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ORIGINAL ARTICLES.

I.—ON THE AGES OF THE "TRAIL" AND "WARP."

By THE REV. O. FISHER, M.A., F.G.S.

THERE are some points in Mr. Maw's¹ article on the relative ages of the Boulder-clays² which require notice from me, because they involve the consequence of assigning to the deposit which I have described under the name of "trail" an antiquity far higher than that which I believe to belong to it.

Mr. Dawkins, in his paper on the Brick-earths of the Thames valley,³ noticed this deposit as being seen in all the sections he described; and he agreed with me in believing it to be a Glacial deposit, and, as I understood him, a subaërial one. In these views he corroborated my conclusions, as will be seen by reference to my papers on the subject in the Quarterly Journal, and this Magazine.³

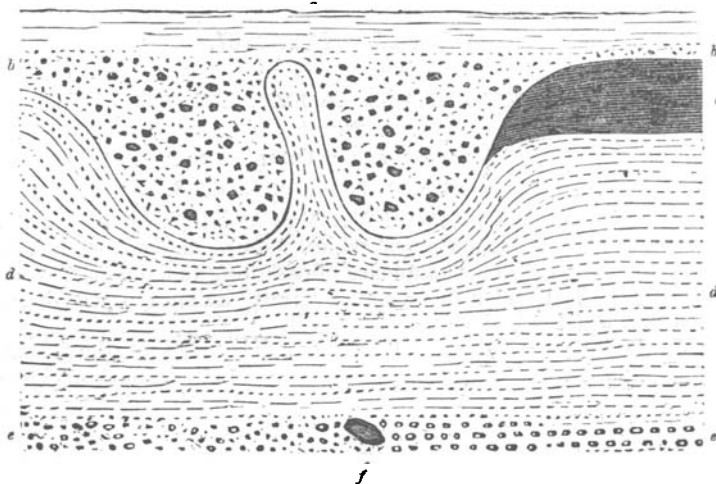
Mr. Maw, however, endeavours to show a probability that the Glacial deposit of the Thames valley is co-ordinate with the Boulder-clay, or till, of the Norfolk coast; and gives reasons for supposing that the latter is more recent than the Boulder-clay capping the higher ground of the Eastern Counties. With regard to this second question, I have nothing to say at present, but I demur entirely to the position that the Glacial deposit overlying the Brick-earth is of the age of the Norfolk till. Mr. Dawkins, if I recollect rightly, put forward the idea that we might have in the Thames valley a remnant of a subaërial deposit of the age of the true Boulder-clay. This was, as Mr. Maw says, objected to during the discussion on the ground that the Thames valley was newer than, or at any rate deepened after, the period of the Boulder-clay. But I went further, and said that I recognized in the apparently Glacial deposit capping the Brick-earths at Ilford and Grays Thurrock the same deposit which I have noticed and described as filling troughs in the general surface of the country, and consisting of materials transported from higher grounds in rear by some agent, which I believe to have been land ice. This deposit, which I call "trail," whatever its origin may be, is evidently connected with the last denudation of the surface.

¹ See GEOLOGICAL MAGAZINE for March last, p. 97.

² Read at the Geological Society, 9th January, 1867.

³ Journal, vol. xxii, p. 554, and GEOLOGICAL MAGAZINE, vol. iii. p. 488.

I have no hesitation in saying that the deposit in question at Ilford and Grays is this trail. At Ilford it consists chiefly of gravel and London clay confusedly mixed. The accompanying sketch, copied from one made on the spot, gives a rough idea of the manner of its occurrence. Now we have both these materials in the neighbourhood of Ilford, in the gravel of the Thames valley, and in the London clay of the higher grounds.



Section of about eight feet of the upper part of Uphall Brick-field at Ilford, Essex.

- a. Warp.
 - b. c. Trail. b is clayey gravel; c, London Clay, with a few gravel pebbles.
 - d. Yellowish light-coloured stratified sand, belonging to the Brick-earth series, but disturbed by the deposition of the trail.
 - e. A pebbly band, in which a tooth of *Elephas antiquus* (in my possession) was found at f.
- (The head of *Elephas primigenius*, in the British Museum, was found in a lower band.)

At Grays, on the other hand, the trail is thinner, and altogether a less important member of the section. The cause of this appears to be that the locality is on sloping ground. The materials of the trail are there chiefly of Thanet sand derived from the hill side above. It contains gravel also, but in subordinate quantities.

I do not believe that any argument as to the age of the Brick-earth can be founded upon this deposit, except—what would be self-evident without it—that it is older than the latest denudation of the surface.

Mr. Wood, jun., in his paper on the Thames valley, looks upon this trail in the Uphall pit at Ilford as a layer of the Thames valley gravel, *in situ*, overlying the Brick-earth, and has thence concluded that the Ilford Brick-earth is older than that of Grays. Mr. Dawkins, however, appeared to consider the two Brick-earths of the same age. Their age relative to each other, or to the Thames gravel, is not affected by the gravelly capping of the Uphall pit on the supposition of its being trail.

Age of the trail.—If this deposit be of Glacial origin, but do not date back to the Glacial epoch as Mr. Dawkins suggested, nor yet to the later Glacial era, which Mr. Maw supposes to be evidenced by the till of the Norfolk cliffs (though the general opinion has been that the Norfolk till belongs to the earlier part of the Glacial epoch), it may be fairly asked, To what Glacial period is it attributable? Is it conceivable that arctic conditions can have obtained at so modern a date as the trail evidently belongs to? To this question I endeavoured to give some reply in the concluding portions of my paper on the warp, as originally communicated to the Geological Society. But it was decided to abridge the paper before publication. The subsequent appearance of the first volume of Sir Charles Lyell's new edition of "The Principles," containing a full discussion of the present state of the theories upon Climatal Changes, now enables me to offer my views on this difficult question with somewhat greater confidence. It also relieves me from the necessity of describing the theories of M. Adhémar and Mr. Croll, which are clearly epitomised by our great geologist. Suffice it to say that the chief point in which the published views of Mr. Croll differ from those of M. Adhémar is, that M. Adhémar considers the present value of the eccentricity of the earth's orbit sufficiently great to produce a marked difference of climate in places having the same latitude in the two hemispheres. Mr. Croll, on the other hand, has stated (though I have reason to believe his opinions are modified) that the present value of the eccentricity is not sufficient for that effect.¹ If I understand Sir C. Lyell rightly, he does not deny that the present state of the eccentricity affects the climates of the two hemispheres, so as to render the northern warmer than it would be if our winter occurred in aphelion.² He only states that the mean temperature of the whole globe is warmer in our summer than in the summer of the antipodes, owing to the greater extent of land exposed to the sun's rays in the northern than in the southern hemisphere. But it seems to follow from the same cause, that since excess of land favors extreme climates, our winters would be colder than at present were the conditions reversed; though the shorter summers would be hotter as far as regarded the absolute power of the sun.

But, no doubt, with our present contour of land, the chief point for consideration is the course of the Gulf Stream. Mr. Croll has well suggested that if the southern summer occurred in perihelion during a state of high eccentricity, the Gulf Stream would be deflected into the Pacific instead of into the Atlantic.³ Part of the equatorial current even now takes that course. It is conceivable that a moderate increase in the mean temperature of the southern hemisphere would so far weaken the force of the S.E. trade winds as to cause the equatorial current to impinge wholly on the southern side of Cape S. Roque, and to be deflected to the south instead of to the north.

If M. Adhémar is correct in his view, that the present extension

¹ Reader, 2nd December, 1865.

² Elements, vol. i. p. 275, ed. 1867.

³ Phil. Mag., Aug. 1864, and Feb. 1867.

of the S. Polar ice is due to the phase of precession in which we now are, then it may be readily admitted that the present position of the equator of warmth to the north of the "line," and the extension of the S.E. Trades in the same direction, is due to that cause; and, consequently, the change of seasons involved in the transference of our winter to aphelion (and of the southern winter to perihelion) would so far warm the southern hemisphere, as to weaken the S.E. trades, and cause what is now the Gulf Stream to flow southward instead of northward.

In all these questions, and many similar ones, the real difficulty is not to see in what direction the effect would be produced, but to what extent. And this difficulty is enhanced in the present case because we do not know with certainty what the absolute heating power of the sun may be, the temperature—239° F., attributed to space being by no means certainly correct.

If, however, Mr. Dawkins and myself are right in attributing this recent deposit to a Glacial origin, it is a proof that *some* refrigerating cause has been in operation during comparatively recent geological times, when this country had, or rather, as I believe, finally received, its present contour. Now, since one cause that we know of has been in operation within such a recent period, viz., that of precession, it seems extremely reasonable to attribute the observed effect to it.

In considering the effect of precession, we must not forget that its efficiency for producing climatal effects depends upon the eccentricity of the earth's orbit. Let us, then, observe what values this element had at those periods nearly preceding our own era, at which the seasons were reversed.

The northern winter solstice occurred in perihelion A.D. 1248. It therefore occurred in aphelion 10468 years previously to that epoch, that is, 11020 years before the year 1800; and at intervals of 20937 years each, preceding that period. Hence we have the following table:—

	Number of years before 1800, when the Northern winter occurred in Aphelion.	Eccentricity of the earth's orbit nearly, + if it was greater, - if it was less than the value given.	Winter temperature of Snowdon without the Gulf Stream on Hopkins' first hypothesis. ¹	Ditto of Scotland, the Gulf Stream being diminished in proportion to the eccentricity (Mr. Croll). ²	Excess of winter over summer in days.
	11020	·0187 +	5°.05	Not given.	8·6
	31957	·0151 —			
	52894	·0131 +			
	73831	·0316 +	—1°.01	5°·1	14·8
	94768	·0452 +	—7°.17	—3°·2	21·0
A	115705	·0460 —	—7°.52	—3°	21·3

The fifth and sixth columns of Sir Charles Lyell's table, which give the mean hottest and coldest months in the latitude of London when winter is in aphelion, are calculated from the present means. It seems to me, however, that, for cold epochs, it will be safer to calculate from the mean as it would have been had the Gulf Stream not existed,

¹ Geol. Jour., Vol. viii. p. 68.

² Phil. Mag. for Feb., 1867, p. 3.

and accordingly I have adopted Mr. Hopkins' value of 23° F. for Snowdon. The equation then becomes $\frac{239^{\circ} + e^{\circ}}{239^{\circ} + 23^{\circ}} = \left(\frac{0.9832}{1 + e} \right)^2$.

I have also added Mr. Croll's values, on the supposition of the Gulf Stream being only partially deflected.¹

My fifth column is calculated from the equation—

$$\text{Excess of winter over summer} = \frac{4e}{3.1416} \times \text{year}.$$

This is slightly more accurate than the rule I gave in the "Reader," 4th November, 1865.

Referring to the table it will be seen that in the year 1800 the eccentricity was .0168. Hence, on the first preceding occasion of winter occurring in aphelion, the eccentricity was greater than at present by a small amount. On the two next occasions it was less. On the fourth it was considerably greater, and winter fifteen days longer than the summer. On the fifth this difference had increased; and on the sixth occasion it was larger still; but it was diminishing rapidly.

Now it is remarkable that though Sir Charles Lyell notices the high eccentricity occurring about the time of these last two epochs, between which falls his period A; yet he has not attributed any known Glacial phenomenon to it. Both he and Mr. Croll consider it too recent for the so-called Glacial epoch, and Sir Charles thinks it not recent enough for the Reindeer period. I would suggest that it is extremely probable that this was the epoch of the formation of the trail, and of the last general denudation of our country.

Then the period 11020 years before 1800 may be supposed to have been that of the reindeer. For the eccentricity was at that time appreciably larger than it is at present, and the winter nine days longer than the summer. This, with the winter in aphelion, might well have produced the change of climate necessary for the southward migration of the reindeer, though not sufficient to envelope these latitudes in a sheet of ice. The objection, that the summers would then have been too hot for the reindeer, may perhaps be met by observing, that the Southern range of that animal in Northern Asia at present reaches almost to latitude 50° , which is within the limit of the summer isotherm of 63° ; while, on the other hand, the localities, in which its remains have been found in Southern Europe, must have been within the influence of the Atlantic, whose waters were at that time cooler than at present. Hence we may suppose that those countries would not have been heated, even by a nearer summer's sun, more intensely than the plains of Asia, which the reindeer inhabits, are heated at the present time. Still further, we must not forget Mr. Croll's arguments for cold and cheerless summers under a high condition of eccentricity. I am inclined to think that this was also the period of the formation of the warp, when, as I have shown, the winter frosts were more severe than they are at present.² The submergence of our lower valleys, beneath the *Scrobicularia* mud,

¹ Phil. Mag. Feb. 1867, p. 3.

² Geol. Journal, vol. xxii. p. 564.

was one of its later phenomena, and the retirement of the sea, which deposited it, formed the commencement of the recent period.¹

It is very satisfactory to observe that the periods thus assigned to the two Glacial phenomena, which I have been discussing, cause them to fall into the positions which they ought to occupy on purely geological grounds, and agree with awards of Sir Charles Lyell and Mr. Prestwich. From reasons, solely grounded upon the order of superposition, I concluded my paper on the warp with the following summary:—

"Upon reviewing the changes which have been indicated by the phenomena discussed in the present paper, we have disclosed, in the first instance, a condition of the surface when the general features of the landscape were the same as at present, during which the great mammalian fauna flourished contemporaneously with the fabricators of the chipped flints" (the Palæolithic period).

"We have, subsequently, though perhaps not in immediate sequence, a period of extensive denudation, indicated by the furrows filled with materials from the higher grounds, which have travelled in a plastic state, and which I have called 'trail.' This denudation brought the surface almost exactly to its present form. The period of the formation of the warp succeeded, in which the winter frosts seem to have been more severe than at the present time.

"It was either during this period or shortly afterwards, that the submarine forests flourished." A submergence of moderate amount, measured by a few tens of feet, next followed, and the *Scrobicularia* mud was deposited over the lowest forest-grounds. The sea was then depressed again, and the recent period commenced.

"The changes of form in the present surface which have taken place since that time may, I believe, be easily recognised, since they usually interrupt the more general contour of the surface."

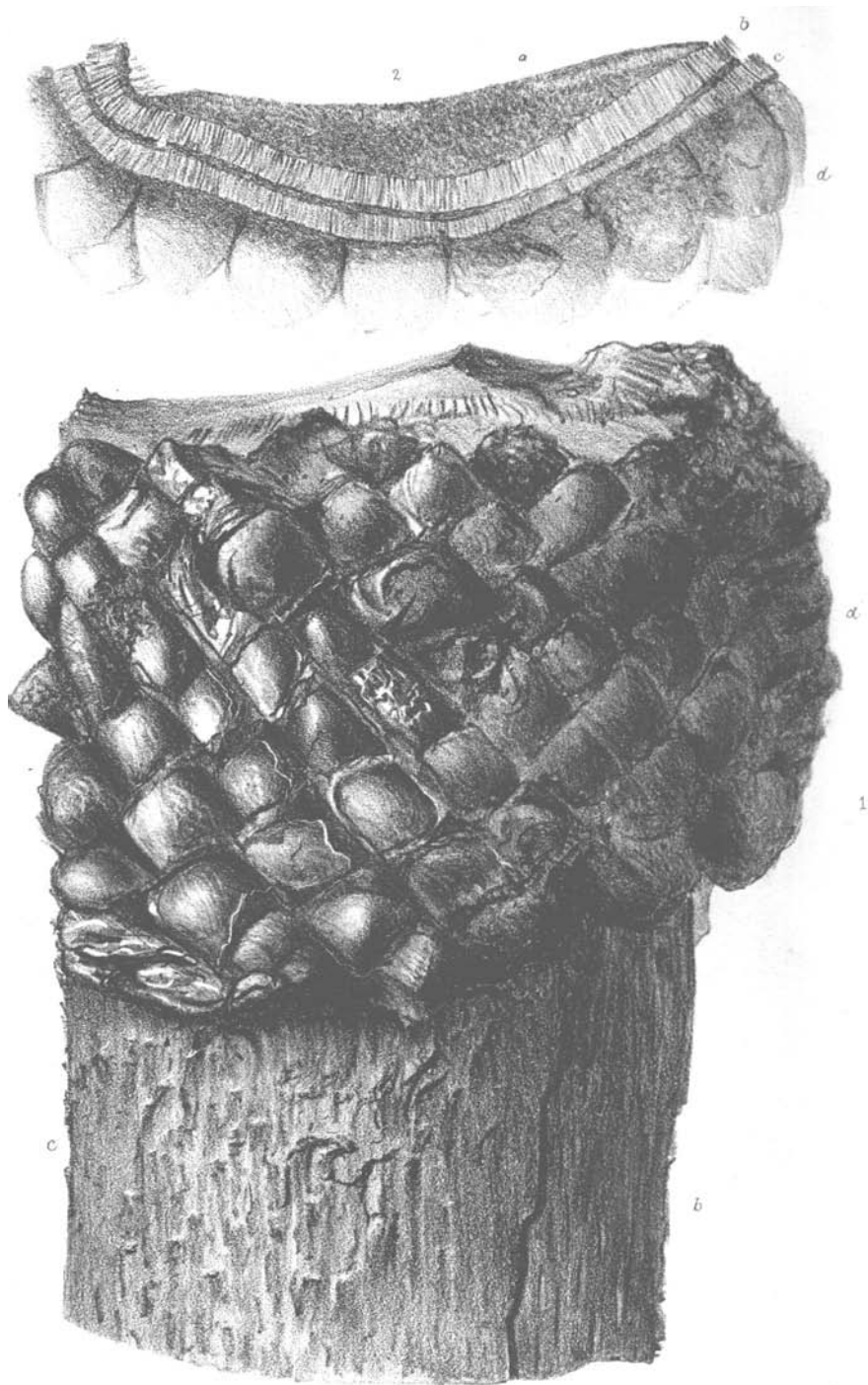
Upon correlating these geological conclusions, with what may be called our astronomical ones, we find that the Palæolithic period, shown to be older than the "trail," is thrown into the times antecedent to Sir Charles Lyell's period A; where, also, he himself places it. Nevertheless, if I should venture to differ from so great an authority, I would suggest that the period B, to which he inclines to assign it, might be somewhat too early, the eccentricity being likely to have rendered it too cold for the phenomena observed, and that the climate of some part of the interval between 100,000 and 200,000 before A.D. 1800, would have been more in accordance with what was requisite, and probably of sufficient duration.

There followed after the Glacial era of the "trail," a lengthened period of equable seasons of about 80,000 years, which would have been that of the submarine forests and their occupants. *Elephas primigenius* was still living in this Island,—witness his remains found at Holyhead harbour, preserved in the British Museum.

A short period of severe winter cold succeeded, which was the period of the warp, and of the *Scrobicularia* clays; and the date of it agrees remarkably with the result arrived at by Mr. Prestwich, on

¹ Geol. Journal, vol. xxii. p. 564.

² *Ibid.*



G. Massee del. et lith.

M. & S. Hanhart imp.

CYCADEAN STEM FROM LEIGHTON BUZZARD.

summing up the evidence in regard to the Quaternary gravels. He is of opinion that the large pachyderms lived down to the commencement of the alluvial period, and on that supposition says, "I do not see any geological reasons why the great extinct mammalia should not have lived down to comparatively recent times, possibly not farther back than 8,000 or 10,000 years ago." In other words, he puts that period as having elapsed since, as I understand him, the last submergence of our lower valleys took place.

According to my views this submergence would have passed away in about a quarter of the term of 10468 years, subsequent to the epoch 11020—that is, about 8,000 years ago. This is, to say the least of it, a remarkable coincidence.

II.—ON *CYCAIDOIDEA YATESII*, A FOSSIL CYCADEAN STEM FROM THE POTTON SANDS, BEDFORDSHIRE.

(PLATE IX.)

By WM. CARRUTHERS, F.L.S., of the British Museum.

WHEN examining the collections of the Geological Society at the time of preparing the notes I published some months ago, on the Fossil Cones of the Secondary Strata, I found a small fragment of a curious vegetable organism, the nature of which I was then unable to determine, but which I was allowed by the kindness of the Secretary to take with me for the purpose of further examination. Some months ago I obtained from James Yates, Esq., a more perfect specimen, which clearly showed that it was the portion of the stem of a cycadean plant, as Mr. Yates had already determined. Professor Church subsequently brought me a yet finer specimen from the Museum of the Royal Agricultural College at Cirencester, and I have a fourth fragment from the collection of Professor Morris.

All the specimens were found in the iron and green sands of Potton, which rest on the Kimmeridge and Oxford clays, and are covered by the Gault. Mr. Seeley, who has paid some attention to these beds, kindly informs me that he considers them to "represent in their *upper part* the *Lower Greensand*, which part is generally unfossiliferous; the *middle part* is very rich in fossils, including many vegetable remains, such as fir and other cones, wood, etc. These beds are regarded as a marine representative of the *Purbeck and Wealden* period; and at the bottom are the representatives of the Farringdon gravels, and unfossiliferous sands." The Cycadean stems are found in the middle part of the sands. They are converted into a rich brown hematite, containing a larger proportion of iron than bog iron ore.

Mr. Pettit drew the attention of the Geological Society to these stems at its meeting on December 2nd, 1857, when he laid some fine specimens on the table. He referred them to *Clathraria*; but no description of them was published, nor further notice taken of them.

Professor Morris had had his attention directed to this fossil some years ago, and having seen the fine specimen at Cirencester, he came to the same conclusion as Mr. Yates regarding its affinities.

It must be referred to Buckland's genus *Cycadoidea* = *Mantellia*,