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Citation for final published version:

Gross, Krisztián, Oszás, Anett, Marton, Tibor, Köhler, Kitti, Gábor Ódor, János, Szécsényi-Nagy, Anna, Bánffy, Eszter, Alt, Kurt W., Bronk Ramsey, Christopher, Kromer, Bernd, Bayliss, Alexandra, Hamilton, Derek and Whittle, Alasdair 2017. Midlife changes: the Sopot burial ground at Alsónyék. *Bericht der Roemisch-Germanische Kommission* 94 , pp. 151-178.
10.11588/berrgk.1938.0.37153 file

Publishers page: <https://doi.org/10.11588/berrgk.1938.0.37153>
<<https://doi.org/10.11588/berrgk.1938.0.37153>>

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Midlife changes: the Sopot burial ground at Alsónyék

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Keywords: Hungary, south-east Transdanubia, Tolnai Sárköz region, Neolithic, Sopot culture, ditch system, burial ground, transition to fifth millennium cal BC

Schlagwörter:

Mots-clés:

Introduction

Archaeological research on the Neolithic of western Hungary started on sites of the Linearbandkeramik (LBK) and Lengyel cultures in the late nineteenth century. The existence of assemblages of the Starčevo culture, representing the earliest Neolithic of Transdanubia, became known much later, in the 1970s. In the late 1960s, a close connection began to be recognised between some previously discovered grave assemblages in western Hungary and what was then called the Sopot-Lengyel (Sopotsko-Lendelska) culture in the Slavonian region of eastern Croatia; this was later labelled as the Sopot culture. However, the full integration of this material into the regional framework of the Neolithic was not without difficulties.

It had already been noted that the pottery in question looked to be closely related to assemblages of the Lengyel culture, the ~~extensive~~ great fifth millennium cal BC entity of western Hungary and beyond. Working within the Three Age system, traditional classifications of the prehistoric archaeological record have often chosen tripartite subdivisions. The study of the Neolithic of western Hungary was no different, in that an early, a middle and a late period were distinguished: broadly equivalent to the Starčevo, LBK and Lengyel cultures respectively. Sopot assemblages posed a real challenge to this neat system, as they could not be attributed simply to either the middle or the late Neolithic. Beyond purely typo-chronological studies, their evidently transitional position between LBK and Lengyel ~~posed~~ many further questions concerning the emergence of the Lengyel culture, and the extent and nature of the Sopot contribution to this process.

Using radiocarbon dates on human and animal bone from the largest Sopot burial ground from Hungary currently known, modelled within a Bayesian statistical framework, this paper seeks to offer new approaches to the chronology of the Sopot culture in Hungary. In so doing, it also aims to add new insight into the emergence of Lengyel communities.

The Sopot occupation at Alsónyék

Following the discovery of the site complex at Alsónyék, further fieldwork was carried out some 1–1.5 km to the east of the main motorway excavations on subsite 5603/2 in 2008–9 (*fig. 1*). Settlement features of the Sopot culture came to light in the small area investigated, which included ten large, complex pits (with diameters of 2–7 m), a well, and short stretches of four more or less parallel ditches. Most of the pits are earlier than the ditches, according to the stratigraphy. Ditch 211 is the third ditch, going outwards from the centre of the encircled area. This feature, where excavated, was approximately 1–2.5 m wide and 80–100 cm deep from the level of the machined surface. It had a single excavated fill that was fairly homogeneous and contained 38 sherds, four fragments of worked Szentgál radiolarite (the well-known source being about 125 km from Alsónyék), and an animal bone assemblage which has not yet been fully evaluated.

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In 2011, 30 hectares were investigated by a large-scale geomagnetic survey to gain additional information on the Sopot occupation. According to preliminary interpretation of the results, two overlapping double ditches could be detected, which ran less regularly than previously expected on the basis of the excavated portion, but the existence of the four ditches was confirmed over a much larger area. The greatest east–west extent of the ditches is about 300 m, while the inner circuit runs for ca. 250 m. The northern limit of the enclosed area is formed by an ancient riverbed that possibly marks a previous course of the Sárvíz River. The southern parts of the ditches run south-west to north-east. Some five ha in all are enclosed.

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Traces of four houses, possibly belonging to the Sopot occupation, were also identified. Many additional features were detected both inside and outside the ditch system, but excavation and field survey have shown that the investigated area was used in different archaeological periods. That is why the density of the Sopot occupation is hard to judge

from the geophysical survey alone (RASSMANN ET AL. 2015, 7–8, figs 11–12). The excavated surface with the uncovered graves of the burial ground is located on the south-eastern edge of the enclosed area.

Eighteen graves with the remains of 20 individuals were also excavated and identified by their associated material culture as belonging to the Sopot occupation. Five graves (434, 210, 372, 373 and 396) cut Ditch 211 (*fig. 2*). Two further graves cut other ditches, with Grave 471 cutting the innermost Ditch 189 and Grave 272 cutting Ditch 195. Nine graves containing ten individuals are located between Ditches 195 and 211. In Grave 475 the skeleton was in a supine position with articulated cattle ribs below the skull. The excavation notes and plans showed that this grave, and 476 next to it, were both overlain by Grave 464. Grave 463 was possibly cut by Grave 282 but their relationship could not be securely reconstructed from the excavation records. The relationship between Graves 282 and 240 is also unknown since the grave pit of the latter was not detected. Grave 470 contained a single individual presumably in a four-post grave although the construction was overlain by another pit and the context is hard to understand (*fig. 3*). Two graves (219 and 220) containing three individuals were uncovered between Ditches 211 and 222.

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Most of the deceased were buried in a crouched position. Half of the 20 Sopot burials were left-crouched, while three were right-crouched. Two individuals (Graves 475 and 476) were buried in an extended (*fig. 4*), supine position. In Grave 470, the upper part of the body was lying on its back, but the lower part was destroyed, so it is impossible to decide whether it was a supine burial as well. The body position of a further two inhumed individuals (Graves 272 and 396) could not be determined. Two cremation burials were found. The small pit of Grave 219 contained a small amount of human ashes and a vessel characteristic of Vinča C assemblages. Only a few burnt fragments of skull and a chipped stone artefact were found below the three vessels deposited upside down in the pit of Grave 434. There were no traces of secondary burning on the pots in either of these cremation graves.

The orientation of 14 out of the 16 measurable burials varied between NE–SW and SE–NW; within these, a NE–SW orientation was found in 11 cases. In Grave 220 there were two NW–SE oriented individuals. No orientation could be recorded for the two cremation graves or for two further burials (272 and 396).

In comparison to earlier periods of the Neolithic in western Hungary, the number and variety of grave goods increased considerably. Three-quarters of the graves were furnished. All except one of them contained pots; six vessels in Grave 476 was the highest count. *Spondylus* objects are frequent, including beads, bracelets and a large pendant with multiple perforations (figs 3–4). The latter form was also found in a Sopot settlement feature. A few ornaments of perforated red deer canine teeth were present (fig. 4). Chipped and polished stone artefacts were included among the grave goods.

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The pottery from the pits and ditches proved to be very homogeneous, without observable typological differences. Some forms from settlement features, such as large storage vessels with cylindrical necks and S-profiles, or (more rarely) with a biconical body below a cylindrical neck, did not occur among the grave goods, but some coarse-ware types found in settlement features, such as flat, oval dishes, were recorded with the burials (fig. 4). The pottery can definitely be attributed to the Sopot culture. The number of coarse-ware sherds ~~which that~~ might be connected with the LBK on the grounds of their production technique and that surface elaboration is very limited. No significant typological links could be observed between LBK and Sopot pottery production within the site complex. Only one S-profiled storage vessel was decorated below its rim with a row of impressed dot-like fingerprints that is typical in the LBK assemblage at Alsónyék.

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Gravel-tempered coarse ware is characteristic, but the use of organic temper is absent. Much of the material consists of flat 'baking dishes' and storage vessels with cylindrical necks and an S-profiled or biconical body. The storage vessels were frequently decorated with pointed, triangular handles.

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Fine-ware pottery was regularly made of fine clay; there was some gravel temper. The most frequent pots are different variants of biconical vessels with a concave upper part. Bowls and jars can be distinguished among them, based on the ratio of the upper and the lower parts. On the outer surface, particularly on the upper part, they were decorated with red painting consisting of narrow stripes, in some cases in a zig-zag pattern (fig. 4). The so-called stern-shaped clay objects appeared first in Sopot contexts in the Hungarian Neolithic (KALICZ / MAKKAY 1972a, 13, fig. 4: 6, 7; 1972b, 96, Abb. 8: 15–16). At Alsónyék they were found both in settlement contexts and graves.

Some vessels demonstrate connections with the pottery traditions of adjacent regions. Close parallels to large bowls with bulging shoulders decorated with wide channels (*fig. 4*) and vessels with punched stripes can be found in Vinča C assemblages. Sherds with panels of incised meandric patterns resemble the decorated ware of the Tisza culture. Conversely, typical Sopot shapes have been found on the Tisza culture tell settlements of the southern Alföld region (HORVÁTH 2005, 58–60, figs 8–9).

The wider Sopot culture context

Though this paper cannot deal in detail with the historiography of typo-chronological and other research on the Sopot phenomenon, some brief introduction to the wider context is useful.

The first evidence for the presence of communities that had a material culture later attributed to the Sopot culture in Hungary was discovered at Bicske-Galagonyás in the 1930s (MAROSI 1932; 1934). The unique character of the pottery was noted when the graves were published in the 1950s (PETRES 1954; 1959), although the assemblage was then connected with the Banat culture (BANNER /PÁRDU CZ 1948): that is to say with Vinča assemblages east of the Tisza river on the northern fringes of that culture (PETRES 1954, 25). Some furnished graves found in the late LBK — in late Zseliz/Želiezovce contexts at Nagytétény (GALLUS 1936; TOMPA 1942, 22, 26, fig. 3: 1–4) and Békásmegyer (TOMPA 1942, fig. 1: 16; PETRES 1954, 26–7; KALICZ / MAKKAY 1972b, 96, 103, Abb. 6: 1–4) — showed vessels like deep biconical bowls different to those typical of early LBK contexts and with Bükk-type incised decoration that originated from north-east Hungary. These assemblages pointed to the cultural complexity of the expiring LBK world in Transdanubia. In the 1960s, when archaeological investigations were started again at Bicske-Galagonyás, one part of the finds was connected again with the Banat/Vinča culture and particularly with the finds from Ószentiván VIII, a site south of Szeged on the Hungarian–Serbian border. Typo-chronological analysis of the pottery paralleled the assemblage with the Vinča B period (MAKKAY 1969).

The Sopot culture is an archaeological concept denoting Neolithic farming communities which appeared in the Dráva–Sava interfluvium, south of Hungary, in the second half of the sixth millennium cal BC (DIMITRIJEVIĆ 1968; 1969, 1979). The phenomenon was

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characterised in the late 1960s as the Sopot–Lengyel culture. At that time the process of development was partly traced to a local component in the form of the Early Neolithic Starčevo culture, but was also seen as having substantial influence from the Vinča culture (DIMITRIJEVIĆ 1968, 53–9, 118–19; 1969). What we would now recognise as Sopot material from the tell settlement of Bapska was then associated with the Lengyel culture (SCHMIDT 1945, 121). Identical assemblages were also discussed by Vladimir Milošević as Slavonian–Syrmanian culture (MILOŠEVIĆ 1949, 83). Early Sopot sites in Slavonia and in the western Srem region (both in north-east Croatia) were seen as contemporary with the settlements of the LBK in Transdanubia and beyond, in central Europe (DIMITRIJEVIĆ 1968). Slovakian researchers described the process discussed here from the viewpoint of the north-west Carpathian Basin and as closely connected with the emergence of the Lengyel culture north of the Danube.

Until recently, ideas about the formation of the Sopot culture were exclusively based on the typological analysis of ceramic assemblages. Identifying the LBK occupation as the most important source of its origin became the dominant trope. The terms *Vorlengyel* and *Protolengyel* were introduced to describe the transition to Lengyel, but the content of those definitions varied in different publications and also changed over the past four decades (TOČIK 1969; PAVÚK 1962; 1969; 2007; 2009). The process of transition to Lengyel was associated with characteristic pottery material such as biconical vessels with a concave upper part, pots with an S-profile and large vessels with a broad belly and cylindrical neck. All forms were seen to have their origins in the Slavonian Sopot culture. In the chronological system of Juraj Pavúk three subsequent phases were introduced, although partial overlaps were not *a priori* excluded. In this framework, the Zseliz/Želiezovce III phase meant the *Vorlengyel* horizon followed by the Bíňa-Bicske phase, the earlier *Protolengyel* horizon. The latter term is confusing as both Bicske and Bíňa are the eponymous sites for an early LBK phase as well. Finally, the younger *Protolengyel* horizon was represented by the Lužianky-type assemblages in Slovakia and by sites such as Sé-Malomi-dűlő in western Hungary (PAVÚK 2007, 11–16, Abb. 8; 2009, 258–62). Despite heated debates on chronology and cultural definition (LICHARDUS / VLADÁR 2003; PAVÚK 2004), the Sopot culture remained a connecting link between the LBK and the Lengyel culture, at least in the eastern part of south-western Slovakia.

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Following the first publication of Stojan Dimitrijević (1968), the Sopot culture was also recognised as an independent cultural unit in western Hungary. It was first labelled as Sopot–Bicske culture after the largest known Hungarian site. Its presence in Hungary was regarded as coeval with the Sopot Ib and II phases (KALICZ / MAKKAY 1972a; 1972b, 95–6). Despite this, the archaeological record remained very incomplete, with most of the known sites in the eastern part of Transdanubia, particularly along the Danube (KALICZ / MAKKAY 1972a; MAKKAY ET AL. 1996). One other group of settlements was localised in south-west Transdanubia, with Becsehely I-Bükkaljai-dűlő as a key site (KALICZ 1980). As a consequence, the Hungarian Sopot distribution was discussed in two distinct areas, and the different character of pottery assemblages was also emphasised. While eastern Transdanubia was directly connected with the Slavonian Vinča distribution, the south-west Transdanubian Sopot sites were associated with the so-called Brezovljani type of north-west Croatia (KALICZ 1988, 110; REGENYE 2002, 31).

The appearance of the Sopot culture north of its core area is often considered to be a catalyst in the emergence of the Lengyel culture out of late LBK groups, and thus the beginning of the local Late Neolithic broadly at the turn of the fifth millennium cal BC (KALICZ 1988). The contradiction caused by obvious relationships with sixth millennium cal BC cultural units in the Carpathian Basin was resolved in a division of the Sopot development into an earlier and a younger phase. The earlier phase was characterised by sharply biconical vessels with a concave upper part and thought to be coeval with the *Vorlengyel* horizon of Pavúk. The vessels of the younger phase, however, usually had an S-profile and were dated to the *Protolengyel* horizon (KALICZ 1988, 114–15). The *Protolengyel* horizon was set coeval with the second half of the Vinča B2 phase and with the start of Vinča C (KALICZ 1988, 116). This is the main reason why the Vinča B2–C horizon was summoned many times to date the Hungarian Sopot context.

When the Sopot assemblages were being compared with the relative chronology of the Vinča culture, the framework of Miložčić was generally used until the late 1990s (MILOŽČIĆ 1949). When Wolfram Schier analysed the pottery of Vinča-Belo Brdo, he found that the changes marking later Vinča culture occurred slightly earlier in the stratigraphic sequence. More precisely, Miložčić had argued for the start of the younger Vinča culture at a depth of 6.0 m. Schier, however, regarded phase 6, equating to levels between 6.4 m and 6.1 m, as the initial phase of the younger Vinča culture and labelled

that Vinča C1. As a result, some forms previously attributed to the Vinča B2 phase were subsequently assigned to C1 (SCHIER 1996, 147–8). That fact needs to be considered when different approaches to the relationship between the Sopot and Vinča cultures are analysed.

Later on, a geographical explanation for the same problem was the idea that the earliest Lengyel culture already existed in north-west and some other parts of western Transdanubia while Sopot culture sites were present in the eastern and south-western part of the region. At this stage of research, already inspired by the results of Schier, it was also emphasised that the typical Sopot shapes of Hungarian assemblages can be found among the finds of the Vinča C period (REGENYE 2002).

Research was also carried out north of Lake Balaton at Ajka and Nemesvámos-Baláca (REGENYE 1994b; 1996a; 1996b; 1998). More recently, in addition to Alsónyék, the most important research on Sopot culture sites along the Danube has been at Fajsz-Garadomb and Fajsz-Kovácsalom, on the left (that is, east) bank. The latter site could be the northernmost tell settlement of the culture. Field and geomagnetic surveys were carried out on both sites, and Fajsz-Garadomb was excavated from 2006–2008 (BÁNFFY ET AL. 2014; RASSMANN ET AL. 2015).

Research on the south-west Transdanubian settlement group of the Sopot culture was substantially intensified by excavations preceding motorway construction. Becsehely I-Bükkaljai-dűlő was investigated over a much larger area than previously possible (KALICZ ET AL. 2007), while another Sopot site was excavated at Petrivente-Újkúti dűlő (HORVÁTH /KALICZ 2003; KALICZ ET AL. 2007). Two other extended settlements are known from Sormás-Török-földek (BARNA 2010; 2011a; 2015) and Sormás-Mántai-dűlő (BARNA 2009; 2011a; 2015). Numerous Sopot houses were recorded there (BARNA 2009; 2011a; 2011b), as well as at Petrivente (KALICZ ET AL. 2007, fig. 2: 6).

In contrast to the former two-phase classification, Nándor Kalicz regarded the recently excavated south-west Transdanubian assemblages as uniform. He also noted that Sé-type figurines were uncovered at Becsehely in one of the Sopot features. This fact was interpreted as possible evidence for the contemporaneity of the *Protolengyel* horizon and the Sopot culture for at least a short period of time, but territorial overlaps between the two were regarded as arguments against their coeval existence (KALICZ ET AL. 2007, 44).

Unlike Lengyel culture enclosures, Sopot culture ditches have not previously been a research focus. The Sopot ditch at Becsehely I-Bükkaljai dűlő was already found in the first investigations (KALICZ 1983–84, 272–3), and large-scale excavations then confirmed the existence of the multiple ditch system there (KALICZ ET AL. 2007, 31, Abb. 1: 2–5). A very similar ditch system was recorded at Petrivente-Újkúti-dűlő both by geomagnetic survey and excavation (KALICZ ET AL. 2007, 31, Abb. 2: 1–5). Another, not completely circular, ditch was uncovered at Sormás-Mántai-dűlő (BARNA 2011a, 70–1; 2015, 402, fig. 1: 1–2). One of the two enclosures (number II) at Sormás-Török-földek was constructed in the Sopot period (BARNA 2010, 95–8; 2011a, 159–63; 2015, 402, fig. 1: 1–2). With the exception of this enclosure, the known ditch systems of the Sopot culture in Hungary are less regular than the rondels of the Lengyel culture and similar to those detected at Alsónyék.

A detailed chronology has been proposed for Sormás-Török-földek, where settlement phases 3a1 and 3a2 represent the occupation of the Sopot culture while phase 3b is already the transition to the Lengyel culture (BARNA 2010, 95–8). Phases 4a and 4b are associated with the Lengyel culture (BARNA 2010, 98–102). On this basis, Judit P. Barna has questioned whether former suggestions of a territorial separation of the (at least partly) contemporaneous Sopot and Sé-type *Protolengyel* assemblages within the western Carpathian Basin can be valid (BARNA 2011a, 260). She has also suggested that the establishment of some of the more easterly sites of the Sopot culture and that of the early phase of the Lengyel culture could have been the work of the south-west Transdanubian settlement group, which probably played a more significant role in the development of the Lengyel culture than the eastern Transdanubian Sopot groups (BARNA 2011a, 267–74).

The largest known burial ground of the Sopot culture in Hungary is now that of Alsónyék, with 20 individuals from 18 graves. Another important burial ground was found at Bicske-Galagonyás. Nine graves arranged in three rows had previously been destroyed (MAROSI 1932, 62). Arnold Marosi excavated seven graves in 1933. There were three left-crouched burials and one supine burial, oriented E–W, and an extended, SE–NW oriented, body lay on its left side. Two further damaged graves were recorded (MAROSI 1934, 39–40; PETRES 1954; 1959). Another E–W supine grave (Grave 1/1974)

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was excavated in 1974. The grave was furnished with four vessels at the head of the deceased, a *Spondylus* belt with over 300 pieces and an antler pierced pick (MAKKAY 1975; MAKKAY ET AL. 1996, 20, 23, figs 6–7).

There are four inhumation graves at Fajsz-Garadomb. Two are supine burials, and in one further case the human remains were carefully deposited in a secondary position (BÁNFFY ET AL. 2014, 354, Abb. 6). Two burials were recorded in settlement pits at Nemesvámos-Baláca. One individual was discovered in Feature 10 in a prone body position with a NE–SW oriented upper body, while the body in Feature 13 was left-crouched and SE–NW oriented (REGENYE 1996b, 25, 27, Abb. 17–18). One supine E–W oriented inhumation grave was disturbed by construction works at the Szentendre-Dr. Nagy Lajos utca-Római sánc utca sarok site. The grave was furnished with two vessels, 28 chipped stone artefacts, six cylindrical shell beads, a chipped stone tool and red ochre (PATAY 1966–67, 8, 10, figs 5–6). Another inhumation grave in Szentendre, at the HÉV-végállomás site (MRT 7, site 28/22) was also destroyed in the course of construction works. The body was probably oriented NW–SE and it was furnished with a biconical vessel that has a concave upper part and striped red painting (DINNYÉS ET AL. 1986, 279, table 3: 13).

The Sopot burial dataset consists of 36 burials. The most frequent body position is left-crouched (39% of all burials; 47% of the precisely recorded ones). Supine burials constitute 19% of all Sopot graves (23% of the ones where body position has been determined), while a right-crouched position was recorded in 8% of the graves (10% of the those where body position has been determined). Further possible supine, prone and extended bodies are also known.

The left-crouched body position was dominant during the Early Neolithic Starčevo occupation of Alsónyék (OROSS ET AL., this volume a). A similar picture could be drawn for the Starčevo-Körös-Criş cultural complex in general (LICHTER 2001, 173–5, Abb. 81; PALUCH 2004, 34–5; 2007, 247). The same dominance has been recorded on LBK sites in Transdanubia (OROSS / MARTON 2012, 264–7, 292, figs 2–3; OROSS 2013, 282–5, 445). In a wider central European LBK context, both settlement burials (VEIT 1996, 182–3, Abb. 9; ORSCHIEDT 1998, 19, Abb. 21) and formal cemeteries share a similar pattern (PESCHEL 1992, 230; NIESZERY 1995, 78).

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Cremation graves had not previously been recorded either in Hungarian Sopot sites or in other earlier, sixth millennium cal BC contexts in Transdanubia. However, this burial custom occurs in different LBK cemeteries in central Europe. Biritual cemeteries are frequent in the central part of the LBK distribution, at sites like Arnstadt, Wandersleben, Niederdorla, Aiterhofen-Ödmühle and Stephansposching (SCHMOTZ 1986; PESCHEL 1992, 11, 77–8, 95–8, Abb. 35; NIESZERY 1995, 53–6, 78, 245–6, Abb. 18–19). It may also be significant that at Györe, in an early phase of the Lengyel culture in south-east Transdanubia, besides seven crouched inhumation graves, there were eight un-urned and scattered cremation graves and one further, unexcavated cremation grave (ZALAI-GAÁL / ÓDOR 2008, 554–6, Table 1). Cremation graves have also been reported from the Lengyel sites of Aszód-Papi-földek (KALICZ 1985, 33–5) and Szentgál (REGENYE 1994a, 75).

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The orientation of 28 Sopot graves from Hungary is known for 28 Sopot graves from Hungary. The most frequent is NE–SW, but E–W and SE–NW were also quite common. The more easterly orientation of the head is definitely preferred. NW–SE oriented graves are exclusively known from Alsónyék. Westerly orientation was probably not definitely proscribed but was avoided in most cases, as in the preceding Starčevo-Körös-Criș complex and in the LBK across central Europe (LICHTER 2001, 175, Abb. 82, 197–8, Abb. 91; OROSS / MARTON 2012, 293–4, figs 16–17). The orientation of supine Sopot burials varies between NE–SW and SE–NW.

Grave 470 probably had a four-post construction over it. This is not unknown from central European LBK sites, as at Wiedecken, Sondershausen and Rixheim, but does not occur in the Hungarian distribution of the LBK (HORVÁTH 1992, 44–5). Similar features are first found in Hungary on earlier fifth millennium cal BC sites of the Tisza culture in south-east Hungary, such as at Hódmezővásárhely-Kökénydomb, Grave 3/1985 (HORVÁTH 1992, 37–8, figs 1–2, tables 1–2) and Hódmezővásárhely-Gorzsa, Grave 51 (HORVÁTH 1992, 38, fig. 3, table 3). The phenomenon is known too from the Lengyel culture context at Alsónyék, from graves such as 813, 4414, 3060 and 1473. The Lengyel graves also had four posts in each corner and inside the grave pit, very similar to Grave 470 of the Sopot burial ground. The Lengyel four-post graves were exceptionally richly furnished (ZALAI-GAÁL / OSZTÁS 2009, fig. 1: 8, fig. 2: 2, 3, 7; ZALAI-GAÁL ET AL.

2012). Nonetheless, because of the disturbed character of Grave 470, further observations are required to reinforce the use of post-framed grave constructions in Sopot burial grounds.

The number and combination of grave goods recorded at Alsónyék can be regarded as typical for the Sopot distribution in eastern Transdanubia. Sopot graves remain unknown in western Transdanubia. Grave goods were normally deposited by the head or legs of the deceased (MAKKAY ET AL. 1996; BÁNFFY ET AL. 2014). The physical anthropological data neither confirm nor refute suggestions of possible population influx connected with the appearance of Sopot material culture (ZOFFMANN 1978; 1996).

Aims of the dating programme

The number of published radiocarbon dates for Sopot contexts in Hungary is very limited. There is one date from Ajka and another from Nemesvámos-Baláca, in northern Transdanubia (REGENYE 1996a, 168). The other four dated sites lie within 15 km of one another in south-west Transdanubia. There are four dates from Becsehely I-Bükkaljai-dűlő (KALICZ ET AL. 2007, 45) but one of them (VERA-3538) was also published as dating the early Lengyel occupation of Sormás-Török-földek (BARNA 2007, 367; 2011a, 245; BARNA 2015, 406, table 2). There is a series of 12 dates are from Petrivente-Újkúti-dűlő (KALICZ ET AL. 2007, 45). Four dates have been published from Sormás-Török-földek (BARNA 2007, 367; 2011a, 243, 245; 2015, 406, table 2). The initially published series for Sormás-Mántai-dűlő consists of three dates (BARNA 2007, 367; 2011a, 243, 245; 2015, 406, Table 2); two others were regarded as dating the LBK occupation of the site (BARNA / PÁSZTOR 2011, 189, table 1). The latter two dates, however, were mentioned in a table of late Sopot and Lengyel dates, most probably in error (BARNA 2015, 406, table 2). To sum up, if we accept VERA-3538 as a Lengyel result from Sormás-Török-földek, there are 24 published Sopot radiocarbon dates from the Hungarian distribution.

Eastern Transdanubia, the territory along the right bank of the Danube, seems to have had a key role in the spread of Sopot culture communities in Hungary. One aim in dating the Sopot burial activity at Alsónyék was to obtain the first absolute chronological dates from this region. We also wanted to answer two fundamental questions, by providing formally modelled date estimates. The first is the specific, local, chronological issue, concerning the relationship of the Sopot community with the extended settlements of

the LBK and the Lengyel culture at Alsónyék. The second is a more general question regarding the possible overlap of those cultural groups in Transdanubia.

Sampling strategy

The first radiocarbon dates from the site were obtained from the five burials (Graves 210, 220A, 396, 463 and 471) which were involved in the aDNA project investigating the population history of the Carpathian basin in the Neolithic. They are located in different parts of the burial ground; two of them cut Ditch 211. The dating project reported here concentrated on those human remains where further stratigraphic information was recorded. These cut Ditch 211 or each other. In one case (Grave 470), an exceptional funerary practice was dated. Animal bone samples were selected from Ditch 211, and the articulated bone of Grave 475 was also dated.

The samples and the structure of the model

A total of 12 samples of human bone from 11 individuals produced 14 results (tab. 1; fig. 5). Additionally, three samples of animal bones from two different features gave three results. The Curt Engelhorn-Zentrum Archäometrie GmbH in Mannheim (MAMS) provided nine results and the Oxford Radiocarbon Accelerator Unit (OxA) eight results. The pretreatment and measurement methodologies used by each of these laboratories for bone samples have been discussed in Bayliss et al. (this volume).

The chronological model was constructed as described by Bayliss et al. (this volume), using OxCal v.4.2 and IntCal13 (fig. 6).

From Ditch 211, two samples of cattle bone were submitted for radiocarbon dating. The first result (OxA-27308) was from a juvenile, right metatarsal proximal diaphysis, while OxA-27872 came from a juvenile metatarsal distal epiphysis from a different animal. The two results are statistically consistent ($T^p=1.1$; $T^p(5\%)=3.8$; $v=1$; WARD AND WILSON 1978) and so the samples could be the same radiocarbon age. The nature of the deposit, animal bones in disarticulation, results in these dates providing a *terminus post quem* for the overlying graves.

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Having been filled, Ditch 211 was cut by four inhumations, a cremation, and two pits. Of these, the four securely Sopot inhumations were dated. MAMS-14813 is from a femur of a slightly crouched inhumation of a male, 35–45 years old, placed on his left side, in Grave 210. MAMS-20487 is from the right tibia of a crouched inhumation of a female, 18–20 years old, placed on her left side in Grave 372. OxA-27579 is from the left tibia of a crouched inhumation of a female, 25–35 years old, placed on her left side in Grave 373. MAMS-14815 is from a humerus of a disturbed burial of a child approximately seven years old in Grave 396.

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From between Ditch 211 and the outermost Ditch 222, there is a result (MAMS-14814) from a femur of burial A from Grave 220, which was one of two individuals excavated in a double grave. This burial is a crouched male, aged 35–45 years old, lying on his left side.

Five burials were dated from between the second Ditch 195 and the third Ditch 211. MAMS-14817 is from a tibia of the skeleton in Grave 463. The individual was placed in the left-crouched position, and is an approximately six-year-old child.

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There is a sequence of intercutting graves that lie to the north of ditch 211. The lower, Grave 476, is a supine inhumation of an adult aged between 18 and 20 years. OxA-28246 is from a rib of this individual. The burial is covered by Grave 464, a left-crouched inhumation of a male, aged 40–45 years old. There are two results from the left tibia (OxA-27578 and OxA-29068), while the other two are from the right ulna (MAMS-20485 and OxA-30283) of the individual in Grave 464. All four measurements are statistically consistent ($T^*=5.8$; $T^*(5\%)=7.8$; $v=3$). The measurements have been combined prior to calibration to form mean 464 (6151 ± 16 BP).

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According to the excavation documentation, Grave 464 also cut Grave 475. Grave 475 is a supine inhumation of an adolescent aged 14–15 years old. MAMS-20486 is from the left tibia of this individual, who was inhumed with the head on a rack of cattle ribs. The cattle ribs almost certainly were placed fresh in the grave, as they remained completely articulated, thus providing a 'perfect pair' of contemporary human and animal bone samples from the grave (OxA-27307). The two results are statistically consistent ($T^*=0.0$; $T^*(5\%)=3.8$; $v=1$) and the samples could be the same radiocarbon age.

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MAMS-20488 is from the right humerus of an adult male, aged between 35 and 45 years in Grave 470. The disturbed body was possibly laid in an extended, supine position. This grave was especially intriguing because of the traces of the four posts marking the grave.

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Finally, MAMS-14818 is from a ~~rib~~ ~~costa~~ ~~rib~~ of the skeleton in Grave 471, which is cut into the innermost Ditch 189, and contained a crouched individual, approximately 13 years old, placed on the right side.

Commented [OK1]: costa in Anna's list. If Alex has no further information than costa is correct, not rib

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The Bayesian model for the Sopot burials has two primary elements. The main element regards the burials as representing a continuous period of activity in this area of the site, and this is modelled in OxCal as a Phase with Boundaries used to estimate the start and end of this activity. Although there is a significant amount of activity that pre-dates the burials in this area, such as the ditched enclosure and earlier large pits, the chronology of the Sopot burials is what we are considering directly with this model. The dated material from within Ditch 211 is almost certainly reworked and in a secondary context; it therefore provides a *terminus post quem* for the infilling of the ditch and thus aids in constraining the dates of the overlying burials from Graves 210, 372, 373 and 396.

Results

The initial model showed poor agreement between the radiocarbon dates and the archaeology ($A_{\text{model}}=4$). This is solely the result of inverted stratigraphic relationships amongst Graves 464, 475 and 476 (*figs 4–5*). The stratigraphy was derived directly from the excavation report and so it was initially thought that a problem might exist with one or more of the dates. However, after carefully reviewing the stable isotope measurements and C:N values, there was no reason to suspect a problem with actual dating, and so the entire basis of the stratigraphic relationships between these three graves was re-examined from the photographs and excavation drawings, as well as the finalised publication report and plans.

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In two points a fundamental modification of the archaeological record was necessary. The first attempt to date Grave 470 yielded a result that dated the individual to cal AD 660–770 (95% probability; OxA-28165). Since a *Spondylus* bracelet was uncovered on the right arm of the skeleton, we investigated carefully the human bones attributed to the

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burial. It has turned out that the remains of two different persons were mixed up following the excavation, and one of them belongs to the burial ground of the Avarian period uncovered in the immediate vicinity. The right humerus of the Neolithic individual directly associated with the *Spondylus* bracelet could be identified unambiguously and yielded an expected date for the burial.

In the group of Graves 464, 475 and 476, according to the excavation plan Grave 464 sealed the other two. The two dates from Grave 475, however, were significantly younger than the four results from Grave 464. After a thorough investigation of the drawings and photographs of Graves 464 and 475, it turned out that the documentation had been wrongly compiled and that the skull of Grave 464 is lying outside the line of the cut of the grave pit of Grave 475. As Grave 464 was lying on the top, exactly 20 cm under the artificial surface of the excavation, it was recognised and excavated first. In the process of the excavation, the north-west cut of Grave 475 was unwittingly destroyed from the outside and it was not observed that the latter grave, with a depth of 43 cm, was a later cut. The excavation mistake together with the incorrect positioning of the grave on the overall plan resulted in a false reading of the stratigraphy of the graves.

The two case studies above provide good examples of how absolute chronological dating and Bayesian modelling can help to verify or amend the archaeological record and to correct mistakes made during the post-excavation processing of the documentation and finds.

The revised model (fig. 6), correcting these stratigraphic errors and incorporating the information that Grave 475 cut Grave 464, has good agreement between the radiocarbon dates and the archaeological prior information ($\Delta_{\text{model}}=83$). The model estimates that the Sopot burials began in 5200–5005 cal BC (95% probability; fig. 8; start: *Alsónyék Sopot burials*), probably in 5095–5020 cal BC (68% probability). The burials lasted for 180–470 years (95% probability; fig. 7; span: *Alsónyék Sopot burials*), probably for 220–340 years (68% probability). The burials ended in 4850–4680 cal BC (95% probability; fig. 8; end: *Alsónyék Sopot burials*), probably in 4825–4750 cal BC (68% probability).

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The model also provides a *terminus ante quem* date for the digging of Ditch 211. This estimate is 4955–4845 cal BC (95% probability; fig. 9; *terminus ante quem: digging ditch 211*), probably 4930–4870 cal BC (68% probability). ~~The latest modelled date (Ox. 4 27308; fig. 9)~~

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Sensitivity analysis

A sensitivity analysis was run using the Mix_Curves function in OxCal, a freshwater reservoir of 545 ± 70 years for the Danube calculated by Bonsall et al. (2015), and the percent freshwater protein input for each burial (BAYLISS ET AL., this volume). The model followed the same overall structure as the primary model. The results of the sensitivity analysis showed no appreciable difference between the start and end dates for the Sopot burial at the site (the median values for the boundaries shown in ~~Fig. 8~~, for example, vary by a maximum of seven years).

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Discussion

The model suggests quite a long period of burial compared with the number of graves discovered. The results suggest that Sopot burial lasted ~~180–470 years (95% probability; fig. 7; span: Alsónyék Sopot burials)~~ — perhaps 7–19 human generations — probably for ~~220–340 years (68% probability)~~ — perhaps 9–14 generations. — In contrast to some former interpretations, a longer period must be taken into account when Sopot communities in Transdanubia are discussed.

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The use of the burial ground probably began in the ~~last~~ century of the sixth millennium cal BC (fig. 8; *start: Alsónyék Sopot burials*). This result means that the first individuals buried in the Sopot culture burial ground at Alsónyék very probably witnessed the occupation of the LBK settlement 1.5 km away, and that activity was surely contemporaneous with the last generations which populated the LBK settlements of Transdanubia and across even wider areas of central Europe (OROSS ET AL., this volume b, with further references).

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The first attempts at the absolute chronological dating of the Sopot culture produced ambiguous results. Radiocarbon dates from sites in south-west Transdanubia (BARNA 2007, 366–7; KALICZ ET AL. 2007, 44–5) appeared to be coeval with early Lengyel features from the same region such as the mass grave of Esztergályhorváti (BARNA 1996; BRONK RAMSEY ET AL. 1999). The informal analysis of the dates for the latter indicated

the start of the Lengyel culture very soon after the beginning of the fifth millennium cal BC. The results of our chronological modelling may suggest that the excavated site at Alsónyék was used as a burial place for the Sopot culture at a time when the earliest, formative Lengyel culture (also labelled as Protolengyel and Lengyel Ia in different publications) already existed elsewhere in Transdanubia. That in turn will require further formal modelling.

Dating the Sopot occupation in Croatia, Bogomil Obelić and his colleagues presented 25 conventional radiocarbon dates from six different sites; in 21 cases charcoal samples were dated. Following an informal analysis of the dates, very broad estimates were given for the different phases of the culture. Sopot I-B was dated to 5480–5070 cal BC, phase II-A to 5030–4770 cal BC and phase II-B to 4800–4250 cal BC (OBELIĆ ET AL. 2004). Later on, a dataset of 29 results was published dating the tell settlement at Sopot by Vinkovci; the majority of the samples were again charcoal. The Sopot culture occupation of the site was dated to 5050–4040 cal BC without formal modelling (KRZRNARIĆ ŠKRIVANKO 2011, 218–23, tabs 1–3). These dates, both conventional and AMS measurements, were used for a Bayesian approach, dating the earlier house units of the site between the 49th and 46th centuries cal BC (SRAKA 2012, 362–6, fig. 7; 2014, 374–5, fig. 4) Marcel Burić listed available radiocarbon dates related to Sopot culture contexts, emphasising the value of AMS measurements on short-lived material, for example from sites like Bapska. He suggested a time span for the Croatian Sopot distribution between the end of the sixth and the mid of the fifth millennium cal BC, but no formal analysis was carried out. The framework of Obelić and colleagues was strongly challenged (BURIĆ 2015). In conclusion, it is hard to make any appropriate comparison between the results from Alsónyék and the Croatian Sopot datasets, although one horizon of the Sopot culture south of Hungary is definitely younger than the burial ground dated here.

The estimates presented here for Alsónyék do not substantially contradict other previous suggestions, based on typo-chronological studies, of the transitional character of Sopot assemblages. On the other hand, the formal estimates enable further inferences to be made. We can exclude the proposed coexistence between Sopot and earliest Lengyel being just a local or a micro-regional phenomenon. Even if a succession from Sopot to earliest Lengyel can be shown at some sites, such as Sormás-Török-földek, that need not define the situation everywhere, especially in complex micro-regions which were contact

zones between the two material culture variants. In conclusion, the archaeological record indicates that the two cultures may have been at least partly coeval across some parts of the western half of the Carpathian Basin.

Recent discoveries in south-west Transdanubia suggest the importance of the foothills in the processes of transmission of new cultural traits towards the north. Following the excavations at Alsónyék and investigations at sites around Fajsz, however, the role of the Danube valley must also be highlighted as a route into central Europe, including at the time of the Sopot culture. Its significance is unambiguous in the post-LBK development of the western Carpathian Basin and in the formation of the Lengyel culture. The radius of Sopot occupation and impacts reaches the region of modern Budapest and even as far as tributaries of the Danube in southern Slovakia, such as the Hron and Žitava. Sopot cultural impact was substantial, and its spatial and temporal dimensions begin to be a little better understood, even if many details remain unclear. The question of direct population influx requires further aDNA research, for example.

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Acknowledgments

Grateful thanks are due to: the European Research Council for funding *The Times of Their Lives* (Advanced Investigator Grant: 295412), led by Alasdair Whittle and Alex Bayliss; the Deutsche Forschungsgemeinschaft for funding *Bevölkerungsgeschichte des Karpatenbeckens in der Jungsteinzeit und ihr Einfluss auf die Besiedlung Mitteleuropas*, led by Kurt W. Alt; Éva Ágnes Nyerges for assistance with identifying the animal bones for sampling; and Daniela Hofmann for undertaking sampling.

Summary · Zusammenfassung · Résumé

SUMMARY To the east of the main excavated area at Alsónyék, a small investigation took place which revealed a Sopot culture occupation, represented by pits, four ditches and 18 graves with the remains of 20 individuals. Some time-depth to the occupation is seen in the ditches cutting the pits, and some of the graves cutting the third ditch. The enclosed area was about five ha, based on geomagnetic survey, but it is not possible to estimate the entire size of the occupation.

The Sopot culture is normally regarded as a horizon with a questionable chronological position on the boundary between the Middle and Late Neolithic in western Hungary. Its role in the formation of the large-scale Lengyel complex remains controversial. Scholars can agree that it was brought to the region from the south, but there have been different views concerning the timing of its spread in the western Carpathian ~~l~~Basin. Some have seen it as an entirely pre-Lengyel development, and others as at least partly contemporaneous with the early Lengyel culture.

Dating within the ERC-funded project, *The Times of Their Lives*, aimed to provide formally modelled estimates of the timing and duration of the Sopot occupation at Alsónyék, and in so doing also to contribute to better understanding of the context and development of the Sopot culture in Hungary. The paper presents 17 dates on human and animal bone (including five existing dates from burials), which are modelled in a Bayesian statistical framework. The model concentrates on the samples available from the burials, and its main element regards the burials as representing a continuous period of activity in this area of the Alsónyék complex. The model estimates that the Sopot burials probably began in 5095–5020 cal BC (68% probability), probably lasted for 220–340 years (68% probability), and probably ended in 4825–4750 cal BC (68% probability). The model also estimates a *terminus ante quem* for the digging of ditch 211, of probably 4930–4870 cal BC (68% probability) ~~and a *terminus post quem* date for the infilling of Ditch 211, of probably 4950–4885 cal BC (68% probability).~~

These estimates help to inform debate about the relative sequence of cultural developments in the region, and the relationship of Sopot communities to those of the LBK and the Lengyel cultures. Being the largest currently known Sopot burial ground in Hungary in eastern Transdanubia, this chronology is particularly valuable for modelling cultural interactions along the Danube between the northern Balkans and the Carpathian ~~l~~Basin. The Sopot component also contributes significantly to the construction of a robust chronology for the long sequence of occupations at Alsónyék.

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