Revisiting the Megalithic Yard

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Abstract

A long-standing question in British archaeology is whether a standard unit of linear measure was used by Neolithic architects and engineers in the construction of megalithic circles. Well-developed trade networks were established throughout the Near East into northern Europe by 4000 BC and commerce required standardized measure of trade goods. Well before this time, standardized linear measure was in use for surveying in the Tigris, Euphrates, and Nile agricultural regions. Growing evidence, such as the Folkton and Lavant chalk drums, suggest that Neolithic construction included standard measurements. We suggest that measurement standards were introduced in Britain with the immigration of Neolithic people about 4000 BC.

Key words: megalithic yard, long foot, Neolithic monuments, megalithic circles, standard linear measure

1 Introduction

Since Thom (1955, 1962) analyzed the geometry of megalithic sites in Britain and defined the Megalithic Yard, there has been considerable discussion of whether a standard unit of length was in use during the Neolithic in Britain. Numerous authors have cited direct evidence for standard units of measure in the form of rulers or rods of Neolithic age in northern Europe and Ireland (*e.g.* Sievers, 2002; Raftery, 1986); however, no such evidence exists in England (Chamberlin and Parker Pearson, 2007). In the absence of archaeological evidence of such a measure, much emphasis has been placed on statistical analyses of Neolithic structures and on assessment of the validity of those analyses (Thom, 1955; Kendall, 1974; Csörgő, 1980; Baxter, 2008; Porteous, 1973; Freeman, 1976). In their recent compilation, Teather *et al.* (2018) make a strong case that the Folkton and Lavant chalk drums represent a measurement standard based on the "Long Foot" of Chamberlain and Parker Pearson (2007). Teather *et al.* (2018) suggest that the chalk drums are representations of lidded wooden drums, around which a rope would have been

wound a particular number of times to accurately delineate length; the lidded drum could also have served as storage for the rope(s) in question. Here we revisit the Megalithic Yard and whether a standard unit of measure was part of Neolithic culture in Britain. Although the archaeological record might never definitively answer this important question, a larger question remains; why would there NOT be a standard unit of measure, a point to which we will return.

2 Background

Most of the sites used in the analyses of Thom (1962) and subsequent investigations date to the Neolithic after about 3500 BC. By this time, numerous standards of measure are suggested to be in place in the Near East and throughout much of Europe (Lyons, 1927; Schmandt-Besserat, 2010). Prior to that, the use of tokens suggests that common containers had been in use throughout the Near East (Schmandt-Besserat, 2010) and many are found throughout southern Europe as well (Budja, 2003). Schmandt-Besserat (1992, 2010) lay out a convincing case that cuneiform script evolved from three-dimensional tokens used primarily for accounting; the need for accounting dating back to the origins of agriculture *ca.* 8000 BC and were used with no discontinuity for 5000 years (Budja, 2003). Tokens were used to represent three concepts: commodities, counters, and quantities (Schmandt-Besserat, 1992; Budja, 2003). Beynon-Davies (2009) interprets tokens, particularly the complex tokens emerging after about 4000 BC, to represent sub-categories of specific goods and allowed for precise inventory and record keeping. Without specified quantities, commercial trade is difficult to imagine.

Evidence suggests that early exchange of raw materials, such as obsidian, in the Near East was occurring by about 11,000 BC (Dixon *et al.*, 1968). Impressed wares appear between 6200 and 5500 BC and are found across southern Europe from Greece to Spain (Robb and Farr, 2005). By 4000 BC trade routes through the Middle East and southern Europe were well developed (Shackelton and Renfrew, 1970; Christiansen *et al.*, 2006), with trade of domestic pigs at least to northern France and Germany (Larson *et al.*, 2007; Robb and Farr, 2005). Trade tokens after 4000 BC exhibit no difference among geographical regions, indicating their universality (Schmandt-Besserat, 1992, 2010; Beynon-Davies, 2009). 5000 years of exchange of goods throughout the Near East and Europe suggests that standard quantities must have been broadly understood and practiced. Communication channels and the exchange of information require agents of intention, message, language, signals, and actual communication, which Beynon-Davies (2009) outlines as Neolithic informatics.

By 8000 BC agriculture was widespread on the flood plains of the Tigris and Euphrates rivers, and agriculture moved into the Nile River floodplain and Delta in Egypt by about 6000 BC (Lyons, 1927; Bar-Yosef, 2017). Regular flooding required reestablishment of property boundaries. Lyons (1927, p. 133) suggests that well-developed methods for measure of land and computation of area were established in Egypt prior to 3000 BC, and that such measure was essential for payment of rent and taxes. Clearly, pacing by individuals without standardization would not have the needed accuracy and a standard must have been established. But upon what was the standard based? We suggest that the foundation of a length standard was likely based on the standards that we still use; a few of the common measures are highlighted in Table 1. A few of the measures such as the inch, hand, and span are useful for things you can hold. Others such as the cubit and fathom for things you can stand up to; cubits and fathoms are relatively useless on the ground. For linear measure over distance, the foot and pace are accurate and repeatable for any one individual. If a unit of distance were specified, say by placing two stakes in the ground, anyone could pace off the distance and reproduce quite accurately the same distance along another transect; the number of paces for each individual will be different, however.

Chamberlain and Parker Pearson (2007) outline numerous problems in determining whether there is a true standard measure such as the Megalithic Yard. However, they cite evidence that a "long foot" was used at Stonehenge and possibly a "short foot" similar to the Roman foot was used at Durrington Walls. The rings of pits and postholes at The Sanctuary suggest a third unit, possibly a multiple of 1.3 statute feet (Chamberlin and Parker Pearson, 2007). Note that 1.3 statute feet is approximately ½ Megalithic Yard. If a standard measure existed, it must have been reproducible (at least closely) and transferrable from person to person or through generations. While there may be a standard measure used at a particular time at a particular site, transferring the standard across distance and time introduces error. Loss of a standard would require making a new one from some other measure introducing further error.

We suggest that Porteous (1973) was correct about Thom's (1962) Megalithic Yard, that it is a consequence of megalithic circles being laid out by pacing with relatively small error. However, we suggest that a standard did exist among Neolithic architects and engineers. A standard would be necessary for accurate construction and was likely based (at least initially) on the average pace. Given the cultural significance of the Neolithic monuments such as Woodhenge, Stonehenge, and the many others throughout Britain, great care in their construction would seemingly have led the architects to a consistent unit of measure. It is certain that pacing by individuals without standardization would not provide the needed accuracy such as that required for reestablishing property boundaries in flood-prone

regions, which were in intensive cultivation nearly three millennia earlier than the Neolithic landscapes of Britain (Allen, 1997; Bar-Yosef, 2017).

So, could the stride (or pace) have been standardized? Any Neolithic builder or architect would recognize the need for a standard measure. However, they would also have recognized the obvious difference in stride length among individuals. Standardization within a site would be desirable or required if multiple engineers or contractors were involved in Neolithic construction. If the same architect or developer moved to another site, it would be logical to bring your "standard" with you; a stick, a rope with knots, a chain, a rod, or a drum of a specific diameter possibly with a rope inside (*e.g.* Teather *et al.*, 2018). Among monuments, the standard could have been copied from somewhere/someone, which would introduce copying error.

3 Methods

As geologists, the authors were taught the art of pace and compass; use your standard pace and calibrate later from map coordinates, GPS, or measuring tape. We happen to know that author HM's stride when consciously pacing is 2.65 feet and PB's stride is 2.78 feet (for an average of 2.72, a Megalithic Yard). To further investigate the pace as unit of measure we enlisted the services of a classroom of students.

A distance was measured off along a central corridor at the University of Minnesota Duluth. The distance was measured with a surveyor's tape at 1327 feet. Seventeen students were enlisted for a pacing study. Two separate experiments were conducted.

1. The seventeen participants were asked to traverse the distance and count their paces. No other instructions were given.
2. After experiment 1, the 17 participants were introduced to Neolithic architecture and the concept of pacing as an accurate measuring technique. They were then asked once again to traverse the distance of 1327 feet and again count their paces, this time knowingly maintaining a steady pace.

Number of paces for each trial and the individuals' heights were recorded. Average student step length ($\bar{L}$) was then corrected for height (H) and is given by

$$(H_{Neo}/H_{Par})\bar{L},$$

where H_{Neo} and H_{Par} are the average Neolithic male and participant heights, respectively. Angel (1984) tabulates average adult stature for Paleolithic through Bronze Age men and women. For the Late Neolithic period 5,000 to 3,000 B.C., average male height is estimated at 63.5 inches (5'3.5") and for the Early Bronze Age, 3,000 to 2,000 B.C., a mean male height of 65.4 inches (5'5.4") is suggested. Therefore, we use an average of these two heights to arrive at the height of a typical Neolithic surveyor at 64.45 inches.

4 Results

Results of the two trials for 17 individuals are shown in Table 2; the number of paces for each individual for each trial, their height, and the length per step in feet are tabulated along with averages and standard deviations. Note that in every case the number of steps for Trial 2 was fewer than for Trial 1. It appears that when given the charge of measuring methodically and consciously, the average pace lengthened by 6.64%. Average length per step for Trial 1 and Trial 2 were 2.67 ft and 2.85 ft, respectively. Average height of participants was 68.29 inches, and the corrected average pace for the participant group is 2.67 ft, a difference 0.05 ft (<2%) smaller than Thom's (1962) Megalithic Yard of 2.72 ft.

5 Discussion and Conclusions

Our pacing investigation is clearly not a rigorous, statistically valid examination, but instead a common sense critique of the validity of a Megalithic Yard. It is unlikely that a standard ruler will be discovered anytime soon and we might never know whether a standardized length unit prevailed in Britain during the Neolithic period. We do know that linear measure was in common use for land surveys in Mesopotamia and Egypt, and by association likely throughout the Near East well before 3000 BC. Standard measures were in common use for trade across the Near East and well into northern Europe by this time, and mounting evidence suggests that the Neolithic transition in Britain was related to immigration of farmers from continental Europe (Brace et al., 2018).

We suggest that Thom's (1962) conclusions, the contribution of Porteous (1973), and our own simple pacing example suggest that pacing was a (if not *the*) standard distance measuring tool. However, even for Neolithic builders pacing would likely not be accurate enough for some construction. Therefore, a rod or chain might provide that consistency of measure to produce circular or rectangular structures. Did Neolithic engineers use an exact quantum, the Megalithic Yard, which was likely based on the pace? Maybe. Whether Neolithic architects conducted experiments of many individuals to determine an

"average" pace will never be known. However, statistically, the average Neolithic male pace length would be approximately 2.7 ft. If pacing was the standard technique of measure and someone wanted greater accuracy for particular projects then the average pace length could be standardized using a rod, rope, or chain. In a larger context, we suggest that evidence is pointing to standardized measure. Whether the megalithic yard, the long foot, or some other measure, we suggest that the long history of linear measure (Lyons, 1927; Bar-Yosef, 2017), Neolithic informatics (Beynon-Davies, 2009), and possibly the chalk drums of Folkton and Lavant (Teather *et al.*, 2018) seem to be pointing in that direction.

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Table 1. Standards of Measure and Explanation (compiled from Klein (1974))	Appropriate Scale (conventional units)
Inch – distance between two knuckles	1 to a few 10s
Hand – width of a hand	1 to 10s
Span – outstretched thumb to little finger	1 to 10s
Cubit – elbow to finger tips	1 to a 10s
Fathom – fingertip to finger tip	One to many depending on what you measure
Foot – no explanation necessary	1 to a 10s
Pace (or stride) – no explanation necessary	A few to one's ability to count
Double stride – 2 of the above	A few to one's ability to count
Rod	Dependent on the ability to count
Chain	Dependent on the ability to count

Table 2. Results of pace length for 17 individuals for two trials.

Individual	Steps Trial 1	Steps Trial 2	Height (in)	Feet/Step Trial 1	Feet/Step Trial 2
1	520	500	68	2.55	2.65
2	507	451	74	2.62	2.94
3	478	466	69	2.78	2.85
4	462	445	67	2.87	2.98
5	476	428	69	2.79	3.10
6	524	454	65	2.53	2.92
7	484	444	68	2.74	2.99
8	492	453	66	2.70	2.93
9	530	510	66	2.50	2.60
10	467	443	66	2.84	3.00
11	535	498	66	2.48	2.66
12	506	475	71	2.62	2.79
13	477	460	71	2.78	2.88
14	480	464	70	2.76	2.86
15	546	520	66	2.43	2.55
16	508	460	70	2.61	2.88
17	482	478	69	2.75	2.78
Min	462	428	65	2.43	2.55
Max	546	520	74	2.87	3.10
Average	498.47	467.59	68.29	2.67	2.85
Std Dev	25.61	25.89	2.42	0.14	0.15