Old spindle whorls – new yarn. The functionality of different types of whorls in practical use based on a case study of Feddersen Wierde, Cuxhaven District

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Zusammenfassung

Alte Spinnwirtel – neue Garne. Die Funktionsweise verschiedener Spinnwirteltypen im praktischen Gebrauch am Beispiel der Feddersen Wierde, Lkr. Cuxhaven

Über die Faktoren, die für die Funktionalität eines Spinnwirtels ausschlaggebend sind, wird in der Textilforschung noch immer debattiert. So soll etwa eine regelmäßige Form oder eine zentral verlaufende Lochung als Kriterium für die Definition eines Wirtels gelten. In der Praxis stellen diese Punkte jedoch keine Hindernisse dar: Das Spinnen eines Fadens in konstanter Dicke mit einem dezentral gelochten, ungleichmäßig zugerichteten Scherbenrondell ist genauso möglich wie die Fadenproduktion mit einer rotierenden Kartoffel. Daneben wird das Gewicht oftmals als ausschlaggebender Punkt für die Garnstärke angesehen. Dem gegenüber stehen Versuchsreihen, die zeigen, dass sowohl leichte als auch schwere Wirtel die Produktion eines breiten Spektrums an Garnstärken ermöglichen. Um zu klären, inwiefern das Gewicht oder die äußere Form eines Spinnwirtels mit dessen Rotationsdauer und den sich daraus ergebenen funktionalen Eigenschaften in Zusammenhang stehen, wurden die Spinnwirtel der Wurtensiedlung Feddersen Wierde, Lkr. Cuxhaven, unter festgelegten Parametern in einer Versuchsreihe angesponnen. Die Ergebnisse lassen auf einen Zusammenhang zwischen Wirteltypen und Spinntechniken schließen.

Schlagwörter Spinnwirtel, Handspindel, Garnproduktion, Spinntechniken, Rotationseigenschaften

Summary

The factors that determine the functionality of a spindle whorl are still being debated in textile research. For example, a regular shape or a perforation running through the centre of a whorl are criteria often put forward for its definition. In practice, however, these aspects are not obligatory for a whorl's function. It is just as possible to spin a thread of constant thickness with a decentrally perforated, unevenly worked shard or even a rotating potato. In addition to the contradictions in object definition, weight is often cited as the determining factor for thread thickness. In contrast, test series show that entirely different whorls of greatly varying weight allow the production of a wide range of yarn diameters. To clarify the extent to which the weight or the shape of a spindle whorl relates to its rotation time and the resulting functional properties, spindle whorls from the Roman Iron Age terp village of Feddersen Wierde, Cuxhaven District, were used in a series of tests under defined parameters. The results suggest a strong functional correlation between whorl types and spinning techniques.

Keywords Spindle whorls, hand spindle, yarn production, spinning techniques, rotation properties

Introduction – the definition of a spindle whorl

»If I devote a special section of my text to spindle-whorls I do so with apologies […]. I suppose that it was Schliemann who first brought the spindle-whorl into prominence – a venial error in his case, but today there is no excuse for wasting space and money on this monotonous and profitless material« (Woolley 1955, 271).

Even though almost 70 years have passed since these lines were written, the quote well reflects the attitude towards a type of find that probably has remained in use for the past 12 000 years (Yashuv/Grosman 2024). Basically, spindle whorls represent a group of objects that are insufficiently mentioned in the literature and do not receive as much research attention as other finds.

In textile research, there is constant debate as to which objects can be considered spindle whorls. Numerous authors[1] argue that the function of a spindle whorl depends strongly on the location of its perforation, claiming that it must run as close and straight as possible along the object's median; this is seen as a criterion for the definition of an object as a whorl. It is argued that the imbalance caused by a perforation that is not located centrally would lead to uneven thread production and thus disqualify such objects as whorls. However, these claims could not be confirmed in practice. On the one hand, rotational imbalances can be compensated with

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[1] E.g. Crewe 1998, 13–14; Barber 1991, 54; Barber 1994, 38; Grömer 2004, 179; Völling 2008b, 110; Carington Smith 1992, 674.

Fig. 1a–b a Spinning with a potato in a self-experiment. The tuber can be used as a whorl without any problems. b A uniform thread is produced.

Abb. 1a–b *a Spinnen mit einer Kartoffel im Selbstversuch. Die Knolle kann ohne Probleme als Wirtel verwendet werden. b Es wird dabei ein gleichmäßiger Faden hergestellt.*

the spindle stick, and on the other hand, they do not necessarily result in uneven yarn production. On the contrary, an object perforated aside from its median that has an outwardly oriented mass distribution can still be spun without any problems using the drop spindle technique.

In addition, some authors have claimed that having a perforation of less than 4 mm in diameter (Carington Smith 1992, 675) or a biconical, i.e. hourglass shape (Liu 1978, 97) would disqualify such objects from being used as whorls. In contrast, a conical perforation is seen as an indicator for an object's use as a spindle whorl (Höllhuber 1981, 82; 88–90).

As mass roughly correlates with size, objects whose dimensions are too small would be disqualified as whorls according to some authors[2]. However, experimental studies show that it is quite possible to spin with rather light objects, even those weighing less than 10 g (Mårtensson et al. 2006a; Mårtensson et al. 2006b). In addition, so-called ›bead whorls‹, still attached to the spindle sticks wrapped in spun yarn, have survived from Peru in weaving baskets (Liu 1978, 90 Fig. 2; 96; 98 Fig. 27–28). E. Völling (2008b, 111) argues that in addition to the very light objects, objects that are too heavy should also be eliminated (although without presenting a maximal weight limit).

The ongoing nature of this discussion is hardly surprising, as the range of objects potentially suitable for spinning is enormous. For example, a thread can easily be spun with a potato attached to the spindle stick (Fig. 1). An apple can also be used instead of the whorl, as was done in Tranysylvania a bit more than a hundred years ago and reported by M. von Kimakowicz-Winnicki (1910, 12). K. Schlabow (1976, 37) also speaks of the *»Erleichterung der Drallgebung durch Aufstecken einer Fruchtknolle«*. In addition, the use of bits of pumpkin pushed onto the spindle stick for spinning cotton has been reported from Sudan (Crowfoot 1931, 38). Although many objects can be used, as the above examples show, E. Völling (2008a, 242; Völling 2008b, 107–108) criticises the current practice of referring to all perforated clay objects as spindle whorls without comparing them to such objects that must be regarded with certainty as spindle whorls, such as pictorial sources or *in situ*-finds. This is a justified objection, but it is difficult to implement, as there are very few completely preserved spindles in northern/north-west Germany from the roman iron age, unlike the Ancient Near East, Egypt or the Mediterranean region.

In addition to the fundamental ambiguities just discussed, almost any object can be used as a whorl with the appropriate spinning technique. A meaningful definition of spindle whorls in archaeological contexts should, therefore, be broad enough to acknowledge the wide spectrum of suitable objects. The approach put forward here targets the understanding of archaeologically-identifiable perforated objects that have survived in the context of those spinning techniques in which they could conceivably be used as whorls.

The functionality of spindle whorls – the relationship between weight and thread (yarn thickness-weight-theory)

There are basically three different spinning techniques, which can be varied according to the person and their needs. The basic principle is to pull out the fibres from the fleece bundle and then twist them together to create a thread. The ends of the raw material must always overlap so that the pulled-out strand does not tear; thus, the individual fibres join together as they twist. The momentum for twisting the wool hairs is provided by a hand spindle, which consists of a spindle whorl (rotational weight) and spindle stick. Spinning with the hanging spindle using the drop spindle technique is probably the best-known and most frequently described spinning technique in literature. One hand turns the spindle while the other holds the fleece bundle, pulling a few fibres out of it that twist together to form a thread. Alternatively, a distaff can be used to hold the fibres. The spinning process is repeated until the spindle has reached the floor, then the yarn produced is wound onto the spindle stick and the process starts all over again. In addition to spinning using the drop spindle technique, it is also possible to spin with the spindle in place (referred to as ›spun with support‹ or ›run in a vessel‹). In this case, the spindle tip runs in a small bowl or on the floor. Unlike the drop spindle technique, the weight of the spindle does not

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[2] E.g. less than 20 mm: see Crewe 1998, 13; Barber 1991, 51–52 and a weight of less than 10 g: Carington Smith 1992, 674; Crewe 1998, 13.

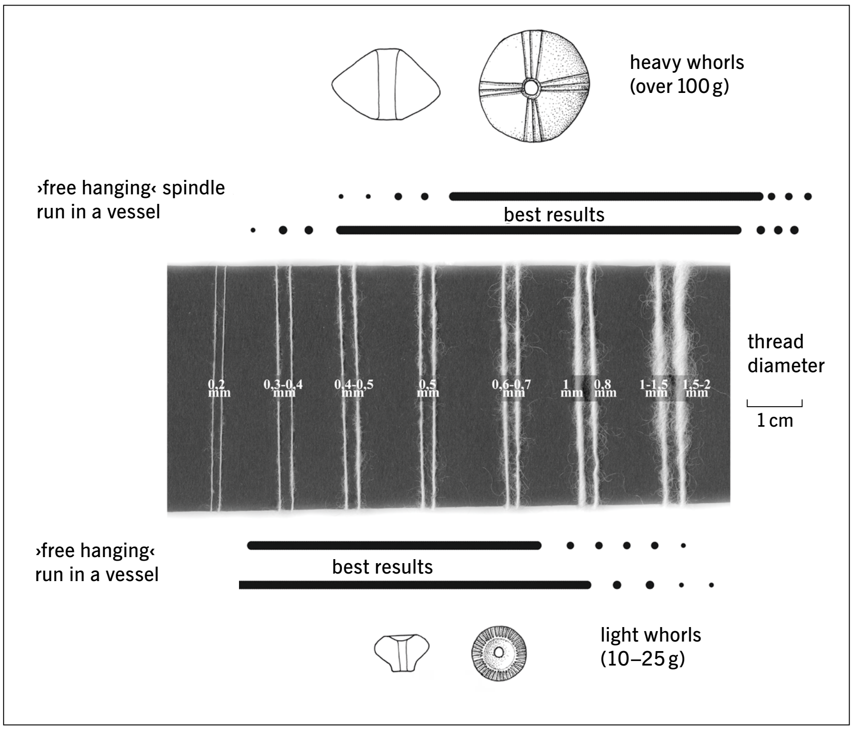

Fig. 2 Yarn thicknesses produced with different whorl weight classes and spinning techniques.

Abb. 2 *Garnstärken, die mit verschiedenen Wirtelgewichtsklassen und Spinntechniken hergestellt wurden.*

pull on the yarn, so its mass plays a less important role. The fleece is held with one hand while the other, the ›spindle hand‹, rotates the spindle and then forms a ›ring‹ with two fingers to give it support, preventing it from tipping over. In contrast to the variant described above, the ›long pull-out‹ is used here. This means that the fibres are not pulled out with the spindle hand, but the fibre hand moves away from the spindle and fibres are pulled out. The twist thus always follows the fibre hand. The third basic method of yarn production is to rotate the stick between the fingers. Here, the lower end is held horizontally and rotated between the fingers without letting go of the spindle. Alternatively, the spindle can also be rolled on the thigh.

To understand how spindle whorls function in practical use, the decisive parameters must first be identified.

Classifications of whorls are repeatedly found in the literature, which states that thin threads can be produced with small, light whorls and coarser threads with heavy, large whorls[3].

Generalised statements regarding whorl weight and thread thickness should be treated with caution, as K. Grömer (2005; Grömer 2010, 90–93 and Fig. 36) shows in spinning experiments. Here, the yarn thicknesses of light (8–25 g) and heavy whorls (over 100 g) were determined both in drop spindle and spun-with-support techniques (Fig. 2). On the one hand, as Fig. 2 illustrates, spindles that are spun with support (i.e. ›run in a vessel‹) produce consistently thinner yarn (both with light and heavy whorls) than those used in the drop spindle technique; on the other hand, the dark lines in the diagram that represent yarn thickness overlap to a relatively large extent for both techniques and both weight classes. In other words, very thin yarns of approx. 0.3 mm thickness can still be produced with heavy whorls when spun with support, whereas yarn diameters > 1.5 mm cannot be achieved with lighter whorls, regardless of the spinning technique applied (Grömer 2005, 115). It has also been stated that finer, as well as coarser yarns, can be produced with every spindle within certain limits (Bohnsack 1981, 59).

In addition, spindle whorls could be removed or attached as required to reduce or add weight. Small whorls, therefore, do not necessarily relate to the production of thin threads but could, instead, have been used as additional weight. It would also be conceivable to reduce the weight if the spindle began to ›wobble‹ due to the accumulated amount of yarn on the spindle stick. The heavy whorl is then exchanged for a lighter one and the spindle rotates better again. Since heavy whorls could also be used to twist two threads and small whorls could have been added or removed as additional weight/weight minimisation, the whorl weight alone can only provide limited information about the yarn thickness produced.

J. Carington Smith (1992, 676) already stated that a heavy whorl does not necessarily produce a thick thread, nor a light one a thin thread. In contrast, thread diameter largely depends on the ability of the spinner, who can influence the thickness of the thread (almost) at will (of course, when using the drop spindle technique, the prerequisite is that the fibres can hold the weight of the spindle). In their spinning experiments, L. Mårtensson et al. (2006a; Mårtensson et al. 2006b) also concluded that the spinning result primarily depended on a person's skill. K. Kania (2013, 24–26) went one step further in her study, stating that the attributes of the yarn produced by one person cannot be predicted, even if another person has already produced yarn under equivalent circumstances (same spindle whorl and fibres).

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[3] E.g. Koch 1994, 51; Löbert 1982, 66; Mückenberger 2013, 67; Westphalen 1999, 24–25.

dm.	h.	wt.	MI
2	16.0	50.0	25.1
3	3.1	21.9	24.8
4	1.0	12.6	25.1
5	0.4	8.8	25.2

a

dm.	h.	wt.	MI
2	8.0	25	12.5
3	3.5	25	28.1
4	2.0	25	50.0
5	1.3	25	78.1

b

Tab. 1a–b Almost identical moments of inertia (MI) despite different heights (h [cm]), diameters (dm. [cm]) and weights (wt. [g]) (a) and different moments of inertia despite identical weight (b).

Tab. 1a–b Beinahe identische Trägheitsmomente (MI) trotz unterschiedlicher Höhen (h [cm]), Durchmesser (dm. [cm]) und Gewichte (wt. [g]) (a) und unterschiedliche Trägheitsmomente trotz identischen Gewichtes (b).

It is therefore clear that it is difficult to classify spindle whorls in functional categories. This becomes even more obvious when, beyond the technical question of the spinning method applied, additional aspects such as tradition, personal preferences, and a person's skill are considered. The spinning craft offers a wide range of possibilities in which there are no precise technical specifications for thread thicknesses, spinning techniques, weight classes or the like. These variable parameters cannot be made tangible with classifications and categorizations.

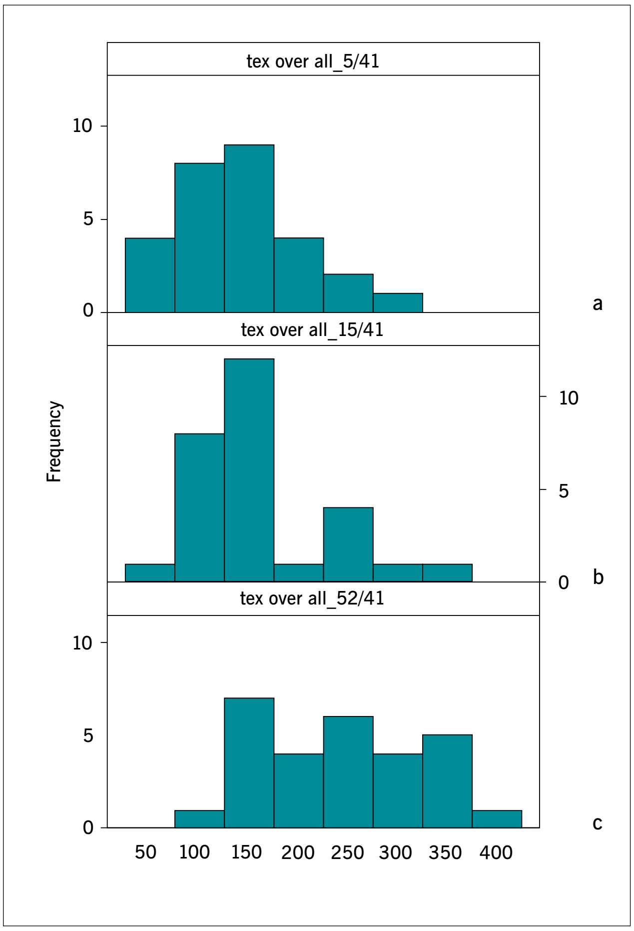

Fig. 3a–c Histograms plot the collected sample size (y axis) against tex values of yarns (x-axis: g per 1000 m spun yarn) for whorls of different weight classes and identical MI. a 5 g; b 15 g; c 52 g.

Abb. 3a–c *In den Histogrammen ist die gesammelte Probengröße (y-Achse) gegen die Tex-Werte der Garne (x-Achse: g pro 1000 m gesponnenes Garn) für Wirtel verschiedener Gewichtsklassen mit identischen MI aufgeführt. a 5 g; b 15 g; c 52 g.*

Functionality of whorl shapes in relation to the spinning technique

So far, the literature on spindle whorls has focussed solely on shape and questions of typology or stratigraphy, while functional aspects of the spindle whorls have been disregarded. As whorls are utilitarian objects that were adapted to the requirements of yarn production, it makes the most sense to combine the shape-based typology with the (inherent) functional properties of the objects.

To better understand the rotational movement of spindle whorls, the Belgian engineer A. Verhecken (2010) studied examples from different areas and periods, including materials from the Viking trading sites of Haithabu, Schleswig-Flensburg District, and Birka, Stockholm County (Sweden) (Andersson 2003), to determine their moments of inertia (MI). The MI refers to the actual state of rest/motion of a body without the effect of an external force. A. Verhecken (2010) found that the rotational properties of a whorl do not primarily depend on its weight (in g), but that diameter (in cm), height (in cm) and mass distribution play an equally significant role, contrary to what is often postulated in the literature (see above). Spindle whorls of almost identical mass may have completely different MI, depending on differences in heights and diameters, i.e. shape variation (Tab. 1b), while whorls with different masses and different heights and diameters can have almost identical inertia (Tab. 1a; Verhecken 2010, 259 Tab. 44.1; 263).

Another study on the functionality of different whorl shapes has been presented by K. Kania (2013; Kania 2015). With her analysis, the author was able to show that neither the different whorl shapes used nor their specific weights would result in the production of yarns of significantly different diameters. This can be seen in the graph (Fig. 3; Kania 2015, 119 Fig. 5): The tex, i.e. yarn weight per length, is measured on the x-axis and the sample size on the y-axis. The tex indicates the weight of the spun yarn in grams per 1000 m length. The results shown are all from spindles with a moment of inertia of 41 and weights of 5, 15, and 52 g. The overlap of tex values between whorl weight classes shows that the thickness of a yarn cannot be easily determined from the whorl used. With these observations, K. Kania (2015, 129) concludes that the spinning result primarily depends on the »human factor« and the spinner's experience, skill and preferences rather than the shape and weight of the whorl.

At the same time, the question arises as to why so many different shapes and weight classes were used if they had

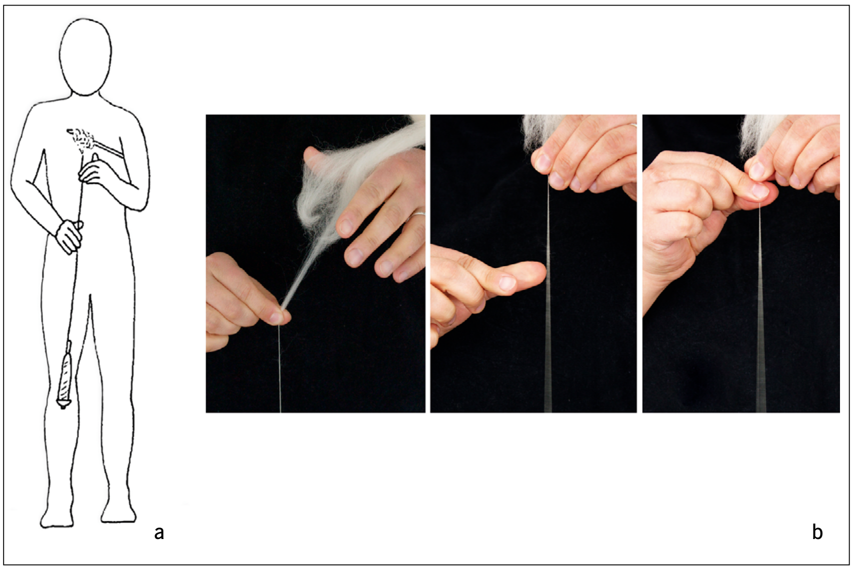

Fig. 4a–b Spinning in drop spindle technique with short distaff (a) and illustration of the short draw (b).

Abb. 4a–b *Spinnen in der Fallspindeltechnik mit kurzem Spinnrocken (a) und Illustration des kurzen Auszugs (b).*

no direct effect on yarn diameters. K. Kania offers an explanation for this, observing that whorls with a low MI spin faster than those with a higher one (Kania 2013, 26–27). In addition, K. Kania (2013, 26–27) explains the wide variety of whorl shapes as possible personal preferences. She also mentions that spinning techniques changed »at some point« according to the image sources (Kania 2017, 2–4).

While the urn from Sopron, Győr-Moson-Sopron County (Hungary; approx. 700 BC; Eibner 1986; Grömer 2004, 179), or the rattle plate from Bologna, Emilia-Romagna Region (Italy; approx. 630 BC; Eibner 1986; Grömer 2004, 179), depict spinning using the drop spindle technique (Fig. 4), medieval spinning depictions show a different technique: the fibres are spun in a long draw. One hand – the fibre hand – pulls the fibres out of the tuft, while the spindle hand moves farther and farther from the distaff. The yarn thus stretches diagonally from top to bottom in front of the body. The spindle itself is always guided close below the spindle hand or rotates constantly in the fingers (Fig. 5a). Similar historical depictions can be found, for example, in the ›Psalter of Fécamp‹ (France, around 1180), in a ›Historien Bibel‹ (Germany, late 14th century; Fig. 5b), or in the ›Taymouth Hours‹ (England, 14th century; Fig. 5c). K. Kania (2017, 3) notes that it is often unclear whether the spindle is held just below the hand or in the hand. While the latter method enables a controlled, relatively slow twist in the fleece, spinning with the spindle hanging just below the hand results in a great deal of twist in the yarn. This is because the spindle turns fastest shortly after it is given momentum. By guiding it close to the hand, it can easily be set in motion again. As

Fig. 5a–c Spinning in the long draw. a The spindle always remains close to the hand; b depiction from a ›Historien Bibel‹ (Germany, late 14th century); c depiction from the ›Taymouth Hours‹ (England, 14th century).

Abb. 5a–c *Spinnen im langen Auszug. a Die Spindel bleibt immer in der Nähe der Hand; b Darstellung aus einer Historienbibel (Deutschland, spätes 14. Jh.); c Darstellung aus dem Stundenbuch von Taymouth (England, 14. Jh.).*

mentioned above, K. Kania (2013, 26–27) states that whorls with a low MI, i.e. whorls with a mass distribution more centred to the stick, rotate faster than whorls with a high MI and a mass distribution closer to the periphery. Although the former rotate quickly, they do not rotate as long.

Applied to the spinning technique, this means that for the drop spindle technique with a short draw, a whorl is required that rotates for as long as possible as it moves farther and farther away from the hands. The person must bend down to set it in motion again. The spinning technique shown in medieval depictions does not require a long-running whorl, as the spindle runs close to or in the hand and can, therefore, be pushed frequently without any difficulty.

Spinning techniques from the Roman Iron Age terp village of Feddersen Wierde

Due to the lack of surviving pictorial and written sources, finding evidence for the spinning techniques used at Feddersen Wierde (late 1st century BC to 5th century AD) is difficult, just as at other sites of similar age Central and Northern Europe. However, based on K. Kania's finding (Kania 2013; Kania 2015; Kania 2017) that different shapes and weight classes may possibly relate to different spinning techniques, new possibilities arise. Although experimental archaeology is of great importance for the understanding of functional objects, it should not be forgotten that the results obtained probably do not match the skills and knowledge of the society of the time, whose members had been engaged in the relevant activities from a young age onwards.

Nevertheless, it is important to take a closer look at these finds to better understand how the spindle whorls were used. For this purpose, all accessible finds of the 552 whorls from the terp village Feddersen Wierde were spun and examined for their spinning properties. Excluded are the whorls that could no longer be attached to the stick due to their state of preservation; also excluded were the objects on display in the Museum Burg Bederkesa, Cuxhaven District, and the Küstenmuseum Wilhelmshaven.

1 Experimental setup

The aim of the experiment was to determine which whorls are suitable for spinning using the drop spindle technique and which are unsuited to this technique. Five straight, round sticks with different diameters (0.29–0.80 cm), weights (0.8–9.2 g) and lengths (20.0–28.8 cm; Tab. 2) were used as spindle sticks (Fig. 6).

For each experiment, the stick that best matched the holes in the whorl was chosen. The whorls were attached at the lower end and affixed with a thin bubble wrap between the perforation and the stick to ensure a tight fit and prevent further wear. Each whorl was spun at least three times, with the spindle being emptied of yarn after each test so that the yarn did not represent an additional rotational mass and the results

Fig. 6 The spindle sticks used for the test series sorted by diameter (in mm) from right to left.

Abb. 6 *Die für die Testreihe verwendeten Spindelstäbe sortiert nach Durchmesser (in mm) von rechts nach links.*

Stick	Weight (g)	Diam. (cm)	Length (cm)
1	0.8	0.29	20.0
2	2.1	0.41	24.0
3	3.3	0.48	29.5
4	5.2	0.60	27.8
5	9.2	0.80	28.8

Tab 2 Dimensions and weight of the spindle sticks used in the case study.

Tab. 2 *Abmessungen und Gewichte der in der Fallstudie verwendeten Spindelstäbe.*

remained comparable. Initially, 1–2 m of yarn was produced, which was not included in the analysis; then the number of times the spindle had to be spun to produce 1 m of yarn was counted. After spinning, spindle whorls were classified as ›short runners‹ or ›long runners‹. Short runners had to be spun at least five times to produce 1 m of yarn. Whorls that could produce 1 m of yarn while being set in motion four times or less were classified as long runners and were, therefore, well suited to spinning using the drop spindle technique. Although ›pushing‹ a spindle four times to produce 1 m of yarn is laborious, as the spindle can only be reached by bending down, the corresponding whorls were (nevertheless) classified as long runners as it can be assumed that the dexterity of the spinners of that era is not comparable to that of most hobby spinners today (Grömer 2004, 179). The spindles were spun with a short draw and the fleece of skudde sheep. In order not to distort the results, the whorls were not sorted according to settlement horizons or subtypes but were chosen at random.

2 Observations and interpretation

In addition to the classification of the whorls into long and short runners, other revealing observations were made during the test series regarding the interplay between 1. shape, 2. weight, 3. hole diameter in relation to the spindle stick, 3. central position of the perforation, as well as the spindle stick and fibre material. The relevant factors for the rotational time of a spindle whorl are listed in Tab. 3 and should be understood in descending order.

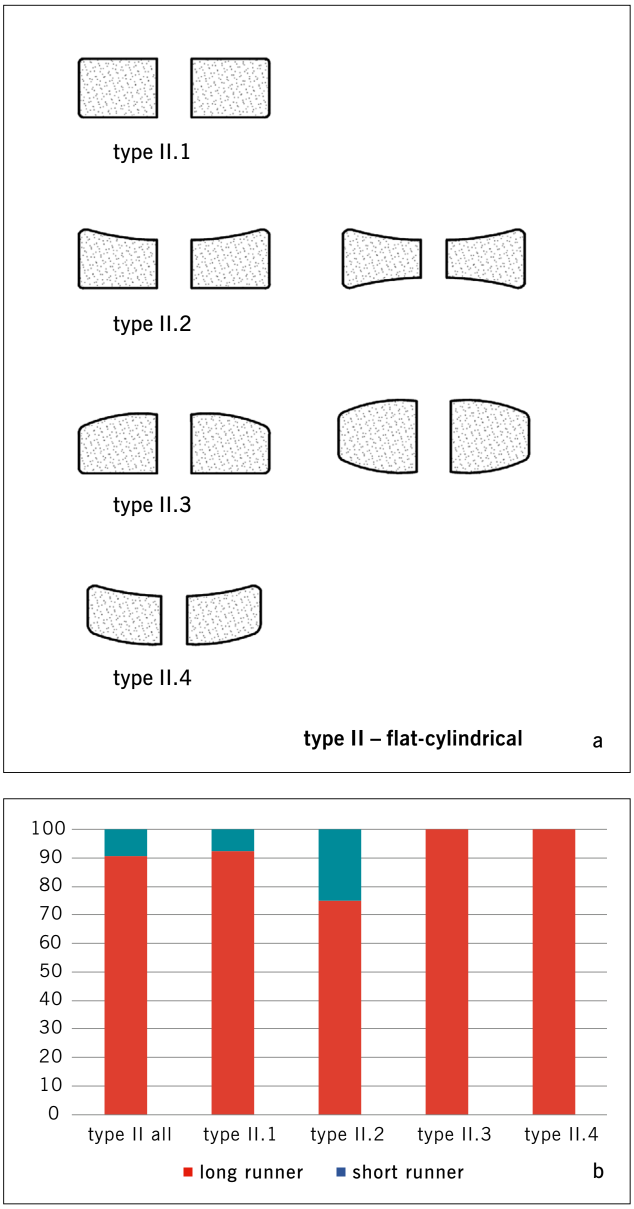

Fig. 7a–b Schematic representation of the flat-cylindrical type II without scale (a) and the corresponding distribution of long and short runners (b; n = 21) in percent.

Abb. 7a–b Schematische Darstellung des flachzylindrischen Typs II ohne Maßstab (a) und die entsprechende Verteilung von Lang- und Kurzdrehern (b; n = 21) in Prozent.

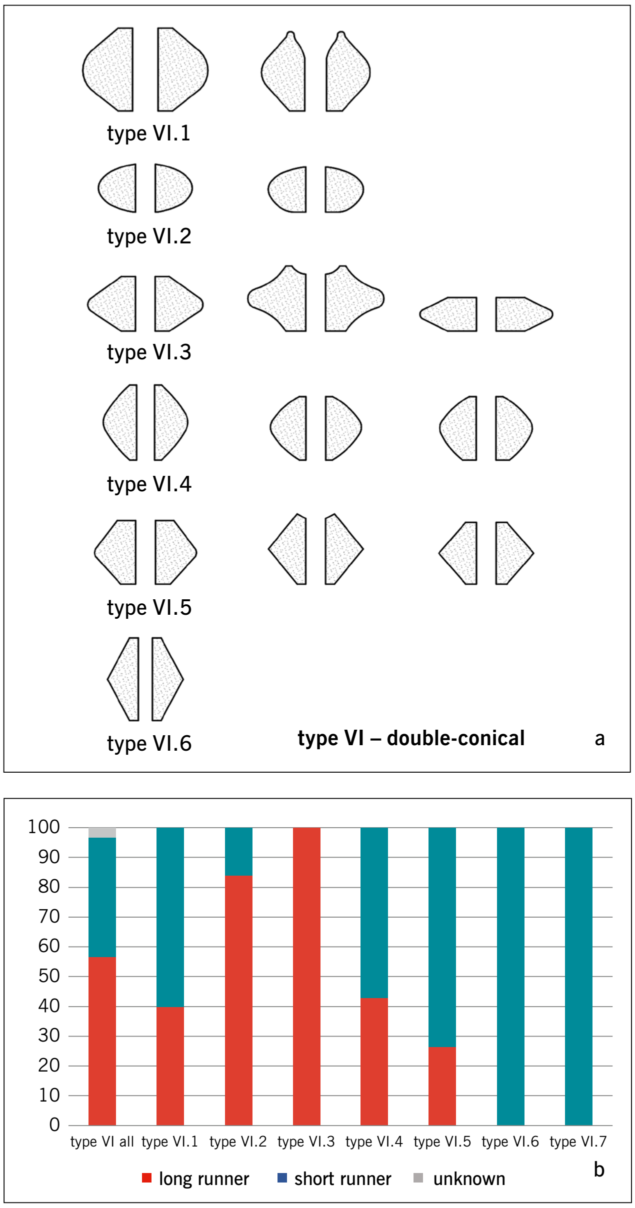

Fig. 8a–b Schematic representation of the double-conical type VI without scale (a) and the corresponding distribution of long and short runners (b; n = 122) in percent.

Abb. 8a–b Schematische Darstellung des doppelkonischen Typs VI ohne Maßstab (a) und die entsprechende Verteilung von Lang- und Kurzdrehern (b; n = 122) in Prozent.

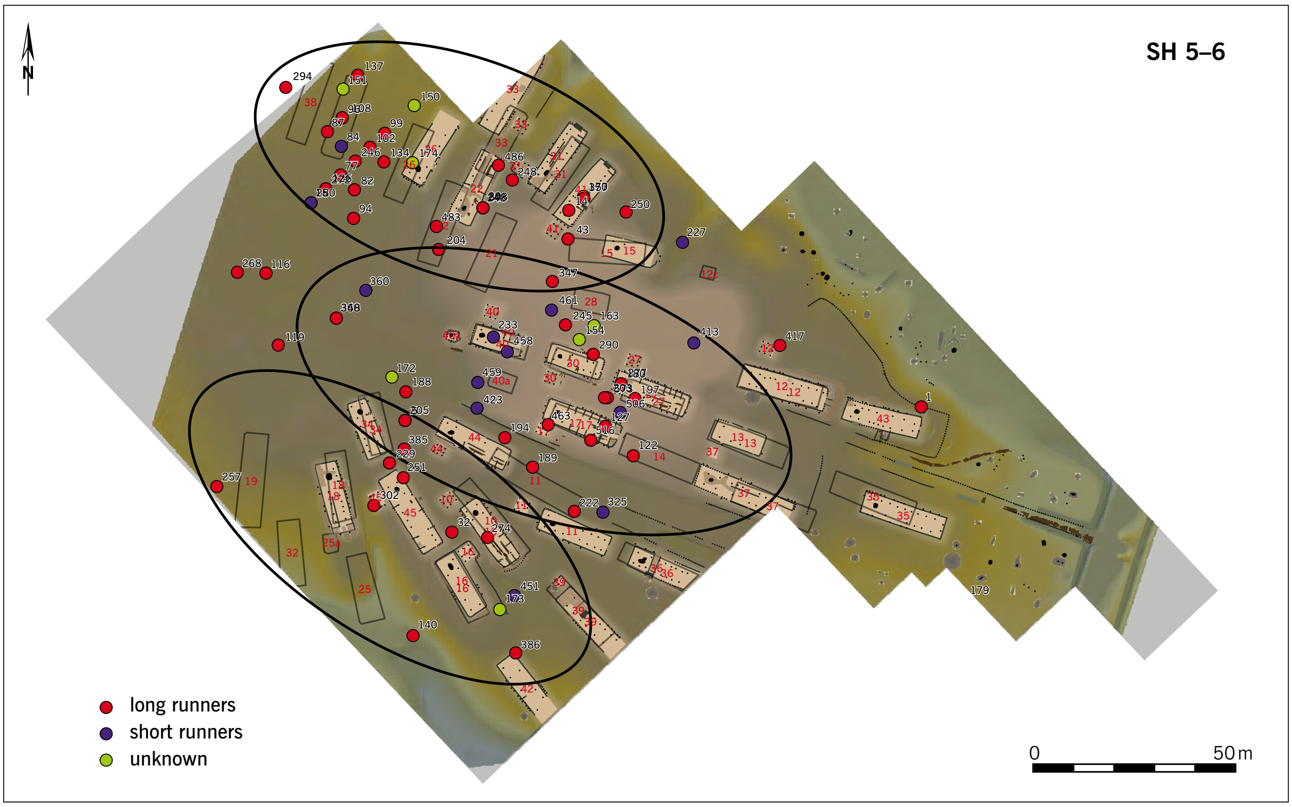

Fig. 9 Feddersen Wierde, Cuxhaven district. Distribution of short and long runners in the settlement horizons (SH) 5–6 (3rd–4th century AD). In the northern and southern areas there are primarily long runners; in the central area, short and long runners are associated.

***Abb. 9** Feddersen Wierde, Lkr. Cuxhaven. Verteilung von Kurz- und Langdrehern in den Siedlungshorizonten (SH) 5–6 (3.–4. Jh. n. Chr.). In den nördlichen und südlichen Bereichen sind Langdreher vorherrschend, während im zentralen Areal Kurz- und Langdreher vergesellschaftet sind.*

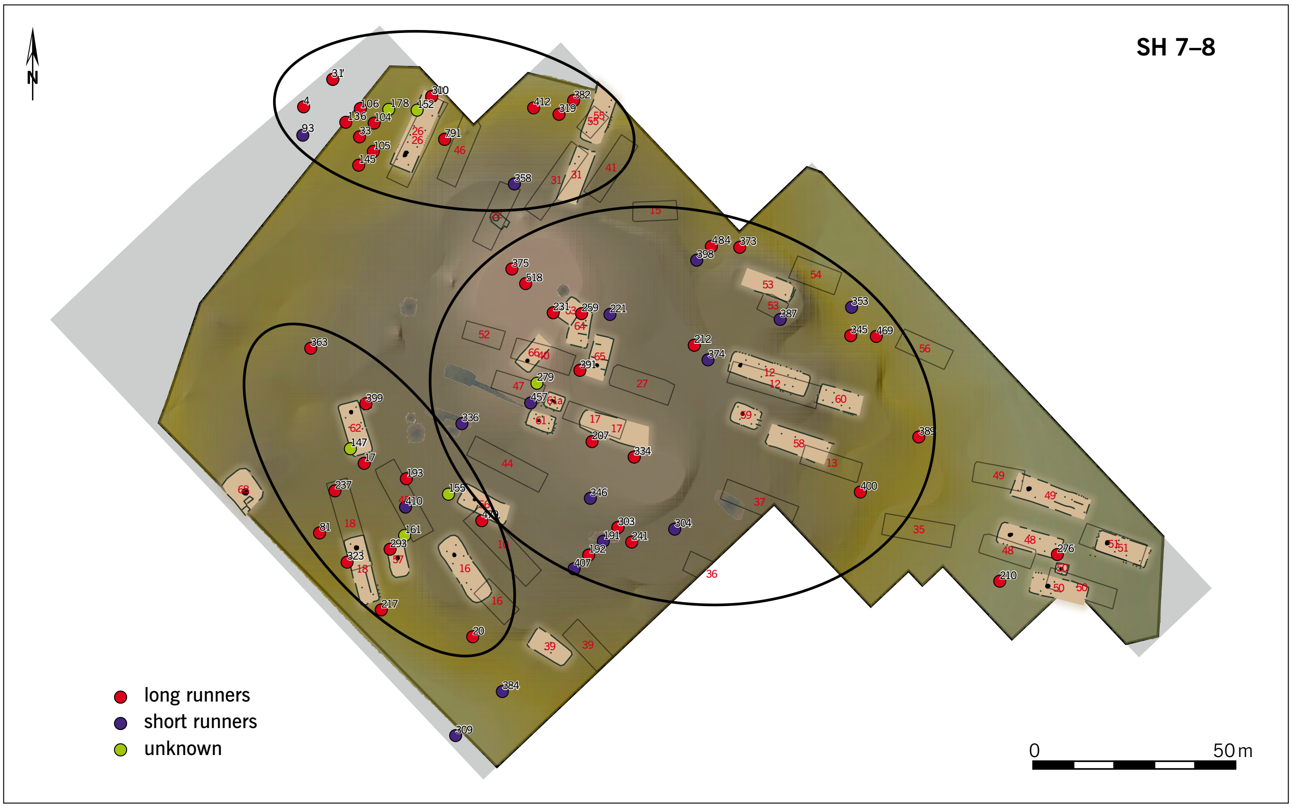

Fig. 10 Feddersen Wierde, Cuxhaven district. Distribution of short and long runners in settlement horizons (SH) 7–8 (4th–5th century AD). In the northern and southern areas there are primarily long runners, in the central area short and long runners are associated.

***Abb. 10** Feddersen Wierde, Lkr. Cuxhaven. Verteilung von Kurz- und Langdreher in den Siedlungshorizonten (SH) 7–8 (4.–5. Jh. n. Chr.). In den nördlichen und südlichen Arealen gibt es vor allem Langdreher, im zentralen Bereich sind Kurz- und Langdreher vergesellschaftet.*

1. The turning time of a whorl depends primarily on its shape. In general, the farther the mass is away from the whorl's centre, the longer it rotates. It should also be noted that a uniform shape is only required for tall, narrow shapes. This means that one can even spin with pottery disks with adjacent corners without any problems.

2. Added to this is the weight: Light whorls are affected more quickly by ›backspin‹ than heavier ones. A small, wide and flat whorl will spin longer than a small, tall and narrow whorl of the same weight but not as long as a heavier whorl with a wide, flat shape.

3. The diameter and centrality of the whorls' perforations also contribute to how long or briefly a spindle rotates. If the perforation takes up a large part of the surface, the whorl will not rotate as long as an almost identical whorl that differs only by a smaller perforation.

3. However, the aspect of the central location of the perforation is only applicable to shapes whose centre of mass is oriented closer to the stick and to small, flat whorls whose centre of mass is located farther out. For a longer rotation time, the latter whorls require a perforation that is as central as possible and runs along the median.

No statements can be made about the effects of the spindle bar and fibre material on the turning time of a whorl, as these factors were not included in the test series.

It is important to note that these statements are only valid when the whorl is fixated at the bottom part of the spindle stick (referred to as a ›foot-heavy‹ spindle) and spun using the drop spindle technique; these statements still must be investigated in relation to other spinning techniques. It must also be emphasised that all these factors are interrelated and should not be considered separately. A generally valid formula cannot be provided, as the whorls are not ideally symmetrical objects, and all three factors can vary greatly depending on the whorl.

Long- and short-running whorl types

The characteristics of the whorls classified as long- or short runners based on the experimental series can be transferred to the types defined by M. Görlitz (2024). For example, there are whorl shapes that can be classified – primarily or even exclusively – as long- or short-running, such as whorls of flat-cylindrical type II (Fig. 7). Although type II shape whorls tend to rotate long (centre of mass tends to lay in the periphery of the whorl), two objects were assigned to the short runners. This shows that although shape is the main criterion for running time, other factors (see above) also have an effect.

There are also whorl types that comprise both long and short runners, such as the double-conical type VI (Fig. 8). Since short running whorls cannot be spun well using the drop spindle technique, they indicate the use of other spinning techniques.

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The long- and short-running whorl types not only provide information about the spinning duration of a spindle whorl and the spinning technique used; their spatial distribution within the settlement area of the Feddersen Wierde also allows contextualisation of these objects within more ›domestic‹ and/or ›professional‹ realms of the terp village. From the 3rd century AD up to the 5th century, the last four settlement horizons (SH) of the settlement area show changing patterns in the spatial distribution of long and short runners. In SH 5–6 (3rd to 4th century AD), three areas can be identified in which primarily long or long/short runners occur. In the northern settlement area, where type I.1 is found, long-running whorls are primarily located. Short running whorls primarily occur in the eastern area of the settlement, where they show a cluster mixed with long-running whorls. In the southern area, on the other hand, primarily long runners are found (Fig. 9). A similar distribution can also be seen in SH 7–8 (4th to 5th century AD; Fig. 10): the clustering of long runners in the northern and southern areas and the short runners mixed with the long-running whorls in the eastern settlement area. The distribution of the long and short runners in SH 5–8 strengthens the observation of an organised domestic trade with different areas of responsibility.

As short-running whorls were probably used in a spinning technique in which the spindle was guided close to the hand, the thread could take up a great deal of twist in a short time; long-running whorls spin longer but do not add as much twist to the yarn. The distribution of long and short runners could be related to the processing of different materials or different staple lengths within the areas. Short-staple fleeces naturally require more twist than longer fibres (Kania 2015, 113). Short-running whorls, therefore, support the requirements of the material. It would also be conceivable to produce warp or weft yarns at different locations. Warp yarns often have more twist than the weft. Strongly twisted yarns in the weft thread, on the other hand, can cause problems if they are not constantly kept under tension (Kania 2017, 4–5). The production of yarns in different thicknesses in different

	Centre of mass at the edge	Centre of mass centred
1. Uniform shape	X	✓
2. Weight	✓	✓
3. Hole diameter	✓	✓
3. Central location of the perforation	X	✓
(Rod and fibres)	?	?

Tab. 3 Factors that are decisive for the rotation duration of whorls with a centre of mass located towards the edge and a centre of mass located towards the middle: ✓ decisive; X no influence; ? unknown.

Tab. 3 *Faktoren, die für die Rotationsdauer von Wirteln mit einem zum Rand hin gelegenen Massenschwerpunkt und einem zur Mitte hin gelegenen Massenschwerpunkt entscheidend sind: ✓ entscheidend; X kein Einfluss; ? unbekannt.*

areas could also be considered, as thicker threads require less twist than thinner ones (Kania 2017, 1–2).

The results of the study provided above document the wealth of information that spindle whorls may provide. Wrongfully, this group of finds is often excluded from more in-depth studies. A detailed typology and large-scale, practical test series not only provide insights into ancient craft techniques but also make it possible to understand the organisational structures of the textile craft within a north-western German settlement during the 1st centuries AD.

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3	after Kania 2015, 119 Fig. 5
4	a Andersson Strand 2015, 46 Fig. 2.10; b Kania 2017, 114 Fig. 1
5	a Kania 2017, Fig 1b; b MS M.741, folio 1v, The Morgan Library, <https://ica.themorgan.org/manuscript/page/3/1131358> (29.12.2024); c British Museum, Public Domain, <https://picryl.com/media/eve-spinning-and-adam-from-bl-yt-13-f-23v-f4e0bd> (05.05.2025)
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