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By Curt Roslund


Ground plans of 100 ship-settings at 63 sites in Scandinavia have been obtained from measurements with a distomat attached to a precision theodolite. The layout of the stones strongly suggests that the great majority of the ship-settings were arranged in accordance with precise rules, often attesting to the considerable geometrical talent and ingenuity of their builders. A slight preference for the main axes running north-south was found.

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A ship-setting is the name given to a prehistoric burial monument made up of stones arranged on the ground in the shape of the curved sides of a ship (Fig. 1). They are unique to southern Scandinavia where more than a thousand have survived to the present day in various states of intactness. Ship-settings come in sizes from a few metres to some 60 metres in length. They stand alone or form groups of up to 10 or more. Some of them have standing stones to outline their sides, while others use flat stones lying on the ground. The stones touch each other in some ship-settings, while they are sparsely set in others. Although very few have been accurately dated, ship-settings are generally assumed to originate from two distinct periods: the late Bronze Age and the late Iron Age. Further information on ship-settings can be obtained from Ohlmarks (1946) and Müller-Wille (1970, pp. 13–24).

The present survey concentrates upon ship-settings longer than 25 metres, which are sufficiently well-preserved to warrant a study of their geometrical and orientational properties. Smaller ship-settings, owing to their great number, were included chiefly according to ease of access.

The measuring equipment used for this study allows a stone’s mass-centre in a typical ship-setting to be located with an accuracy of a few centimetres. This suffices to demonstrate that the outline of most ship-settings is generated geometrically by two intersecting circular curves of the same radius. Only nine ship-settings in this survey show clear evidence of deviations. They are, strangely enough, among the most prominent ship-settings. Out of the 18 ship-settings which are longer than 40 metres, eight have sides that do not conform to true circles. One explanation for this could be that difficulties in setting out circular arcs with a radius of 40 metres or more in rough terrain have forced the builders to consider other solutions. Another possibility is that in some cases, clumsy attempts at restoration may have distorted the outlines into unrecognizable forms.

However, there are other indications that the longest ship-settings form a distinct class of their own. They show no coherence in orientation, they are often solitary and there is a marked absence of ship-settings in the middle range of lengths between 30 and 40 metres (Fig. 2).

Geometry

When two or more ship-settings of identical shape and size appear at the same site, they were probably set up deliberately in this way accor-
Fig. 1. The well-proportioned design of the recently restored ship-setting at Gannarve on Gotland is enhanced by its commanding situation in an archaic landscape. Photo by J. Ryegård.

Fig. 2. Distribution of the lengths of the ship-settings studied in this investigation in five-metre intervals. The dashed lines indicate sizes for which the investigation is incomplete. – Diagram över fördelningen av uppmätta skeppssättningars längd i 5-meters intervall. De streckade linjerna anger att underlaget är mycket bristfälligt för korta skeppssättningar.

Fig. 3. The third at right angles to the first two (Fig. 3).

At Rannarve on the Island of Gotland in the Baltic, a formation of four identical ship-settings sail in a straight line, stern to stern (Roslund, 1983) (Fig. 4).

Ship-settings differ greatly in their breadth of beam. When defined as the ratio of the length of the major axis to that of the minor axis, the beam-width in Fig. 5 is found to vary from 1.7 for the vesica piscium figure to 7.2 for narrow lozenge-like ovals with a pronounced clustering at the axial ratio 3.0, in close accord with earlier results (Rausing, 1984, p. 49).

The preference for the axial ratio 3.0 indicates that the 3-4-5 right-angled triangle might have been used in its construction. A simple method to obtain ship-settings with this axial ratio is to draw two circles of radius 5 units from points 4 units above and below the midpoint of a major axis measuring 6 units.

The two ship-settings in Fig. 6 at the famous site at Badelunda near Västerås in central Sweden provide a striking illustration of this method of construction (Roslund, 1992). They
both employ the 3–4–5 triangle but in two different ways. While one ship-setting of axial ratio 3.0 may have been constructed in the manner described above, the other with a major axis of the same length but now instead divided into 8 units has the centres of its sides placed 3 units from the axis, giving an axial ratio of 2.0. However, Mattsson (1991) recently remarked that nearly the same axial ratios, 3.08 and 2.06, can be obtained with a construction method based on the Golden Section.

There is some further evidence in the distribution of axial ratios in Fig. 5 that whole numbers were preferred. This points to the use of other Pythagorean triangles with sides in ratios of whole numbers for the construction of ship-settings.

Another less conspicuous clustering in Fig. 5 occurs at axial ratio 2.4. This implies a design which relies for its construction on a square with its diagonal along the major axis. The previously mentioned line of ship-settings at Rannarve was undoubtedly built on a ground plan of four equal chessboard squares arranged along a common diagonal (Roslund, 1983).

Other ship-settings may have been constructed with the help of the equilateral triangle, giving an axial ratio of 3.7. This is definitely the case with a three-leaved rosette of ship-settings at Vedeby outside Karlskrona in southern Sweden (Roslund, 1984) (Fig. 7).

Of the nine ship-settings in this survey with sides which do not conform to circular arcs, four appear to be of elliptical outline. These four are to be found in Sweden at Södra Ugglarp and Kivik in the province of Scania, at Össlöv in Småland and at Näsja in Östergötland. They are all severely flattened (see Fig. 8) with an eccentricity greater than 0.9. By a strange coincidence, the ship-settings at Södra Ugglarp and Össlöv are very similar in form and size; the eccentricities are 0.96 and 0.95 and the major axes 42.3 and 41.3 metres, respectively.

One ship-setting, the monumental Ale’s Stones at Kåseberga in southern Scania, is clearly composed of two identical but opposing parabolas with their axes of symmetry falling...
Fig. 4. The construction of four ship-settings at Rannarve may have been based on four equal squares in contact along a common diagonal. - Fyra skeppssättningar vid Rannarve på Gotland kan ha konstruerats med hjälp av fyra lika stora kvadrater placerade i en följd uteftet en gemensam diagonal.

Fig. 5. Distribution of axial ratios at intervals of 0.2 for 89 ship-settings. Ship-settings at the same site differing in axial ratios less than 0.2 have been counted as one. - Diagram över fördelningen av axelförhållanden i intervall om 0,2 enheter för 89 skeppssättningar. Skeppssättningar inom samma fornlämningsområde vars axelförhållande skiljer sig med mindre än 0,2 enheter har behandlats som en enda.

along the same line (Roslund, 1980; 1993) (Fig. 9). The remaining four ship-settings have outlines which could not be assigned to any particular type of geometric curve.

The examples described here strongly support the idea that the builders of ship-settings understood the basic laws of geometry and knew how to use them in order to arrive at an aesthetically pleasing composition.

Orientation
Ship-settings are found pointing in all directions on the horizon. However, as shown in Fig. 10, there is a clustering near the north-south direction which becomes more pronounced if the longest ship-settings are excluded. The latter seem to be wholly randomly oriented, while 45 per cent of the ship-settings shorter than 40 metres point within a 30 degree interval of the horizon centred at azimuths 10 and 190 degrees. This asymmetry with regard to the local meridian could be an effect of our temporal conception of midday, which usually lags behind the astronomically determined midday, when the sun reaches its highest position in the sky. A ten-degree departure in azimuth from the meridian corresponds to just over half an hour in clock-time at the equinoxes at these latitudes.
Fig. 6. The construction of two ship-settings at Badelunda may have been based on the Pythagorean 3-4-5 triangle giving axial ratios 3.0 on the left and 2.0 on the right. - Två skeppssättningar vid Badelunda utanför Västerås kan ha konstruerats med hjälp av den pythagoranska 3-4-5-triangeln som gett dem axelförhållandet 3,0 till vänster och 2,0 till höger.

Fig. 7. The construction of three ship-settings at Vedebä by may have been based on the equilateral triangle. - Tre skeppssättningar vid Vedebä by utanför Karlskrona kan ha konstruerats med hjälp av liksidiga trianglar.
The preference for a north-south orientation of ship-settings was observed already by Ohlmarks (1946, pp. 207-210). The same effect, with a small deviation towards increasing azimuths, was also seen for 274 ship-settings on Gotland, mostly from the Bronze Age (Eriksson, 1987, p. 23). However, no such clustering tendency towards the north and south was found for 78 ship-settings, mainly from the late Iron Age, in the province of Uppland in Sweden (Karlsson and Åman, 1980, p. 31, pp. 71-72).

The monumental Ale's Stones constitutes a special case with respect to its orientation. The directrix of its southern parabola points almost exactly towards the rising point of the Midsummer sun (Roslund, 1980; 1993). It is therefore tempting to regard it as a parabola for inter-

polating the precise time of the summer solstice in a manner similar to that suggested by Thom (1971, pp. 83-90) for the moon.

It is somewhat unexpected that the longest
ship-settings show no preferential orientation. They are usually assigned to the late Iron Age when the Norsemen are known to have acquired considerable navigational skills. It would be understandable if a Norse chief wanted his grave ship to steer the right course to the realm of the dead. Apparently, other considerations proved more influential when the ship-settings were laid out. Precisely what they were, we do not know, except that geometry played an important role.

References
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Skandinaviska skeppssättningars geometri och orientering
Ett hundra skeppssättningar på sammanlagt 63 fornlämningsplatser i Skandinavien har uppmätts med en distomat kopplad till en precisionsteodolit. Mätningarna ger vid handen att stenarna som definierar skeppssättningarnas sidor satts ut på geometriskt konstruerade cirkelbågar. Endast nio skeppssättningar av de studerade uppvisar definitivt avvikande former. Av dessa kan fyra skeppssättningar möjligen ha lagts ut som ellipsor: de vid Södra Ugglarp och Kivik i Skåne, vid Össlov i Småland och vid Näsja i Östergötland. En skeppssättning, Ales stenar i Skåne, kan ha konstruerats som två motstålda paraboler.
Skeppssättningarna företer en stor variationstrikedom i förhållandet mellan längd och bredvid med en tydlig förkärlek för axelförhållandet 3,0. Detta kan tolkas som att byggherarna utnyttjat den välkända pythagoranska 3-4-5-triangeln för utläggning av sidorna som för de två stora skeppssättningarna vid Badelundan utanför Västerås. Andra ofta förekommande axelförhållanden pekar mot att man också använt sig av både kvadrater, som vid Rannarve på Gotland, och liksidiga trianglar som vid Vedebäck utanför Karlskrona.
Trots att skeppssättningar tillkommit under en lång tidrymd har de uppförts enligt samma regler. Konstruktionerna vittnar om en ingående kändedom om geometri och om en vilja att tillämpa denna kunskap.
Skeppssättningar kortare än 40 meter företer en svag tendens att föredra en nord-sydlig orientering. Förvånansvärt nog delar de längre skeppssättningarna inte denna samordning utan ligger jämnt fördelade runt horisonten.