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THE
PALÆOLITHIC IMPLEMENTS
OF THE
VALLEY OF THE DELAWARE.

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AN HISTORICAL SKETCH OF THE DISCOVERIES OF
PALAEOLITHIC IMPLEMENTS IN THE VALLEY OF THE
DELAWARE RIVER.

BY C. C. ABBOTT, M.D.

In March, 1872, I published a brief notice—in the *American Naturalist*—of the various patterns of stone implements found in New Jersey, and therein described certain rude implements that I had found *associated* with the ordinary forms of flint arrowheads and other relics of the Indians; and I then remarked that these rude and elaborate forms, although associated, appeared to indicate that the Indian, while an occupant of our Atlantic seaboard, had passed “from a palaeolithic to a neolithic” condition; and also called attention to the marked similarity between these surface-found rude implements, and the palaeolithic implements found in the river valleys of England and France.

This similarity was also remarked by the late Professor Wyman, to whom I had forwarded specimens. He says, in the *Fifth Annual*

Report of the Peabody Museum, that "they closely resemble the celts of the drift period of Europe, especially those found at St. Acheul, two or three of which, except for their material, could hardly be distinguished from them."

In April, 1873 — also in the *American Naturalist* — I again called attention to these rude implements, and while realizing that *they were certainly older*, did not ascribe to them other than an Indian origin, but did see in them, as I believed, evidence that the Indian was in a palaeolithic stage of culture when he reached our shores; thus classing these objects with the ordinary relics of the surface.

At this time, also, I gave a detailed description of three specimens of chipped pebbles, which had been picked up, at different times, while in search of mineralogical specimens; for at that time, I never imagined that any traces of Man would occur at other than unimportant depths from the surface. One of these chipped pebbles was found at a depth of sixteen feet; another four feet from the surface. As it did not appear possible for these to have reached these depths by natural means, I was led to remark that *these* were even older than surface-found rude implements, and that "we must admit the antiquity of American man to be *greater* than the advent of the so-called Indian; *i. e.*, supposing the latter to be a comparatively recent comer to the Atlantic coast."

The discovery of these first suggested to me that there might be a commingling of two classes of stone implements upon the surface, which had diverse origins, and this came the more forcibly to my mind, as I had already noticed and remarked, that in the gravel that has only the cultivated soil above it very many of the rude implements have occurred — indeed the great majority had been found in the *loose* gravels, wherever exposed.

Thus it will be seen, that from the first, while the character of these implements was recognized, their whole significance had not been, except in the case of two specimens (the third probably being a natural form), and these were considered at the time as *apparently indicative* of what has since been demonstrated.

In January, 1877, the Annual Report of the Smithsonian Institution for 1875 was published. This contained a more extensive

notice, written by me, in 1872, of the stone implements of New Jersey, and I there devoted a chapter to the consideration of rude stone implements, where I maintained that they were older than jasper and quartz arrowheads. One of these rude forms I referred to as "a fair representative of the implements met with . . . in the gravelly bluff or bank of the Delaware River, south of Trenton, New Jersey, and occasionally on the surface of the ground *in the same neighborhood.*"

Thus while pursuing my collecting of Indian relics, it was gradually forced upon my mind that these rude implements were more intimately associated with the gravel than with the surface of the ground and the relics of the Indians found upon it.

Acting upon this, I continued for two years to most carefully examine both the surface of our fields and every exposure of the underlying gravels; and in June, 1876, after having found several chipped implements *in situ*, expressed the opinion that the Delaware river, "now occupying a comparatively small and shallow channel, once flowed at an elevation of nearly fifty feet above its present level; and it was when such a mighty stream as this, that man first gazed upon its waters and lost those rude weapons in its swift current, that now in the beds of gravel which its floods have deposited, are alike the puzzle and delight of the archaeologist. Had these first comers, like the troglodytes of France, had convenient caves to shelter them, doubtless we would have their better wrought implements of bone to tell more surely the story of their ancient sojourn here; but wanting them, their history is not altogether lost, and in the rude weapons, now deep down beneath the grassy sod and flower-decked river bank, we learn, at least, the fact of the presence, in the distant past, of an earlier people than the Indian."

Thus it will be seen that I have been fairly cautious in my statements, and slow in reaching any conclusions with reference to these implements which separated them from ordinary Indian relics, the identity of which cannot, of course, be questioned.

Furthermore, it is difficult to see why there should not have been that succession of stages of culture, known as *palaeolithic* and *neolithic*, in North America, as has been so clearly shown as true of Europe. Had the Delaware river been a European

stream, the implements found in its valley would have been accepted at once as evidence of the so-called *palaeolithic man*; but being in another continent, and one supposedly beyond the reach of this early man, as theoretical ethnologists have considered him, my claims that I had discovered in America traces of this primitive chipper of pebbles, have been strenuously denied, especially by a few, who have never visited the locality or seen a specimen of chipped implement taken therefrom, as altogether unwarranted by the facts.

In this matter there has been, as my several publications show, no attempt to make the facts conform to a pre-conceived theory. The pre-conception, on the contrary, being that all traces of man in America were to be referred to the *neolithic* Indian, and the many facts in the case, finally forced me to relinquish it.

In September, 1876, Mr. Putnam, the Curator of the Peabody Museum of Archaeology at Cambridge, Mass., favored me with a visit, and together we carefully examined the river bluff below Trenton, and succeeded in finding *two* specimens *in situ*, such as I had previously described in the *American Naturalist*, and at his request I continued my examinations of these gravels, acting under an appropriation made by the Peabody Museum for this purpose; and, in November of the same year, submitted to him a report *On the Discovery of Supposed Palaeolithic Implements from the Glacial drift in the Valley of the Delaware River, near Trenton, New Jersey*. Still realizing how all important it was in this matter to make haste slowly, I purposely referred to these chipped stones as *supposed* palaeolithic implements, and gave, in detail, my reasons for thus considering them.

Referring to this report Mr. Putnam remarked, in his annual report to the trustees of the Peabody Museum, that "from a visit to the locality with Dr. Abbott, I see no reason to doubt the general conclusion he has reached in regard to the existence of man in glacial times on the Atlantic coast of North America."

Before this report was published these gravel deposits were visited by Prof. N. S. Shaler, who was fortunate enough to find a characteristic specimen, but not *in situ*. I also found one, likewise in the talus. Of these specimens, Professor Shaler says, "Although the whole face of the escarpment is in motion, creep-

ing slowly under the influence of frost and gravity towards its base, it was difficult to believe that these specimens, found about twelve feet below the top of the bank, had travelled down from the superficial soil."

Continuing my own researches, in 1877, I made a second report on the occurrence of these implements, and re-affirmed my conviction that in the specimens of artificially chipped pebbles, from these gravel deposits, we have evidence of man's presence at an earlier date than the supposed advent of the Red Indian; and referred them geologically to the Glacial epoch, in accordance with the writings of Professor Cook, our State Geologist, who had pronounced these gravels as of glacial origin.

This, briefly, is the history of my own labors in this field.

As the result, in material gathered, there are now in the Peabody Museum about four hundred specimens, of which about sixty have been taken from recorded depths; about two hundred and fifty from the talus, at the bluff facing the river, and the remainder from the surface or derived from collectors who did not record the positions or circumstances under which they were found. While these figures are approximative only they do not materially vary from the notes that I have taken, which, generally being packed away with the specimens, I have not the time to carefully go over and repeat to you verbatim.

Somewhat similar conditions occur also in other river valleys, as the Schuylkill and Susquehanna, in Pennsylvania, and in the valley of the Potomac, near Washington. The geological structures of these valleys, with rock formations coming near to or constituting the surface, not improbably explains much of this difference as compared with the Delaware valley, wherein, south of Trenton, N. J., there is no living rock in place except at great depths.

In the valleys of the Schuylkill and Potomac, Mr. Berlin, of Reading, Pa., and Dr. Hoffman, of Washington, D. C., have found implements of palaeolithic character under circumstances pointing to a remote antiquity, although none have occurred at as great depths as at Trenton, N. J.

Prof. Haldeman also found rude implements in the Susquehanna valley, which, as his own statement regarding them clearly

shows, were, in all probability of like age and origin as those found in the valley of the Delaware.

The published account of Mr. Berlin's "finds" is in the first volume of the *American Naturalist*; that of Dr. Hoffman in the thirteenth volume of the *American Naturalist*, and that of Dr. Haldeman in the *Peabody Museum Reports*, Vol. II, p. 255.

Col. C. C. Jones, Jr., in his instructive volume on the Antiquities of the Southern Indians, published in 1873, records the discovery of drift implements of precisely the same type and under similar conditions as those found in the valley of the Delaware River. (Chap. xii, p. 292, pl. xvi, fig. 10.)

Furthermore, I desire now to call attention to the fact that the archaeological interest centering in these gravels, does not rest solely on my own labors. Others have examined them carefully, and have published, or will do so, the results of their visits to the locality.

In October, 1877, the late Thomas Belt visited the locality, and gathered specimens therefrom. His account of his visit will be found in the *Quarterly Journal of Science*, London, for January, 1878, p. 55.

In September, 1878, Prof. J. D. Whitney and Mr. Carr, of the Peabody Museum, visited the locality, and of this visit Mr. Carr has stated, in the Twelfth Annual Report of the Museum, "in September last, in company with Prof. J. D. Whitney of Harvard College, I visited Trenton, and we were fortunate enough to find several of these implements *in place*. Professor Whitney has no doubt as to the antiquity of the drift, and we are both in full accord with Dr. Abbott as to the artificial character of many of these implements."

In June, 1879, and again, in June, 1880, Mr. Putnam visited Trenton, and he also has gathered excellent specimens from the undisturbed gravels, at various depths. As both he and Mr. Carr are present, they will refer to these themselves.

Lastly, in November, 1880, Prof. W. Boyd Dawkins, Prof. Henry W. Haynes, Rev. G. Fred. Wright, and Henry Carvill Lewis of the Geological Survey of Pennsylvania, gave these gravels a critical examination. The results in part of this visit will be given this evening by two of these gentlemen, and it

remains for me only to briefly call attention to one or two points that may not be touched upon by those who will further discuss the significance of these chipped implements.

In the spring of 1877, Mr. Henry C. Lewis was detailed by the State Geologist of Pennsylvania to critically examine and map out the various gravels in the neighborhood of Philadelphia, Pa. The result of his studies showed that these several gravel beds were to be referred to different geological eras, as the Bryn Mawr gravel (Upper Tertiary), Glassboro gravel (Pliocene), Philadelphia brick clay (containing boulders), the Trenton gravel, and the recent Alluvium; the oldest being that first named, and coming down to the present in the order named; and further showed that the "yellow gravel" (a marine gravel), which forms the boundaries of the newer Trenton gravels, was high and dry during the deposition of the circumscribed Trenton gravel, which is purely *river drift*, derived from the terminal moraine lying in the upper valley of the Delaware, and extending across the State. This most important discovery has an important bearing on the age of the palaeolithic implements, in that, he shows, that there was an extensive area of habitable land from Trenton southward during the close of the glacial period; and which Professor Cook, the State geologist of New Jersey, has asserted in his latest reports, to have been submerged during this same period;— thus demonstrating that a habitable country enclosed or bordered *the latest in time, or Trenton gravels, during the time that they were accumulating*—and further showing, beyond question, that *if anywhere*, relics of man are to be found, other than on the surface, it would be in this Trenton gravel. Furthermore, Mr. Lewis carefully mapped this gravel, and practically completed his labors before he was aware of my discoveries.

THEN, on comparing his results with my own, he found that the implements I had collected, *in situ*, were gathered *only* from those localities where this Trenton, or newest gravel, occurs.

Thus, he, from a geological standpoint, working upward, to the present; and I, pushing my researches backward, from the historical point, met upon common ground, and each in total ignorance of the other's labors, until our respective studies brought us face to face.

What further evidence of the substantial correctness of my own conclusions, as to the existence of palaeolithic man, can be asked?

To the subject of *erosion* of the present surface of the locality, whereby the uplands are being worn away, and the valleys filled I can but briefly refer; merely calling attention to the fact that by this agency the recent Indian relics are brought down, as it were, to the level of the gravels; and likewise, the implement-bearing gravels are brought to the surface; thus commingling objects, in many cases, that originally were separated by the stratum of soil that capped the gravels in former times. To return to the consideration of the Trenton gravel I will say, in conclusion, that it is clearly evident, as Mr. Wright will explain to you, that the accumulation of these gravels was gradual, and considerable time may have elapsed from the date of the first or lowest of the gravels, before additional material was brought from above. Beyond the limits of these gravels stretched in every direction a vast area of habitable ground, as I have mentioned, with a fauna adapted to supply man with every need; and how natural that the primitive American should have gone to these then accumulating beds of shingle, to select and chip into proper shape, the pebbles, that thus worked upon, constituted his only known weapons; the same the world over: Europe, Asia Africa and *America!*

No cataclysm drove him from the spot, and all those years that the ever increasing beds of sand, gravel and boulders were accumulating, he dwelt here, familiar, it is now known, with the mastodon, and likewise with the bison, reindeer, musk-ox and the fauna of the present time: and when the last of these transporting floods had wholly passed away this primitive man was America's sole occupant, and left upon the surface of the latest stratum of sand and pebbles, that floods from a once glaciated valley brought from the mountains beyond, the same rude implements of stone that his ancestors had lost in the underlying gravels beneath his feet.

We are to-day contemporary with vast accumulations of alluvium that are steadily increasing in our river valleys;—why then might not palaeolithic man as readily have been contemporary with the almost as gradual growth of these older beds of gravel?

I do not presume to boldly assert that America's early man, at least on the Atlantic coast, was *pré-glacial*; but that he *antedates* the Red Indian, *if it be true that the latter is a recent comer*, I do confidently maintain, backed as I am by the unquestionable testimony of the Trenton gravel.

THE ARGILLITE IMPLEMENTS FOUND IN THE GRAVELS
OF THE DELAWARE RIVER, AT TRENTON, N. J., COM-
PARED WITH THE PALAEOLITHIC IMPLEMENTS OF
EUROPE.

BY HENRY W. HAYNES.

The *first question* to be decided in regard to the rude implements, mostly made out of argillite, and alleged to have been discovered in the gravels of the Delaware, is as to their authenticity. Were they actually found where, and under the circumstances in which, they are claimed to have been discovered? Upon this fundamental point we are not restricted to the unsupported testimony of a single observer, whose prepossessions may possibly have misled him, or whose observations may be objected to as lacking in exactness. In addition to the very extensive series of these objects found by Dr. Abbott, Professor Putnam, Mr. Carr and Professor Whitney all alike report that they have discovered precisely similar objects themselves, in the same localities and under like conditions.

During the past autumn I visited the region myself in company with the Rev. Geo. Fred. Wright, Professor W. Boyd Dawkins, and Mr. H. C. Lewis, of the Penn. Geol. Survey, under Dr. Abbott's guidance. Several implements were taken by the others, either from the gravel, or the talus on the river bank, in my presence, and I found five myself. All these objects were precisely similar in appearance, material and method of fabrication, to those placed by Dr. Abbott in the Peabody Museum at Cambridge. They were all found under exactly the same circumstances, and in like situations, as were the greater part of those described by him in the two accounts of his discoveries published in the Reports of the Museum for the years 1877 and 1878. Other examples, however, were taken by him from undisturbed gravels at varying depths.

For my own part I consider it absolutely and incontestably established that these objects have come, as alleged, from the gravel-beds of the Delaware valley, and that occasionally only have they been found on the surface.

A *second question* then arises in regard to the character of the objects themselves.

Do they show incontestable marks of human workmanship?

This is a problem to be decided only by the verdict of such persons as have had large experience in searching for and studying pre-historic stone implements, and who have thus acquired the skill of the expert in discriminating between the natural and the artificial fracture of the various kinds of stone out of which the early man manufactured his first rude implements. I venture to offer my own opinion upon this question because I think my opportunities for this kind of study have been unusually great. For six years I have studied the stone age in various countries of Europe, in all of them searching diligently for implements, and I have handled stones artificially broken literally by the hundreds of thousands. I have also carefully examined the celebrated collections of such objects to be found in the various museums of different countries, and I have enjoyed the personal acquaintance and companionship of many of the leading cultivators of pre-historic studies. In this way I have participated in a great deal of inquiry and discussion in regard to the characteristics and peculiarities which such implements present. Applying the experience thus acquired, I trace many striking resemblances between these argillite objects and the palaeolithic implements of Europe, made from flint or quartzite. It is undeniable that the argillite implements are of ruder workmanship, but I think this arises solely from the circumstance that the material from which they are fabricated is much less susceptible of being finely worked. Especially is the flint *derived from the chalk*, of which nearly all the European implements are made, capable of being chipped into much more perfect and symmetrical shapes than is the coarse-grained variety of clay-stone, from which the New Jersey implements are fashioned. But the types of the two classes of implements are remarkably similar. To whatever uses and purposes the European implements were capable of

being applied I regard these Delaware objects as being equally well adapted. The same general description applies to both classes of implements alike. The characteristic European palaeolithic implement is commonly known to archaeologists there by the name of the "axe of the type of St. Acheul." This designation is derived from the old Abbey of this name, close to Amiens, in the valley of the Somme, in Northern France, where they were first discovered by Boucher de Perthes in 1841, and where they have since been found in greater numbers than in any other locality. This "axe of the type of St. Acheul" may be described as being usually of large size, longer than it is wide, thick in the middle and sharpened at the edges. One end is more or less pointed, and the other, which was doubtless intended to be held in the hand, is thick and rounded. Their most distinguishing characteristic is that both sides, or faces, are chipped into a shape more or less convex and symmetrical. An implement of this description, it will be seen at a glance, is entirely unlike the ordinary Indian axe, or tomahawk, made of polished stone, and very generally provided with a groove around the middle, intended to hold a handle made of twisted wythes. Accompanying these St. Acheul axes there are also found in Europe smaller objects, such as spear-heads, and knives fashioned out of flakes detached from blocks of flint. All such flakes bear a peculiar mark, called the "bulb of percussion," which proves them to be of man's fabrication, as it is never found upon chance-broken splinters of flint. It indicates the spot where an intentionally directed blow was struck upon the nucleus from which the flake was detached. Similar flakes of argillite are also found in New Jersey accompanying the larger objects made from that material, which proves that such implements were manufactured on or near the spot where the flakes occur; but the number of such flakes that has hitherto been found is quite limited.

It would be incorrect, however, to suppose that the European archaeologists discriminate between the palaeolithic implements (the oldest objects of human workmanship thus far discovered, and which all present the type that I have described) and those that belong to the later neolithic period, or the age of "Polished Stone" (to which is to be referred the common Indian axe or

tomahawk of North America), merely by their shape and mode of fabrication. The term palaeolithic is primarily restricted in meaning to such objects as I have described, when met with under peculiar geological conditions; that is to say, when found embedded in the gravels which have been deposited by certain rivers during the period known to the geologists as the quaternary or pleistocene period. At that time their volume of water was much greater than it now is, which was caused by the melting of the great ice-cap that once covered the northern portion of both continents, accompanied by a climate much more humid than we have at present. Such accumulations of gravel are often of very great thickness, and embedded in them, side by side with the stone implements above described, are found the fossil bones of extinct species of animals, such as the mammoth, the rhinoceros tichorhinus, and numerous others, or of animals like the reindeer, or the musk-sheep, which have since migrated to the colder regions of the north, or which are now restricted to the higher Alpine slopes.

This leads us to the *third question* to be considered, viz, the localities and geological conditions, under which these New Jersey implements have been discovered. Though the objects themselves may present the right type, shape, and general appearance, we must look carefully at the conditions under which they have been discovered before we can pronounce judgment as to whether they are to be regarded as "palaeolithic implements," or not. Of course when found in gravel beds, accompanied by fossil animal bones, no such question can be raised. But since the pleistocene period these gravel beds have been subjected to a constant process of denudation and removal by the action of the rain and other natural causes, with the result that in some localities they have either partially or entirely disappeared. The same causes that would sweep away the finer and lighter particles would not be powerful enough to affect the heavy palaeolithic implements, which would accordingly be left behind. Consequently we sometimes find such implements upon the surface in localities where the pleistocene gravels are no longer to be seen. Such is the case, for example, in the Valley of the Nile, where there are now no longer pleistocene deposits, though these occur in the adjacent Desert of the Sahara. Yet in the bottoms of the dry ravines or

wadys, which pierce the hills that bound the valley of the Nile, I have found numerous specimens of flint axes of the type of St. Acheul, which have been adjudged to be true palaeolithic implements by some of the most eminent cultivators of prehistoric science.

Each particular discovery accordingly must be tested by the peculiar conditions of locality and circumstances under which it has occurred.

Now it has been my good fortune to find palaeolithic implements in Europe in several localities, both where they have been accompanied by the characteristic fossil bones, and where these have been wanting. I have thus had the opportunity of making myself familiar with the general character of such localities and the appearance of the country in the vicinity, together with the nature and quality of the gravels in which the implements are found. I have especially studied the gravel beds of the valley of the Seine, in the vicinity of Paris, and of the Tiber, near Rome, for several successive years, and in a very great number of visits, and from both these localities I have obtained fossil bones of the mammoth, the rhinoceros, the hippopotamus, the *bos antiquus*, the great extinct elk, the horse, the reindeer, etc. Accompanying these fossil bones were found the characteristic palaeolithic implements. I have also visited the famous locality of St. Acheul, and the well-known gravel-pits near Salisbury, England, in both of which spots have occurred numerous finds of palaeolithic implements, accompanied by similar fossil bones. In another locality, near Dinan, in Normandy, where the pleistocene deposits no longer exist, as is also the case in the valley of the Nile, I have found a large quantity of palaeolithic implements made out of quartzite. From these various experiences I feel myself warranted in stating that the general appearance of the country, and the character of the gravels, at Trenton, N. J., present a most striking resemblance to what I have seen in the various localities in the Old World to which I have referred. There is the same rudely stratified mingling of coarse materials marked by a similar absence of clay. It is true that in the gravels of New Jersey thus far not many fossil bones have been discovered, but only a few of the mammoth, the bison, the reindeer and the walrus, some of

which, like the animals of Europe under similar circumstances, have since migrated to the colder regions of the north. But the fact remains that fossil animal bones have actually been discovered in these gravels, and when we call to mind to what a limited extent they have as yet been examined we may reasonably expect more to be found hereafter.

I limit myself to a general statement like this in regard to the marked resemblance of the locality, and the precisely similar character of the gravels at Trenton, New Jersey, to what I have seen in many localities in Europe, which have yielded true palaeolithic implements, and I leave in more competent hands the discussion and determination of the true geological character of the gravels of the Delaware valley.

Speaking then merely from an archaeological stand-point, I do not hesitate to declare my firm conviction that the rude argillite objects found in the gravels of the Delaware river, at Trenton, New Jersey, are true palaeolithic implements.

AN ATTEMPT TO ESTIMATE THE AGE OF THE PALAEO-LITHIC-BEARING GRAVELS IN TRENTON, N. J.

BY G. FREDERICK WRIGHT.

Four years ago Professor Shaler concluded his brief and cautious report upon the gravel beds which form the subject of the present paper, by expressing the "hope hereafter to furnish a detailed account of the geology of these gravel beds, and to support these preliminary statements by evidence in the way of sections and maps." (Report of Peabody Museum for 1876, Vol. II. p. 47.) It is greatly to be regretted that the pressure of other duties prevented him from carrying out his designs. Meanwhile, facts bearing upon the solution of this interesting problem have been rapidly accumulating, until now we apparently see the beginning of the end.

Briefly stated, the progress of discovery has been this: In the Annual Report of Professors Cook and Smock, State Geologists of New Jersey for 1877, the southern limit of the ice field during the glacial age was indicated. (See pp. 9-19.) The

boundary of this field crosses the state by a curve convex to the south from Perth Amboy to Belvidere on the Delaware River, about sixty miles above Trenton. As bearing in a general way upon the question in hand, we should mention the conclusions of Col. Charles Whittlesey in 1866, and of Prof. N. H. Winchell, T. C. Chamberlain, and R. D. Irving, a few years later, concerning the terminal moraine in Wisconsin and other western states. The investigations of Professor Hilgard touching the bluff deposits in the lower Mississippi valley, and of Col. D. K. Warren upon those of the upper portion of this valley, are also of great significance in connection with this question. Nor should we fail to mention the extremely valuable papers of Professor J. D. Dana upon the condition of southern New England during the melting of the great glacier. (See *Am. Journ. Science* for 1875, Nos. 57, 58, 59, and 60.) My own study of the kames and moraines of New England, the results of which are published in the *Proceedings of this Society*, and that of Mr. Warren Upham (see *New Hampshire Geological Report*, Vol. III.), and of Professor George H. Stone of Maine, serve to connect the operation of a widespread cause with the particular effects produced in the Delaware valley. It is also proper to repeat that the first announcement in 1877 of the line of the terminal moraines across southern New England was made in a publication of this Society, in a communication to the writer by Mr. Clarence King. (See *Proceedings*, Vol. XIX. pp. 50-63.)

A second step in advance was made by the New Jersey geologists (see *Report for 1878*, p. 22; *Clay Report for 1878*, p. 17) in recognizing a distinction between the implement-bearing gravels of Trenton and the general deposit of yellow gravel which spreads over the southern part of the state. But the credit of accurately describing the peculiar character and limits of these Trenton gravels must be given to Professor H. C. Lewis, of Philadelphia. (See *Proc. Min. and Geol. Section Acad. Nat. Sci., Phila.*, for Nov. 1878 and Nov. 1879.)

A third step of great importance was also made by Professor Lewis in pointing out the relations of the Philadelphia brick clay to the other superficial formations of the Delaware valley.

Having recently spent two weeks with Professor Lewis in going

over this ground and in extending investigations to the upper waters of the Delaware, I will now endeavor to put into intelligible shape the facts, both new and old, which bear upon the interesting question announced as the subject of this paper.

The city of Trenton is built upon a horse-shoe shaped gravel deposit which is about three miles in diameter, extending back about that distance to the east from the present river. This deposit is somewhat lower along its inland boundary than along the river. The prongs of this horse-shoe rest, one at Trenton, and the other about two miles below, just this side the house of Dr. Abbott.

The characteristics of this gravel are thus accurately described by Professor Shaler:

“The general structure of this mass is neither that of ordinary boulder clay nor of stratified gravels, such as are formed by the complete rearrangement by water of the elements of simple drift deposits. It is made up of boulders, pebbles, and sand, varying in size from masses containing one hundred cubic feet or more to the finest sand of the ordinary sea beaches. There is little trace of true clay in the deposit. There is rarely enough to give the least trace of cementation to the masses. The various elements are rather confusedly arranged; the large boulders not being grouped on any particular level, and their major axes not always distinctly coinciding with the horizon. All the pebbles and boulders, so far as observed, are smooth and water-worn; a careful search having failed to show evidence of distinct glacial scratching or polishing on their surfaces. The type of pebble is the sub-ovate or discoidal, and though many depart from this form, yet nearly all observed by me had been worn so as to show that their shape had been determined by running water. The materials comprising the deposit are very varied, but all I observed could apparently with reason be supposed to have come from the extensive valley of the river near which they lie, except, perhaps, the fragments of some rather rare hypogene rocks.”

It is now settled beyond controversy that the rocks from which these beds were derived are all in place in the upper Delaware valley. (See N. J. Rep., 1877, p. 21; Lewis on Trenton Gravel, p. 5.)

The distinction between the river gravel and that which overlies the larger part of southern New Jersey is marked in several ways. The Trenton gravel is much coarser than the

general deposit, it is also largely composed of fresher looking and softer pebbles, showing that it has been subject to much less abrasion than the other, and that it is of more recent age; it is also limited to the river valley, and finally is not overlaid by the Philadelphia brick clay which, so far as it extends, rests unconformably upon the general deposit of gravel. The general deposit of gravel in this region is composed almost exclusively of small, well rounded pebbles of quartz and of hard limestone which "are not fresh looking, but are eaten and weather-worn by age."

The elevation of this implement-bearing gravel at Trenton is not far from forty feet above the present high water limit; and Trenton is now at the head of tide-water. These gravels are continuous as a terrace all along up the river. As one ascends the river, however, their height (at least below the Water Gap) is reduced to fifteen or twenty feet above the present flood plain.

But most significant of all the facts indicated are the character and position of the Philadelphia brick clay. This also is confined to the river valley and its tributaries, and rests unconformably upon the older gravel formations, rising to a height of one hundred and fifty feet above the river, and there ceasing. This elevation relative to the river is maintained with tolerable constancy as far up as Easton, where the bed of the river itself is one hundred and fifty-seven feet above tide level. Finally, this Philadelphia brick clay contains numerous boulders of considerable size, derived from the ledges of Medina sandstone and other rocks above. This marks it as a deposit of the glacial flood sometime during the declining centuries of the great ice period.

The succession of events would seem to be as follows: During the early part of the glacial period the ice accumulated in the upper portion of the valley of the Delaware to a depth of many hundred feet. Two and one half miles north of the Delaware at Martin's Creek, Professor Lewis and myself saw, in going south, the last distinct evidences of direct glacial action at a height of six hundred and forty feet above the river and eight hundred and forty feet above the sea. Penobscot Knob, on the water-shed between the Susquehanna and the Lehigh east of Wilkesbarre, and only a few miles north of the southern limit of glaciation,

itself bears every mark of glaciation. This is two thousand one hundred feet above the sea and one thousand six hundred feet above the level of the Lehigh at Mauch Chunk, and one thousand eight hundred feet above the level of the Delaware at the Water Gap. The area in the valley of the Delaware covered by the ice is not far from six thousand square miles. It is not improbable that the average depth of the ice accumulated over the region was one thousand five hundred feet, or a quarter of a mile, making the total accumulation of ice not far from fifteen hundred cubic miles, with its southern border sixty miles above Trenton. All this as it melted must find its outlet to the sea through the Delaware River. It is evident at a glance that during the decline of the glacial period, when the process of melting was proceeding with greatest rapidity, the floods in the valley below must have been upon a scale of surprising magnitude.

And yet it is impossible that these glacial floods in the Delaware should have been so enormous as to have filled the valley below Trenton to the height of one hundred and fifty feet, for this valley is no where less than five miles in width and constantly enlarges towards the sea. If the water at Trenton were raised one hundred and fifty feet, the slope would be about two feet per mile to the bay. Now a current of five miles per hour, one hundred and fifty feet deep and *one* mile wide would discharge a cubic mile of water every eight hours or three cubic miles per day. (The mean rate of the Ohio River, with an average descent of five inches to the mile, is three miles per hour — that of the Mississippi very nearly the same.) To supply such a volume of water as this, the whole accumulation of ice in the upper Delaware would suffice for only five hundred days, or for about sixteen months. And to furnish this amount of water there would need to be, during such floods, a daily accumulation by rains and the melting ice over the whole upper valley of the Delaware of about three feet of water, which of course is incredible, even if we suppose the floods confined to a single month of each successive year. Hence, without doubt, we may conclude that the deposition of the boulder-bearing brick clay in the Delaware valley below Trenton implies a depression of that region to the extent of one hundred or more feet.

Doubtless the region north of Trenton shared in this depression, but, being above tide-water, the effects would not be equally evident. The valley above Trenton is narrow. At Lambertville about twelve miles up the stream, a trap dike contracts the valley to a width of not more than one quarter of a mile. Above this point the supposition of floods sufficient to deposit the boulder-bearing clay is, perhaps, not incredible. For though the descent in the stream is now about four feet to the mile from the Delaware Water Gap down to tide level (about eighty miles), it was probably less during the Champlain epoch. For the depression of that period proceeded at increased rate northward. In Montreal it was five hundred feet; in Vermont, three hundred feet; and how much more or less in the vicinity of Lake Erie we cannot tell, though the phenomena of the lake ridges would indicate that it was considerable, perhaps three hundred or four hundred feet. A depression gradually increasing north-westward would greatly diminish the velocity of the torrent of the Champlain epoch and the narrow places in the valley would greatly retard it. Professor Dana has shown that in the lower part of the valley of the Connecticut River the floods rose during the Champlain epoch from one hundred and fifty to two hundred feet above the present high water mark. The Connecticut River valley below Middletown is contracted by trap dikes much as the Delaware is at Lambertville. But the drainage basin of the Connecticut is three times as extensive as that of the Delaware (being twenty thousand square miles). This, however, is partly offset by the branch currents which, as Professor Dana shows, set off from the Connecticut at various places above Middletown.

At any rate in the Delaware valley we find boulder-bearing clay rising to a height of one hundred and fifty feet above the present high water level. In the Lehigh valley, at Bethlehem, a few miles above its junction with the Delaware, and several miles south of the limit of the ice field, Professor Lewis and I found this boulder-bearing clay containing scratched pebbles and lying unconformably upon thick deposits of coarse stratified gravel at a height of one hundred and eighty feet above the river. Farther up the Lehigh valley also, near Weissport, we ascertained the limit of ice-carried boulders to be one hundred and eighty feet above the river.

We are probably safe in assuming that these floods, depositing clay and boulders at the height above mentioned, mark both the period of greatest depression during the Champlain epoch and the period when the ice was most rapidly melting away. Of course the deposition of what Professor Lewis styles "red gravel" and the high gravels at Bethlehem occurred earlier, since the clay overlies them. These gravels I should assign to the early stages of the Champlain epoch.

It is evident that the deposition, both of this red gravel and the boulder-bearing clay is separated from that of the implement-bearing gravel at Trenton by a period of vast physical changes, if not of vast time.

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Considering, now, this Trenton gravel, we find it to be limited at the head of tide water to a level of about forty feet, and diminishing in height relatively to the river both as one ascends and as one descends the channel, until at Yardleyville, a few miles above Trenton, it merges into the terrace which maintains a pretty uniform height of fifteen or twenty feet above the river all the way to the Water Gap. Above the Water Gap the gravel terraces rise to a much greater height. At Stroudsburgh a second terrace stands seventy-five feet above the first terrace which is about fifteen feet above Broadhead Creek. But this upper terrace is kame-like in its structure, and hence would be explained in part by the lingering presence of the glacier itself.

The descent of the river valley from Belvidere, where the ice sheet terminated, to Trenton is two hundred and thirty-two feet, or at the rate of nearly four feet per mile, as the river runs.

The transportation of gravel by a river is dependent both upon the amount of material accessible to the running stream and upon the rapidity of the current. Toward the close of the glacial period the pebbles accessible to the stream were superabundant, having been deposited in excessive amount by the melting of the glacier in the lower latitudes. The water-worn pebbles at Trenton were probably largely derived from this source. Even a glacial torrent may have more loose material than it can manage, and so may silt up its bed with gravel. Hence it is not necessary to suppose the river at this point to have been of sufficient volume to fill the whole valley with water to the height of the

terrace, fifteen or twenty feet. The river may have flowed upon the surface of the gravel in a shallower current than the terrace would seem to imply.

But when the current, passing down this declivity of four feet to the mile, reached the level of the sea at Trenton, its transporting power would be greatly diminished and thus we should have an accumulation of gravel at the head of tide water, without bringing into the problem the supposition of any very extraordinary increase in the volume of the river. The loss of transporting power upon diminishing the rapidity of a current of water is enormous. The transporting capacity of a stream of water is estimated to vary as the sixth power of the velocity, *i.e.*, if a current is checked so that it moves at only half its former rate, its transporting capacity is diminished to one sixty-fourth. It is easy to see that the sudden enlargement of the valley just above Trenton, as well as the occurrence there of tide water, would diminish the rapidity of the river and hence cause an extraordinary deposition of gravel when it was abundant above.

The most likely time for this deposition to have occurred was near the very close of the glacial period, when the lower moraines were fresh and when ice fields still lingered in the southern valleys of the Catskills. The process of deposition must have been so rapid that it could not have been much subsequent to the withdrawal of the continental glacier north of the Catskills. The time required for the river under present conditions to erode the channel it now occupies was of much greater duration.

I hope another season to devote a month or two to further investigations and will now but briefly indicate what seems very probable and what is still in doubt.

1. It seems altogether probable that the Philadelphia brick clay was deposited during the height of the Champlain epoch when the Delaware valley was considerably depressed below its present level.

2. Towards the close of that period when the land had resumed nearly its present level and the ice had nearly all disappeared south of the Catskills, the still swollen stream brought down the superabundant loose material from the kames and moraines and deposited it in the valley below. The material was

so abundant that doubtless the whole channel was silted up so that the bed of the river was considerably above that it now occupies. At Trenton it flowed over and through an extensive delta of coarse gravel forty feet above its present level; and above Trenton, over an accumulation of gravel from fifteen to twenty feet above the present high water mark. This period was marked by the presence of the mastodon and other extinct animals (the skeleton of a mastodon having been found in the Trenton gravels) and by the advent of palaeolithic man to the neighborhood of Trenton.

3. During the Terrace epoch the river worked its way down through the delta of gravel at Trenton, and has since eroded its present channel which is about two miles wide at that point. Higher up, where the current is swift, the lateral erosion in recent times has been small.

4. To determine approximately the date of the earliest evidence of man's appearance at Trenton we have as data, (1) The amount of erosion in the palaeolithic gravels at Trenton. (2) The general evidence from other sources bearing upon the date of the close of the Champlain epoch in this country. As bearing upon this, several terrestrial time-measures are accessible, the most important of which are the recession of various waterfalls, like those of Niagara and St. Anthony, which occupy post-glacial beds; and the extent to which sediment and peat have accumulated in post-glacial lakes and kettle holes. It will be much safer to draw conclusions from such tangible data as these, than from the distant regions of astronomy, or from the uncertain rate at which the evolution of plants and animals has proceeded, or the development of man has progressed.

Mr. Lucien Carr said that in September 1878, he had visited Trenton in company with Professor Whitney of Cambridge, and that together they had examined the implement-bearing gravel bed. During the investigation it was his good fortune to find one specimen in place, under such circumstances that it must have been deposited at the time the containing bed was laid down. It was in the ravine which cuts through the bluff near Dr. Abbott's house, in a fresh exposure made by a recent heavy storm, and

was about three feet deep in the ground and one foot in from the perpendicular face of this newly exposed surface. He also stated that, although neither Dr. Abbott nor the officers of the Peabody Museum had any doubt as to the artificial character of these implements, yet he had recently submitted a series of them to leading archaeologists in London, Paris and Copenhagen, all of whom unhesitatingly confirmed their decision.

Dr. M. E. Wadsworth having been requested by the Curator of the Peabody Museum of Archaeology to give some account of his observations on the specimens in the Peabody Museum said to have come from the Trenton (N. J.) gravels, remarked as follows:—

Certain of these specimens were placed in my hands in 1876 for examination, their lithological character then being unknown. They were found by macroscopic and microscopic examination to have been made from argillite, greatly indurated, and breaking with a conchoidal fracture. The specimens were weathered to a greater or less extent and showed plainly that the fractures must have been made long ago. A few small fractures of secondary character occur. This secondary chipping evidently took place long after the original fracturing, but also long ago, as is shown by the weathering of the surfaces of both the primary and secondary fractures. The few secondary fractures are probably natural, and could easily occur if subjected to the action Dr. Abbott supposes. The original chipping could not have taken place by any known natural causes acting upon rocks, so far as the writer has any knowledge. Of course it then brings us to the only agency that could do the work: man. The characters of the specimens, petrographically, bore out the statements made to me by Mr. Putnam, of the conditions under which they were found, whether upon the surface or in the gravels. I do not see how it is possible that such correspondence of characters could exist unless the specimens were found under the conditions reported.

The lithological characters then show that the specimens are not natural forms; that being composed of a slow weathering rock, they must have been made long years ago; that many years

later they were subject to other conditions, probably natural, by which part have been modified; that since then, they have lain for many, many years exposed to weathering agencies; some showing that they have been subject to this action while lying on or near the surface, and others while buried to some depth.

Their weathering corresponds to that observed on pebbles of similar composition in gravels elsewhere. It is to be remembered that all the weathering has taken place since the Abbott specimens were originally chipped.

The term weathering as here employed means the alteration and decay that has taken place on the *surface* of the specimen, but does not imply that it has been exposed on the *surface* of the ground; it may or may not have been; the weathering itself shows with greater or less clearness whether this occurred from surface exposure or not.

Part of the specimens shown me bore evidence that they had originally been exposed to weathering on the surface of the ground and been covered since, but the covering evidently took place ages ago, if the weathering that they have been subjected to since is any criterion.

The term "argillite," as employed by me, is used to designate all argillaceous rocks, in which the argillaceous material is the predominant characteristic; slate or clay-slate, clay-stone, etc. are simply varieties of it, the term slate being only rightfully used when slaty cleavage is developed. The argillite out of which these specimens were made has no trace of cleavage.

Mr. F. W. Putnam said:— It is left for, me Mr. President, to say a few words, in conclusion, on the subject of Palaeolithic man on the Atlantic coast of America, which has been so forcibly presented by the several speakers this evening; but first I wish to give the reason, apart from my long personal relations with Dr. Abbott, that has so closely identified the Peabody Museum of Archaeology with Dr. Abbott's discoveries in New Jersey.

In Mr. Peabody's letter of gift to the gentlemen he appointed as Trustees of the Museum of American Archaeology and Ethnology, which he then founded, under date of Oct. 8, 1866, are the following words: "In the event of the discovery in America of

human remains or implements of an earlier geological period than the present, especial attention be given to their study, and their comparison with those found in other countries." This request of Mr. Peabody makes it incumbent on the Trustees of the Museum to do what they can in aid of such explorations as those conducted by Dr. Abbott, and on my calling the attention of the Board of Trustees to the importance of his investigations, appropriations were at once granted to enable him to continue his work in connection with the Peabody Museum. The results of this work have been presented to-night, and they have certainly shown that palaeolithic man lived on the Atlantic coast of America at a time so remote that the implements which he made were now found buried in the same glacial gravel and reassorted river drift which contained the remains of the bison and the mastodon, and under conditions corresponding with those under which implements of the same character had been buried in the gravels of the river valleys of Europe.

Dr. Abbott, with proper scientific caution, has not mentioned the discovery of a peculiar human skull under such reported conditions as would, if true, show it to be contemporaneous with the stone implements of the gravel. Still as the skull was not secured by Dr. Abbott until some time after it was said to have been dug out of the gravel several feet below the surface, its consideration must be deferred until further evidence is obtained of human bones in the Trenton gravel.

As Dr. Abbott has stated, in his historical summary of the discovery of the implements in the gravel, it has been my good fortune to take, with my own hands, five unquestionable palaeolithic implements from the gravel at various depths and at different points. The relation of the circumstances under which one of these (now on the table) was found will be sufficient to convince you that the implement was in the position where it was buried by the four feet of gravel which had been deposited over it.

A short distance from Dr. Abbott's house and very near where the Trenton gravel joins the marine gravel, there is a deep gully through which flows a small brook. In this gully the gravel bank is constantly washing away and presenting new surface exposures.

After a heavy rain in June, 1879, I visited the spot with Dr. Abbott and his son. Here I noticed a small boulder of about six or eight inches in diameter, projecting an inch or two from the face of the bank about four feet from the surface of the soil above; I worked the stone from the gravel in which it was firmly imbedded and drew it out. At the back part of the cavity thus made I noticed the pointed end of a stone and after working it up and down a few times, so as to loosen the gravel about it, I drew out the implement now exhibited.

On the same day I discovered a second specimen in place eight feet from the surface, and Dr. Abbott's son Richard found another about four feet from the surface. These three specimens were found within twenty or thirty feet of each other, after a heavy shower had made the most favorable conditions for their discovery. A long continued search on several following days, at various places along the gravel bluff, failed of success in finding other specimens in place, although several were obtained from the talus. This shows how seldom the implements are likely to be found, and it may be from this cause that some unsuccessful hunters have doubted the occurrence of the implements in the gravel. Certainly the evidence that has been brought forward to-night will clear away all doubts as to the importance and reliability of Dr. Abbott's discoveries and investigations, which have proved the former existence of palaeolithic man in the valley of the Delaware.







