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RESEARCH REPORT

The Astronomical Significance of the Crucuno Stone Rectangle

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thro' the whins, an' by the cairn . . .
ROBERT BURNS, *Halloween*

While we were engaged on extensive surveys in the Carnac area in Brittany in July 1970, three of us (A. S. Thom, R. L. Merritt, and A. L. Merritt) decided to take a look at an unusual geometric configuration of megaliths—the rectangular Cromlech de Crucuno,[1] referred to by Niel (1970:156) as amongst the most remarkable megalithic monuments in the world.[2] As a result we produced a large-scale survey which is shown on a reduced scale in figure 1. Astronomical observations were made for azimuth so that the plan could be accurately orientated. The dotted rectangle was superimposed on the plan with its short sides exactly on the meridian. The rectangle as drawn is 30 × 40 megalithic yards[3] and so has a diagonal of 50.

[The above report was sent for comment to the same 50 scholars who were invited to participate in the review of the Baity article above (pp. 389–449), and the following responded: Rainer Berger, Geoffrey A. Clark, P.-R. Giot, Jonathan E. Reyman, Charles H. Smiley, Dean R. Snow, and James L. Swauger. Their comments are printed below and are followed by a reply from the authors—EDITOR.]

It is probably not coincidence that the two 3-4-5 Pythagorean triangles formed by the diagonal have sides which are multiples of 10 megalithic yards. Thom (1967, 1968) has shown that megalithic man, when constructing stone circles and rings in Britain, often dealt in multiples of $2\frac{1}{2}$, 5, and 10 megalithic yards, and employed perfect Pythagorean triangles in the geometry of the construction of numerous stone rings. Thom and Thom (1972) have shown that the main Carnac alignments were set out with a unit of $2\frac{1}{2}$ megalithic yards, and this is also found in the perimeters of practically all megalithic rings in Britain (Thom 1966, 1968). The Crucuno rectangle thus falls into line metrologically with other megalithic remains in both Britain and Brittany.

At Crucuno, as elsewhere in Brittany, well-meaning people have re-erected fallen stones without knowledge of the exact original positions. Knowing how accurately megalithic engineers could work, we think it unlikely that they left the untidy rectangle which we now see.[4] While elsewhere, when erecting freestanding circles, they measured to the centers of the stones, here they may have placed the stones outside but touching the rectangle. This too is unlikely, but only excavation can settle the matter.

On the south side of the rectangle, the whin bushes have grown so deep that some stones are obscured and are difficult to locate even when their presence is known—particularly the 3-ft. stone and the fallen stone in the southwest corner. The whin and the trees in the neighborhood make it impossible to measure the horizon altitudes, but the contours on the Institut Géographique National 1:25,000 map[5] show that only directly to the west is it likely that the horizon is elevated by much more than 10–15′. The site was doubtless chosen with this in mind.

It has been claimed that the diagonals of the Crucuno rectangle indicate the rising and setting points of the sun at the summer and winter solstices (Charrière 1965).[6] But such an arrangement for a 3 × 4 (or 30 × 40) rectangle is only possible where certain unusual conditions obtain. We shall proceed to explain these conditions.

First let us find the latitude in which a 3 × 4 rectangle could be used to show the sun rising and setting at both solstices. For zero true altitude of the sun's center, we have the simple relation $\sin \epsilon = \cos A \cos \lambda$, where ϵ is the sun's declination at the solstice (i.e., the obliquity of the ecliptic), A the azimuth, and λ the latitude. Since the Crucuno rectangle is 30 × 40 MY, $\cos A = 3/5$ and so $\cos \lambda = (5/3) \sin \epsilon$. If $\epsilon = 23°54'$ (the obliquity of the ecliptic about 1800 B.C.), $\lambda = 47°31'$. It is remarkable that this is so near to the latitude of Crucuno, 47°37′.5.

Refraction raises the sun more and more as it approaches the horizon, so that when the true altitude of the sun's center is zero, the apparent altitude of the upper limb is about 41′ and that of the lower limb about 15′. This last is not very different from the estimated horizon altitudes at Crucuno other than in the west.

We deduce that the diagonals of a 3 × 4 rectangle in the latitude of Crucuno with the short sides in the meridian will show the sun apparently resting on the horizon provided that the horizon has an altitude of about 14′. If the altitude of the horizon to the west is $(14' + h)$ and to the east is $(14' - h)$, the rectangle will still be correct, but the short sides will need to be directed about $1.37h$ to the west of North. The erectors need not have known that the orientation was not in the meridian.

Now we consider whether the long sides of such a rectangle can show the sun on the horizon at the equinoxes. As has been shown elsewhere (Thom 1967: chap. 9), megalithic man's equinox occurred when the sun's declination was about + 0° 25′. For a line lying exactly east and west, this needs,

[1] The Cromlech de Crucuno is located in a field called "Parc Vinglass" (Gaillard 1892:18) or "Parc vein glass (le champ de la pierre bleue)" (Gaillard 1883:5), about 1,200 ft. east of the hamlet of Crucuno (Erdeven, Morbihan).

[2] Niel (1966:15) and Gaillard (1892:18) both note that the Crucuno rectangle is a "très rare" form of cromlech.

[3] Thom (1966, 1967, 1968) has shown that megalithic man in Britain used a very precise unit of length of 2.720 ± 0.003 ft.—the megalithic yard (MY). A study of the alignments at Le Ménec shows a value of the MY of 2.721 ± 0.001 ft. (Thom and Thom 1972). Fletcher (1968) postulates a derivation of the MY from the double *remen* of predominantly Egyptian provenance. It is interesting to observe that the double *remen* was a length of 40 digits, whereas the MY was a length of 40 megalithic inches (Thom 1969). Ivimy (1969) suggests that the MY is $\sqrt{5}$ *remens*, or the diagonal of a 2 × 1-*remen* rectangle. Newham (1972:26) interprets the geometrical designs at Stonehenge to be based on a Lunar Measure (LM) of 47.6 ft., which equals $17\frac{1}{2}$ MY.

[4] Giot (1960:120) states that "unfortunately we do not know what it was like before the restoration." Niel (1970:157) makes a similar observation and refers (1970:172) to a "restauration maladroite vers 1890," but Gaillard (1883:4) asserts that the exactness of the restoration is beyond doubt.

[5] Institut Géographique National Auray Nos. 1–2 map sheet of the Carte de France, scale 1:25,000.

[6] Charrière (1965:166, 168) states that it is the upper limb of the sun to which the diagonals point today at the solstices, i.e., first and last gleam ("le soleil, quand son bord supérieur apparait à l'horizon").

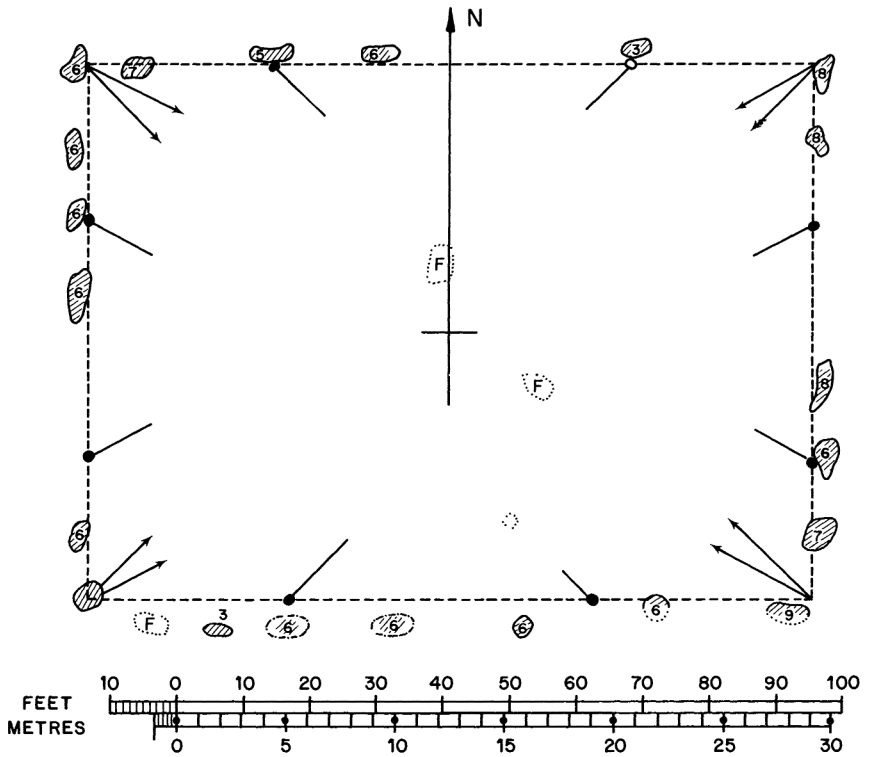

FIG. 1. The Crucuno rectangle (lat. 47°37′.5 N, long. 3°07′.3 W; map reference 19003059). Dotted parts of stone outlines indicate an uncertainty in the outline; on the south side of the rectangle, the stones were so covered by whin bushes that it was extremely difficult to obtain an accurate outline. Numbers beside the stone outlines represent the heights of the stones in feet; *F* indicates a fallen stone. Arrows and dots indicate directions to the rising and setting points of the moon in its extreme positions.

at Crucuno, a true altitude of the sun's center of some 33′, which corresponds to a lower-limb apparent altitude of about 43′. Looking to the west, the higher ground at Crucuno itself produces roughly this altitude, but to the east the ground does not seem to be high enough. Thus on our present knowledge of the horizon altitudes it appears that the equinox would be shown by the lower limb of the sun setting on the line of the long side of the rectangle. However, we cannot yet exclude the possibility that the actual altitudes all round are such that the rectangle could have been orientated to show the solstices and the equinoxes at both rising and setting.

In figure 1, the rising and setting points of the moon in its extreme positions are shown by arrows at the corners pointing to dots on the far sides of the rectangle. It will be seen that five of these dots are at stone positions and the remaining three are in gaps where there may have been stones. There is thus a possibility that the moon in its eight "standstill" positions was indicated. It could only have been *indicated* because for this kind of observation to be of any use the necessary accuracy is about an arc minute (and this is attained elsewhere; see Thom 1971; Thom and Thom 1971, 1972), and at Crucuno it is doubtful if an accuracy of half a degree was possible.

It should be understood that Crucuno, unless it had foresights some distance away, could never have been more than a symbolic observatory like Castle Rigg in the north of England near Keswick, Cumberland (Thom 1971:12). In the absence of such foresights the rectangle would have been useless as a scientific observatory, although precise lunar observations such as are required for eclipse predictions were made elsewhere in the neighborhood (Thom and Thom 1971). It could have been used, however, to give the calendar dates corresponding to the equinoxes. A second visit, in 1972, showed that the necessary foresights may indeed have existed.

On the high ground to the west, close to the hamlet of Crucuno,[7] lies the stone called "La Chaise du Pape,"[8] 875 ft. from the center of the rectangle. This stone is close to the horizon as seen from the rectangle, and may indeed have appeared on the skyline before it fell. The azimuth and altitude from the center of the rectangle are 268°.0 and 0°.8. An observer remaining inside the rectangle and using La Chaise du Pape as a foresight could obtain a declination range of −2°.8 to +0°.8. Standing at the southwest corner, he could see the upper limb of the sun appear on La Chaise du Pape when the sun's declination was +0°.5, almost exactly the value at megalithic man's equinox.

Farther along the high ground to the south, there are three fallen menhirs 9 to 12 ft. long.[9] These seem to have formed an alignment about 40 ft. long at an azimuth of 115° ± 10°. From the center of the rectangle the azimuths of the menhirs are *about* 236°.1, 237°.0, and 237°.8 and the horizon altitudes about 0°.8. The possible declinations from the rectangle range from −18°.8 to −23°.7. Bearing in mind that the declination of the upper limb of the solstitial sun was −23°38′ and that the lunar declination at the minor standstill was −18°45′ (parallax affects the apparent declination by about 44′), we find that the necessary backsights for solar and lunar work lay close to diagonally opposite corners of the rectangle. Today trees prevent direct measurement of the azimuths, and the necessary traverse surveys were further complicated by growing crops. Before we attempt more accurate work, we hope that a trained archaeologist, with the permission of the French government, will undertake to carefully excavate the inside of the rectangle where several stones show up in the vegetation. These may give a clue as to where the actual backsights were intended to be.[10]

[7] Within a privately owned parcel of land originally named "Tal Ty Pabe" (translated literally, "Près de la maison du Pape") on the Cadastre in 1834 (M. Isnard, personal communication, May 3, 1972).

[8] This menhir was located with the kind assistance of M. Isnard, Le Directeur de la Brigade topographique Nationale du Cadastre, Paris, to whom we wish to express our deep appreciation of his interest, and that of his staff, in our project. M. Isnard also called to our attention that the axis of the Dolmen du Crucuno points to La Chaise du Pape, and that the latter was visible from the dolmen before the construction of buildings in the hamlet.

[9] In Le Rouzic (1965:80) the three fallen menhirs are called "Er Men Cam."

[10] Sitwell (1930:96) states that when he visited Crucuno in 1926 there was "a large single menhir more than 100 yards" to the northwest of the rectangle. This menhir is no longer standing, and we did not locate its former position.

Comments

by RAINER BERGER

Los Angeles, Calif., U.S.A. 1 III 73

It would be highly desirable to establish when the Crucuno stone rectangle was built by searching carefully for material suitable for radiocarbon dating. We need to know more about the evolution of megalithic observatories. Our laboratory would be glad to participate in dating programs to elucidate this question.

by GEOFFREY A. CLARK

Tempe, Ariz., U.S.A. 12 III 73

Being neither a mathematician nor an astronomer nor an expert on paleometrology, I will limit myself to the following general comments:

1. This is a highly specialized article about a rather obscure subject: paleometrology (a term, incidentally, which appears nowhere in the paper). Too much knowledge is assumed of the reader with respect to general objectives of paleometrological research and its accompanying methodology. Most major libraries have copies of Thom's (1967, 1971) recent books; however, knowledge of paleometrology among anthropologists is limited to a very small number of specialists. Some prefatory remarks would have been in order. A paper describing the checkered historical background of paleometrological research (e.g., pyramidology), contemporary objectives, and the rather complex methodology (quantum mathematics) employed in the derivation of ancient units of measurement would have been of more general interest to CA readers than the report submitted. Thom is eminently qualified to write such a paper.

2. Concerning the article itself, there are so many potential sources of measurement error (inaccurate reconstruction of the rectangle, measurement difficulties due to vegetation) as to cast doubt on conclusions based upon the determinations used, which are treated, in spite of caveats, as reliable. A horizon elevation of 10 to 15 minutes is considerable, not slight, and so the argument for site location based upon the topographical situation at Crucuno does not follow.

3. The authors' discussion of lunar extreme positions vis-à-vis the Crucuno rectangle seems consistent with the data presented. Although predicated on an uncertainty (the positions of the missing stones), conclusions appear to follow logically and the authors' reservations are commendable.

4. The mathematical derivation of quanta to pragmatically absurd levels of precision should not, as Thom et al. seem to suggest (n. 3), be taken to imply that prehistoric man employed such units. It should be borne in mind that any quantum may be a multiple or submultiple or may in fact correspond to the real but unknowable standard used (Broadbent 1955:46, 47; Hudson 1971). However, a quantum is a mean and is accompanied by a standard deviation. The standard described by that mean, like measurement units employed today, is used in daily life only as an approximation. An analogous situation would be to determine the length of a foot by precisely measuring a large number of twelve-inch rulers. The values could be carried to an infinite number of decimal places (because length is a continuous variable), but such precision is irrelevant to the standard used in daily life. Thus to convey the impression that "megalithic man" thought in terms of a standard "megalithic yard" equivalent to 2.720 ± 0.003 ft. seems unjustified.

5. Finally, the Fletcher (1968) derivation of the megalithic yard from the Egyptian double remen (n. 3) is reminiscent of the diffusionist model carried to such extremes by the so-called pyramidologists (e.g., Pickett 1928:42; cf. Fakhry 1969:123, 124) and so thoroughly discredited in recent years (Hudson 1971). It may be interesting to observe, for example, that the megalithic yard is $\sqrt{5}$ remens, but it is also probably coincidental and irrelevant.

by P.-R. GIOT

Rennes, France. 20 II 73

The supervisor of the 1882–83 reconstruction of the Crucuno rectangle, Gaillard, published his plan of the monument in his own pioneer book on prehistoric astronomy (1897:144). As there were more fallen stones than still erect ones, for a long time we suspected that the perfect orientation and proportions of the reconstructed monument were the result of Gaillard's theoretical views. A first result of the Thom et al. survey is to vindicate the purity of Gaillard's intentions.

by JONATHAN E. REYMAN

Normal, Ill., U.S.A. 9 III 73

As the authors admit, thorough demonstration of the astonomical alignments of the Crucuno rectangle must await excavation and proper placement of the fallen stones (assuming that the latter can be done). Nevertheless, from the results of their preliminary study, we can accept their inferences that (1) the site fits with others in Britain and France in that its construction was based on the megalithic yard (MY) and (2) its ground plan embodies significant solar and lunar orientations. Furthermore, it is becoming increasingly clear from this and other reports (e.g., Thom 1967, 1971) that although Pythagoras may have been the first to describe in writing the geometric principles of the 3-4-5 right triangle, the abstract formulation and systemization of these principles and their operationalization in engineering predate his work by 1,500+ years.

The builders' incorporation of astronomical alignments and the 3-4-5 triangle are interesting in themselves; yet I am bothered by the fact that the authors offer no explanation for *why* the Crucuno rectangle was constructed. Thom (1971:10–11) has previously argued that many megalithic sites, especially in south Argyllshire, England, were lunar observatories used in connection with navigation of the Sound of Jura and other waters. This may have been the case for certain sites, but it is not an adequate explanation for the large number and close proximity of the existing structures, particularly those which are not immediately adjacent to the coast. Moreover, the evidence indicates that the study of lunar motion was carried far beyond the requirements of navigation (Thom 1971:11).

What, then, was the purpose(s) of these sites, including Crucuno and others in Brittany? The authors state that the site of Crucuno was *deliberately* chosen because of the relatively flat horizon. Is this the whole answer? Probably not, and perhaps it is time to begin examining the cultural-ecological contexts in which this and other sites are found.

What do the archaeological data tell us regarding the subsistence patterns of the area at 1800 B.C.? How would we classify the people who built Crucuno? Were they hunter-foragers, or pastoralists, or agriculturalists? What are the relationships among these ecotypes, the site location, and the astronomical orientations? Did the builders construct the Crucuno rectangle with sufficient accuracy to allow its use as a calendrical device in conjunction with the agricultural cycle (assuming that these people were agriculturalists)? The answer to this last question must await excavation of the site. At this point, however, it seems that we have sufficient data to begin formulating *specific* problems, hypotheses, and test implications regarding the prehistoric use of Crucuno and other megalithic "observatories."

by CHARLES H. SMILEY
Providence, R.I., U.S.A. 18 III 73

I have followed with interest Thom's work on units of length and orientations of megalithic circles. The only comment I have to make on this paper concerns possible astronomical orientations with respect to the Milky Way passing through the zenith. In such a case, the Milky Way meets the horizon at right angles at two points opposite each other, generally twice a day, although both will not necessarily be seen in a dark sky in the same season. The diagonals of the rectangle at Crucuno might represent two such orientations with respect to the Milky Way in A.D. 994. I suspect that Thom and his colleagues will be able to discard this because of the lateness of the date.

In the following, the discussion will be limited to the northern hemisphere, although a similar discussion would hold for the southern hemisphere. In 4442 B.C., the north pole of the Milky Way (considered as a great circle) was seen in the zenith at latitude 53° 57′ .5 N, and the Milky Way was seen around the horizon once a day. In latitude 36° 02′ .5 N at the same time, the Milky Way was seen to pass through the zenith and to meet the horizon at the east and west points once a day; that is, the Milky Way lay along the prime vertical once a day. As time passed, the Milky Way was seen around the horizon at points farther south and along the prime vertical at latitudes farther north.

In 2800 B.C., the Milky Way was seen along the horizon at Stonehenge, and in 116 B.C. it was seen along the prime vertical there. By 1300 B.C. at latitude 45° N, the Milky Way could be seen in the plane of the horizon and (at another season, to have a dark sky, of course) in the prime vertical.

In general, at latitudes south of that for which the Milky Way is seen along the prime vertical, it will be seen to pass through the zenith in a vertical plane twice a day, with azimuths symmetrical with respect to the north-south line.

There appears to be some evidence that in Central and South America, stone structures and desert lines were oriented with respect to the Milky Way passing through the zenith.

In these comments, a period of precession of 25,725 years has been used, and the Milky Way passed through the vernal equinox in 4442 B.C.

by DEAN R. SNOW
Albany, N.Y., U.S.A. 17 III 73

So far, archaeoastronomy and ethnoastronomy have flourished amidst the largely uncritical enthusiasm that often follows a new scientific revelation. My inclination is to accept the astronomical significance of the Crucuno stone rectangle at face value. Still, we are told that "an observer remaining inside the rectangle and using La Chaise du Pape as a foresight could obtain a declination range of −2° .8 to +0° .8." Using the authors' own figures, I get a declination range of 2.5 times that amount. Their figure is therefore either inadequately explained or in error. It seems that the removal of bothersome bushes is not the only kind of clarification required before the site can be properly assessed. I look forward to seeing detailed and exhaustive analyses of this and similar sites, because without them the valuable contributions of these and other investigators may not survive the general housecleaning that must eventually occur in this somewhat too popular subdiscipline.

by JAMES L. SWAUGER
Pittsburgh, Pa., U.S.A. 16 III 73

Another in a lengthy series of studies on archaeoastronomy by the major author in particular, this article is impressive in its sober appraisal of the Crucuno megalithic arrangement. Thom et al. carefully point out that the Crucuno arrangement does not comprise an exact "scientific observatory" despite the occurrence of use of the megalithic yard, Pythagorean triangles, and minor azimuth deviations. Not yet as convinced as some of the precision of other monuments probably used as astronomical tools, I believe it possible that the Crucuno arrangement was used empirically as such a tool despite its lack of perfect alignments.

Reply

by ROBERT L. MERRITT
Cleveland, Ohio, U.S.A. 12 IV 73

Some of the comments on our report on the Crucuno stone rectangle demonstrate the desirability of restraint in interdisciplinary response.

Geoffrey A. Clark, being neither a mathematician nor an astronomer nor an expert on paleometrology, perhaps should not have responded at all. This is a research report on archaeoastronomy, not paleometrology. The astronomical aspects of the Crucuno site and of the 3 × 4 stone rectangle would have been the same whether the unit of measurement employed in the construction of the rectangle were the megalithic yard, the meter, the English foot, or some other unit. It *is* significant that we find the sides to measure 30 × 40 megalithic yards, and the diagonal 50, consistent with findings elsewhere in Brittany and in Britain (including our 1972 surveys in the Orkney Islands), but that is not the main thrust of the article. For a recent Fourier type of analysis of A. Thom's megalithic yard data, see Kendall (n.d.).

Dean R. Snow's general comments seem inappropriate. Moreover, Snow is in error in asserting a declination range from inside the rectangle, using La Chaise du Pape as a foresight, of 2.5 times that stated. Snow does not give his computations. I refer him to the formula given in Thom (1967:17) and remind him to take account of refraction (see Thom 1967:25).

We are pleased to have from Pierre-Roland Giot the reference to Felix Gaillard's published plan of the Crucuno rectangle. Gaillard's book, *L'Astronomie préhistorique,* is not listed in the National Union Catalog, and is not known to me to be in any library in the United States. However, I find that early issues of *Les Sciences Populaires,* including the 1895 and 1896 volumes (2^{e} series, vols. 9 and 10), which contain the original Gaillard articles (reprinted in *L'Astronomie préhistorique*), are in the Library of Congress and in the Library of Harvard College Observatory. CA readers in the United States who wish to study the original Gaillard articles can find them there.

Rainer Berger correctly states the desirability of obtaining radiocarbon dates for megalithic observatories. For a provisional chronology for the geometric designs of megalithic sites, based on evidence from architecture, carbon-14, and artifacts, see Burl (1973).

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