion regarding the wide variety of gate azimuths could be that they were not related to the date of celebration, much less to the measurement of time. This is especially plausible if we assume that the groups practicing rondel building celebrated simultaneously. As argued by Hayden and Villeneuve (2011; see also

further literature), Neolithic societies did not require a special calendar—let alone an extremely costly one in the form of monumental architecture—to set the dates for sowing and harvesting. They relied on vegetative indicators of changing seasons, among other things. Hayden and Villeneuve also suggest that even Upper Paleolithic hunter-gatherer societies celebrated at the same time and could use simple tools to accurately determine the dates of the equinoxes and solstices, which were associated with their most important festivals. This knowledge was quite widespread (in the Neolithic context, it can be suggested that each extended household had such a knowledgeable person) and was mutually controlled due to the great importance attached to setting the dates of celebrations. The measurement techniques used by hunter-gatherers involved daily observation of sunrises and sunsets using a pole driven into the ground (or a tree) and marking the spot on a horizontally positioned stick where the shadow of the pole fell at sunrise. The observation site, chosen for ease of access and safety, was usually located near the observer's home (Hayden & Villeneuve, 2011: 337). In the Neolithic period, the technique of measuring time likely remained unchanged, as did the celebration of the winter solstice.

To sum up, I propose that Neolithic people, even those living in small groups on the outskirts of major settlement centers (such as the community that built the rondel at Nowe Objezierze), were capable of accurately drawing circles and precisely determining specific dates, such as the winter solstice. Therefore, the absence of regular circles or identical azimuths in the rondels does not contradict the idea that they perceived the rondel as a circular form and celebrated simultaneously. This argument can also be applied to the gate azimuths. However, in the latter case, it is more plausible that they referred to the territorial divisions surrounding the rondel. This does not preclude the possibility that these communities attributed cosmological meanings to elements of rondel architecture. Such meanings were inherently part of their social and religious functions as ceremonial monuments (*e.g.* Bourdieu, 1991; Bradley, 1998; Chapman et al., 2006). Similarly, these elements were significant components of the rituals associated with the establishment of villages, the opening of new arable fields and the construction of longhouses. From the perspective of communities whose lives were imbued with magical thinking, rituals and cosmology were natural components of their technology (*e.g.* Waterson, 2013).

Construction Time and Celebration Time as Seasonal Events

Building on the suggestions from the previous section, I propose examining the timing of construction and celebration through the lens of the seasonality of everyday life in farming communities (*e.g.* Sillar, 2014). The next step involves defining a general 'work calendar' and incorporating significant cosmological dates, such as the winter solstice (Hayden & Villeneuve, 2011).

Initially, I assume that the complex ceremonial cycle, centered around the rondel, must have had a fixed place in the social calendar, accessible to the entire community. This period likely spanned several weeks, encompassing time-consuming preparations interspersed with minor festivities that marked the opening and closing of various work stages. Key tasks included renewing the wall surrounding the rondel's

interior, digging the ditch and forming the embankment. Additionally, it was necessary to gather food, prepare decorations and create costumes. Within this context, the construction of the rondel should be seen as initiating the associated history of celebration, perceived from the outset as part of a planned 'perpetual' ceremonial cycle in which the rondel was renewed. It seems evident that the celebration, including the rondel's construction, was excluded from the farming period, which spanned from March to September. I also consider the argument (see the "Ceremonial Setting Out of the Circle and Marking the Axis of the Gates" section) that the technical feasibility of digging ditches and extracting clay was limited to periods of high soil moisture. Consequently, the only viable period for constructing the rondel was from late autumn to early spring (October–March).

Potential festival dates within this timeframe include (1) the autumnal equinox (September 21), (2) the winter solstice (December 21) and (3) the spring equinox (March 21). The first date seems ideal for commencing construction or renovation work, as it coincided with the end of the agricultural season. The second date would be ideal for starting the ceremonies. As Hayden and Villeneuve (2011) emphasize, based on ethnographic descriptions, the winter solstice was often chosen as a celebration date, at least by hunter-gatherer societies. If we assume that 'Danubian' communities also celebrated this day, it can be estimated that rondel builders had a 3-month period, usually warmer than January and February, allowing them to carry out construction or renovation in relatively good weather conditions and at a manageable pace. The period around the winter solstice was also optimal for slaughtering some livestock, a practice often undertaken before spring due to dwindling hay and leaf stocks (Wiślański, 1969).

Foundation Festival

For a facility of significant social importance, it is highly likely that the act of laying the foundation, such as outlining the plan, took the form of a public ceremony, possibly combined with an inaugural festival and communal feast. This event provided an opportunity for entertainment and simultaneously allowed for the public presentation of the construction (ritual) leader, the division of construction-related roles and the associated responsibilities. It undoubtedly served as a means of mobilizing further activities. During this event, the contributions of individual households, in terms of building materials and food donations, may have been announced. The greatest prestige was associated with providing cattle, which were consumed during the feast (Price & Makarewicz, 2023). Their heads, in the form of bucrania, could then be displayed on the surrounding wall or on separate poles to commemorate the event.

The organization of a festival combined with feasting inside the rondel at Nowe Objezierze is supported by evidence in the form of bone remains, almost exclusively of cattle, and the deposition of selected body parts (see below). The high proportion of flint arrowheads, with no traces of wild animal consumption, may also suggest a staged hunt involving cattle. In this context, reference to anthropological literature is particularly relevant. Examples of celebrations marking the end of significant stages

are provided by descriptions of preparations for the Kula expeditions (Malinowski, 1966; also, Dalton, 1984; other examples: Waterson, 1997, 121; 2013: 387).

The celebration could also have marked the completion of the collection of building materials at the construction site and the completion of the surrounding wall. Highlighting the festivities separating individual stages of construction work significantly changes the perspective on the construction process and subsequent renovations. While the festivals extended the implementation time and increased costs, they also broadened participation, thereby enhancing social acceptance and creating an audience for the speeches of political leaders. In other words, it was these festivals that transformed the rondel into a political tool, fostering a spirit of competition.

Cyclic Renewal of the Surrounding Wall as a Ritual Repetition of the Rondel Construction: Digging and Backfilling Ditches as Opening and Closing Ceremonies

The renovation of the surrounding wall and the associated ditch work involved a complex sequence of tasks and rituals, forming an extended ceremonial cycle that likely culminated in a celebration of the winter solstice. By reenacting the construction process, these actions connected the present to the distant past, marking both the beginning and end of the celebration.

The recurring practice of digging and backfilling the ditch raises the question of why the same ditch was not continuously maintained, but instead abandoned in favor of a new one over time. It is plausible that a similar mechanism was at play as with the abandonment of one rondel and the construction of another nearby, based on a different design (Vondrovský et al., 2022). In the latter case, political motivations linked to the rivalry among leaders seem evident.

At Nowe Objezierze, the creation of a new ditch in relation to the old one signifies both change and continuity. It is suggested that a new ditch was constructed when one ritual leader died and was succeeded by another. However, as indicated by chronological modeling, the oldest ditch at Nowe Objezierze was used for a period longer than a single human lifespan, enduring through two or possibly more leadership transitions. Therefore, an additional factor, such as a change in the lineage of the new leader, must have been involved. It can be speculated that such moments may have led to conflicts that determined either the continuation (by opening a new ditch) or the abandonment of the existing rondel in favor of constructing a new one.

Cleaning and Deposition of Waste as Rituals of Commemoration and Closure

In addition to observations concerning construction, repairs and reconstruction, the items involved in the ceremonial use of the rondel are crucial for interpreting its function. In the examined rondel, as in most structures of this type, nearly all such items were found in the ditches. Due to the variety of potential depositional processes (such as backfilling and renewal), interpreting the context of the rondel's ditches is challenging. This complexity is often noted in attempts to model radiocarbon dates (*e.g.* Řídký et al., 2019; Czerniak et al., 2024).

At Nowe Objezierze, the ditch fillings are predominantly composed of animal bones, fragments of ceramic vessels and flint products. For further analysis, I categorize these as waste, although they may include (1) objects deposited ceremonially (either whole or deliberately fragmented), (2) waste discarded into the ditch during the cleaning of the rondel and (3) waste that naturally entered the ditches by gravity during their filling. This general classification is a simplification, reflecting my inability and decision not to distinguish these categories further in the analysis. However, I will emphasize the absence of evidence of earlier settlement at Nowe Objezierze, which is an exceptional circumstance among the rondels studied thus far, allowing for a more daring interpretation of the refuse distribution.

Table 1 presents general quantitative data on the occurrence of three main types of 'waste' in the ditches. To account for the varying lengths of the ditch segments studied, the number of artifacts was adjusted (numbers in brackets). I assumed a constant length for the compared segments of 5.3 m (the average length of the segments studied, excluding the longest (4B) and shortest (4C) segments). By calculating the ratio between the actual segment length and the model length, I determined a multiplier to adjust the amount of waste. Additionally, I note that the ditches were investigated only near the gates, over relatively small sections (Fig. 1). For four ditches and three gates, this resulted in a total length of 117 m and a sum of 2965 artifacts (2664.3 when adjusted to sections of constant length). This location of trenches is not fully representative of the entire structure. However, the results obtained are comparable with respect to the three main categories into which locations within the ditch can be divided: (1) gates (according to azimuths: N, W, S), (2) ditches (1, 2, 3, 4) and (3) parts of ditches separated by gates (A, B, C).

The focus on studying the gate surroundings was influenced by observations at the Goseck rondel, which was examined in its entirety, is located relatively close to Nowe Objezierze, belongs to SBK and has three gates. These observations show that the most intense deposition occurred at the gates (Henkel, 2023: 197 and Fig. 2). This suggests the prominent role of gates in the location of ceremonies at the rondel. The gates serve as the most significant reference points both in the division of the rondel's interior and in relation to the potential territorial division from the outside (gate azimuth lines). Therefore, if groups with distinct identities (*e.g.* clans) existed within the local community, they might have identified themselves by referring to the gates.

At the current stage of research, the analysis of two phenomena appears particularly intriguing. First, the general distribution of waste within the ditches. Through a highly generalized quantitative approach, patterns can be observed related to the locations of deposition, which are associated with the cleaning and closure of the ditches. These patterns may reveal deeper divisions within the local community, indicating groups that used specific gates and sections of the rondel ditches. Second, the structures of animal bones. If we assume these are remnants of ceremonial feasts, their structure should be unique in terms of the selection of animal species and the ritual context of their deposition. The issue of the deposition of broken ceramic vessels in the ditches and the strongly conservative stylistic pattern of the vessels used at the rondel is also noteworthy. However, the latter will be addressed in a separate publication.

Table 1 Nowe Objezierze, site 22. Distribution of the main categories of 'waste' in the ditches of the rondel (see Fig. 1)

GATE//DITCH	Length of the excavated ditch section	POTTERY	FLINTS	ANIMAL BONES	SUM
GATE N					
DITCH 1 A	3.35 m (1.58)	9 (14.22)	2 (3.16)	0	11 (17.38)
DITCH 2 A	6.78 m (0.78)	21 (16.38)	0	0	21 (16.38)
DITCH 3 A	8.0 m (0.66)	22 (14.52)	14 (9.24)	2 (1.32)	38 (25.08)
DITCH 4 A	6.85 m (0.77)	29 (22.33)	41 (31.57)	6 (4.62)	76 (58.52)
DITCH 4 B	7.21 m (0.74)	95 (70.3)	90 (66.6)	9 (6.66)	184 (136.16)
GATE S					
DITCH 1 B	4.76 m (1.11)	19 (21.9)	31 (34.41)	21 (23.31)	71 (78.81)
DITCH 1 C	6.26 m (0.85)	12 (10.2)	18 (15.3)	71 (60.35)	101 (85.85)
DITCH 2 B	4.12 m (1.29)	3 (3.87)	21 (27.09)	28 (36.12)	52 (67.08)
DITCH 2 C	5.63 m (0.94)	14 (13.6)	28 (27.26)	13 (12.22)	55 (51.7)
DITCH 3 B	2.61 m (2.03)	18 (36.54)	31 (62.93)	1 (2.03)	50 (101.5)
DITCH 3 C	3.73 m (1.42)	26 (36.92)	20 (28.4)	0	46 (65.32)
DITCH 4 B	13.96 m (0.39)	215 (83.85)	97 (37.83)	109 (42.51)	421 (164)
DITCH 4 C	1.98 m (2.68)	6 (16.08)	6 (16.08)	0	12 (32.16)
GATE W					
DITCH 1 A	6.15 m (0.86)	248 (213.28)	230 (197.8)	188 (161.68)	666 (572.76)
DITCH 1 C	4.23 m (1.25)	97 (121.25)	21 (26.25)	4 (5)	122 (152.5)
DITCH 2 A	5.76 m (0.92)	117 (107.64)	50 (46)	28 (25.76)	195 (179.4
DITCH 2 C	4.71 m (1.13)	71 (80.23)	16 (18.08)	14 (15.82)	101 (114.13
DITCH 3 A	4.81 m (1.1)	103 (113.3)	26 (28.6)	24 (26.4)	153 (168.3)
DITCH 3 C	5.28 m (1.0)	22 (22)	10 (10)	42 (42)	73 (73)
DITCH 4 A	5.19 m (1.02)	189 (192.78)	42 (42.84)	133 (135.66)	364 (371.28)
DITCH 4 C	5.67 m (0.93)	78 (72.54)	29 (26.97)	36 (33.48)	143 (132.99)
TOTAL AMOUNT	**117.04 m**	**1413 (1283.73)**	**823 (756.41)**	**729 (634.94)**	**2965 (2664.3)**

Table 1 (continued)

GATE//DITCH	Length of the excavated ditch section	POTTERY	FLINTS	ANIMAL BONES	SUM
DITCH SECTION	Length of the excavated ditch section	POTTERY	FLINTS	ANIMAL BONES	SUM
A	46.89 m	(694.45)	(359.21)	(357.14)	(1410.8)
B	32.66 m	(216.46)	(228.86)	(110.63)	(555.95)
C	37.49 m	(372.92)	(168.34)	(168.87)	(710.13)
DITCH					
1	24.75 m	(380.85)	(276.92)	(250.34)	(908.11)
2	27.0 m	(221.72)	(118.77)	(89.92)	(430.41)
3	24.43 m	(223.28)	(139.17)	(71.75)	(434.2)
4	40.86 m	(457.88)	(221.89)	(223.19)	(943.82)
GATE					
N	32.9 m	(137.75)	(110.57)	(12.6)	(253.52)
S	43.05 m	(222.96)	(249.3)	(176.54)	(646.42)
W	41.8 m	(923.02)	(396.54)	(445.8)	(1764.36)
TOTAL AMOUNT	**117.04 m**	**(1283.73)**	**(756.41)**	**(634.94)**	**(2664.3)**

Waste Distribution

A general comparison of the ditches, as presented in Table 1, shows that the total amount of waste in ditches 1 and 4 is similar and more than twice as large as in ditches 2 and 3. These proportions apply to all three categories of waste. For the oldest ditch (ditch 4), the large amount of waste compared to the neighboring ditches can be explained by at least two factors. First, ditch 4 enclosed the area where construction-related activities and the most intensive use were concentrated. Therefore, it seems evident that most of the waste accumulating on the surface could have ended up there during both construction and use. This pattern is similar to other rondels. Consequently, the ditch closest to the interior (often distinguished by its greater width, depth and number of renovation traces) is referred to as the "main" ditch (Neugebauer, 1986: 189; Podborský, 1999; Řídký et al., 2019: 78). Second, ditch 4 at Nowe Objezierze was certainly used for the longest duration. Radiocarbon dating suggests it could have been in use for 100–150 years, which is nearly half the period of the rondel's use, equating to the combined duration of the three remaining ditches.

The interpretation presented above does not align with ditch no. 1 (the youngest and located furthest outside) due to its waste content being as high as that of the oldest ditch. Therefore, it must have been exceptional in some way. In this case, I propose a connection with the final closure of the rondel. I suggest that the rondel, which had been used 'from time immemorial' from the perspective of that era, was abandoned with respect for its significance and long history. Consequently, the abandonment ceremonies might have included the dismantling of decorations (such as bucrania and ceramic vessels displayed on the surrounding wall), their deposition in the ditch (either whole or in fragments) and the cleaning up of all waste traces from the use of the rondel. I believe the validity of this hypothesis could be assessed by searching for patterns in the spatial distribution of waste. I should add that, although the analysis of waste distribution divided into three sections highlights the distinct role of section A (which contains twice as much waste as sections B and C combined), the division into sections seems to be of marginal importance compared to the division into gates.

Quantitative data are presented as both the actual amount and the adjusted amount (in brackets), proportional to the length of the excavated ditch section. In the adjusted case, an average excavated ditch section length of 5.3 m was assumed. The amount of waste was adjusted using a multiplier (number provided in brackets in the second column) calculated with the formula: (5.3 / length of excavated ditch) × amount of waste.

At first glance (Table 1), it is evident that the western gate (W) stands out. The amount of waste deposited at this gate is twice as high as the combined total for the southern (S) and northern (N) gates. The large disparity between the N and S gates may be coincidental, as ditches 1–3 in section B were not examined at the N gate. The dominance of the W gate might also seem coincidental, as section A of ditch 1 is particularly prominent, containing 21.5% of all waste—twice as much as all ditches at the N gate and slightly less than all ditches at the S gate combined. This pattern is repeated in section A of ditch 4, which contained the second-largest collection of

waste (13.9% of the total). This suggests a pattern of significantly higher amounts of waste on one side of the gate. A closer examination of this phenomenon at the W gate reveals a clear disproportion between the amount of waste from sections A and C. The largest difference is visible in ditch 1, where side A dominates over C (572:152) and in ditch 4 (371:132). Similar, though less pronounced, observations are made for ditch 2 (179:114) and ditch 3 (168:73). The situation at the N gate is less clear, as only ditch 4 was examined on both sides. However, a similar disproportion is observed here as well: B:A = 136:58. The situation at the S gate is more complex. Only in ditch 4 is there a clear predominance of waste on the side of section B (B:C = 164:32). In the remaining ditches, the ratios are balanced and variable depending on the waste category. In other words, with the exception of ditch 4, the amount of waste appears to be random.

The above observations can be summarized as follows. It is highly probable that during the use of ditch 4, waste was deposited at each gate (with a slight preference for the W gate), while during the use of ditch 1, it was deposited almost exclusively at the W gate. Of course, waste is present in all sections of the ditches, so this hypothesis only concerns significant surpluses above a certain level, which seems to be constant. It can be assumed that a certain amount of waste present in all sections of the ditches—a kind of 'background' that blurs the picture—ended up there spontaneously from waste abandoned on the surface, which was dug up and thrown back in as a result of repeated opening and closing of the ditches. In the case of ditches 2 and 3, it seems that deliberate waste deposition was carried out as a result of cleaning, following a pattern similar to that in ditch 4. This pattern is most clearly visible at the W gate, indicating more intensive use. The most important observation seems to be that the general pattern of waste deposition changed radically in the last phase of the rondel's use. It was concentrated almost exclusively at the W gate, which from the beginning stood out as a place with an increased presence of waste. In ditch 1 at the W gate, 572 waste items were found, which is only slightly less than the sum of waste items found at all three gates in ditch 4 (671), possibly confirming the equivalence of both situations. How can we explain the shift from relatively even waste deposition at all gates to deposition at only one?

Palynological data provide a clue, indicating a sharp decline in the local population size around the beginning of the last period of ditch use at the rondel (Czerniak et al., 2023). The most likely interpretation is that a significant portion of the local population left the microregion, while a small group remained and continued to use the rondel until its final abandonment, which occurred about 50 years later. This suggests a late phase in the monument's history, during which a conflict or even a 'rebellion' against the concept embodied by the rondels could have occurred. This issue requires further research, which should consider both evidence of changes within settlements and other instances of rondel abandonment (*e.g.* Podborský & Kovárník, 2006; Vondrovský et al., 2022).

However, it is possible to propose at least a preliminary hypothesis: the individual gates may have belonged to separate groups, each gathering around 'their own' gate during celebrations and depositing waste in one of the nearest ditches. Perhaps the group that remained was associated with the western gate, which is why they only deposited waste there after the final cleaning of the rondel, when there were no

longer users of the N and S gates. The fact that the largest amount of waste accumulated at the W gate throughout the rondel's operation may indicate that it was used by the strongest group, which from the beginning played a leading role in the ceremonial life of the rondel.

Animal Bone Deposits in the Ditches

The bone collection obtained from the exploration of the rondel ditches (730 NISP) is predominantly composed of cattle remains (92.8%). Sheep/goat bones are the second most common (6.3%), with only trace amounts of aurochs, roe deer and fish bones. It is noteworthy that the proportion of wild animal bones is extremely low (for more detailed data, see Czerniak et al., 2022; a full analysis is being prepared by A. Marciniak). Although cattle generally dominate the bone assemblages of Danubian cultures, especially in the Polish Lowlands (cf. Marciniak, 2005), such a high frequency is exceptional and may be interpreted as evidence of the ceremonial use of cattle at the rondel and collective feasting (Marciniak, 2005:140–142). Additionally, observations from the LBK period indicate the deliberate burial of cattle remains following ceremonial consumption (Marciniak, 2005:188–190). The deliberate backfilling of the rondel ditches after ceremonies may be linked to this long-standing tradition.

Another notable feature is the composition of cattle bones, with head parts being the most numerous (56.7%, including horn cores at 30.1% and mandible bones plus teeth at 26.3%). Long bones (19.6%) and scapulae (5.3%) are also significant. The remaining 19.4% consists of various skeletal parts that are best categorized as 'waste'. A closer examination reveals that most head bones were found near the W gate, with twice as many in ditch 4 compared to ditch 1, suggesting possible changes over time. In contrast, the S gate area was dominated by scapulae and fragments of long bones, which were scarce near the western gate. The concentration of head bones near the W gate might indicate that the group residing there provided the cattle for the feast, granting them the privilege of retaining the heads and displaying them as bucrania.

The dominance of specific skeletal parts (heads, long bones and scapulae) sets this assemblage apart from typical post-consumption waste structures. This suggests a dual selection process: first, determining which animals were consumed during the ceremonies, and second, deciding which body parts were deposited in the ditches. The special significance of cattle head bones (similar observations were made at the Goseck rondel: Bertemes & Northe, 2012; Henkel, 2023) may point to the persistence (or revival) of the Anatolian Neolithic tradition of depositing bucrania (the most famous examples are from Çatalhöyük: Hodder, 2006). However, at the rondel, we do not find whole skulls but rather fragments, usually single horn cores or halves of mandibles (Fig. 9). This may indicate the intentional fragmentation of bucrania, with only selected parts deposited in the ditches and the rest distributed as ceremonial souvenirs. This hypothesis is supported by the presence of small fragments from other skull parts in the ditches. It is also possible that the skulls were symbolically reduced and represented by their most recognizable fragments: horns and mandibles.

Fig. 9 Examples of deposits of parts of cattle heads: **a** mandible (southern gate, ditch B4, arbitrary layer 14), **b** horn core (western gate, ditch A1, arbitrary layer 5) photo Lech Czerniak

It remains a riddle whether the deposition of bucrania fragments in the ditches occurred immediately after the ceremonies, during which the animals were killed, or much later, possibly during the final closing of a particular ditch. The latter hypothesis is supported by the exceptionally large accumulation of bones in section A of the youngest ditch at the western gate. Radiocarbon dating indicates that this accumulation is significantly older than the surrounding context and corresponds to the rondel's construction phase (Czerniak et al., 2024). However, the situation may be more complex, as suggested by the composition of these bones. Of the six dated bones from this collection, only two were head parts (a horn core and a deciduous tooth), and one was a scapula. The remaining three (1, fragments of pelvis; 2, distal left tibia; 3, proximal metatarsal) are more likely to be interpreted as incidental waste. Therefore, it is possible that the closing of the ditch (and in this case, the rondel) involved not only the deposition of 'special' bones but also the disposal of waste collected from the surface during cleaning.

Concluding

1. The use of the *chaîne opératoire* method provides a valuable opportunity to reflect on the possibility of reconstructing the complete sequence of events that constitute the rondel's biography. This approach has highlighted previously underexplored aspects of planning construction works, the skills of ritual leaders and the seasonal availability of certain construction materials. Consequently, the construction and use of rondels can be presented as a complex ceremonial cycle, extended over time and punctuated by festivals. When the rondel was ready, the cycle began with the renovation of the surrounding wall and the digging of the ditch, likely culminating on the day of the winter solstice. The celebrations concluded with a ceremony to backfill the ditch. This process is summarized in detail in the diagram (Table 2).

Table 2 Diagram displaying the particular steps of the chaîne opératoire of rondel's

CONSTRUCTION OF THE RONDEL AND THE FIRST HOLIDAYS	
ACQUIRING AND COLLECTING BUILDING MATERIALS	- structural timber (mainly pine): felling trees, debarking and dividing the trunks into posts and connecting elements - hazel twigs for weaving panels used as a base for plasters covering the surrounding wall - ropes made of bast (probably oak or lime) - reeds for roofing the surrounding wall - clay for plastering - lime for preserving wood and painting the plaster, dyes for painting on plaster
PREPARATION FOR CEREMONIAL BEGINING OF CONSTRUCTION	- preliminary marking of the rondel construction site - removal of trees and bushes - removal of the soil layer (?) - preparing decorations and food for the feast and wood for burning fires
OPENING CEREMONY OF CONSTRUCTION	- marking the circle - marking the gate axes - securing the posts forming the gate frames - foundation festival combined with collective feasting and presentation of the division of roles concerning construction, supply of raw materials and the foundation of food
CONSTRUCTION OF SURROUNDING WALL	- digging in foundation trenches - leveling the inside of the roundel to obtain clay for plasters - making the frame of the structure (setting the posts in the foundation trenches, connecting the posts with horizontal beams, making other connections between the wall lines that stiffened the entire structure, making the structure for the roof covering) - covering the roof with reeds - making and installing panels of hazel twigs connecting the spaces between the posts - plastering the surfaces of the surrounding walls - covering the plasters and free-standing posts with lime - making (?) geometric and figurative paintings
DIGGING OF THE SURROUNDING DITCH and PREPARATION WORK FOR THE CELEBRATION	- marking the outline of the trench parallel to the surrounding walls - digging the ditch - preparing decorations, work related to preparing food for the feast and wood for burning fires
FESTIVAL AND CEREMONIES CELEBRATING THE WINTER SOLSTICE	- commemorative ceremonies (re-enactments, dances and singing) - collective feasting - display of heads of consumed cattle
CLOSING CEREMONY: FILLING THE DITCH	- cleaning up the remains of the feast, depositing them in the ditch - filling the ditch

Table 2 (continued)

CONSTRUCTION OF THE RONDEL AND THE FIRST HOLIDAYS
CYCLIC REPETITION OF HOLIDAYS AND RONDEL'S RENEWAL
RENEWAL OF THE SURROUNDING WALL
REDIGGING OF THE SURROUNDING DITCH
WINTER SOLSTICE FESTIVAL AND CEREMONIES
CLOSING CEREMONY: FILLING THE DITCH
ABANDONMENT OF THE RONDEL AFTER c. 250 YEARS OF USE

2. One criterion for assessing the importance of rondels may be the role they played within a specific historical context. Rondels, as an architectural project, appeared as part of a 'package' of many other changes (new forms and constructions of houses, changes in mortuary practices), indicating that a process of social change affecting many spheres of life had been initiated. Among these changes, the construction of rondels seems to be key to understanding these processes because they involved significant social energy and required extraordinary motivation. Therefore, the construction of monumental ceremonial centers is easier to comprehend when placed in the context of the 'collapse' of the LBK. This collapse was accompanied (to varying degrees in different regions) by population decline, settlement relocations and settlement dispersion. These processes, even though they disrupted the sense of security and common identity, lasted for many generations and had to consolidate as new settlement practices and more particular identities (based on belonging to separate households). The formation of new settlement centers of LgK and SBK ushered in a new period of prosperity: settlement agglomeration and demographic growth, leading to increased competition for land and decreased sense of permanence of possession. The introduction of rondels, with their function as ceremonial centers, could have played a leading role in reintegration (building a common identity with a wide social scope) and ensuring the legal security of property. Rondels can be seen not only as gathering places for celebrating cyclical holidays but also as monuments commemorating ancestors, whose reference could be the main justification for territorial claims.
3. The role that rondels played in the Lowlands, where they arrived as an established institution with a group of migrants, did not necessarily differ much from the one described above. The group of newcomers also needed symbols to justify their right to settle. Rondels could have also served as effective tools for negotiation and understanding with the local 'epi/post-LBK' population. The relatively low popularity of rondels in the Lowlands is a problem worth considering separately. We know of a few similar monuments from this area (including at least two certain ones: Wenecja and Tylice), but the chances of discovering many more are decreasing. In the last 5 years, there have been no new discoveries, despite the availability of high-resolution aerial photography, the widespread use of drones and the popularity of searching for rondels among amateur archaeologists. The excellent visibility of the rondel at Nowe Objezierze in the form of plant markers

suggests that if there were many more such monuments in the Lowlands, there would have been a significant increase in similar discoveries. Therefore, I suppose that the scale of migration to the Lowlands of groups using rondels was too small, and perhaps they did not find imitators on a wider scale. An additional reason could be the low demographic potential of the local post-LBK groups, as well as other needs shaped by 200 years of relative isolation of the Lowlands after the collapse of the LBK.

4. An important aspect of examining rondels is recognizing the role of collective participation in their construction process. This suggests a deep sense of community, continuous co-creation of the building and continuity referring to the achievements of distant ancestors. On the other hand, the construction and maintenance of the rondel, based on a complex network of supplying necessary materials and food, made it an institution that created political power and social order. The accompanying competition and inequalities in access to the prestige provided by roles associated with leading construction and ceremonies allow us to better understand both how the rondels functioned and the ease with which they were abandoned, both in terms of individual structures and the idea itself.

5. In the context outlined above, phenomena such as rondels with unfinished ditches and rondels left with open ditches can be interpreted as objects abandoned without completing the closing ceremony. The phenomenon of political rivalry and conflicts justifies rethinking the problem of the short biographies of individual rondels (*e.g.* Schier & Gebhard, 2023) and the influence of this phenomenon on the narrow range of dating of the idea of rondels within the SBK (Řídký et al., 2019; Riedhammer, 2018; Vondrovský et al., 2022). In contrast, one can cite the example of the long period of use of the rondel at Nowe Objezierze, which was contextualized by a social environment with a low level of political rivalry.

6. The end of the use of the rondel at Nowe Objezierze can be observed from two independent perspectives: the palynological profile and the archaeological dating of the ditches. Together, they allow us to describe the abandonment of the rondel as a gradual process, spread over a longer period. It can be suggested that after the construction of the fourth and last ditch, there was a split in the local community, with the majority leaving the microregion and the remaining part continuing to use the monument. Emigration could have been an expression of radical opposition by a group dissatisfied with its position established in the tradition of using the rondel. It is possible that this was the general process of abandoning rondels: as the decline of an institution which, through increased rivalry and violations of the ethics of egalitarianism, turned out to be too costly a tool for maintaining community.

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Author Contribution LC wrote the main manuscript text and prepared all figures.

Data Availability No datasets were generated or analysed during the current study.

Declarations

Conflict of Interest The authors declare no competing interests.

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