A closer look at wound cord: technical analysis of Neolithic pottery decoration from Latvia

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ABSTRACT - Wound cord (whipped cord, cord stamp) decoration on pottery from the late 4th to early 3rd millennium BC in Latvia has been subject to detailed stereomicroscope study, incorporating reflectance transformation imaging, which proved an invaluable tool for documenting impressions. While this kind of ceramic ornamentation constitutes a European-scale phenomenon, considerable local variation in the methods of making pottery stamps emerges, most significantly in the kinds of support used for winding the cord, which indicates the importance of vertical transmission for this component of pottery technology. Further, the similarity of the cordage to that used for fishing nets implies a close link between pottery-making and fisheries.

KEY WORDS - pottery; wound cord stamp; Latvia; fishing nets; reflectance transformation imaging

Introduction

During the later part of the Neolithic, in the 4th and 3rd millennium BC, a special kind of pottery stamp came to be employed across vast areas of Europe: a cord wound onto a support, giving an elongated imprint consisting of a row of short hollows corresponding to the individual windings of the cord. Referred to as wound cord (also familiar as whipped cord or cord stamp), it is a phenomenon that deserves special attention because it spans such a wide spectrum of ceramic traditions. And not for this reason alone:

1 German Wickelschnur; French barbelé; Italian a filo spinato.
2 The author considers cord stamp a misleadingly general term, since stamps for pottery decoration can also be made using cord in other ways than by winding, for instance by knotting or plaiting.
crucially, we are dealing with a class of ceramic ornamentation that links directly to the fibre arts, providing a special window of evidence on textiles of this period.

Furthermore, viewing by naked eye and ordinary photography are simply inadequate for distinguishing and recording the technical intricacies and identifying variation in cordage characteristics and stamp construction. Accordingly, in order to exploit their full information potential, in the present study stereomicroscope examination of the impressions has been complemented with reflectance transformation imagery (RTI), an outstanding and very accessible but hitherto under-used tool for comparing, documenting and illustrating the features of ceramic surfaces.

Two main tasks were set in this study. The first, drawing on previous research, was to provide an analytical frame and methodology for the microscopic study of wound cord decoration on pottery, employing RTI for documentation. The second task was to investigate the varieties of wound cord decoration identifiable on late 4th and early 3rd millennium BC (late Middle Neolithic) pottery from present-day Latvia, seeking to characterize the cord and construction of the stamp. The concluding section of the article considers these results within the wider context of cordage use and wound cord decoration in European prehistory.

The phenomenon of wound cord decoration and its research potential

The decoration considered here was made with stamps consisting of a cord wound on some kind of rigid support or, in other cases, a cord wound around itself. Close observation generally permits the imprints obtained with this kind of stamp to be distinguished from the superficially similar ornamentation made using comb-like tools or denticulated stamps fashioned from hard materials.3

A comprehensive account of the spatiotemporal distribution of wound cord decoration on prehistoric pottery across Europe is quite beyond the scope of this article. But a rough assessment can be given. Thus, in a wide region of north-eastern and eastern Europe – present-day Finland, Karelia, central Russia and Belarus – this kind of ornament is recorded on the pottery of hunter-fisher cultures already in the 5th millennium BC (Piezonka 2015.178,192,195, 205,216). The appearance of wound cord decoration is similarly dated in the south-east of Europe: it is found on the pottery of the Sredny Stog Culture in south-eastern Ukraine from c. 4600 BC; thereafter it occurs in the Cucuteni-Trypillia area and, more sporadically, in the central and southern Balkans (Kotova 2010; Bulašović 2014; Uhl 2015), preceding the ‘classic’ cord ornamentation that would spread so widely across Europe as the most prominent feature of Corded Ware. Einar Østmo (2010) attempts to trace the diffusion of wound cord decoration in Scandinavia during the late 4th and 3rd millennium BC, from the Funnel Beaker Culture, where it is dominant in the decoration of the Virum style, to the 3rd millennium pottery of Norway (even proposing the concept of a ‘Cord Stamp Culture’) and thence into the Swedish–Norwegian Battle-Axe Culture. Wound cord also occurs in the Netherlands, in the West Group of the Funnel Beaker Culture (Bakker 1979) and subsequently on Late Neolithic and Early Bronze Age pottery (Lanting 1973). This kind of ornamentation is also a prominent feature of Neolithic and Early Bronze Age pottery in Britain, apparently going out of use by 1200 BC (Gibson 2002.59,Ch. 4.5). It is seen on Bell Beaker ceramics from various regions of France (Salanova 2000.Fig. 28.4,47.8,64.4) and is widely represented in the Early Bronze Age of south-eastern France (Vital et al. 2012.91–109).

To give a wider context, it should be mentioned that wound cord decoration is also encountered on pottery from other parts of the world, notably the Jomon ceramics of Japan, spanning the 7th to 2nd millennium BC, and the Woodland pottery of North America, dating from a much later period, namely the 1st and early 2nd millennium AD (Hurley 1979).

In the research history on European prehistoric pottery, wound cord decoration has generally been put into service as one of the countless pottery traits that contribute to building chrono-typologies for the various regions where it occurs. However, the use of this specific class of stamp for decorating a diversity of ceramic wares across a vast area during a millennia time interval is a phenomenon in itself, one that has hitherto received practically no consideration. Exceptional as a regional study focussing

3 Somewhat similar impressions can also be obtained using the distal end of a bird tarsometatarsal bone (Liddell 1929. Figs. 6a,7a).
on this particular kind of decor is Østmo’s (2010) attempted delineation of the ‘trajectory’ of wound cord decoration across the Neolithic cultures of Scandinavia. Noting the relative technical complexity of the stamp, inasmuch as it seems to have consisted of two elements, whereas all other pottery ornamentation instruments used during the Scandinavian Neolithic were apparently single-piece, and positing that it is unlikely to have been invented more than once, he suggests that wound cord ornaments in the South Scandinavian TRB may have been inspired by impulses originating far away, perhaps in south-eastern Europe, and seeks to account in social terms for their transmission between different Scandinavian cultural milieux.

Østmo’s treatment demonstrates the interpretive potential of tracing specific decoration methods across archaeological cultures. At the same time, interpretations in the cultural/social realm must be built upon a firm technical comprehension along with a sufficiently clear and consistent terminology, so as to permit the distinction of significant variation and avoid confusion between different kinds of stamping tools that yield superficially similar imprints. This has been a real problem in the history of research. In the Netherlands, for example, Jan N. Lanting (1973) and subsequently Jan A. Bakker (1979) have wrestled to resolve confusion and inconsistency in the identification and nomenclature of wound cord and classes of decoration resembling it. An instructive example comes from the investigation of roulette stamps in Africa (Gosselain et al. 2010), where the need for an adequately descriptive, systematic and clear classification has proved a strong motivation for research collaboration, with the agreed aim of reconstructing the actual tools used as the essential path to obtaining a clear picture of variation in decorative practices.

Unlike their colleagues studying rouletting in Africa, who also have recourse to ethnographic data, researchers seeking to characterize the tools used to create the wound cord decoration on Neolithic to Bronze Age pottery in Europe have had to rely on replication experiments, and such work has been pursued several countries: in Russia by Sergei Aristarkhovich Semenov (1955) and more recently by Igor G. Glushkov and Tamara N. Glushkova (1992) and Ekaterina N. Dubovtseva (2016), in Norway by Østmo (2008; 2010), in south-eastern France by Joël Vital et al. (2012:91–97) and in Slovenia by Matija Crešnar (2010) and Elena Leghissa (2015; 2021), while in Latvia via Baiba Dumpe (2003) has examined the use of a similar instrument not for stamping but for texturing the pottery surface by rouletting.

Under the designation ‘cord-wrapped sticks’, wound cord decoration is included in the classification of cordage techniques employed by William Hurley (1979) in studying the North American material, a system that draws heavily on the replication work by the Japanese researcher Sugao Yamanouchi. This includes elaborations of the technique, whereby the cord was wound in a complex pattern around a split stick or several sticks and the stamp applied as a rouletting tool to produce a complex design. The ethnographic and experimental research into the roulette decoration that features so prominently on past and present African pottery also deserves attention, since this also includes various classes of tools consisting of a cord wound on a core, which were not only rolled across the pottery surface but also used to make single impressions (Livingstone Smith et al. 2010; MacDonald, Manning 2010). Dubovtseva’s (2016) experimental work replicating Western Siberian pottery decoration in the 7th to 4th millennium BC likewise reveals the use of a variety of techniques for making imprints with wound cord stamps. Also relevant methodologically are studies of ‘classic’ cord decoration and various other kinds of cord impressions in pottery (Hurley 1979; Hullhén 1991:21–22; Korkeakoski-Väisänen 1993; Grömer, Kern 2010; Skrzyniecka 2020).

As emphasized in the introduction, wound cord also deserves attention because of the window of insight it offers into textiles, since it constitutes one of the major kinds of pottery decoration in prehistoric Europe that brings together ceramic and fibre technologies. Whereas actual cordage survives archaeologically only under special conditions, the imprints preserved in the fired clay can potentially offer a spatiotemporally broad insight into ancient cordage and the ways it was employed in making stamps for pottery.

Archaeological and ethnographic pottery from around the world displays a wide variety of impressed decoration created using cordage and other textile materials. This intersection of ceramic and fibre arts is interesting in itself, but is all the more important in archaeology because impressions in a material as durable as ceramics can furnish lasting evidence about the highly perishable products of fibre techno-
logies. The comprehensive studies of ancient cordage conducted in North America and Japan solely on the evidence of impressions in pottery (Hurley 1979) testify to the wide potential of this kind of data. Technical studies on various kinds of cord decoration of pottery in Europe have begun to exploit this resource, indicating the character and possible origin of the fibre as well as various characteristics relating to cord production, namely the twist direction, tightness of twist and cord diameter (e.g., Semenov 1955; Malmer 1962; Korkeakoski-Väisänen 1993; Dumpe 2003; Östmo 2008; Larsson 2009; Grömer, Kern 2010; Koško et al. 2010a; 2010b; Dubovtseva 2016; Skrzyniecka 2020; Šatavièè 2020). Specifically with regard to wound cord, it must be said, however, that much of its potential as a proxy source on Neolithic and Bronze Age cordage remains to be tapped.

The study material

Previous general research on Neolithic pottery in Latvia (Zagorskis 1967; Loze 1988) indicates that wound cord first appears in the impressed decoration during the Middle Neolithic, a period approximately corresponding to the 4th millennium BC. A new treatment of the ceramic assemblage from the Rиїukalns site, by Lake Burtnieks in north-central Latvia, showed that wound cord was a commonly used stamp form during the midden phase of this site, dated to the end of the 4th millennium (Spataro et al. 2021). Broadening the investigation, the present study also examines other pottery assemblages from central and eastern Latvia that can be typologically dated to the late Middle Neolithic. Pottery displaying impressions macroscopically resembling wound cord was subject to preliminary inspection under a stereomicroscope, selecting sherds that display one or more largely or completely preserved stamp impressions with clearly visible twists of cordage on the imprints of the windings, thus permitting unequivocal separation from other, superficially similar kinds of stamp, such as shallowly impressed comb. The aim was to obtain a set of samples reflecting the range of variation of wound cord stamps in the region during this period.

Pottery assemblages from four settlements were found to include a number of sherds with sufficiently clear and complete wound cord impressions. These are the above-mentioned Riїukalns site, Dviete and Munči in south-eastern Latvia and Nainiekste near Lake Lubâns in the east of the country (Tab. 1, see below; Fig. 1). These collections supplied a set of 37 sample sherds for detailed analysis. All of the finds are held at the National History Museum of Latvia, except for the pottery from the 2017–2018 Riїukalns excavation, which is being held temporarily at the Institute of Latvian History, University of Latvia, pending analysis and transfer to the museum’s collection.

The sherds with wound cord ornamentation included in the study (Fig. 2) are tempered with shell, in many cases also showing voids from plant inclusions, with striated or smooth surfaces. Seven are sherds from direct rims with a flat lip, while the rest are body sherds. All of the study material can be assigned to the late Middle Neolithic, i.e., the end of the 4th millennium BC or the very beginning of the 3rd.

Methodology

Technical analysis of cord stamp impressions in pottery can shed light on the production of cordage in general, and on the particular way cord was utilized in making this kind of stamp (generally in combination

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4 Here, the term Neolithic designates the ceramic final stage of the Stone Age, rather than indicating the subsistence basis (on this terminological issue, see Bërziš 2008, 37).
with a hard material providing the support), in addition to which specific features may be distinguished that reflect the way the stamp was impressed or otherwise applied to the vessel surface, i.e., the application technique. All of these aspects were considered in devising the research methodology.

The selected sample sherds were compared against each other macroscopically to verify that each is from a different vessel; in doubtful cases, the features of the impressed ornamentation were compared microscopically. A Bresser Science ETD-301 trinocular stereomicroscope with a Bresser MikroCamII (12 megapixel) camera was used for studying the impressions, primarily at very low magnification (7x). The features of the impressions were characterized by direct observation through the microscope, using a small hand-held flashlight to provide slanting light from different angles.

Nowadays, a wide variety of imaging techniques have enhanced our capacity for technical studies of relief patterns on various materials, including ceramic decoration, and, what is no less important, for accurately documenting the observed features and communicating this information effectively within the research community. The present study explores the potential of RTI as an aid for identifying and recording the technical characteristics of impressed pottery decoration. RTI is a computational photography technique that captures the surface shape and color of the artefact and enables interactive re-lighting of the subject from any light direction. With its capacity for exposing and effectively displaying a variety of pottery surface textures, in ceramic studies RTI has hitherto served to clarify the techniques used in forming vessels (de Souza, Trognitz 2021; Gunnarsstone et al. 2021) and applying relief decoration (Artal-Isbrand et al. 2011), as well as permitting the decipherment of inscriptions on makers’ stamps (Lech et al. 2021). The present study extends the application of RTI to the analysis of impressed decoration, in this case specifically wound cord impressions.

The sets of photographs needed for compiling the RTI images were obtained using the highlight image-capture technique (Cultural Heritage Imaging 2010), with a Panasonic Lumix DMC-FZ1000 (20 megapixel) digital camera and a small flashlight. The reflecting sphere for recording light directions was a 2mm diameter ball bearing pasted onto 2mm squared paper to provide the scale. A set of 37 to 62 (generally c. 40) photographs with different lighting directions was used to create each RTI image. The data were processed with the free program RTIBuilder (v. 2.0.2, HSH fitter) for viewing in RTIViewer (v. 1.1.0).

The attributes of the wound cord impressions, as recorded microscopically, can be divided into three groups: (1) attributes characterizing the cordage; (2) attributes relating to the construction of the stamp; and (3) attributes relating to the application technique. The different sets of attributes are each considered in turn in the following subsections. Some of the attributes defined below have been adopted from previous studies on wound cord and other kinds of cord impressions in ceramics (as indicated by the references), while the rest were developed in the initial examination of the decoration in the frame of this study.
All linear measurements were made on the RTI images (or on macrophotographs in cases where RTI images were not prepared).

**Attributes characterizing the cordage**

The study was limited to stamp impressions that show unequivocally identifiable imprints of twisted thread, thus excluding unclear impressions and potential examples of the use of unspun fibre, a strip of leather or other kinds of winding material. The following attributes serve to characterize the cordage used for the stamps.

- **Fibre characteristics.** In cases where individual fibres are visible, they may be descriptively characterized in terms of coarseness and stiffness (Semenov 1955; Østmo 2008; Grömer, Kern 2010; Dubovtseva 2016).

- **Spin direction.** Likewise recorded in those cases where individual fibres are visible (e.g., Fig. 4) is the spin direction of the yarns making up the cord (S or Z). The spin direction can generally be assumed to be the opposite from the twist direction (see below), but has been separately recorded where observable. The true spin direction is documented, remembering that the spin direction as seen in the impressions is a reversed image.

- **Twist direction of the cord (S or Z).** Again, the impression will show a reverse image of the twist direction, but the true twist direction has been documented.

- **Twist angle (Fig. 3).** This describes the intensity of twist, as defined by Emery (1966.11), where a loose yarn has a twist angle of 10 degrees, a medium yarn is defined by values between 10 and 15 degrees, and a tight yarn has a 25- to 40-degree twist angle (Grömer, Kern 2010). The twist angle was measured using a screen protractor overlaid on an RTI image of the imprint (or an unprocessed macrophoto of the imprint in those cases where an RTI image was not created). Where possible, the angle was measured from multiple windings. Since there is an element of subjectivity in the recording of twist angle, making high precision unrealistic, for the purpose of further analysis the measurements were rounded to the nearest 10 degrees.

- **Width of cord impression (to 0.1mm) (Fig. 3): this feature defines the measurable width of the impression of the cord, as seen on the sherd. The width of the impression was measured for up to five windings on an impression, recording the minimum and maximum width.

- **Cord diameter (to 0.1mm) (Fig. 3).** The width of a cord impression will correspond to the true diameter of the cord if the depth of the impression is at least 50% of the cord diameter (Grömer, Kern 2010). This will definitely be the case for those wound cord imprints that also display marks from the support between the cord windings, since this shows that the cord has been completely impressed into the clay. Accordingly, in cases where marks of the support can be seen between the cord windings the maximum width of the cord impressions is taken to equal the true diameter of the cord. In the absence of a mark from the support, the verticality of the sides of the imprint was used to assess whether it is impressed to at least 50% of its diameter and can be regarded as indicating the cord diameter.

**Attributes relating to stamp construction (cord + support)**

- **Overall length of stamp impression (Fig. 3).** This is the distance between the outer margins of the terminal windings of the stamp (to 0.1mm).

- **Maximum width of the overall stamp impression (Fig. 3), equal to the length of the longest winding impression (to 0.1mm).**

- **Is the overall axis of the stamp straight or curved, and is there variation between stamps in the degree of curvature?** This can help to characterize the material of the support. Thus, if the curvature of the overall stamp axis varies, then this will indicate the use of some kind of flexible support.

- **Number of windings.**

- **Distance between windings (to 0.1mm).** The true spacing of the windings of the stamp can be measured only in cases where an imprint from the support appears between the windings. Multiple measurements were taken where possible.

- **Orientation of windings in relation to the long axis of stamp (degrees).** This is the positive (anti-clockwise) angle between the long axis of the stamp imprint (taken as the initial side of the angle) and the long axis of the imprint of the winding, as measured...
from the RTI image using a screen protractor. Whenever possible, the orientation was recorded for multiple windings of a stamp imprint. As in the case of twist angle, there is an element of subjectivity, and accordingly for further analysis the measurements were rounded to the nearest 10 degrees.

- Number of twists visible across the winding impressions. This can help indicate the width of the support.

- Do the terminal windings of the stamp show any distinctive characteristics, compared with the middle windings? This may give an indication of the method of winding.

- Form of the impressions of individual windings across the width of the stamp, such as rounded, which may indicate a cylindrical support, flattened, which may indicate a support with a flat face, or angular (V-shaped), which may indicate a support with a sharp edge (see Leghissa 2015; 2021).

- Description of marks left by the support, between the windings and/or at the ends of the stamp, with attention to features that can help indicate the form and material of the support (Østmo 2008.114–116; Vital et al. 2012.94–97; Leghissa 2015; 2021; Dubov'tseva 2016).

Attributes relating to application technique

- Orientation of the stamp impressions in relation to the vessel body (vertical/oblique/horizontal, etc.), where this can be identified.

- Maximum depth of impression (to 0.5 mm). The depth of the deepest winding impression. Only an approximate measurement, since this attribute is very difficult to determine objectively.

- Description of any noticeable variation in the depth between the ends of the stamp impressions (‘pitch’ in terms of ship motion) or between the sides of impressions (‘roll’ in terms of ship motion) (see also Vital et al. 2012.99).

- Is the wound cord stamp also used in other ways, for instance to texture the surface or provide other kinds of decoration (e.g., scraping by dragging across the surface, rouletting, making impressions with the end of the stamp)?

Results and interpretation

The most important attributes for the set of sample sherds, characterizing the cordage and stamp construction, are given in Table 2 (see below). The full dataset can be freely accessed on the Zenodo repository (https://doi.org/10.5281/zenodo.8129223), together with the corresponding set of RTI images and an instruction for viewing them. The actual RTI images offer a greatly enhanced visual representation of the impressions, compared with the ‘snapshots’ of them presented in Figures 4 and 7 of this article.

Cordage production

In the material under study, imprints of individual fibres could be discerned only in a small number of cases (Fig. 4). The fibres appear rather coarse and stiff – characteristics that, in accordance with observations from experimental studies by Semenov (1955), Østmo (2008.116) and Karina Grömer and Daniela Kern (2010), point to the use of fairly coarse plant fibre. Given the widespread use of bast in the region, in both twisted and untwisted form, as indicated by finds from the Šventoji and Särnate wetland sites of this same period (Rimantienė 2005; Bērziņš 2008. Ch. 6), it appears likely that this material, obtainable in the greatest quantities from the lime tree (Tilia cordata), would also have been used for the cordage of the stamps, although this cannot be verified. Fragments of net mesh from Šventoji, consisting of cordage with a comparable diameter to that attested here, have been identified as lime bast (Rimantienė 2005.65, Fig. 32,174–176).

The twist direction was clear for almost all of the samples, and all except one cord (RK-012) are S-twisted (Tab. 2). In the few instances where the individual fibres are visible (Fig. 4), they are Z-spun – which is only to be expected, since spinning in one direction
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(1995), cordage spin and twist direction may potentially relate to the natural predisposition of fibres to twist in one or other direction, to the specific method of cordage production and minor variations in this method as well as to belief systems concerning rotation directions. The picture may also be complicated by right-/left-handedness and idiosyncratic variation. Jill C. Minar (2001) and, following her, Herrero-Otal et al. (2023), see cultural preference (rather than fibre characteristics, production method or handedness) as the determining factor in spin/twist direction. Observing the total absence of Z-twisting among the samples of cordage decorating the Battle Axe Culture pottery of Sweden, Larsson concludes that the making of cords within this culture was “a tightly controlled practice where no exceptions were allowed”; this strong cultural preference is contrasted with the Funnel Beaker community, in which “some cord makers twisted the fibres clockwise, while others twisted them counter-clockwise” (Larsson 2009.244).

Specifically with regard to lime bast, it may be noted that the fibre strands naturally tend to spiral in the Z direction as they dry out. If indeed lime bast was widely employed for the cord of these stamps (which seems likely for this period in the East Baltic region, though it cannot be verified), this pre-rotated condition of the raw material could have promoted a general tendency towards the practice of Z-spinning and S-twisting.

The measured twist angles fall in the range 20 to 60 degrees, most commonly 40 degrees, i.e. tightly twisted according to Emery’s classification (Fig. 4, top). There do appear to be some differences between sites. Thus, some of the cordage used at Nainiekste shows relatively loose twisting, with three recorded instances of 20-degree twist angles, whereas there is no indication of such loose twisting at the other sites. On the other hand, some of the cord represented in the Rišuuki material is extremely tightly twisted, with two cases of 60-degree twist angles.

For comparison, the results of Grömer and Kern’s (2010) analysis of cords impressed in Corded Ware may again be cited: they mostly recorded twist angles of 40 to 50 degrees (exceptionally 20 or 30 degrees), which accords quite well with the results of the pres-
ent study. Šatavičė’s (2020) examination of Lithuanian Corded Ware recorded twist angles varying from 20 to 50 degrees.

The author’s own experience with simple methods of cord production indicates that the finger- and thigh-rolling methods widely attested in ethnographic accounts give a much looser twist (Fig. 6.2, top). Tightly twisted cordage of the kind observed in this study and the others cited above can be made from lime bast strands using the finger-twisting method (Fig. 6.2, bottom). In this method, while holding the two strands together between the index finger and thumb of the left hand, the strand furthest from the person’s body is taken up with the right hand, spun in the Z-direction and then laid across the other strand, thus twisting them together in the S-direction, after which the process is repeated with the other strand, producing in this way a length of Z-spun and S-twisted cord. The spin and twist directions can be reversed to obtain S-spun and Z-twisted cord (this will likewise be the case if precisely the same process is carried out by a left-handed individual). Tight twisting is not necessarily indicative of this particular cord-making method, however, since the use of simple tools permits the manufacture of cordage in various other ways (see, e.g., Herrero-Otal et al. 2023; Hurcombe 2008.Pl. 1).

The cord diameter, which could be ascertained for 31 stamps (Fig. 5, bottom), varies in the range of 1.1 to 2.4mm (mean: 1.80mm), the thickest cords being recorded for stamps from Munči.

As noted above, actual cordage from this period is preserved in the collection of finds from the Sārnate site, a wetland settlement near the coast of western Latvia. Among many other organic finds, this collection, held at the National History Museum of Latvia, includes a peat block with a fragment of fishing net mesh (Fig. 6.1,3), recovered from dwelling ADR in 1954 in the course of the excavation directed by Lucija Vankina (1970.94; Bērziņš 2008.238–239 5). Like the cordage used for the pottery stamps, the cord of the net mesh has been Z-spun and S-twisted from two strands, and the diameter, too, is comparable: approximately 1 to 1.5mm. The raw material has not been positively identified, but the general appearance indicates vegetable fibre, most probably tree bast (and bast, in the form of simple, untwisted strands, has been widely used on this site for tying net floats and sinkers; see Bērziņš 2008.Ch. 6).

This find shows that cord of comparable diameter and the same spin and twist direction (and quite possibly from the

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Fig. 5. Top: Graph of cordage twist angle. Bottom: Graph of cord diameter versus distance separating cord windings for the 31 stamps where these parameters could be measured. Distance between windings given as an interval, from narrowest to widest measurable distance between the windings of one stamp (illustration by V. Bērziņš).

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5 The incorrect twist direction is given in the cited work.
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Just a little slanting – at an angle of c. 100 degrees (i.e. ‘leaning to the left’). Such a pattern might be seen as consistent with the practice of holding the support with the left hand and winding the cord around it away from the body (first over and then back under the support), which would seem, from personal experience, to be the most comfortable and efficient technique for a right-handed person.

Twenty-one of the samples show at least some imprints from the support, permitting the distinction of different kinds of support. The length of the longest winding imprint is also relevant here, as the length of cord impressed into the clay from each winding evidently relates to the width and form of the support. The rounded support imprint of the support (Fig. 7.1, 4, 6) takes the form of a straight, narrow trough (varying in width from 1.4 to 2.9mm but most commonly c. 2mm wide) visible in the spaces between the windings, extending a little beyond the outer windings and terminating abruptly, generally cut of approximately at right angles to the long axis of the support. The maximum length of the winding imprint on these stamps varies from 4.0 to 5.5mm. Since, as described above, the windings are generally oriented approximately perpendicularly to the axis of the support, even when widely spaced, the cord cannot have been wound onto a stick or some other kind of cylindrical rod, as if the windings are widely spaced with this kind of support they will be obliquely oriented – a distinguishing characteristic highlighted in Leghissa’s (2015; 2021) experiments with replication of wound cord decoration. Instead, the support must have

same raw material) was being used for pottery-decorating stamps in this region during the 4th millennium BC as was used for making fishing nets. The wider implications are briefly discussed in the closing section of the article.

Stamp construction

The stamp impressions vary in length from 6mm to at least 35mm, the longest being represented by incomplete impressions, and they have between three and at least 13 windings. The shortest stamps are from Rūnukalns, but this site also has a much larger proportion of long stamps for which there are no complete impressions. Moreover, many of the decorative patterns in the Rūnukalns material involve the placement of wound cord impressions end to end, making it hard to identify where one stamp impression ends and the next begins.

The winding imprints display between one and three twists of the cord. The recorded width of the spaces between windings (which could be measured for 31 stamps) ranges overall from zero to 3.9mm (Fig. 5, bottom). The widest space between windings occurs in an imprint from Rūnukalns; more generally, however, it is the stamps from Muncī that have relatively widely spaced windings, compared to the other sites. These same Muncī stamps also tend to utilize thicker cordage and consequently are more ‘robust’ in overall appearance.

The imprints of the cord windings are most commonly oriented approximately at right angles to the long axis of the stamp, with the exception of the Muncī site, where the winding imprints are more commonly just a little slanting – at an angle of c. 100 degrees (i.e. ‘leaning to the left’). Such a pattern might be seen as consistent with the practice of holding the support with the left hand and winding the cord around it away from the body (first over and then back under the support), which would seem, from personal experience, to be the most comfortable and efficient technique for a right-handed person.

Twenty-one of the samples show at least some imprints from the support, permitting the distinction of different kinds of support. The length of the longest winding imprint is also relevant here, as the length of cord impressed into the clay from each winding evidently relates to the width and form of the support.

The round-edged support

The imprint of the support (Fig. 7.1, 4, 6) takes the form of a straight, narrow trough (varying in width from 1.4 to 2.9mm but most commonly c. 2mm wide) visible in the spaces between the windings, extending a little beyond the outer windings and terminating abruptly, generally cut of approximately at right angles to the long axis of the support. The maximum length of the winding imprint on these stamps varies from 4.0 to 5.5mm. Since, as described above, the windings are generally oriented approximately perpendicular to the axis of the support, even when widely spaced, the cord cannot have been wound onto a stick or some other kind of cylindrical rod, as if the windings are widely spaced with this kind of support they will be obliquely oriented – a distinguishing characteristic highlighted in Leghissa’s (2015; 2021) experiments with replication of wound cord decoration. Instead, the support must have

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Fig. 6. 1,3 Net mesh fragment from Sārnate, Dwelling ADR (National History Museum of Latvia, A 11418:120m); 2 experimental cordage, Z-spun and S-twisted from two strands of bast: finger-rolled, showing very loose twist (top), and finger-twisted, showing moderately tight twist (bottom); 4 experimental wound cord stamp with mussel shell as support; 5 impression made with the tool (photos by V. Bērziņš).
been a relatively wide flat plate, one margin of which has been impressed into the clay. The form of the support is most clearly seen from sample MU-011: in this case, the impressions exhibit pronounced ‘roll’, where one side of the stamp has been more deeply impressed than the other, thus also imprinting part of one of the flat faces of the support. The morphology of the impressions from this group of stamps does not provide a clear indication of the object used for the support, but the similarity between the support imprints of several stamps rather suggests that we might be dealing here with a specific anatomical form (e.g., a specific bone from a particular animal species) that was traditionally employed for this purpose. In the case of MU-011, some longitudinal striae are faintly observable on the imprint of the support.

An imprint from this kind of support is observable in the case of stamps MU-001, MU-002, MU-004, MU-008, MU-011 and MU-012 from Muncī and DV-002 from the nearby site of Dviete. In the case of MU-002, MU-004, MU-009, MU-011 and MU-012 the stamp impression is relatively short: three to five windings, with a total length of 10 to 14mm. MU-007 is similar, only in this case the ends of the imprint of the support are rounded (Fig. 7.1). MU-001 and DV-002 are longer than the rest: DV-002 has seven windings and a total length of 19mm, while MU-001, represented only by partial impressions, has at least nine windings, the total length exceeding 20mm. These longer stamp impressions display fairly pronounced ‘pitch’ – one end of the stamp has been impressed more deeply into the clay than the other.

**The sharp-edged support**

In these cases (Fig. 7.3, 5, 8) the imprint of the support occurs in the form of a longitudinal groove, appearing in the spaces between windings and sometimes seen to terminate a little beyond the outer windings. The impressions of the windings themselves are somewhat angular (V-shaped). These features indicate that the support must have been some kind of sharp-edged object. Compared with the stamp impressions showing a round-edged support, the winding imprints are shorter: the maximum length varies from 2.7 to 4.9mm.

![Fig. 7. RTI images of impressions of selected wound cord stamps illustrating the imprints from various kinds of supports, with interpretation of the different elements of the impression: green for the windings and orange for the support. 1, 4, 6 round-edged support (Muncī: MU-007, MU-004, MU-008); 2 support in the form of a plaited (?) object (Muncī: MU-013); 3 sharp-edged support, short stamp (Rīņukalns: RK-016); 5, 8 sharp-edged support, long stamp (Rīņukalns: RK-006, RK-015); 7 impression terminating in short imprint of cord (?) (Nainiekste, NN-005) (photos by V. Bērziņš).](image-url)
Wound cord decoration with imprints of support has been found only on pottery from the Rīņukalns site. RK-001, RK-012, RK-013, RK-014, and RK-016 have been impressed with short stamps of this kind, 6 to 10mm long and with three to four windings. The last two have a markedly curved groove. RK-002 is 10mm long with eight windings, while RK-006, RK-008, RK-009 and RK-015 show fragmentary impressions from longer stamps. RK-006 and RK-015 differ in that their windings are more widely spaced.

Experiments to replicate wound cord impressions with imprints of the support in the form of a groove of V-shaped cross-section have been undertaken by Vital et al. (2012.94–96), seeking to characterize the stamps used on Early Bronze Age pottery in southeastern France, and by Leghissa (2015; 2021), focusing on Late Bronze Age ceramics from Slovenia. They consider that short flint blades provided the sharp-edged supports used for this purpose, while Leghissa reports successful replication using sharp-edged flat plates of wood and bone.

Freshwater mussels constituted a significant food source at Rīņukalns in this period (as attested by the midden deposit at this site), and the shells were very widely used as pottery temper in the region (Spataro et al. 2021), so the outer margin of a mussel shell may seem a logical choice as the support for a wound cord stamp producing a longitudinal groove. An experimental tool fashioned from the shell of a large freshwater mussel (Unio sp.), filed down to leave a 12mm long section of the margin and wound with cord (Fig. 6.4), did indeed produce an imprint closely resembling the examples in the pottery assemblage from Rīņukalns (Fig. 6.5).

The stamp impression terminating in a shorter imprint of cord (?)

This form of stamp has been distinguished only on three sample sherds in the Nainiekste material (Fig. 7.7). The impressions are relatively long: 14mm with seven windings (NN-001), 16mm with eight windings (NN-002) and at least 17mm with at least eight windings (NN-005). The impressions of the windings are of comparable length to those of the stamps with a round-edged support (max. length: 3.8mm; 3.8mm; 5.4mm), whereas the only evidence of a support is a shallow, wide, rounded depression seen in the spaces between the windings on the latter two samples. At least one end of each stamp impression terminates in what appears to be a shorter impression of the cord, resembling a narrow winding of which only a single twist is visible. In the case of NN-005, this terminal feature of the stamp also has some faintly visible texture – apparently fibers of mixed orientation. This feature might be interpreted as relating to a particular kind of cord whipping technique, but definitive interpretation is currently not possible.

Sample MU-013 (Fig. 7.2), from Munči, displays a fairly clear imprint of a support differing markedly from the others. Appearing at one end of the stamp as well as between the windings, it is difficult to interpret but may consist of some kind of plaited object, possibly knotted at the end.

Application technique

The wound cord impressions on the vessel exteriors have been placed vertically or obliquely, and form horizontal and oblique rows of impressions that can often be seen to constitute parts of more complex designs (Fig. 2). In four cases, rows of wound cord are also found on the inside near the rim, and in six cases on the flat lip. The impressions are shallow: generally 1 to 2mm, exceptionally reaching a depth of 3mm. In some cases the stamp has been more deeply impressed at one end (‘pitch’) or more deeply on one side than the other (‘roll’), but these characteristics are not widely represented in the set of samples.

A stamp consisting of cord wound onto a cylindrical support can be used not only for impressing but also as a roulette stamp, rolled across the pottery surface to create distinctive patterns. This technique is widely attested in the Jomon pottery of Japan and in North America (Hurley 1979). Of course, wound cord stamps with a support in the form of a flat object, as identified in this study, have no potential for use in this manner. Significantly, wound cord stamps with a cylindrical support did come into use in eastern Latvia at the close of the Neolithic, and were indeed widely employed for rouletting, as revealed in the study by Dumpe (2003). The change in the form of support thus very significantly influences its potential modes of application and the spectrum of pottery decorating techniques.

It may be noted that the investigated samples from Latvia do not indicate the use of the kinds of special decorating techniques using wound cord stamps (‘stepping’, ‘pricking-incising’) that Dubovtseva (2016) has identified in the Neolithic material of Western Siberia.
The only other use of a wound cord stamp attested in the set of material investigated here is the possible utilization of the four-winding stamp of sample MU-007 for scraping the interior of the vessel, so as to create a regular striated pattern. Sets of four striae on the inside of the vessel have the same combined width (12mm) as the width of the wound section of the stamp. The correspondence is not, however, clear enough to confirm that this was the tool used. Two other sample sherds also show pronounced striation of the surface, but in these cases comparison of the wound cord impressions with the striations indicates that the wound cord stamp was not used for creating the striated finish. Whether various kinds of wound cord stamps can also double as effective tools for producing a striated finish on pottery is a question that would seem to merit experimental work in future studies.

**Discussion and conclusions**

Before considering the specific results of this study and their implications, it is worth noting that RTI did indeed prove a most valuable aid. This imaging technique, complementing examination of the pottery decoration under the stereomicroscope, provided a rapid, straightforward and inexpensive way to document the impressions, with a sufficient level of detail. The manipulation of lighting direction to reveal different details plays a very important role in the examination of relief decoration on pottery, and RTI provides an effective means of replicating this in a virtual environment. Maximally exploiting this possibility, the collection of RTI models was extensively utilized for taking measurements and, most importantly, for comparison among samples.

Given its potential and accessibility, RTI merits wider application as a tool for analysing decoration and perhaps deserves to become a standard component in the toolkit for analysing and documenting pottery surface features. It should be noted, however, that RTI does not offer a true 3D picture. Accordingly, certain kinds of important observations, for example, regarding the cross-sectional shape of various elements of the impressions, need to be made under the stereomicroscope, since the RTI models will not provide this information.

The comprehensive study of the set of 37 samples of wound cord decoration from four sites has given a new understanding of how this concept of decorating pottery was implemented in practice in this particular territory in the late 4th and early 3rd millennium BC. It appears that plant fibre (bast?) was widely used, almost always twisted in the S-direction from two Z-spun strands into a cord of c. 1 to 2.5mm diameter, using some method (such as finger-twisting) by which the strands could be tightly twisted. The stamps were fashioned so as to produce an impression from 6mm to at least 35mm in length, with three to at least 13 windings of cord. Rather than being wound on a stick or other cylindrical object, in this region and period the cord was generally wound on a support consisting of a flat plate with a rounded edge (at Munči and Dviete) or with a sharp edge (in the case of Rīnķukalns), while some other kind of support, not clearly identified, was used at Nainiekste.

Thus, while maintaining the essential concept of a stamp consisting of cord wound on a rigid support, there is marked variation even across this relatively small area, in terms of cord diameter, stamp impression length, number of windings and, most importantly perhaps, the kind of support employed. The differences between the sites in the form of the support indicate that we are seeing local-level technical solutions for implementing a general idea shared across a vast region. It may be noted that the detailed study by Vital et al. (2012.107–109) on Early Bronze Age pottery in south-eastern France likewise demonstrates considerable technical variation within that region in terms of the execution of this kind of impressed ornamentation, involving the use of different kinds of support. Both of these cases imply a strong element of vertical (generation-to-generation) transmission of the technical knowledge of pottery stamp production, as opposed to widespread sharing of methods between groups, which could be expected to give greater regional uniformity.

This can be related to the social context of pottery production and use, which determines the visibility of particular technical traits. Essentially, the patterns impressed on a vessel can be observed by anyone handling it or viewing it close up, and on the basis of such observations a stamp may be made that produces similar decoration. On the other hand, knowledge of the actual form of stamp that has been used for decorating a vessel and the method of making it was a part of the pottery-making tradition that stayed ‘behind the scenes’ and was not automatically accessible to those outside the tradition.
Thus, lack of knowledge about the stamping tools used to achieve particular kinds of imprints is not only the archaeologist’s problem. It is a situation that would have confronted contemporaries when faced with decorated vessels made in a ceramic tradition they did not belong to. Illustrative of such situations are Olivier Gosselain’s et al. (2010) accounts of contemporary African potters’ reactions to decorative treatments unfamiliar to them, where they were inclined to reinterpret the unknown technical practice in terms of the materials and techniques that they were accustomed to applying in their own pottery traditions.

It is the sharing of stamp-making methods (rather than the creation of superficially similar impressions) that indicates close cultural ties, while the use of different methods points to the existence of boundaries between traditions. Hence, if the distinction and classification of different kinds of wound cord stamps could be performed systematically on a wider spatiotemporal scale, the data thus obtained might be applied in tracing cultural traditions and characterizing sociocultural relationships between groups. The limited conclusion from the analysis of the Latvian material, in light of this argumentation, is that specific communities tended to retain their own technical practices of stamp-making for wound cord decoration, which were practiced in contexts not readily accessible to outsiders and were not widely shared across the region.

Setting local variation aside, we may now return to the question of the cultural significance of this Europe-wide phenomenon, represented in various regions during a total period of at least three millennia, of ornamenting pottery with impressions of cord wound on a support. It is a concept of pottery decoration spanning very different ceramic traditions, and moreover shared between pottery-makers belonging to farming communities in Central Europe and their contemporaries in northern and eastern parts of Europe living mainly or exclusively from wild resources. The fact that they could all relate to this concept in spite of the significant differences in lifeways can most probably be explained in terms of the importance of cordage for all of these societies. There is no doubt that cord served a wide variety of needs in agricultural and fishing/hunting communities alike.

It may be noted in this connection that the creation of a pottery stamp by winding an object with cord, or whipping, is closely related to the binding of tools tightly to their handles with multiple windings of cord. Among the scatter of Stone Age finds of implements secured in their hafts by means of whipping, there are a couple of such pieces from the Eastern Baltic region, namely an eel leister and a wooden axe/adze sleeve from Šventoji (Rimantienė 2005; Figs. 125.10, 186.5–6). Thus, in preparing this kind of instrument for stamping their pottery, people would have been applying technical skills they commonly employed in hafting various tools and weapons, and this may have been a factor promoting the rapid and wide spread of the practice.

While the everyday need for cordage is essentially universal, there is a domain of prehistoric subsistence technology that required cord in particularly large amounts. This is, of course, the use of nets in fishing. Communities that engaged in net fishing had a need to process fibres into cordage on a large scale, meaning that the activity would have held a major place in these people’s lives, demanding a considerable investment of material, labour and time. This also applies to the communities inhabiting the coastal areas and lakeshores of the Eastern Baltic region during the period in question: the importance of fisheries for subsistence is indicated by stable isotope studies of human skeletons (Meadous et al. 2018; Simčenka et al. 2022), and indeed nets were an important part of the fishing toolkit (Rimantienė 2005; Bėrziūs 2008).

As noted above, the cord employed for the pottery stamps was of the same kind as that utilized for fishing nets, so that the use of such stamps on pottery created a close technological and presumably also perceptual/semantic link between fishing and the production and use of pottery. More probably, in fact, the decoration of pottery with stamps of cord simply reinforced a pre-existing link between these two spheres of life, since lipid analysis of residues on pottery indicates that cooking fish was one of the main functions of pottery vessels of the 6th to 4th millennium BC in the region (Spataro et al. 2021). Cordage production for fishing nets and the practices of catching fish, pottery-making and pottery use for boiling fish all constituted elements in a technological web of everyday tasks. Consequently, at least in this region, wound cord decoration on pottery can be readily understood as a reflection of these connections.

The proposed link to net fishing does not, in itself, indicate why wound cord decoration came into use in...
this particular period and spread across such a vast region, including farming communities. After all, fishing nets were already known in Northern Europe a long time before ceramics came into use (Berihuete-Azorín et al. 2023), but wound cord does not feature in the decorative repertoire of the earliest pottery. Accordingly, the widespread adoption of wound cord decoration, especially in the 4th millennium, might be taken as an indication that cordage and articles made from cord had obtained a heightened significance in this particular period. Presumably, the subsequent rise of ‘classic’ cord decoration, as seen on Corded Ware – likewise across a wide swathe of Europe – relates to the same phenomenon. Taken together, these pottery ornamenting techniques imply a particular cultural focus on cordage during the later part of the Neolithic and the Early Bronze Age, spilling over, as it were, into the medium of ceramics.

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Normunds Grasis provided all possible assistance for studies of the pottery at the National History Museum of Latvia. I am also most grateful to my colleague Vanda Haferberga for introducing RTI as a method of recording pottery surface features. The RTI images were created and viewed using software made freely available by Cultural Heritage Imaging (https://culturalheritageimaging.org).

The late Anne Reichert, experimental archaeologist from south Germany, showed me how to make cord by the finger-twisting method. Her painstaking work in the replication of ancient fibre articles has been an inspiration.

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A closer look at wound cord: technical analysis of Neolithic pottery decoration from Latvia

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<td>Dviete (DV)</td>
<td>Eduards Šturms, 1938 (surface collection of redeposited artefacts)</td>
<td>Šturms 1938; Zagorski 1967</td>
<td>Mixed assemblage dominated by shell- and organic-tempered pottery with direct rim and inward-sloping flat lip. Impressed decoration includes pits, bars, narrow comb, textile impressions and cord. Admixture of rock-tempered Comb Ware.</td>
<td>Studied sherds typologically dated to late Middle Neolithic.</td>
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<td>Zagorski 1967</td>
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<td>Studied sherds typologically dated to late Middle Neolithic.</td>
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<td>Loze 1988</td>
<td>Organic- and shell-tempered, round-based pots with direct rim and flat lip. Impressed decoration includes pits, bars, comb, wound cord, circles, arcuate impressions. Also includes some rock-tempered Comb Ware.</td>
<td>14C date: area A, peat sample at depth 40–50 cm, lithological layer 4: 3262–2347 calBC (LE-648, 4170±130; 95.4% prob.; OxCal v4.4.4 Bronk Ramsey (2021); atmospheric data from Reimer et al. (2020)) (Loze 1988. 99). Studied sherds typologically dated to late Middle Neolithic.</td>
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<td>Carl Georg Sievers, 1874–1875, 1877; several other excavations in late 19th, early 20th cent.; Ilga Zagorska, 2011; Valdis Bērziņš, 2017–2018</td>
<td>Bērziņš et al. 2014; Brinker et al. 2020; Spataro et al. 2021</td>
<td>Studied samples derive from midden deposit: shell-tempered, pointed-based pots with direct rims, most commonly with inward-sloping flat lip. Impressed decoration includes pits, wound cord, bars, grooves, porpoise tooth, narrow comb. Also incised lines.</td>
<td>Several 14C dates for midden deposit: late 4th millennium BC (late Middle Neolithic).</td>
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Tab. 2. Most important attributes of the sample set of sherds with wound cord impressions (for full table of observations and RTI images see dataset on Zenodo repository: [https://doi.org/10.5281/zenodo.8129223](https://doi.org/10.5281/zenodo.8129223)).

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<th>Overall length of stamp impression (mm)</th>
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<td>Overall length of stamp impression (mm)</td>
<td>Overall width of stamp impression (mm)</td>
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<td>Distance between windings where support visible between windings, giving true spacing of windings</td>
<td>Orientation of windings in relation to long axis of stamp impression</td>
<td>Twist angle</td>
<td>Cord twist direction (S/Z) (true, not reversed direction)</td>
<td>Yarn spin direction (s/z) (true, not reversed direction)</td>
<td>Ceramic technology sample no.</td>
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<td>Identified form of support in relationship to long axis of stamp impression</td>
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<td>Accession no.</td>
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<td>Cord twist direction (S/Z) (true, not reversed direction)</td>
<td>Twist angle</td>
<td>Cord diameter</td>
<td>Overall length of stamp impression (mm)</td>
<td>Overall width of stamp impression (mm)</td>
<td>No. of windings</td>
<td>Distance between windings where support visible between windings, giving true spacing of windings</td>
<td>Orientation of windings in relation to long axis of stamp</td>
<td>Identified form of support</td>
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<td>&gt;13.0</td>
<td>3.7</td>
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*Tab. 2 continued*