

AN ATTEMPT TO ASCERTAIN THE DATE
OF THE ORIGINAL CONSTRUCTION OF
STONEHENGE FROM ITS ORIENTATION.¹

THIS investigation was undertaken in the spring of the present year, as a sequel to analogous work in Egypt and Greece, with a view to determine whether the orientation theory could throw any light upon the date of the foundation of Stonehenge, concerning which authorities vary in their estimate by some thousands of years. We beg to lay before the Royal Society the results derived from a careful study of its orientation for the purpose of arriving at the probable date of its foundation astronomically. This is not, indeed, the first attempt to obtain the date of Stonehenge by means of astronomical considerations. In Mr. Godfrey Higgins' work² the author refers to a method of attack connected with precession. This furnished him with the date 4000 B.C.

More recently, Dr. W. M. Flinders Petrie,³ whose accurate plan is a valuable contribution to the study of Stonehenge, was led by his measures of the orientation to a date very greatly in the opposite direction, but, owing to an error in his application of the change of obliquity, clearly a mistaken one.

As the whole of the argument which follows rests upon the assumption of Stonehenge having been a solar temple, a short discussion of the grounds of this view may not be out of place; and, again, as the approximate date which we have arrived at is an early one, a few words may be added indicating the presence in Britain at that time of a race of men capable of designing and executing such work.

As to the first point, Diodorus Siculus (ii. 47) has preserved a statement of Hecataeus in which Stonehenge alone can by any probability be referred to.

"We think that no one will consider it foreign to our subject to say a word respecting the Hyperboreans.

"Amongst the writers who have occupied themselves with the mythology of the ancients, Hecataeus and some others tell us that opposite the land of the Celts [*ἐν τοῖς ἀντιπέραν τῆς κελτικῆς τόποις*] there exists in the Ocean an island not smaller than Sicily, and which, situated under the constellation of The Bear, is inhabited by the Hyperboreans; so called because they live beyond the point from which the North wind blows. . . . If one may believe the same mythology, Latona was born in this island, and for that reason the inhabitants honour Apollo more than any other deity. A sacred enclosure [*ἅγιον*] is dedicated to him in the island, as well as a magnificent circular temple adorned with many rich offerings. . . . The Hyperboreans are in general very friendly to the Greeks."

The Hecataeus above referred to was probably Hecataeus of Abdera, in Thrace, fourth century B.C.; a friend of Alexander the Great. This Hecataeus is said to have written a history of the Hyperboreans: that it was Hecataeus of Miletus, an historian of the sixth century B.C., is less likely.

As to the second point, although we cannot go so far

¹ By Sir Norman Lockyer, K.C.B., F.R.S., and F. C. Penrose, F.R.S., communicated to the Royal Society on October 19.

² "The Celtic Druids," 4to. (London, 1827.)

³ "Stonehenge," &c. 1880.

back in evidence of the power and civilisation of the Britons, there is an argument of some value to be drawn from the fine character of the coinage issued by British kings early in the second century B.C., and from the statement of Julius Cæsar (*de bello Gallico*, vi., 13) that in the schools of the Druids the subjects taught included the movements of the stars, the size of the earth and the nature of things (*Multa præterea de sideribus et eorum motu, de mundi magnitudine, de rerum natura, de Deorum immortalium vi ac potestate disputant et juventuti tradunt.*)

Studies of such a character seem quite consistent with, and to demand, a long antecedent period of civilisation.

The chief evidence lies in the fact that an "avenue," as it is called, formed by two ancient earthen banks, extends for a considerable distance from the structure, in the general direction of the sunrise at the summer solstice, precisely in the same way as in Egypt a long avenue of sphinxes indicates the principal outlook of a temple.

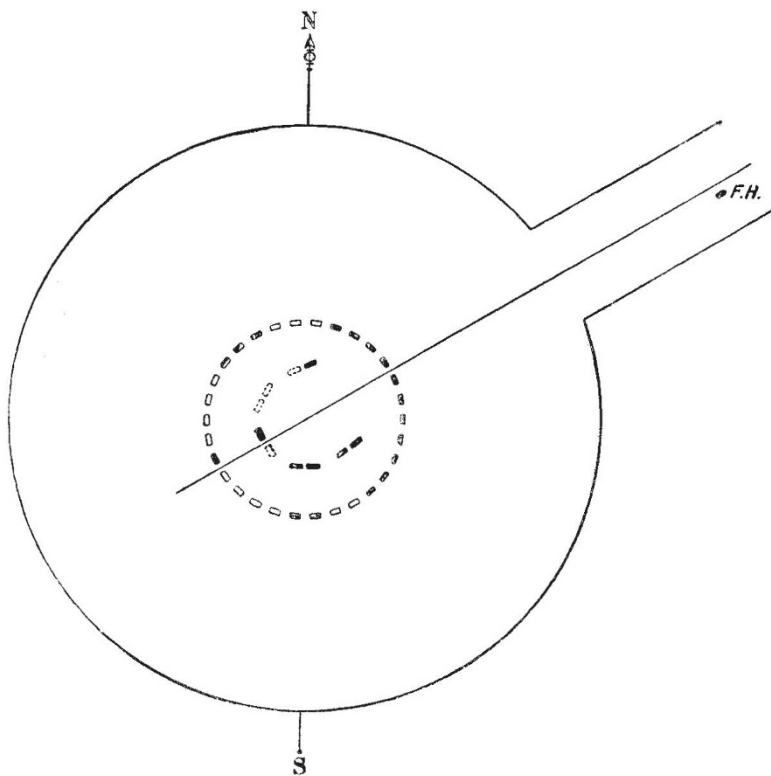


FIG. 1.—Plan of Stonehenge.

These earthen banks defining the avenue do not exist alone. As will be seen from the plan which accompanies this paper, there is a general common line of direction for the avenue and the principal axis of the structure, and the general design of the building, together with the position and shape of the Naos, indicate a close connection of the whole temple structure with the direction of the avenue. There may have been other pylon and screen equivalents as in ancient temples, which have disappeared, the object being to confine the illumination to a small part of the Naos. There can be little doubt, also, that the temple was originally roofed in, and that the sun's first ray, suddenly admitted into the darkness, formed a fundamental part of the cultus.

While the actual observation of sunrise was doubtless made within the building itself, we seem justified in taking the orientation of the axis to be the same as that

of the avenue, and since in the present state of the south-west trilithon the direction of the avenue can probably be determined with greater accuracy than that of the temple axis itself, the estimate of date in this paper is based upon the orientation of the avenue. Further evidence will be given, however, to show that the direction of the axis of the temple, so far as it can now be determined, is sufficiently accordant with the direction of the avenue.

The orientation of this avenue may be examined upon the same principles that have been found successful in the case of Greek and Egyptian temples—that is, on the assumption that Stonehenge was a solar temple, and that the greatest function took place at sunrise on the longest day of the year. This not only had a religious motive; it had also the economic value of marking officially and

that we can rely only on the secular changes of the obliquity as affecting the azimuth of the point of sunrise. This requires the measurements to be taken with very great precision, towards which care has not been wanting in regard to those which we submit to the Society.

The main architecture of Stonehenge consisted of an external circle of about 100 feet in diameter composed of thirty large upright stones, named sarsens, connected by continuous lintels, and an inner structure of ten still larger stones, arranged in the shape of a horseshoe, formed by five isolated trilithons. About one-half of these uprights have fallen and a still greater number of the lintels which they originally carried. There are also other lines of smaller upright stones respecting which the only point requiring notice in this paper is that none of them would have interrupted the line of the axis of the avenue. This circular temple was also surrounded by an earthen bank, also circular, of about 300 feet in diameter, interrupted towards the north-east by receiving into itself the banks forming the avenue before mentioned, which is about 50 feet across. Within this avenue and looking north-east from the centre of the temple, at about 250 feet distance and considerably to the right hand of the axis, stands an isolated stone, which from a mediæval legend has been named the Friar's Heel.

The axis passes very nearly centrally through an intercolumnation (so to call it) between two uprights of the external circle and between the uprights of the westernmost trilithon as it originally stood. Of this trilithon the southernmost upright with the lintel stone fell in the year 1620, but the companion survived as the leaning stone which formed a conspicuous and picturesque object for many years, but happily now restored to its original more dignified and safer condition of verticality. The inclination of this stone, however, having taken place in the direction of the axis of the avenue, and as the distance between it and its original companion is known both by the analogy of the two perfect trilithons and by the measure of the mortice holes on the lintel they formerly supported, we obtain by bisection the measure (viz. 11 inches) from its edge of a point in the continuation of the central axis of the avenue and temple, and which has now to be determined very accurately.

The banks which form the avenue have suffered much degradation. It appears from Sir Richard Colt Hoare's account that at the beginning of the last century they were distinguishable for a much greater distance than at present, but they are still discernible, especially on the northern side, for more than 1300 feet from the centre of the temple, and particularly the line of the bottom of the ditch from which the earth was taken to form the bank, and which runs parallel to it. Measurements taken from this line assisted materially those taken from the crown of the bank itself. With this help and by using the southern bank and ditch whenever it admitted of recognition, a fair estimate of the central line could be arrived at. To verify this, two pegs were placed at points 140 feet apart along the line near the commence-



FIG. 2.—The Temple Axis (shown by the direction of the stake on the fallen stone).

distinctly that time of the year and the beginning of an annual period.

It is, indeed, probable that the structure may have had other capabilities, such as being connected with the equinoxes or the winter solstice; but it is with its uses at the summer solstice alone that this paper deals.

There is this difference in treatment between the observations required for Stonehenge and those which are available for Greek or Egyptian solar temples—viz. that in the case of the latter the effect of the precession of the equinoxes upon the stars, which as warning clock stars were almost invariably connected with those temples, offers the best measure of the dates of foundation; but here, owing to the brightness of twilight at the summer solstice, such a star could not have been employed, so

ment of the avenue, and four others at distances averaging 100 feet apart nearer the further recognisable extremity, and their directions were measured with the theodolite, independently by two observers, the reference point being Salisbury Spire, of which the exact bearing from the centre of the temple had been kindly supplied by Colonel Johnston, R.E., the Director-General of the Ordnance Survey. The same was also measured locally by observations of the sun and of Polaris, the mean of which differed by less than 20" from the Ordnance value. The resulting observations gave for the axis of the avenue nearest the commencement an azimuth of $49^{\circ} 38' 48''$, and for that of the more distant part $49^{\circ} 32' 54''$. The mean of these two lines drawn from the central interval of the great trilithon, already referred to, passes between two of the sarsens of the exterior circle, which have an opening of about 4 feet, within a few inches of their middle point, the deviation being northwards. This may be considered to prove the close coincidence of the original axis of the temple with the direction of the avenue.

This value of the azimuth, the mean of which is $49^{\circ} 35' 51''$, is confirmed by the information also supplied from the Ordnance Office that the bearing of the principal bench mark on the ancient fortified hill, about eight miles distant, a well-known British encampment named Silbury or Sidbury, from the centre of the temple is $49^{\circ} 34' 18''$, and that the same line continued through Stonehenge to the south-west strikes another ancient fortification, namely Grovely Castle, about six miles distant and at practically the same azimuth, viz. $49^{\circ} 35' 51''$. For the above reasons $49^{\circ} 34' 18''$ has been adopted for the azimuth of the avenue.

The present solstitial sunrise was also watched for on five successive mornings, viz. June 21 to 25, and was successfully observed on the latter occasion. As soon as the sun's limb was sufficiently above the horizon for its bisection to be well measured, it was found to be $8' 40''$ northwards of the peak of the Friar's Heel, which was used as the reference point, the altitude of the horizon being $35' 48''$. The azimuth of this peak from the point of observation had been previously ascertained to be $50^{\circ} 39' 5''$, giving for that of the sun when measured, $50^{\circ} 30' 25''$, and by calculation that of the sun with the limb $2'$ above the horizon should be $50^{\circ} 30' 54''$. This observation was therefore completely in accordance with the results which had been obtained otherwise.

The time which would elapse between geometrical sunrise, that is, with the upper limb tangential with the horizon, and that which is here supposed, would occupy about seventeen seconds, and the difference of azimuth would be $3' 15''$.

The remaining point is to find out what value should be given to the sun's declination when it appeared showing itself $2'$ above the horizon, the azimuth being $49^{\circ} 34' 18''$.

The data thus obtained for the derivation of the required epoch are these:—

(1) The elevation of the local horizon at the sunrise point seen by a man standing between the uprights of the great trilithon (a distance of about 8000 feet) is about $35' 30''$, and $2'$ additional for sun's upper limb makes $37' 30''$.

(2) — Refraction + parallax, $27' 20''$.

(3) Sun's semidiameter, allowance being made for greater eccentricity than at present, $15' 45''$.

(4) Sun's azimuth, $49^{\circ} 34' 18''$, and N. latitude, $51^{\circ} 10' 42''$.

From the above data the sun's declination works out $23^{\circ} 54' 30''$ N., and by Stockwell's tables of the obliquity, which are based upon modern determinations of the elements of the solar system,¹ the date becomes 1680 B.C.

¹ "Smithsonian Contributions to Knowledge," vol. xviii. No. 232. Table ix. (Washington, 1873.)

It is to be understood that on account of the slight uncertainty as to the original line of observation and the very slow rate of change in the obliquity of the ecliptic, the date thus derived may possibly be in error by ± 200 years.

In this investigation the so-called Friar's Heel has been used only as a convenient point for reference and verification in measurement, and no theory has been formed as to its purpose. It is placed at some distance, as before-mentioned, to the south of the axis of the avenue, so that at the date arrived at for the erection of the temple the sun must have completely risen before it was vertically over the summit of the stone. It may be remarked further that more than 500 years must yet elapse before such a coincidence can take place at the beginning of sunrise.

We have to express our thanks to Sir Edmund Antrobus, Bart., for much kind assistance during our survey; and to Mr. A. Fowler and Mr. Howard Payn, for skilful and zealous cooperation in the measurements and calculations. As already stated, Colonel Duncan A. Johnston, R.E., Director-General of the Ordnance Survey, has also been good enough to furnish us with much valuable information, for which our best thanks are due.

TWO BOOKS OF TRAVEL.¹

IN its general scope and character the first-named of these two works is very similar to Hudson's "The Naturalist in Plata"; the one giving as excellent a picture of wild animal life in the more remote parts of the United States as the other does for the Argentine Republic. Mr. Fountain, although evidently not a trained naturalist, appears to be an excellent observer of the habits of animals, and many of the facts he records, if not new, are certainly not matters of common knowledge. So far as the title is concerned, it might well be concluded that the work is a record of observations made during recent travel, but this is far from being the case, the author's journeys having been made during the 'sixties and early 'seventies, when a large part of the territory of the United States was more or less unexplored, and when the bison still swarmed in its untold thousands on the prairies. Consequently, in many respects, the observations on the fauna of the various districts traversed and on the habits and distribution of the larger mammals are far more valuable and important than any which could be made at the present day. It is perhaps to be regretted that greater pains were not taken to identify some of the animals referred to, which would have avoided certain corrections made in the appendix and have considerably increased the value of the work. Not improbably, however, the author may have had only his notes, and not actual specimens, to rely upon; and if this be so, he may well be excused the lack of the details in question. Taken altogether, with a certain allowance for more or less pardonable faults, it may truly be said to be one of the most delightful works of its kind that it has been our pleasure to read for a very long time, and it may be recommended to all lovers of Nature and a life in the wilds without a shadow of reserve.

To judge from its title (in the selection of which we think the author has scarcely done himself justice) the work might well have been taken for a record of travel, but, as a matter of fact, a very large proportion of it is

¹ "The Great Deserts and Forests of North America." By Paul Fountain. Pp. ix + 295. (London: Longmans, Green and Co., 1901.) Price 9s. 6d. net.

"Sunshine and Surf; a Year's Wanderings in the South Seas." By D. B. Hall and Lord Albert Osborne. Pp. xiv + 320. Illustrated. (London: A. and C. Black, 1901.) Price 12s. 6d.