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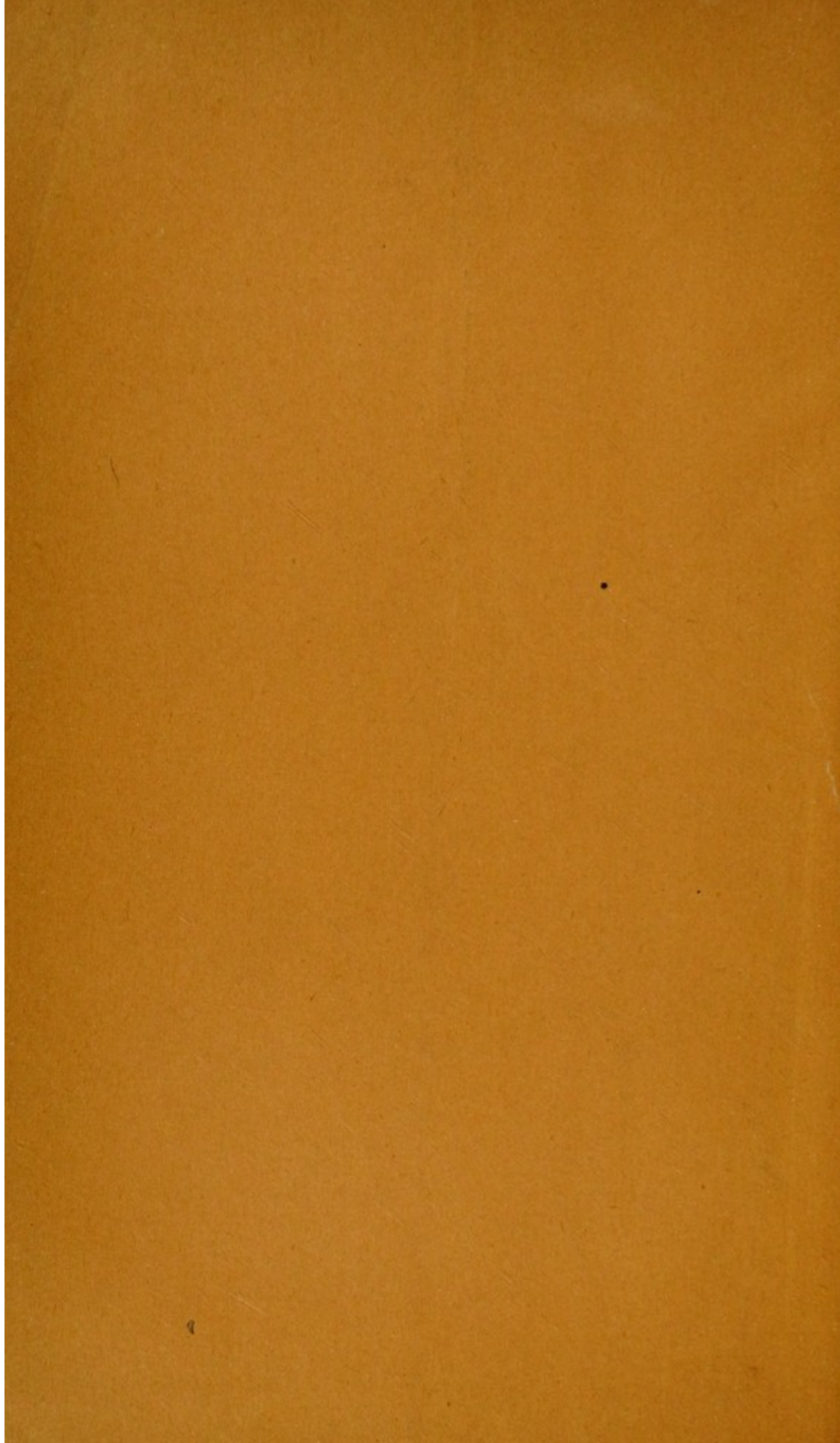


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4th May 1891



* * * *The Institute's object being to investigate, it must not be held to endorse the various views expressed either in the Papers or discussions.*

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For the use of members desiring to join in the discussion.

SPECIAL.

The Presence at the Meeting of those whose studies have lain in the direction of the subject taken up is always important; should any such be unavoidably prevented from attending, the Council will be much gratified by receiving their MS. comments upon this Paper.

If possible before the Meeting, if not then within 60 days.

VICTORIA INSTITUTE.—Paper to be read at a Meeting of the Members and Associates, on Monday, March 19,

AT HALF-PAST FOUR O'CLOCK, at

THE HOUSE OF THE SOCIETY OF ARTS, JOHN STREET, STRAND.

(By kind permission.)

*A POSSIBLE CAUSE FOR THE ORIGIN OF THE TRADITION OF THE FLOOD.** By JOSEPH PRESTWICH, D.C.L. (Oxon.), F.R.S., F.G.S., Corr. Inst. France, etc.

THE geologist has to interpret two very distinct classes of phenomena. Firstly, those connected with the great mass of stratified and solid Rocks, and secondly, those relating to the thin sprinkling of *débris* derived from those rocks and scattered over their surface. These latter, termed superficial or Drift deposits are, nevertheless of no less interest than the stratified rocks, as they are connected with the first appearance of Man and with the distribution of the existing Fauna and Flora on the surface of the Earth. These Drifts consist of beds of sand, gravel, and loam, sometimes showing stratification, at other times unstratified. They at first attracted but little attention, and were *all* included together under the general term of Diluvium, it being then supposed that they were due to "an universal and transient deluge," whereby the animals whose remains are buried in these beds were destroyed and their remains dispersed "by the waters

* The facts on which this hypothesis is founded are only given in short abstract in this paper. The full evidence will be found in the two memoirs referred to in a note, p. 3.

of the same inundation which produced the deposits of loam and gravel in which they are imbedded.”*

This view, which was held by many distinguished men, was however soon found to be untenable. An universal deluge was recognised to be a physical impossibility, while further research led to the conclusion that the superficial loams, gravel, and sand, instead of being the result of one rapid rush of waters over the surface, were due to the prolonged action of the several agencies which are still acting on the surface of the globe. Large spreads of gravel and sand are now known to have been deposited on the flanks and terraces of our valleys by the old Rivers, when, before they had excavated their channels to the present depths, they flowed at various higher levels. That this was their origin is shown by the fact that these deposits contain fluviatile shells, mostly such as now live in our rivers together with the rolled and worn bones of the contemporary land animals. The preservation of such remains is, however, partial and irregular. because the beds in which they are entombed are in general so permeable that the percolation of the surface waters has very commonly removed the calcareous matter of the bed itself together with the embedded shells and bones, but where these have been protected by beds of loam or clay, the organic remains are often well preserved. The higher and older the terrace, the more rare are the organic remains.

Another large section of these deposits contains rock *débris* and boulders, transported far from their native place. This was formerly looked upon as evidence of the inrush of the diluvial waters, but now it is well established that these boulders have been carried to their present positions by the slow action of either land or floating ice and not by any sudden transport by water. Other portions of the Drift are of marine origin, as indicated by the presence of sea-shells, while subærial processes, weathering, etc., have in places contributed to the general result.

In this way the origin of the larger proportion of the superficial deposits of loam, gravel, and sand have been accounted for, and shown to be due to the same agencies, though often acting with greater intensity and force than those which now act upon the surface of the land, and that so far from

* Buckland, *Reliquiæ Diluvianæ*, pp. 184, 185.

being the result of a sudden and transient catastrophe, they result from the long continued and gradual action of known agencies, and represent the work of a long period of time.

THE RUBBLE DRIFT.*

Nevertheless, it became evident to me, in the course of studying the Drift beds of the South of England and the North of France, that, besides the Drifts referable to known causes, there was a residue which could not be referred to any of the causes generally assigned for the formation of these deposits. Such was also the conclusion which Sir Roderick Murchison† was led to form, though he failed to eliminate some of the recognized Drifts, and ascribed them generally to a wave of translation. More lately Professor James Geikie‡ has expressed a similar opinion. Speaking of "certain accumulations of coarse gravels and detritus which have yielded mammalian remains and palæolithic implements, he remarks that they are spread continuously over wide districts in Southern England," and "bear little or no relation to the present drainage systems of the country, and could not have been laid down by ordinary river action." In explanation of these deposits Professor Geikie adopts a suggestion of Darwin's—that their origin is to be attributed to the cold and snow of the Glacial period. Though it seems to me that in both cases reference is made to other drifts besides the Rubble-drift, and our explanations differ, still the essential fact remains of the recognition of an aberrant form of drift.

This Rubble-drift, as I have named it, is distinguished by a general want of that *wear and rounding* of the rock fragments, and of the included organic remains, which characterise the fluvial and marine drifts, while none of the materials are *glaciated*, nor are any of them *transported from beyond the immediate vicinity of the place* of their occurrence, as is the case with beds of glacial origin.

* I gave a short notice of this Drift in the South of England at the meeting of the British Association in Swansea in 1880, but fuller details will be found in the *Quarterly Journal of the Geological Society*, vol. xlviii, p. 326, while I have since described in the *Philosophical Transactions for the Royal Society* for 1893, p. 903, some of the chief localities where it occurs on the Continent.

† *Quart. Journ. Geol. Soc.*, vol. vii, p. 349.

‡ *Prehistoric Europe*, p. 140.

The explanation which I would suggest and which seems to me best to satisfy all the conditions of the problem is that the special character and position of this Rubble-drift are due to the submergence and subsequent re-elevation of a land surface, whereby the Fauna and Flora of the submerged area were destroyed, and their remains dispersed over the surface of the submerged land. Subsequently, as that surface emerged from beneath the waters, the scattered remains of that fauna, together with the loose land *débris*, were swept together down the slopes of the hills and into the valleys, leaving traces or isolated portions in any cavities or hollows over which the Rubble passed. The stone implements and weapons of Quaternary Man left and lost on the old land surface, would necessarily be caught up with the general mass of *débris*, as would also human remains where Man had failed to escape. That such may have been the case is shown by the circumstance that the Rubble-drift contains the remains of the various Quaternary animals living at the time of its formation, together with, in places, Flint Implements of human workmanship, and in a few rare instances portions of the human skeleton itself. Although the phenomena differ widely in aspect and have been referred to different agencies, they are all concordant and admit of explanation by reference to one common cause. The following are the more common forms assumed by this Rubble-drift in England.

The Angular Rubble and "Head" over the Raised Beaches.—These, which are the commoner forms of this drift in this country, have accumulated in hollows on the surface or under the lee of the old cliffs of the Raised Beaches. Owing to the existence on the coasts of the Channel, of an old shore line, now raised 10 to 30 feet above the level of the present beach, those conditions are often present, the Old Cliffs being generally masked and hidden by a mass of this Rubble. The idea that it was a mere talus was soon abandoned, because the *débris* does not lie at the angle of repose assumed by a talus, and because it contains blocks of stone not belonging to the cliff, but that have come from beds at some distance inland. Amongst the best examples of the "*Head*," as it has been termed, overlying the Raised Beaches, are the masses of rubble exhibited in the cliff immediately east of Brighton, and on the cliffs at Portland Bill, Hope's Nose near Torquay, and at Baggy Point near Barnstaple.

The two most usual explanations that have been proposed to account for the *Head* are, 1st, that the rubble was shot over the old cliffs at a time of excessive rainfall during the late Quaternary or Glacial period; 2nd, that during the Glacial period, sheets of frozen snow or ice slid down the hill slopes above, and carried with them the *débris* of the surface. The objection to the first is that the rain draining off the land would have worn water-channels, while the *débris* would have been spread out in the form of cones of dejection and would also have been waterworn; whereas there are no special water-channels, and the *débris* is spread over the cliff edge in the form of broad sheets conterminous with the extent of the cliff itself. Nor, as a rule, are the rock or bone fragments in any degree worn. For these and other reasons given in the paper read before the Geological Society,* this cause must be considered inadequate.

The agency of Snow and Ice is open to fewer objections. It would in fact account for many of the phenomena. Where the slopes were sufficient, frozen masses of snow or sludge might carry down with them the surface *débris* and lodge it at the foot of the cliff or slope, but the angles of the slopes above, and the extent of the gathering grounds, are in most cases insufficient, and no instances are recorded where such *débris*, formed at the present day, contains perfect land shells and fractured sharply angular bones. The grinding of the mass as it slid down would be fatal to the preservation of fragile shells, and to the retention of the sharp angles of the bones. A still more serious objection to either of these causes is the distance to which the *débris* has been projected and the large blocks moved, of both of which we shall give instances presently. It must be borne in mind also that it is very unlikely that a surface subject to the frequent occurrence of these slides could contain organic remains of the character found in the *Head*. As often happens, explanations are tendered in consequence of their satisfying some of the conditions of the problem, but without satisfying others, or having regard to the consequences which must ensue were the assumption adopted.

Ossiferous Fissures.—Another feature connected with one phase of the Rubble-drift is that relating to the fissures, often

* *Quart. Journ.* for 1892, p. 326.

of large size, so common in some limestone districts, filled to the brim with a breccia of limestone fragments, imbedded in a red earth or loam, and generally cemented by calcite. In this rubble, bones of extinct mammalia, and occasionally land shells, are not unfrequently met with. The only locality in England where these Ossiferous Fissures are common, is the neighbourhood of Plymouth. On the shores of the Mediterranean they occur in many places.

The origin of these Ossiferous Fissures has been attributed to the circumstance of rents in the rocks formed during the Quaternary period having been long left open. Into these it was supposed that, from time to time, animals fell, as they do now in similar unprotected pitfalls, or else that they were driven into them when pursued by beasts of prey. The washing in of the soil by streams and the fall of fragments from the side rock, were supposed to have gradually filled the fissures. But there is nothing to show the presence and action of streams, or to indicate that the process was a long one. On the contrary, there are *no water-worn materials*, and the bones are all in the same *unworn condition*, nor do they show any of the ordinary effects of weathering. Besides, had the bones been those of animals *which had fallen into the fissures, the entire skeletons of those animals should be there*, though the bones might be displaced. So far from that being the case, the occurrence of an entire skeleton is a rare and exceptional event. It is rare even to find the bones of a single limb in relative position. The *bones are dispersed without order*, teeth largely predominating, and entire bones being comparatively scarce, whilst broken fragments and splinters abound. These, I conceive, are fatal objections to the explanation that the bones are those of animals which fell into the fissures whilst alive.

The following list, the result of the collection made by an early visitor to one of the Fossiliferous Fissures near Plymouth, will serve to show the character of the animals and the relative proportion and abundance of their bones.

	Teeth.	Jaws.	Vertebræ and portions of skulls and bones more or less perfect.	Fragments of bones without distinct characters.
Cave tiger	1,587	147	279	1,000
Cave hyæna				
Wild boar				
Fossil horse ...				
Ox				
Deer				
Wolf				
Fox				
Hare	1,587	147	279	1,000
Water rat				

In addition to the above, there have since been found by later observers, remains of—

Mammoth.	Reindeer.
Rhinoceros (two species).	Bear (two species).
Hippopotamus.	Bison.

Human remains are also reported to have been found in one of the fissures, but this wants confirmation.

These fissures are sometimes spoken of as bone-caves, but the condition of the bones is entirely different from those found in true bone-caves, where they are in greater part more or less *gnawed by carnivora*, and also from those found in river deposits, where they are more or less *rolled*; but they agree exactly both in *species* and *condition* with those found in the *Head* or Rubble-drift. In both instances they are almost all broken, and the fractured surfaces *retain their sharp angles*; in both the bones occur detached and without order, and in both *land-shells* are occasionally found. It is to be inferred from this that the two deposits are closely related, though occurring under different conditions—not, however, so different in reality as in form—the one having been drifted into rents on the surface, and the other swept into hollows or over the face of old sea cliffs which were thereby swamped and hidden.

The structure of the Rubble-drift, as exhibited on the *Head* which overlies the beaches, suggests its origin. It is composed of alternate layers of *débris* of the adjacent rocks, and where the strata consists, as at Brighton, of a soft rock with

intercalated hard bands (of flint), these materials (or rather their *débris*) alternate in the *head*—not with the regularity of stratified strata, but irregularly, and with much confusion, the upper bed especially being rolled over and *thrown back*, as though by some sudden *strong driving force*. It is possible to conceive that a rubble of this character might have been projected on the old cliff by an ice or snow slide, were it not for the objections I have before urged, and the fact of finding, as at Brighton, large angular blocks of rock that have been transported from a distance of a mile or more inland, and must have required considerable force to move. At the same time there are intercalated beds of fine chalk silt, sometimes laminated, and at Sangatte containing uninjured fragile land shells, which could not have been subjected to rough treatment. A body of water acting under great pressure, and with varying velocity as the land rose, could, I conceive, alone have accomplished these variable results.

The late Mr. Hopkins* of Cambridge has shown that if a considerable area at the bottom of the sea were *suddenly* elevated, a *wave of translation*, accompanied by a current, the velocity of which would depend principally upon the depth of the sea, would diverge in all directions from the central disturbance. Calculations, he says, “prove beyond all doubt that paroxysmal elevations, beneath the sea, varying from 50 to 100 feet in height, may produce currents of which the velocities shall vary from at least 5 or 6 to 15 or 20 miles an hour, provided the depth of the sea do not exceed 800 or 1,000 feet.” In considering the magnitude of the blocks which might be moved, he found that the force exerted on a surface of given magnitude *increases as the square of the velocity*, and that it “*varies as the sixth power of the velocity of the current*.” But the movements must be repeated for large blocks to travel beyond short distances.

It is evident that we have in this form of disturbance an engine of enormous power, and though our hypothesis does not deal with the greater movement and powerful currents contemplated by Mr. Hopkins, we may infer what the results might be with changes having even only a fraction of such magnitude. Movements of this character would, like Nasmyth’s hammer, be capable at times, when the uplift was rapid, of exerting enormous force; while at other times, when the

* *Quart. Journ. Geol. Soc.*, vol. iv, p. 90.

uplift was slow, the action might be of the most gentle description. It follows from these premises that the character of the deposits formed under such circumstances will afford an approximately relative measure of the velocity and duration of the currents under which they were accumulated. Where, for example, the sediment is fine, we may conclude that the velocity was slow and the rise which gave origin to it small. When, on the contrary, the materials are coarse, we may suppose the rise to have been more rapid and the velocity of the current greater, though they might have been continuous.

These considerations, added to the circumstance that this rubble contains the remains of *a land fauna only*, led me to conclude that the South of England had been submerged at the close of the Post-glacial period to the depth of not less than about 1,000 feet, for to that height there are traces of this Rubble-drift. As the surface of the submerged area shows no marine terraces indicating periods of rest, it may be inferred that the submergence was comparatively slow and gradual, the only disturbance being the removal of the finer surface materials, and sediment, with which the waters would become charged. On the other hand, the alternation of fine and coarse materials in the *head* indicate that the upheaval was by movements alternately slow and rapid, during the latter of which the *débris* of the surface so submerged was swept down to lower levels, or lodged in the Hollows and Fissures of that surface, together with the remains of the animals and land shells that had inhabited the submerged land. I conclude further, from the absence of marine sedimentation and of marine shells on the submerged area, that the submergence was of too short duration to admit of such sedimentation or to afford time for the immigration of a marine fauna from adjacent unsubmerged areas.

The Phases of the Rubble-drift on the Continent and Mediterranean Coasts.—The Rubble-drift of the Continent, which is met with at various places over Western Europe and along the coasts of the Mediterranean, accords perfectly with that of the South of England. But it presents in addition other phenomena, which although differing in detail, bear the same construction, and point to the same common origin, and are all explicable on the hypothesis of a comparatively recent, geologically speaking, submergence of the land. We may mention a few of these phases and places.

Passing by the fine specimen of Raised Beach and “*Head*”

at Sangatte, near Calais, which is identical with the section at Brighton, the old Beach in the estuary of the Somme, and the traces of "*Head*" on the coasts of Normandy, we come to the novel and very illustrative case furnished by the Channel Islands. Both Guernsey and Jersey consist in greater part of a table-land of granitic and metamorphic rocks 300 to 400 feet high, more or less covered by a deposit, 5 to 20 feet thick, of loam or Loess, and terminating in high cliffs. At the foot of these are occasional remnants of an old Raised Beach, 6 to 20 feet above the present beach, surmounted by a sloping "*Head*" composed of rock fragments and loam carried down from the hills inland. It is certain that it is not a mere talus, for the rubble has a base of loam identical with that on the central plateau, and the *débris* has often been propelled to considerable distance outwards from the foot of the cliffs.

The plateau loam or Loess deserves special attention, for as there are no rivers to have originated flood waters, this Loess cannot have had a fluvial origin; nor, as there is no higher ground, could it be the result of rain-wash; neither can it be the result of the disintegration of the surface rocks.* It must therefore have had an origin different from that usually ascribed to the *Loess*, and which I would attribute to the deposition of sediment from the turbid sea-waters during submergence, whilst the "*head*" results from the surface *débris*, together with portions of this loamy sediment, swept off by divergent currents in quaquaversal directions during upheaval. Considering the isolation of these islands, no other explanation seems to me possible to account for the presence of Loess in such a position. The cause must have been continental, not insular.

The High-level Loess of France and Central Europe.—A great portion of the Loess of Europe is no doubt of fluvial origin, and is confined to river valleys. But there is a still larger portion, to which such an origin cannot be ascribed, for this latter is not confined to the river valleys, but is found on the dividing watersheds and on the high plains separating the river basins. In the North of France it attains a height of 400 to 600 feet, and in the neighbourhood

* No land shells have been found in this loam in either Jersey or Guernsey, but they have been found in a similar deposit in the island of Bréhat on the coast of Brittany.

of Lyons of 1,300 feet, whilst in the great upper valleys of the Rhine and Danube it reaches an altitude of 1,500 feet, which is even exceeded further to the east. It likewise covers the high plains of Hungary and Southern Russia. Various theories have been proposed to account for this wide dispersion of the Loess, the principal of which attribute its formation:—1. To a depression of Central Europe whereby the gradient of the upper valleys was greatly reduced, while no change of level occurred nearer the sea.* 2. To the advance of the great northern ice sheet, blocking the large rivers of Central Europe, and damming back their waters, and so flooding the land.† 3. To high winds acting upon disintegrated rock surfaces. There are grave objections, which I have specified in the papers before referred to, to all these views. Such an accumulation of silt would, however, necessarily be one of the consequences of the submergence suggested. It is such a sedimentation as would fall from the turbid waters as they slowly advanced or rested, whilst as they retreated those portions of the sediment most exposed to the effluent currents would again be swept away, and spread over lower levels. And in this case, as in those of the other phases of the Rubble-drift, the organic remains of this Loess are those of the Quaternary *land fauna* living in the respective districts at the time of the inundation, and include in several instances the remains of Man. It tells therefore the same tale as the Angular Rubble and “*Head*.”

The Ossiferous Breccias of the Continent.—FRANCE. On some of the hill slopes in inland parts of France and again on the face of the precipitous hills on the coast near Mentone, there are masses of angular *débris* of local origin containing the remains of extinct Quaternary Mammalia with occasional traces of the works of Man. The same rubble masks some of the celebrated bone-caves of Belgium, and forms slopes, covering the cave-beds, at their entrance.

It is, however, where this rubble has been swept into Fissures and Cavities that it is best preserved and presents the most interesting features. As before mentioned, a few such fissures, occasionally ossiferous, occur in the limestone rocks around Plymouth, but they are more common on the Mediterranean

* Lyell, *Antiquity of Man*, p. 383.

† Belt, *Quart. Journ. Geol. Soc.*, vol. xxx, p. 490.

coast of France. Nor are they wanting inland. To take a few of the more illustrative cases, such for example as those of Nice, Pédémar, Santenay, &c. At all these places the breccia contains the remains of the *Mammoth*, *Woolly Rhinoceros*, and other Quaternary animals. It is a remarkable fact that these fissures are generally situated on *isolated hills* often of considerable height. In explanation of the presence of the animal remains, it has been suggested that the bones are those of animals which fell into the fissures while still open, or else that they were remains brought together by predaceous animals. But neither of these opinions can be correct, for *no skeleton is found entire*, very few of the *bones are in their relative position*, and none of the bones *have been gnawed* by carnivora. As M. Gaudry asks in discussing the facts presented by the fissure on the "Montagne de Santenay"—a flat-topped hill near Chalons-sur-Saône—"Why should so many Wolves, Bears, Horses, and Oxen have ascended a hill isolated on all sides?" The members of the Geological Society of France present at the *réunion* at which this remark was made, seemed to agree that the animals had met their death by drowning, but in what way was left indeterminate.*

In most of these cases, those hills rise *in the midst of plains or low grounds*. At Nice the hills are 132 and 436 feet high, at Antibes, 250 feet, and at Cette, which resembles on a small scale the Rock of Gibraltar, the hill rises 355 feet above the sea level. Still more formidable are the hills inland. Mont Pédémar (Gard) rises to a height of 1,128 feet, whilst Santenay is not less than 1,640 feet high. Among the animal remains found in the Ossiferous Fissures are those of—

5 Carnivores	{	Felis.	4 Ungulates	{	Mammoth.
		Lynx.			Rhinoceros.
		Wolf.			Wild Boar.
		Hyæna.			Horse.
2 Rodents	{	Bear.	3 Ruminants	{	Ox.
		Lagomys.			Deer.
		Hare.			Antelope.

Together with *land shells* of various living species. The breccia, which is composed of *sharp angular* fragments of the *local* rocks usually imbedded in a matrix of red clay or loam, is

* *Bull. Soc. Geol. de France*, 3rd series, vol. iv, p. 681.

generally cemented by calcite. The bones are mostly broken and splintered into innumerable sharp fragments, and evidently *are not those of animals devoured by beasts of prey; nor have they been broken by man.* It is not possible to suppose that animals of such different natures, and of such different habitats, could in life ever have herded together. Difficult as the alternative is, I see no other explanation of the phenomena than that of a wide-spread temporary submergence, accompanied by strong earth tremors. In such a case it is easy to conceive that as the waters gradually advanced over the low lands, the animals of the plains would naturally seek safety on the higher grounds and hills. Flying in terror, and cowed by the common danger, the Ruminants and other Herbivores, together with the Carnivores, would, as in the case of the flooding in our days of large deltas, alike seek refuge on the same safety spot. Where that spot was an isolated hill, they would, if it were not out of reach of the flood waters, eventually suffer the same fate. Subsequently the detached limbs and bones, carried, as the land rose again, together with the surface *débris*, by the effluent currents into the open fissures, were subjected to the clashing of the rubble and the fall of large fragments of rock from the sides of the fissures—whence the reason of their having been so generally crushed and broken.

An early French geologist—an able and acute observer—after noting the presence of land shells and bones in a state of disorder in the Ossiferous Fissures of Nice was led incidentally to remark that they seemed as if thrown in by an angry sea invading the land.

GIBRALTAR.* The Atlantic waves have left few traces of Raised Beaches and “head” on the Western Coasts of Spain and Portugal, but on the Rock of Gibraltar there are traces of several such beaches, covered in places by local angular rubble (or *head*). This rubble extends over the lower slopes of the Rock on both sides. On the Western side it is projected 550 yards seaward at an angle of 8° to 9° (sometimes even less) and attains a thickness of 100 feet. It is clearly not a talus, nor is it a cone of dejection. Its origin has been referred to two periods of severe cold and snow slides. The

* Sir A. Ramsay and Prof. Jas. Geikie, *Quart. Journ. Geol. Soc.*, vol. xxxiv, p. 505. G. Busk, *Trans. Zool. Soc.* vol. x, pt. 2.

objection to this is the great volume of the detritus, the size of the blocks (some being 12 feet in diameter), and the distance to which it is projected compared to the very limited snow-collecting surface, and the *small angle of slope*. The Ossiferous Fissures of Gibraltar are on a very large scale, and contain remains of *Felis*, *Hyæna*, *Bear*, *Rhinoceros*, *Wild Boar*, *Ibex*, *Ox*, *Horse*, *Deer*, *Hare*. The bones are, as usual, much broken and splintered, and Dr. Falconer tells us that *none belonged to an entire skeleton*. A human molar tooth and some worked flint flakes were also found in this breccia.

It has been suggested that these remains are those of animals that had lived and died on the Rock, and were afterwards washed into the fissures by heavy rains. But this is difficult to conceive, and besides, there is the same incompatibility in the habits and resorts of the animals thus associated as in the other fissures before mentioned. The *Hyæna*, *Felidæ*, and *Bears* might have frequented the dens and crags of the Rock, but the *Deer*, *Bovidæ*, *Horse*, and others must have lived in the surrounding plains, and it has not been suggested that they were carried to the Rock by carnivora. A great and common danger alone could have driven together the animals of the plains and of the crags and caves. As the Rock after its submergence was again upheaved, the currents swept down on both sides of it the *débris* of the limestone disintegrated by the previous long glacial cold, together with the scattered remains of the animals and men drowned by the inundating waters. That the propelling force of the effluent waters was great, is shown by the distance to which the breccia extends from the base of the Rock. The scale is different, and the materials are different, but in all essential respects the phenomena are analogous to those presented by the "head" at Brighton and Sangatte. There is the same restriction to local *débris* with large blocks, the same absence of wear, the same traces of rude bedding, and the same occasional presence of mammalian remains.

SICILY.* Traces of similar phenomena exist in Sardinia, Corsica, Italy, and the coast of Dalmatia. The remarkable

* Dr. Christie, *Phil. Mag.* for Oct. 1831, p. 1. Dr. Falconer, *Quart. Journ. Geol. Soc.*, vol. xvi, p. 99.

caves of Sicily arrest attention from the extraordinary quantity of bones of *Hippopotami* (belonging to hundreds of individuals) which were found in connexion with them. Twenty tons of these bones were shipped from the one cave of San Ciro, near Palermo, within the first six months of working, and they were so fresh that they were sent to Marseilles to furnish animal charcoal for use in the sugar factories. How could this bone breccia have been accumulated? No predaceous animals could have brought together or left such a collection, and though Hyænæ lived on the island, they have left no traces of their presence, nor marks of their teeth, in this wonderful mass of bones. This breccia has been classed with the breccia of bone-caves, but the bones are *not gnawed* as is the case with the bones of the caves, and besides they are the bones almost exclusively of *Hippopotami*, of which the remains are very rare in caves. The only other suggestion that has been made is that the bones are those of successive generations of *Hippopotami* which went there to die. But this is not the habit of the animal, and besides the bones are those of animals of *all ages down to the fœtus*, nor do the bones show traces of weathering or exposure. The explanation which suggests itself to me is founded on the local topographical features of the island. The plain of Palermo is encircled by an amphitheatre of hills, rising to the height of 2,000 to 3,000 feet, and presenting mural precipices towards the plain.

The Caves are situated near the base of this escarpment, and at San Ciro the breccia not only faces the cave, but extends to some distance *in front* and *on either side*. When, therefore, the island was submerged, the animals in the plain of Palermo would naturally retreat, as the waters advanced, deeper into the amphitheatre of hills until they found themselves embayed, as in a seine, with promontories running out to sea on either side, and a mural precipice in front. As the area became more and more circumscribed the animals must have thronged together in vast multitudes, crushing into the more accessible caves, and swarming over the ground at their entrance, until overtaken by the waters and destroyed. A few of the more agile animals may have escaped to higher unsubmerged ground inland, for though the remains of *Deer*, *Ox*, *Bear*, and *Felidæ* occur, they are exceedingly scarce; but the unwieldy *Hippopotami* perished in hundreds. As the land afterwards emerged by intermittent stages, first the rocky *débris*, and finally large blocks from the

sides of the hills were hurled down, crushing and smashing the bones, which are, with few exceptions, broken into thousands of fragments. I would account for the numbers of *Hippopotami* by the fact that after the formation of the Raised Beaches, there was a considerable elevation of the coast, which led, as in more North-western Europe, to a large increase of the land area: so that the plain of Palermo may then have been of greater extent, and the rivers much larger.

MALTA.* The drift deposits of Malta present on the whole the same general features as those of Sicily, but owing to its peculiar population of *dwarf Elephants* with the *small Hippopotamus*, and the absence of other Quaternary Mammalia, the faunal remains have a distinct local colouring. They indicate that, like the Channel Islands, Malta had been long isolated before the spread of the Rubble-drift; but, nevertheless, it is evident that it did not escape the catastrophe which affected the adjacent lands. On the south side of the island escarped rocks rise abruptly to the height of 200 to 300 feet. The lower part of these slopes is covered by a consolidated red breccia consisting of angular fragments of the adjacent rocks, mixed with the red earth which covers the hill tops. This breccia, which contains in places remains of the *pigmy Elephant* I take to be the representative of the "head" at Brighton and Sangatte, only that in this instance the height of the escarpment has prevented its being entirely swamped as were the old cliffs at those places. It resembles closely the breccia on the Mentone slopes. It is probable that this island, no part of which exceeds a height of 800 feet, was entirely submerged, for not a single species nor even one genus of its Quaternary Mammalia are now living on the island, nor did any of its peculiar forms pass to the adjacent lands.

GREECE. The surface deposits of Turkey and Southern Russia are seemingly in general accordance with those I have just described. The rubble beds are, however, better developed in Greece, and are there occasionally ossiferous. An angular rubble forms great sheets extending to the shore, where it is worn back, and form cliffs 30 to 40 feet high, whilst the present torrents cut through and carry down the

* Admiral Spratt, *Quart. Journ. Geol. Soc.*, vol. xxiii. Dr. Leith Adams, *The Nile Valley and Malta*, p. 161.

rubble *débris*, spreading it out on the coast in the form of cones of dejection, and where it has often become re-cemented like the older breccia from which it is derived. On the adjacent island of Cerigo, Ossiferous Fissures, said to contain *human* remains, occur on the summit of an isolated flat-topped hill. This discovery has never been followed up.

ASIA MINOR. A Raised Beach, 5 to 30 feet above present sea level, surrounds Cyprus, but it does not appear to be accompanied by a *head*, though a sandy bed, "like Loess," overlies it in places. Nor is there any record of Ossiferous breccia or fissures. This may be owing to the submergence here having been small.

On the coast of PALESTINE* Raised Beaches range up to the height of 220 feet or more, but I cannot find any record of an overlying rubble or *head*, unless it be represented in part by a bed of red sand near Beyrout, described by Sir William Dawson. Traces of a bone-breccia of uncertain relations have also been found near Beyrout, and detrital deposits are alluded to; but the best preserved bone-cave there appears to be of Neolithic age. No distinct Ossiferous Fissures have been noticed. I conclude that the submergence, if any, of this district must have been small, whilst of its extension eastward or northward we want further evidence. Monsieur L. Lartet states that stone implements of the Palæolithic type have been found near Bethlehem, and in some other places, but they were on the surface, and give us no clue to the circumstances which led to their being in their present position.

NORTH AFRICA. The coast of North Africa presents confirmatory evidence. It is fringed by Raised Beaches—one in particular, 10 to 40 feet above the sea-level, is very constant. Ossiferous Fissures are met with on the coast of Tetuan, Oran, and other places in Algeria. They present the same characters and contain the remains of similar animals as those found at Nice and Gibraltar. The fissures do not, however, seem to extend to the eastward of Algeria, for none have been recorded in the province of Constantine, though there is a breccia which is suggestive of a Rubble-drift. In Algeria† Palæolithic flint implements have also been found in a few places on the surface.

* L. Lartet, *Géologie de la Palestine*. Prof. E. Hull's *Western Palestine*.

† Sir John Lubbock, *Jour. Anthropol. Inst.*, vol. x, p. 316.

Eastward of Tunis, the country has been described as consisting of rolling hills of cretaceous rocks in a sea of Quaternary drift, which, from the account of it, resembles a Rubble-drift, but Osseous Breccias and Fissures seem absent. It would appear, therefore, that, as on the north shores of the Mediterranean, the evidence of submergence becomes less as we proceed from west to east along the African coast.

EGYPT.* It may in fact be a question whether the submergence extended in this direction beyond the Lybian Desert. The escarped limestone hills and long lines of quarries in Egypt show no Ossiferous Fissures, nor does there seem to be any Rubble-drift overlying the fluvial terraces of the Nile, or underlying the river Alluvium. Nevertheless there is reason to believe that Palæolithic Man did exist there, for flint implements of the same type as those of the Thames and Somme Valleys have been found, but they were all on the surface, and none are from any deposit of well-ascertained Quaternary age. It is possible that they may have remained there, or in some fluvial deposits since Palæolithic Man inhabited the land. It may further be noticed that several of the animals which disappeared with the Rubble-drift in the more western districts, such as *Lion*, *Panther*, *Spotted Hyæna*, *Hippopotamus*, *African Elephant*, *Caffir Cat*, survived in the Nile Valley to historic times.

CONCLUSION.

concluding I would observe that all the phases of the Rubble-drift are such as show a common origin. Briefly, whether it be the Rubble or *Head* over the Raised Beaches, the *Osseous breccia* on slopes, or the *Ossiferous fissures*, the materials of all of them present a complete absence of that wear which must result from river, sea, or ice action; in all cases they are of *local* origin, while all the faunal remains of these, and of one section of the *Loess*, are such as might come from the wreck of a *land surface*, and a land surface only. The bones of the animals have evidently been subjected to considerable but not lasting violence, for they are *broken* and *splintered*, yet *not worn*; and though these remains are associated together in as it were a common grave, it is impossible to suppose that

* Sir W. Dawson, *Egypt and Syria*; L. Adams *op. cit.*

under the ordinary conditions of animal existence, such dissimilar orders could have been associated in life, nor, as the bones are *free from all traces of gnawing*, could those remains have been collected and left by beasts of prey. These concurrent conditions, together with the mode of dispersion of the Rubble-drift from many *independent centres*, seem to me, howsoever startling may be the conclusion, to be only explicable upon the hypothesis of a wide-spread and short submergence followed by early re-elevation, and this hypothesis will, I think, be found to satisfy all the important conditions of the problem.

In the first place the Rubble-drift overlies all the other superficial deposits and is therefore clearly the result of the last geological event that preceded the recent Alluvial beds and Neolithic man. Nowhere between the Rubble-drift and the Alluvial beds have there been found any deposits of Quaternary age. Nor has there been any land-erosion indicating a long lapse of time, though we have a fairly definite measure of marine denudation in the wear of the Rubble-drift where it has been exposed to the action of the sea, as on the coasts of Cornwall, at Brighton, Barnstaple, Sangatte, and around the islands of Jersey and Guernsey. But the cliffs so formed would certainly require no very great length of time for their formation, as in no case do they seem to be worn back more than half-a-mile, whilst in many cases it is not more than 100 to 200 feet. Reckoning therefore the rate of wear on the south coast, say at one foot annually, this comes well within the limits of data I have assigned to the Rubble-drift.

On Croll's estimate, however, for which Geologists mostly have contended, a period of some 80,000 years intervened between the disappearance of Palæolithic Man, with the cotemporary extinct Mammalia of the Post-glacial period, and the advent of Neolithic Man. Many years ago I expressed an opinion, in which I am confirmed by the recent observations of American geologists, that the close of the Glacial period comes down to within about 10,000 to 12,000 years of our own times. Not only is there nothing on geological grounds to sustain the opinion that a period of 70,000 to 80,000 years intervened between the close of the Glacial period and the appearance of Neolithic Man, but the same conclusion is forced on us on archæological grounds alone, for it is difficult to suppose that Palæolithic Man with his stone weapons and tools, his sculptured bones and rude but not inartistic sketches

of the cotemporary animals, could in that long interval of time have made so little progress as that exhibited by the similar surroundings of Neolithic Man.

To those who have followed me in this enquiry it cannot have escaped notice that we have possibly in the wide-spread catastrophe involved in the foregoing hypothesis, a more adequate cause for the Tradition of the Flood than any local river or land flood, however great it may have been. Such floods, whether of the Euphrates, the Tigris, or any other large river, have been recurrent at comparatively short intervals, and have attracted but little more than temporary attention. Their limits also are restricted to the valleys, broad though they may be, and consequently involve no such wide-spread catastrophe as that indicated by the Tradition of the Flood. Even those of the Yellow River, extensive as its inundations are, make but little impression on a busy people, and are soon forgotten.

On the other hand we have in this submergence an inundation of continental dimensions, and destructive to large populations of men and animals. The few who resorted to heights and mountain summits, could alone have escaped, and, from those centres, peopled afresh the surrounding areas.

Although our knowledge of all the phenomena is still very imperfect, it is remarkable how in all the leading points the facts agree with the Tradition. In each area the few survivors may well, in their limited world, have looked upon the Flood as universal. To them, as the subsidence was slow, the land movement would not have been apparent, and the only visible sign must have been the slow encroachment of the waters over their visible land. The geological phenomena have also led me to suppose that the submergence was, as in the Tradition, of short duration, and the retreat of the waters comparatively gradual, while the great destruction of animal life is sufficiently shown in the numerous remains preserved in the different forms of the Rubble-drift, wherever the conditions were favourable.

That Man lived at the time is now a question not necessary to argue, since the fact of the existence of Palæolithic Man over the whole of the area we have described, is, at the present day, a well-established fact. Therefore that Early Man must have suffered in the general catastrophe may be taken for granted, as the dispersion of the Rubble-drift took place at the close of the Quaternary period.

At the same time, although portions of the *human* skeleton have been found in Quaternary bone-caves and in the high-level Loess, it is chiefly by his stone tools and weapons that the presence of Man in the Quaternary period has been proved. In the Rubble-drift there are very scarce records of human remains, but flint implements fashioned by the hand of Man have been discovered in it at Portslade near Brighton, at Sangatte, Mentone, Algeria, and other places. Little systematic search has, however, yet been made, and the field is a new one. That a not inconsiderable population was spread over Western Europe and the shores of the Mediterranean, at a time anterior to the Rubble-drift, is certain. Still further proofs of Man having been involved in this wide-spread catastrophe should be forthcoming, although, owing no doubt partly to his having known better how to avoid the threatened danger, his remains are rare in comparison with those of the cotemporary animals. It must also be remembered that at that time there were but few men compared with the vast number of animals to be affected by the event.

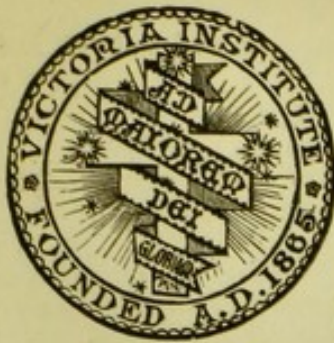
It is not easy to believe that any local river or land flood could have given rise to so sustained a Tradition as that of the Flood, whereas a Submergence of this vast extent, and of so exceptional a character, would be in accordance with the magnitude of the recorded catastrophe, and of the deep and lasting impression produced on those cotemporary peoples who were sufficiently near to be cognisant of its results. Nor would it accord less well with the remoteness of the event, and the dimness of the Tradition.*

The annexed short table will serve to show the chronological relation of the Rubble-drift to the other Drift and Alluvial beds:—

ALLUVIAL BEDS	{ Contains the remains of the <i>existing</i> <i>Fauna</i> and of <i>Neolithic Man</i> .
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* It is many years since first I had occasion to notice the exceptional nature of the "*Head*" at Sangatte, but I did not then go beyond attributing its formation to some temporary but unknown *debâcle*; and it was on geological considerations alone I was led to conclude that the South of England and North of France had undergone submergence at a comparatively recent period. Later on, it was the recognition of similar phenomena elsewhere on the Continent which led me to extend this conclusion.

RUBBLE-DRIFT ..	{	Contains the scattered remains of a Post-glacial land surface and Fauna with scarce traces of <i>Palæolithic Man</i> .
VALLEY GRAVELS and CAVES of Post - glacial Age.	{	With abundant remains of the late <i>Quaternary Fauna</i> , including the great extinct Mammalia (Mammoth, Woolly Rhinoceros, various Deer, Horse, Bovidæ, &c.), together with a large number of rude Stone Implements of <i>Palæolithic Man</i> . This Fauna marks the close of the Glacial Period.



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94. Instinct and Reason. By C. COLLINGWOOD, Esq., M.A., M.B., M.R.C.P., F.L.S., &c. Remarks by Professor HULL, F.R.S., and others.
The Science of Rectitude as Distinct from Expedience. By Rev. H. J. CLARKE.
God in Nature. By Professor E. HULL, D.C.L., F.R.S., Director of the Geological Survey of Ireland.
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The Botany and Entomology of Iceland. By Rev. F. A. WALKER, D.D., F.L.S. Remarks by Dr. J. RAB, F.R.S., Dr. G. HARLEY, F.R.S., Professor LOGAN LOBLEY, F.G.S., &c.
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96. The Dispersal of Plants as illustrated by the Flora of the Keeling Islands. By H. B. GUPPY, Esq., M.B. Remarks thereon by Professor T. RUPERT JONES, F.R.S., Mr. JOHN MURRAY (*Challenger* Expedition) and others.
Sketch of the Geological History of Egypt and the Nile Valley. By Professor E. HULL, LL.D., F.R.S., F.G.S., &c., with map.

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98. Chinese Chronology by Professor J. LEGGE, M.A., Oxford University. Remarks by Sir THOMAS WADE, G.C.M.G., and others.
The Garden of Eden, a criticism on the views of certain modern writers. By HORMUZD RASSAM, Esq. Remarks by Sir G. G. STOKES, Bart., F.R.S., Sir J. W. DAWSON, C.M.G., F.R.S., Professor A. H. SAYCE, D.D., Mr. T. PINCHES, Major CONDER, D.C.L., &c., M. BERTIN, and others. With a map engraved by Mr. Stanford from the official surveys.
Annual Meeting.
Islâm. By Rev. W. St. C. TISDALL, M.A. Remarks by Sir T. FORD, Major CONDER, D.C.L., Dean GOULBURN, Rev. Dr. KÖELLE, Rev. H. LANSDALL, D.D., M.R.A.S., Mr. RASSAM, and other authorities.
99. On the Reality of the Self. By W. L. COURTNEY, M.A., LL.D.
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100. On the Apparent Cruelty of Nature. By Rev. T. WOOD, M.A. Remarks by Sir J. FAYRER, K.C.S.I., F.R.S., and others.
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