

SOME CROMLECHS IN NORTH WALES.¹

II.

BEFORE I refer to other matters I give a plan made by Mr. Neil Baynes, which he kindly permits me to use, of the cromlech at Ty Newydd. It shows well the kind of nut the archæologist has to crack when cromlechs are studied astronomically. It appears

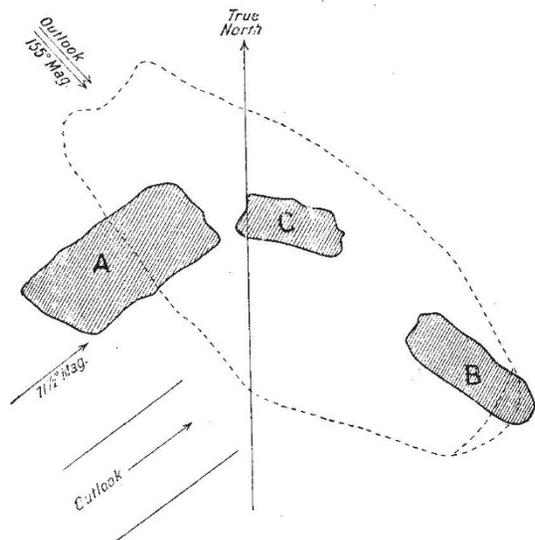


FIG. 6.—Plan of the Ty Newydd Cromlech.

twice in Mr. Griffith's list. I made it out as oriented to the *winter* solstice rising, Mr. Baynes to the *summer* solstice rising. We took our angles along two surfaces of the same nearly rectangular supporter A; I nearly along the line of the quoit, he across it. I also give a copy of a photograph taken by my wife showing the clino-compass in the line of the outlook between the stones A and C. Either reading may be the correct one, but, be it remarked, *both are solstitial*, and no other astronomical alignment is suggested by the arrangement of the stones. It may be that the outlook was between the stones C and B, the direction being parallel to the south surface of A, and not as I placed it; on this view we are dealing with the summer solstice sunrise, and this may be accepted for the statistical statement.

With regard to the *distribution* of the sight-lines, the most abundant are the solstitial; summer solstice, 3, winter solstice, 4, total 7.

Next comes the May year, both May and November (3), and last of all the equinoxes (2). With regard to warning stars, two alignments to the Pleiades were noted; of cromlech alignments on a clock-star none was seen. There is one case at Lligwy of a clock-star alignment from an equinoctial cromlech. At Plas Newydd and Bryn Celli Ddu there were outlying stones to be further examined.

As the measures recorded by Mr. Griffith are the only ones available, we are compelled, if we wish to make comparisons with other temple-fields, to take them as fair samples of the distribution of the various alignments in the region under investigation, although the number of cromlechs included, fifteen, is doubtless

¹ Continued from vol. lxxviii., p. 635.

only a small fraction of those which remain to be examined when the Welsh archæologists set to work.

The most remarkable fact is the total absence of circles and avenues in the region examined. In another cromlech region, Brittany, we have no circles, but a preponderance of avenues.

Next, the Cornish solar monuments deal chiefly with the May year. This is reversed in North Wales, where the solstitial year is mainly in question. In Brittany the avenues seem fairly divided between the May and solstitial years; touching the cromlechs there I have no information.

Another point is the absence of clock-star alignments. This, perhaps, may be associated with the absence of circles either of the Cornish or Aberdeen type. In Aberdeenshire we find a very large proportion of the alignments set out for observations of clock-stars. In Cornwall they are about as numerous as the solar alignments. Indeed, the great distinction between North Wales and Aberdeen lies, not only in the absence of cromlechs in Aberdeen, but in the large percentage of clock-star alignments as compared with solar alignments. There is an inversion,

I pointed out when discussing the Aberdeen results that the number of true north alignments, almost entirely absent in Cornwall, might indicate that clock-star work was being given up in consequence of a much better knowledge of astronomy rendering the observations of the *rising* of clock-stars unnecessary. The question is, does this consideration explain the very small attention to clock-stars in North Wales? If so, North Wales is later than Aberdeen. In true north alignments a cromlech could not be conveniently used, but, unfortunately, circles seem not to have entered into the North Wales building system, so that the question cannot be settled by statistics.

In Aberdeenshire the number of May-year and solstitial alignments measured was about the same, but I found reason for thinking that some May monuments had been tampered with. As these were not included in the tables, there was a slight prepon-



Photo. by Lady Lockyer.

FIG. 7.—The Ty Newydd Cromlech looking S.E.

derance to the solstitialists, but not so great as in Wales.

There are many arguments which may be used to show that, as in Egypt, the solstitial year followed the May year, and, accepting them, there is a clear indication that the more prolific building period in North Wales was later than in Cornwall.

I have already given my opinion that the balance of the evidence is in favour of the view that the building period in Aberdeen was later than in Cornwall.

When more observations are available to compare the lateness of North Wales with that of Aberdeen, a question of great interest will be presented to the

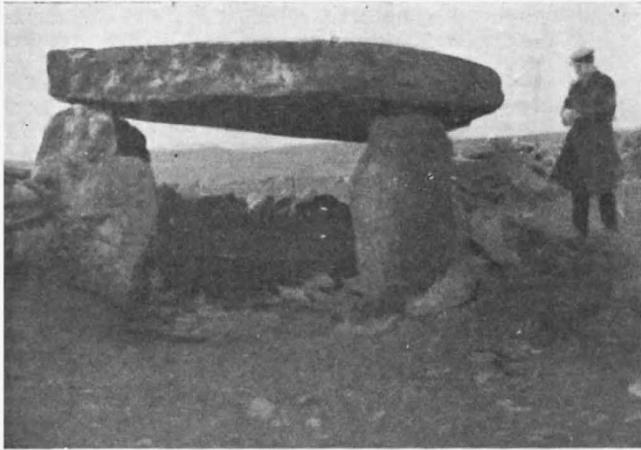


FIG. 8.—Ystym Cegid (Ple'ades)

Photo by Lady Lockyer.

Welsh archæologists; but already it may be gathered from the preceding summary of the facts so far garnered that they are in harmony with the information handed down from Roman times.

Cæsar does not locate the Druids,¹ except that there were none in Germany. But Tacitus only refers to them in Anglesey (Mona), "A common refuge for all the discontented Britons."² In his account of the attack upon the island (p. 30) he tells us:—"The Druids were ranged in order with hands uplifted, invoking the gods, and pouring forth horrible imprecations." He adds, "The religious groves, dedicated to superstitious and barbarous rites, were levelled to the ground."

I cannot help thinking that unless Anglesey were specially Druidical, Tacitus would have referred to Druidism in other parts of his history, and that the Roman writers refer to the occupation of Anglesey by the Druids in such a way as to suggest that they did not come across them in force anywhere else.

If a large number had taken refuge in Anglesey after they had been driven by one race or another from their former haunts elsewhere, we should expect their temple building to be such as we have found it, *i.e.* a few monuments of the most ancient type, showing that it was from the earliest times a druidical sanctuary, scattered among a larger number of comparatively modern provenance.

I now come to the method employed in laying out the cromlechs. In previous notes I have pointed out that it was to be gathered from the Cornish cromlechs that the actual direction of the completed struc-

ture was parallel to the principal face of one of the supporting uprights, and that probably this setting out of the alignment was the work of one possessing a greater knowledge than those who eventually completed the erection. This view has been entirely borne out by the Anglesey cromlechs; Pant y Saer is a good case in point; there are three stones parallel to the alignment, and two at right angles to it. The S.E. stone on Bryn Celli Ddu dominates the orientation of the creepway, as I have already stated.

In the case of some cromlechs which have been surveyed with great care by Mr. Baynes, and of which he has been good enough to send copies of the plans which have been published in the "Archæologia Cambrensis" or elsewhere, most extraordinary blunders in the direction of the north point have been brought to light. No wonder that the solstitial alignment of Bryn Celli Ddu was not recognised when its orientation on the plan was 35° out!

Although I have dealt with some of the general questions which have been raised by the observations made by Lord Boston, Mr. Baynes, the Rev. J. Griffith, and myself on the small number of North Wales cromlechs which we were able to measure in the limited time at our disposal, they are by no means exhausted. It may also be added that when the orientations of a much larger number have been recorded the general questions raised are certain to be increased.

It is worth while to point out again that all the orientations found in North Wales are identical with those already noted in Cornwall and elsewhere; by which, of course, I do not mean that the sight-lines are parallel, but that their object was the same; and no better proof of this could be afforded than by



FIG. 9.—Pant y Saer (May Sunrise).

Photo by Lady Lockyer.

the facts that to secure the same object the differences of latitude, azimuth, and height of the horizon, when taken into account, give us the same declinations of the sun at the summer and winter solstices, and for the critical dates of the May year when the sun's declination is 16° 20' N. and S.

Work is also provided for the new Royal Commissioners who, I am delighted to learn, have now been appointed to study the few remnants of the ancient monuments of England, Wales, and Scotland which still remain to us, in spite of the ignorance and carelessness of successive governments and owners.

¹ "Bello Gallico," vi., 13-14, 16-21.

² Annals, xiv., 29. Murphy's Translation. (Dent and Co.)

Before the astronomical study of them was commenced a very few years ago, if we accepted the available records the cromlechs were all directed helter-skelter, their sight-lines were without any meaning, and no astronomical or practical use was served by them, except, perhaps, as tombs. A comparatively few observations have sufficed to show the absurd inaccuracy of these views; for full light we may be content to wait for the authoritative inquiries now happily commenced. That our knowledge will be largely increased in many directions there is no room to doubt.

NORMAN LOCKYER.

NIAGARA AS A GEOLOGICAL CHRONOMETER.

THE use of Niagara as a geological chronometer dates from the visit there of Lyell in 1835. He recognised that the Falls must date from the close of the Glacial period, and that the Niagara gorge must have been excavated since the retreat of the glaciers from the Great Lakes. The necessary assumptions as to uniformity of rate and condition being granted, he held that the length of the gorge divided by the amount which the Falls recede up-stream annually would give the length of post-Glacial times for the Niagara district in years. He realised the uncertainty of some of the data, but estimated that the age of the Falls is about 35,000 years. The problem, however, is not to be solved by simple rule of three, for the data are complex, and there are many variable factors. Lyell himself used one of the unknown elements to explain the formation of the Niagara Whirlpool. He rightly attributed it to the existence of a channel filled with drifts, which are now worn away more quickly by the river than the rocks of the old river banks; and if part of the existing gorge had been formed by the re-excavation of a channel filled with drift, the process would have been much quicker than if the Falls had to cut their way for the whole distance through the hard Niagara limestone. Lyell's estimate has therefore been greatly reduced by some later geologists, and Dr. G. K. Gilbert has allowed the Niagara Falls a life of only some 7000 years, with a possibility of even considerably less.

The last contribution to the Niagara question is a monograph by Dr. J. W. W. Spencer, published by the Canadian Geological Survey.¹ It makes two important additions to the known facts. A series of borings has been made to determine the course of the former river channel which is exposed at the Niagara Whirlpool, and the Niagara River below the Falls has been carefully sounded. The soundings have proved the existence of a basin 192 feet deep immediately below the Falls; the river then shallows, until at the Cantilever Bridge the depth is only 86 feet. The basin is due to the filling up of the channel by material that has fallen in from the sides of the gorge after the Falls have passed up-stream, a fact proved by work undertaken in connection with the foundations of the bridge.

Dr. Spencer, in addition to these important contributions to the facts, has carefully re-discussed the evidence and shown how complicated the problem is, owing to the numerous post-Glacial changes in the physical geography of the Niagara area during the lifetime of the Falls. According to his calculations, the Falls have receded up-stream at a mean rate of 4.2 feet per annum, during the sixty-three years between 1842 and 1905. The rate of retreat is not uniform, for the process consists in the cutting of a V-shaped groove, which is gradually widened during a period

¹ "The Falls of Niagara: their Evolution and Varying Relations to the Great Lakes; Characteristics of the Power and the Effects of its Diversion." (Ottawa: Geol. Survey of Canada, 1907.) Pp. xxxi+490; plates and maps.

when there is no recession of the notch; the edge of the Falls thus becomes straighter, and then the formation of the horse-shoe curve begins again. By the double process $7\frac{3}{4}$ acres of the river bed above the Falls have been removed since 1842.

The precise measurements of the recession of the Falls in recent years have been accompanied by increasing recognition of the extreme complexity of the problem. The existing river system connected with the Great Lakes necessarily dates from the close of the Glacial period in that area; for it was not until the ice had disappeared that rivers could be formed, and many of them had their sources in the extensive glacial lakes along the receding ice-front. The course of these rivers altered as the lake levels were lowered, and also in consequence of earth-movements, possibly due to the removal of the ice-load.

When the waters of Niagara first fell from the plateau into the basin of Lake Ontario they had a fall of only 35 feet, for the lake then stood at the level of some of its uppermost beaches, and the river discharged directly into the lake. The power of the Falls was then comparatively small, for they had only 20 per cent. of their present height, and only 15 per cent. of the present volume. For the Niagara River was then fed only by the overflow from a comparatively diminutive lake in the lowest depression on the plains now covered by Lake Erie. The drainage from the Great Lakes, instead of passing through Lake Erie into the Niagara River, was collected into Lake Huron, and was discharged through the gap containing Lake Nipissing to the valley of the Ottawa River.

This arrangement was disturbed by the subsidence of the country to the north-east of Lake Ontario, whereby the level of that lake was lowered, and the outlet from Lake Huron to the Ottawa River closed. A fresh channel was opened from the southern end of Lake Huron through a valley now filled up with drift into Lake Ontario. Further movements led to the closing of this outlet, and the waters of Lake Huron flooded the valleys of the southern tributaries and the area that is now Lake St. Clair. The level of the lake rose until it found an outlet at the head of the Detroit River into Lake Erie, and thus at length Niagara received the overflow from the Great Lakes.

A further complication is introduced by the fact that for one period the Great Lakes had an escape southward from Lake Michigan, near Chicago, into the Mississippi; but this outlet appears to have existed for a comparatively short time.

The value of Niagara as a geological clock is therefore open to grave suspicion, for the erosive power of the Falls must have varied enormously, both with the varying resistance of the rocks and with the varying volume of the Niagara River and height of its Falls. Nevertheless, Dr. Spencer is delightfully confident of the exact accuracy of his conclusions. "The work of the Falls of Niagara along its whole course has now been made known," and the author claims that his work has brought the dates of the various geographical episodes at Niagara out of the realm of speculation. He rejects the shorter estimates of the length of the Niagara Falls, and somewhat exceeds the result adopted by Lyell, for he assigns them an age of 39,000 years. He also claims to have determined in years the date of the chief episodes in the life-history of the Falls. According to Dr. Spencer, the overflow from Lake Michigan to the Mississippi occurred from 2000 to 2500 years ago; the Falls were at the Whirlpool 3000 years ago, and the capture of the discharge from the Great Lakes by the Niagara River happened 3500 years ago.

The future of the Great Lakes and of Niagara is threatened by two dangers. The diversion of water