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Runes from Lány (Czech Republic) - The oldest inscription among Slavs. A new standard for multidisciplinary analysis of runic bones

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ABSTRACT

When Roman administration and legions gradually withdrew from the outer provinces after the fall of the Western Roman Empire, they created a power void filled by various groups. The dynamic Migration Period that followed is usually considered to have ended when the Germanic Lombards allegedly left Central Europe and were replaced by Slavs. Whether or how Slavic and Germanic tribes interacted, however, is currently disputed. Here we report the first direct archaeological find in support of a contact: a bone fragment dated to ~600 AD incised with Germanic runes but found in Lány, Czechia, a contemporaneous settlement associated with Slavs. We documented and authenticated this artifact using a combined approach of use-wear analysis with SEM microscopy, direct radiocarbon dating, and ancient DNA analysis of the animal bone, thereby setting a new standard for the investigation of runic bones. The find is the first older *fuþark* inscription found in any non-Germanic context and suggests that the presumed ancestors of modern Slavic speakers encountered writing much earlier than previously thought.

1. Introduction

The first written reports about Slavs, referred to as *Sclavini* or *Antes*, describe their attacks on the Byzantine Empire at the beginning of the 6th century(Curta, 2006; Haury and Dewing, 1914). By 800 AD, Slavs had settled vast territories of Europe, as attested by finds of their material culture (Barford, 2001; Brather, 2008; Gojda, 1991). In Central Europe, early mentions of Slavs include *Sclauos* in the foundation deed of the monastery of Kremsmünster, AD 777 (Kremsmünster, Stiftsarchiv Urkunden 0777–0778), *Boemanos Sclavos* in the Annales Fuldenses, AD 805, *omnium orientalium Sclavorum, id est … Beheimorum, Morvanorum* in Annales Regni Francorum, AD 822 and *Sclavos Marganses* in the Annales Fuldenses, AD 855 (Bartoňková et al., 2019; Wolfram, 1995). Whether this Slavicization was the result of cultural diffusion or human migration remains disputed (e.g. Preiser-Kapeller et al., 2020), particularly for Central Europe, where it was weighted with various political and nationalist reminiscences (Curta, 2001, 2009; Pohl, 2003).

According to some anthropologists, palaeodemographic analyses do not provide evidence for a mass migration of Slavs (Mielnik-Sikorska et al., 2013; Piontek, 2006). According to many linguists, however, the Slavic language was spoken in many European territories by the first millennium AD, where Slavic speakers overlaid the older Germanic, Roman or Greek language substrate (Birnbaum, 1993; Gołą;b, 1992; Koder, 2020; Lindstedt and Salmela, 2020; Smith, 2005). While such a change of language could have been the result of the arrival of a new population (Heather, 2009), it could also have been the result of a language shift, during which one ethnolinguistic group persuades another to switch language through force or prestige (Blench, 2004).

While genetics proved powerful to disentangle cultural diffusion from human migration in several cases (e.g. Hofmanová et al., 2016;

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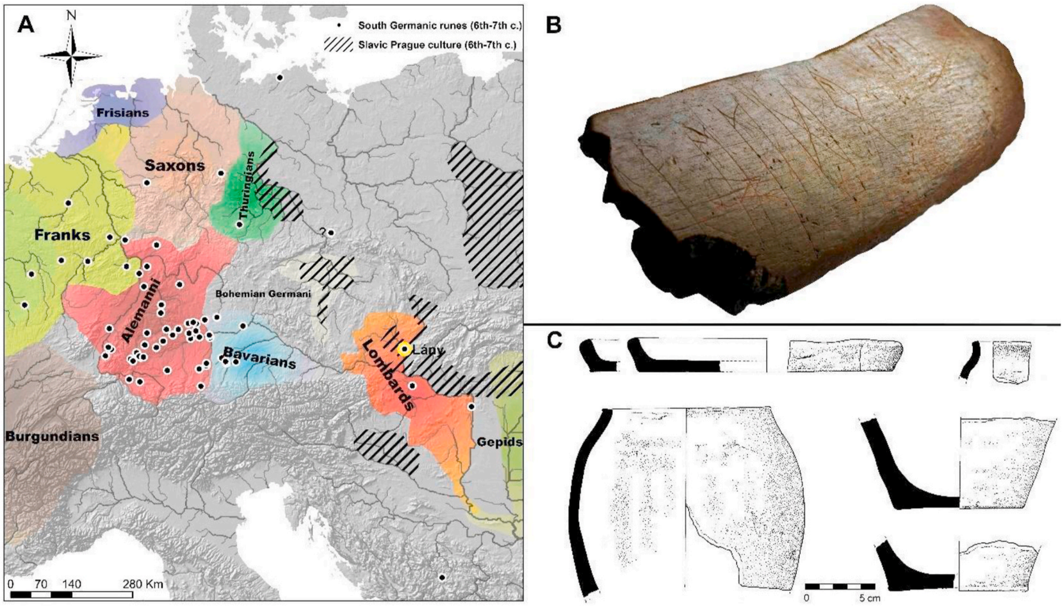

Fig. 1. The rune bone found in Břeclav-Lány. A) Distribution of South Germanic runic inscriptions from the 6th and 7th century AD, location of the Germanic tribes around 568 AD and the Early Slavic settlements. B) The rune-inscribed bone from Lány. C) Prague type pottery from the same pit as B.

Narasimhan et al., 2019), it has so far been inconclusive regarding the hypothesized expansion of Slavs. At a very local scale, a Slavic language isolate in Germany was found to be genetically closer to Slavic speakers than to local Germans (Veeramah et al., 2011), indicative of at least some migration during the spread of Slavic languages. At the continental scale, modern Slavic speakers were found to share more haplotypes among each other than with other Europeans. This was initially also interpreted as evidence for a demic expansion (Hellenthal et al., 2014; Ralph and Coop, 2013), but might be equally consistent with low population size (Al-Asadi et al., 2019; Ringbauer et al., 2017).

Nevertheless, in some regions, a physical replacement of the population after the Migration Period is more obvious. In Northern Germany (Schleswig-Holstein), for instance, the Angles, Jutes and other Germanic tribes initially inhabiting the region left during the Migration Period (Brugmann, 2011), as confirmed by ancient DNA research for their migration to the British Isles (Schiffels et al., 2016). As confirmed by palaeobotany and archaeology (Wieckowska et al., 2012; Wiethold, 1998), the region remained not or only sparsely occupied for at least 200 years, after which it was settled by various groups. Some of those are connected with Slavs based on archaeological finds and written records of later periods, as well as linguistic (toponomastic) evidence (Herrmann, 1985).

In other locations of Central Europe, the discontinuity is less obvious. In the central Danube region, for instance, Germanic, Avar and Slavic settlement followed each other very closely in time (Koncz, 2015; Urbańczyk, 2004). However, the archaeological assemblage associated with Early Slavs (the Prague Culture) is distinct from that of Germanic communities previously inhabiting Central Europe (Barford, 2001; Biermann, 2016; Brather 2008; Gojda, 1991; Parczewski, 1991). As defined by M. Parczewski (2004) based on finds from Ukraine and Poland, typical Early Slavic settlements i) are located on the edge of a river valles, ii) allowed for a self-sufficient lifestyle, and iii) consisted of small sunken-floor huts with a stone or clay oven and built on a square plan. Further, iv) cremation was the predominant funeral rite, and v) no well-developed handicrafts other than rudimentary iron works and handmade undecorated pottery of the Prague type existed.

To date no archaeological find is generally accepted as evidence for a direct contact between Germanic tribes and Early Slavs in Central Europe (Brather, 2004). Here we report a novel archaeological find in support of a direct contact: a rune-inscribed fragment of a bone from the late 6th century found in a Slavic settlement (Fig. 1). Runes are an alphabetic script, called *fuþark*, used among Germanic tribes. While many inscriptions exist in younger *fuþark*, there are only about 430 extant inscriptions in older *fuþark* (used until ~700), of which only 17 contain complete, incomplete or abbreviated abecedaries. Less than 100 inscriptions that span from the late 3rd to early 7th century make up the South-Germanic corpus. Most of them were found on metal objects in 6th century graves (Düwel et al., 2020) and contain personal names (Nedoma, 2004). The find reported here renders six of the last eight runes of the older *fuþark*, making it the first find containing the final part of the older *fuþark* in South-Germanic inscriptions, and the only one found in a non-Germanic context.

While runology has generally focused on the interpretation of runic inscriptions in terms of runic characters, linguistic forms and text function (Barnes, 2013; Grimm and Pesch, 2015), we show here that material science and the scientific analysis of both the inscriptions and the inscribed objects may provide additional, valuable information. The organic material of rune-inscribed bones, for instance, allowed us to precisely date the find using radiocarbon dating and to determine the animal species using ancient DNA (aDNA) analysis. We further used optical and scanning electron microscopy (SEM) to authenticate the inscription by means of use-wear analyses. Such analysis will likely set the new standard in the field.

2. Material and methods

2.1. SEM microscopy and use-wear analysis

Use-wear analysis is a group of methods dedicated to the identification and determination of superficial traces on archaeological mobile objects. The traces observed on the item surface could result from functional use, transport, hafting, or accidental impact during and after the deposition. Use-wear analysis is able to differentiate between intentional and random traces, or traces of different ages. We studied the discovered artifact surface using both optical reflected light microscope and scanning electron microscope (SEM). Optical microscopy was used to inspect texture differences on the surface, identify possible recent impact and traces of manufacturing and use. Electron microscopy was used to inspect the stratigraphy of traces. The chemical composition was measured with the aim to identify possible color highlighting of engraved rune lines and two stave lines.

2.2. Runology

Runology is the term applied to the study of runes (Fig. S3) and runic inscriptions which includes studies of the object, runic characters, linguistic forms and text function. We investigated the runic artifact as follows: First, we examined the inscribed object from an archaeological point of view, focusing on the context of the find, its mode of use, provenance and the dating of the runic item. Second, we identified the characters by means of autopsy using the unaided eye and a microscope. This epigraphical evidence yields a verifiable philological basis which is usually given in the form of transliteration. Third, we compared the characters to existing runic inscriptions to identify commonalities and peculiarities about the incised runes. Fourth, we interpreted the runic sequence using methods of historical linguistics. As a result of phonological, morphological, semantic and syntactic analysis (and interpretation) we get linguistic forms that constitute a text of various length (or, occasionally, an abecedary). Fifth, we use the cultural context to determine the function of the inscription and its social-historical setting (Düwel, 2008; Düwel and Heizmann, 2006).

2.3. Radiocarbon dating through accelerator mass spectrometry (AMS)

The samples of the runic bone and of two additional cattle bones from settlement pit 25 (Poz- 99473, Poz-98266, Poz-98267) were successfully dated at the Poznan Radiocarbon Laboratory (AMS 14C measurements in graphite targets on spectrometers 1.5 SDH-Pelletron Model) thanks to its relatively high content of bone collagen (5,3%–7.1% coll.). We calibrated the date using the software OxCal - v 4.3 Web interface build number: 114 (Bronk Ramsey and Lee, 2013), with the application of the InCal13 calibration curve (Reimer et al., 2013). After the calibration we determined the calendar age of bones at probability levels of 68.2% and 95.4%.

2.3.1. Bayesian modelling of radiocarbon data (OxCal)

We used available radiocarbon dates to investigate the chronology between settlements of early Slavs and Lombards using Bayesian modelling. We compared three groups of dated samples (Supplementary Table S1): 1) human bones from Lombard cemeteries in Moravia and Lower Austria (31 samples + 4 outliers according to Bayesian modelling) (Stadler et al., 2008), 2) human bones from Lombard cemeteries in Pannonia (13 samples + 1 outlier according to Bayesian modelling) (Amorim et al., 2018; Schmidtová et al., 2009; Stadler et al., 2008) and 3) animal bones from early Slavic settlements in Moravia (Pavlov, Břeclav/Lány) (this study, Jelínková, 2012) and human cremations from a Slavic burial mound (Bernhardsthal) in Lower Austria (7 samples) (Macháček et al., 2018). We ordered these groups using the OxCal (Bronk Ramsey, 2008) into a chronological sequence. We assumed that the different phases were completely independent (overlapping phases) and estimated their start and end date individually.

2.4. aDNA analysis of the animal bones

We identified the animal species of the rune-inscribed bone both morphologically and using aDNA analysis. In order to minimize destructive sampling, a small part of the bone extracted for 14C dating was sent to a dedicated aDNA facility (Mainz, Germany). The bone characteristics of the sample (rib) were highly unfavorable for aDNA preservation (Pinhasi et al., 2015). Consequently, and despite applying various modifications to the extraction protocol (with and without pre-lysis step), preliminary shallow sequencing via MiSeq did not produce enough endogenous sequences to allow for taxonomic (or any further) analysis of the sample. We therefore prepared a mixture of independently indexed libraries and sent them for taxonomical target enrichment to the Australian Centre for Ancient DNA (ACAD).

2.4.1. Bone preparation and extraction

The bone preparation, decontamination, surface preparation and milling was performed following the instructions in Scheu et al. (2015). DNA extraction was performed following Gamba et al. (2014), with modifications from Hofmanová et al. (2016) and Scheu et al. (2015). Both prelysis (initial dissolution of the bone powder with EDTA) and lysis (dissolution after 48 h) material was used in further analysis.

2.4.2. Library preparation and initial screening

The library protocol mainly followed Kircher et al., (2012) with the adaptations described in Hofmanová et al. (2016). From both the prelysis extract and the lysis extract, one parallel was amplified for shallow MiSeq screening on Illumina MiSeq for 50 cycles (single end). Additionally, three parallels of each extract were amplified at a later stage to increase variability of the endogenous molecules for target enrichment. Reads of the MiSeq sequencing were processed as follows: Adapters were trimmed using trimgalore (Babraham Bioinformatics, v.0.4.3), applying a length filter of 30bp. The general quality of sequencing results and a control of successful adapter removal was performed using FastQC (Babraham Bioinformatics, v0.11.5). Mapping the reads against the human (hg19) and Bos Taurus genomes resulted in spurious alignments only. Screening sequencing data are available in ENA (SAMEA4704853).

2.4.3. Hybridisation capture of mitogenomes and sequencing

The six libraries were pooled and sent to ACAD for enrichment of mitochondrial genome sequences by hybridisation to biotinylated RNA baits (Arbor Biosciences, MI, USA) designed from 24 placental mammal mitochondrial genome sequences (Supplementary Table S2) (Mitchell et al., 2016b). We used the Mybaits v3 protocol (Arbor Biosciences, MI, USA) with modifications. First, an equimolar mix (50 μM) of RNA oligonucleotides (P5_short_RNAblock: 5′-ACACUCUUUCCCUACACGAC-3'; P7_short_RNAblock: 5′-GUGA CUGGAGUUCAGACGUGU-3′) was used to block Illumina adapter sequences. Second, the hybridisation capture reaction was incubated for 30 h. Third, streptavidin beads were incubated with yeast tRNA to block non-specific binding sites, as described previously (Richards et al., 2019). The enriched DNA libraries were amplified and sequenced on an Illumina MiSeq using 150 cycles paired-end with v3 chemistry at the ACRF Cancer Genomics Facility (Adelaide, SA, Australia). Enrichment sequencing data are available in ENA (SAMEA6807023).

2.4.4. Data processing after hybridisation

The sequencing service provider performed demultiplexing of the data based on the indexes using CASAVA v1.8. The raw FASTQ files were processed and mapped using the PALEOMIX v1.2 pipelines (Schubert et al., 2014). Finally, fragment length and characteristic patterns of ancient DNA damage were assessed using mapDamage2.0 (Jonsson et al., 2013).

2.4.5. Phylogenetic analyses

We aligned the mitogenome sequence (without the d-loop) of all the taxa selected for the bait design and the Reconstructed Sapiens Reference Sequence (Supplementary Table 2, SI Fig. S4-S6). We constructed a 75% consensus sequence from the mapping against the taurine cattle mitogenome (depth $\geq$ 3) using Geneious R11 (Biomatters). This consensus sequence was included in two separate multiple sequence alignments using previously published cattle mitogenome datasets, with or without the d-loop (Achilli et al., 2008; Bro-Jørgensen et al., 2018). We performed phylogenetic analyses under a Maximum Likelihood (ML) framework as implemented in RAxML v8.2.11 (Stamatakis, 2014). The outgroup taxa were the water buffalo (Bro-Jørgensen et al., 2018) and the yak (Achilli et al., 2008), respectively. In all analyses, we used the GTRGAMMA model of substitution. The ML analyses included a search for the best scoring tree out of 500 bootstrap replicates.

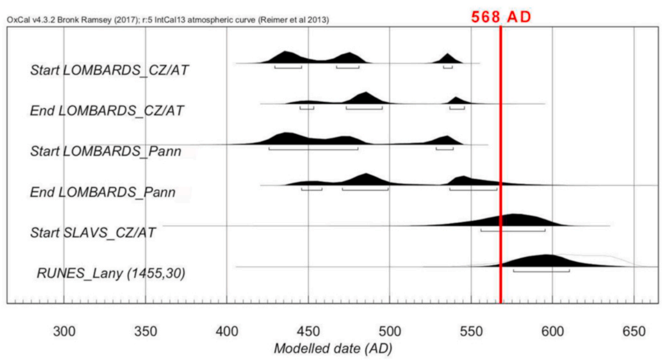

Fig. 2. Archaeological site of Břeclav-Lány (Moravia, Czechia). Excavated area (2015–2017) with settlement features assigned to chronological phases and the placement of the rune-inscribed cattle bone.

3. Theory

The discovery of a rune-inscribed bone from Lány (Břeclav, Moravia/ Czech Republic) challenges the prevalent opinion that the older *fuþark* was used exclusively by Germanic-speaking populations. The cattle rib bearing a runic inscription was found during an excavation together with pottery which is, by analogies from Ukraine (Baran, 1988), traditionally considered part of the material culture of the earliest Slavs (Profantová, 2012). The discovery was made in a region where Slavs are thought to have arrived at the end of the Migration Period after the Germanic tribes had left and the use of a Slavic language is historically confirmed as of the 9th century (in so-called Great Moravian empire). This find opens up a new door to study the partial continuity and exchange among historical populations in Central Europe. Interpreted within its broader context, it also questions the sharp dichotomy between the Germanic and the Slavic part of Europe as presented by historians, archaeologists or linguists and abused by politicians throughout the 19th and a greater part of the 20th century.

4. Results

The reported bone fragment, a rib, originates from Břeclav-Lány in South Moravia, Czechia. It was a typical example of an Early Slavic settlement of the 6th-7th century AD according to the definition of M. Parczewski (2004) and was continuously inhabited until the 9th century, as attested by direct dating and typological continuity in the archaeological record (Macháček et al., in press). This typological continuity from the Prague Culture to the Middle Hillfort Period is a feature of many Early Slavic sites (Profantová, 2012), including nearby Pohansko - the center of the Great Moravian polity, with well-attested

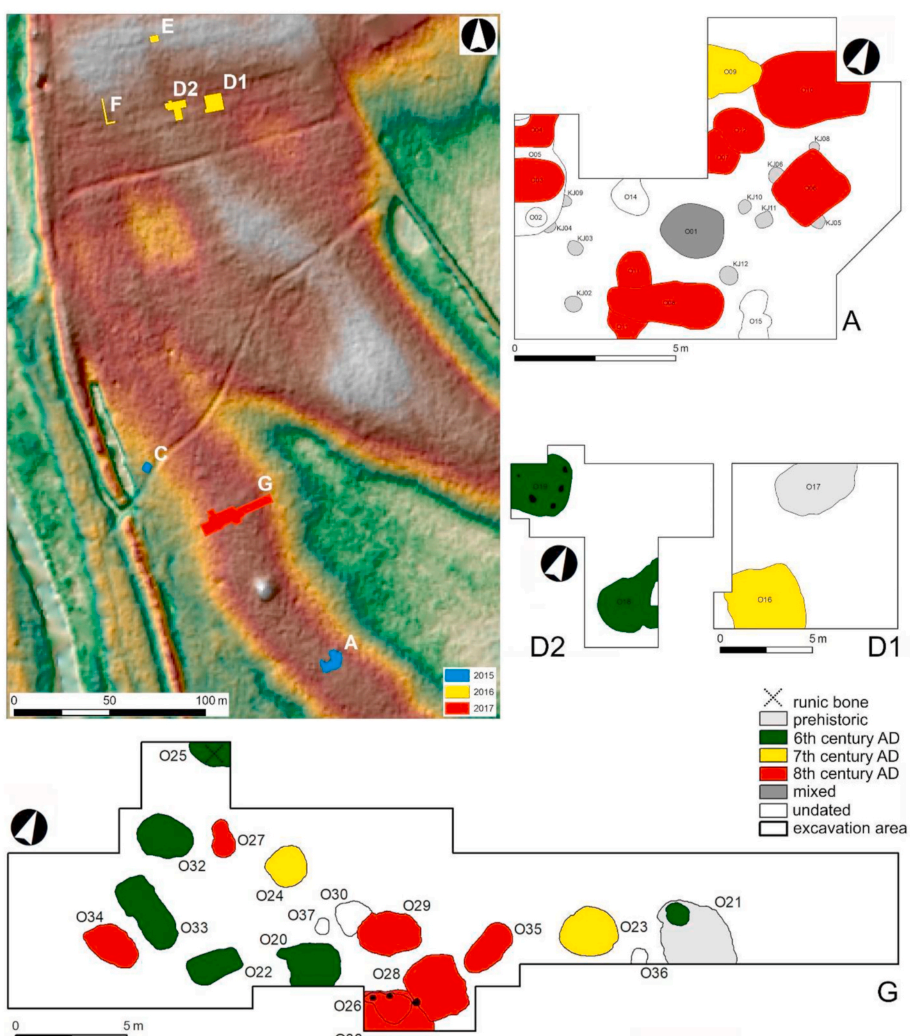

Fig. 3. Bayesian modelling of radiocarbon data. Data was used from Lombard and Early Slavic sites excavated in the Czech Republic (CZ), Austria (AT) and Pannonia (Pann: Slovakia and Hungary) and of the rune-inscribed cattle bone from Břeclav-Lány.

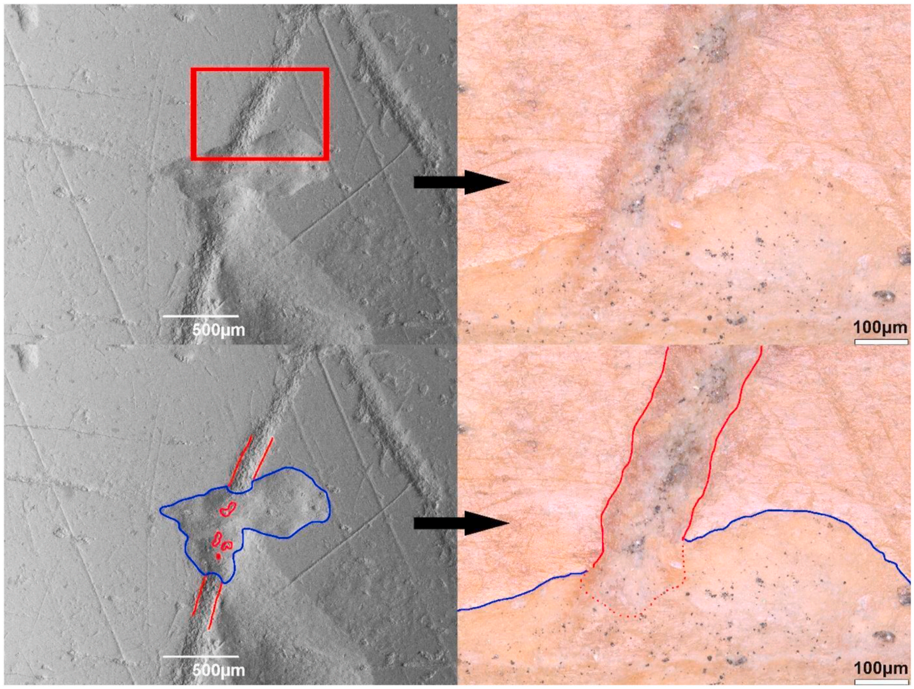

Fig. 4. Six runs of the older *fuþark* on the reported rune bone. Photo by Vojtěch Nosek.

Slavinity based on written sources - that extends this continuity until its fall in the 10th century (Macháček, 2010).

The rune-inscribed bone fragment (Fig. 1:B) was uncovered in the top section (0–25 cm) of Pit 25 (depth 70 cm), next to other animal bones and pottery of the Prague type (Fig. 1:C). This pit cannot be excavated fully because of full-grown trees. It was most probably a rest of a sunken-floored hut (Fig. 2). The archaeological finds from the pit consist of handmade pottery and clay pans (Fig. 1:C), which have been associated with competitive feasting and the rise of political leaders among those known from the written sources as *Sclavenes*/Slavs (Curta, 2017).

We dated the bone inner section (Poz-99473) containing 7.1% collagen with AMS and OxCal v4.3 to 585–640 AD (68.2% CI, 95.4% CI 555–650 AD). We confirmed the dating of the pit using two cattle bones without inscriptions from slightly lower levels of the fill (Poz-98266: 68.2% CI 540AD - 601AD; Poz-98267: 68.2% CI 536AD –604AD), making the pit the oldest 14C-dated Early Slavic feature within Czechia and Austria (Jelínková, 2012). The rune-inscribed bone is thus clearly contemporary with the Early Slavic settlement on this site and does not originate from the previous Migration Period.

We further used OxCal on available radiocarbon data (Supplementary Table 1) to investigate the chronology between settlements of early Slavs and Lombards, which are believed to have been the last Germanic tribe in East-Central Europe with their exodus to what is today Italy in 568 AD historically described and supported by ancient DNA (Amorim et al., 2018). Roman and Byzantine written sources report that Lombards were involved in battles, and in events of resettlement and land seizures, initially on the middle Danube in Lower Austria or in Moravia, and subsequently in Pannonia (Pohl, 1997). Our estimates, which are highly concordant with previous estimates on partially different data (Kaizer et al., 2019), indicate that the Lombards abandoned their burial grounds prior to 566 AD (CI 68.2%, Fig. 3), in line with their historically known departure in 568 AD, and that the Slavic settlements appeared in South Moravia after 556 AD (CI 68.2%). This cultural transition thus predated the making of the rune-inscribed bone fragment (Fig. 3).

On the ventral side of the fragment, six letters of the older *fuþark* are incised (Fig. 4), but the inscription likely started on the now missing section. The deeply engraved inscriptions are authentic as confirmed

Fig. 5. Superposition of original artificial incision and post-depositional root impact. Left: Scanning electron microscope (SEM) image of the top section of the rune *o* (ᛟ). Right: Reflected light microscope image at magnification 200x of the section marked with a red square on the left. Top: original images. Bottom: Images with color lines indicating root impact (blue) and the original incision (red), including residues of incision bottom out of reach of root impact. The dotted area highlights the original incision bottom, identified by its reddish and whitish colouring matching that of the rest of the incision. Photo by Ludmila Kaňáková-Hladíková and Jindřich Štelcl. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

through optical and scanning electron microscopy: their state of preservation matches that of the surrounding surface and accidental scratches and post-depositional plant root etching are superimposed

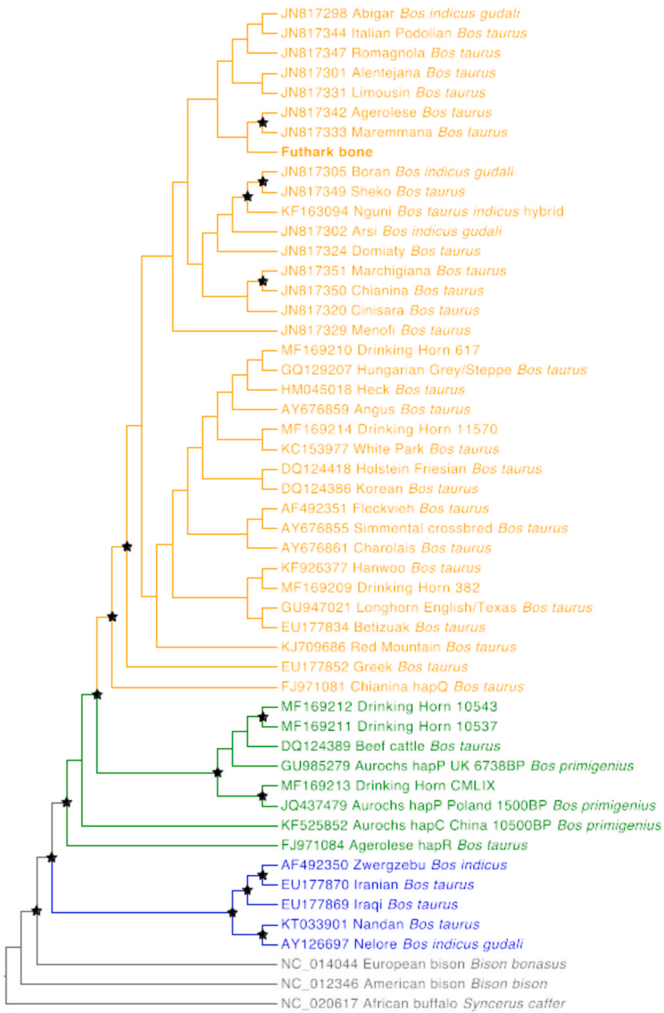

Fig. 6. Taxonomic identification of the reported rune bone. Phylogenetic tree of mitochondrial genomes (Supplementary Table 2) of European cattle (orange), aurochs (green), indicine cattle (blue) and outgroup taxa (grey). Stars indicate nodes with >80% bootstrap support. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

(Fig. 5). The engraved inscriptions were further differentiated from all other traces as they were slightly rounded and most likely intentionally colored, as indicated by a high presence of iron (Fig S2). The surface of the bone fragment showed organized parallel striations indicative of surface smoothing (Fig. S1-S2). Due to the fracture, the first two runes are incomplete, but were most likely a *t* (ᛏ) followed by a *b* (ᛒ) with wide-spaced pockets, a typical feature of the South Germanic inscriptions. The remaining are *e* (ᛖ), *m* (ᛗ), *d* (ᛞ) and *o* (ᛟ).

The carver was likely not very experienced and produced runes with distorted proportions: the ᛗ has an elongated left staff, and the ᛞ is broader than the other runes and its diagonals, cut in segments, do not reach the tops of the staffs. The right-descending branch of the ᛗ and the left staff of the ᛞ were attempted multiple times.

The runes (*tbemdo*) render six of the last eight runes of the older *fuþark* (*tbemlŋdo*), suggesting that the bone originally exhibited the whole abecedary, but it is unclear why the carver omitted the *l* and *ŋ* runes. Remarkably, this is the first find containing the final part of the older *fuþark* in South-Germanic inscriptions as none of the other extends after the *l*-rune (Düwel and Heizmann, 2006).

To confirm the fragment was of European cattle (Fig. 6), we generated aDNA individually indexed sequencing libraries, which we subjected to taxonomical target enrichment (Mitchell et al., 2016a) (at ACAD, Uni Adelaide). This yielded 3190 reads uniquely mapping to the taurine cattle mitogenome (excluding the d-loop), covering 92.1% at 14.1x. In contrast, only 201 reads mapped uniquely against the human mitogenome, mostly in highly conserved regions, suggesting low human contamination. As expected for authentic aDNA, mapped reads were short (71bp on average) and showed an accumulation of C-to-T substitutions at the 5' end (>15% at the first two bases). In a phylogenetic tree inferred with RAxML v8.2.11, the consensus mitogenome of the bone fragment was nested among European cattle (Fig. 6, Supplementary Table 2).

5. Discussion and conclusions

Here we report a rune-inscribed bone fragment discovered at the site of Břeclav-Lány in South Moravia, Czechia. We documented this rare artifact by making extensive use of recent technological advances not previously applied to runic items. These included the use of scanning electron microscopy to authenticate the runic inscriptions and the direct dating of the fragment from a minute bone powder sample of the inner section. From that bone powder sample, we also managed to extract DNA. The DNA was very poorly preserved, but thanks to DNA enrichment techniques targeting the mitochondrial genome of mammals, the artifact was identified unambiguously as of cattle origin.

From a runologic perspective, the discovered inscription is readily attributed to the South Germanic corpus, albeit likely carved by an inexperienced artist. What is surprising, however, is the archaeological context of the find: it is the first runic item discovered in a non-Germanic context, namely in a settlement of the Prague Culture generally associated with Early Slavs.

The find therefore attests to a direct interaction between the Slavic and Germanic ethnolinguistic groups that were presumably differentiated in Central Europe during the 6th century. But the context of this find does not inform about the nature of this interaction. Given the cultural significance of runes to Germanic people but not Slavs, it appears unlikely that the bone was brought by Germanic merchants. Instead, the runes may have been incised by people of Germanic origin that remained in the region after the departure of the Lombards, or later immigrated. However, there is only anecdotal evidence for rare immigrants (Haury and Dewing, 1914–1928) and no convincing evidence for the survival of Germanic elements in Slavic territories, except in Pannonian Basin, where Slavs and Germanic peoples lived among other ethnolinguistic groups in the Avar khaganate (Koncz, 2015).

Alternatively, the runes may have been engraved by a Slav. If runic knowledge was transferred from Germanic peoples to Slavs, it must have happened in Central Europe as judged by the rune shapes. Or it may have persisted in the region as a result of population continuity between Lombards and Slavs. In contrast to other places (Brather, 2004), the Germanic and Slavic settlements followed each other closely in the region and the different ethnolinguistic groups could have merged towards the end of the Migration Period (Koncz, 2015). This is thought to have happened in the Balkans, where locals and non-locals cannot be archeologically distinguished and the term "Slavs'' may have been used as an umbrella term for groups living on the frontier of the Byzantine Empire (Curta, 2001).

While our find does not allow to disentangle these or other hypotheses, it challenges a sharp dichotomy between the Germanic and Early Slavic peoples and attests to at least some form of direct contact. It further questions whether the first contact of Slavs with writing was indeed through Constantine (†869 AD) and Methodius (†885 AD) that created an alphabet to write liturgical texts in "Slavic" for their mission to Great Moravian Slavs. There is no hard evidence for any writing in a Slavic language before that (Cubberley, 1996), yet the 9th century monk Chrabr mentioned that pagan Slavs used "lines and cuts" to count and predict (in his treatise *On the Letters*). It is assumed that he refers to counting signs rather than an alphabet (Cubberley, 1996), but he could refer to the use of the runic alphabet by some Slavs, which would imply that runes were not strictly limited to the Germanic world.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jas.2021.105333.

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