JOURNAL OF

THE TRANSACTIONS

OF

The Victoria Institute,

OR,

Philosophical Society of Great Britain.

EDITED BY THE SECRETARY.

VOL. XL.

LONDON:

(Published by the Institute, 1, Adelphi Terrace House, Charing Cross, W.C.)

1908.

ORDINARY GENERAL MEETING.*

MR. MARTIN L. ROUSE, B.L., IN THE CHAIR.

The Minutes of the previous meeting were read and confirmed.

ASSOCIATE.—Miss Ellen Rouse, 10, Leinster Gardens, London, was elected Associate.

The following paper was read :—

THE INFLUENCE OF THE GLACIAL EPOCH UPON THE EARLY HISTORY OF MANKIND. By Rev. Professor G. FREDERICK WRIGHT, LL.D., F.G.S.Am.

WHEN in 1859 Dr. Falconer, Professor Prestwich, Sir John Evans, and Sir Charles Lyell with some other English geologists returned from a visit to Amiens and Abbeville, in the valley of the Somme in northern France, and reported their acquiescence in the genuineness of the discoveries by Boucher-de-Perthes of rough stone implements in connection with the bones of *Elephas primigenius* and other extinct animals in the "high-level" gravels of the Somme, a great sensation was produced in the scientific world. For, as was fully shown by Sir Charles Lyell in his work upon the *Antiquity of Man*, published in 1863, these discoveries, and other similar ones made in different parts of France and in southern England, involved the existence of man during the continuance of the Glacial Epoch. Innumerable subsequent discoveries both in Europe and America have confirmed this conclusion; and the existence of "glacial man" has been very generally accepted.

One of the chief reasons for the general public's hesitation to accept the evidence for glacial man arose from the then prevalent opinion that the Glacial epoch closed about 100,000

* 6th January, 1908.

years ago, and, therefore, that the acceptance of this view involved an enormous antiquity for the human race. At that time Lyell's uniformitarian theory concerning geological movements was scarcely questioned by any, and it was deemed legitimate for geologists to make unlimited demands upon the Bank of Time. An interesting illustration of this is found in the calculation made by Charles Darwin in the first edition of his *Origin of Species*,* where he estimated that a limited amount of erosion of the geological deposits in southern England must have occupied over 306 million years, which he says is a "mere trifle" of geologic time. Indeed, the uniformitarians generally regarded such a period as 500,000,000 years as a convenient thing to conjure with, while Sir Andrew Ramsay and others† maintained that for all we could tell geologic time was absolutely limitless.

But since the publication of the first edition of *The Origin of Species* and of Lyell's *Antiquity of Man* there has been a startling revolution in the opinion of scientific men concerning the age of the world and the length of geologic periods. In the later editions of *The Origin of Species* the calculation above referred to has been omitted and a paragraph inserted in its place, making some very pertinent remarks about the inadequate conception which most men have of the significance of even one million years and of the changes which would take place during that period, even at a very slow rate. Sir Archibald Geikie emphasises the point by calling attention to the fact that if a river lowers its bed by erosion one foot in one thousand years (which certainly is a very slow rate) it would produce a gorge 1,000 feet in depth in one million years. Such rivers as the Colorado in America are entirely competent to have eroded a cañon 6,000 feet in depth in one million years. Indeed on every hand evidence is multiplying of the great activity of the forces which produce changes in the earth's surface and in the species of animals and plants which live upon it.

It was Professor George H. Darwin who first demonstrated to the satisfaction of his fellow mathematicians that the moon was thrown off from the world not more than one hundred million years ago, and therefore, that the geological ages whose history is studied in the stratified rocks of the earth must be compressed within that period. Later, Lord Kelvin has voiced the pretty general belief of his associates in maintaining that

---

* See pp. 250–252.

† See Lord Kelvin's Annual Address at the Victoria Institute, 1897.

wenty-four million years is all the time which geologists can have at their disposal.* With him Alfred Russell Wallace is in substantial agreement, maintaining from the rate of probable deposition of geological strata that thirty million years is really all the time that geologists require.

The approximate correctness of these recent calculations cannot well be doubted, since they rest upon very substantial data from which speculative considerations are largely eliminated. Professor Darwin's calculations are based upon the known influence of the tides in retarding the revolution of the moon upon its axis, while Lord Kelvin's confident assertion rests upon the known laws governing the radiation of heat from the solar system, and Wallace's conclusions are largely derived from the new light which recent studies have shed upon the rate of erosion which is going on upon the surface of the earth at the present time. Extended and careful investigations show that the Mississippi is depositing sediment in the Gulf of Mexico at a rate which would require the removal of one foot of soil from the entire area of the Mississippi basin, stretching from the Rocky to the Alleghany mountains, in less than 5,000 years. This would lower the level of the whole American continent 200 feet in 1,000,000 years. If this process continues without interruption not much will be left of North America after 3,000,000 or 4,000,000 years. Other river systems are much more active on account of the steeper gradient of their channels. The Po, for example, is lowering its basin at the rate of one foot in 700 years.

It is true that geologists have not readily accepted these narrow limits imposed upon them by the astronomers and physicists, and they are attempting by various lines of argument to obtain an extension of credit to the extent of 100,000,000 years or so. But even with such an extension the case is very different from what it was when 306,000,000 years could be spoken of as a "mere trifle." In the readjustment of the ratios of geologic periods under these new limits the Glacial Epoch is brought down to comparatively recent time.

Dana's estimate of these ratios are twelve for the Palæozoic Period, three for the Mesozoic, and one for the Cainozoic, which includes the whole of Tertiary and post-Tertiary time. If we accept Lord Kelvin's estimate of the whole time at the disposal of geologists, these ratios would give us 18,000,000 for Palæozoic time, 4,500,000 for Mesozoic, and 1,500,000 for Cainozoic time,

* See Annual Address as above.

while post-Tertiary time, which includes both the Glacial and post-Glacial Epochs, is probably not more than one-thirtieth of the Cainozoic Period, which would be 50,000 years. But even if this is doubled, and 100,000 years is allowed for it, the post-Glacial Period, which is certainly not more than one-tenth as long as the Glacial, would be only 10,000 years.

We are, however, not dependent on speculative calculations alone to bring the close of the Glacial Epoch down to so recent a period that it is injected far into that of human history. Within the past twenty-five years, innumerable data have accumulated in America to prove that the ice of the Glacial Epoch lingered over the northern part of the United States as far south as the 43 degree of N. latitude as late as 7,000 years ago. This evidence is so clear and of such a varied character that it cannot be resisted when once it is clearly understood.

The evidence naturally falls under five divisions:—

1st. The small recession of post-glacial waterfalls.
2nd. The small enlargement of post-glacial river valleys.
3rd. The limited extent to which post-glacial lakes, ponds, and kettle holes have been filled with sediment.
4th. The small amount of the sub-aerial erosion of the surface of limestone rocks in post-glacial time; and
5th. The identity of the flora of glacial with that of the present time.

1st. In America, at least, nearly all the waterfalls are in the glaciated region, and have been produced by the damming up of pre-glacial water-courses with glacial *débris,* so that the drainage is diverted into new channels where we can estimate the amount of erosion which has taken place since the withdrawal of the ice. The Falls of Niagara and those of St. Anthony in the Mississippi River at Minneapolis are among the most spectacular of the instances at our command, but they are by no means the only ones. The waterfalls in the United States which have been produced by obstruction of the pre-glacial drainage by the irregular deposit of glacial *débris,* are numbered by the thousand, and everywhere illustrate the limited amount of work accomplished by streams since the Glacial Epoch. But in none can calculations be so easily made as in the cases of Niagara and the Falls of St. Anthony.

In pre-glacial times the drainage of the Lake Erie basin followed a channel leading to the head of Lake Ontario forty or fifty miles west of the Niagara. This had been occupied for such an enormous period that the Lake Erie basin was drained

to its bottom, and whatever cataract had formerly existed had entirely disappeared, and there was an uninterrupted channel from one basin to the other. During the Glacial Epoch this channel was filled with glacial *débris*, or boulder clay, so that it was completely obstructed and the water diverted to its present channel. But the drainage of this basin could not resume its eastward flow to the Atlantic Ocean until the glacial ice obstructing it had retreated from the Mohawk Valley in the central part of the State of New York.

The difference between the levels of Lake Erie and Lake Ontario is, in round numbers, 325 feet (Lake Erie being 575 feet above tide and Lake Ontario 250 feet), but the coll at Rome, New York, leading into the Mohawk Valley, is, in round numbers, only 100 feet above Lake Ontario. Until, therefore, the ice had retreated from this coll at Rome, New York, there could have been no eastward drainage from the Great Lakes, but as soon as it was removed the renewed eastward drainage could begin, and the Niagara river would commence the erosion of its gorge where it plunged over the escarpment at Queenstown. The time required for the erosion of this gorge between Queenstown and the present cataract represents the time which has elapsed since the ice of the Glacial Period retreated from the central part of New York between the Adirondack and the Catskill mountains; while over the lower St. Lawrence Valley, and indeed over nearly all of Quebec and Ontario, it must have lingered to a much later date. The problem, therefore, is to find the age of the Niagara gorge. Until recently this was largely a matter of conjecture, but now our calculations may rest upon a solid basis of observed facts.

The length of the Niagara gorge is, in round numbers, 7 miles or 35,000 feet. The strata of rock through which it is cut are of very uniform composition. At the surface we have a stratum of compact Niagara limestone, 25 or 30 feet thick at the mouth of the gorge, but between 70 and 80 feet at the present cataract. Underneath the Niagara limestone very uniform strata of Niagara shale, about 80 feet thick, extend through the whole distance. It is this relation of the soft beds of Niagara shale to the overlying stratum of compact limestone which occasions the cataract. The back lash of the plunging water erodes the underlying shale and leaves projecting masses of limestone over which the water falls in perpendicular descent. From time to time these masses of projecting rock fall to the bottom, so that the edge of the cataract is made to retreat.

But the volume of water is so tremendous and its fall so great that the largest masses of rock are moved by it, and, being rubbed together by the motion, are gradually reduced to powder, and carried away piecemeal, leaving the base of the fall unencumbered.

Underneath the Niagara shale there are four other persistent strata of alternate hard and soft character. The Clinton limestone is about 30 feet thick and very compact, but it rests upon about 70 feet of shaley rock which is easily disintegrated. This Clinton shale in turn rests upon a stratum of compact Medina sandstone 20 to 30 feet thick; and that upon a shaley rock reaching to the water's edge. All these strata dip slightly to the south toward the cataract. Owing to this dip and to the gradient of the stream, all but the two upper strata disappear below the level of the stream a little more than half way to the cataract, so that practically our problem involves the simple question of the erosion of the 35,000 feet of the two Niagara strata.

In 1841, Sir Charles Lyell visited Niagara, and from a hasty examination published a random guess that the rate of recession did not exceed 1 foot a year, and probably was not greater than 1 foot in three years; according to which the beginning of the erosion of the gorge must have been as far back as 35,000 years at least, and probably 100,000 years. Unfortunately, these figures have passed into the literature of the subject, and, owing to Lyell's great authority, have been accepted as scientific facts. But Sir Charles was himself very far from regarding them so; for, at the time, he urged Professor James Hall, of the New York State Geological Survey, who accompanied him, to make an accurate trigonometrical survey of the crest of the Falls, so that there should be a proper basis of comparison with future surveys, which would reveal the actual facts.

Such a survey was made in 1842. Permanent monuments were erected at the points at which the angles were taken, and all the details properly recorded in the third volume of the report of the Natural History Survey of the State of New York. After the lapse of sixty-three years, the last of four recent official surveys of the falls was made in 1905 by Mr. W. Carvel Hall. Taking these surveys as the basis of his calculations, Dr. G. K. Gilbert, one of the most experienced members of the United States Geological Survey,* has reached the conclusion that the actual annual rate of recession of the Horse Shoe Fall for the

* See *Bulletin of the U.S. Geological Survey*, No. 306, 1907.

whole period between 1842 and 1905 is 5·3 feet. The Horse Shoe Fall has receded since Sir Charles' visit 338 feet. There can be no question, therefore, that at the beginning of the Christian era the edge of the cataract was $1\frac{3}{4}$ miles lower down than now, and that at the time of the Trojan War it was at the head of the whirlpool rapids, nearly three miles below, and that at that more distant period of human history, marked by recent discoveries in Egypt and Babylonia, this marvellous cataract was just beginning its work of erosion while Canada was still as well within the grasp of the Glacial Epoch as Greenland is to-day.

Professor N. H. Winchell's investigations into the age of the Falls of St. Anthony at Minneapolis lead to almost identical results, results which are confirmed by the general appearance of almost all the waterfalls of the glaciated region of North America.

2nd. There are innumerable river valleys, large and small, within the glaciated region whose limited depth and width bear indubitable testimony to the shortness of time during which the streams have been active in erosion. Through some public works in Oberlin, Ohio, I have had unusual opportunities the last few years to make definite observations upon the extent of the erosion of a small post-glacial stream and upon the rate of its activity.

As soon as the glacial ice had retreated north of the watershed separating the Mississippi valley from the Great Lakes, and up to the time when the ice had melted off from the Mohawk Valley, permitting the Falls of Niagara to begin their work, a temporary body of water occupied the Lake Erie basin with its outlet into the Mississippi Valley. The shore lines of this temporary lake are easily followed for hundreds of miles.

Plum Creek, from which this new evidence comes, is in the village of Oberlin, Lorain County, Ohio, 12 miles back from the present lake and 5 miles back from the old shore line. This old shore line is 200 feet above the present lake, and Plum Creek is 250 feet above the lake, or 50 feet above the level of the shore line of the glacial lake. The creek, therefore, has been at work eroding its present trough ever since the ice retreated from the southern watershed far enough to permit the water of the glacial lake to settle down to the level of the 200 foot shore line. It is well known that this level was determined by the elevation of the coll at Fort Wayne, Indiana, leading into the Mississippi Valley through the head waters of the Wabash River. Plum Creek, therefore, is as much older

than Niagara as the time required for the retreat of the ice from the Mississippi watershed to its removal from the valley of the Mohawk in Central New York, amounting perhaps to 1,000 or 2,000 years.

Upon measuring a section of the eroded valley 5,000 feet long, I was able to determine the total amount of work done by the stream since the beginning of its flow. Twelve years ago the village, in constructing waterworks, turned the course of the stream into a new channel, cut for it 500 feet long, so that we are now able to estimate the rate at which this stream under favourable circumstances is carrying away material from the valley. As the full calculations and results are soon to be published elsewhere, I shall not go into details here, but will simply say that they are entirely inconsistent with a supposition of more than 10,000 or 12,000 years as the period of the stream's activity. The calculations fully corroborate those which have been made concerning the age of Niagara Falls. The supposition that this creek has been at work for 100,000 or even 35,000 years is erroneous in view of its present known activity.

3rd. The small extent to which the innumerable lakes, ponds, and kettle-holes which dot the glaciated region have been filled up leads to the same conclusion. Such are the forces at work to drain and fill up these depressions, that a few thousand years is all that is required to bring them into their present condition. Many of them have been already obliterated, while the others show that the obliterating forces cannot have been in operation many thousand years.*

4th. Another confirmatory witness to the short time which has elapsed since the Glacial Epoch is found in the small extent to which the surface of limestone strata, which were once highly polished through the action of glacial ice, have since that time been disintegrated and eroded by sub-aerial agencies. The activity of these agencies can be seen on the tombstones in any ancient cemetery and in the exposed walls of old buildings. Now, in the glaciated region, where polished limestone surfaces have been exposed, there are frequently in close proximity areas that have been protected by superincumbent large boulders which are standing on a low pedestal left in the process of surrounding sub-aerial erosion. But these pedestals are never more than two or three inches in height, showing that a few thousand years would be amply sufficient to produce the results.

* See Author's *Ice Age in North America*.

5th. Though there was a great destruction of animal species in connection with the closing stages of the Glacial Epoch, there has been little change since then in the species of plants that remain; while the identity of the species of plant life and the freshness of their remains found in glacial deposits make an irresistible impression of the proximity of the great ice age to the present time. In various parts of the United States there are the remains of red cedar forests buried beneath glacial drift in which the perfume of the cedar lingers as fresh as if cut but yesterday.

Comparing now the chronology of the human race in the Euphrates Valley and that of glacial man in North-Western Europe and in America, it would appear that they were for a time contemporaneous; and that the human race presented about as great extremes in culture then as it does now. With the exception of various labour-saving inventions which have been made within the last three or four centuries, the civilization in ancient Babylonia was as far above that of contemporary Paleolithic man, living on the border of the ice-fields in England and America, as that of Europe is above that of the Esquimaux who live upon the borders of the Greenland ice-fields. Substantially the same differences in culture existed then as exist now.

Considered in its total result, the progress of mankind has not been by any means so great as it is popularly represented to have been. Ten thousand years ago the human race possessed all the leading characteristics which it possesses at the present time. There were centres of high civilization in favoured localities, and there were wide areas of barbarism and savagery where man barely maintained his existence through a desperate struggle with the conditions of life. The same is true to-day, only the centres have shifted and some races have come into possession of knowledge enabling them to control the forces of nature for certain purposes much more completely than ever before; but a large portion of the human race is still carrying on the struggle while in possession of only the most primitive means of culture. The Stone Age has not wholly disappeared from the world.

The probable influence of the Glacial Epoch upon the early history of mankind will be best perceived by taking a general view of the progress of geological events in post-Tertiary time. In doing so it is important to note that the Tertiary Period which culminated in the Glacial Epoch closed with a high

elevation of land over all the Northern hemisphere. This is evident from so many facts that we do not need to pause here for their full presentation. Briefly stated, the facts are that all the northern part of America stood at an elevation of between 2,000 and 3,000 feet above that which it has at present. The same is also true of Northern Europe. During the Tertiary Period, also, as is well known, all the high mountain chains of the world received their present elevation; marine strata of the Middle Tertiary Period being frequently found at an elevation of from 10,000 to 15,000 feet above the sea. In the latter part of the Tertiary Period, also, the animal species which now occupy the earth attained their present characteristics, while a large number of closely allied species which attained great prominence flourished for a while, but in connection with the vicissitudes of the Glacial Epoch either became extinct, or shifted the centre of their field of occupation. From the evidence of man's co-existence with them during the closing stages of the Glacial Epoch, it would appear that he, too, came upon the scene soon after the close of the Tertiary Period, and was distributed over the surface of the earth while the elevation of the Tertiary Period still furnished land communication between the Eastern and Western hemispheres.

Presumably this land communication was between Asia and North America in the region of Behring's Straits and Behring's Sea. Here an elevation of a few hundred feet would lay bare a vast tract of land furnishing pasturage for animals and all the means of sustenance that primitive tribes would demand. The same amount of elevation would also lay bare a border of the American continent all the way to California, which is now only slightly submerged; and open the way for the dispersal through America both of man and of the now extinct animals with which he was associated.

Clear evidence that this was the course of events is shown by man's association with the mammoth. The remains of this huge species of elephant are found in great abundance in connection with those of man, not only over North-Western Europe, whither they had migrated in one direction from their original centre, but all over Northern Siberia and the islands adjoining, and onward to Alaska and over the northern part of the United States, penetrating on the western coast as far south as Mexico.

With these things in mind, we may now see how important a factor the Glacial Epoch probably was in affecting the destinies of man. This elevation of land at the beginning of

the Glacial Epoch probably continued far down towards its close, when it was followed by a depression to a level considerably below that of the present time. This is clearly evinced by post-glacial marine deposits and beaches which are now found several hundred feet above the sea in Canada and Scandinavia. The extreme depression, as shown by these raised beaches, was in both places fully 1,000 feet. It is evident also that, at the time of the extreme extension of glacial ice in America, the gradient of all the south-flowing streams was greatly reduced, indicating a differential northerly depression over the whole interior of the United States.

It is easy to see, therefore, that during the culminating period of the Glacial Epoch, man and his contemporary animals in America were shut off from communication with Asia, and the area from which they derived subsistence was greatly limited, both by the submergence of the continental shelf and by the great extension of the ice fields, reaching in the Mississippi Valley in Southern Illinois the latitude of 38°. At the same time, there was a great incursion of the ice upon the fertile portions of Europe. Switzerland was obliterated, Great Britain nearly so, all Northern Germany was covered, and Russia to within a short distance of the Black Sea.

On the other hand, Central Asia seemed to receive a great increase of fertility. From recent investigations it appears that Siberia and Central Asia were not invaded by glacial ice.* But there was a great extension of the glaciers still existing in the high mountains. Those of the Thianshan range merit special mention. This vast mountain system rises in peaks to a height of 23,500 feet, or 8,000 feet higher than the Alps; while its mass is estimated to be twenty times that of the Alps. Small glaciers still exist far up in the higher altitudes. During the Glacial Epoch they descended to the 7,000 foot level, but never reached the great plains at a lower level. A subsidiary result of this extension of the mountain glaciers in Central Asia was a marked increase in the size of the mountain streams upon which the population of the plains depended for irrigation.

The importance of irrigation to the population of Central Asia is not generally appreciated. Our attention has so long been fixed upon Egypt and its dependence upon the Nile that we have not given sufficient consideration to other regions dependent upon irrigation. Now, around the base of the Thianshan mountains, there is an area many times the size of

* See Wright's *Asiatic Russia*, 2 vols., McClure & Co., New York.

Egypt, whose life depends upon innumerable streams—large and small—which bring down their life-giving supplies of water in due season from the heights where it has been detained in unfailing cold-storage reservoirs far more regular and reliable than the lakes of Central Africa, which are subject to the vicissitudes of the annual precipitation and to the temporary obstruction of their outlets by the accumulation of vegetable matter.

The natural influence of the vicissitudes of the Glacial Epoch upon the development of life in Central Asia can be readily perceived. The conditions leading to the increase of glaciers in the mountains, especially those connected with the rapid melting of the ice during the declining portion of the epoch, would greatly extend the area of fertility and promote the interests of all forms of life. It is interesting to learn that this very region, which is the traditional centre for the dispersion of the human race, and in which, beyond all reasonable doubt, the Aryan races had their original home, has recently been found to be an important centre of pre-historic man. Professor Raphael Pumpelly announces, as one of the results of the Carnegie Expedition to explore the pre-historic mounds of Turkestan, the discovery of remains of man which he estimates to date from 8250 B.C., and of other evidence, showing that at about this time man had already succeeded in accomplishing the wonderful feat of domesticating the ox and several other animals.*

The decline of the Glacial Epoch in Central Asia is connected, either as cause or effect, with the subsequent diminution of the size of the mountain streams and the general desiccation of that region, thus reducing its fertility. The result of this has been to intensify the struggle for existence, to compel increased migration, and thereby to give a new impulse to new centres of civilization. It is worthy of mention, also, that the same diminution of glacial conditions in Central Asia which limited its capacity to support population opened up the fairest portions of Europe and North America and invited their occupation by man. In America we are but just entering upon our inheritance, America's great prosperity being largely due to the rapidity with which we are now seizing the reserved stores of richness accumulated in our soil by the glacial deposits and by the chemical changes which have taken place during the thousands of years through which it has since been lying fallow.

* See his *Report to the Carnegie Institution, Washington*, 1906.

The disturbing influence of the Glacial Epoch is specially to be noted in the destruction of animal species, which in some way took place in connection with it, including, apparently, that of a large portion of mankind. At the close of the Tertiary Period "the great Irish elk, the *machairodus* and cave lion, the rhinoceros, hippopotamus, and elephant" roamed over Europe, and "equally large felines, horses and tapirs, larger than any now living, a llama as large as a camel, great mastodons and elephants and abundance of great megatheroid animals of almost equal size" were abundant in North America, "while in South America these same megatheroids in great variety, numerous huge armadillos, a mastodon, large horses and tapirs, large porcupines, two forms of antelopes, numerous bears and felines, including a *machairodus* and a large monkey," flourished. But all of these have become "extinct since the deposition of the most recent of the fossil-bearing strata,"* and their destruction can be very clearly traced to the vicissitudes of the Glacial Epoch.

In the glaciated regions the bones of all these northern species are found in abundance in the gravel and loess deposits connected with the closing scenes of the epoch, or in the bogs where the animals had been mired in the early part of the post-Glacial Period. That man shared in this destruction throughout North America and Europe is rendered altogether probable by the way in which his remains are associated with those of these extinct animals. These have been found in connection with the bones of one or more of the above-mentioned animals deeply buried in undisturbed beds of loess in definite relations to certain stages of the glacial recession at Omaha, Nebraska, Lansing, Kansas, and Kiev, Russia. They have been found in similar connection with the bones of these extinct animals in various gravel deposits of glacial origin in the United States (notably at Trenton, New Jersey) and in similar deposits, doubtless of the same age, in Northern France and Southern England, while a similar connection between these extinct animals and man is shown by still more abundant evidence in the results yielded by the excavations of numerous pre-historic cave dwellings in North-Western Europe.

At this point it will be profitable to turn our attention to the process by which this great destruction of man and his post-Tertiary animals was secured. Evidently the destruction was brought about largely as a result of the disturbance of conditions

* Alfred Russell Wallace, *Geological Distribution of Animals.*

affecting the struggle for life between competing species. In the advance of the glacial ice in North America, for instance, animals and plants were driven southwards from an area of 4,000,000 square miles; the southern border of which reached in Illinois nearly to the junction of the Ohio with the Mississippi River in latitude 38°.

It is impossible to over-estimate the strenuousness of the struggle for existence which was set up in the restricted area in the southern part of the United States and Northern Mexico, lying between the glacial conditions in the north and the tropical conditions which prevented migrations southward across Central America. Then, again, upon the amelioration of the northern climate and the re-opening of the northern region to the animals which had survived the former changes of conditions, many of them re-occupied the ground, and began the struggle with new conditions, to which some of them, especially the mammoth, in due time succumbed.

Local floods of enormous extent during the closing stages of the Glacial Epoch seem to have been connected in a marked degree with the destruction of both man and animals which took place during this epoch. The remains of man which have been found within the last few years in the loess of the Missouri Valley (referred to above) are connected with annual floods which can be definitely proved to have risen 200 feet. These floods were occasioned by the rapid melting of the ice in the upper part of the valley, and the gorging of the water lower down, producing annually for a while in the latter part of each summer a temporary lake 1,000 miles long and from 70 to 80 miles wide. Similar conditions existed in the valley of the Ohio and down the Mississippi as far as Vicksburg.

At this time the depression which now contains Great Salt Lake in Utah was filled up to a depth of 1,000 feet, and covered an area of 20,000 square miles, ten times that of the present lake. When at last this glacial lake surmounted its barriers and broke over into the Snake River Valley, it quickly brushed away 350 feet of the mud barrier which restrained it, and that depth of water rushed down the valley in a torrent as large as Niagara for 25 years.* The results of this are incomprehensible.

Likewise in Southern Russia, if the loess covering that region is connected with the same stage of the glacial recession, man

* See Gilbert's *Report on Lake Bonneville, U.S. Geological Survey.* A summary is given in my *Man and the Glacial Period*, New York, 1900.

and his associates were there subject to a similar destruction by local floods. Distinct evidence of a great change of land level of that region at about that time appears in a raised beach of modern origin 750 feet above the Black Sea at Trebizond. In fact, I think there is conclusive evidence that all Northern Siberia, Western Turkestan, and the larger part of Russia were depressed below sea-level in connection with the great earth movements which took place during the latter part of the Glacial Epoch.

At a corresponding period, also, the Tarim depression south of the Thianshan mountains was covered with water to a great depth. I had suggested* that this may have been occasioned at the time of the depression apparent in Northern Siberia by the water pouring over into the desert of Gobi through the Sungarian depression; but Mr. Ellsworth Huntington, who has recently returned from an exploring expedition in that region, thinks that this accumulation of water in the Gobi basin was directly due to the glacial conditions which gave to the glaciers in the surrounding mountains the vast extension to which we have already referred.† If that be so, it would be in close analogy to the enlargement of Great Salt Lake, the existence of both bodies of water being synchronous.

In the case of the Dead Sea, which Professor Hull has shown to have been filled with water within a comparatively recent time, he has suggested that this enlargement, like that of Great Salt Lake and Lob Nor, was a direct result of the Glacial Epoch, and of the accumulation of glaciers upon the mountains at the north. But as my investigations appear to show that the Lebanon mountains never supported more than one glacier, and that a small one, on whose terminal moraine the famous grove of cedars is now standing, I am inclined to connect the temporary enlargement of the Dead Sea (during which the Jordan Valley was filled to a depth of 1,400 feet) to that post-glacial depression of land which we have traced so extensively elsewhere, and of which Professor Hull and others have adduced such clear evidence around the eastern border of the Mediterranean basin. This depression was certainly 250 feet, which would be sufficient to admit Mediterranean water into the Jordan Valley through the valley of Esdrealon, whose highest point is only 215 feet above sea-level.

---

* See *Scientific Confirmations of O.T. History*, Hodder and Stoughton, London, 1907.

† See the *Geographical Journal*, vol. xxx, No. 3, Sept. 1907.

That these great changes of land level were in some way connected with the Glacial Epoch is beyond question. And it is not difficult to perceive in the forces connected with this remarkable epoch a cause for this unstable condition of the earth's crust so late as that of the pre-historic period of man's existence. During the Glacial Epoch at least 6,000,000 cubic miles of ice were piled up over the northern part of America and of Europe. For the production of this ice enough water would have to be abstracted from the ocean to lower its level 250 feet the world over. Other high authorities would make the amount of ice twice, or even three times, that which we have indicated, with a correspondingly larger amount of water abstracted from the ocean.* But even on my own moderate estimation we have a shifting of weight from the ocean beds to the limited area of glaciation amounting to 24,000,000,000,000,000 tons, equalling the total weight of the North American continent. The transference of such an enormous weight from the ocean to the continents and its subsequent return to the ocean is a force so inconceivable that we cannot estimate its efficiency in disturbing the equilibrium of the continents, and causing depressions and elevations of land out of all analogy to those which we have witnessed within the historic period. But pre-historic man evidently did witness these disturbances and was profoundly affected by them.

Indeed, the story of the Noachian Deluge becomes easily credible to the attentive student of the shifting forces at work during the glacial epoch; and the rapidly changing conditions to which man was subjected during this trying period of his history may readily account, on the principle of Natural Selection, for the rapid differentiation of the race in its final distribution over the world.

While the results of our studies in the Glacial Epoch are not as definite in their results as one would wish, this important conclusion is established, namely, that in the early periods of the existence of the human race there was an instability of conditions arising from the instability of land levels caused by the Glacial Epoch which frustrates all attempts to reason backwards by analogy from present conditions.

---

* See Chamberlin and Salisbury's *Geology*, vol. iii, pp. 327–502.

Discussion.

Professor Hull desired to be allowed to move the thanks of the meeting to Dr. Frederick Wright for his remarkable and very able paper to which they had just listened. It was of special interest to have amongst us a recognised leading geologist from the other side of the Atlantic; and he (the speaker) had to confess that when the title of the paper was placed in his hands as Secretary, he felt very curious to find whether the author would be able to bring into closer proximity than is generally allowed these two great events —namely, the appearance of Man, and the disappearance of the Glacial Epoch. After listening to the evidence adduced, he felt free to admit that the author had succeeded in doing so to a large extent. He thought that Dr. Wright's paper would help to forward the view that the lapse of time since the close of the "great Ice Age" was shorter than some geologists had supposed—notwithstanding the great physical changes which had taken place in the earth-history of post-Tertiary times. The uniformitarian theory would have to be abandoned, notwithstanding the distinguished names by which it has been advocated. In opposition to this theory it was equally arguable, that the geological history was one of alternating paroxysms and repose; in the latter of which, we, as human beings, have, by the foresight of an over-ruling Providence, had our lot cast —after the paroxysmal epoch of Pliocene times—when stupendous earth-movements had their sway both over continents and oceans. He begged to move the best thanks to the author.

Professor Langhorne Orchard, M.A.—It gives me much pleasure to second the vote of thanks, so felicitously proposed by Professor Hull, to the author of one of the most valuable papers brought before this Society. The reasoning is clear, crisp, convincing, and it is no small advantage to students of the subject to listen to the careful conclusions of a geologist who is easily among the leaders in his profession.

One of the earliest allusions in the paper is to the important work done by Lor Kelvin in fixing the time-limit of terrestrial life.

That "Prince of Science" is no longer with us. The whole civilised world is conscious of a great absence. Not by our Society only, but wherever science and philosophy have a home, Lord Kelvin's name is known and honoured. A born investigator, he recognised the Creator through the Creation, and natural phenomena were to him avenues to the great First Cause. He consistently interpreted the secrets of Nature in the language of truth; whatever he touched he beautified, and he illuminated science with the calm lustre of a Christian life. As we offer to Lord Kelvin's memory the tribute of an affectionate admiration, we thank God for giving such a man. His work will remain with us as a permanent asset, his example as an inspiration.

In connection with Darwin's mistake, referred to by the author, one is reminded that this is not the only instance of the healthy common sense of the people rebuking the theories of a visionary scientist.

Two very important points are emphasised in the paper. The first is the young antiquity of Man, who is supposed to have made his appearance in Central Asia (where the temperature was not severe) at the close of the Glacial—or may I say at the beginning of the post-Glacial ?—Period. According to Dana's estimate of ratios, Man's appearance took place about 5,000 years ago; but the learned author seems to prefer 7,000. I would suggest that we take the mean of these two estimates, 6,000 years or thereabout, as the probable length of Man's terrestrial tenancy up to the present time. This is in close agreement with that obtained by applying Dana's ratios to Wallace's estimate. It also accords with the belief of Professor McK. Hughes, that there is no real evidence of Man's existence at a period more remote than "the post-Glacial river gravels." The second important point is that "the story of the Noachian Deluge becomes easily credible to the attentive student . . . ." With regard to this matter, scientists have progressed surely, if slowly: and, to quote the words of Sir J. W. Dawson, we may be satisfied that "geological investigation has now finally taken its place along with sacred history in the vindication and illustration of the much-controverted and much-ridiculed flood of Noah."

I beg to second the vote of thanks.

Mr. MARTIN L. ROUSE, B.L.—We owe deep and cordial thanks to Professor Wright; for he has given us this paper, not as one who has any reputation to earn through our means, but as one who

has long since made a name in the field of geologic science. He has here proved by solid research and experiment, made both by others and by himself, that the whole period of human existence upon the Earth is far shorter than recent geologists have maintained, and approaches much nearer to the extent that we infer for it from a study of the Bible.

I would ask, however, whether the result that apparently flows from Dr. Gilbert's measured annual recession of Niagara Falls—namely, a period of 7,000 years for its total recession—may not at once be greatly reduced by taking into account the relative thickness of compact rock in the uppermost hundred yards where the recession has been measured, and which is close upon 80 feet, and the average thickness for the whole course of seven miles [which I find to be only about 66. The recession probably started from the complete break-up of the Glacial Epoch, so I await a still further reduction in the reckoning]. Meanwhile, it can be proved in another way that the human period is vastly shorter than is supposed by many scientists who ignore the figures that have come down to us in the Bible.

Taking an estimate given by Lord Avebury in 1904* (which is only a third of the one given by Professor Ray Lankester last year)†—namely, that mankind had been upon the Earth 50,000 years—let us find what average yearly increase would produce in that period from an original human pair the population of the world as it stands now—that is (according to the last census for all civilised peoples and according to expert calculations for all barbarous ones) 1,564,000,000.‡

Let $\frac{1}{x}$ stand for the unknown yearly increase. Then every unit in each successive year has become $1+\frac{1}{x}$; and this process has been repeated 50,000 times.

---

* At the meeting of the British Association, in a discussion upon a paper by Dr. Arthur Evans upon the Chronology of Crete.

† In his Romanes lecture.

‡ From Pannell's *Reference Book* (Granville Press, 1906).

Thus the equation runs—

$$2\left(1+\frac{1}{x}\right)^{50000}=1{,}564{,}000{,}000$$

$$\left(1+\frac{1}{x}\right)^{50000}=782{,}000{,}000$$

$$\log.\left(1+\frac{1}{x}\right)=\log.782{,}000{,}000\div 50{,}000$$

$$=8{\cdot}8932068\div 50{,}000$$

$$=0{\cdot}000177864$$

$$1+\frac{1}{x}=1{\cdot}00040906$$

$$\frac{1}{x}=0{\cdot}00040906$$

$$=0{\cdot}409 \text{ per thousand per year,}$$

or, say, $\frac{2}{5}$ of a man per thousand per year; which works out to 4·14 persons per thousand in ten years, or would show that only 8·28 more have been born than have died in every ten years—a figure that need only be mentioned to be scouted by every thoughtful mind. On the other hand, taking the interval from the Deluge to be what Ussher's chronology makes it (only with the addition of three years, so as to place Christ's birth in the year of the Egyptian census 8 B.C.) we have

4,000 − 1,656 = 2,344 years from the Deluge to the Birth of Christ,
7 years thence to the usual beginning of the Christian Era,
1,900 years thence to the last general census,

4,251 years in all.

So, letting $\frac{1}{x}$ stand as before for the average fractional increase per year, and having 8 persons instead of 2 as the number at our starting point, we get the equation—

$$8\left(1+\frac{1}{x}\right)^{4251}=1{,}564{,}000{,}000$$

$$\left(1+\frac{1}{x}\right)^{4251}=195{,}500{,}000$$

$$\log.\left(1+\frac{1}{x}\right) = \log. 195{,}500{,}000 \div 4251$$
$$= 8{\cdot}82911468 \div 4251$$
$$= 0{\cdot}0019504$$
$$1+\frac{1}{x} = 1{\cdot}004501$$
$$\frac{1}{x} = 0{\cdot}0045$$

or $4\frac{1}{2}$ per thousand; or 9 persons on an average have been born per thousand more than have died in every successive year since the Deluge, which works out to 92 per thousand in every ten years.* [One may add that the average excess of births at the present time in such European nations as publish returns—namely, all the Central and Western ones and three of the Balkan States—is 10·74 per thousand per year.]†

Professor Wright has also indicated that the sudden melting of the ice heaped up in Europe and America during the Glacial Epoch, where now there is none, would have raised the level of the ocean everywhere 250 feet, and so have produced a world-wide flood. But this melting itself, as our Secretary has through his own and similar researches shown, was produced by a gradual subsidence of the land surfaces, which itself caused the overflowing at least of those vast belts of land that now lie hundreds of fathoms beneath the sea.

Rev. A. IRVING, D.Sc.—The Victoria Institute is to be congratulated on the two papers bearing on the relation of the Glacial Epoch to the early life-conditions of Primeval Man, which have come before it in the present session. Here, where geology meets history, everything has a double interest—the scientific and the human; and the usefulness of Professor Wright's paper is the greater, when it is taken in connection with the bibliography of the "Literature of the Niagara Falls," which is appended to it, in which I am glad to see that the work of my friend Professor J. W. Spencer holds a conspicuous place. The fresh and breezy style of Dr. Wright's paper, as he brushes aside the cobwebs of accumulated geologic

* The idea of my equations I owe to an article that appeared in the French review, *Les Mondes*, in 1863.

† Calculated from the tables in Bartholomew's *Handy Reference Atlas*.

dogma on the Glacial Epoch and on geologic time generally, is not its least meritorious feature. It seems to me that, to any one not obstinately committed to the views of a school, it must be difficult to refuse to accept most of, if not all, Dr. Wright's conclusions. His remarks on what has recently come to light in connection with the ancient civilisations of Central Asia far back in the remote past, and the relations in which they stood to other primeval portions of the great Human Family, seem to me to add to the human interest of the subject; and the more so, when we recollect that on the other side of the great Thianshan range another ancient civilisation —that of Tibet—was developed, upon which, no doubt, much new light will soon be thrown, as experts get to work upon the magnificent Tibetan library recently presented by the Master of St John's College to the University of Cambridge.

When we piece together the results put forward in the present paper with those obtained by the Belgian explorers and those described by Professor Hermann Credner for North Germany (*Elemente der Geologie*, 10th ed., 1906), we get such a complete picture of the combined action of ice and water in influencing the conditions of life of Primeval Man, as perhaps had never been given before to the scientific world. It is no longer a question of "Ice *or* Water?" (which are, after all, only two different physical conditions of one and the same substance essentially*), but rather a contemplation of the vastness of results achieved by *variations of temperature* over vast portions of the surface of our planet, as these have been determined by *regional oscillations* of level of the lithosphere acting during long periods of time. Dr. Wright's work, carried on in the free scientific atmosphere of the New World, seems to have emancipated his mind from that *slavish literalism* in the interpretation of the prehistoric records of humanity, of which a former President of the Victoria Institute (the late Sir Gabriel Stokes, F.R.S.) used to speak with a sort of contempt, and of which we have had recent reminders in the correspondence-columns of the *Guardian* newspaper, in connection with the Creation-story of Genesis 1. The concluding paragraphs of Dr. Wright's paper justify the remark, that the last word of science on the "Noachian Deluge" has not yet been

* That is to say, they are one and the same chemical body ± 80 Centigrade thermal units per unit of mass.

written; but that rather, when a systematic geological survey of the Euphrates-Tigris basin shall have been carried out—such as that which has been accomplished in recent years for the Nile-basin under the directorship of my friend Captain H. G. Lyons, D.Sc., F.R.S.—a good deal of what has been written by Professor Driver of Oxford in his work on Genesis (pp. 99–108 of the latest edition) will probably have to be re-written. It would be no compliment to a man in Dr. Driver's position to suppose that he himself believes that in the single paragraph (pp. 102, 103, *op. cit.*) in which he notices Professor Prestwich's views, as they were put before the Victoria Institute some years ago, he has done justice to a paper occupying twenty-two pages of the Institute's *Journal of Transactions*, with the sixteen pages of a closely-printed report of the discussion thereupon, in which many of the foremost geologists of the day took part. Such regional oscillations of level of the lithosphere relatively to the hydrosphere would, in the nature of things, and as shown in Prestwich's great paper on the *Rubble Drift*, be *differential;* and Dr. Wright's instance of a raised beach 750 feet above the present level of the Black Sea, gives us some indication of the great vertical range of such differential movements, and points as a finger-post to other possible differential movements in connection with the great elevated region of Asia Minor and Armenia, which might give us all we need to enable us to realise the actuality of such a catastrophe as is implied in the Genesis narrative of the "Noachian Deluge," when due allowance is made for those elaborate and hyperbolic habits of expression, on which the author of a recent work on "the Magi"* (along with Sir William Ramsay, LL.D.) has laid special stress, as characteristic of the Oriental mind.

There are two minor points in Dr. Wright's paper open to criticism—(i) his use of the word "cataract" for a waterfall, the former word having been associated for centuries with certain features in the Nile channel, while we are told in the latest monograph issued by the Egyptian Survey Department (1907) that "there is nothing about the Nile cataracts in any way resembling the falls of Niagara or even the falls of the Rhine at Schaffhausen"; and (ii) it has been shown in the great monograph on the "Physio-

* *The Magi*: *how they recognised Christ's Star*, by Lieut.-Colonel G. Mackinlay (Hodder and Stoughton, 1907).

graphy of the Nile Basin," which (as the result of a twelve years' survey by Captain Lyons and his accomplished staff) will be the standard work of reference for many years to come, that the Nile Flood and its variations depend upon the annual rainfall in the Abyssinian Highlands, and not upon any periodic overflow of the lakes of Central Africa (p. 62). But these are incidental matters, and do not detract from the solid value of an otherwise excellent paper.

From Mr. HENRY PROCTOR, F.R.S.L., M.R.A.S. :—

In Professor Wright's paper on "The Influence of the Glacial Epoch upon the Early History of Mankind," he speaks of centres of high civilization which existed on the earth ten thousand years ago, which is far anterior to the time which the Bible assigns to Adam. But in this connection it is important to note that the Bible nowhere speaks of Adam as the first man, for it is clearly evident that what is called the Elohistic account of creation in the first chapter of Genesis, is quite distinct from the Jehovistic narrative of the advent of Adam contained in the second chapter.

The differences, indeed, are so great that it is difficult to imagine how it could have been believed so long that they were merely two versions of the same account of creation.

For in the first chapter we see that men and women are created (bāra) without specifying the number, whereas in the second account it is first one man only, and subsequently one woman, who are *formed* (asah). In the first chapter they are to occupy the whole earth: to rule, subdue and replenish it; and in the second chapter, the one man Adam is to occupy Paradise, a garden specially prepared by God—"Eastward in Eden." To Primeval Man every tree and herb is granted without restriction, but to Adam, one tree, the tree of knowledge, is forbidden on pain of death. Primeval Man was not restricted to any particular place; all the fruits and animals of the earth were his, by right, as well as the fishes of the sea. He probably lived, according to the geological evidence, in a similar manner to that which we find the aborigines living now, not tilling the soil, but living by hunting and fishing, and on the spontaneous produce of Mother Earth. But, on the other hand, Adam was specially formed and cared for, and specially restricted. God breathed into him "nishmath Khayyim"—the breath of lives, a portion of God's own life, so that he would have

lived "for ever," if he had not fallen from his high estate as a son of God (Luke iii, 38) and partaker of the Divine Nature, and of the "nishmath-Shaddaï," or inspiration of the Almighty. The comparison instituted between him and our Blessed Lord in the New Testament as the First and Second Adams, points to a similarity of purpose in the advent of both. In accordance with this view, Jacob Böhman gives a remarkable description of Adam. "Adam was created," he says, "to be the *restoring* angel of this world. His nature was twofold: *Within* he had an angelic soul and body, derived from the powers of heaven. *Without* he had a life and body derived from the powers of earth. The former was given him that he might be separate from, and superior to, the world. He was endowed with the latter, that he might be connected with and operative in the world.

This conception of Adam as Ben-Elohim, or Son of God, explains the otherwise inexplicable passage in Genesis vi, 2–6 (R.V.).

The Beney-Elohim of this chapter are the Adamic race, the Benoth Ha-adham are the women of the pre-Adamic races. The mingling of races is put as the cause of the great increase of wickedness on the earth. In this chapter we can distinguish four races, viz.:—

(1) Beney-Elohim, or Elohites.
(2) Beney-ha-adam, or Adamites.
(3) The Nephilim.
(4) A mixed race (Hag-gibborim) resulting from the union of the first three.

Adam was the first Federal Head of the human race, just as our Lord was the second. In this sense, therefore, he is the father, and Eve the mother, of the human race.

The expression "mother of all living" (Genesis iii, 20), however, is not a genuine reading, but a gloss, according to Hastings' *Dictionary of the Bible*, article "Adam."

From the hypotheses here indicated, it will be seen: (1) That the Sacred Book is in opposition to no branch of science or to any historical record; and

(2) That the original record in Genesis i, being absolutely dateless, it does not conflict with any discovery, geological, monumental, or otherwise, which has been, or may be made, pointing to an immense antiquity for Man.

LITERATURE ON NIAGARA FALLS.

Gilbert, G. R.

1. *Annual Report of the Commissioners of the State Reservation at Niagara*, 1889, pp. 61–84.
2. *Smithsonian Report*, 1890.
3. *National Geographical Society of the U.S.*, vol. i, Sept. 1895, pp. 203–236.
4. "Rate of Recession of Niagara Falls," *Bulletin of U.S. Geol. Survey*, No. 306, 1907.

Da. Pohlman.

1. *Proc. Am. Ass. Science*, vol. xxxii, pp. 183–202.
2. *Transactions of Mining Engineers*, vol. xvii, pp. 322–338, 1888.

Spencer, J. W.

The Duration of Niagara Falls, and the History of the Great Lakes, New York, Humboldt Pub. Co., 1895.

Geological Magazine, October, 1907.

A still more recent and detailed work has just (1908) been published by Professor J. W. Spencer, of which a *resumé* was delivered before the Geological Society of London in 1907.

Upham, Warren.

"Niagara Gorge and St. David's Channel," *Bulletin of Geol. Soc. of America*, vol. ix, 1898, pp. 101–110.

Wright, G. F.

Ice Age in North America, cap. xii.

"New Method of Estimating the Age of Niagara Falls," *Popular Science Monthly* for June, 1899.

"The Rate of Lateral Erosion at Niagara," *American Geologist*, March, 1902.